APPENDIX B4

DESCRIPTIONS FOR ASSESSED WETLANDS BETWEEN LOCK 4 AND LOCK 5

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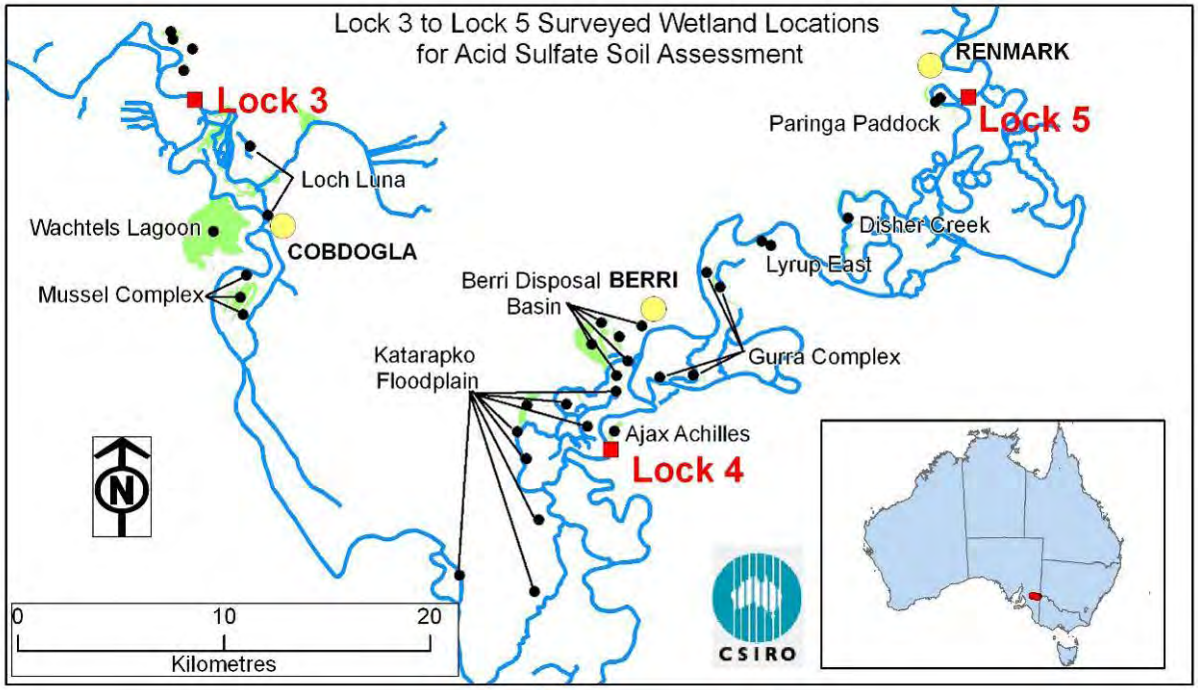
MAP SHOWING LOCATION OF WETLANDS BETWEEN LOCK 3 AND LOCK 5



1. AJAX ACHILLES (WETLAND ID. 12298)

1.1. Location and setting description

Ajax Achilles (Wetland ID. 12298) is situated on the eastern side of the River Murray, adjacent to and slightly up river from Lock 4. The wetland is irregular in shape formed by two sections that are joined in the middle and the wetland occurs on the inside of a tight bend in the river. It is about 1.5 kilometres in length and about 200 metres at it's widest, with a total surface area of 22 hectares. The wetland is bounded by a raised floodplain that separates it from the river to the west and a steep hill slope to the east.

The wetland is permanently connected to the river by an inlet at the northern end and another at the southern end. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is not managed. Typha and Phragmites were growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Nine sites were sampled as shown in Figure 1-1.

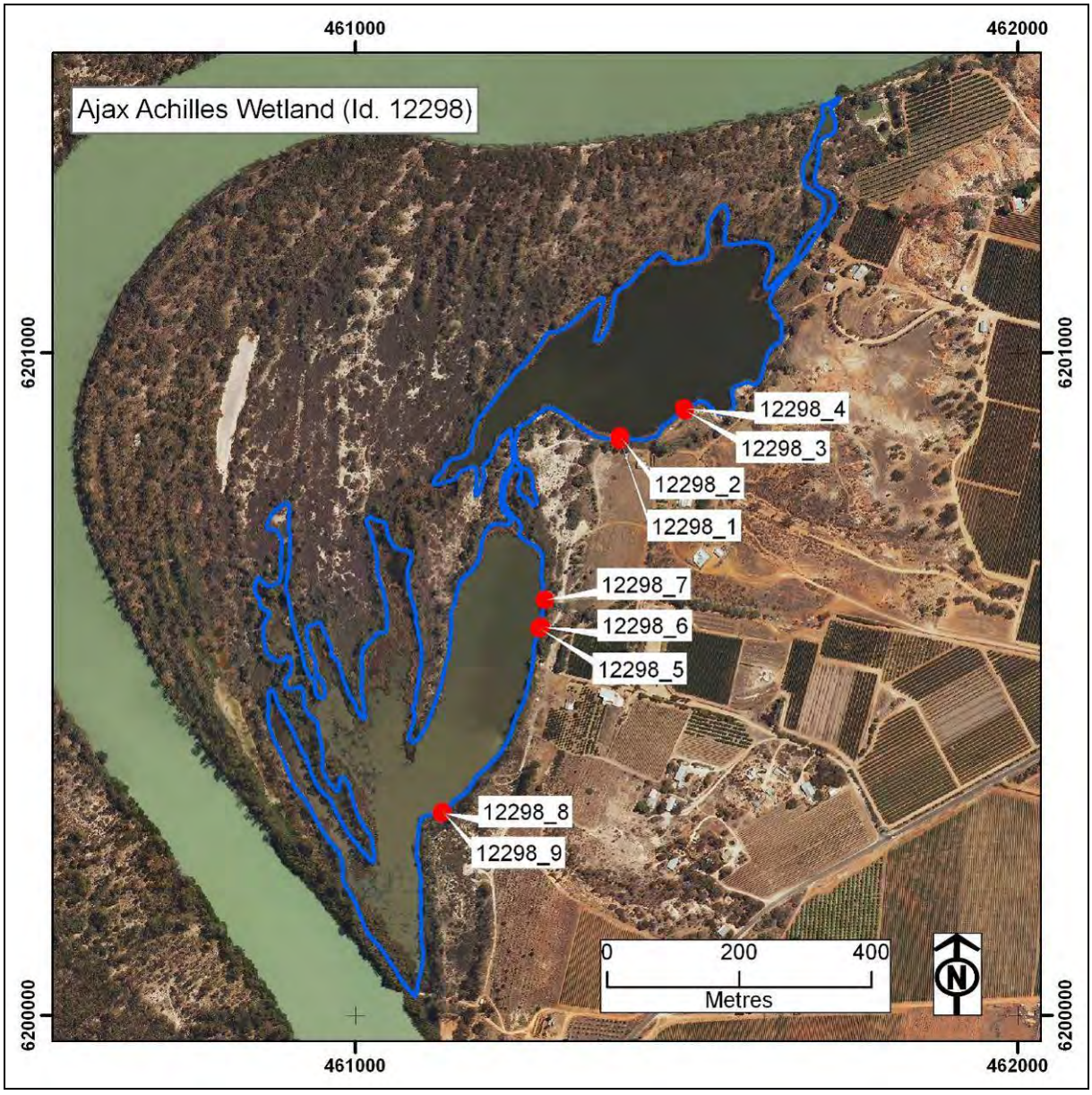


Figure 1-1. Ajax Achilles (Wetland ID. 12298) and sample site locations.

1.2. Soil profile description and distribution

Nine sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 1-1. Sites were distributed as pairs around the wetland, with sites in both the northern lagoon (Sites 1, 2, 3 and 4), and southern lagoon (Sites 5, 6, 7, 8 and 9) 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 transects

Site 1 (Figure 1-3) occurred adjacent to the bank amongst thick reeds in water (40 cm deep), and the soil consisted of a dark greyish brown, very weak, sand. Site 2 (Figure 1-4) occurred in open water (110 cm deep), and the soil consisted of a dark greyish brown, loose, sand. Site 3 (Figure 1-5) occurred amongst reeds in water (50 cm deep), and the soil consisted of a dark greyish brown, very weak sand. Site 4 (Figure 1-6) occurred in open water (110 cm deep), and the soil consisted of a dark grey, very weak, sand.

Southern transects

Site 5 (Figure 1-7) occurred adjacent to the bank amongst thick reeds in water (90 cm deep), and the soil consisted of a dark grey, weak, peat with sulfurous odour over dark grey, very firm, clay. Site 6 (Figure 1-8) occurred in open water (120 cm deep), and the soil consisted of a dark grey, weak, clay loam with sulfurous odour, over a dark grey, very firm, clay. Site 7 occurred in open water where a water sample was collected, the site is similar to Site 6 and no soil sample was collected. Site 8 (Figure 1-9) occurred adjacent to the bank amongst reeds in water (60 cm deep), and the soil consisted of a yellowish brown, weak, peat, over a dark grey, very firm, clay. Site 9 (Figure 1-10) occurred in open water (120 cm deep), and the soil consisted of a dark grey, weak, peaty clay loam, over a very dark grey, very firm, clay.

Table 1-1. Soil identification, subtype and general location description for Ajax Achilles (Wetland ID. 12298).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12298_1	461400	6200868	Hypersulfidic Subaqueous Soil (sandy)	mid to high elevation, near wetland margin
12298_2	461400	6200874	Hypersulfidic Subaqueous Soil (sandy)	mid elevation, wetland margin in reeds
12298_3	461499	6200913	Hypersulfidic Subaqueous Soil (sandy)	low elevation, edge of reeds to open water
12298_4	461497	6200916	Subaqueous Soil (sandy)	low elevation, open water
12298_5	461279	6200584	Subaqueous Soil (clayey)	mid elevation, wetland margin in reeds
12298_6	461281	6200586	Subaqueous Soil (clayey)	low elevation, edge of reeds to open water
12298_7	461287	6200627	Subaqueous Soil (clayey)	low elevation, out from boat ramp, water sample only collected, site adjacent to Site 6.
12298_8	461131	6200305	Hypersulfidic Subaqueous Soil (clayey)	mid elevation, wetland margin in reeds
12298_9	461132	6200307	Subaqueous Soil (clayey)	low elevation, edge of reeds to open water

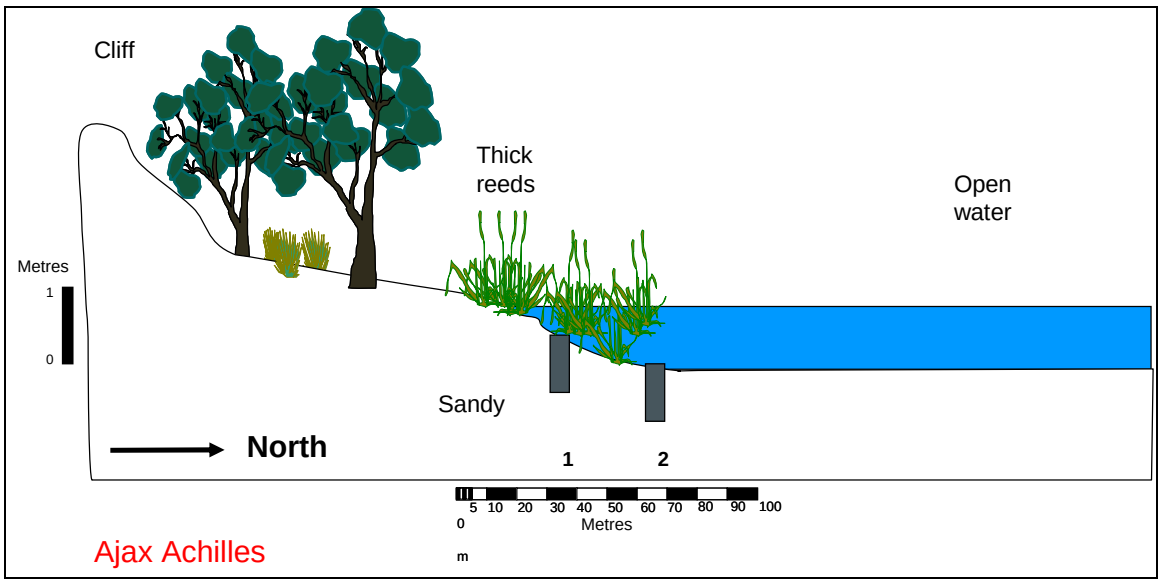


Figure 1-2. Conceptual cross-section diagram, showing locations of Sites 1 and 2.

Figure 1-3. Photograph of Site 1, showing the site location in water amongst thick reeds.

Figure 1-4. Photograph of Site 2, showing the site location on the edge of the reeds into open water.

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

Figure 1-6. Photograph of Site 4, showing the site location at the edge of reeds to open water.

Figure 1-7. Photograph of Site 5, showing the site location adjacent to the bank in water and before a line of reeds to open water.

Figure 1-8. Photograph of Site 6, showing the site location in open water adjacent to reeds.

Figure 1-9. Photograph of Site 8, showing the site location adjacent to the bank in water and thick reeds.

Figure 1-10. Photograph of Site 9, showing the site location in open water and a view of the wetland.

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 1-11. The pH_W data ranged from 4.63 to 8.69 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.41 to 8.88 and identified that surface layers in 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 3.31 to 8.03 and identified that surface samples in Profiles 1, 2, 3 and 8 on incubation declined below the critical values of pH <4, indicating that these soils potentially would form sulfuric material on oxidation.

1.3.2. Acid base accounting

The acid base accounting data is provided in Table 1-4 and summarised in Figure 1-12.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.03 to 1.16 $\%S_{CR}$ and sulfidic materials were detected in all samples for all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 29.85 mole H^+/tonne and were detected in samples from at least one layer in Profiles 1, 2, 5, 6, 8 and 9.

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 3.81 $\%CaCO_3$ and were measured in samples from at least one layer in all profiles (except Profile 1).

Net acidity

Net acidity values ranged from -460 to 747 mole H^+/tonne. All profiles had moderate or high net acidity values and they tended to decline in value with depth and in some profiles they were negative.

1.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 1-4 identified Profiles 1, 3, 4, 6, 8 and 9 had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

1.3.4. Acid volatile sulfur

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

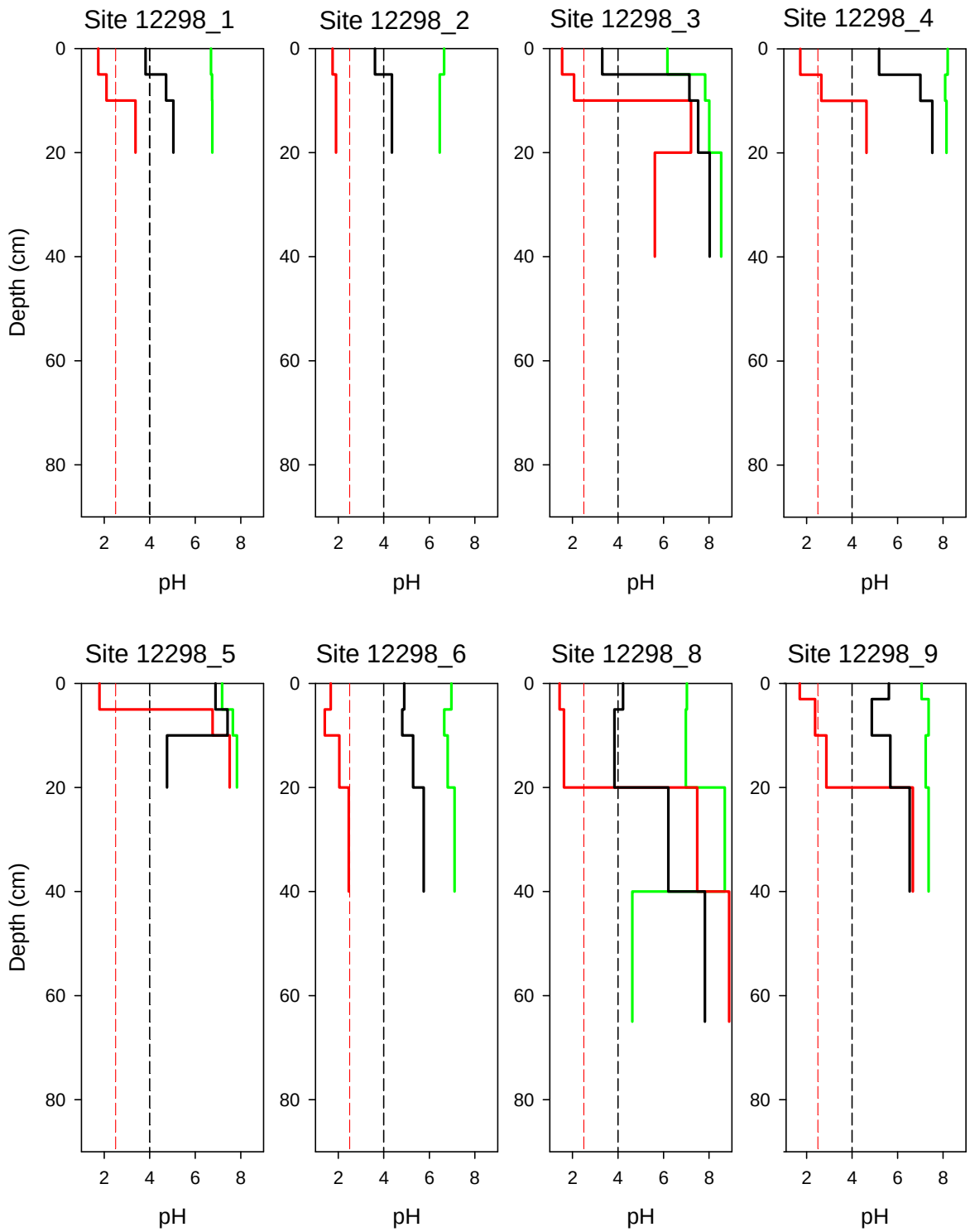


Figure 1-11. Depth profiles of soil pH for Ajax Achilles (Wetland ID. 12298), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

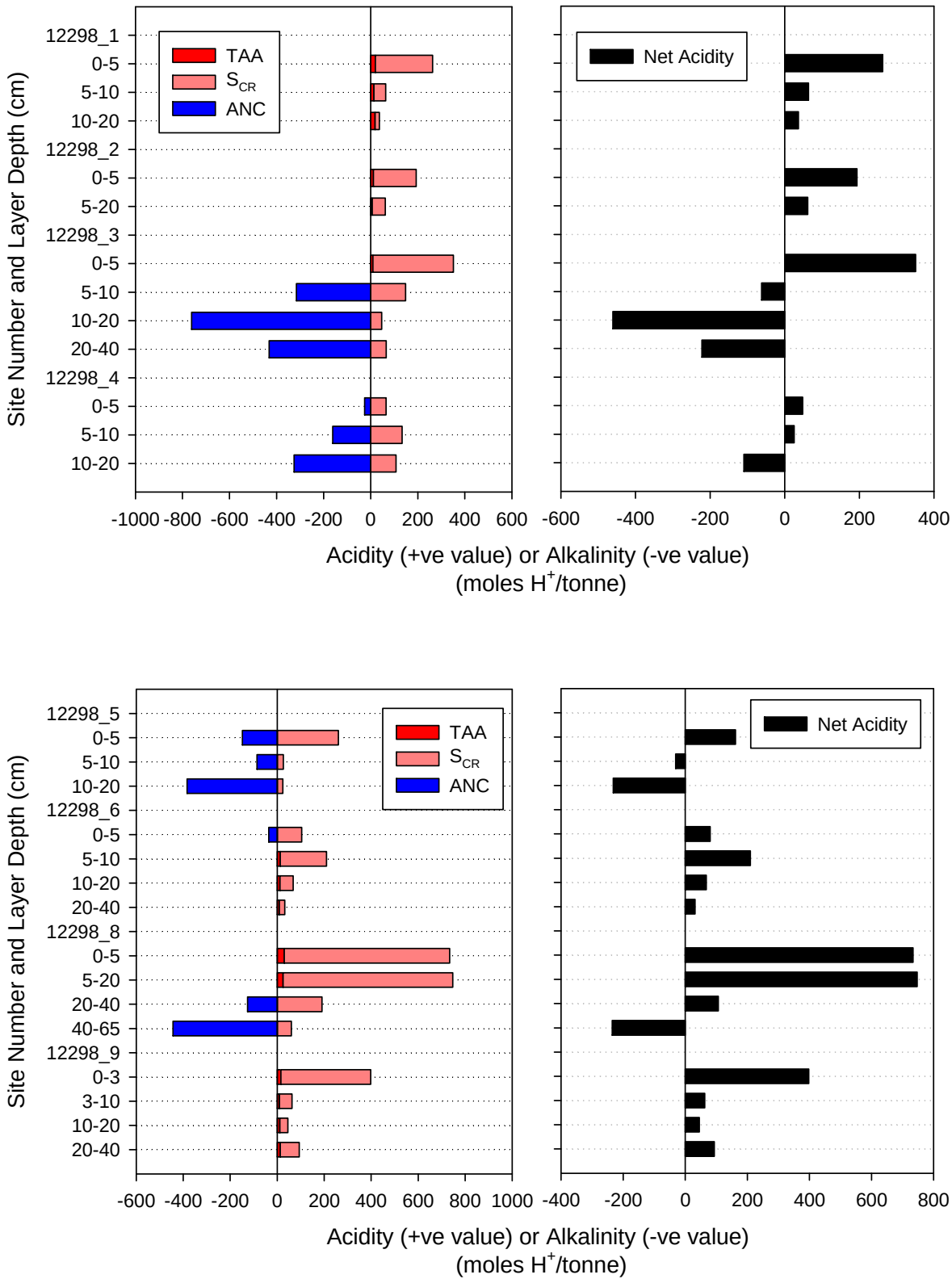


Figure 1-12. Acid base accounting depth profiles for Ajax Achilles (Wetland ID. 12298). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

1.3.5. Hydrochemistry

Two surface water samples were collected from the wetland and no groundwater samples as none of the marginal areas were dry. Field parameters are shown in Table 1-5. The surface waters had slightly alkaline pH and were fresh. Dissolved oxygen was moderately high and the waters were moderately turbid. Alkalinity was similar to the range expected for the river along this section of the catchment.

The surface waters were of Na-Cl type (Table 1-6, Figure 1-13). Sulfate concentrations in the surface waters were between 12 and 16 mg l^{-1}. The SO_4/Cl ratio in the surface waters (0.10 to 0.11) were slightly lower than seawater (0.142). For the nutrients, PO_4 and NH_4 concentrations were slightly above ANZECC Guideline values. Trace metal concentrations were typically low with slightly elevated Zn and Al.

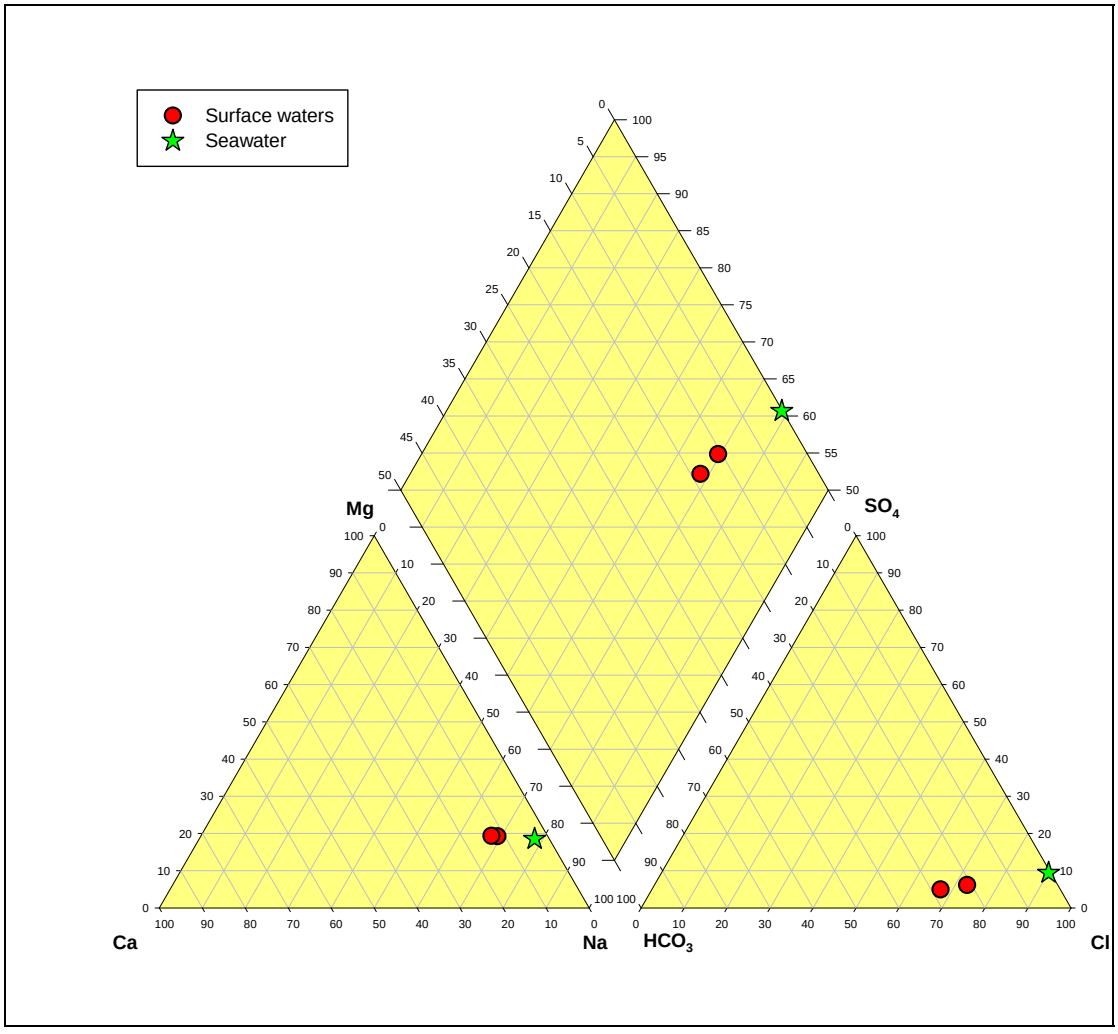


Figure 1-13. Piper diagram of hydrochemical data for Ajax Achilles (Wetland ID. 12298).

1.4. Discussion

Acid sulfate soil materials at Ajax Achilles (Wetland ID. 12298) were identified as hypersulfidic for the surface layers of Profiles 1, 2, 3 and 8, the remaining samples were characterised as hyposulfidic. The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (clayey or sandy) that tended to occur on the wetland margins where the site was in reeds, and Subaqueous Soil (clayey or sandy) that occurred throughout the wetland.

The soils throughout the north lagoon of the wetland were dominantly sandy textured and in the south lagoon the surface soils were dominantly loamy over clay subsoils.

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

The potential hazards posed by acid sulfate soil materials at Ajax Achilles (Wetland ID. 12298) are:

- Acidification hazard: The data identified moderate or high net acidity values in the surface layers for all profiles 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 potential for monosulfidic materials to form in the surface layers of some soils, although monosulfidic material was not observed at any of these submerged sites. There is a low to medium level of concern.
- Metal mobilisation: The high acidification hazard indicates that the soil acidification potential may increase the solubility of metals. There is a high level of concern.

Summary of key findings Ajax Achilles (Wetland ID. 12298):

Soil materials:	The soil layers throughout the wetland were hypersulfidic or hyposulfidic. Soils were sandy textured throughout in the north lagoon and loamy textured at the surface and clayey textured in the subsoil in the south lagoon. All profiles had a moderate or high net acidity value for the surface samples that tended to decline in value with depth and negative in some areas in the subsoil layers, and pH data indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Hypersulfidic Subaqueous Soil (clayey or loamy) – occurring where there was reeds growing and in open water. Sub - dominant (<50%) in extent. • Subaqueous Soil (clayey or loamy) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – high level of concern • De-oxygenation hazard – low to medium level of concern • Metal mobilisation hazard – high level of concern

Table 1-2. Site description data for Ajax Achilles (Wetland ID. 12298).

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	13/04/2010	461400	6200868	40	water, plant material	water, Typha	mid to high elevation, near wetland margin
2	13/04/2010	461400	6200874	110	water	water, Typha	mid elevation, wetland margin in reeds
3	13/04/2010	461499	6200913	50	water	water, Typha	low elevation, edge of reeds to open water
4	13/04/2010	461497	6200916	110	water	water	low elevation, open water
5	13/04/2010	461279	6200584	90	water	water, Typha	mid elevation, wetland margin in reeds
6	13/04/2010	461281	6200586	120	water	water	low elevation, edge of reeds to open water
7	13/04/2010	461287	6200627	120	water	water	low elevation, out from boat ramp
8	13/04/2010	461131	6200305	60	water	water, Phragmites	mid elevation, wetland margin in reeds
9	13/04/2010	461132	6200307	120	water	water	low elevation, edge of reeds to open water

Table 1-3. Soil profile description data for Ajax Achilles (Wetland ID. 12298).

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 greyish brown (2.5Y4/3)	plant material	wet		massive	very weak	plant root material
1_2	5 - 10	small pit	dark grey (10YR4/1)	sand	wet		massive	very weak	
1_3	10 - 20	push tube	light olive brown (2.5Y5/4)	sand	wet		massive	very weak	too sandy to auger below
2_1	0 - 5	small pit	dark greyish brown (2.5Y4/2)	sandy peat	wet		single grain	loose	strong sulfurous odour, many plant roots
2_2	5 - 20	small pit	dark greyish brown (2.5Y4/2)	sand	wet		single grain	loose	
3_1	0 - 5	small pit	dark greyish brown (2.5Y4/2)	peat	wet		massive	weak	strong sulfurous odour
3_2	5 - 10	small pit	dark greyish brown (2.5Y4/2)	sand	wet		single grain	very weak	
3_3	10 - 20	small pit	greyish brown (2.5Y5/3)	sand	wet		single grain	very weak	white specs of shells
3_4	20 - 40	push tube	dark grey (2.5Y4/0)	sand	wet		massive	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
4_W1	110 - 0	surface water							water sampled
4_1	0 - 5	small pit	dark olive grey (5Y3/2)	loamy sand	wet		single grain	very weak	sulfurous odour
4_2	5 - 10	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	
4_3	10 - 20	small pit	dark grey (5Y4/1)	sand	wet		massive	very weak	
5_W	90 - 0	water							
5_1	0 - 5	small pit	dark grey (5Y4/1)	peat	wet		massive	weak	sulfurous odour
5_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
5_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	2% carbonate segregations, too clayey to auger below
6_W	120 - 0	water							
6_1	0 - 5	small pit	very dark grey (5Y3/1)	clay loam	wet		massive	very weak	sulfurous odour
6_2	5 - 10	small pit	dark grey (5Y4/1)	clay loam	wet		massive	weak	sulfurous odour
6_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	firm	few carbonate segregations
6_4	20 - 40	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	
7_W1	120 - 0	surface water							water sampled, only measurement at this site
8_W	60 - 0	water							
8_1	0 - 5	small pit	yellowish brown (10YR5/4)	peat	wet		massive	weak	
8_2	5 - 20	small pit	yellowish brown (10YR5/4)	peat	wet		massive	weak	
8_3	20 - 40	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
8_4	40 - 65	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	too clayey to auger below
9_1	0 - 3	small pit	dark grey (10YR4/1)	peaty clay loam	wet		massive	weak	
9_2	3 - 10	small pit	dark grey (5Y4/1)	clay loam	wet		massive	very firm	
9_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
9_4	20 - 40	push tube	very dark grey (2.5Y3/0)	clay	moist		massive	very firm	
1_W	15 - 0	water							

Table 1-4. Laboratory data for acid sulfate soil assessment of Ajax Achilles (Wetland ID. 12298).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	129	6.69	1.74	6.54	3.82	190	5.70	19.60	0.39	..	..	263	hypersulfidic
1.2	5-10	Fine	128	6.74	2.10	6.41	4.72	37	5.31	13.87	0.08	..	..	64	hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	97	6.75	3.38	6.66	5.04	58	5.24	18.17	0.03	..	..	37	hyposulfidic (S_{CR}<0.10%)
2.1	0-5	Medium	148	6.65	1.75	6.39	3.61	68	6.00	11.48	0.29	..	0.00	193	hypersulfidic
2.2	5-20	Medium	130	6.46	1.90	6.30	4.36	39	6.02	6.69	0.09	..	0.00	62	hyposulfidic (S_{CR}<0.10%)
3.1	0-5	Medium	237	6.17	1.55	7.12	3.31	500	6.19	9.08	0.55	..	0.00	351	hypersulfidic
3.2	5-10	Medium	227	7.83	2.07	7.08	7.14	110	8.43	0.00	0.24	..	1.58	-62	hyposulfidic (S_{CR}≥0.10%)
3.3	10-20	Coarse	246	8.01	7.21	7.37	7.52	49	9.01	0.00	0.08	..	3.81	-460	hyposulfidic (S_{CR}<0.10%)
3.4	20-40	Medium	523	8.53	5.62	7.65	8.03	73	8.36	0.00	0.11	..	2.16	-222	hyposulfidic (S_{CR}≥0.10%)
4.W1	110-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
4.1	0-5	Medium	129	8.20	1.72	7.03	5.19	59	7.12	0.00	0.10	..	0.13	48	hyposulfidic (S_{CR}≥0.10%)
4.2	5-10	Medium	159	8.09	2.65	7.12	7.00	160	8.16	0.00	0.21	..	0.81	25	hyposulfidic (S_{CR}≥0.10%)
4.3	10-20	Medium	249	8.15	4.63	7.29	7.52	66	8.00	0.00	0.17	..	1.63	-110	hyposulfidic (S_{CR}≥0.10%)
5.1	0-5	Medium	123	7.18	1.79	6.76	6.89	87	6.63	0.00	0.42	..	0.74	162	hyposulfidic (S_{CR}≥0.10%)
5.2	5-10	Fine	76	7.65	6.76	6.90	7.42	45	6.61	0.00	0.04	..	0.43	-31	hyposulfidic (S_{CR}<0.10%)
5.3	10-20	Fine	182	7.83	7.51	7.04	4.76	33	7.99	0.00	0.04	..	1.92	-232	hyposulfidic (S_{CR}<0.10%)
6.1	0-5	Medium	96	6.97	1.67	6.67	4.90	97	6.86	0.00	0.17	..	0.18	80	hyposulfidic (S_{CR}≥0.10%)
6.2	5-10	Medium	73	6.66	1.41	6.61	4.81	160	6.15	12.72	0.32	..	0.00	210	hyposulfidic (S_{CR}≥0.10%)
6.3	10-20	Fine	51	6.81	2.05	6.59	5.29	61	5.65	11.74	0.09	..	..	68	hyposulfidic (S_{CR}<0.10%)
6.4	20-40	Fine	69	7.11	2.46	6.60	5.75	30	5.96	8.81	0.04	..	..	32	hyposulfidic (S_{CR}<0.10%)
7.W1	120-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
8.1	0-5	Medium	145	7.03	1.43	6.92	4.22	310	5.41	29.85	1.13	..	..	734	hyposulfidic (S_{CR}≥0.10%)
8.2	5-20	Medium	132	6.98	1.63	6.64	3.84	480	5.59	25.45	1.16	..	..	747	hypersulfidic
8.3	20-40	Fine	121	8.69	7.48	6.51	6.21	91	6.65	0.00	0.31	..	0.63	107	hyposulfidic (S_{CR}≥0.10%)
8.4	40-65	Fine	123	4.63	8.88	7.77	7.82	33	7.78	0.00	0.10	..	2.22	-235	hyposulfidic (S_{CR}<0.10%)
9.1	0-3	Medium	107	7.05	1.70	6.53	5.62	230	5.98	16.15	0.61	..	..	398	hyposulfidic (S_{CR}≥0.10%)
9.2	3-10	Fine	82	7.36	2.38	6.34	4.87	55	5.94	9.30	0.09	..	..	63	hyposulfidic (S_{CR}<0.10%)
9.3	10-20	Fine	75	7.23	2.87	6.53	5.68	53	5.74	11.26	0.05	..	..	45	hyposulfidic (S_{CR}<0.10%)
9.4	20-40	Fine	154	7.36	6.67	6.62	6.53	32	5.63	13.21	0.13	..	..	94	hyposulfidic (S_{CR}≥0.10%)

Table 1-5. Summary of hydrochemical field measurements for Ajax Achilles (Wetland ID. 12298).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=2)	7.36-7.98	546-622	10.7-14.3	-34 - -20	39-60	69-85

Table 1-6. Summary of hydrochemical field measurements for Ajax Achilles (Wetland ID. 12298).

Parameter	units	ANZECC Guidelines	Site 4 (SW)	Site 7 (SW)
Na	mg l^{-1}		81.6	67.4
K	mg l^{-1}		5.2	4.3
Ca	mg l^{-1}		12.5	11.8
Mg	mg l^{-1}		12.5	10.6
Si	mg l^{-1}		2.99	2.94
Br	mg l^{-1}		0.3	0.3
Cl	mg l^{-1}		140	120
NO_3	mg l^{-1}	0.7	<0.022	<0.022
NH_4-N[K]	mg l^{-1}	0.01	**0.02**	**0.011**
PO_4-P[E]	mg l^{-1}	0.005	**0.050**	**0.048**
SO_4	mg l^{-1}		16	12
Ag	µg l^{-1}	0.05	<0.01	<0.01
Al[A]	µg l^{-1}	55	**92**	48
As[B]	µg l^{-1}	13	0.9	0.9
Cd	µg l^{-1}	0.2	0.02	0.01
Co	µg l^{-1}	2.8	0.07	0.04
Cr[C]	µg l^{-1}	1	0.1	<0.1
Cu[H]	µg l^{-1}	1.4	1	0.8
Fe	µg l^{-1}	300	<100	<100
Mn	µg l^{-1}	1700	9.36	5.18
Ni[H]	µg l^{-1}	11	0.7	0.4
Pb[H]	µg l^{-1}	3.4	0.1	0.12
Se	µg l^{-1}	11	<0.06	<0.06
Zn[H]	µg l^{-1}	8	**71.5**	**52**
DOC	mg l^{-1}		8.8	8.2

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

2. BERRI DISPOSAL BASIN (WETLAND ID. 12092)

2.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12092) is situated on the north-western side of the River Murray, about 3 kilometres down river from the town of Berri. The wetland is a creek that is sinuous in shape and is one of many wetlands in the complex. It is about 2.5 kilometres in length and about 10 metres at its widest, with a total surface area of 2 hectare. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12101, 12095, 12104, 12102, and 12103.

The wetland is connected to the river at the eastern end. At the time when the soil survey was conducted in March 2010 the wetland did not have surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Lignum and sedges were growing on the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 2-1.

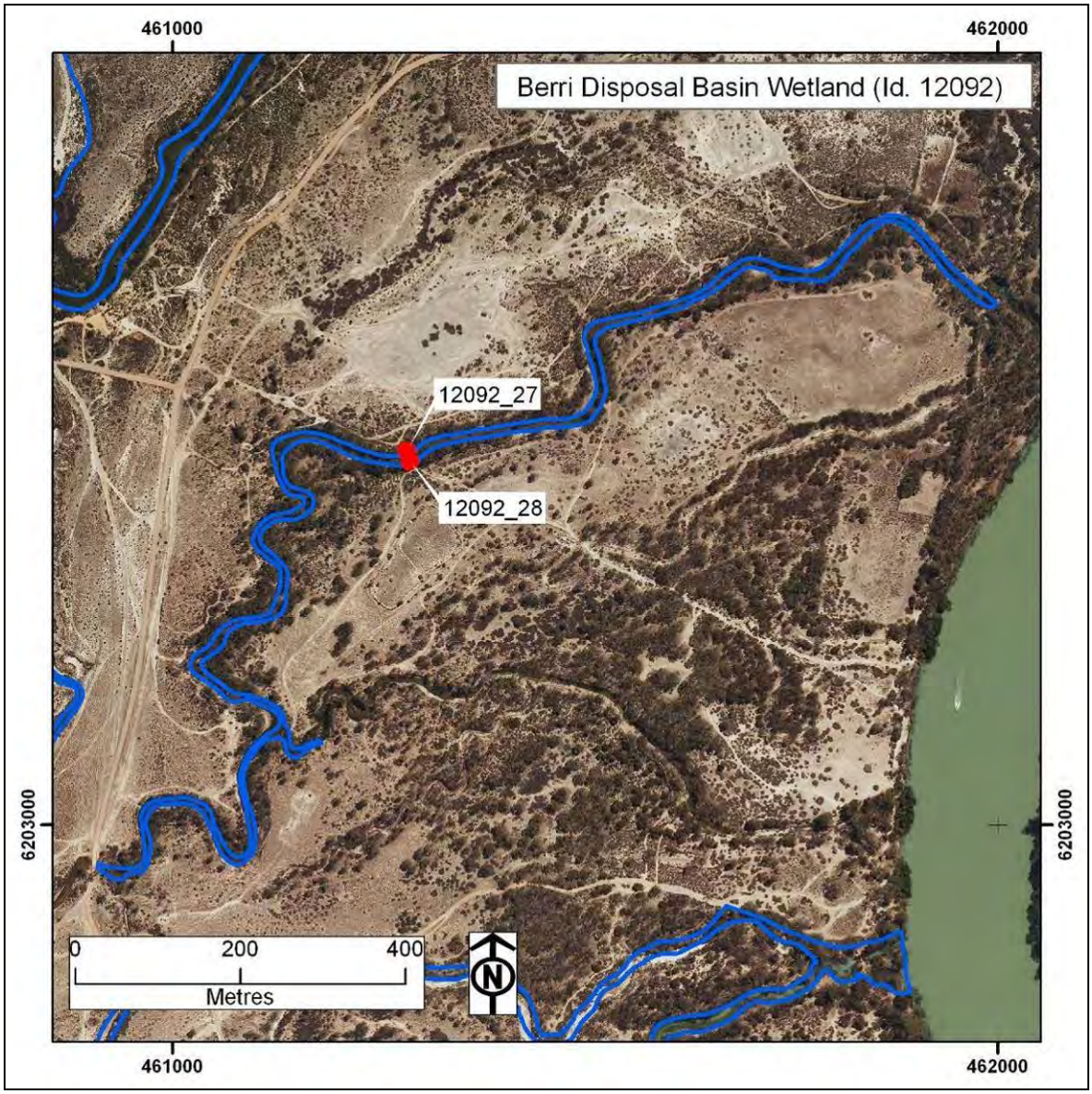


Figure 2-1. Berri Disposal Basin (Wetland ID. 12092) and sample site locations.

2.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 2-1. Sites were placed as a pair with one site near the bank and the other near the centre 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.

Site 27 (Figure 2-3) occurred at a low point in the wetland amongst lignum, and the soil consisted of a grey, very firm, blocky structured, clay. Site 28 (Figure 2-4) occurred at high elevation where lignum was growing, and the soil consisted of brown, very firm to rigid, blocky structured, clay.

Table 2-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12092).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12092_27	461284	6203453	Other Soil (clayey)	low elevation in channel
12092_28	461288	6203440	Other Soil (clayey)	high elevation in channel

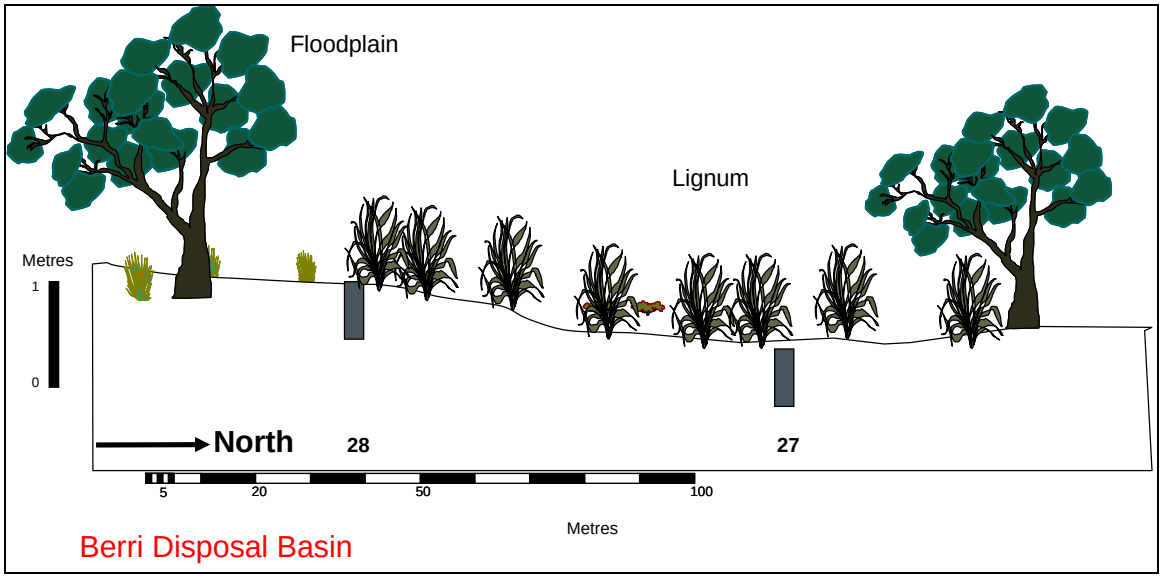


Figure 2-2. Conceptual cross-section diagram, showing locations for Sites 27 and 28.

Figure 2-3. Photographs of Site 27, showing the site location at a low elevation amongst lignum, and the soil profile.

Figure 2-4. Photographs of Site 28, showing the site location at higher elevation in an open area where lignum grows, and the soil profile.

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 2-5. The pH_W data ranged from 5.35 to 6.39 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 3.53 to 4.63 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 5.51 to 7.59 and identified that no samples on incubation declined below the critical values of pH <4.

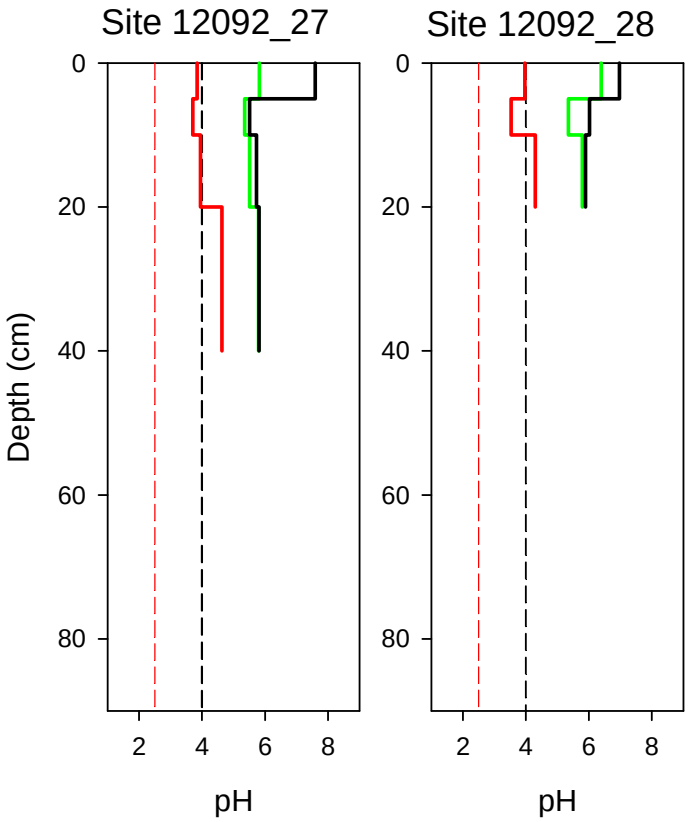


Figure 2-5. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12092), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} 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 2-6.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.04 $\%S_{CR}$ and sulfidic materials were detected in Profile 28 samples but not in samples from Profile 27.

Titratable actual acidity

Titratable actual acidity values ranged from 0 to 14.30 mole H^+/tonne and were measured in nearly all 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 0.00 to 0.40 $\%CaCO_3$ and were measured in the surface layers.

Net acidity

Net acidity values ranged from -35 to 32 mole H^+/tonne. Low or moderate net acidity values were recorded in both Profiles and a negative value for the surface layer of Profile 27.

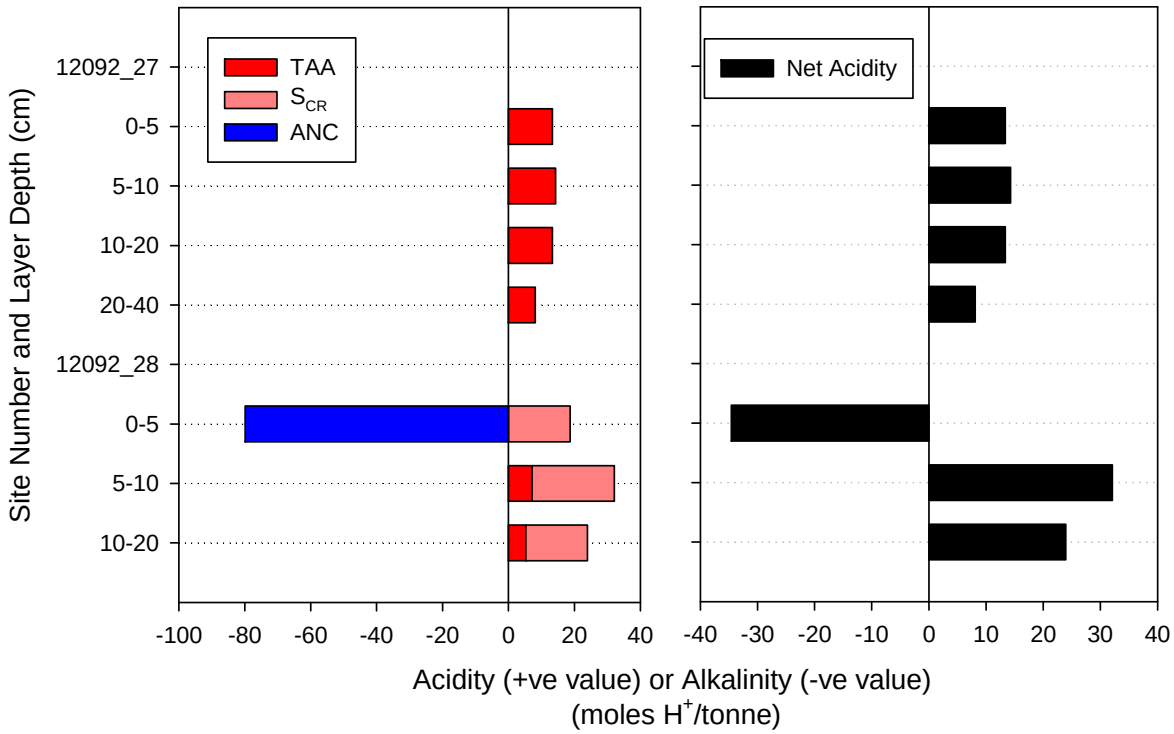


Figure 2-6. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12092). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

2.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 2-4 identified that surface layers of Profile 28 was above the criterion trigger value of 100 mg/kg SO_4.

2.3.4. Acid volatile sulfur

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

2.3.5. Hydrochemistry

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

2.4. Discussion

Acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12092) were identified as hyposulfidic in Profile 28 and in Profile 27 as other soil material or other acidic. The acid sulfate soil subtype class identified was Other Soil (clayey).

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

Monosulfidic material was not observed but the water soluble sulfate data identified that surface layers for Profile 28 was in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12092) are:

- Acidification hazard: The data identified low or moderate net acidity values generally for samples of both profiles, and the 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 Profile 28, however monosulfidic material was not observed. There is a low to 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 Berri Disposal Basin (Wetland ID. 12092):

Soil materials:	The soil layers throughout the wetland were hyposulfidic or other soil materials. Soils were clayey textured in the surface and subsoil layers. Both profiles had a low or moderate net acidity values and pH data did not indicate acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (clayey) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low to medium level of concern • De-oxygenation hazard – low to medium level of concern • Metal mobilisation hazard – low level of concern

Table 2-2. Site description data for Berri Disposal Basin (Wetland ID. 12092).

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
27	30/03/2010	461284	6203453	not reached	clay	lignum	low elevation in channel
28	30/03/2010	461288	6203440	not reached	clay	lignum	high elevation in channel

Table 2-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12092).

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
27_1	0 - 5	small pit	grey (10YR6/1)	clay	dry		subangular blocky	very firm	few carbonate fragments
27_2	5 - 10	small pit	grey (10YR5/1)	clay	dry		subangular blocky	very firm	few carbonate fragments, plant roots
27_3	10 - 20	small pit	grey (10YR5/1)	clay	dry		subangular blocky	very firm	few carbonate fragments, plant roots
27_4	20 - 40	small pit	dark grey (10YR4/1)	clay	dry		subangular blocky	very firm	plant roots
28_1	0 - 5	small pit	brown (10YR5/3)	clay	dry		angular blocky	very firm	
28_2	5 - 10	small pit	brown (10YR5/3)	clay	dry	15% reddish brown infused into the matrix along faces of peds	angular blocky	rigid	contains specs of gypsum
28_3	10 - 20	small pit	brown (10YR5/3)	clay	dry	15% reddish brown infused into the matrix along faces of peds	angular blocky	rigid	contains specs of gypsum, too hared to auger below

Table 2-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12092).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
27.1	0-5	Medium	1,417	5.82	3.84	6.87	7.59	12	6.22	13.35	<0.01	..	0.00	13	other soil material
27.2	5-10	Medium	2,250	5.35	3.71	5.17	5.51	12	5.54	14.30	<0.01	..	..	14	other acidic
27.3	10-20	Medium	2,470	5.51	3.95	5.41	5.73	36	5.72	13.35	<0.01	..	..	13	other acidic
27.4	20-40	Medium	3,390	5.79	4.63	5.56	5.81	64	5.94	8.10	<0.01	..	..	8	other soil material
28.1	0-5	Medium	1,850	6.39	3.97	6.90	6.97	210	6.60	0.00	0.03	..	0.40	-35	hyposulfidic (S_{CR}<0.10%)
28.2	5-10	Medium	2,710	5.35	3.53	6.09	6.02	160	5.98	7.15	0.04	..	..	32	hyposulfidic (S_{CR}<0.10%)
28.3	10-20	Medium	2,730	5.79	4.30	5.63	5.89	93	6.01	5.24	0.03	..	0.00	24	hyposulfidic (S_{CR}<0.10%)

3. BERRI DISPOSAL BASIN (WETLAND ID. 12095)

3.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12095) is situated on the north-western side of the River Murray, about 2 kilometres down river from the town of Berri. The wetland is a creek that is sinuous in shape and is one of many wetlands in the complex. It is about 800 metres in length and about 10 metres at its widest, with a total surface area of 2 hectare. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12101, 12092, 12104, 12102, and 12103.

The wetland is connected to the river at the eastern end. At the time when the soil survey was conducted in March 2010 the wetland had surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Sedges were growing in the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 3-1.

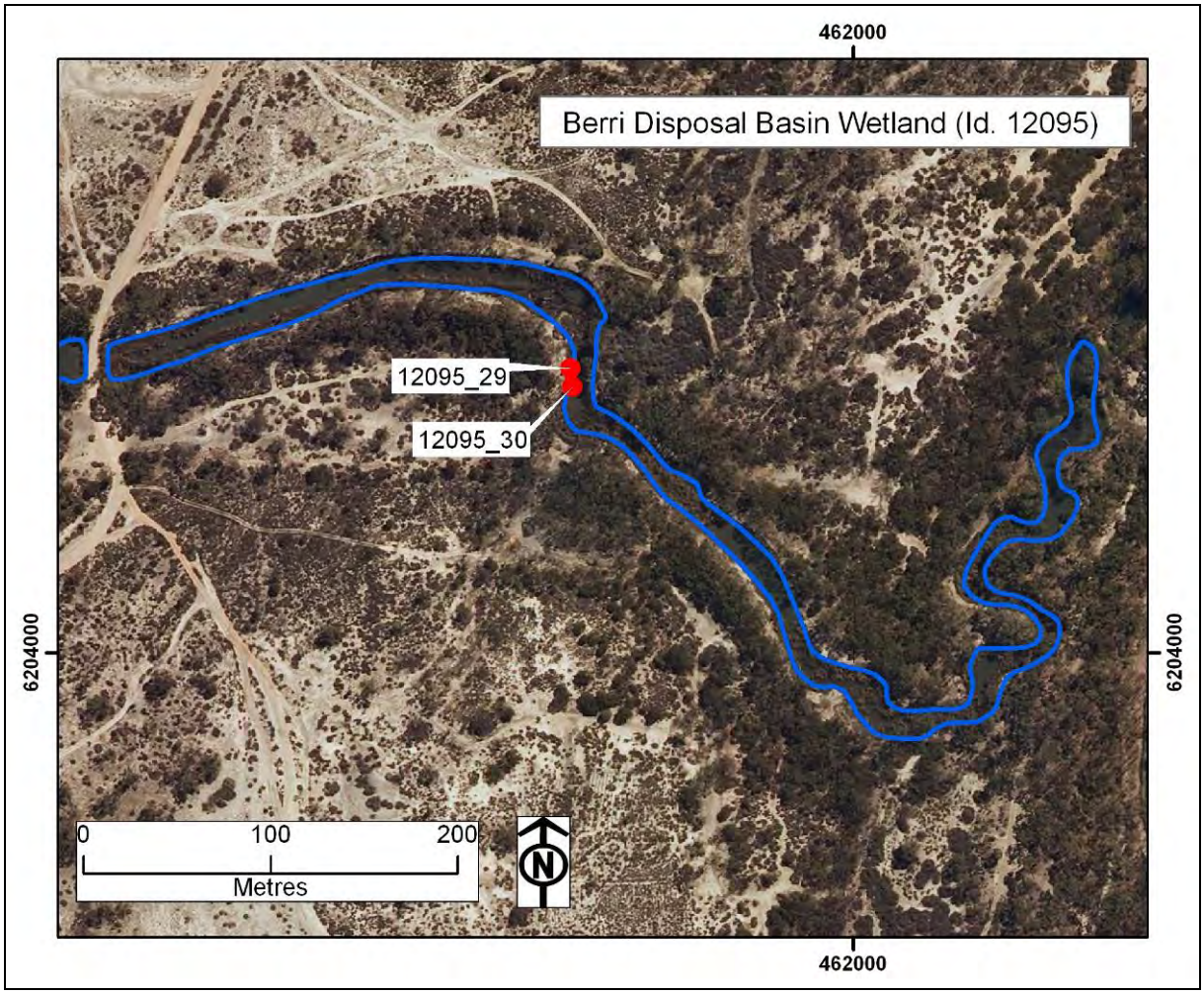


Figure 3-1. Berri Disposal Basin (Wetland ID. 12095) and sample site locations.

3.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 3-1. Sites were placed as a pair with one site near the bank and the other in open water 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.

Site 29 (Figure 3-3) occurred at the side of the creek amongst reeds in water (50 cm deep), and the soil consisted of a very dark greyish brown, very weak, mucky loam sand, over a light brownish grey, very firm, sandy clay loam. Site 30 (Figure 3-4) occurred in the creek amongst Typha and in water (70 cm deep), and the soil consisted of a greyish brown, very weak, mucky loamy sand, over a greyish brown, very weak, loamy sand with a sulfurous odour.

Table 3-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12095).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12095_29	461849	6204152	Hypersulfidic Subaqueous Soil (loamy)	side of creek, amongst reeds
12095_30	461850	6204142	Hypersulfidic Subaqueous Soil (sandy)	middle of creek, amongst reeds

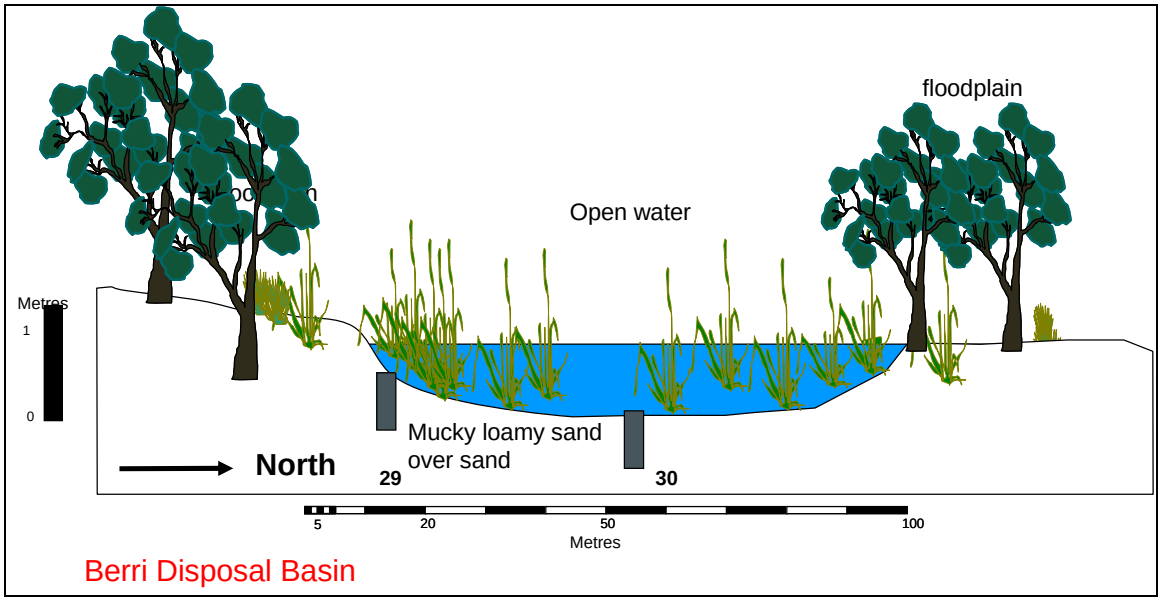


Figure 3-2. Conceptual cross-section diagram, showing locations for Sites 29 and 30.

Figure 3-3. Photograph of Site 29, showing the site location adjacent to the creek bank amongst thick reeds.

Figure 3-4. Photographs of Site 30, showing a view along the creek and the site location in water where the reeds were less dense than the margins.

3.3. Laboratory data assessment

3.3.1. Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 3-4 and pH profiles are presented in Figure 3-5. The pH_W data ranged from 5.87 to 6.76 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.85 to 5.01 and identified that the surface sample in Profile 29 and samples in Profile 30 were all 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 3.43 to 4.49 and identified that one sample in Profile 29 and samples in Profile 30 declined below the critical values of pH <4 on incubation, indicating that these soils potentially would form sulfuric material on oxidation.

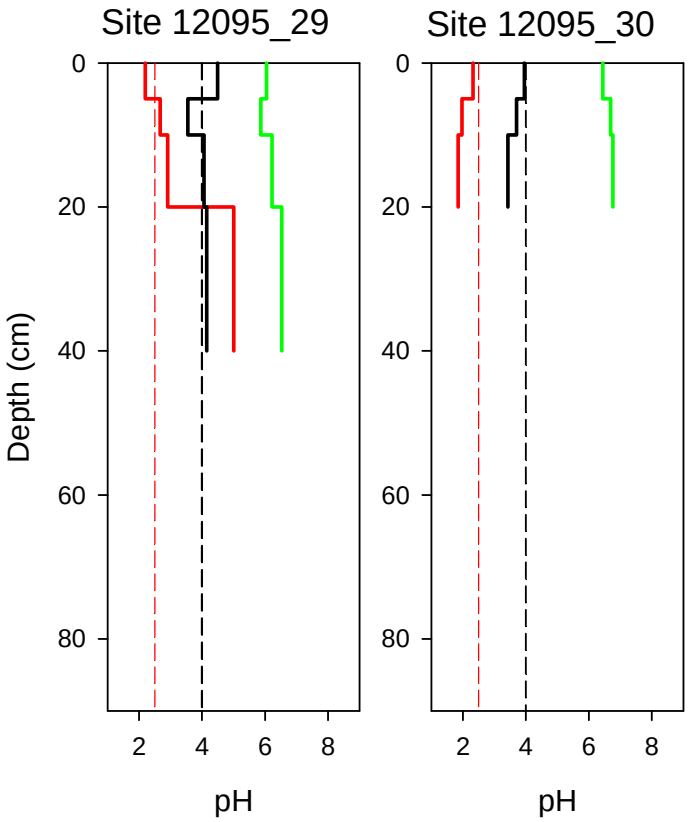


Figure 3-5. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12095), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

3.3.2. Acid base accounting

The acid base accounting data is provided in Table 3-4 and summarised in Figure 3-6.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.09 to 0.33 $\%S_{CR}$ and sulfidic material were detected in all samples.

Titratable actual acidity

Titratable actual acidity values ranged from 0 to 24.31 mole H^+/tonne and were measured in nearly all 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 was not found in the measured samples.

Net acidity

Net acidity values ranged from 65 to230 mole H^+/tonne. Moderate or high net acidity values were recorded in all samples.

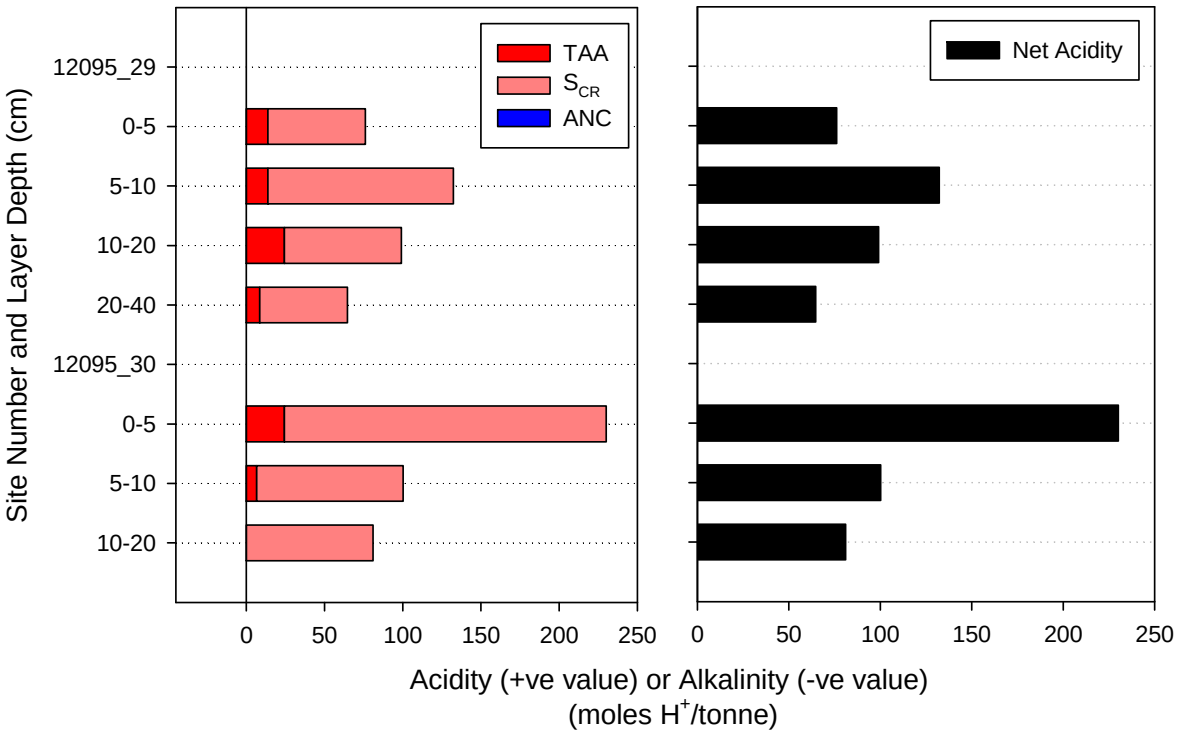


Figure 3-6. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12095). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

3.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 3-4 identified that no surface layers were above the criterion trigger value of 100 mg/kg SO_4.

3.3.4. Acid volatile sulfur

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

3.3.5. Hydrochemistry

One surface water sample was collected from this narrow wetland. Field parameters are shown in Table 3-5. The surface waters had a circumneutral pH and relatively low salinity. Alkalinity was similar to that expected in the river.

The water was of Na-Cl type, with enrichment in Ca and HCO_3 compared to seawater composition (Table 3-6, Figure 3-7). Sulfate concentration in the surface water was 12 mg l^{-1}. The SO_4/Cl ratio in the surface water (0.174) was slightly higher than seawater (0.142). Nitrate concentrations were below detection limit, and PO_4 was slightly elevated above ANZECC Guideline values. The concentrations of most trace metals were low, but with high Mn and slightly elevated Zn. Organic C concentrations were also very high.

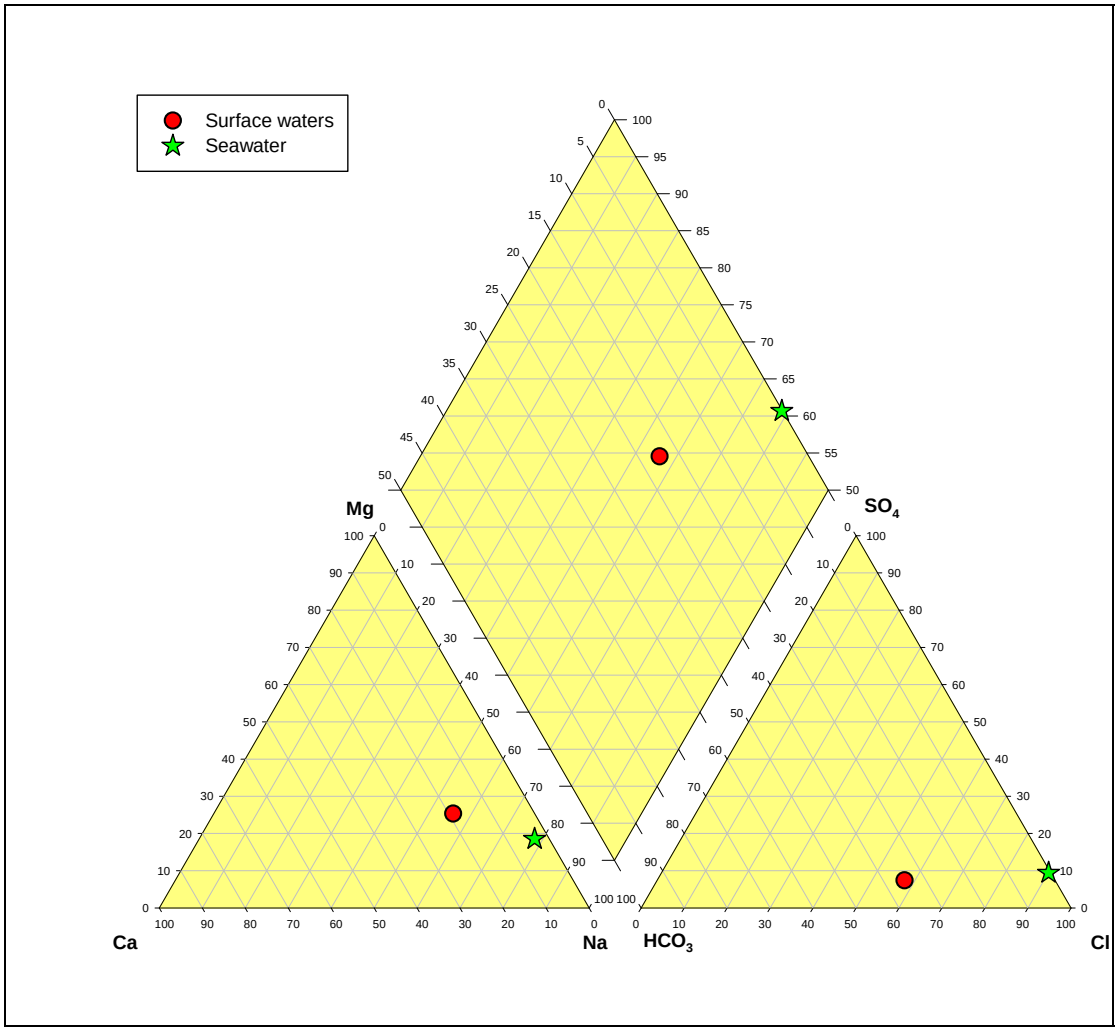


Figure 3-7. Piper diagram of hydrochemical data for Berri Disposal Basin (Wetland ID. 12095).

3.4. Discussion

Acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12095) were identified as hypersulfidic in both Profiles, and hyposulfidic in Profile 29. The acid sulfate soil subtype class identified was Hypersulfidic Subaqueous Soil (loamy or sandy) that occurred throughout the wetland.

The soils throughout the wetland were dominantly mucky loamy sand textured in the surface layers and sandy clay loam or loamy sand in the subsoil layers.

Monosulfidic material was not observed and the 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 Berri Disposal Basin (Wetland ID. 12095) are:

- Acidification hazard: The data identified moderate or high net acidity values in the surface and subsoil samples from both profiles, pH data did not indicate 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, 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 Berri Disposal Basin (Wetland ID. 12095):

Soil materials:	The soil layers throughout the wetland were hypersulfidic or hyposulfidic. Soils were mucky loamy sand textured in the surface layers and sandy clay loam or loamy sand in the subsoil layers. Both profiles had moderate or high net acidity values and pH data indicate an acidification hazard due to oxidation.
Acid sulfate soil identification:	• Hypersulfidic Subaqueous Soil (loamy or sandy) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – high level of concern • De-oxygenation hazard – low level of concern • Metal mobilisation hazard – medium level of concern

Table 3-2. Site description data for Berri Disposal Basin (Wetland ID. 12095).

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
29	30/03/2010	461849	6204152	50	water	reeds	side of creek
30	30/03/2010	461850	6204142	70	water	reeds	middle of creek

Table 3-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12095).

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
29_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	mucky loamy sand	wet		gel	very weak	
29_2	5 - 10	small pit	light brownish grey (2.5Y6/2)	sandy loam	wet		massive	weak	
29_3	10 - 20	small pit	light brownish grey (2.5Y6/2)	sandy clay loam	wet		massive	firm	
29_4	20 - 40	small pit	light brownish grey (2.5Y6/2)	sandy clay loam	moist		massive	very firm	
30_1	0 - 5	small pit	greyish brown (10YR5/2)	mucky loamy sand	wet		gel	very weak	sulfurous odour
30_2	5 - 10	small pit	greyish brown (10YR5/2)	loamy sand	wet		massive	very weak	sulfurous odour
30_3	10 - 20	small pit	greyish brown (10YR5/2)	loamy sand	wet		massive	very weak	sulfurous odour
30_W1	70 - 0	pit water							water sampled

Table 3-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12095).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
29.1	0-5	.Fine	82	6.05	2.20	6.11	4.49	38	5.75	13.82	0.10	..	..	76	hyposulfidic (S_{CR}≥0.10%)
29.2	5-10	Fine	37	5.87	2.67	6.21	3.55	94	4.78	13.82	0.19	..	..	132	hypersulfidic
29.3	10-20	Fine	35	6.22	2.91	6.02	4.06	78	4.85	24.30	0.12	..	..	99	hyposulfidic (S_{CR}≥0.10%)
29.4	20-40	Fine	55	6.53	5.01	6.18	4.15	48	5.40	8.58	0.09	..	..	65	hyposulfidic (S_{CR}<0.10%)
30.W1	70-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
30.1	0-5	Fine	105	6.44	2.32	5.96	3.95	44	5.75	24.31	0.33	..	..	230	hypersulfidic
30.2	5-10	Fine	82	6.69	1.97	5.93	3.70	87	5.64	6.67	0.15	..	..	100	hypersulfidic
30.3	10-20	Medium	71	6.76	1.85	6.22	3.43	75	6.79	0.00	0.13	..	0.00	81	hypersulfidic

Table 3-5. Summary of hydrochemical field measurements for Berri Disposal Basin (Wetland ID. 12095).

	pH	SEC µS cm^{-1}	DO mg l^{-1}	Eh mV	Turbidity NTU	Alkalinity as HCO_3
Surface waters (n=1)	7.06	661	3.77	164	48	72

Table 3-6. Summary of hydrochemical field measurements for Berri Disposal Basin (Wetland ID. 12095).

Parameter	units	ANZECC Guidelines	Site 30 (SW)
Na	mg l^{-1}		67.4
K	mg l^{-1}		4.3
Ca	mg l^{-1}		11.8
Mg	mg l^{-1}		10.6
Si	mg l^{-1}		2.94
Br	mg l^{-1}		0.3
Cl	mg l^{-1}		120
NO_3	mg l^{-1}	0.7	<0.022
NH_4-N[K]	mg l^{-1}	0.01	0.01
PO_4-P[E]	mg l^{-1}	0.005	**0.048**
SO_4	mg l^{-1}		12
Ag	µg l^{-1}	0.05	<0.2
Al[A]	µg l^{-1}	55	<100
As[B]	µg l^{-1}	13	<20
Cd	µg l^{-1}	0.2	<0.6
Co	µg l^{-1}	2.8	2
Cr[C]	µg l^{-1}	1	<5
Cu[H]	µg l^{-1}	1.4	<10
Fe	µg l^{-1}	300	<100
Mn	µg l^{-1}	1700	**2755**
Ni[H]	µg l^{-1}	11	6.0
Pb[H]	µg l^{-1}	3.4	<1
Se	µg l^{-1}	11	<4
Zn[H]	µg l^{-1}	8	**90**
DOC	mg l^{-1}		155

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

4. BERRI DISPOSAL BASIN (WETLAND ID. 12101)

4.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12101) is situated on the north-western side of the River Murray, about 1 kilometre southwest from the town of Berri. The wetland is somewhat rectangular in shape and is one of many wetlands in the complex. It is about 150 metres in length and about 70 metres at its widest, with a total surface area of 1 hectare. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river 300 metres away to the southeast. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12092, 12095, 12104, 12102, and 12103.

The wetland is not connected to the river and is essentially an internal basin. At the time when the soil survey was conducted in March 2010 the wetland did not have surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Grassland was growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 4-1.

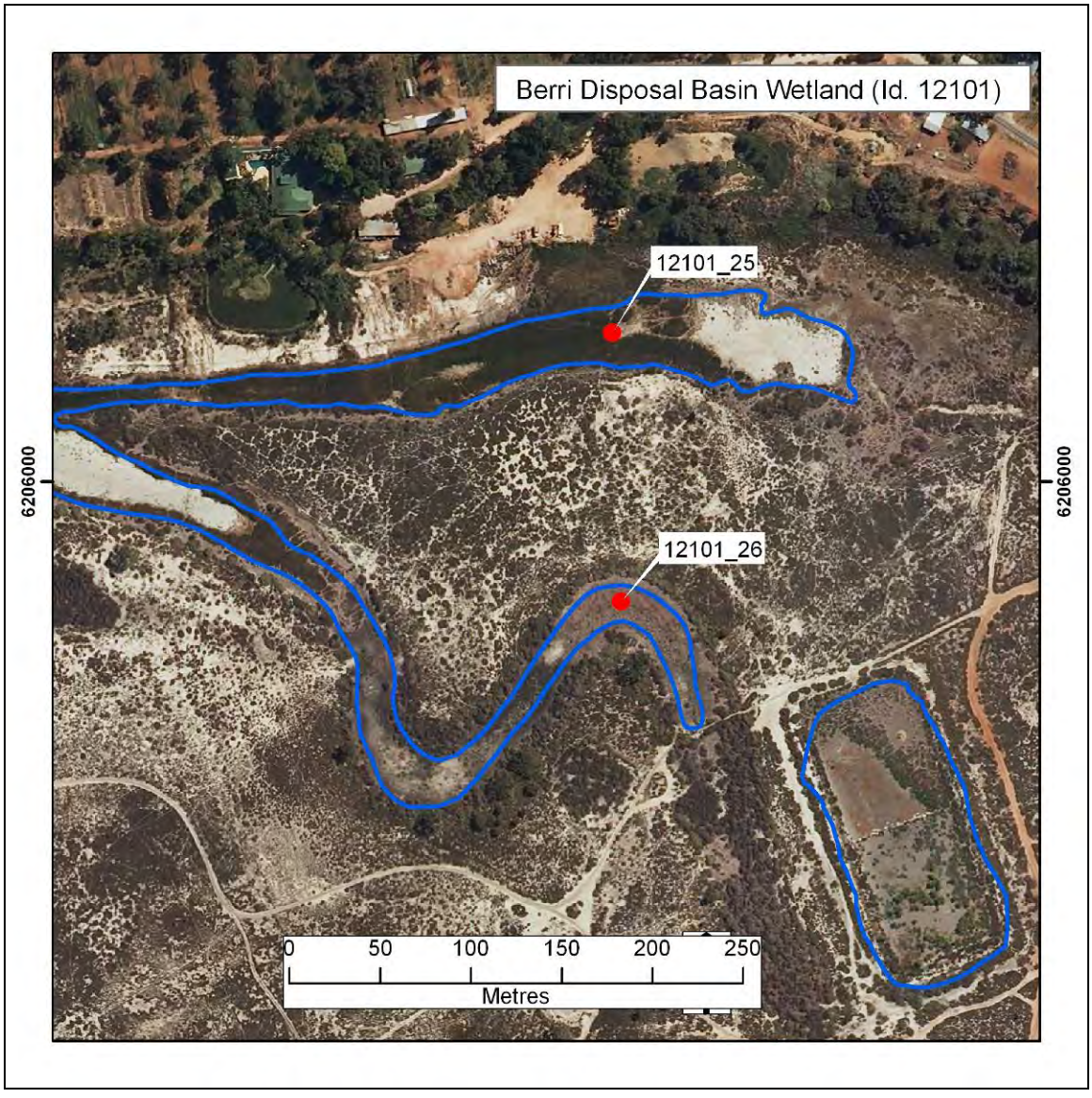


Figure 4-1. Berri Disposal Basin (Wetland ID. 12101) and sample site locations.

4.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 4-1. It was not possible to identify this wetland in the field and sites were placed separately across an adjacent wetland that was in the same landscape. The site and soil profile descriptions are presented in Table 4-2 and Table 4-3. A conceptual cross-section diagram was not generated for this wetland as there was insufficient soil profile and landscape information to construct the diagram.

Site 25 (Figure 4-2) occurred at a low point in the wetland amongst Phragmites, and the soil consisted of an olive grey, firm, granular structure, clay, over an olive grey very firm, blocky structured, clay. Site 26 (Figure 4-3) occurred in an open area where lignum was growing, and the soil consisted of a brown, very weak, plant material, over a dark grey, very firm, blocky structured, clay.

Table 4-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12101).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12101_25	462420	6206082	Other Soil (clayey)	low elevation, amongst Phragmites
12101_26	462425	6205934	Other Soil (clayey)	low elevation, where lignum was growing

Figure 4-2. Photographs of Site 25, showing the site location near reeds in a low grassed area, and the soil profile.

Figure 4-3. Photographs of Site 26, showing the site location in an open area where lignum grew, 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 4-4. The pH_W data ranged from 4.64 to 7.93 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 2.85 to 7.89 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 4.28 to 8.28 and identified that no samples on incubation declined below the critical values of pH <4.

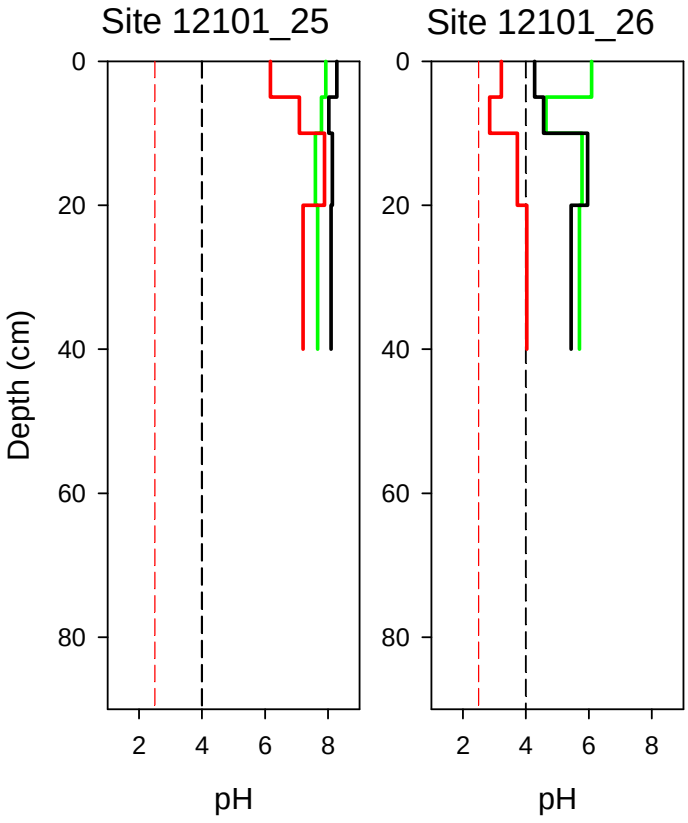


Figure 4-4. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12101), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} 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 4-5.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.05 %S_{CR} and sulfidic materials were detected in at least one sample for each profile with the remaining values as zero.

Titratable actual acidity

Titratable actual acidity values ranged from 0 to 116.30 mole H^+/tonne and were measured in all layers of Profile 26 and in none of the layers for Profile 25.

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 0.54 %$CaCO_3$ and were measured in all samples for Profile 25 and not in Profile 26.

Net acidity

Net acidity values ranged from -65 to 147 mole H^+/tonne. All Profile 25 samples had negative net acidity values and all Profile 26 samples were high and declined to low net acidity values with depth.

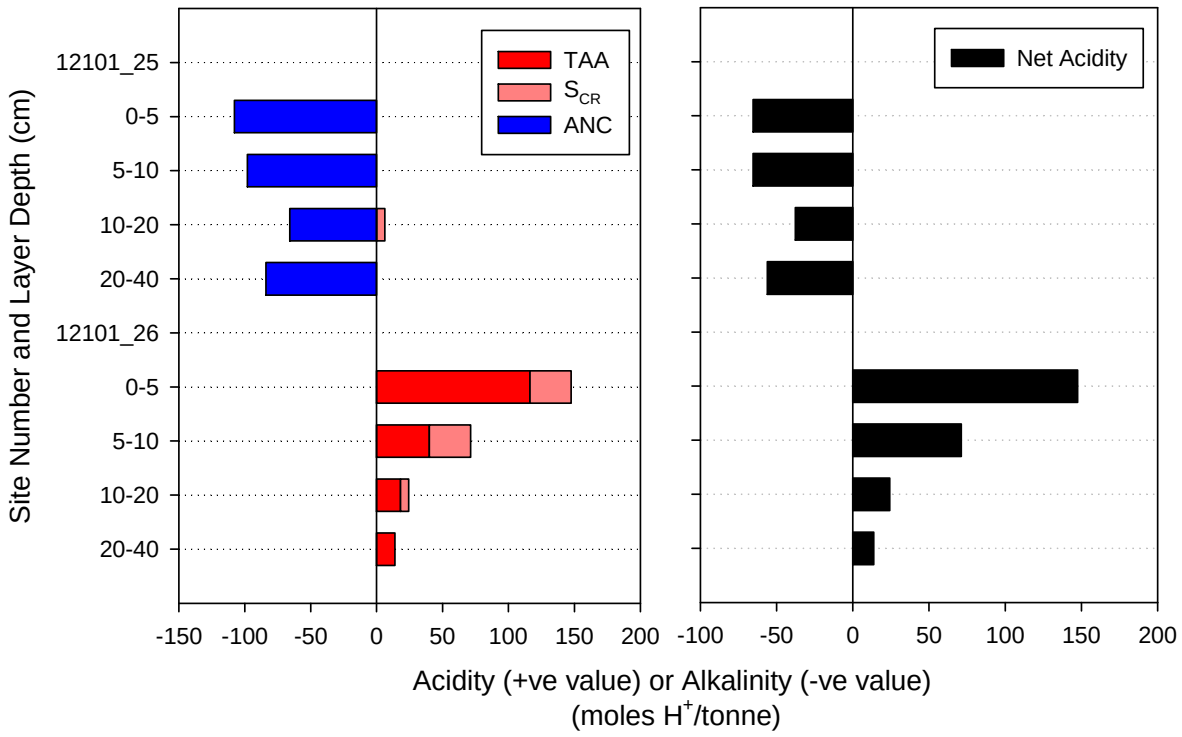


Figure 4-5. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12101). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

4.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 4-4 identified that surface layers of Profile 25 were above the criterion trigger value of 100 mg/kg SO_4.

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 Berri Disposal Basin (Wetland ID. 12101) were identified as hyposulfidic and occurred in both of the profiles often at the surface and the remaining layers were characterised as other soil material. The acid sulfate soil subtype classes identified were Other Soil (clayey) that occurred throughout the wetland.

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

Monosulfidic material was not observed but the water soluble sulfate data identified that surface layers for Profile 25 were in excess of the 100mg/L trigger value for monosulfide formation potential.

The potential hazards posed by acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12101) are:

- Acidification hazard: The data identified high to low net acidity values in one profile with negative values in the other profile, 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 Profile 25, monosulfidic material was not observed. There is a low to 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 Berri Disposal Basin (Wetland ID. 12101):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic or other soil materials. Soils were clayey textured in the surface and subsoil. One of the two profiles had samples with a high to low net acidity values and pH data did not identify potential acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (clayey) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low to medium level of concern • De-oxygenation hazard – low to medium level of concern • Metal mobilisation hazard – low level of concern

Table 4-2. Site description data for Berri Disposal Basin (Wetland ID. 12101).

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	30/03/2010	462420	6206082	not reached	plant material, sealed	Phragmites	low elevation
26	30/03/2010	462425	6205934	not reached	Phragmites material, organic material	none, was Phragmites	low elevation, old motorbike area ????

Table 4-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12101).

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	olive grey (5Y5/2)	clay	dry		granular	firm	
25_2	5 - 10	small pit	olive grey (5Y5/2)	clay	dry	5% reddish brown infused into the matrix adjacent to pores	angular blocky	very firm	few carbonate fragments
25_3	10 - 20	small pit	olive grey (5Y5/2)	clay	dry		angular blocky	very firm	10% small carbonate fragments, too hard to auger below
25_4	20 - 40	small pit	olive grey (5Y5/2)	clay	dry		angular blocky	very firm	
26_1	0 - 5	small pit	dark brown (7.5YR3/2)	plant material	dry		massive	very weak	
26_2	5 - 10	small pit	dark brown (7.5YR3/2)	plant material	dry		massive	very weak	
26_3	10 - 20	small pit	dark grey (5Y4/1)	clay	dry		angular blocky	very firm	many plant roots
26_4	20 - 40	small pit	dark grey (5Y4/1)	clay	dry		angular blocky	very firm	many plant roots

Table 4-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12101).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
25.1	0-5	Medium	11,050	7.93	6.17	8.14	8.28	1,200	7.77	0.00	<0.01	..	0.54	-65	other soil material
25.2	5-10	Medium	4,990	7.79	7.09	7.66	8.03	90	7.33	0.00	<0.01	..	0.49	-65	other soil material
25.3	10-20	Medium	5,420	7.60	7.89	7.69	8.14	110	7.18	0.00	0.01	..	0.33	-38	hyposulfidic (S_{CR}<0.10%)
25.4	20-40	Fine	4,570	7.67	7.21	7.53	8.10	120	6.90	0.00	0.00	..	0.42	-56	other soil material
26.1	0-5	Organic matter	535	6.09	3.22	5.11	4.28	75	4.59	116.30	0.05	..	..	147	hyposulfidic (S_{CR}<0.10%)
26.2	5-10	Organic matter	1,519	4.64	2.85	4.61	4.56	76	5.03	40.04	0.05	..	..	71	hyposulfidic (S_{CR}<0.10%)
26.3	10-20	Fine	4,530	5.78	3.73	5.75	5.96	780	5.76	18.11	0.01	..	..	24	hyposulfidic (S_{CR}<0.10%)
26.4	20-40	Fine	2,550	5.70	4.03	5.28	5.44	170	5.54	13.82	0.00	..	..	14	other acidic

5. BERRI DISPOSAL BASIN (WETLAND ID. 12102)

5.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12102) is situated on the north-western side of the River Murray, about 3 kilometres southwest from the town of Berri. The wetland is somewhat oval in shape and is one of many wetlands in the complex. It is about 2.5 kilometres in length and about 650 metres at its widest, with a total surface area of 211 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river 1 kilometre away to the southeast, and by a hill slope to the west. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12092, 12095, 12101, 12103, and 12104.

The wetland is not connected to the river but is connected to a creek line at the southern end that may at times link it to the river if there was sufficient water; the wetland is essentially an internal basin. At the time when the soil survey was conducted in March 2010 the wetland had isolated areas of surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Grassland was growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Twelve sites were sampled as shown in Figure 5-1.

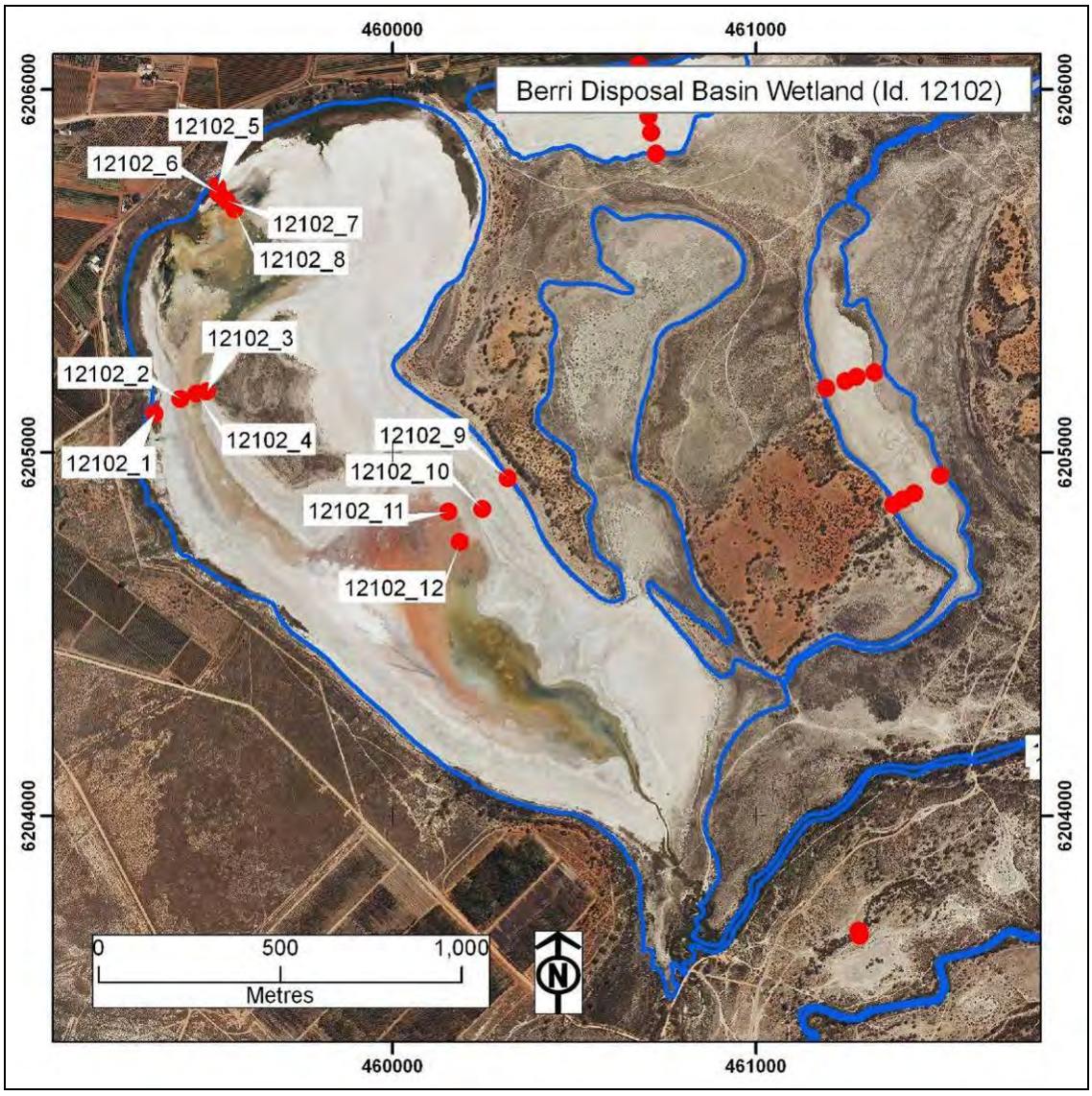


Figure 5-1. Berri Disposal Basin (Wetland ID. 12102) and sample site locations.

5.2. Soil profile description and distribution

Twelve sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 5-1. Sites were distributed along three transects placed around the wetland, with transects at the western side (Sites 1, 2, 3 and 4), northern end (Sites 5, 6, 7 and 8), eastern side (Sites 9, 10, 11 and 12) of the wetland. The site and soil profile descriptions are presented in Table 5-2 and Table 5-3, and a conceptual cross-section diagram in Figure 5-2.

Western transect

Site 1 (Figure 5-3) occurred on the wetland margin at the edge of vegetation growing, the water table was at about 60 cm depth, and the soil consisted of a light brownish grey, firm, platy, sandy clay loam, over a grey, firm, clay. Site 2 (Figure 5-4) occurred adjacent to surface water, the water table was at about 3 cm depth, and the soil consisted of a light brownish grey, firm, clay, over a black, very weak, monosulfidic material, over an olive grey, very firm, clay. Site 3 (Figure 5-5) occurred on the margins of an island in the middle of the wetland, and the soil consisted of a pale brown, firm, sand, over a greyish brown, very firm, sandy clay loam. Site 4 (Figure 5-6) occurred at low elevation in shallow surface water (15 cm deep), and the soil consisted of a light olive grey, very weak, sandy clay loam, over a black, very weak, monosulfidic material with strong sulfurous odour, over a very dark grey, very weak, clay.

Northern transect

Site 5 (Figure 5-7) occurred on the wetland margin amongst Phragmites growing, the water table was at about 60 cm depth, and the soil consisted of a light brownish grey, weak, clay over a grey, firm, sandy clay loam. Site 6 (Figure 5-8) occurred in the area between the wetland margin and surface water, the water table was at about 10 cm depth, and the soil consisted of a pale olive, weak, clay, over grey, very firm, clay. Site 7 (Figure 5-9) occurred near the surface water shoreline, the water table was at about 5 cm depth, and the soil consisted of a grey, weak, clay, over a very dark grey, very weak, monosulfidic material and clay. Site 8 (Figure 5-10) occurred where there was surface water (3 cm deep), and the soil consisted of a light olive grey, weak, clay, over a black, very weak, monosulfidic material and clay with a strong sulfurous odour.

Eastern transect

Site 9 (Figure 5-11) occurred on the wetland margin, and the soil consisted of a light grey, weak, sand, over dark greyish brown, very firm, clay. Site 10 (Figure 5-12) occurred in the area between the wetland margin and surface water, and the soil consisted of a dark grey, weak, clay over a dark grey, firm, clay. Site 11 (Figure 5-13) occurred near the surface water shoreline, the water table was at about 45 cm depth, and the soil consisted of a olive grey, weak, clay. Site 12 (Figure 5-14) occurred where there was surface water (2 cm deep), and the soil consisted of a grey, weak, clay, over a dark grey, very firm, clay.

Table 5-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12102).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12102_1	459345	6205107	Other Soil (clayey)	mid/high elevation at edge of vegetation
12102_2	459416	6205147	Other Soil (clayey)	low elevation, adjacent to water
12102_3	459489	6205169	Other Soil (sandy)	mid/high on island
12102_4	459460	6205163	Subaqueous Soil (clayey)	low elevation in water
12102_5	459517	6205734	Other Soil (clayey)	high elevation, in Phragmites at margin
12102_6	459521	6205713	Other Soil (clayey)	mid elevation below vegetation on margin
12102_7	459543	6205694	Other Soil (clayey)	low elevation, edge of shoreline
12102_8	459565	6205671	Subaqueous Soil (clayey)	low elevation, surface water, soft surface not weight bearing
12102_9	460317	6204929	Other Soil (sandy)	high elevation, on margin
12102_10	460248	6204844	Other Soil (clayey)	mid elevation, dead tree area
12102_11	460154	6204837	Other Soil (clayey)	near low elevation
12102_12	460185	6204754	Subaqueous Soil (clayey)	low elevation

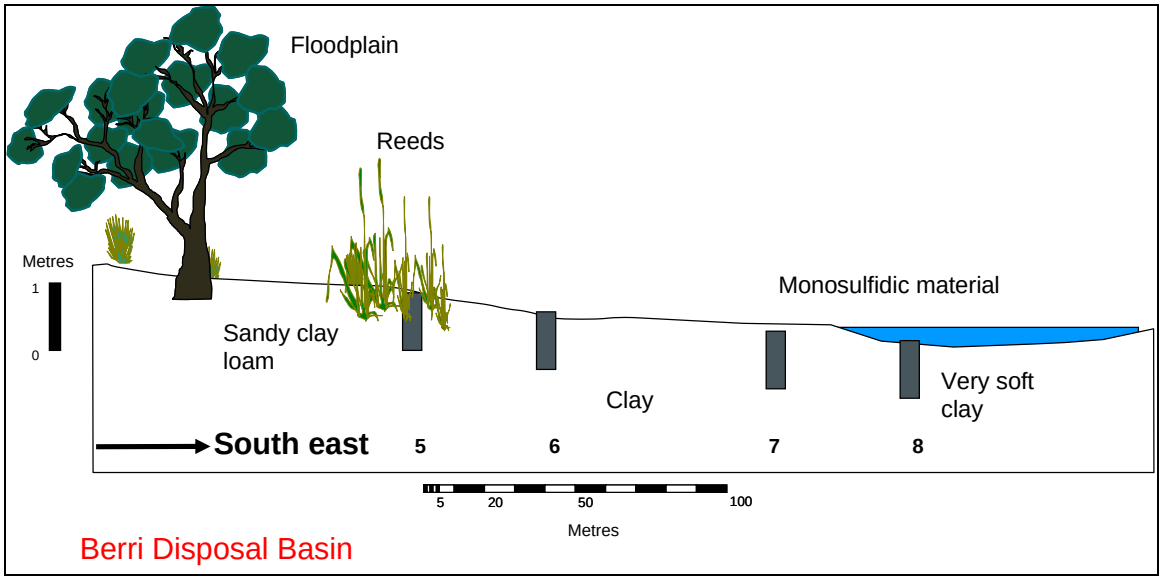


Figure 5-2. Conceptual cross-section diagram, showing locations of Sites 5 to 8.

Figure 5-3. Photograph of Site 1, showing the soil profile that is located on the wetland margin where samphire was growing.

Figure 5-4. Photograph of Site 2, showing the site location at the edge of the surface water.

Figure 5-5. Photographs of Site 3, showing the site location on the margin of an island in the middle of the wetland and the soil profile.

Figure 5-6. Photograph of Site 4, showing the shallow water where the site was located, viewed across the shallow surface water to the edge of the wetland.

Figure 5-7. Photograph of Site 5, showing the site location placed in thick Phragmites on the wetland margin.

Figure 5-8. Photograph of Site 6, showing the site location near the shoreline of the surface water.

Figure 5-9. Photograph of Site 7, showing the site location and profile pit where the soil surface is an algae mat over very weak black monosulfidic material.

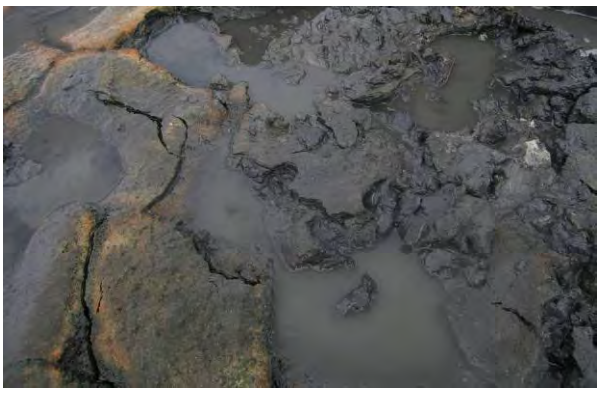


Figure 5-10. Photograph of Site 8, showing the site location placed towards the centre of the wetland where the soil surface has water and a thick algae mat over black, very weak, monosulfidic material.

Figure 5-11. Photographs of Site 9, showing the site location placed on the wetland margin where samphire is growing and the soil profile.

Figure 5-12. Photographs of Site 10, showing the site location placed between the wetland margin and surface water, and the soil profile.

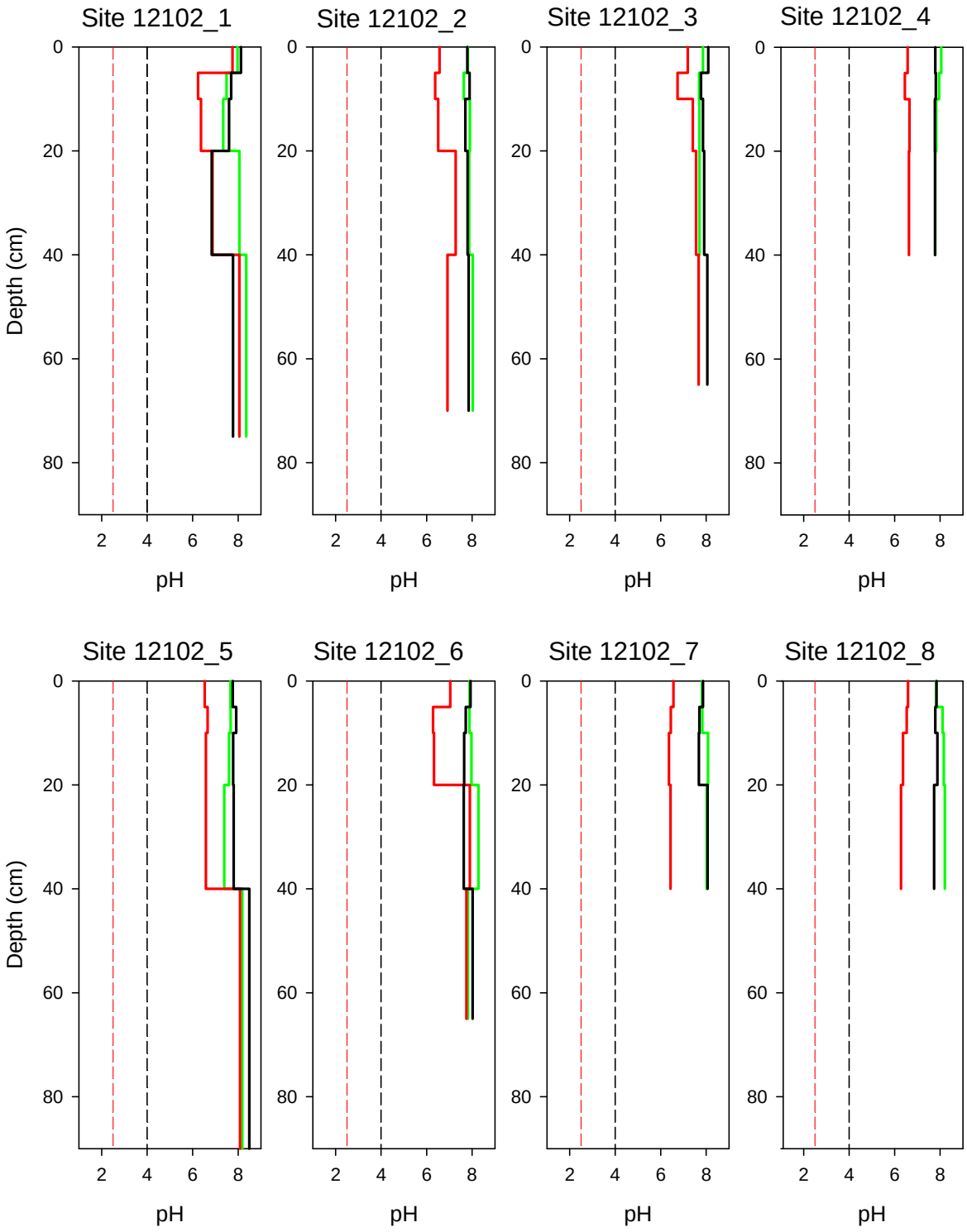
Figure 5-13. Photograph of Site 11, showing the site location placed adjacent to the surface water.

Figure 5-14. Photograph of Site 12, showing the site location that was placed in the surface 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 5-15. The pH_W data ranged from 6.29 to 8.35 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 2.67 to 8.08 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 6.15 to 8.49 and identified that no samples on incubation declined below the critical values of pH <4.



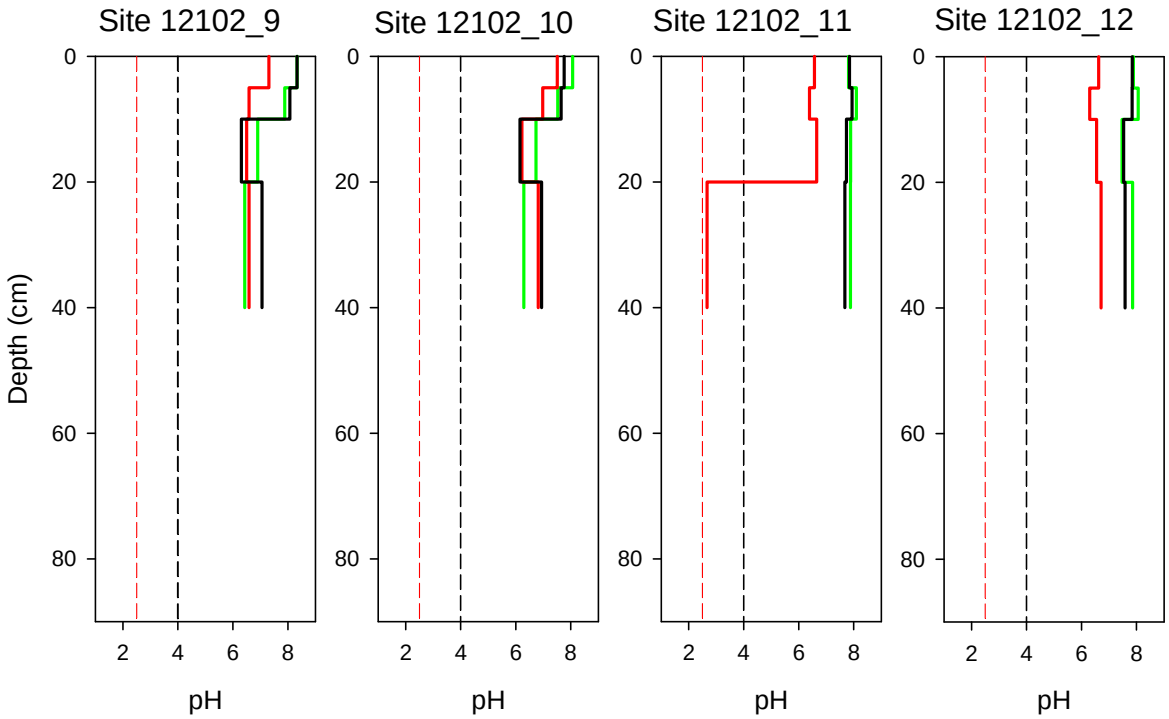


Figure 5-15. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12102), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} 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 5-16.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 1.15 $\%S_{CR}$ and sulfidic materials were detected in all soil profiles except for Profile 3.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 1.45 mole H^+/tonne and were detected only in Profile 10.

Retained acidity

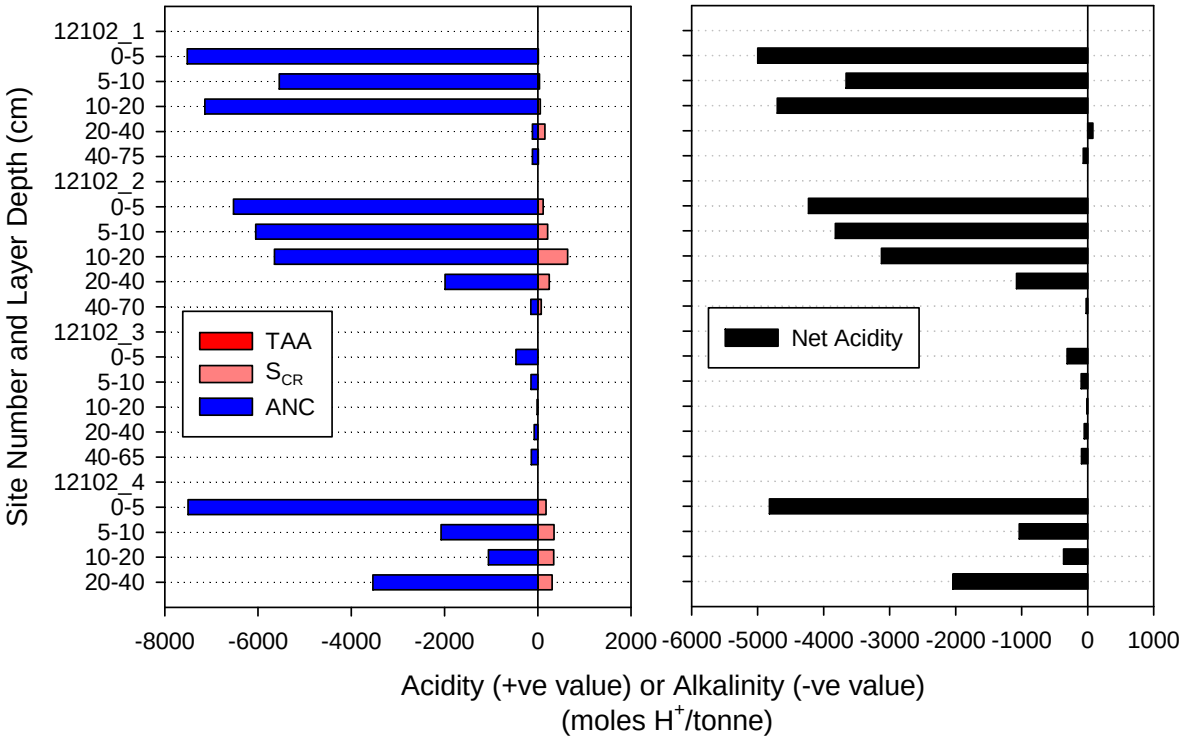
Retained acidity was not measured in any of the layers as all samples had a pH_{KCl} of greater than 4.5.

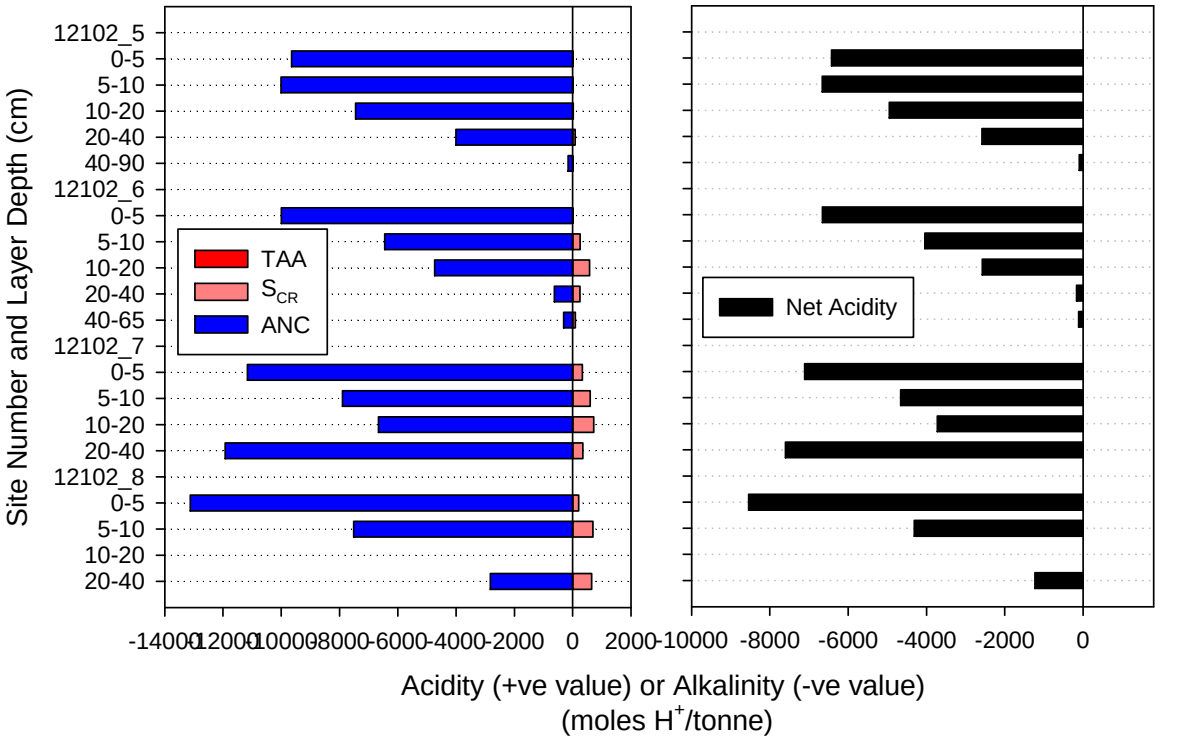
Acid neutralising capacity

Acid neutralising capacity values ranged from 0.06 to 65.66 $\%CaCO_3$.and were measured in all samples.

Net acidity

Net acidity values ranged from -8540 to 148 mole H^+/tonne. All profile samples had negative net acidity values except for Profiles 1 and 11 that contained layers with a moderate and high net acidity values.


Site Number and Layer Depth (cm)
12102_1
0-5
5-10
10-20
20-40
40-75
12102_2
0-5
5-10
10-20
20-40
40-70
12102_3
0-5
5-10
10-20
20-40
40-65
12102_4
0-5
5-10
10-20
20-40
TAA
S_{CR}
ANC
Net Acidity
-8000 -6000 -4000 -2000 0 2000
-6000 -5000 -4000 -3000 -2000 -1000 0 1000
Acidity (+ve value) or Alkalinity (-ve value)
(moles H^+/tonne)


Site Number and Layer Depth (cm)
12102_5
0-5
5-10
10-20
20-40
40-90
12102_6
0-5
5-10
10-20
20-40
40-65
12102_7
0-5
5-10
10-20
20-40
12102_8
0-5
5-10
10-20
20-40
TAA
S_{CR}
ANC
Net Acidity
-14000 -12000 -10000 -8000 -6000 -4000 -2000 0 2000
-10000 -8000 -6000 -4000 -2000 0
Acidity (+ve value) or Alkalinity (-ve value)
(moles H^+/tonne)

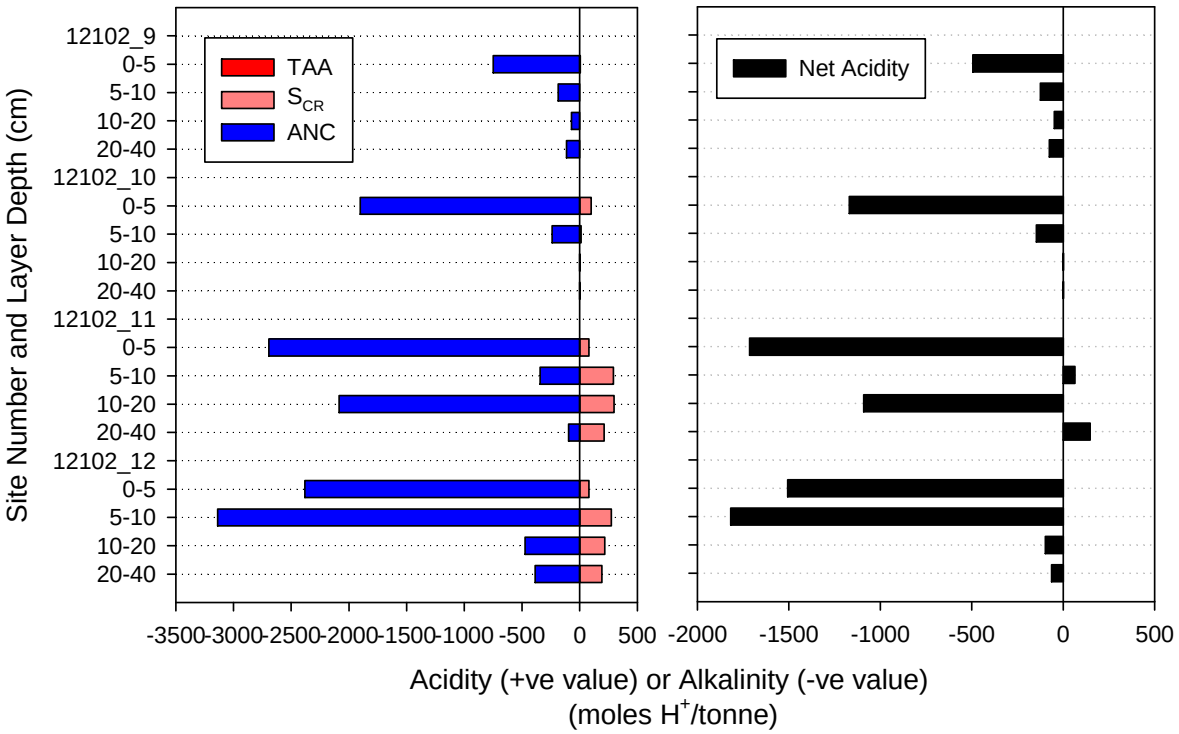


Figure 5-16. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12102). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

5.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 5-4 identified that all surface layers were above the criterion trigger value of 100 mg/kg SO_4.

5.3.4. Acid volatile sulfur

Monosulfidic materials were observed in Profiles 2, 7 and 8, and samples were collected for analysis. The values are all above S_{AV} ≥0.01% S, the criteria value for identifying monosulfidic material.

5.3.5. Hydrochemistry

Three surface waters and 3 pit waters were collected, one of each from each transect in the wetland. Surface water was shallow with large parts of the wetland dry. Field parameters are shown in Table 5-5. The surface waters had circumneutral to slightly alkaline pH and salinity was high and variable. The waters also varied in dissolved oxygen and turbidity was low to moderate. Alkalinity was high in all samples but was variable.

The SEC in the pit waters was also high (Table 5-6, Figure 5-17). The pH was slightly acidic to slightly alkaline, and DO and Eh were low (but have likely been modified by contact with the atmosphere). Alkalinity was similar to the surface waters.

All waters were of Na-Cl type. Sulfate concentrations in the surface waters varied from 2600 to 2800 mg l^{-1}, and were much higher in the pit waters varying from 10000 to 17000 mg l^{-1}. The SO_4/Cl ratio in the surface waters (0.182-0.236) was slightly higher than seawater (0.142), and also slightly higher than those in the pit waters (0.142-0.196). Nitrate concentrations were below detection limit in the surface waters. The concentrations of NH_4 and PO_4 were significantly higher than ANZECC Guideline values in some of the samples (Table 1-6). The detection limit for a number of trace metals was high due to required dilution prior to analyses. Nevertheless, concentrations of Cu and Zn were significantly higher than ANZECC Guideline values. Organic C was relatively high in some samples.

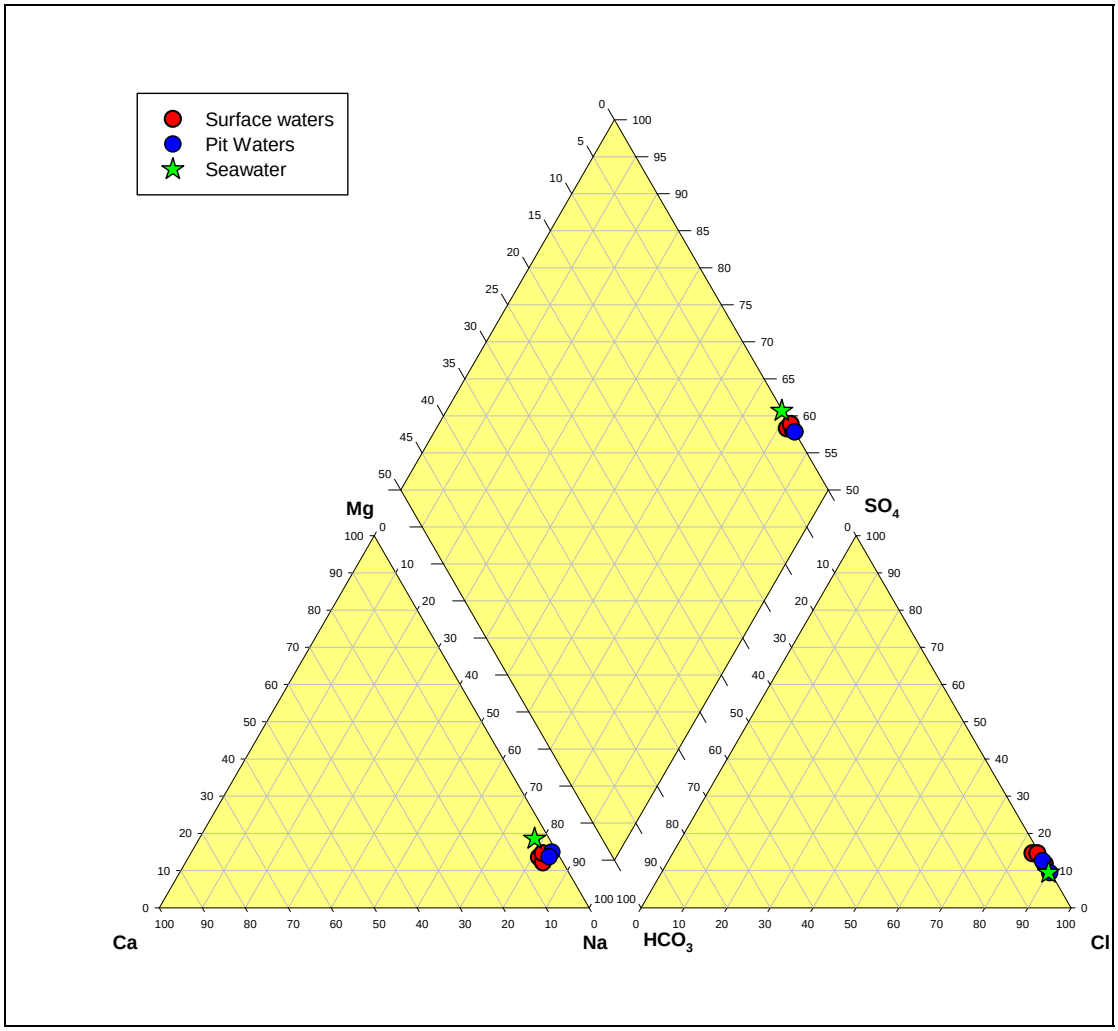


Figure 5-17. Piper diagram of hydrochemical data for Berri Disposal Basin (Wetland ID. 12102).

5.4. Discussion

Acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12102) were identified as hyposulfidic and occurred in most layers for all profiles, except for Profile 3 and most layers of Profile 9 where the layers were characterised as other soil material. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey) that occurred as an isolated area where shallow surface water had accumulated, and Other Soil (clayey or sandy) that occurred on the wetland margins.

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

Monosulfidic material was observed at three sites and water soluble sulfate data identified that surface layers for all 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 Berri Disposal Basin (Wetland ID. 12102) are:

- Acidification hazard: The data identified negative 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 potential for monosulfidic materials to form in the surface layers of soils, and monosulfidic material was observed. There is a high 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 Berri Disposal Basin (Wetland ID. 12102):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic. Soils were sandy or clayey textured at the surface and clayey textured in the subsoil. Most profile samples had negative net acidity values, where positive values did occur they were at depth in the profile, and pH data did not indicate acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (sandy or clayey) – occurring on the wetland margins down to the lower wetland areas except for where there was surface water. Dominant (>50%) in extent. • Subaqueous Soil (clayey or sandy) – occurring where there was surface water throughout the wetland. Sub-dominant (<50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – low level of concern

Table 5-2. Site description data for Berri Disposal Basin (Wetland ID. 12102).

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	29/03/2010	459345	6205107	60	firm	samphire	mid/high elevation at edge of vegetation
2	29/03/2010	459416	6205147	3	soft, reed algae	bare	low elevation, adjacent to water
3	29/03/2010	459489	6205169	not reached	sandy	samphire	mid/high on island
4	29/03/2010	459460	6205163	15	water, soft	bare	low elevation in water
5	29/03/2010	459517	6205734	60	plant material	Phragmites	high elevation, in phragmites at margin
6	29/03/2010	459521	6205713	10	salt crust now wet	bare but new Phragmites edge	mid elevation below vegetation on margin
7	29/03/2010	459543	6205694	5	algae mat, soft	bare	low elevation, edge of shoreline
8	29/03/2010	459565	6205671	3	algae mat	bare	low elevation, surface water, soft surface not weight bearing
9	29/03/2010	460317	6204929	not reached	sandy	samphire, dead trees	high elevation, on margins
10	29/03/2010	460248	6204844	not reached	clayey	bare	mid elevation, dead tree area
11	29/03/2010	460154	6204837	45	sealed, red coating, cracking when dry	bare	near low elevation
12	29/03/2010	460185	6204754	2	soft, sealed, red colour	bare	low elevation

Table 5-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12102).

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 (2.5Y6/2)	clay	moist		platy	firm	few white carbonate fragments
1_2	5 - 10	small pit	grey (5Y5/1)	clay	moist		angular blocky	firm	slickensides, few white carbonate fragments
1_3	10 - 20	small pit	grey (5Y5/1)	sandy clay loam	moist		angular blocky	firm	slickensides, few white carbonate fragments
1_4	20 - 40	small pit	grey (5Y5/1)	sandy loam	moist		massive	firm	
1_5	40 - 75	push tube	grey (5Y5/1)	clay	moist		massive	very firm	
2_1	0 - 5	small pit	light brownish grey (2.5Y6/2)	clay	wet		platy	firm	
2_2	5 - 10	small pit	light brownish grey (2.5Y6/2)	clay	wet		angular blocky	firm	
2_3	10 - 20	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
2_4	20 - 40	small pit	olive grey (5Y5/2)	mucky clay	moist		massive	very weak	
2_5	40 - 70	push tube	olive grey (5Y5/2)	mucky clay	moist		massive	very firm	
2_W1	-	pit water							water sampled
3_1	0 - 5	small pit	pale brown (10YR6/3)	sand	moist		massive	firm	
3_1DUP	0 - 5	small pit	pale brown (10YR6/3)	sand	moist		massive	firm	
3_2	5 - 10	small pit	pale brown (10YR6/3)	sand	moist	5% reddish brown In the matrix	massive	firm	
3_3	10 - 20	small pit	greyish brown (2.5Y5/3)	sand	moist	10% reddish brown In the matrix	massive	firm	
3_4	20 - 40	small pit	greyish brown (2.5Y5/3)	sand	moist	10% brown infused into the matrix adjacent to pores	massive	firm	
3_5	40 - 65	push tube	greyish brown (2.5Y5/3)	sandy clay loam	moist		massive	very firm	
4_W1	15 - 0	surface water							water sampled
4_1	0 - 5	small pit	light olive grey (5Y6/2)	sandy clay loam	wet		massive	very weak	
4_2	5 - 10	small pit	very dark grey (2.5Y3/0)	clay	wet		massive	very weak	strong sulfurous odour
4_3	10 - 20	small pit	very dark grey (5Y3/1)	clay	wet		massive	very weak	strong sulfurous odour
4_4	20 - 40	small pit	very dark grey (5Y3/1)	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
5_1	0 - 5	small pit	light brownish grey (2.5Y6/3)	clay	moist	15% yellowish brown In the matrix	subangular blocky	weak	
5_2	5 - 10	small pit	light brownish grey (2.5Y6/3)	clay	moist	20% yellowish brown infused into the matrix along faces of peds	subangular blocky	weak	contains many plant roots
5_3	10 - 20	small pit	light brownish grey (2.5Y6/3)	clay	moist	10% yellowish brown infused into the matrix along faces of peds	massive	weak	contains many plant roots
5_4	20 - 40	small pit	light brownish grey (2.5Y6/3)	clay	moist		massive	firm	
5_5	40 - 90	small pit	grey (5Y6/1)	sandy clay loam	wet		massive	firm	
6_1	0 - 5	small pit	pale olive (5Y6/4)	clay	moist		massive	weak	thin red algae layer under salt crust
6_2	5 - 10	small pit	pale olive (5Y6/4)	clay	wet	15% brown infused into the matrix adjacent to pores	subangular blocky	very weak	
6_3	10 - 20	small pit	grey (5Y5/1)	clay	wet	5% brown infused into the matrix adjacent to pores	subangular blocky	very weak	
6_4	20 - 40	small pit	grey (5Y5/1)	clay loam	wet		massive	firm	
6_5	40 - 65	push tube	grey (5Y5/1)	clay	wet		massive	very firm	
6_W1	-	pit water							water sampled
7_1	0 - 5	small pit	grey (5Y6/1)	clay	wet		massive	weak	
7_2	5 - 10	small pit	grey (5Y6/1)	clay	wet		gel	very weak	
7_3	10 - 20	small pit	very dark grey (5Y3/1)	monosulfidic black ooze	wet		gel	very weak	
7_4	20 - 40	small pit	very dark grey (5Y3/1)	monosulfidic black ooze	wet		gel	very weak	
8_W1	3 - 0	surface water							water sampled
8_1	0 - 5	small pit	light olive grey (5Y6/2)	clay	wet		massive	weak	
8_2	5 - 10	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous small
8_3	10 - 20	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
8_4	20 - 40	small pit	olive grey (5Y4/2)	clay	wet		gel	very weak	
9_1	0 - 5	small pit	light grey (10YR7/2)	sand	dry		single grain	very weak	
9_2	5 - 10	small pit	light grey (10YR7/2)	sand	dry	5% yellowish brown In the matrix	single grain	very weak	
9_3	10 - 20	small pit	dark greyish brown (10YR4/2)	sand	moist		subangular blocky	weak	
9_4	20 - 40	small pit	dark greyish brown (10YR4/2)	clay	moist		massive	very firm	too clayey and 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
10_1	0 - 5	small pit	dark grey (5Y4/1)	clay	moist		massive	weak	contains a thin red brown layer within horizon that is possibly monosulfidic material
10_2	5 - 10	small pit	dark grey (5Y4/1)	clay	moist	10% yellowish brown In the matrix	subangular blocky	firm	
10_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist	5% yellowish brown In the matrix	subangular blocky	firm	
10_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist		massive	firm	
11_1	0 - 5	small pit	olive grey (5Y5/2)	clay	moist		columnar	weak	brown clay coatings between peds
11_2	5 - 10	small pit	olive grey (5Y4/2)	clay	moist		columnar	weak	brown clay coatings between peds
11_3	10 - 20	small pit	olive grey (5Y4/2)	clay	moist		columnar	weak	very sticky
11_4	20 - 40	small pit	olive grey (5Y4/2)	clay	moist		subangular blocky	weak	very sticky
11_W1	-	pit water							water sampled
12_W1	2 - 0	surface water							water sampled
12_1	0 - 5	small pit	grey (5Y5/1)	clay	wet		columnar	weak	brown clay coatings between peds
12_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		columnar	very weak	brown clay coatings between peds
12_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist		subangular blocky	very weak	brown clay coatings between peds, very sticky
12_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist		massive	very firm	very sticky, too clayey to auger below

Table 5-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12102).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%S_{av})	Acid Sulfate Soil Material Classification
1.1	0-5	Fine	25,200	7.97	7.75	8.22	8.12	3,500	9.53	0.00	0.02	37.61	-4997		hyposulfidic (S_{CR}<0.10%)
1.2	5-10	Fine	27,200	7.49	6.24	7.37	7.69	2,200	8.92	0.00	0.06	27.75	-3659		hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	18,500	7.34	6.37	7.29	7.60	2,600	8.78	0.00	0.09	35.72	-4702		hyposulfidic (S_{CR}<0.10%)
1.4	20-40	Fine	6,780	8.05	6.87	7.31	6.84	620	8.49	0.00	0.25	0.57	80		hyposulfidic (S_{CR}≥0.10%)
1.5	40-75	Fine	4,090	8.35	8.05	8.27	7.77	260	8.40	0.00	0.02	0.58	-65		hyposulfidic (S_{CR}<0.10%)
2.1	0-5	Fine	37,900	7.81	6.57	7.71	7.79	6,000	8.77	0.00	0.19	32.65	-4231		hyposulfidic (S_{CR}≥0.10%)
2.2	5-10	Fine	37,900	7.63	6.38	7.04	7.89	5,000	8.78	0.00	0.34	30.27	-3821		hyposulfidic (S_{CR}≥0.10%)
2.3	10-20	Fine	64,000	7.90	6.51	6.95	7.70	5,200	8.38	0.00	1.03	28.26	-3122	0.09	hyposulfidic (S_{CR}≥0.10%) monosulfidic
2.4	20-40	Fine	8,810	7.87	7.28	6.98	7.80	2,100	8.71	0.00	0.40	9.95	-1076		hyposulfidic (S_{CR}≥0.10%)
2.5	40-70	Fine	19,660	8.03	6.92	7.27	7.85	610	8.61	0.00	0.12	0.73	-22		hyposulfidic (S_{CR}≥0.10%)
2.W1	-	..	..	..	..	..	..	..	..	..	..	..	..		pit water
3.1	0-5	Coarse	15,010	7.86	7.19	7.89	8.09	1,600	9.35	0.00	<0.01	2.34	-312		other soil material
3.2	5-10	Coarse	13,280	7.69	6.74	7.56	7.77	300	9.38	0.00	<0.01	0.71	-95		other soil material
3.3	10-20	Coarse	10,960	7.70	7.41	7.60	7.86	240	8.24	0.00	<0.01	0.06	-8		other soil material
3.4	20-40	Medium	9,300	7.71	7.56	7.52	7.91	240	7.63	0.00	<0.01	0.37	-49		other soil material
3.5	40-65	Fine	7,440	7.67	7.67	7.80	8.05	710	8.37	0.00	<0.01	0.68	-91		other soil material
4.W1	15-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
4.1	0-5	Fine	22,460	8.05	6.57	7.62	7.79	2,800	8.73	0.00	0.29	37.54	-4820		hyposulfidic (S_{CR}≥0.10%)
4.2	5-10	Fine	25,400	7.96	6.45	7.39	7.81	4,300	8.68	0.00	0.56	10.39	-1034		hyposulfidic (S_{CR}≥0.10%)
4.3	10-20	Fine	17,680	7.83	6.65	7.00	7.77	1,900	8.64	0.00	0.55	5.29	-362		hyposulfidic (S_{CR}≥0.10%)
4.4	20-40	Fine	23,640	7.79	6.63	7.08	7.78	3,200	8.67	0.00	0.50	17.68	-2043		hyposulfidic (S_{CR}≥0.10%)
5.1	0-5	Fine	16,090	7.66	6.53	7.67	7.76	2,800	8.72	0.00	0.01	48.28	-6425		hyposulfidic (S_{CR}<0.10%)
5.2	5-10	Fine	17,080	7.67	6.66	7.72	7.91	1,600	8.83	0.00	0.02	50.09	-6660		hyposulfidic (S_{CR}<0.10%)
5.3	10-20	Fine	17,670	7.60	6.58	7.56	7.78	1,700	8.80	0.00	0.03	37.30	-4949		hyposulfidic (S_{CR}<0.10%)
5.4	20-40	Fine	20,420	7.39	6.58	7.45	7.80	2,100	8.18	0.00	0.14	20.05	-2584		hyposulfidic (S_{CR}≥0.10%)
5.5	40-90	Fine	2,280	8.18	8.08	7.55	8.49	160	8.26	0.00	0.01	0.78	-98		hyposulfidic (S_{CR}<0.10%)
6.1	0-5	Fine	20,440	7.89	7.04	7.66	7.93	3,100	8.81	0.00	0.01	50.02	-6657		hyposulfidic (S_{CR}<0.10%)
6.2	5-10	Fine	13,440	7.88	6.28	7.62	7.72	2,600	8.59	0.00	0.41	32.26	-4042		hyposulfidic (S_{CR}≥0.10%)
6.3	10-20	Fine	17,070	7.97	6.32	7.46	7.65	3,000	8.47	0.00	0.93	23.69	-2576		hyposulfidic (S_{CR}≥0.10%)
6.4	20-40	Fine	13,060	8.28	7.90	7.16	7.63	980	8.55	0.00	0.40	3.16	-171		hyposulfidic (S_{CR}≥0.10%)
6.5	40-65	Fine	10,770	7.81	7.75	7.06	8.02	810	8.55	0.00	0.15	1.55	-114		hyposulfidic (S_{CR}≥0.10%)
6.W1	-	..	..	..	..	..	..	..	..	..	..	..	..		pit water

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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%S_{av})	Acid Sulfate Soil Material Classification
7.1	0-5	Fine	13,140	7.82	6.56	7.56	7.86	2,100	8.67	0.00	0.53	55.88	-7112		hyposulfidic (S_{CR}≥0.10%)
7.2	5-10	Fine	12,890	7.83	6.44	7.56	7.70	2,200	8.37	0.00	0.97	39.52	-4659		hyposulfidic (S_{CR}≥0.10%)
7.3	10-20	Fine	11,490	8.08	6.36	7.55	7.68	2,200	8.47	0.00	1.15	33.33	-3722	0.06	hyposulfidic (S_{CR}≥0.10%) monosulfidic
7.4	20-40	Fine	9,310	8.02	6.43	7.35	8.06	2,100	8.58	0.00	0.56	59.69	-7601	0.12	hyposulfidic (S_{CR}≥0.10%) monosulfidic
8.W1	3-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
8.1	0-5	Fine	6,300	7.83	6.59	7.68	7.84	540	8.74	0.00	0.33	65.66	-8540		hyposulfidic (S_{CR}≥0.10%)
8.2	5-10	Fine	6,970	8.11	6.53	7.83	7.79	780	7.96	0.00	1.12	37.63	-4314	0.08	hyposulfidic (S_{CR}≥0.10%)
8.3	10-20	..	4,170	8.16	6.37	7.43	7.88	920	..	..	..	..	..		salt crust
8.4	20-40	Fine	5,110	8.21	6.28	7.32	7.74	1,100	8.29	0.00	1.04	14.13	-1233		hyposulfidic (S_{CR}≥0.10%)
9.1	0-5	Coarse	8,570	8.33	7.31	8.41	8.33	1,700	8.89	0.00	0.01	3.75	-493		hyposulfidic (S_{CR}<0.10%)
9.2	5-10	Coarse	12,980	7.88	6.59	7.82	8.07	560	9.27	0.00	<0.01	0.93	-124		other soil material
9.3	10-20	Fine	13,940	6.90	6.50	6.08	6.31	810	7.96	0.00	<0.01	0.36	-48		other soil material
9.4	20-40	Fine	9,110	6.43	6.59	6.53	7.06	640	7.54	0.00	<0.01	0.56	-75		other soil material
10.1	0-5	Fine	33,100	8.07	7.51	7.31	7.76	5,500	7.02	0.00	0.16	9.52	-1169		hyposulfidic (S_{CR}≥0.10%)
10.2	5-10	Fine	34,000	7.53	6.98	7.07	7.65	3,200	8.60	0.00	0.02	1.19	-146		hyposulfidic (S_{CR}<0.10%)
10.3	10-20	Fine	19,690	6.74	6.22	5.66	6.15	1,700	6.42	1.45	<0.01	0.00	1		other soil material
10.4	20-40	Fine	17,830	6.29	6.82	6.21	6.94	940	6.40	0.97	<0.01	0.00	1		other soil material
11.1	0-5	Fine	35,900	7.81	6.57	7.37	7.85	6,500	8.91	0.00	0.13	13.48	-1714		hyposulfidic (S_{CR}≥0.10%)
11.2	5-10	Fine	31,300	8.10	6.39	7.31	7.94	5,300	8.81	0.00	0.47	1.71	65		hyposulfidic (S_{CR}≥0.10%)
11.3	10-20	Fine	31,100	7.89	6.65	7.11	7.74	5,000	8.70	0.00	0.48	10.43	-1091		hyposulfidic (S_{CR}≥0.10%)
11.4	20-40	Fine	18,550	7.88	2.67	7.53	7.68	1,600	8.42	0.00	0.34	0.48	148		hyposulfidic (S_{CR}≥0.10%)
11.W1	-	..	..	..	..	..	..	..	..	..	..	..	..		pit water
12.W1	2-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
12.1	0-5	Fine	39,200	7.89	6.62	7.31	7.85	6,400	9.30	0.00	0.13	11.92	-1506		hyposulfidic (S_{CR}≥0.10%)
12.2	5-10	Fine	30,900	8.06	6.30	7.56	7.84	3,600	8.93	0.00	0.44	15.70	-1817		hyposulfidic (S_{CR}≥0.10%)
12.3	10-20	Fine	19,830	7.47	6.55	7.10	7.53	3,100	8.63	0.00	0.35	2.37	-98		hyposulfidic (S_{CR}≥0.10%)
12.4	20-40	Fine	20,340	7.86	6.71	6.62	7.58	2,800	8.59	0.00	0.31	1.92	-63		hyposulfidic (S_{CR}≥0.10%)

Table 5-5. Summary of hydrochemical field measurements for Berri Disposal Basin (Wetland ID. 12102).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=3)	7.32-7.89	27442-180556	0.81-13.8	44-195	18-85	105-349
Pit waters (n = 3)	6.51-8.09	106889-174952	0.1-4.91	47-193		144-349

Table 5-6. Summary of hydrochemical field measurements for Berri Disposal Basin (Wetland ID. 12102).

Parameter	units	ANZECC Guidelines	Site 2 (PW)	Site 4 (SW)	Site 6 (PW)	Site 8 (SW)	Site 11 (PW)	Site 12 (SW)
Na	mg l^{-1}		56100	5560	27100	6190	55500	29300
K	mg l^{-1}		484.0	73.4	377.0	94.8	636.0	376.0
Ca	mg l^{-1}		702	291	705	304	815	1090
Mg	mg l^{-1}		5310	493	2360	485	4690	2800
Si	mg l^{-1}		<25	4.87	9.04	2.24	<5	<5
Br	mg l^{-1}		260.0	26.0	120.0	28.0		130.0
Cl	mg l^{-1}		120000	11000	51000	12000		55000
NO_3	mg l^{-1}	0.7	<0.022	<0.022	**0.974**	0.025		0.022
NH_4-N^K	mg l^{-1}	0.01	**6.10**	**0.014**	**1.100**	**0.200**		**1.400**
PO_4-P^E	mg l^{-1}	0.005	**5.521**	**0.077**	**2.300**	**0.153**		**0.043**
SO_4	mg l^{-1}		17000	2600	10000	2800		10000
Ag	µg l^{-1}	0.05	<0.2	<0.4	<0.1	<0.4	<0.4	<0.4
Al^A	µg l^{-1}	55	<400	<1000	<300	<1000	<1000	<1000
As^B	µg l^{-1}	13	<8	<20	<5	<20	<20	<20
Cd	µg l^{-1}	0.2	<0.4	<1	<0.3	<1	<1	<1
Co	µg l^{-1}	2.8	<0.3	<0.8	0.2	<0.8	<0.8	<0.8
Cr^C	µg l^{-1}	1	<2	<5	<1	<5	<5	<5
Cu^H	µg l^{-1}	1.4	<8	<20	<5	**80**	**40**	**40**
Fe	µg l^{-1}	300	<50000	<1000	<10000	<1000	<10000	<10000
Mn	µg l^{-1}	1700	108	**8682**	54	1278	570	264
Ni^H	µg l^{-1}	11	<4	<10	<3	<10	<10	<10
Pb^H	µg l^{-1}	3.4	<4	<10	<2	<10	<10	<10
Se	µg l^{-1}	11	<3	<8	<2	<8	<8	<8
Zn^H	µg l^{-1}	8	**50**	**180**	<10	**160**	<40	**260**
DOC	mg l^{-1}		99.7	15.4	49.4	22.6		87.6

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

6. BERRI DISPOSAL BASIN (WETLAND ID. 12103)

6.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12103) is situated on the north-western side of the River Murray, about 1 kilometre southwest from the town of Berri. The wetland is a somewhat crescent shape and is one of many wetlands in the complex. It is about 2.5 kilometres in length and about 200 metres at its widest, with a total surface area of 23 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river 1 kilometre away to the southeast, and by a hill slope to the north. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12092, 12095, 12101, 12102, and 12104.

The wetland is not connected to the river, and is essentially an internal basin and creek line. At the time when the soil survey was conducted in March 2010 the wetland did not have surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Grassland was growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Eight sites were sampled as shown in Figure 6-1, the two sites shown in the north east are described as part of Wetland ID. 12101.

Figure 6-1. Berri Disposal Basin (Wetland ID. 12103) and sample site locations.

6.2. Soil profile description and distribution

Eight sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 6-1. Sites were distributed along two transects placed across the wetland, at the southern end (Sites 17, 18, 19 and 20) and centre (Sites 21, 22, 23 and 24) 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.

Southern transect

Site 17 (Figure 6-3) occurred on the wetland margin at the edge where vegetation was growing, and the soil consisted of a greyish brown, very weak, granular structured clay loam, over greyish brown, very firm, blocky, clay. Site 18 (Figure 6-4) occurred mid way into the centre of the wetland, and the soil consisted of a dark greyish brown, very weak, clay loam, over a dark greyish brown, firm, clay. Site 19 (Figure 6-5) occurred near the wetland centre at the lowest elevation, and the soil consisted of a dark olive grey, very weak, granular structured, clay loam, over a dark grey, firm, blocky, clay. Site 20 (Figure 6-6) occurred at the wetland margin, and the soil consisted of very dark greyish brown, very weak, granular structured, clay loam, over dark olive grey, very firm, clay.

Central transect

Site 21 (Figure 6-7) occurred on the wetland margin where samphire vegetation was growing, and the soil consisted of a dark brown, very weak, clay loam, over an olive grey, very firm, clay. Site 22 (Figure 6-8) occurred near the centre of the wetland at the lowest elevation, and the soil consisted of a dark greyish brown, firm, clay loam over clay. Site 23 (Figure 6-9) occurred mid elevation, and the soil consisted of a grey, weak, clay, over a grey, very firm, clay. Site 24 (Figure 6-10) occurred on the wetland margin, and the soil consisted of a very dark greyish brown, weak, clay loam, over an olive grey, very firm, clay.

Table 6-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12103).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12103_17	461379	6204856	Other Soil (clayey)	high elevation on margins in line with dead trees
12103_18	461407	6204871	Other Soil (clayey)	low elevation end of lagoon
12103_19	461438	6204887	Other Soil (clayey)	low elevation, centre
12103_20	461509	6204936	Other Soil (clayey)	high elevation on margin
12103_21	461195	6205178	Other Soil (clayey)	high elevation, margin
12103_22	461248	6205197	Other Soil (clayey)	low elevation, centre
12103_23	461279	6205208	Other Soil (clayey)	low elevation
12103_24	461328	6205220	Other Soil (clayey)	high, margin

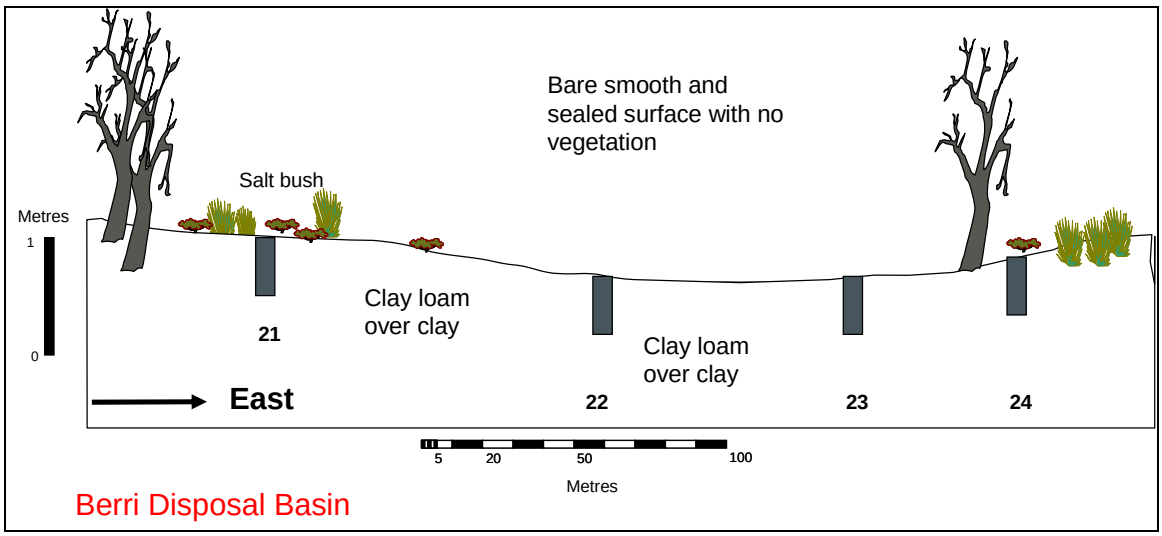


Figure 6-2. Conceptual cross-section diagram, showing location of Sites 21 to 24.

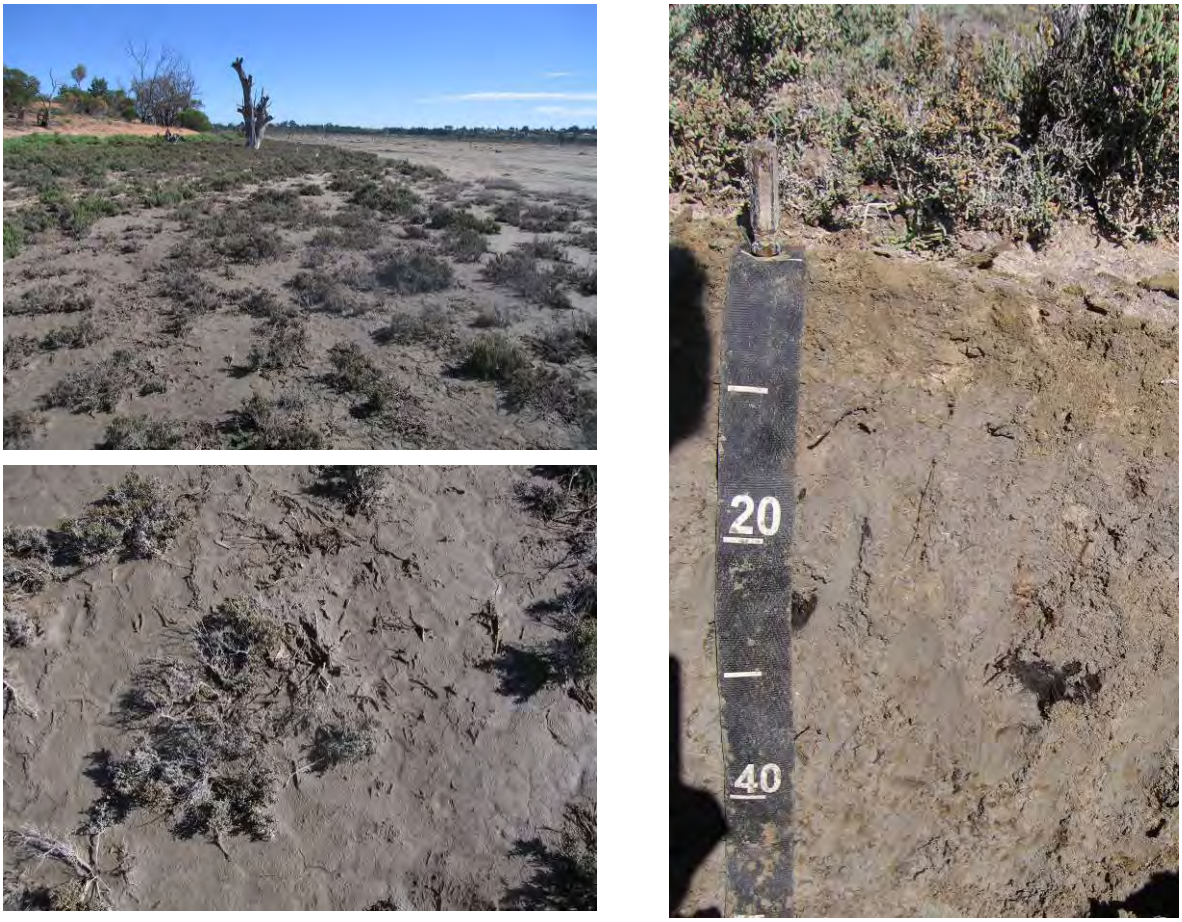


Figure 6-3. Photographs of Site 17, showing the site location on the wetland margin, the sealed soil surface, and soil profile.

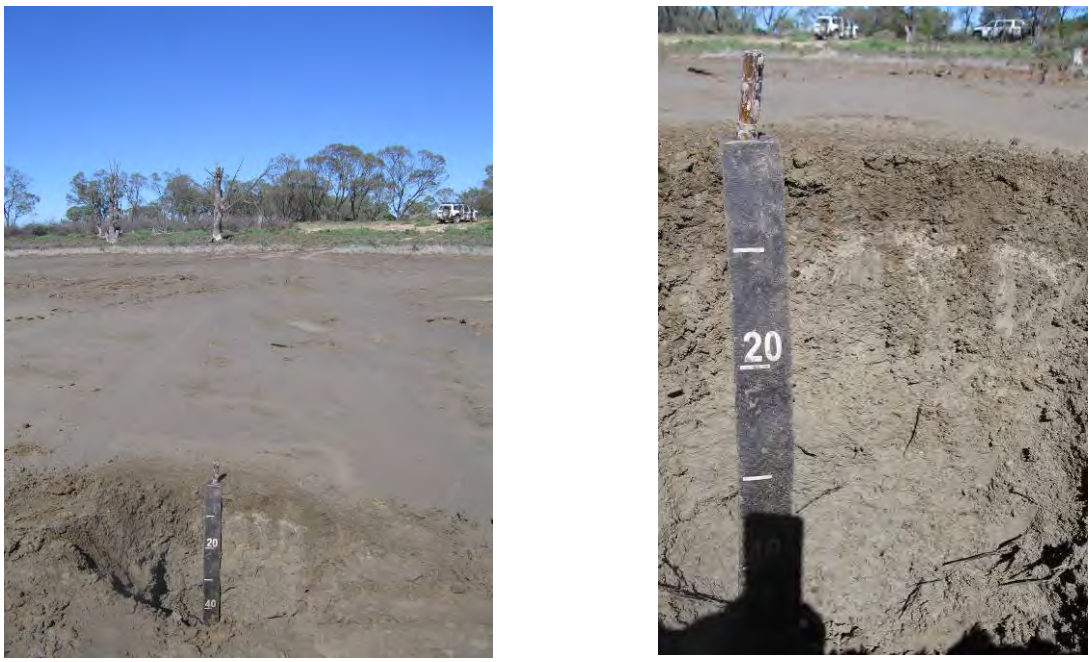


Figure 6-4. Photographs of Site 18, showing the site location relative to the nearest wetland margin, and the soil profile.

Figure 6-5. Photographs of Site 19, showing the site location near the middle of the wetland, and the soil profile.

Figure 6-6. Photographs of Site 20, showing the site location on the wetland margin, and the soil profile.

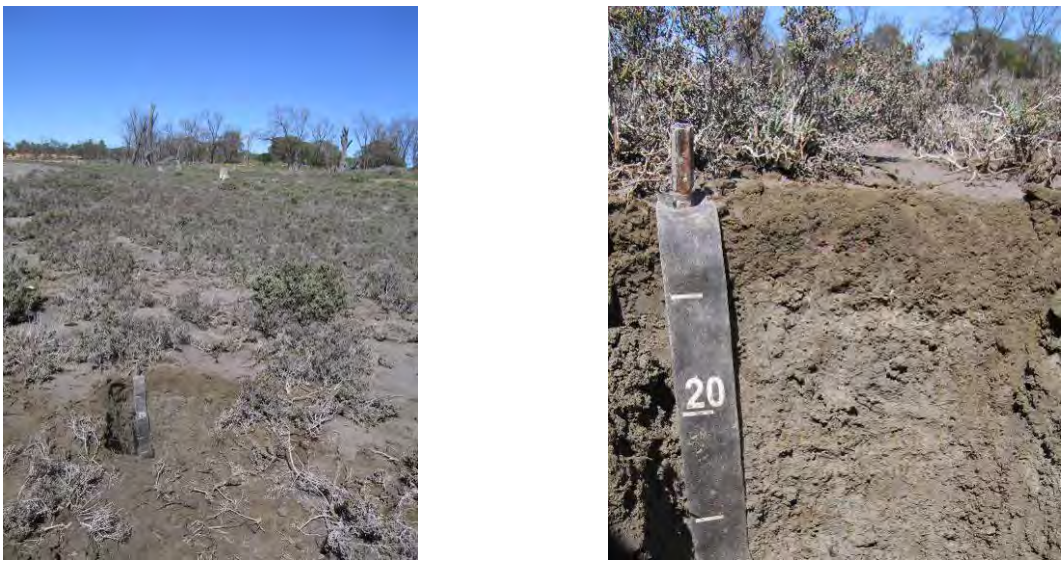


Figure 6-7. Photographs of Site 21, showing the site location on the wetland margin, and the soil profile

Figure 6-8. Photographs of Site 22, showing the site location near the centre of the wetland, and the soil profile.

Figure 6-9. Photographs of Site 23, showing the site location near the wetland centre where the soil surface is sealed, and the soil profile.

Figure 6-10. Photographs of Site 24, showing the site location near the wetland margin where vegetation was growing, and the soil profile.

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 6-11. The pH_W data ranged from 4.58 to 7.97 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 5.50 to 8.26 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 6.71 to 8.01 and identified that no samples on incubation declined below the critical values of pH <4

6.3.2. Acid base accounting

The acid base accounting data is provided in Table 6-4 and summarised in Figure 6-12.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.02 $\%S_{CR}$ and sulfidic materials were detected in at least one sample for each profile with the remaining sample values as zero.

Titratable actual acidity

Titratable actual acidity was detected only in one subsoil sample of Profile 22.

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 0.06 to 8.16 $\%CaCO_3$.and were measured in all samples.

Net acidity

Net acidity values ranged from -1086 to 2 mole H^+/tonne. All profile samples had negative net acidity values except for one subsoil layer in Profile 22 that was a low value.

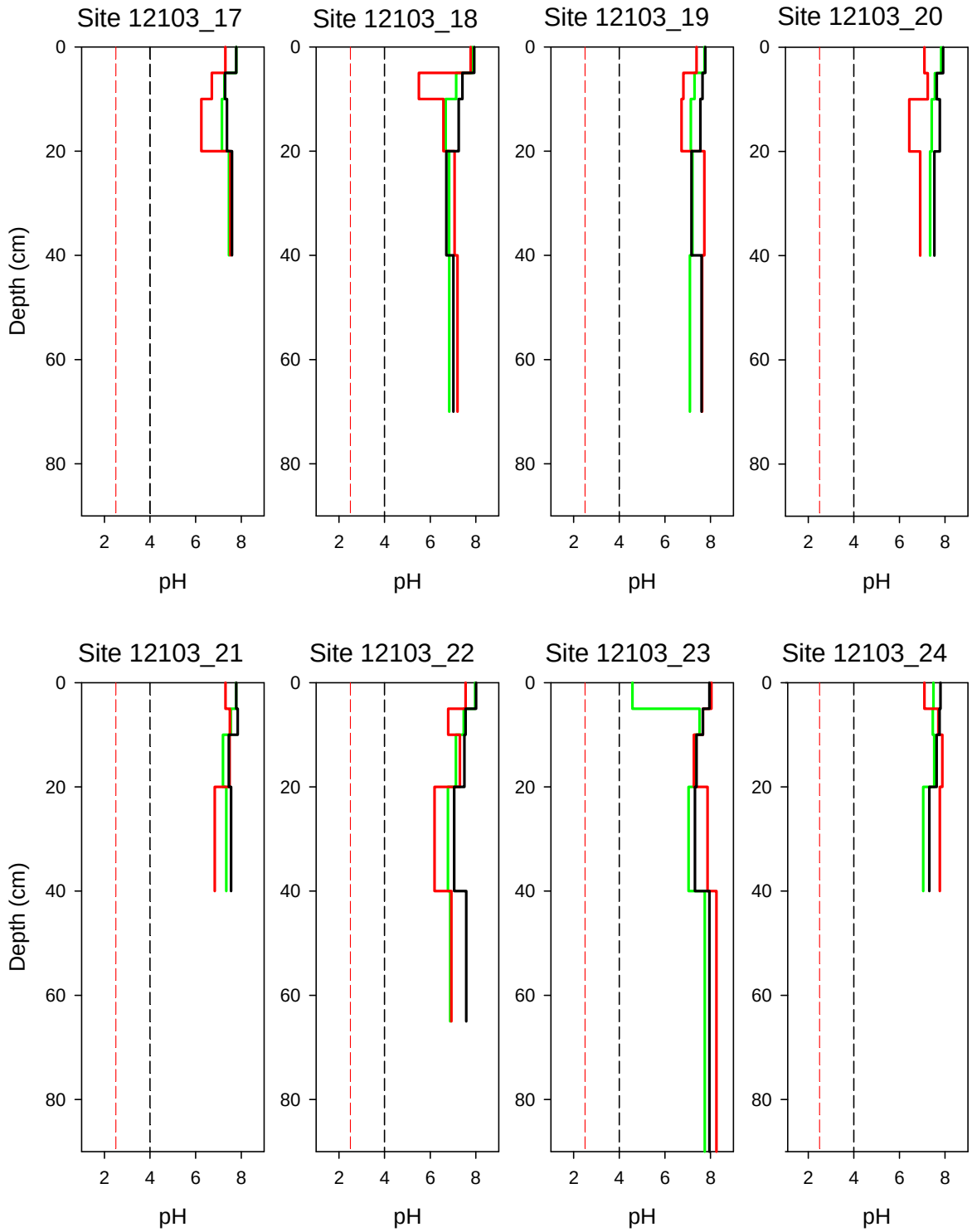


Figure 6-11. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12103), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

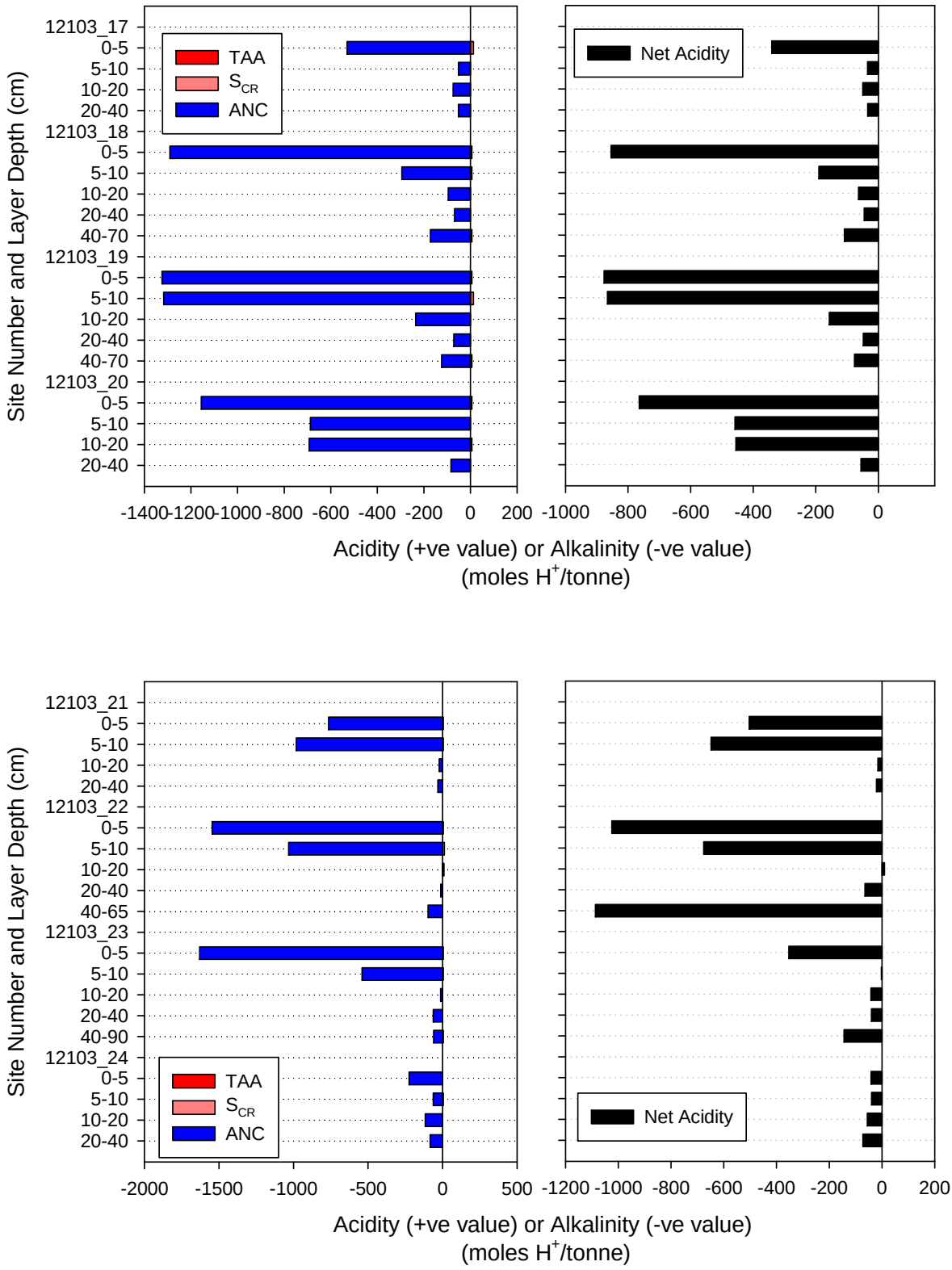


Figure 6-12. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12103). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

6.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 6-4 identified that all surface layers were above the criterion trigger value of 100 mg/kg SO_4.

6.3.4. Acid volatile sulfur

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

6.3.5. Hydrochemistry

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

6.4. Discussion

Acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12103) were identified as hyposulfidic and occurred in all of the profiles, often at the surface and the remaining layers were characterised 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 clay loam textured in the surface layers and clay textured in the subsoil layers.

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

The potential hazards posed by acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12103) are:

- Acidification hazard: The data identified negative net acidity values in all but one profile sample 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 soils, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that the low soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings Berri Disposal Basin (Wetland ID. 12103):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic or other soil materials. Soils were generally clay loam textured in the surface layers and clay textured in the subsoil layers. All but one sample had negative net acidity values and pH data did not indicate acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (clayey) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern • De-oxygenation hazard – medium level of concern • Metal mobilisation hazard – low level of concern

Table 6-2. Site description data for Berri Disposal Basin (Wetland ID. 12103).

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
17	30/03/2010	461379	6204856	not reached	light clayey, sealed	samphire	high elevation on margins in line with dead trees
18	30/03/2010	461407	6204871	not reached	sealed	bare	low elevation end of lagoon
19	30/03/2010	461438	6204887	not reached	sealed, clayey	bare	low elevation, centre
20	30/03/2010	461509	6204936	not reached	sealed, clayey	samphire	high elevation on margins
21	30/03/2010	461195	6205178	not reached	sealed, clayey	samphire	high elevation, margins
22	30/03/2010	461248	6205197	not reached	sealed, clayey	bare	low elevation, centre
23	30/03/2010	461279	6205208	not reached	sealed, clayey	bare	low elevation
24	30/03/2010	461328	6205220	not reached	clay, sealed	samphire, dead trees	high, margins

Table 6-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12103).

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	greyish brown (2.5Y5/2)	clay loam	dry		granular	very weak	
17_2	5 - 10	small pit	greyish brown (2.5Y5/2)	clay	moist	5% brown In the matrix	angular blocky	firm	
17_3	10 - 20	small pit	greyish brown (2.5Y5/2)	clay	moist	25% brown In the matrix	angular blocky	firm	
17_4	20 - 40	small pit	greyish brown (2.5Y5/2)	clay	moist	20% brown In the matrix	angular blocky	very firm	
18_1	0 - 5	small pit	dark greyish brown (2.5Y4/2)	clay loam	moist		granular	very weak	
18_2	5 - 10	small pit	dark greyish brown (2.5Y4/2)	clay	moist	10% olive brown In the matrix	angular blocky	firm	
18_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	moist	15% olive brown In the matrix	angular blocky	firm	
18_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	clay	moist	15% olive brown In the matrix	subangular blocky	firm	possible slickensides, 5% carbonate fragments
18_5	40 - 70	small pit	dark greyish brown (2.5Y4/2)	clay	moist		angular blocky	very firm	
19_1	0 - 5	small pit	dark olive grey (5Y3/2)	clay loam	moist		granular	very weak	
19_2	5 - 10	small pit	dark olive grey (5Y3/2)	clay	moist	10% olive In the matrix	subangular blocky	firm	
19_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist	15% olive brown In the matrix	subangular blocky	firm	
19_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist	20% olive brown In the matrix	subangular blocky	firm	slickensides
19_5	40 - 70	small pit	dark grey (5Y4/1)	clay	moist		subangular blocky	firm	slickensides
20_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	clay loam	moist		granular	very weak	
20_2	5 - 10	small pit	very dark greyish brown (10YR3/2)	clay	moist	10% reddish brown infused into the matrix along faces of peds	subangular blocky	firm	
20_3	10 - 20	small pit	dark olive grey (5Y3/2)	clay	moist	20% reddish brown infused into the matrix along faces of peds	subangular blocky	firm	
20_4	20 - 40	small pit	dark olive grey (5Y3/2)	clay	moist	10% reddish brown infused into the matrix along faces of peds	subangular blocky	very firm	5% carbonate fragments, too clayey to auger

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
21_1	0 - 5	small pit	dark brown (10YR3/3)	clay loam	moist		granular	very weak	fragments have a fluffy feel
21_2	5 - 10	small pit	dark brown (10YR3/3)	clay	moist	10% reddish brown infused into the matrix along faces of peds	subangular blocky	firm	
21_3	10 - 20	small pit	olive grey (5Y4/2)	clay	moist	15% reddish brown infused into the matrix along faces of peds	subangular blocky	firm	
21_4	20 - 40	small pit	olive grey (5Y4/2)	clay	moist	20% reddish brown infused into the matrix along faces of peds	subangular blocky	very firm	too clayey and hard to auger
22_1	0 - 5	small pit	dark greyish brown (10YR4/2)	clay loam	moist		granular	weak	
22_2	5 - 10	small pit	dark greyish brown (10YR4/2)	clay	moist	20% reddish brown infused into the matrix along faces of peds	subangular blocky	firm	
22_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	moist	5% olive infused into the matrix along faces of peds	subangular blocky	firm	
22_4	20 - 40	small pit	dark greyish brown (2.5Y4/2)	clay	moist		subangular blocky	firm	
22_5	40 - 65	small pit	dark greyish brown (2.5Y4/2)	clay	moist		subangular blocky	very firm	
23_1	0 - 5	small pit	grey (5Y5/1)	clay	moist		granular	weak	
23_2	5 - 10	small pit	grey (5Y5/1)	clay	moist	25% dark brown infused into the matrix adjacent to pores	subangular blocky	firm	
23_3	10 - 20	small pit	grey (5Y5/1)	clay	moist	25% dark reddish brown infused into the matrix adjacent to pores	subangular blocky	firm	
23_4	20 - 40	small pit	grey (5Y5/1)	clay	moist	15% dark reddish brown infused into the matrix	subangular blocky	very firm	
23_5	40 - 90	small pit	grey (5Y5/1)	clay	moist		subangular blocky	firm	
24_1	0 - 5	small pit	very dark greyish brown (2.5Y3/2)	clay loam	moist		granular	weak	
24_2	5 - 10	small pit	very dark greyish brown (2.5Y3/2)	clay	moist	15% reddish brown infused into the matrix adjacent to pores	subangular blocky	firm	
24_2DUP	5 - 10	small pit	very dark greyish brown (2.5Y3/2)	clay	moist	15% reddish brown infused into the matrix	subangular blocky	firm	
24_3	10 - 20	small pit	olive grey (5Y4/2)	clay	moist		subangular blocky	firm	slickensides, 10% carbonate fragments
24_4	20 - 40	small pit	olive grey (5Y4/2)	clay	moist		subangular blocky	firm	slickensides, 10% carbonate fragments

Table 6-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12103).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
17.1	0-5	Medium	20,590	7.78	7.30	7.67	7.78	2,600	8.66	0.00	0.02	2.65	-341	hyposulfidic (S_{CR}<0.10%)
17.2	5-10	Medium	10,230	7.26	6.71	7.05	7.29	1,100	7.97	0.00	<0.01	0.26	-35	other soil material
17.3	10-20	Fine	9,060	7.15	6.25	7.20	7.37	360	7.59	0.00	<0.01	0.37	-50	other soil material
17.4	20-40	Fine	11,720	7.46	7.52	7.40	7.59	760	7.14	0.00	<0.01	0.26	-34	other soil material
18.1	0-5	Fine	25,300	7.84	7.77	7.65	7.93	4,100	8.23	0.00	0.01	6.46	-854	hyposulfidic (S_{CR}<0.10%)
18.2	5-10	Fine	13,380	7.14	5.50	7.03	7.41	890	8.13	0.00	0.01	1.47	-190	hyposulfidic (S_{CR}<0.10%)
18.3	10-20	Fine	16,540	6.68	6.58	6.95	7.25	980	7.37	0.00	<0.01	0.48	-64	other soil material
18.4	20-40	Fine	14,900	6.83	7.07	6.56	6.71	1,600	7.00	0.00	<0.01	0.34	-45	other soil material
18.5	40-70	Fine	14,240	6.84	7.20	6.53	7.02	790	7.30	0.00	0.01	0.86	-108	hyposulfidic (S_{CR}<0.10%)
19.1	0-5	Fine	25,400	7.74	7.39	7.29	7.77	4,300	8.09	0.00	0.01	6.63	-877	hyposulfidic (S_{CR}<0.10%)
19.2	5-10	Fine	29,000	7.30	6.81	7.36	7.65	3,300	8.44	0.00	0.02	6.59	-866	hyposulfidic (S_{CR}<0.10%)
19.3	10-20	Fine	20,180	7.14	6.73	7.09	7.56	790	8.26	0.00	<0.01	1.18	-157	other soil material
19.4	20-40	Fine	18,470	7.21	7.73	7.06	7.17	860	7.52	0.00	<0.01	0.36	-48	other soil material
19.5	40-70	Fine	14,990	7.10	7.63	7.02	7.61	1,200	7.72	0.00	0.01	0.62	-76	hyposulfidic (S_{CR}<0.10%)
20.1	0-5	Fine	22,330	7.83	7.09	7.79	7.92	3,600	8.46	0.00	0.01	5.78	-764	hyposulfidic (S_{CR}<0.10%)
20.2	5-10	Fine	20,970	7.55	7.24	7.30	7.64	2,200	8.48	0.00	<0.01	3.44	-458	other soil material
20.3	10-20	Fine	15,840	7.41	6.43	7.29	7.77	1,200	8.47	0.00	0.01	3.47	-455	hyposulfidic (S_{CR}<0.10%)
20.4	20-40	Fine	12,150	7.34	6.91	7.38	7.53	740	7.90	0.00	<0.01	0.42	-56	other soil material
21.1	0-5	Fine	20,500	7.77	7.31	7.72	7.78	4,200	8.26	0.00	0.01	3.83	-503	hyposulfidic (S_{CR}<0.10%)
21.2	5-10	Fine	19,210	7.54	7.50	7.57	7.84	2,500	8.38	0.00	0.01	4.91	-648	hyposulfidic (S_{CR}<0.10%)
21.3	10-20	Fine	14,460	7.20	7.49	7.24	7.45	690	7.82	0.00	<0.01	0.11	-15	other soil material
21.4	20-40	Fine	12,860	7.34	6.84	7.49	7.55	800	7.51	0.00	<0.01	0.15	-21	other soil material
22.1	0-5	Fine	21,670	7.97	7.55	7.95	8.01	3,700	8.38	0.00	0.01	7.74	-1024	hyposulfidic (S_{CR}<0.10%)
22.2	5-10	Fine	26,400	7.47	6.79	7.61	7.55	1,700	8.43	0.00	0.02	5.16	-675	hyposulfidic (S_{CR}<0.10%)
22.3	10-20	Fine	18,810	7.13	7.30	7.05	7.50	930	6.26	3.34	0.01		2	hyposulfidic (S_{CR}<0.10%)
22.4	20-40	Fine	16,080	6.78	6.19	6.70	7.05	600	6.62	0.00	<0.01	0.06	-64	other soil material
22.5	40-65	Fine	16,050	6.88	6.93	6.88	7.58	600	6.67	0.00	<0.01	0.48	-1086	other soil material
23.1	0-5	Fine	25,600	4.58	8.04	7.77	7.95	3,400	7.57	0.00	0.01	8.16	-353	hyposulfidic (S_{CR}<0.10%)
23.2	5-10	Fine	21,460	7.52	7.67	7.30	7.67	900	8.46	0.00	0.01	2.70	-2	hyposulfidic (S_{CR}<0.10%)
23.3	10-20	Fine	10,580	7.32	7.27	7.33	7.39	290	7.80	0.00	<0.01	0.06	-42	other soil material
23.4	20-40	Fine	7,070	7.04	7.87	7.20	7.32	280	7.54	0.00	<0.01	0.31	-40	other soil material
23.5	40-90	Fine	7,140	7.75	8.26	7.18	7.95	360	7.48	0.00	0.01	0.30	-144	hyposulfidic (S_{CR}<0.10%)

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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
24.1	0-5	Fine	20,850	7.49	7.09	7.57	7.80	3,300	7.53	0.00	<0.01	1.13	-41	other soil material
24.2	5-10	Fine	17,750	7.46	7.71	7.52	7.76	520	7.80	0.00	0.01	0.31	-39	hyposulfidic (S_{CR}<0.10%)
24.2DUP	5-10	Fine	18,220	7.45	7.64	7.52	7.80	510	7.54	0.00	<0.01	0.34	-77	other soil material
24.3	10-20	Fine	16,060	7.52	7.88	7.35	7.63	450	7.50	0.00	<0.01	0.58	-55	other soil material
24.4	20-40	Fine	8,160	7.04	7.77	7.23	7.31	390	7.15	0.00	<0.01	0.42	-72	other soil material

7. BERRI DISPOSAL BASIN (WETLAND ID. 12104)

7.1. Location and setting description

Berri Disposal Basin (Wetland ID. 12104) is situated on the north-western side of the River Murray, about 1 kilometre southwest from the town of Berri. The wetland is somewhat rectangular in shape and is one of many wetlands in the complex. It is about 750 metres in length and about 250 metres at its widest, with a total surface area of 15 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river 1 kilometre away to the southeast, and by a steep hill slope to the north. The other associated wetlands in the Berri Disposal Basin Complex that were surveyed are wetland IDs. 12092, 12095, 12101, 12102, and 12103.

The wetland is not connected to the river and is essentially an internal basin. At the time when the soil survey was conducted in March 2010 the wetland did not have surface water. The wetland is controlled by Department of Environment and Natural Resources (DENR) and it is not known if it is managed. Grassland was growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Four sites were sampled as shown in Figure 7-1.

Figure 7-1. Berri Disposal Basin (Wetland ID. 12104) and sample site locations.

7.2. Soil profile description and distribution

Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 7-1. Sites were distributed along one transects placed across the centre (Sites 13, 14, 15 and 16) of the wetland. The site and soil profile descriptions are presented in Table 7-2 and Table 7-3, and a conceptual cross-section diagram in Figure 7-2.

Centre transect

Site 13 (Figure 7-3) occurred on the wetland margin at the edge where vegetation was growing, and the soil consisted of a dark greyish brown, weak, clay loam, over a greyish brown, very firm, clay. Site 14 (Figure 7-4) occurred mid way into the centre of the wetland, and the soil consisted of an olive grey, weak, clay loam, over an olive grey, very firm, clay. Site 15 (Figure 7-5) occurred near the wetland centre at the lowest elevation, and the soil consisted of an olive grey, weak, clay loam, over an olive grey, very firm, clay. Site 16 (Figure 7-6) occurred at the wetland margin adjacent to the hill slope, and the soil consisted of a greyish brown, firm, clay loam, over a greyish brown, very firm clay.

Table 7-1. Soil identification, subtype and general location description for Berri Disposal Basin (Wetland ID. 12104).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12104_13	460726	6205823	Other Soil (clayey)	high on margin
12104_14	460713	6205882	Other Soil (clayey)	mid elevation, where vegetation stops.
12104_15	460705	6205926	Other Soil (clayey)	low elevation, centre wetland
12104_16	460678	6206067	Other Soil (clayey)	mid/high, below base of slope

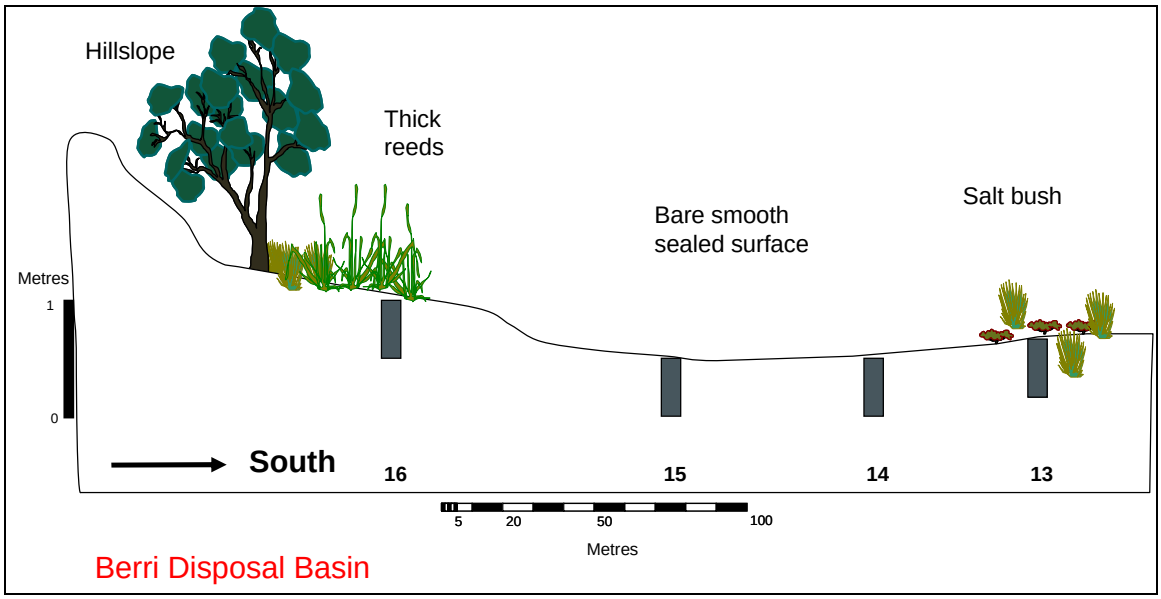


Figure 7-2. Conceptual cross-section diagram.

Figure 7-3. Photographs of Site 13, showing the site location on the wetland margin, and the soil profile.

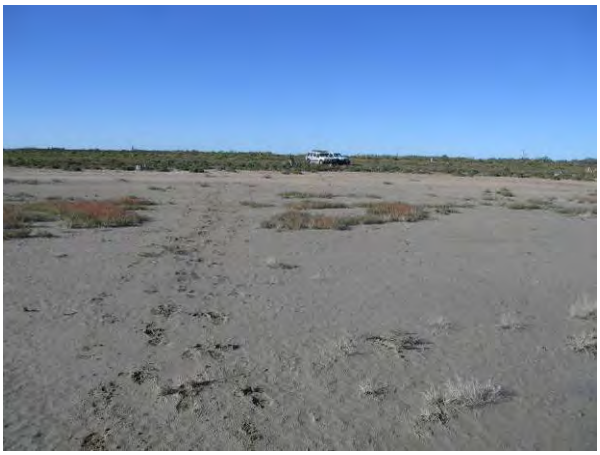


Figure 7-4. Photograph of Site 14, showing the site location relative to the nearest wetland margin defined by the vegetation in the background.

Figure 7-5. Photograph of Site 15, showing the site location near the middle of the wetland.


Figure 7-6. Photographs of Site 16, showing the site location on the wetland margin adjacent to the hill slope amongst Phragmites, and the soil profile.

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 7-7. The pH_W data ranged from 7.52 to 8.14 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 6.43 to 8.23 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 7.80 to 8.20 and identified that no samples on incubation declined below the critical values of pH <4.

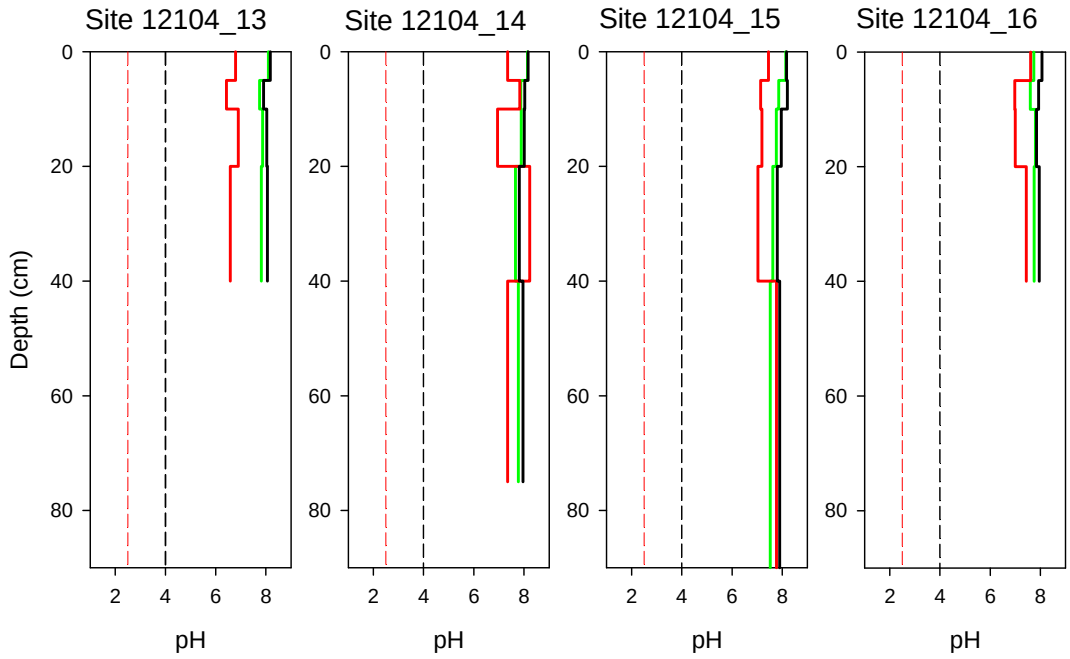


Figure 7-7. Depth profiles of soil pH for Berri Disposal Basin (Wetland ID. 12104), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} 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 7-8.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.02 $\%S_{CR}$ and sulfidic materials were just detected in at least one sample for each profile with the remaining values as zero.

Titratable actual acidity

Titratable actual acidity was not measured in any of the samples.

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 0.45 to 30.53 $\%CaCO_3$.and were measured in all samples.

Net acidity

Net acidity values ranged from -4054 to -54 mole H^+/tonne. All profile samples had negative values.

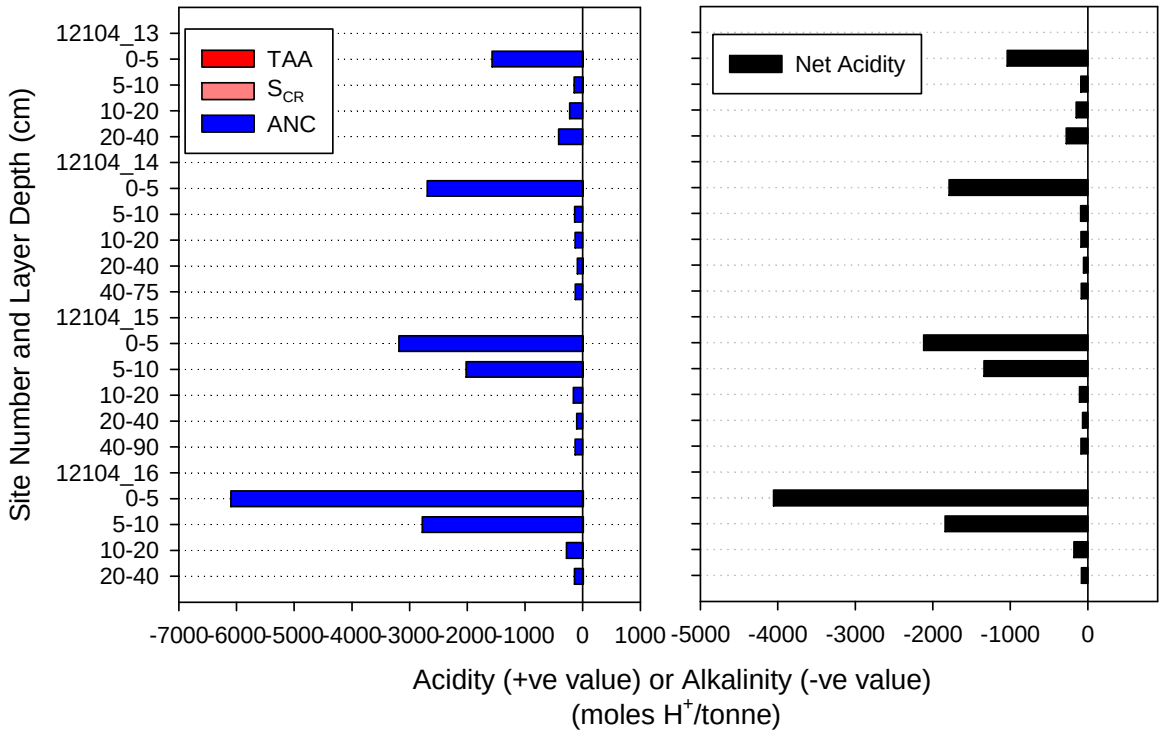


Figure 7-8. Acid base accounting depth profiles for Berri Disposal Basin (Wetland ID. 12104). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

7.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 7-4 identified that all surface layers were above the criterion trigger value of 100 mg/kg SO_4.

7.3.4. Acid volatile sulfur

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

7.3.5. Hydrochemistry

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

7.4. Discussion

Acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12104) were identified as hyposulfidic and occurred in all of the profiles often at the surface, the remaining layers were characterised 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 clay loam textured in the surface layers and clay textured in the subsoil layers.

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

The potential hazards posed by acid sulfate soil materials at Berri Disposal Basin (Wetland ID. 12104) are:

- Acidification hazard: The data identified negative net acidity values in all profile 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 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 Berri Disposal Basin (Wetland ID. 12104):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic or other soil materials. Soils were clay loam textured in the surface and clay textured in the subsoil layers. All samples had negative net acidity values and pH data did not indicate acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (clayey) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern • De-oxygenation hazard – medium level of concern • Metal mobilisation hazard – low level of concern

Table 7-2. Site description data for Berri Disposal Basin (Wetland ID. 12104).

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
13	30/03/2010	460726	6205823	not reached	sealed, cracking when dry	samphire	high on margin
14	30/03/2010	460713	6205882	not reached	sealed, cracking when dry	samphire, veg edge	mid elevation, where vegetation stops.
15	30/03/2010	460705	6205926	not reached	sealed	bare	low elevation, centre wetland
16	30/03/2010	460678	6206067	not reached	firm	Phragmites	mid/high, below base of slope

Table 7-3. Soil profile description data for Berri Disposal Basin (Wetland ID. 12104).

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_1	0 - 5	small pit	dark greyish brown (10YR4/2)	clay loam	dry		massive	weak	
13_2	5 - 10	small pit	dark greyish brown (10YR4/2)	clay	dry		subangular blocky	very firm	many plant roots
13_3	10 - 20	small pit	greyish brown (2.5Y5/2)	clay	moist		subangular blocky	very firm	many plant roots
13_4	20 - 40	small pit	greyish brown (2.5Y5/2)	clay	moist		massive	very firm	common plant roots
14_1	0 - 5	small pit	olive grey (5Y5/2)	clay loam	dry		subangular blocky	weak	
14_2	5 - 10	small pit	olive grey (5Y5/2)	clay	moist	2% dark brown In the matrix	angular blocky	firm	
14_3	10 - 20	small pit	olive grey (5Y5/2)	clay	moist	5% olive brown In the matrix	angular blocky	firm	
14_4	20 - 40	small pit	olive grey (5Y5/2)	clay	moist		angular blocky	firm	
14_5	40 - 75	small pit	olive grey (5Y5/2)	clay	moist		massive	very firm	
15_1	0 - 5	small pit	olive grey (5Y5/2)	clay loam	dry		angular blocky	weak	
15_2	5 - 10	small pit	olive grey (5Y4/2)	clay	moist		angular blocky	very firm	
15_3	10 - 20	small pit	olive grey (5Y4/2)	clay	moist		angular blocky	very firm	slickensides observed on ped faces
15_4	20 - 40	small pit	olive grey (5Y4/2)	clay	moist		angular blocky	very firm	slickensides observed on ped faces, slightly sticky
15_5	40 - 90	small pit	olive grey (5Y4/2)	clay	moist		angular blocky	very firm	slickensides observed on ped faces, slightly sticky
16_1	0 - 5	small pit	greyish brown (2.5Y5/2)	clay loam	moist		subangular blocky	firm	
16_2	5 - 10	small pit	greyish brown (2.5Y5/2)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	subangular blocky	firm	many roots
16_3	10 - 20	small pit	greyish brown (2.5Y5/2)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	subangular blocky	very firm	many roots
16_4	20 - 40	small pit	greyish brown (2.5Y5/2)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	subangular blocky	very firm	many roots

Table 7-4. Laboratory data for acid sulfate soil assessment of Berri Disposal Basin (Wetland ID. 12104).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
13.1	0-5	Medium	21,300	8.10	6.79	8.05	8.18	2,600	8.82	0.00	0.01	..	7.86	-1040	hyposulfidic (S_{CR}<0.10%)
13.2	5-10	Fine	10,640	7.75	6.43	7.88	7.91	800	8.51	0.00	0.01	..	0.72	-90	hyposulfidic (S_{CR}<0.10%)
13.3	10-20	Fine	8,450	7.87	6.90	7.91	8.04	540	8.78	0.00	<0.01	..	1.13	-150	other soil material
13.4	20-40	Fine	8,430	7.82	6.58	7.95	8.06	500	8.94	0.00	<0.01	..	2.09	-278	other soil material
14.1	0-5	Fine	14,830	8.14	7.35	8.27	8.16	2,600	8.93	0.00	0.01	..	13.49	-1790	hyposulfidic (S_{CR}<0.10%)
14.2	5-10	Fine	7,820	7.87	7.83	7.88	8.03	640	7.92	0.00	<0.01	..	0.69	-92	other soil material
14.3	10-20	Fine	9,260	7.89	6.95	7.84	8.01	600	7.57	0.00	<0.01	..	0.66	-88	other soil material
14.4	20-40	Fine	7,390	7.66	8.23	7.72	7.81	620	7.16	0.00	0.01	..	0.45	-54	hyposulfidic (S_{CR}<0.10%)
14.5	40-75	Fine	7,120	7.78	7.35	7.69	7.96	690	7.59	0.00	<0.01	..	0.64	-85	other soil material
15.1	0-5	Fine	17,830	8.14	7.45	8.03	8.17	5,700	8.76	0.00	0.01	..	15.94	-2118	hyposulfidic (S_{CR}<0.10%)
15.2	5-10	Fine	20,560	7.86	7.14	8.23	8.20	2,100	8.82	0.00	0.01	..	10.10	-1339	hyposulfidic (S_{CR}<0.10%)
15.3	10-20	Fine	16,290	7.76	7.19	7.74	7.96	1,000	7.93	0.00	<0.01	..	0.80	-106	other soil material
15.4	20-40	Fine	14,950	7.62	7.03	7.65	7.80	890	7.38	0.00	<0.01	..	0.50	-67	other soil material
15.5	40-90	Fine	8,440	7.52	7.77	7.48	7.90	870	7.14	0.00	<0.01	..	0.66	-88	other soil material
16.1	0-5	Fine	11,550	7.74	7.61	7.96	8.06	1,000	8.91	0.00	0.02	..	30.53	-4054	hyposulfidic (S_{CR}<0.10%)
16.2	5-10	Fine	7,880	7.60	6.98	8.09	7.93	670	8.94	0.00	0.02	..	13.92	-1841	hyposulfidic (S_{CR}<0.10%)
16.3	10-20	Fine	7,820	7.80	7.00	7.89	7.85	510	8.69	0.00	0.01	..	1.40	-180	hyposulfidic (S_{CR}<0.10%)
16.4	20-40	Fine	5,460	7.75	7.44	7.95	7.95	460	8.35	0.00	0.02	..	0.71	-82	hyposulfidic (S_{CR}<0.10%)

8. GURRA COMPLEX (WETLAND ID. 12338)

8.1. Location and setting description

Gurra Complex (Wetland ID. 12338) is situated on the eastern side of the River Murray, about, approximately 3 kilometres up river from the town of Berri. The wetland is rectangular in shape. It is about 600 metres in length and about 80 metres at its widest, with a total surface area of 4 hectares. The wetland is bounded by a raised floodplain that separates it from the river and the Gurra Lake that it is adjacent to.

The wetland is not directly connected to the river but is connected with the Gurra Lakes that are connected to the river. 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). There are sparse areas of Typha, Phragmites and Samphire growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 8-1.

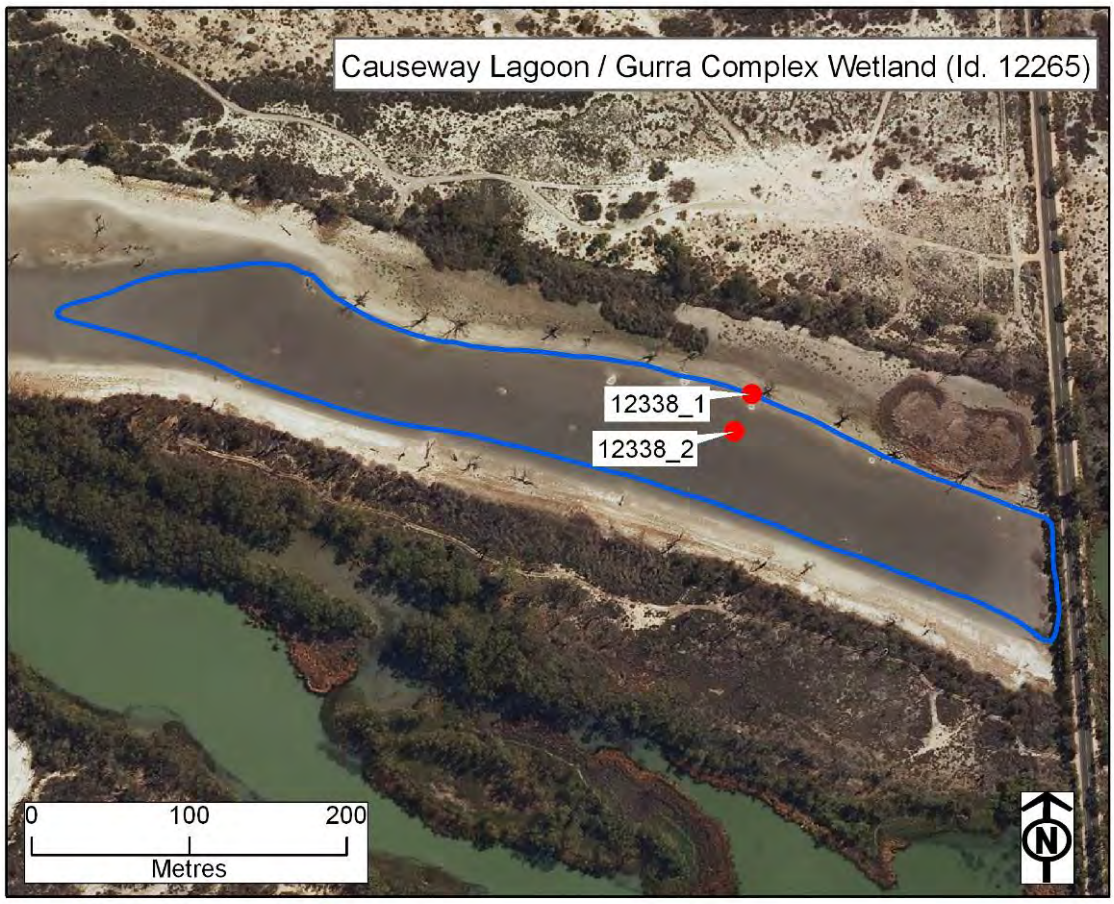


Figure 8-1. Gurra Complex (Wetland ID. 12338) and sample site locations.

8.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 8-1. Sites were distributed as a pair near the centre (Sites 1 and 2) 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.

Centre transect

Site 1 (Figure 8-3) occurred in water (10 cm deep), and the soil consisted of a black, very weak, monosulfidic material, over dark grey, very weak, clay. Site 2 (Figure 8-4) occurred in water (40 cm deep), and the soil consisted of a black, very weak, monosulfidic material, over a dark grey, very weak, clay.

Table 8-1. Soil identification, subtype and general location description for Gurra Complex (Wetland ID. 12338).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12338_1	463532	6203322	Subaqueous Soil (clayey)	mid elevation, 3 m offshore
12338_2	463521	6203298	Subaqueous Soil (clayey)	low elevation

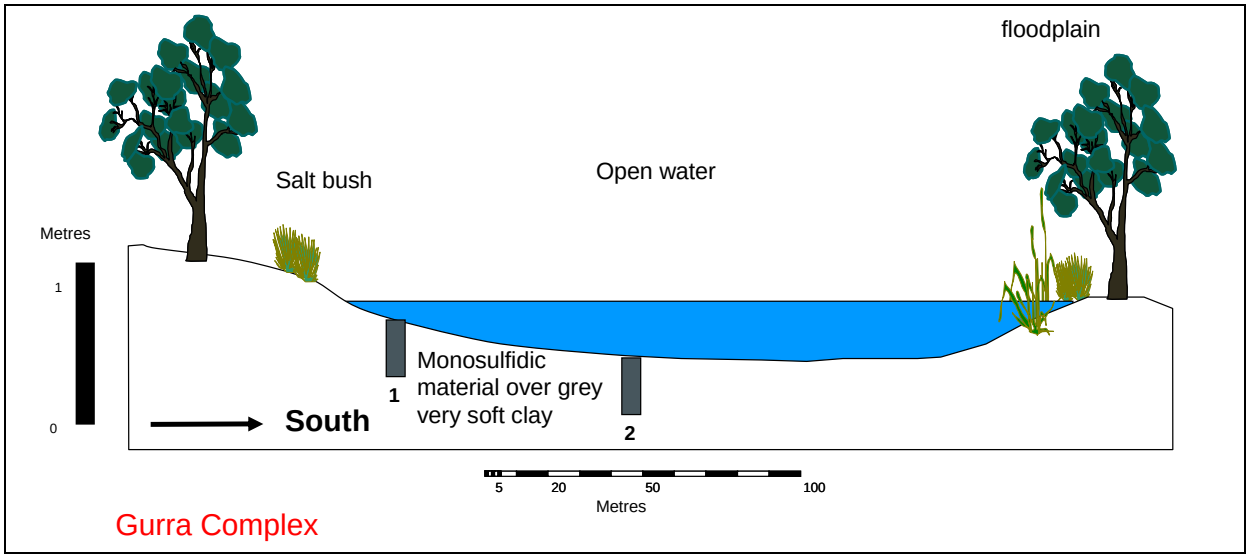


Figure 8-2. Conceptual cross-section diagram.

Figure 8-3. Photograph of Site 1, showing the site location on the wetland margin.

Figure 8-4. Photograph of Site 2, showing the site location placed in the surface water.

8.3. Laboratory data assessment

8.3.1. Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 8-4 and pH profiles are presented in Figure 8-5. The pH_W data ranged from 6.42 to 7.93 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 2.36 to 8.47 and identified that the subsurface layer in Profiles 1 was 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 5.64 to 7.97 and identified that no samples on incubation declined below the critical values of pH <4, indicating that these soils potentially would form sulfuric material on oxidation.

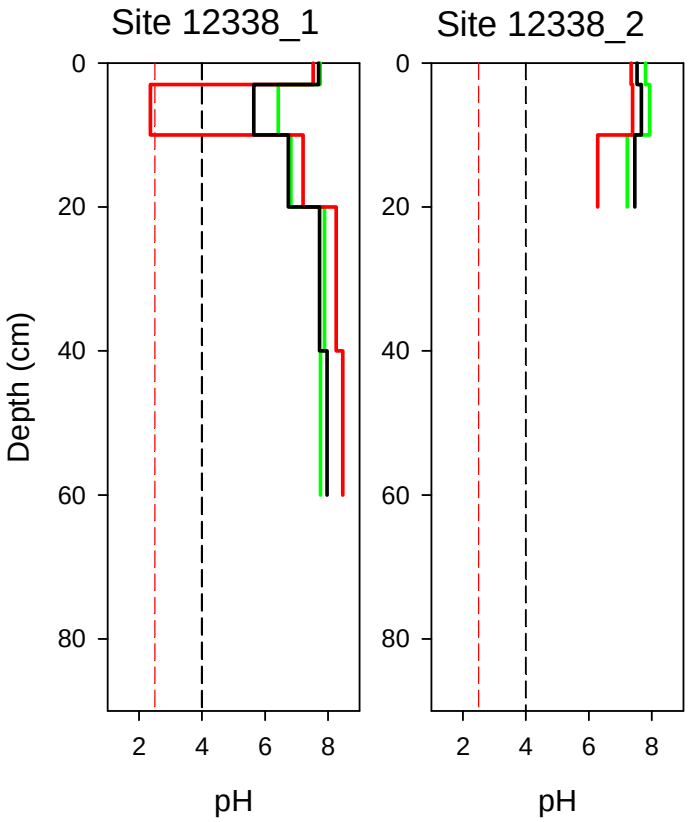


Figure 8-5. Depth profiles of soil pH for Gurra Complex (Wetland ID. 12338), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

8.3.2. Acid base accounting

The acid base accounting data is provided in Table 8-4 and summarised in Figure 8-6.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.57 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 6.76 mole H^+/tonne and were detected only in samples of Profile 1.

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 0.30 to 7.57 $\%CaCO_3$.and were measured in all samples.

Net acidity

Net acidity values ranged from -710 to 2 mole H^+/tonne. In the surface samples net acidity values were negative and in the subsoil layers the samples were low values.

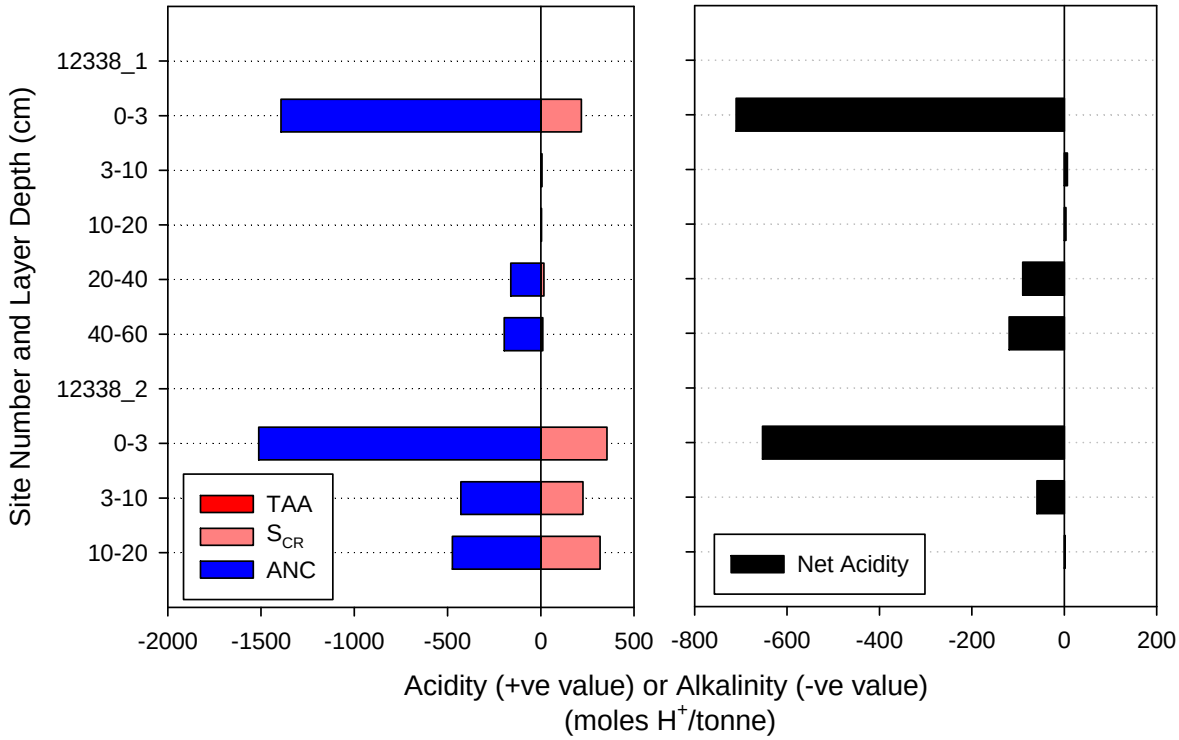


Figure 8-6. Acid base accounting depth profiles for Gurra Complex (Wetland ID. 12338). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

8.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 8-4 identified all profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

8.3.4. Acid volatile sulfur

Monosulfidic materials were observed in the upper layers of Profiles 1 and 2 and sampled for analysis. The values shown in Table 1-4 were all above S_{AV} ≥0.01% S, the criteria value for identifying monosulfidic material.

8.3.5. Hydrochemistry

One surface water sample was collected from the site which contained monosulfidic materials. Field parameters are shown in Table 8-5. The surface water had moderately alkaline pH and relatively high salinity. Dissolved oxygen was high, and alkalinity was relatively high.

The surface waters are of Na-Cl type, with Ca and HCO_3 being slightly higher relative to seawater (Table 8-6, Figure 8-7). Sulfate concentrations in the surface water were high at 5600 mg l^{-1}. The SO_4/Cl ratio in the surface water (0.373) was much higher than seawater (0.142). For the nutrients, NH_4 was high and PO_4 elevated above ANZECC Guideline values.. Aluminium, As, Cu, Zn and Mn concentrations were elevated above ANZECC Guideline values. Organic C concentrations was also very high.

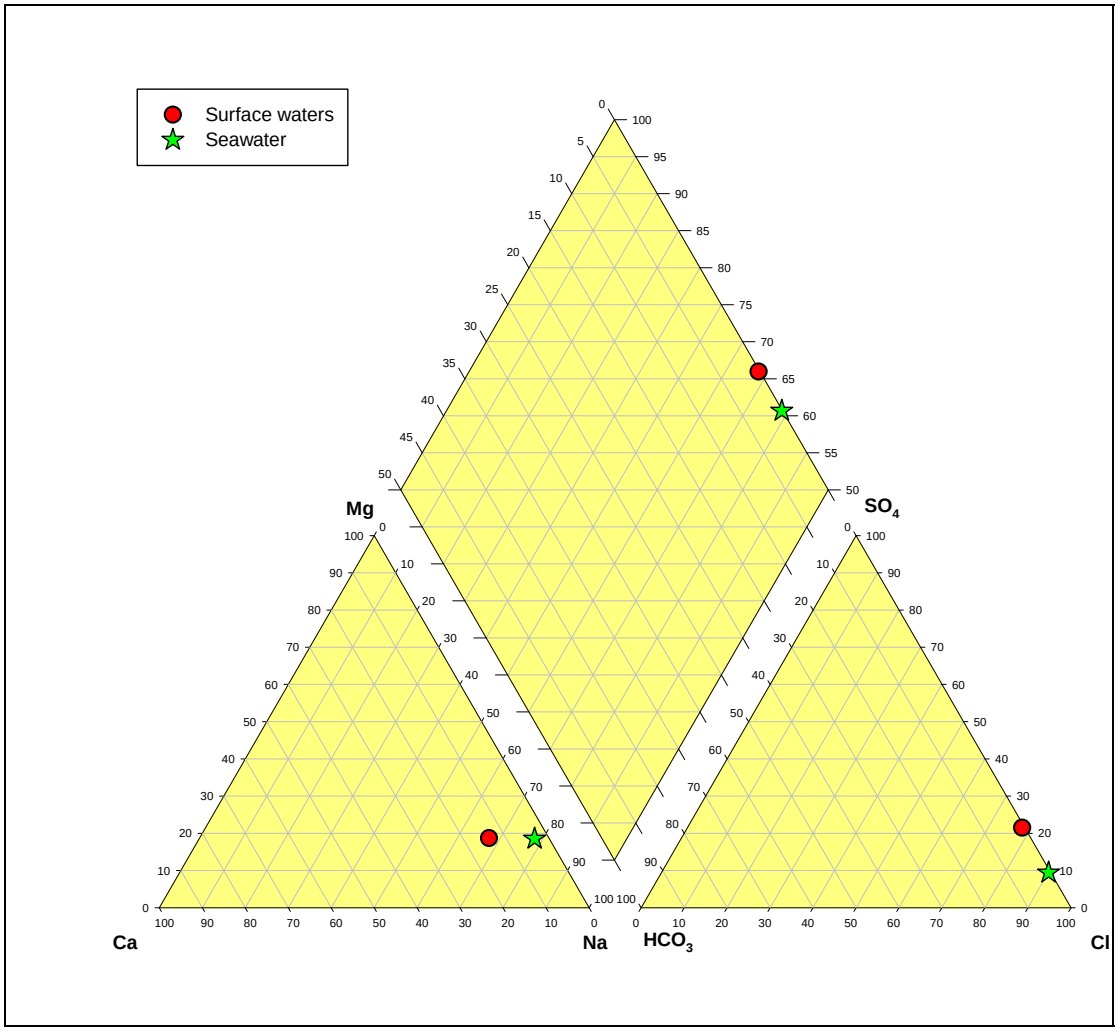


Figure 8-7. Piper diagram of hydrochemical data for Gurra Complex (Wetland ID. 12338).

8.4. Discussion

Acid sulfate soil materials at Gurra Complex (Wetland ID. 12338) were identified as hyposulfidic and two samples were characterised as other soil material. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey) that occurred throughout the wetland.

The soils throughout the wetland were dominantly clayey textured.

Monosulfidic material was 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 Gurra Complex (Wetland ID. 12338) are:

- Acidification hazard: The data identified negative net acidity values in the surface layers and positive values in the subsoil samples and pH_{OX} data identified one sample with a value 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 potential for monosulfidic materials to form in the surface layers of all soils, monosulfidic material was observed throughout the wetland where sites occurred below surface water. There is a 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 Gurra Complex (Wetland ID. 12338):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic for both profiles. Soils were clayey textured in the surface and subsoil layers. The profile surface samples had negative net acidity values and low values in the subsoil samples, and pH_{OX} data for one sample indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (loamy) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low to medium level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – low level of concern

Table 8-2. Site description data for Gurra Complex (Wetland ID. 12338).

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	463532	6203322	10	water, soft	water	mid elevation, 3 m offshore
2	18/04/2010	463521	6203298	40	water, soft	water	low elevation

Table 8-3. Soil profile description data for Gurra Complex (Wetland ID. 12338).

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 - 3	small pit	black (N2.5/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour
1_2	3 - 10	small pit	dark gray (N4/0)	medium clay	wet		massive	very weak	pellety
1_3	10 - 20	small pit	dark grey (5Y4/1)	medium clay	wet		massive	very weak	pellety
1_4	20 - 40	small pit	gray (N5/0)	medium clay	wet		massive	very weak	
1_5	40 - 60	push tube	dark grey (5Y4/1)	medium clay	wet		massive	very weak	
2_W1	0 - 40	surface water							water sampled
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	dark gray (N4/0)	medium clay	wet		massive	very weak	pellety, sulfurous odour
2_3	10 - 20	small pit	very dark grey (5Y3/1)	medium clay	wet		massive	very weak	

Table 8-4. Laboratory data for acid sulfate soil assessment of Gurra Complex (Wetland ID. 12338).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav)	Acid Sulfate Soil Material Classification
1.1	0-3	Medium	8,740	7.75	7.53	6.63	7.70	2,300	8.30	0.00	0.35	..	6.97	-710	0.20	hyposulfidic (S_{CR}≥0.10%) monosulfidic
1.2	3-10	Fine	137	6.42	2.36	6.06	5.64	500	6.00	6.76	<0.01	..	0.00	7		other soil material
1.3	10-20	Fine	4,700	6.82	7.21	5.91	6.74	440	6.35	3.87	<0.01	..	0.00	4		other soil material
1.4	20-40	Fine	5,490	7.89	8.26	6.45	7.73	460	7.17	0.00	0.03	..	0.80	-89		hyposulfidic (S_{CR}<0.10%)
1.5	40-60	Fine	5,630	7.76	8.47	6.93	7.97	600	6.68	0.00	0.02	..	0.98	-119		hyposulfidic (S_{CR}<0.10%)
2.1	0-3	Medium	8,620	7.80	7.34	6.94	7.53	3,400	8.30	0.00	0.57	..	7.57	-653	0.18	hyposulfidic (S_{CR}≥0.10%) monosulfidic
2.2	3-10	Fine	6,750	7.93	7.39	7.10	7.67	1,500	7.51	0.00	0.36		2.14	-59		hyposulfidic (S_{CR}≥0.10%)
2.3	10-20	Fine	6,360	7.22	6.28	6.91	7.46	1,400	7.68	0.00	0.51		2.37	2		hyposulfidic (S_{CR}≥0.10%)

Table 8-5. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12338).

	pH	SEC µS cm^{-1}	DO mg l^{-1}	Eh mV	Turbidity NTU	Alkalinity as HCO_3
Surface waters (n=1)	8.81	45060	13.9	52	60	169

Table 8-6. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12338).

Parameter	units	ANZECC Guidelines	Site 2 (SW)
Na	mg l^{-1}		7060
K	mg l^{-1}		45.0
Ca	mg l^{-1}		1280
Mg	mg l^{-1}		1040
Si	mg l^{-1}		<5
Br	mg l^{-1}		43.0
Cl	mg l^{-1}		15000
NO_3	mg l^{-1}	0.7	<0.022
NH_4-N[K]	mg l^{-1}	0.01	**0.51**
PO_4-P[E]	mg l^{-1}	0.005	**0.028**
SO_4	mg l^{-1}		5600
Ag	µg l^{-1}	0.05	0.02
Al[A]	µg l^{-1}	55	**60**
As[B]	µg l^{-1}	13	**14**
Cd	µg l^{-1}	0.2	<0.08
Co	µg l^{-1}	2.8	1.59
Cr[C]	µg l^{-1}	1	<0.6
Cu[H]	µg l^{-1}	1.4	**2**
Fe	µg l^{-1}	300	<5000
Mn	µg l^{-1}	1700	**5040**
Ni[H]	µg l^{-1}	11	4.8
Pb[H]	µg l^{-1}	3.4	0.2
Se	µg l^{-1}	11	<0.5
Zn[H]	µg l^{-1}	8	**36**
DOC	mg l^{-1}		120

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

9. GURRA COMPLEX (WETLAND ID. 12343)

9.1. Location and setting description

Gurra Complex (Wetland ID. 12343) is situated on the eastern side of the River Murray, approximately 3 kilometres across from the town of Berri. The wetland is crescent in shape forming a linear creek line. It is about 3 kilometres in length and about 50 metres at its widest, with a total surface area of 11 hectares. The wetland is bounded by a raised floodplain that separates it from the river and the Gurra Lake that it is adjacent to.

The wetland is not directly connected to the river but is connected with the Gurra Lake that is connected to the river. At the time when the soil survey was conducted in April 2010 the wetland had areas of surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). There are sparse areas of Typha, Phragmites and Samphire 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 9-1.

Figure 9-1. Gurra Complex (Wetland ID. 12343) and sample site locations.

9.2. Soil profile description and distribution

Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 9-1. Sites were distributed as pairs at the southern end (Sites 1 and 2), and at the northern end (Sites 3 and 4) 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.

Southern transect

Site 1 (Figure 9-3) occurred adjacent to the bank in water (15cm deep) amongst reeds, and the soil consisted of a very dark greyish brown, very weak, clay, over a grey, very weak, clay. Site 2 (Figure 9-4) occurred in the open water (46 cm deep), and the soil consisted of a very dark grey, very weak, clay over a grey, very weak, sandy clay loam.

Northern transect

Site 3 (Figure 9-5) occurred on the margin amongst salt bush, and the soil consisted of a grey, very firm, sand, over a grey, very firm, sandy clay loam. Site 4 (Figure 9-6) occurred at the low part of the wetland, and the soil consisted of a salt crust, over a dark grey, very firm, clay, over a greyish brown, very weak, clay.

Table 9-1. Soil identification, subtype and general location description for Gurra Complex (Wetland ID. 12343).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12343_1	464473	6203258	Subaqueous Soil (clayey)	mid elevation, 3 m from edge
12343_2	464473	6203250	Subaqueous Soil (clayey)	low elevation, 50 m from edge
12343_3	464734	6204061	Other Soil (sandy)	mid elevation, 10 m from edge of wetland
12343_4	464756	6204064	Other Soil (clayey)	low elevation, 10 m from edge of wetland

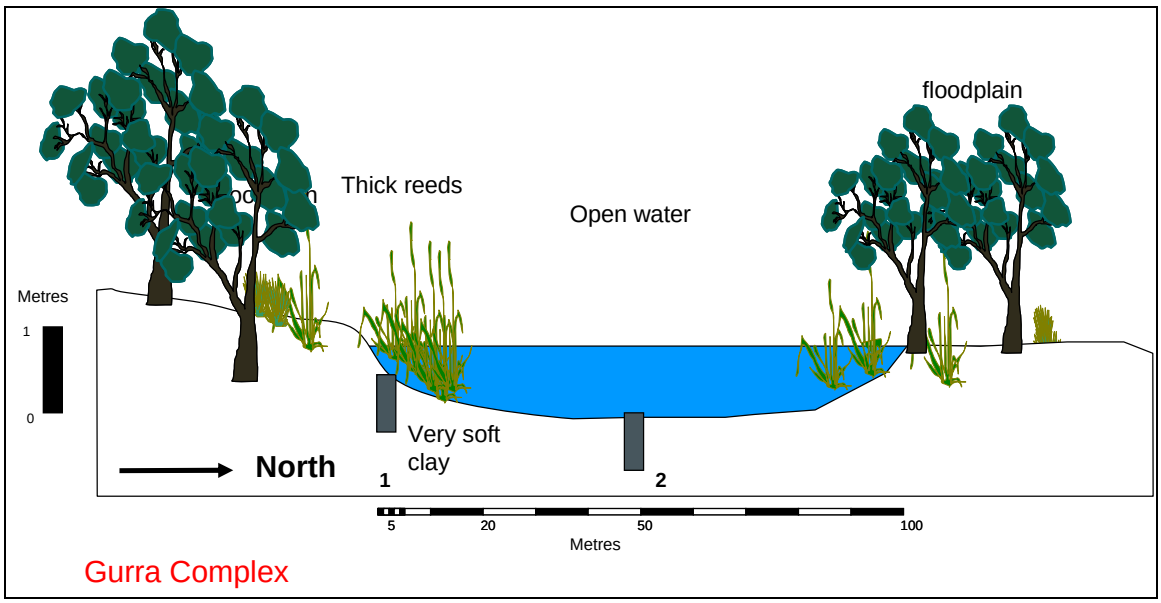


Figure 9-2. Conceptual cross-section diagram, showing locations for Sites 1 and 2.

Figure 9-3. Photograph of Site 1, showing the site location on the edge of the wetland amongst reeds.

Figure 9-4. Photograph of Site 2, showing the site location in open water.

Figure 9-5. Photographs of Site 3, showing the site location on the wetland margin, and showing the soil profile of sand over clay.

Figure 9-6. Photographs of Site 4, showing the site location near the centre of the wetland amongst salt bus, and showing 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 9-7. The pH_W data ranged from 4.79 to 7.01 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.82 to 5.68 and identified that layers in Profiles 1 and 2 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 4.66 to 6.63 and identified that no samples on incubation declined below the critical values of pH <4.

9.3.2. Acid base accounting

The acid base accounting data is provided in Table 9-4 and summarised in Figure 9-8.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.17 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 67.17 mole H^+/tonne and were detected in at least one layer for each profile.

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 1.33 $\%CaCO_3$ and were measured in samples from Profiles 3 and 4.

Net acidity

Net acidity values ranged from -177 to 147 mole H^+/tonne. Samples in Profiles 1 and 2 had moderate or high net acidity values, negative values in Profile 3, and for Profile 4 negative values except for the subsoil that were moderate values.

9.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 9-4 identified Profiles 3 and 4 had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

9.3.4. Acid volatile sulfur

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

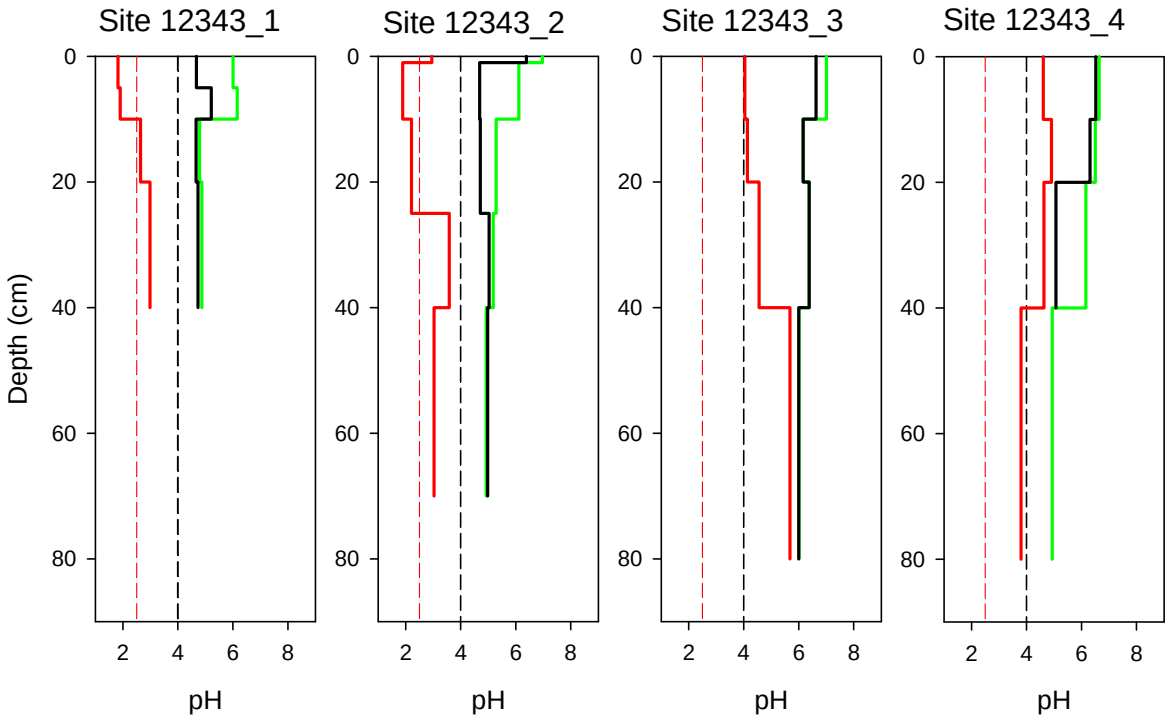


Figure 9-7. Depth profiles of soil pH for Gurra Complex (Wetland ID. 12343), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

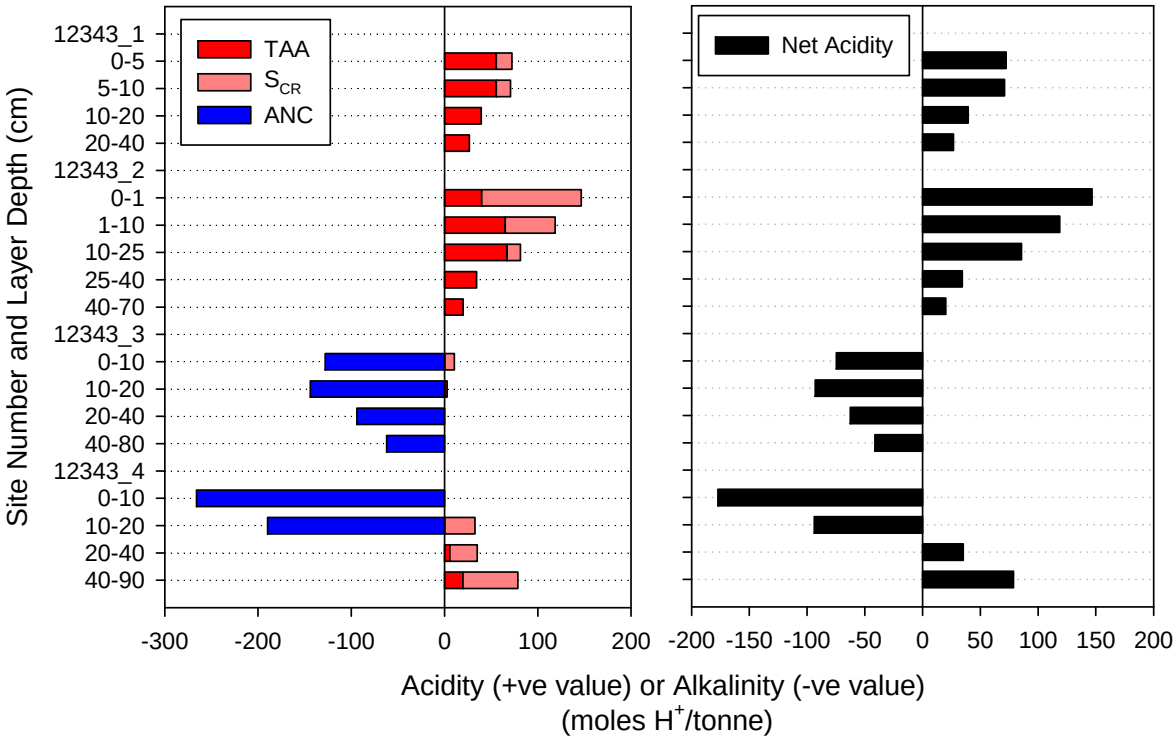


Figure 9-8. Acid base accounting depth profiles for Gurra Complex (Wetland ID. 12343). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

9.3.5. Hydrochemistry

One surface water sample was collected from the wetland. Field parameters are shown in Table 9-5. The surface water had slightly alkaline pH and moderate salinity. Dissolved oxygen was low, and alkalinity relatively high.

The surface water was of Na-Cl type (Table 9-6, Figure 9-9). Sulfate concentration in the surface water was 33 mg l^{-1}. The SO_4/Cl ratio in the surface water (0.092) was significantly lower than seawater (0.142). For the nutrients, NH_4 and PO_4 were slightly elevated above ANZECC Guideline values. Of the metals, Fe, Al and Zn (and Cu slightly) concentrations were elevated above ANZECC Guideline values.

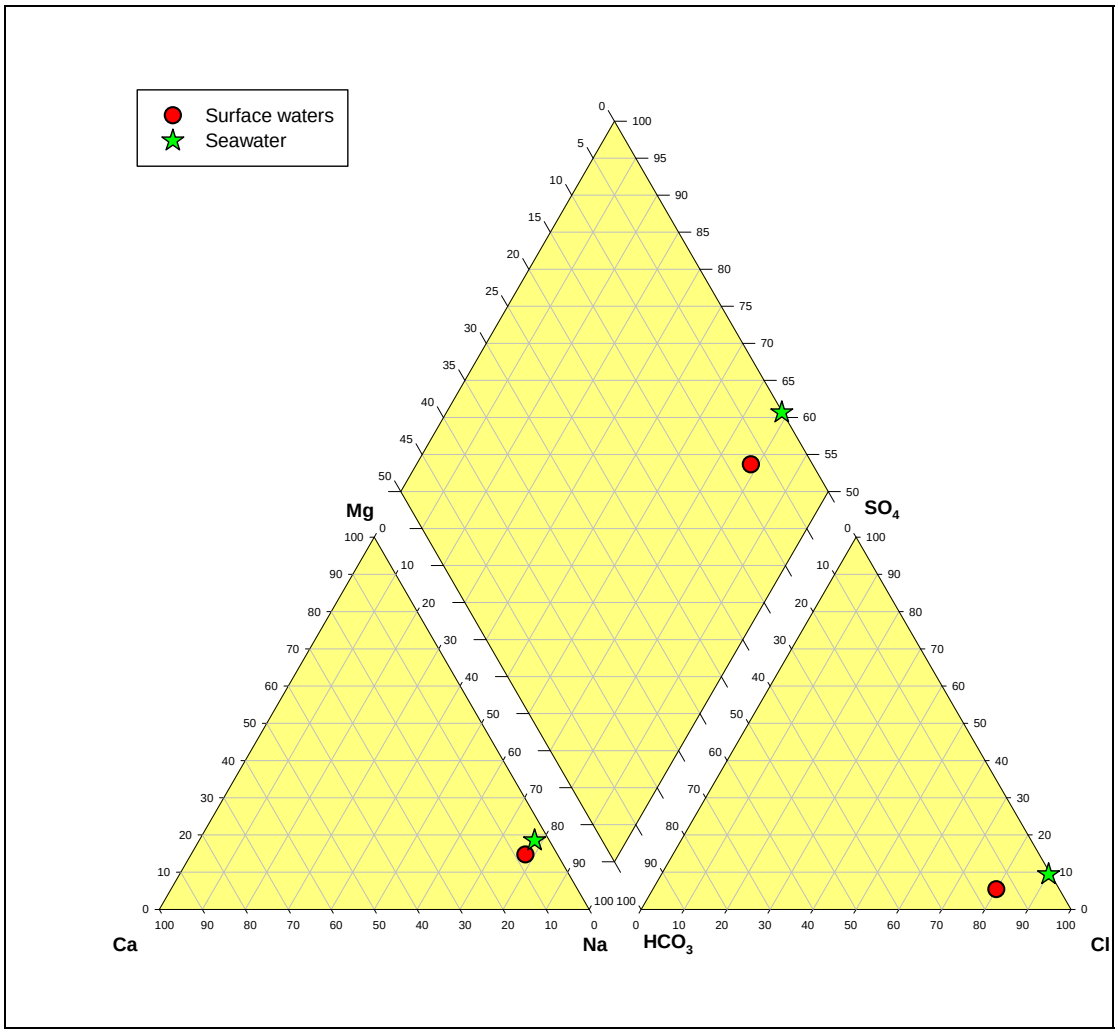


Figure 9-9. Piper diagram of hydrochemical data for Gurra Complex (Wetland ID. 12343).

9.4. Discussion

Acid sulfate soil materials at Gurra Complex (Wetland ID. 12343) were identified as hyposulfidic and occurred throughout in all profile layers, a few samples were characterised as other acidic or other soil materials. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey or loamy) that occurred throughout the main wetland area, and Other Soil (clayey) occurred on the wetland margins.

The soils throughout the wetland were generally clayey textured in the surface and subsoil layers, with one profile having sandy and loamy upper soil layers.

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

The potential hazards posed by acid sulfate soil materials at Gurra Complex (Wetland ID. 12343) are:

- Acidification hazard: The data identified moderate and high net acidity values in two of the four profiles 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, monosulfidic material was not observed. There is a medium level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a medium level of concern.

Summary of key findings Gurra Complex (Wetland ID. 12343):

Soil materials:	The soil layers throughout the wetland were hyposulfidic for all profiles. Soils were generally clayey textured in the surface and subsoil layers and in some areas there were sandy surface layers. Moderate and high net acidity values occurred in two of the profiles and pH_{OX} data for a few samples indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (clayey or sandy) – occurring where there was surface water in the wetland. Dominant (>50%) in extent. • Other Soil (clayey) – occurring on the wetland margins above the water shoreline. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – medium level of concern • De-oxygenation hazard – medium level of concern • Metal mobilisation hazard – medium level of concern

Table 9-2. Site description data for Gurra Complex (Wetland ID. 12343).

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	464473	6203258	15	water, soft	phragmites and Typha	mid elevation, 3 m from edge
2	18/04/2010	464473	6203250	46	water, soft	water	low elevation, 50 m from edge
3	18/04/2010	464734	6204061	-80	sandy	saltbush	mid elevation, 10 m from edge of wetland
4	18/04/2010	464756	6204064	-50	cracking, rigid	saltbush	low elevation, 10 m from edge of wetland

Table 9-3. Soil profile description data for Gurra Complex (Wetland ID. 12343).

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	very dark greyish brown (10YR3/2)	medium clay	wet		massive	very weak	
1_2	5 - 10	small pit	very dark greyish brown (10YR3/2)	heavy clay	wet		massive	very weak	
1_3	10 - 20	small pit	grey (10YR5/1)	medium clay	wet		massive	very weak	
1_4	20 - 40	small pit	grey (10YR5/1)	medium clay	wet	5% strong brown	massive	very weak	
2_W1	0 - 46	surface water							water sampled
2_5	40 - 70	push tube	grey (10YR5/1)	sandy clay loam	wet	8% strong brown	massive	very weak	
2_1	0 - 1	small pit	very dark grey (5Y3/1)	medium clay	wet		massive	very weak	pellety clay
2_2	1 - 10	small pit	very dark grey (5Y3/1)	medium clay	wet	2% brown	massive	very weak	pellety clay
2_3	10 - 25	small pit	dark greyish brown (10YR4/2)	medium clay	wet	10% brown	massive	very weak	pellety clay
2_4	25 - 40	push tube	grey (5Y5/1)	heavy clay	wet	10% dark yellowish brown	massive	very weak	
_	0 - 46	#N/A							
3_1	0 - 10	small pit	pale brown (10YR6/3)	sand	dry		massive	very weak	soft dust
3_2	10 - 20	small pit	grey (10YR5/1)	heavy clay	moist		massive	very firm	
3_3	20 - 40	small pit	greyish brown (10YR5/2)	clayey sand	moist	10% brown	massive	very firm	
3_4	40 - 80	push tube	grey (5Y5/1)	sandy clay loam	moist	2% brown	massive	very firm	white fungal hyphae
4_1	0 - 10	small pit	greyish brown (10YR5/2)	medium clay	dry	10% yellowish brown	massive	loose	pellety
4_2	10 - 20	small pit	dark grey (5Y4/1)	heavy clay	dry	2% brown	massive	very firm	
4_3	20 - 40	small pit	grey (10YR5/1)	heavy clay	dry	2% yellowish brown	massive	very weak	mussel shells
4_4	40 - 90	push tube	greyish brown (10YR5/2)	heavy clay	dry	10% dark brown	massive	very weak	

Table 9-4. Laboratory data for acid sulfate soil assessment of Gurra Complex (Wetland ID. 12343).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Fine	10,300	6.01	1.82	6.12	4.67	27	4.56	55.60	0.03	..	..	72	hyposulfidic (S_{CR}<0.10%)
1.2	5-10	Fine	14,180	6.16	1.90	6.05	5.21	31	4.54	55.60	0.02	..	..	71	hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	14,740	4.79	2.64	4.84	4.66	100	4.54	39.50	<0.01	..	..	40	other acidic
1.4	20-40	Fine	552	4.87	2.98	4.76	4.73	97	4.69	26.80	<0.01	..	..	27	other acidic
2.1	0-1	Fine	386	6.97	2.95	6.53	6.39	53	5.09	40.11	0.17	..	..	147	hyposulfidic (S_{CR}≥0.10%)
2.2	1-10	Fine	255	6.11	1.89	5.83	4.69	100	4.53	65.23	0.09	..	..	119	hyposulfidic (S_{CR}<0.10%)
2.3	10-25	Fine	855	5.29	2.21	4.81	4.71	180	4.28	67.17	0.02	0.00	..	86	hyposulfidic (S_{CR}<0.10%)
2.4	25-40	Fine	776	5.18	3.58	5.08	5.03	100	4.66	34.31	<0.01	..	..	34	other acidic
2.5	40-70	Fine	627	4.93	3.03	4.93	4.98	130	4.80	20.10	<0.01	..	..	20	other acidic
3.1	0-10	Fine	556	7.01	4.04	6.51	6.63	1,000	6.80	0.00	0.02	..	0.64	-75	hyposulfidic (S_{CR}<0.10%)
3.2	10-20	Fine	386	6.17	4.13	5.93	6.16	680	6.53	2.90	<0.01	..	0.72	-93	other soil material
3.3	20-40	Fine	204	6.38	4.56	5.98	6.38	340	7.32	0.00	<0.01	..	0.47	-63	other soil material
3.4	40-80	Fine	143	6.01	5.68	5.62	6.00	360	6.64	0.00	<0.01	..	0.31	-42	other soil material
4.1	0-10	Fine	108	6.64	4.61	6.39	6.52	890	6.53	0.00	<0.01	..	1.33	-177	other soil material
4.2	10-20	Fine	118	6.50	4.91	5.86	6.31	140	6.60	0.00	0.05	..	0.95	-94	hyposulfidic (S_{CR}<0.10%)
4.3	20-40	Fine	73	6.16	4.63	5.77	5.07	180	6.26	5.80	0.05	..	0.00	35	hyposulfidic (S_{CR}<0.10%)
4.4	40-90	Fine	217	4.94	3.80	4.64	4.64	130	5.09	19.81	0.09	..	..	79	hyposulfidic (S_{CR}<0.10%)

Table 9-5. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12343).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=1)	7.30	1406	1.5	30		113

Table 9-6. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12343).

Parameter	units	ANZECC Guidelines	Site 2 (SW)
Na	mg l^{-1}		186
K	mg l^{-1}		6.1
Ca	mg l^{-1}		15.8
Mg	mg l^{-1}		19
Si	mg l^{-1}		4.12
Br	mg l^{-1}		0.9
Cl	mg l^{-1}		360
NO_3	mg l^{-1}	0.7	<0.022
NH_4-N^K	mg l^{-1}	0.01	**0.02**
PO_4-P^E	mg l^{-1}	0.005	**0.052**
SO_4	mg l^{-1}		33
Ag	µg l^{-1}	0.05	<0.01
Al^A	µg l^{-1}	55	**82**
As^B	µg l^{-1}	13	1.5
Cd	µg l^{-1}	0.2	0.03
Co	µg l^{-1}	2.8	0.43
Cr^C	µg l^{-1}	1	0.2
Cu^H	µg l^{-1}	1.4	**1.6**
Fe	µg l^{-1}	300	**385**
Mn	µg l^{-1}	1700	130
Ni^H	µg l^{-1}	11	1.3
Pb^H	µg l^{-1}	3.4	0.18
Se	µg l^{-1}	11	<0.06
Zn^H	µg l^{-1}	8	**102**
DOC	mg l^{-1}		12.0

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

10. GURRA COMPLEX (WETLAND ID. 12363)

10.1. Location and setting description

Gurra Complex (Wetland ID. 12363) is situated on the eastern side of the River Murray, about, approximately 3 kilometres up river from the town of Berri. The wetland is linear in shape. It is about 750 metres in length and about 50 metres at its widest, with a total surface area of 3 hectares. The wetland is bounded by a raised floodplain that separates it from the river to the west and an associated wetland ID. 12364 to the east.

The wetland is not connected to the river and appears to be an internal basin that may have a connection with wetland ID 12364. At the time when the soil survey was conducted in May 2010 the wetland had no surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). There are sparse areas of salt bush growing along parts of the wetland, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 10-1.

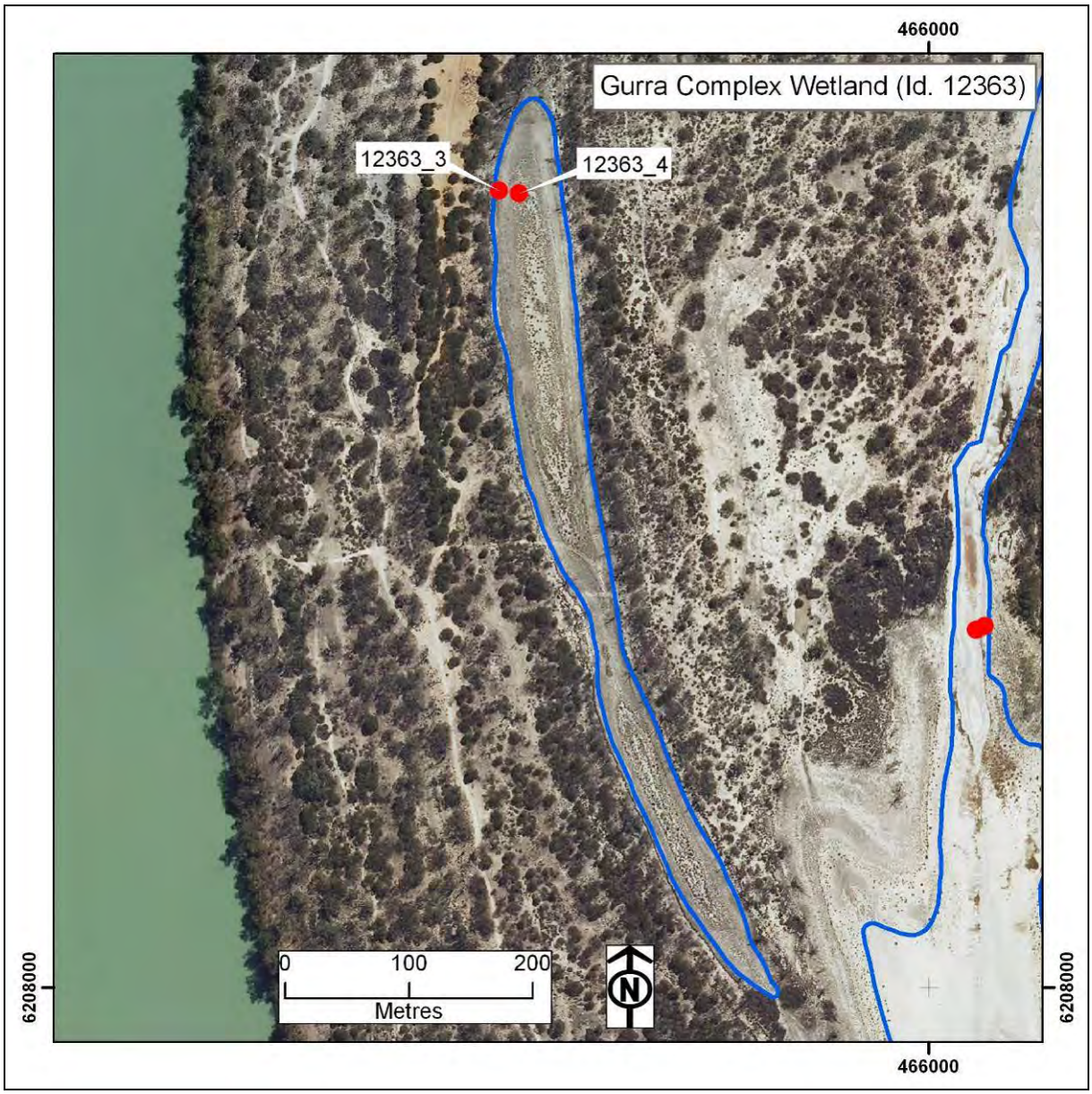


Figure 10-1. Gurra Complex (Wetland ID. 12363) and sample site locations.

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 placed at the northern end (Sites 3 and 4) of the wetland. The site and soil profile descriptions are presented in Table 10-2 and Table 10-3,and a conceptual cross-section diagram in Figure 10-2.

Northern transect

Site 3 (Figure 10-3) occurred on the margin at high elevation where salt bush was growing, and the soil consisted of a pale brown, very weak, sand, over a dark grey, firm loamy sand to sandy loam with depth. Site 4 (Figure 10-4) occurred in the centre of the wetland, and the soil consisted of a dark greyish brown, loose, sand, over a dark greyish brown, clay loam.

Table 10-1. Soil identification, subtype and general location description for Gurra Complex (Wetland ID. 12363).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12363_3	465654	6208642	Other Soil (sandy)	high elevation on margin of wetland
12363_4	465670	6208640	Other Soil (loamy)	low elevation, at end of wetland

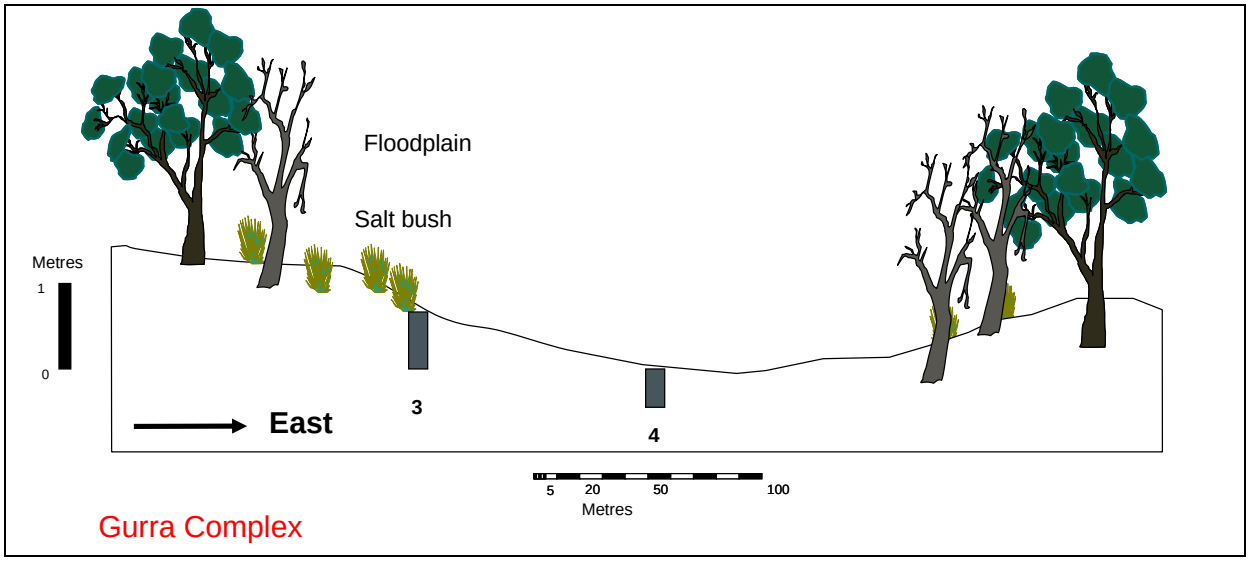


Figure 10-2. Conceptual cross-section diagram.

Figure 10-3. Photographs of Site 3, showing the wetland and site location on the wetland margin.

Figure 10-4. Photographs of Site 4, showing the wetland and site location placed at the lowest part of the wetland.

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 5.55 to 7.73 and sulfuric materials with pH_W <4 were not identified. The pH_{OX} data ranged from 3.96 to 7.09 and identified that no samples were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 5.48 to 7.50 and identified that no samples on incubation declined below the critical values of pH <4.

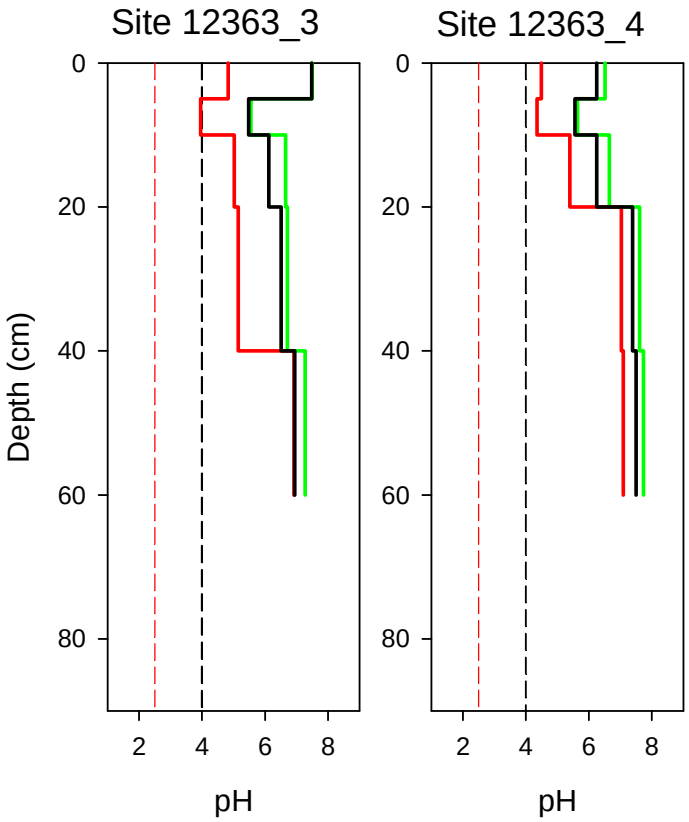


Figure 10-5. Depth profiles of soil pH for Gurra Complex (Wetland ID. 12363), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value 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 0.01 $\%S_{CR}$ and sulfidic materials were below detection in all profiles except for one sample in Profile 3.

Titratable actual acidity

Titratable actual acidity values ranged from 0.0 to 7.02 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_{KCl} of greater than 4.5.

Acid neutralising capacity

Acid neutralising capacity values ranged from 0.0 to 1.02 $\%CaCO_3$ and were measured in samples from all profiles.

Net acidity

Net acidity values ranged from -136 to 6 mole H^+/tonne. All samples had negative or low net acidity values.

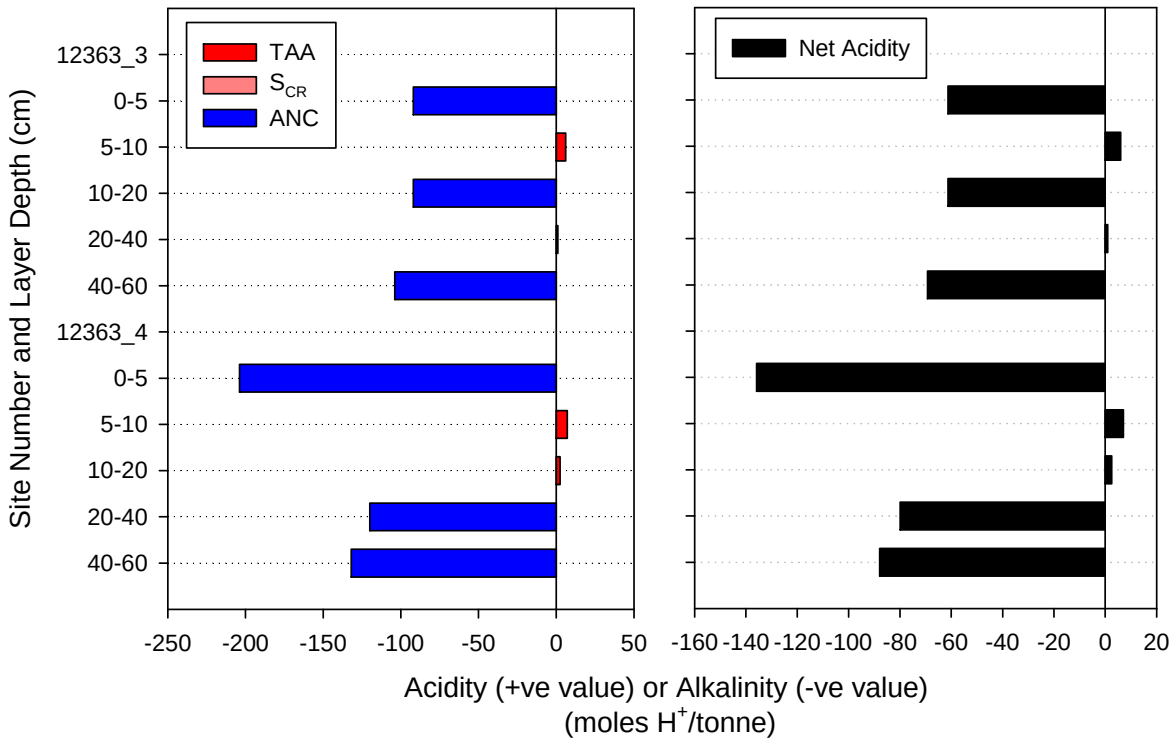


Figure 10-6. Acid base accounting depth profiles for Gurra Complex (Wetland ID. 12363). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

10.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 10-4 identified all profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

10.3.4. Acid volatile sulfur

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

10.3.5. Hydrochemistry

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

10.4. Discussion

Acid sulfate soil materials at Gurra Complex (Wetland ID. 12363) were identified in one sample as hyposulfidic, generally all samples were characterised as 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 sandy over loamy on the margin areas and loamy in the lower centre part of the wetland.

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 Gurra Complex (Wetland ID. 12363) are:

- Acidification hazard: The data identified negative or low net acidity values 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, however monosulfidic material was not observed. There is a low to medium level of concern.
- Metal mobilisation: The low acidification hazard indicates that low soil acidification potential is not likely to increase the solubility of metals. There is a low level of concern.

Summary of key findings Gurra Complex (Wetland ID. 12363):

Soil materials:	The soil layers throughout the wetland were characterised as other soil materials. Soils were sandy over loamy textured on the margins and in the centre of the wetland loamy textured. Profiles had negative or low net acidity values and pH data did not indicate a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Other Soil (sandy or loamy) – occurring throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – low level of concern • De-oxygenation hazard – low to medium level of concern • Metal mobilisation hazard – low level of concern

Table 10-2. Site description data for Gurra Complex (Wetland ID. 12363).

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
3	5/05/2010	465654	6208642	not reached	sandy	samphire	high elevation on margin of wetland
4	5/05/2010	465670	6208640	not reached	sandy	samphire	low elevation, at end of wetland

Table 10-3. Soil profile description data for Gurra Complex (Wetland ID. 12363).

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_1	0 - 5	small pit	pale brown (10YR6/3)	sand	dry		single grain	very weak	
3_2	5 - 10	small pit	dark greyish brown (10YR4/2)	sand	dry		single grain	very weak	
3_3	10 - 20	small pit	dark grey (10YR4/1)	loamy sand	moist		single grain	weak	
3_4	20 - 40	small pit	dark grey (10YR4/1)	loamy sand	moist		massive	firm	
3_5	40 - 60	small pit	dark grey (10YR4/1)	sandy loam	moist	5% yellowish brown In the matrix	massive	firm	
4_1	0 - 5	small pit	dark greyish brown (10YR4/2)	sand	dry		single grain	loose	
4_2	5 - 10	small pit	dark greyish brown (10YR4/2)	sandy clay loam	moist		massive	weak	
4_3	10 - 20	small pit	dark greyish brown (10YR4/2)	sandy clay loam	moist		massive	weak	
4_4	20 - 40	small pit	dark grey (10YR4/1)	sandy clay loam	moist		massive	firm	
4_5	40 - 60	small pit	dark grey (5Y4/1)	clay loam	moist	5% reddish brown infused into the matrix adjacent to pores	massive	firm	

Table 10-4. Laboratory data for acid sulfate soil assessment of Gurra Complex (Wetland ID. 12363).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
3.1	0-5	Coarse	4080	7.50	4.83	6.57	7.48	110	7.27	0.00	<0.01	..	0.46	-61	other soil material
3.2	5-10	Medium	7050	5.55	3.96	5.72	5.48	490	5.94	6.02	<0.01	..	..	6	other soil material
3.3	10-20	Medium	6340	6.65	5.02	6.20	6.12	120	6.54	0.00	<0.01	..	0.46	-61	other soil material
3.4	20-40	Medium	7940	6.71	5.15	6.39	6.51	230	6.49	1.00	<0.01	..	0.00	1	other soil material
3.5	40-60	Medium	8360	7.27	6.92	6.28	6.94	320	6.71	0.00	<0.01	..	0.52	-69	other soil material
4.1	0-5	Fine	20250	6.51	4.49	6.27	6.25	2200	6.56	0.00	<0.01	..	1.02	-136	other soil material
4.2	5-10	Fine	13310	5.64	4.35	5.62	5.56	680	6.10	7.02	<0.01	..	0.00	7	other soil material
4.3	10-20	Fine	9490	6.65	5.40	6.21	6.25	290	6.40	2.51	<0.01	..	0.00	3	other soil material
4.4	20-40	Fine	9310	7.61	7.03	6.78	7.39	330	6.70	0.00	<0.01	..	0.60	-80	other soil material
4.5	40-60	Fine	8050	7.73	7.09	7.49	7.50	340	7.37	0.00	<0.01	..	0.66	-88	other soil material

11. GURRA COMPLEX (WETLAND ID. 12364)

11.1. Location and setting description

Gurra Complex (Wetland ID. 12364) is situated on the eastern side of the River Murray, about, approximately 3 kilometres up river from the town of Berri. The wetland is linear in shape. It is about 3 kilometres in length and about 100 metres at its widest, with a total surface area of 19 hectares. The wetland is bounded by a raised floodplain that separates it from the river and an associated wetland ID. 12363 to the west, to the east there is a steep hill slope.

The wetland is not directly connected to the river but probably has a temporary connection with the Gurra Lake but this was difficult to determine with certainty. At the time when the soil survey was conducted in April 2010 the wetland had isolated areas of surface water. The wetland is managed by Department of Environment and Natural Resources (DENR). There are sparse areas of Typha, Phragmites and Samphire 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 11-1.

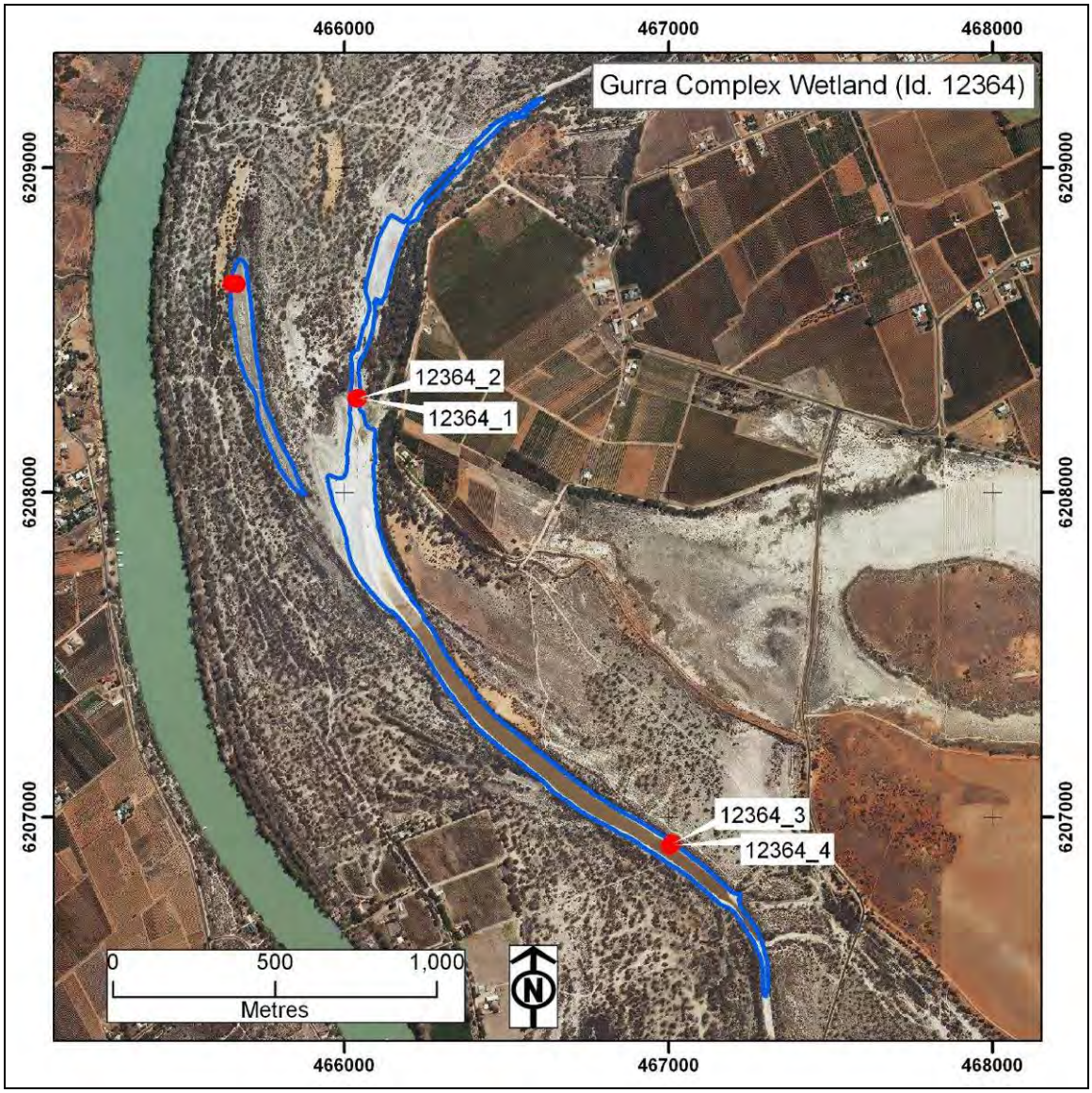


Figure 11-1. Gurra Complex (Wetland ID. 12364) and sample site locations.

11.2. Soil profile description and distribution

Four sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 11-1. Sites were distributed as pairs at the northern end (Sites 1 and 2), and at the southern end (Sites 3 and 4) 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 margin at high elevation where salt bush was growing, and the soil consisted of a dark grey, firm, sandy clay loam, over a dark grey, very firm, clay. Site 2 (Figure 11-4) occurred in the surface water (20 cm deep), and the soil consisted of a black, very weak, monosulfidic material, over a greyish brown, very firm, clay.

Southern transect

Site 3 (Figure 11-5) occurred on the margin at mid elevation where salt bust was growing, and the soil consisted of a grey, loose, sand. Site 4 (Figure 11-6) occurred at the low part of the wetland where there was surface water, and the soil consisted of a salt crust, over black, very weak, monosulfidic material, over a grey, very weak, clay.

Table 11-1. Soil identification, subtype and general location description for Gurra Complex (Wetland ID. 12364).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12364_1	466045	6208291	Other Soil (clayey)	high elevation, on margin with salt bush
12364_2	466038	6208288	Subaqueous Soil (clayey)	low elevation, in water
12364_3	467012	6206918	Other Soil (sandy)	mid elevation, 10m down slope from edge of dry channel
12364_4	467006	6206910	Subaqueous Soil (clayey)	low elevation, centre of channel in water

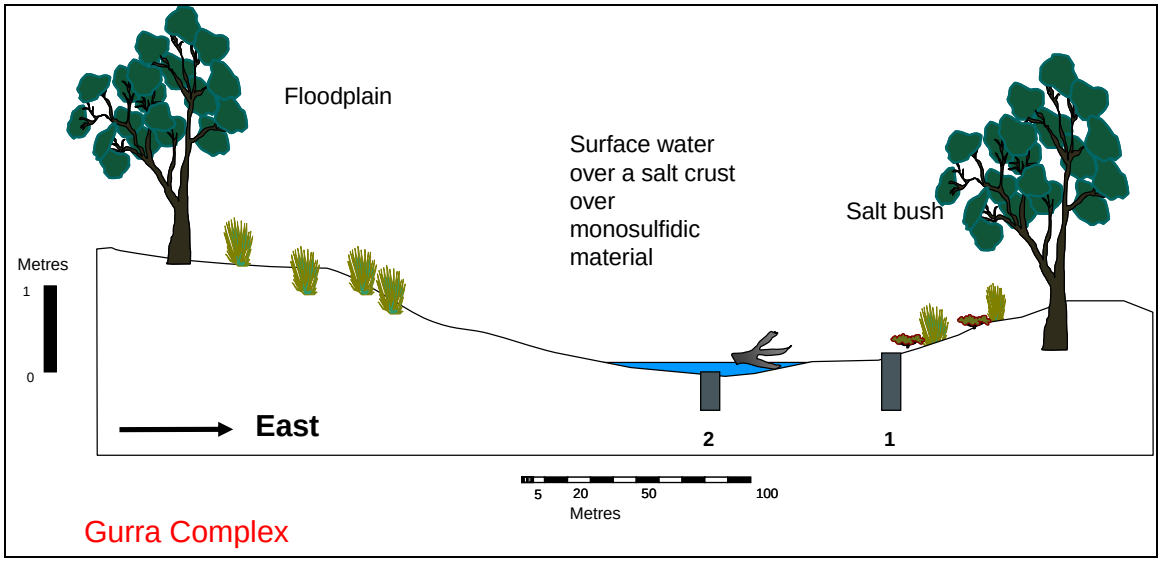


Figure 11-2. Conceptual cross-section diagram, showing locations of Sites 1 and 2.

Figure 11-3. Photograph of Site 1, showing the site location on the wetland margin.

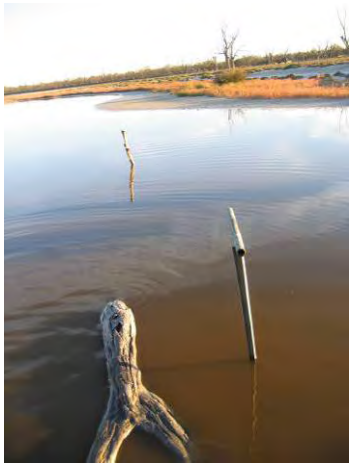


Figure 11-4. Photograph of Site 2, showing the site location placed in the surface water.

Figure 11-5. Photographs of Site 3, showing the site location on the wetland margin, and showing the soil profile.

Figure 11-6. Photograph of Site 4, showing the site location in the water at the low centre part of the wetland.

11.3. Laboratory data assessment

11.3.1. Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 11-4 and pH profiles are presented in Figure 11-7. The pH_W data ranged from 7.74 to 9.06 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.25 to 8.54 and identified that layers in Profiles 3 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 4.51 to 8.45 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 11-8.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.01 to 0.28 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity was not detected in any of the samples.

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 0.13 to 19.03 $\%CaCO_3$ and were measured in samples from all profiles.

Net acidity

Net acidity values ranged from -2444 to 87 mole H^+/tonne. Net acidity values were negative in all samples except for Profile 3 subsoil samples that were moderate values.

11.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 11-4 identified all profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

11.3.4. Acid volatile sulfur

Monosulfidic materials were observed in the upper layers of Profiles 2 and 4 and sampled for analysis. The values shown in Table 11-4 were all above S_{AV} ≥0.01% S, the criteria value for identifying monosulfidic material.

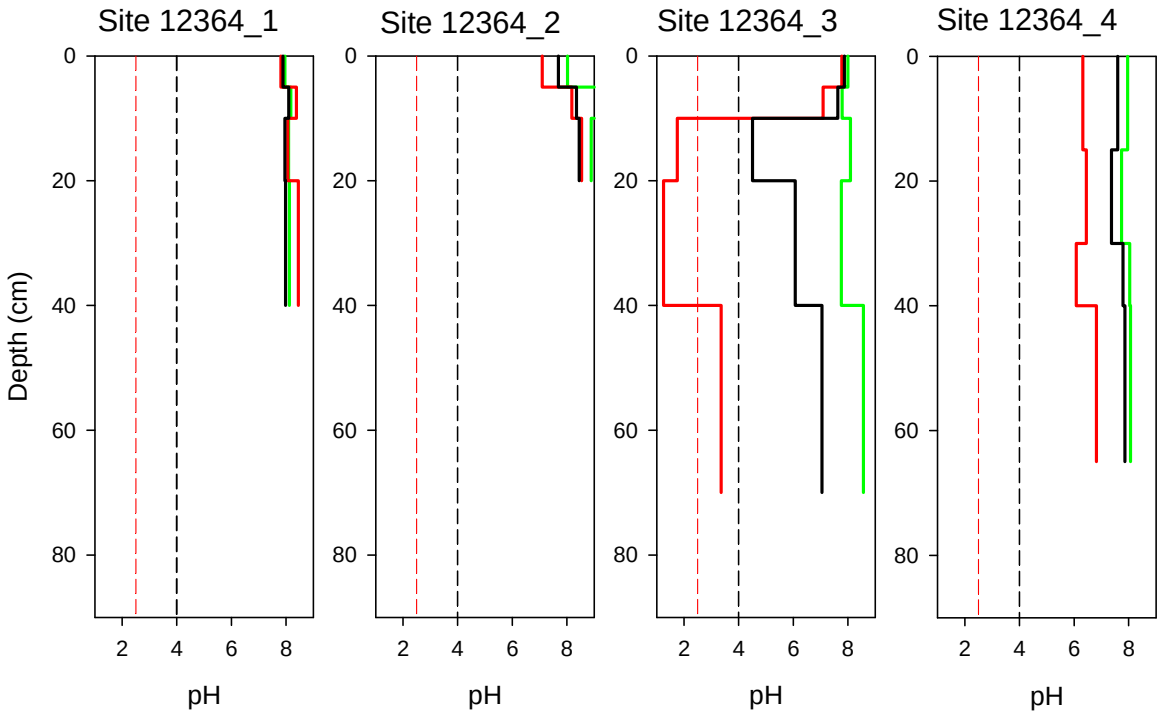


Figure 11-7. Depth profiles of soil pH for Gurra Complex (Wetland ID. 12364), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

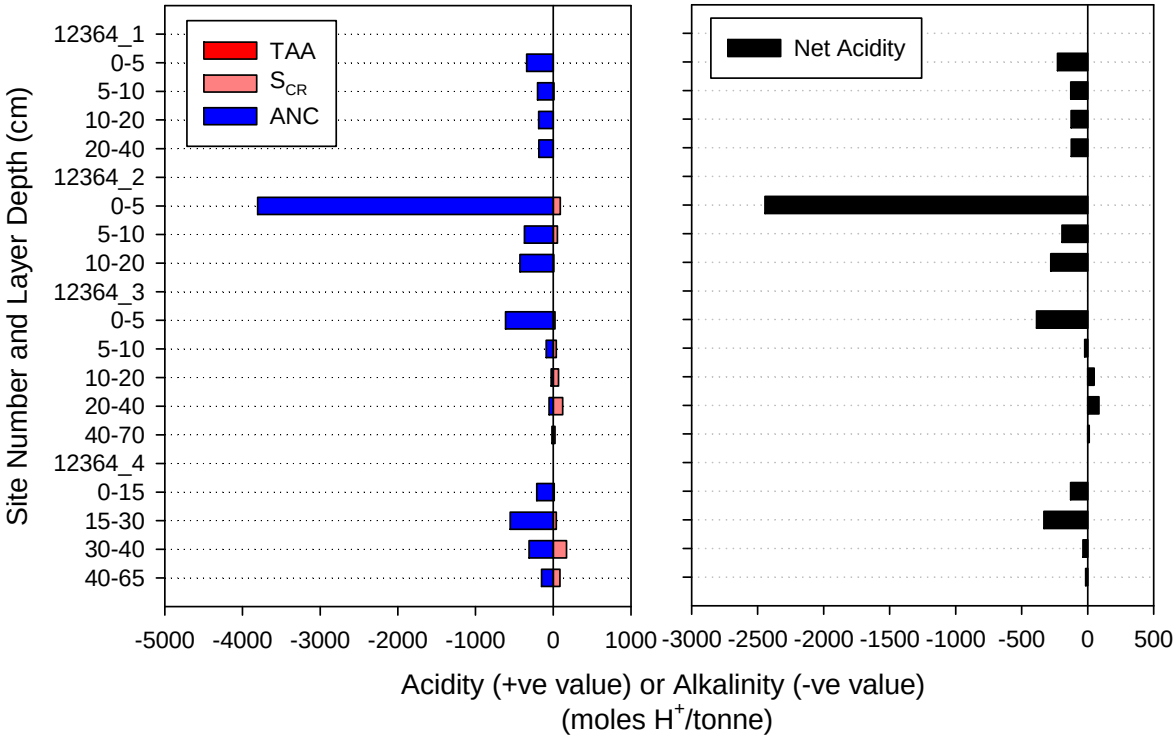


Figure 11-8. Acid base accounting depth profiles for Gurra Complex (Wetland ID. 12364). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

11.3.5. Hydrochemistry

Two surface waters and a pit water sample were collected from the wetland. Field parameters are shown in Table 11-5. The surface waters had a slightly alkaline pH and were hypersaline. The waters had variable dissolved oxygen and turbidity was high. Alkalinity was high in all samples.

The SEC in the pit waters was also hypersaline with circumneutral pH and alkalinity was high.

All waters were of Na-Cl type (Table 11-6, Figure 11-9). Sulfate concentrations in the surface water varied from 13000 to 34000 mg l^{-1}, and the pit water contained 6500 mg l^{-1}. The SO_4/Cl ratio in the surface waters (0.160 to 0.213) was slightly higher than seawater (0.142), as was the pit water (0.148). Nitrate concentrations were below detection limit, and NH_4 was present at high concentrations. Phosphate was high at the southern transect comprising sites 3 and 4. Iron was below the very high detection limit (due to dilution requirements for chemical analysis of the hypersaline waters) and Mn was high. Zinc contents were high in all samples, and As was significantly higher than ANZECC Guidelines. Organic C concentrations were very high in the surface water samples.

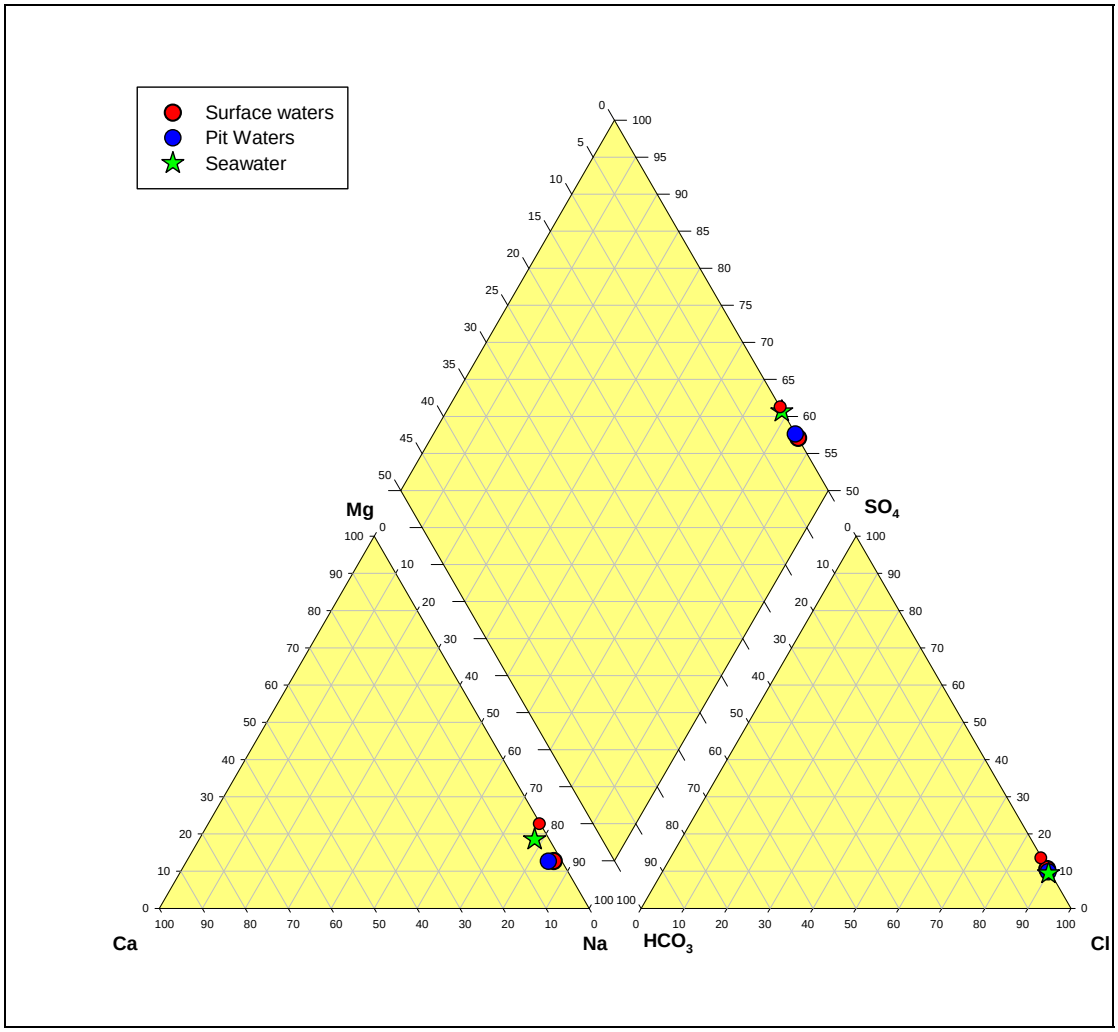


Figure 11-9. Piper diagram of hydrochemical data for Gurra Complex (Wetland ID. 12364).

11.4. Discussion

Acid sulfate soil materials at Gurra Complex (Wetland ID. 12364) were identified as hyposulfidic and occurred throughout in all profile layers. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey) that occurred throughout the main wetland area, and Other Soil (clayey or sandy) occurred on the wetland margins.

The soils throughout the wetland were dominantly clayey textured in the surface and subsoil layers and in some areas they were sandy textured.

Monosulfidic material was 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 Gurra Complex (Wetland ID. 12364) are:

- Acidification hazard: The data identified negative net acidity values and moderate values in the subsoil samples for one profile 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 all soils, monosulfidic material was observed throughout the wetland where sites occurred below surface water. There is a high level of concern.
- Metal mobilisation: The medium acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a medium level of concern.

Summary of key findings Gurra Complex (Wetland ID. 12364):

Soil materials:	The soil layers throughout the wetland were hyposulfidic for all profiles. Soils were generally clayey textured in the surface and subsoil layers and in some areas sandy. Most profiles had negative net acidity values, and pH_{OX} data for a few samples indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (clayey or loamy) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent. • Other Soil (clayey or loamy) – occurring on the wetland margins above the water shoreline. Sub-dominant (<50%) in extent.
Hazard assessment	• Acidification hazard – medium level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – medium level of concern

Table 11-2. Site description data for Gurra Complex (Wetland ID. 12364).

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	15/04/2010	466045	6208291		Sandy	Salt bush	high elevation, on margin with salt bush
2	15/04/2010	466038	6208288		Firm, salt crust	water	low elevation, in water
3	18/04/2010	467012	6206918		sandy	saltbush	mid elevation, 10 downslope edge of dry channel
4	18/04/2010	467006	6206910		firm, halite crust	water	low elevation

Table 11-3. Soil profile description data for Gurra Complex (Wetland ID. 12364).

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)	sandy clay loam	dry		platy	firm	
1_2	5 - 10	small pit	dark grey (5Y4/1)	clay	moist	2% yellowish brown In the matrix	angular blocky	very firm	
1_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist	2% yellowish brown In the matrix	angular blocky	very firm	sticky
1_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist		angular blocky	very firm	sticky, too clayey to auger below
2_W1	20 - 0	surface water							water sampled
2_1	0 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
2_2	5 - 10	small pit	grey (5Y5/1)	clay	wet		angular blocky	weak	
2_3	10 - 20	small pit	grey (5Y5/1)	clay	wet		massive	very firm	40% calcrete nodules, a calcrete layer too hard to auger below
2_4	20 - 40	small pit	dark grey (5Y4/1)	light clay	wet		massive	very weak	
2_5	40 - 90	push tube	grey (5Y5/1)	heavy clay	wet		massive	very weak	
3_1	0 - 5	small pit	grey (5Y5/1)	sand	dry	40% yellowish brown	single grain	loose	
3_2	5 - 10	small pit	dark greenish gray (10BG4/1)	sand	dry	20% brown	single grain	loose	
3_3	10 - 20	small pit	dark bluish gray (5B3/1)	sand	dry	10% brown	single grain	loose	
3_4	20 - 40	small pit	dark grey (5Y4/1)	sand	wet		single grain	very weak	
3_5	40 - 70	push tube	grey (5Y5/1)	sand	dry		single grain	loose	
4_1	0 - 15	small pit	black (N2.5/0)	salt	wet		single grain	very weak	
4_2	15 - 30	small pit	black (N2.5/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour, halite present
4_3	30 - 40	push tube	dark greenish gray (10Y4/1)	light clay	wet		massive	very weak	
4_4	40 - 65	push tube	greenish grey (5GY5/1)	light clay	wet		massive	very weak	
4_1	0 - 70	push tube							
4_2	-	pit water							water sampled

Table 11-4. Laboratory data for acid sulfate soil assessment of Gurra Complex (Wetland ID. 12364).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav)	Acid Sulfate Soil Material Classification
1.1	0-5	Medium	18430	7.96	7.81	7.45	7.89	780	8.31	0.00	<0.01	1.71	-228	..	other soil material
1.2	5-10	Fine	7930	8.17	8.38	7.65	8.10	240	7.76	0.00	0.01	1.01	-127	..	hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	6380	8.09	8.06	7.60	7.96	210	7.12	0.00	<0.01	0.94	-125	..	other soil material
1.4	20-40	Fine	3170	8.12	8.45	7.43	7.98	150	6.92	0.00	<0.01	0.93	-124	..	other soil material
2.W1	20-0														surface water
2.1	0-5	Medium	32500	8.02	7.10	7.01	7.69	2500	9.00	0.00	0.15	19.03	-2444	0.07	hyposulfidic (S_{CR}≥0.10%) monosulfidic
2.2	5-10	Fine	3040	9.06	8.18	7.73	8.35	240	8.71	0.00	0.09	1.86	-194	..	hyposulfidic (S_{CR}<0.10%)
2.3	10-20	Fine	3430	8.89	8.54	7.29	8.45	170	8.77	0.00	0.01	2.14	-279	..	hyposulfidic (S_{CR}<0.10%)
3.1	0-5	Medium	2520	8.00	7.78	7.53	7.87	2200	9.00	0.00	0.04	3.08	-387	..	hyposulfidic (S_{CR}<0.10%)
3.2	5-10	Medium	10900	7.79	7.09	7.17	7.63	510	9.10	0.00	0.06	0.45	-23	..	hyposulfidic (S_{CR}<0.10%)
3.3	10-20	Coarse	9690	8.10	1.76	7.64	4.51	440	7.86	0.00	0.11	0.13	50	..	hyposulfidic (S_{CR}≥0.10%)
3.4	20-40	Coarse	8230	7.76	1.25	7.32	6.07	670	7.30	0.00	0.20	0.26	87	..	hyposulfidic (S_{CR}≥0.10%)
3.5	40-70	Medium	7630	8.57	3.36	7.22	7.05	330	7.88	0.00	0.04	0.08	12	..	hyposulfidic (S_{CR}<0.10%)
4.1	0-15	Medium	174600	7.96	6.32	7.16	7.60	6900	9.31	0.00	0.02	1.06	-129	0.01	hyposulfidic (S_{CR}<0.10%) monosulfidic
4.2	15-30	Medium	108100	7.74	6.45	6.47	7.37	5100	9.10	0.00	0.06	2.77	-332	0.03	hyposulfidic (S_{CR}<0.10%) monosulfidic
4.3	30-40	Fine	3400	8.04	6.08	6.63	7.79	1900	8.64	0.00	0.28	1.56	-35	..	hyposulfidic (S_{CR}≥0.10%)
4.4	40-65	Fine	17100	8.07	6.82	7.08	7.86	1100	8.74	0.00	0.14	0.76	-14	..	hyposulfidic (S_{CR}≥0.10%)

Table 11-5. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12364).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=2)	7.68-8.85	164027-207300	0.3-10.0	-52 - 0	260	230-591
Pit waters (n = 1)	7.30	105600	0.0	104		267

Table 11-6. Summary of hydrochemical field measurements for Gurra Complex (Wetland ID. 12364).

Parameter	units	ANZECC Guidelines	Site 2 (SW)	Site 3 (PW)	Site 4 (SW)
Na	mg l^{-1}		42800	24700	84700
K	mg l^{-1}		326	163	970
Ca	mg l^{-1}		822	813	231
Mg	mg l^{-1}		3380	1970	13300
Si	mg l^{-1}		<2.5	7.48	<5
Br	mg l^{-1}		250	130	890
Cl	mg l^{-1}		81000	44000	160000
NO_3	mg l^{-1}	0.7	<0.022	<0.022	<0.022
NH_4-N^K	mg l^{-1}	0.01	**0.65**	**0.356**	**0.368**
PO_4-P^E	mg l^{-1}	0.005	<0.002	**0.534**	**1.454**
SO_4	mg l^{-1}		13000	6500	34000
Ag	µg l^{-1}	0.05	<0.1	<0.08	<0.3
Al^A	µg l^{-1}	55	<90	<50	<200
As^B	µg l^{-1}	13	**20**	<8	**90**
Cd	µg l^{-1}	0.2	<0.5	<0.3	<0.9
Co	µg l^{-1}	2.8	1.2	1.5	0.6
Cr^C	µg l^{-1}	1	<4	<2	<7
Cu^H	µg l^{-1}	1.4	<9	<5	<20
Fe	µg l^{-1}	300	<5000	<5000	<10000
Mn	µg l^{-1}	1700	1664	1283	**4278**
Ni^H	µg l^{-1}	11	<5	2.0	<10
Pb^H	µg l^{-1}	3.4	<0.9	<0.5	<2
Se	µg l^{-1}	11	<3	<2	5
Zn^H	µg l^{-1}	8	**60**	**360**	**80**
DOC	mg l^{-1}		123	18.8	518

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

12. LYRUP EAST (WETLAND ID. 12565)

12.1. Location and setting description

Lyrup East (Wetland ID. 12565) is situated on the southern side of the River Murray, approximately 10 kilometres up river from the town of Berri. The wetland is rectangular in shape. It is about 600 metres in length and about 80 metres at its widest, with a total surface area of 4 hectares. The wetland is bounded by a raised floodplain that separates it from the river and farmland.

The wetland is not directly connected to the river but is connected via an inlet with the adjacent Lyrup East Wetland ID. 12566 to the west. At the time when the soil survey was conducted in May 2010 the wetland had surface water. The wetland is not managed. There are areas of Typha, Phragmites and Samphire growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 12-1.

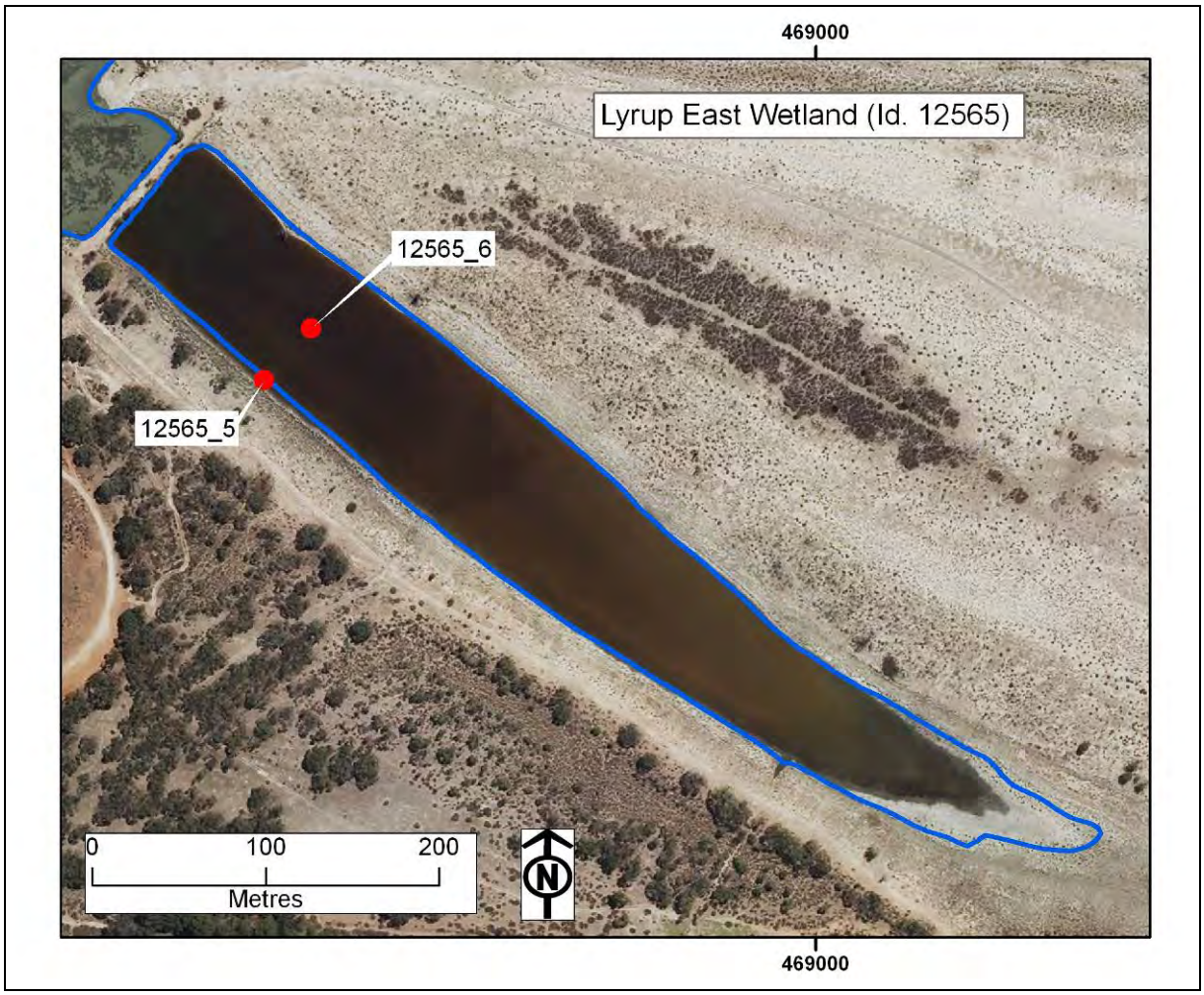


Figure 12-1. Lyrup East (Wetland ID. 12565) and sample site locations.

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 distributed as a pair near the centre to western end (Sites 5 and 6) of the wetland. The site and soil profile descriptions are presented in Table 12-2 and Table 12-3, and a conceptual cross-section diagram Figure 12-2.

Centre transect

Site 5 (Figure 12-3) occurred on the wetland margin, and the soil consisted of a dark grey, firm, clay loam, over a dark grey, very firm clay. Site 6 (Figure 12-4) occurred in water (20 cm deep), and the soil consisted of a very dark grey, very weak mucky clay, over a dark grey, very firm, clay.

Table 12-1. Soil identification, subtype and general location description for Lyrup East (Wetland ID. 12565).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12565_5	468682	6209779	Other Soil (clayey)	high elevation, 5m from water
12565_6	468709	6209809	Hypersulfidic Subaqueous Soil (clayey)	low elevation, middle of wetland in water

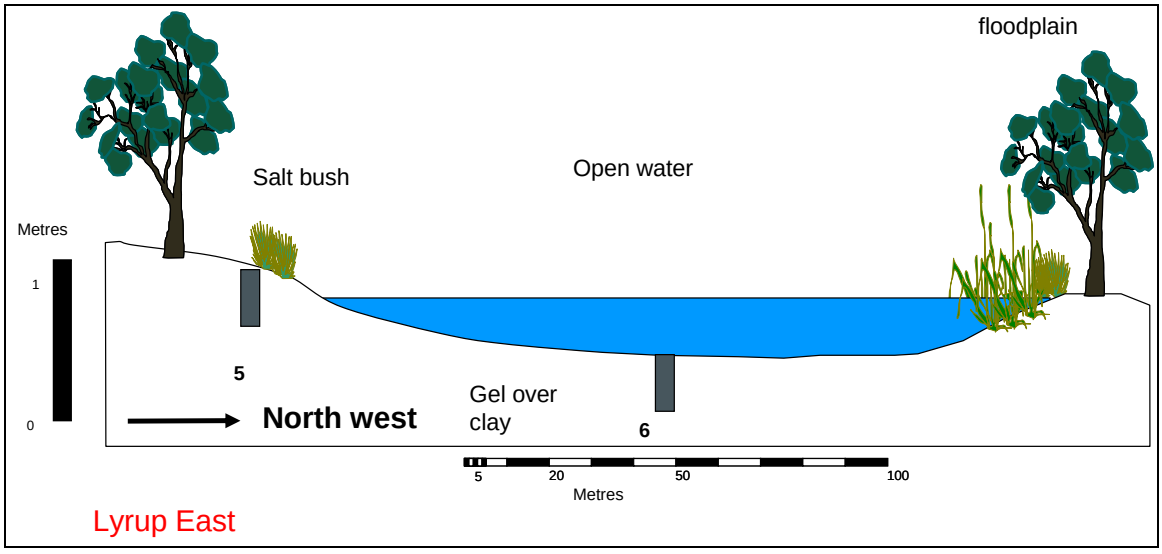


Figure 12-2. Conceptual cross-section diagram, showing locations for Sites 5 and 6.

Figure 12-3. Photograph of Site 5, showing the site location on the wetland margin at the edge where salt bush was growing.

Figure 12-4. Photograph of Site 6, showing the site location placed in the surface water.

12.3. Laboratory data assessment

12.3.1. Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 12-4 and pH profiles are presented in Figure 12-5. The pH_W data ranged from 4.16 to 7.26 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.91 to 7.04 and identified that the subsurface layer in Profiles 6 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 2.71 to 7.49 and identified that samples in Profile 6 on incubation declined below the critical values of pH <4, indicating that these soils potentially would form sulfuric material on oxidation.

12.3.2. Acid base accounting

The acid base accounting data is provided in Table 12-4 and summarised in Figure 12-6.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.00 to 0.30 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 78.27 mole H^+/tonne and were detected samples of both profiles.

Retained acidity

Retained acidity was measured in the upper two layers of Profile 6 at 22 and 68 mole H^+/tonne.

Acid neutralising capacity

Acid neutralising capacity values were not measured except for one lower subsoil sample in Profile 5 of 0.91 $\%CaCO_3$.

Net acidity

Net acidity values ranged from -90 to 270 mole H^+/tonne. Generally samples were low, moderate or high net acidity values with one negative value for the lower subsoil layer of Profile 5.

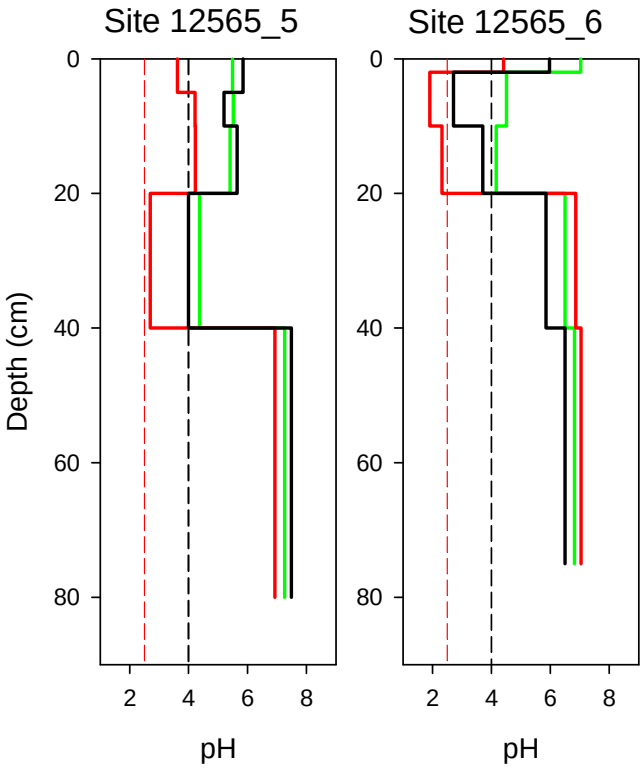


Figure 12-5. Depth profiles of soil pH for Lyrup East (Wetland ID. 12565), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

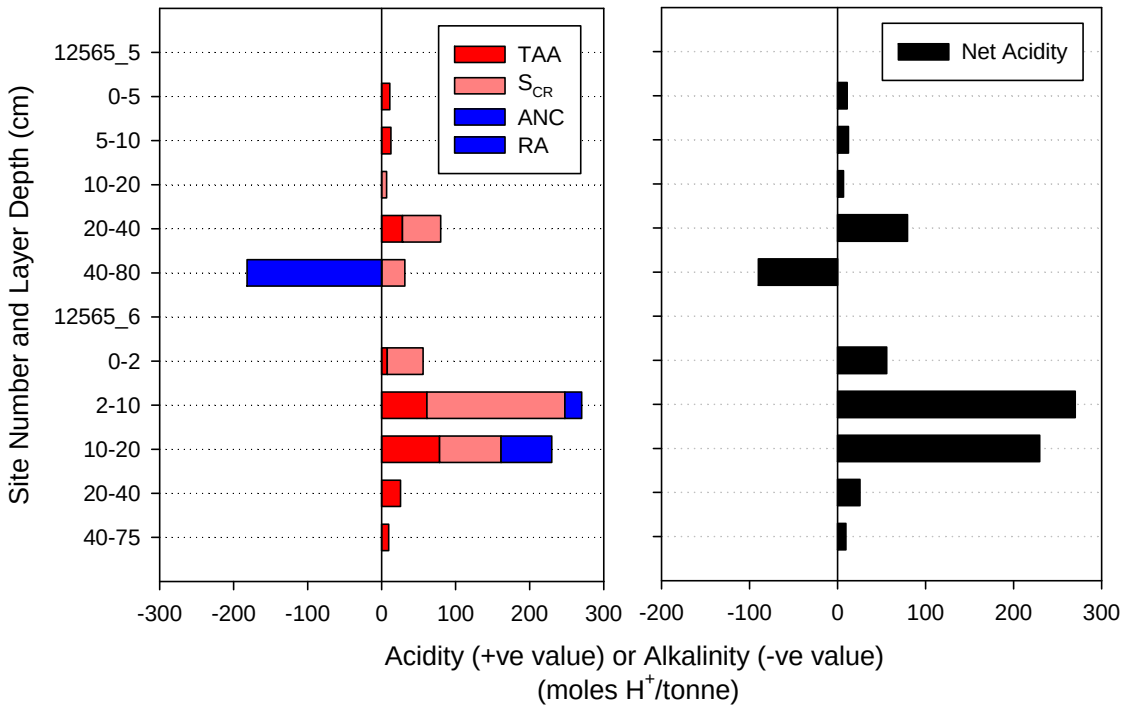


Figure 12-6. Acid base accounting depth profiles for Lyrup East (Wetland ID. 12565). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), retained acidity (RA - +ve blue bar), and acid neutralising capacity (ANC - -ve blue bar), and right side shows net acidity.

12.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 12-4 identified both profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

12.3.4. Acid volatile sulfur

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

12.3.5. Hydrochemistry

One surface water sample was collected from this wetland. Field parameters are shown in Table 12-5. The surface water had a slightly acidic pH and moderate salinity. Dissolved oxygen was high, turbidity and alkalinity were low.

The surface water was of Na-SO_4 type (Table 12-6, Figure 12-7). Sulfate concentration in the surface water was high at 1600 mg l^{-1}. The SO_4/Cl ratio in the surface waters (1.684) was much higher than seawater (0.142). For the nutrients, NH_4 was slightly elevated above the ANZECC Guideline value. Of the metals, Co, Cu, Mn and Ni concentrations were elevated above ANZECC Guideline values.

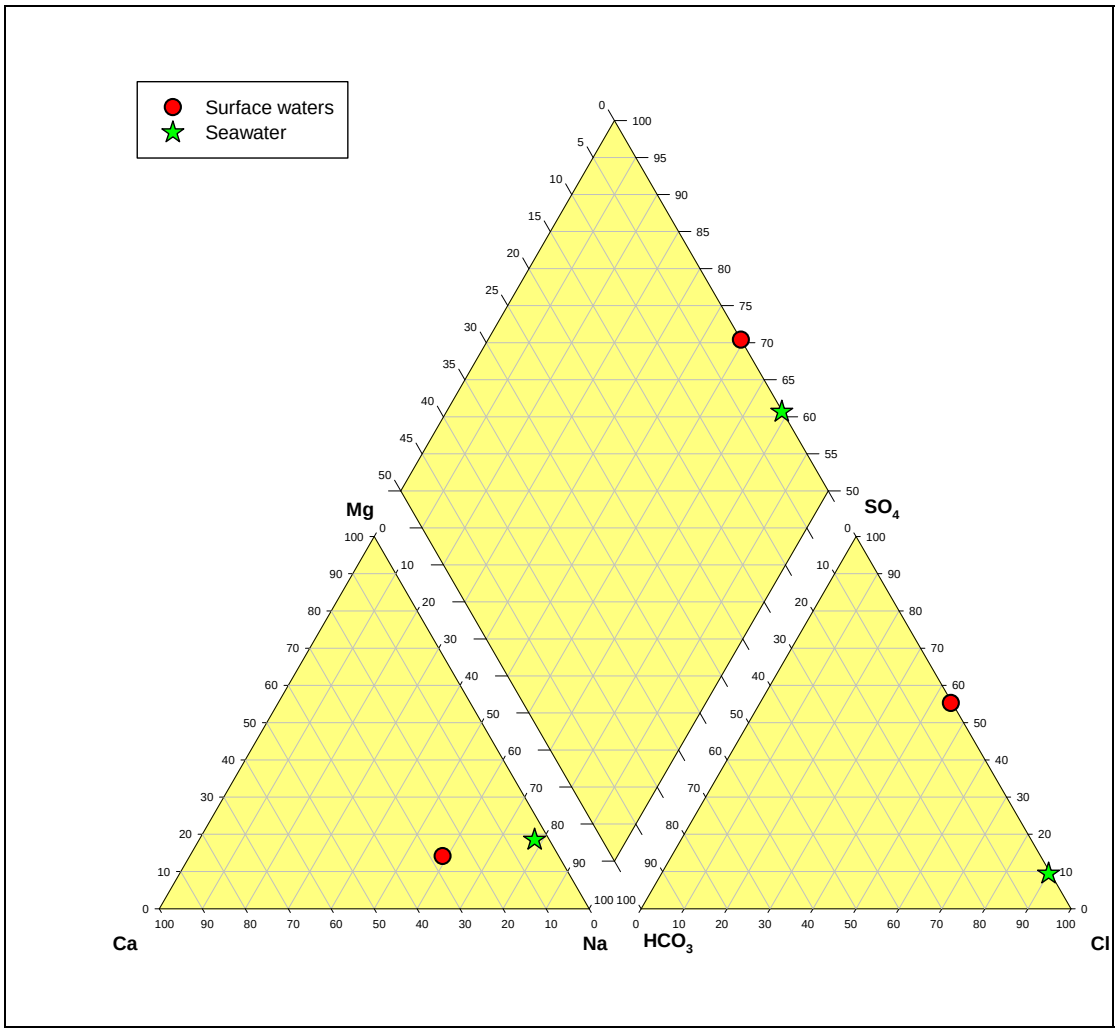


Figure 12-7. Piper diagram of hydrochemical data for Lyrup East (Wetland ID. 12565).

12.4. Discussion

Acid sulfate soil materials at Lyrup East (Wetland ID. 12565) were identified as sulfuric and hypersulfidic occurring in Profile 6, the remainder of the samples in both profiles were hyposulfidic. It is likely that the sulfuric sample was actually a hypersulfidic sample that oxidised very quickly after sampling and therefore hypersulfidic is a better description for the sample. The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (clayey) that occurred throughout the wetland where there was surface water and Other Soil (clayey) that occurred on the margin areas.

The soils throughout the wetland were dominantly clayey textured.

Monosulfidic material was not observed however 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 Lyrup East (Wetland ID. 12565) are:

- Acidification hazard: The data identified low, moderate and high net acidity values in both 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 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 high acidification hazard indicates that soil acidification potential is not likely to increase the solubility of metals. There is a high level of concern.

Summary of key findings Lyrup East (Wetland ID. 12565):

Soil materials:	The soil layers throughout the wetland were hypersulfidic and hyposulfidic for both profiles. Soils were clayey textured. The profiles had low, moderate or high net acidity values and pH data indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Hypersulfidic Subaqueous Soil (clayey) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent. • Other Soil (clayey) – occurring on the wetland margins above the water. Minor (<25% in extent)
Hazard assessment	• Acidification hazard – high level of concern • De-oxygenation hazard – medium level of concern • Metal mobilisation hazard – high level of concern

Table 12-2. Site description data for Lyrup East (Wetland ID. 12565).

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
5	5/05/2010	468682	6209779	not reached	sealed, clayey	samphire	high elevation, 5m from water
6	5/05/2010	468709	6209809	20	water	water	low elevation, middle of wetland

Table 12-3. Soil profile description data for Lyrup East (Wetland ID. 12565).

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_1	0 - 5	small pit	dark grey (5Y4/1)	clay loam	moist		subangular blocky	firm	very sticky
5_2	5 - 10	small pit	dark grey (5Y4/1)	clay loam	moist		subangular blocky	firm	very sticky
5_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist		massive	very firm	very sticky
5_4	20 - 40	small pit	dark grey (2.5Y4/0)	clay	moist		massive	very firm	
5_5	40 - 80	small pit	dark grey (2.5Y4/0)	clay	moist		massive	very firm	
6_W1	20 - 0	surface water							water sampled
6_1	0 - 2	small pit	very dark grey (2.5Y3/0)	mucky clay	moist		gel	very weak	
6_2	2 - 10	small pit	very dark grey (5Y3/1)	clay	moist		angular blocky	very firm	
6_3	10 - 20	small pit	dark grey (5Y4/1)	clay	moist		angular blocky	very firm	
6_4	20 - 40	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	
6_5	40 - 75	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	

Table 12-4. Laboratory data for acid sulfate soil assessment of Lyrup East (Wetland ID. 12565).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
5.1	0-5	Fine	17650	5.49	3.62	5.95	5.85	3600	5.79	11.04	<0.01	..	..	11	other acidic incubation
5.2	5-10	Fine	5140	5.52	4.22	5.84	5.20	1700	5.50	12.54	<0.01	..	..	13	other acidic incubation
5.3	10-20	Fine	4610	5.41	4.23	6.81	5.65	1200	6.50	0.00	0.01	..	0.00	7	hyposulfidic (S_{CR}<0.10%)
5.4	20-40	Fine	3810	4.37	2.70	4.61	4.00	1100	4.84	28.10	0.08	..	..	80	hyposulfidic (S_{CR}<0.10%)
5.5	40-80	Fine	2402	7.26	6.93	7.31	7.49	340	6.60	0.00	0.05	..	0.91	-90	hyposulfidic (S_{CR}<0.10%)
6.W1															surface water
6.1	0-2	Fine	1075	7.03	4.41	6.67	5.97	650	6.26	7.53	0.08		0.00	56	hyposulfidic (S_{CR}<0.10%)
6.2	2-10	Fine	1097	4.51	1.91	4.76	2.71	670	4.34	61.21	0.30	22.64	..	270	hypersulfidic
6.3	10-20	Fine	2108	4.16	2.32	3.93	3.71	900	4.13	78.27	0.13		..	230	sulfuric
												68.39			(hypersulfidic)
6.4	20-40	Fine	2275	6.50	6.86	6.29	5.85	430	5.07	25.59	<0.01	..	..	26	other acidic incubation
6.5	40-75	Fine	1491	6.82	7.04	6.69	6.50	320	6.07	9.53	<0.01	..	0.00	10	other acidic incubation

Table 12-5. Summary of hydrochemical field measurements for Lyrup East (Wetland ID. 12565).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=1)	6.78	5119	12.81	-121	16	9

Table 12-6. Summary of hydrochemical field measurements for Lyrup East (Wetland ID. 12565).

Parameter	units	ANZECC Guidelines	Site 6 (SW)
Na	mg l^{-1}		729
K	mg l^{-1}		12.7
Ca	mg l^{-1}		295
Mg	mg l^{-1}		93.7
Si	mg l^{-1}		1.21
Br	mg l^{-1}		2.3
Cl	mg l^{-1}		950
NO_3	mg l^{-1}	0.7	**0.771**
NH_4-N[K]	mg l^{-1}	0.01	**0.41**
PO_4-P[E]	mg l^{-1}	0.005	0.003
SO_4	mg l^{-1}		1600
Ag	µg l^{-1}	0.05	<0.01
Al[A]	µg l^{-1}	55	<4
As[B]	µg l^{-1}	13	1.2
Cd	µg l^{-1}	0.2	0.06
Co	µg l^{-1}	2.8	**12.1**
Cr[C]	µg l^{-1}	1	<0.2
Cu[H]	µg l^{-1}	1.4	**2**
Fe	µg l^{-1}	300	<500
Mn	µg l^{-1}	1700	**3300**
Ni[H]	µg l^{-1}	11	**22.0**
Pb[H]	µg l^{-1}	3.4	0.04
Se	µg l^{-1}	11	0.1
Zn[H]	µg l^{-1}	8	7
DOC	mg l^{-1}		18.6

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

13. LYRUP EAST (WETLAND ID. 12566)

13.1. Location and setting description

Lyrup East (Wetland ID. 12566) is situated on the southern side of the River Murray, approximately 10 kilometres up river from the town of Berri. The wetland is somewhat rectangular in shape. It is about 600 metres in length and about 80 metres at its widest, with a total surface area of 4 hectares. The wetland is bounded by a raised floodplain that separates it from the river and farmland.

The wetland is permanently connected to the river by a wide inlet to the west, and to the east it is connected via an inlet with the adjacent Lyrup East Wetland ID. 12565. At the time when the soil survey was conducted in May 2010 the wetland had surface water. The wetland is not managed. There are areas of Typha, Phragmites and Samphire growing along parts of the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Two sites were sampled as shown in Figure 13-1.

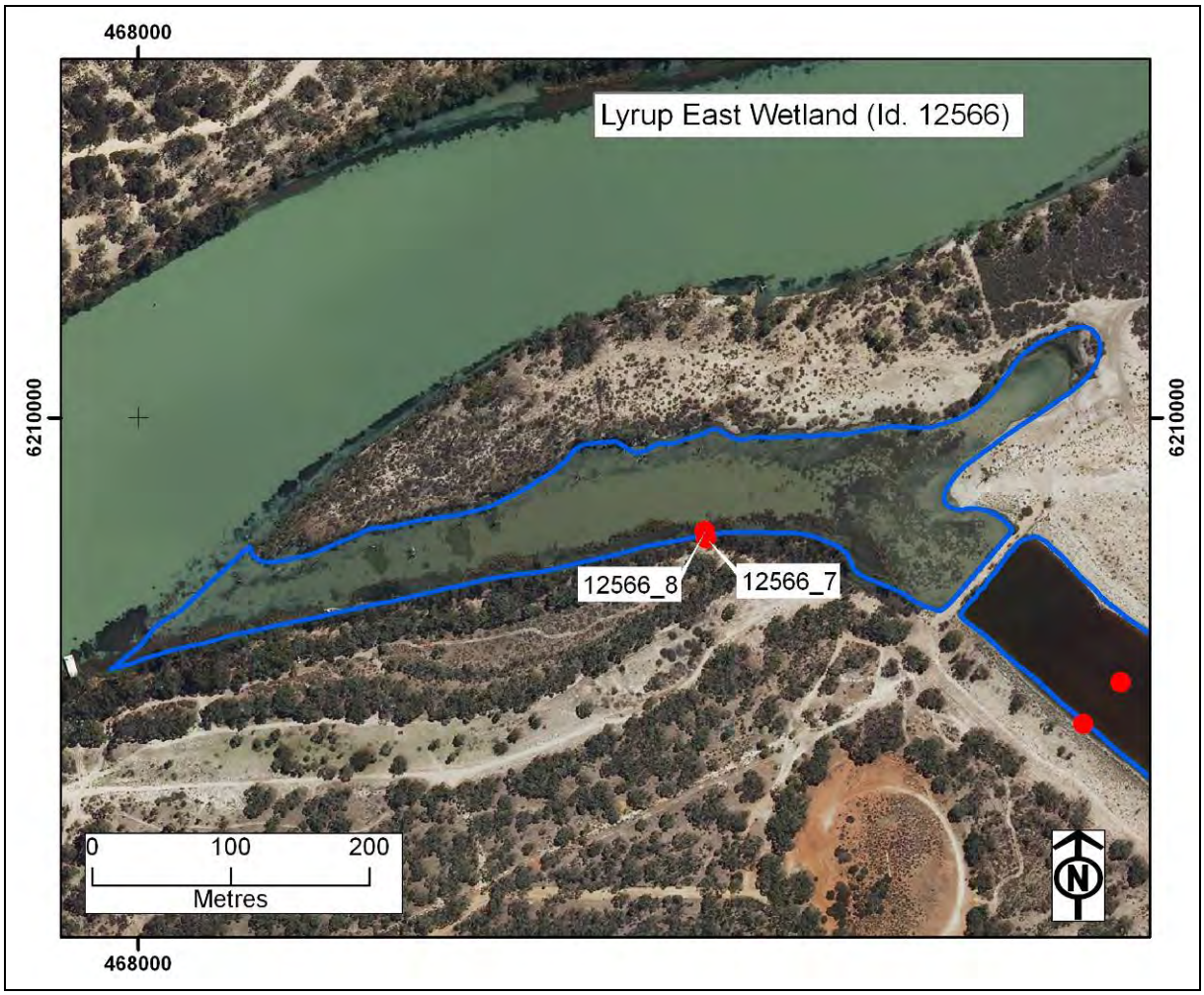


Figure 13-1. Lyrup East (Wetland ID. 12566) and sample site locations.

13.2. Soil profile description and distribution

Two sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 13-1. Sites were distributed as a pair near the centre (Sites 7 and 8) of the wetland. The site and soil profile descriptions are presented in Table 13-2 and Table 13-3, and a conceptual cross-section diagram in Figure 13-2.

Centre transect

Site 7 (Figure 13-3) occurred mid way between the bank and a line of reeds in water (30 cm deep), and the soil consisted of a very dark greyish brown, very weak, mucky sand, over a dark grey, firm, clay. Site 8 (Figure 13-4) occurred adjacent to reeds in open water (60 cm deep), and the soil consisted of a dark grey, very weak, mucky clay with a sulfurous odour, over a dark grey, very firm, clay.

Table 13-1. Soil identification, subtype and general location description for Lyrup East (Wetland ID. 12566).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12566_7	468410	6209913	Subaqueous Soil (clayey)	margin of wetland, adjacent to bank
12566_8	468409	6209918	Subaqueous Soil (clayey)	open water 3m from reeds

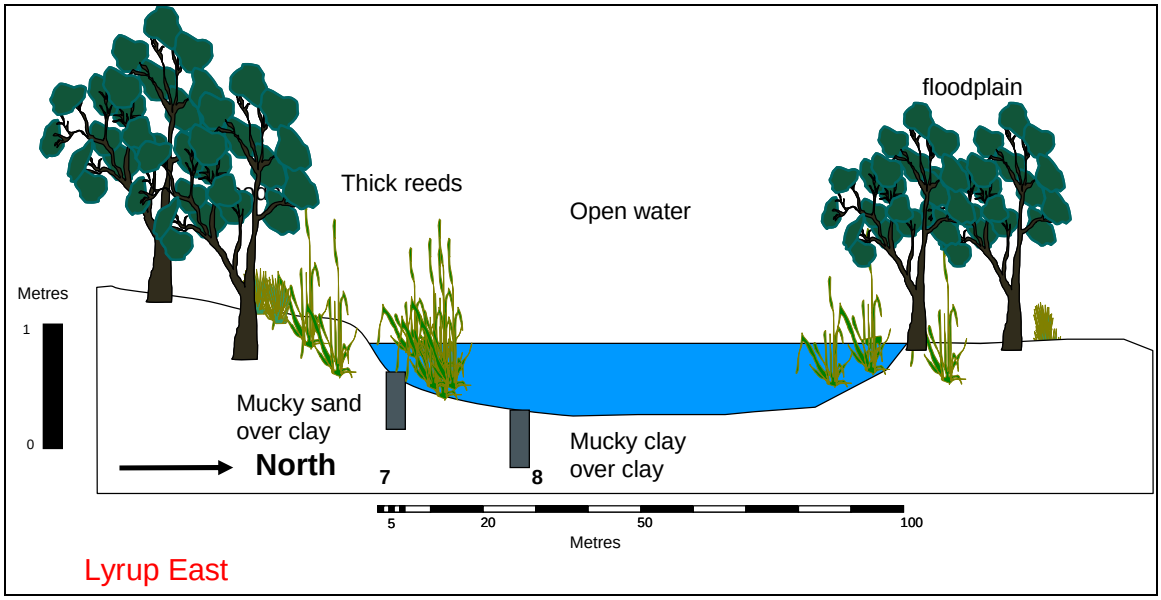


Figure 13-2. Conceptual cross-section diagram, showing locations of Sites 7 and 8.

Figure 13-3. Photograph of Site 7, showing the site location in water between the bank and a line of reeds.

Figure 13-4. Photograph of Site 8, showing the site location placed 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 13-5. The pH_W data ranged from 6.38 to 8.28 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.66 to 7.96 and identified that the surface layers in both Profiles were below the critical value of pH_{OX} <2.5. The pH_{INC} data ranged from 4.20 to 8.04 and identified that no samples on incubation declined below the critical values of pH <4.

13.3.2. Acid base accounting

The acid base accounting data is provided in Table 13-4 and summarised in Figure 13-6.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.00 to 0.22 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 23.08 mole H^+/tonne and were detected in samples of both profiles.

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 0.57 $\%CaCO_3$.and were measured in Profile 7 and not in Profile 8.

Net acidity

Net acidity values ranged from -67 to 159 mole H^+/tonne. Samples had high or moderate net acidity values and Profile 8 had a negative value in the deeper subsoil layers.

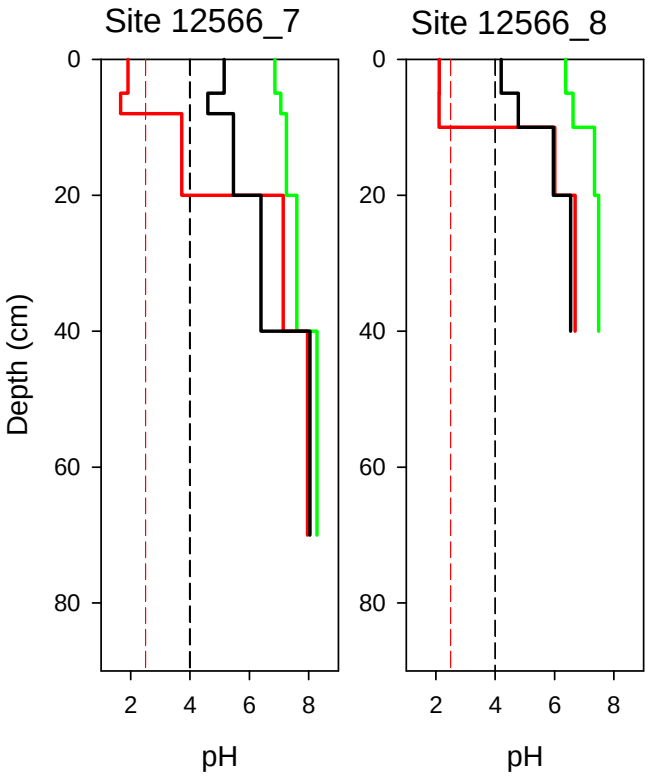


Figure 13-5. Depth profiles of soil pH for Lyrup East (Wetland ID. 12566), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

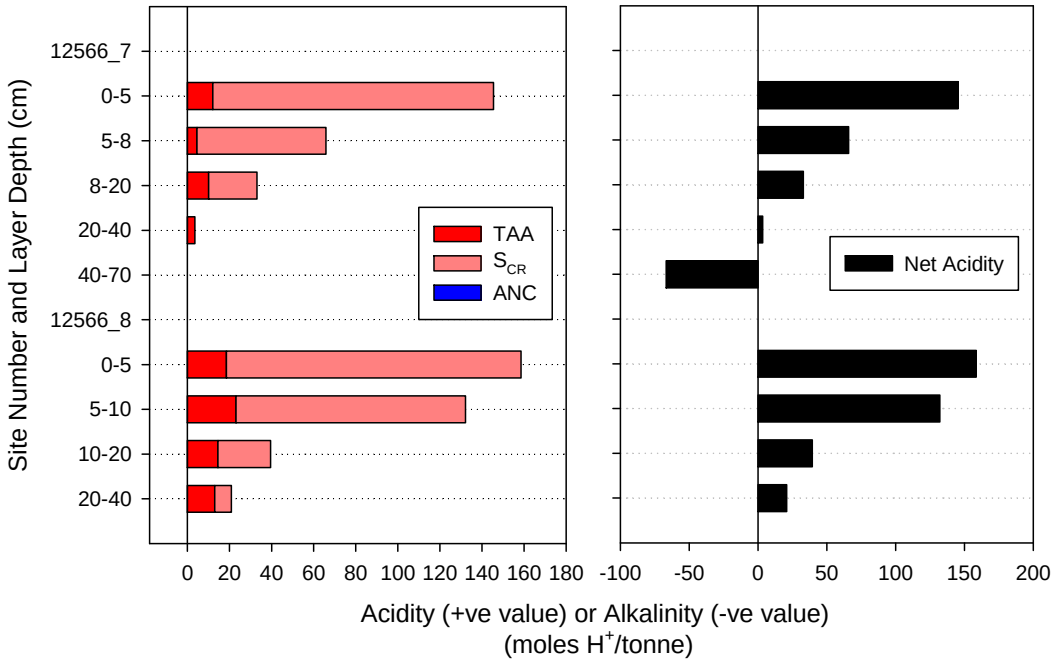


Figure 13-6. Acid base accounting depth profiles for Lyrup East (Wetland ID. 12566). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

13.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 13-4 identified profiles did not have surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

13.3.4. Acid volatile sulfur

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

13.3.5. Hydrochemistry

One surface water sample was collected from this wetland. Field parameters are shown in Table 13-5. The surface water had circumneutral pH and was fresh. Dissolved oxygen was high, turbidity was moderate and alkalinity slightly high.

The surface water sample was of Na-Cl type, with elevated HCO_3 compared to seawater composition (Table 13-6, Figure 13-7). Sulfate concentration in the surface water was low at 8.7 mg l^{-1}. The SO_4/Cl ratio in the surface water sample (0.116) was similar to seawater (0.142). For the nutrients, NH_4 and PO_4 were very slightly elevated above ANZECC Guideline values in some samples. Of the metals, Al and Zn concentrations were locally elevated above ANZECC Guideline values, although for Al, this may be partly due the high turbidity in some samples with colloidal material present.

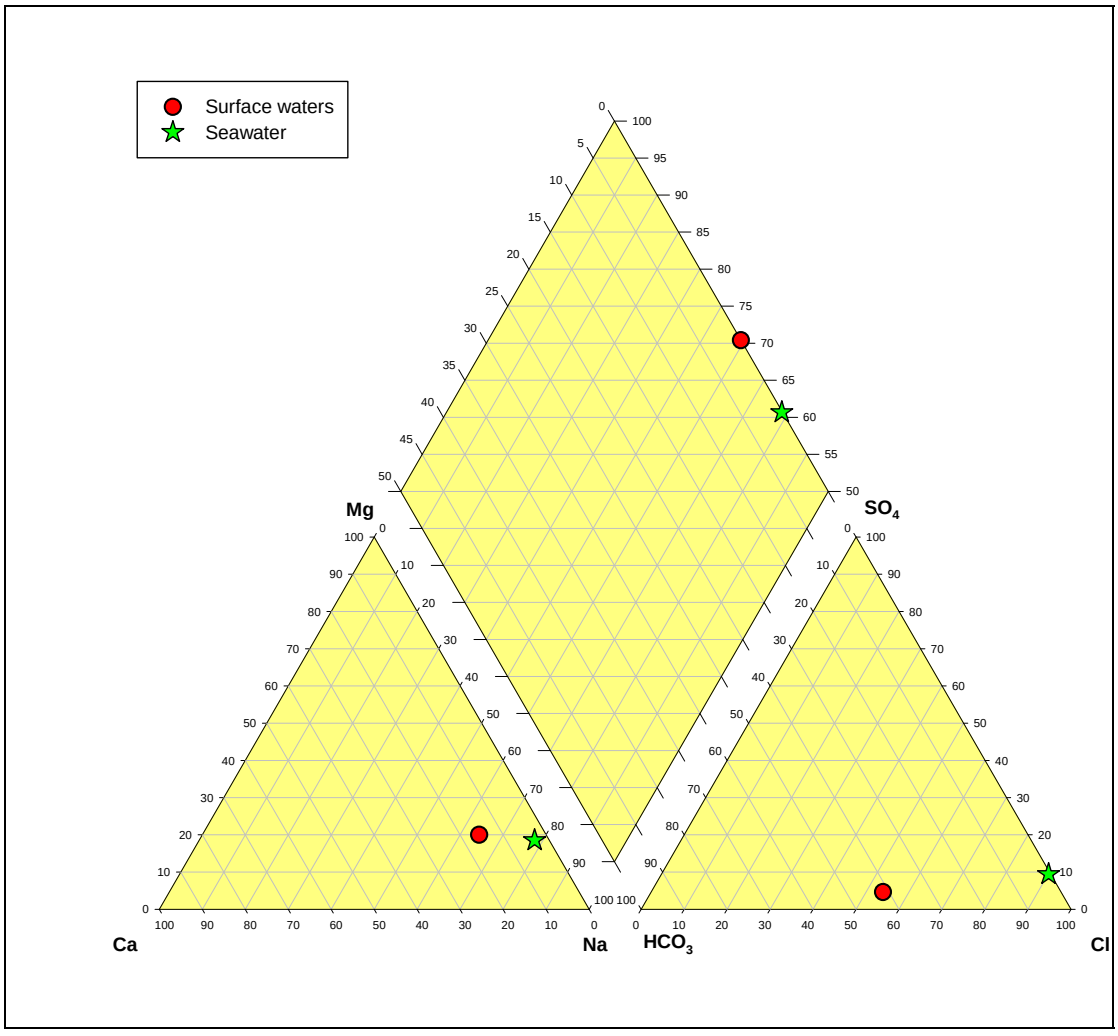


Figure 13-7. Piper diagram of hydrochemical data for Lyrup East (Wetland ID. 12566).

13.4. Discussion

Acid sulfate soil materials at Lyrup East (Wetland ID. 12566) were identified hyposulfidic in the upper soil layers, and the deep subsoil layers were characterised as other soil material. The acid sulfate soil subtype class identified was Subaqueous Soil (clayey) that occurred throughout the wetland.

The soils throughout the main wetland area were dominantly clayey textured in the surface and subsoil layers, and in some areas sandy texture for the surface layers adjacent to the bank.

Monosulfidic materials were not observed and water soluble sulfate data identified that no 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 Lyrup East (Wetland ID. 12566) are:

- Acidification hazard: The data identified high or moderate net acidity values in both profiles and pH data identified 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 was no potential for monosulfidic materials to form in the surface layers, 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 Lyrup East (Wetland ID. 12566):

Soil materials:	The soil layers throughout the wetland were hyposulfidic. Soils were clayey textured and in some areas sandy textured surface layers near the bank. The profiles had high or moderate net acidity values and pH data indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (clayey) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – medium to high level of concern • De-oxygenation hazard – low level of concern • Metal mobilisation hazard – medium level of concern

Table 13-2. Site description data for Lyrup East (Wetland ID. 12566).

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
7	5/05/2010	468410	6209913	30	water, soft	water, Phragmites	margin of wetland, adjacent to bank
8	5/05/2010	468409	6209918	60	water	water	open water 3m from reeds

Table 13-3. Soil profile description data for Lyrup East (Wetland ID. 12566).

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_W	30 - 0	water							
7_1	0 - 5	small pit	very dark greyish brown (10YR3/2)	mucky sand	wet		single grain	very weak	fine plant material, sulfurous odour
7_2	5 - 8	small pit	dark grey (5Y4/1)	sand	wet		single grain	weak	sulfurous odour
7_3	8 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	firm	contains plant material and roots
7_4	20 - 40	push tube	dark grey (5Y4/1)	clay	moist		massive	firm	
7_5	40 - 70	push tube	grey (5Y5/1)	clay	moist		massive	very firm	
8_W1	60 - 0	surface water							water sampled
8_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	sulfurous odour
8_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	sulfurous odour
8_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	sulfurous odour
8_4	20 - 40	push tube	dark grey (2.5Y4/0)	clay	wet		massive	very firm	

Table 13-4. Laboratory data for acid sulfate soil assessment of Lyrup East (Wetland ID. 12566).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
7.1	0-5	Fine	148	6.86	1.91	6.43	5.15	54	6.17	12.04	0.21	..	0.00	145	hyposulfidic (S_{CR}≥0.10%)
7.2	5-8	Medium	89	7.06	1.66	6.95	4.60	64	6.25	4.52	0.10	..	0.00	66	hyposulfidic (S_{CR}<0.10%)
7.3	8-20	Fine	121	7.25	3.72	7.29	5.46	31	5.89	10.04	0.04	..	..	33	hyposulfidic (S_{CR}<0.10%)
7.4	20-40	Fine	158	7.60	7.14	7.40	6.39	9	6.38	3.51	<0.01	..	0.00	4	other soil material
7.5	40-70	Fine	230	8.28	7.96	7.94	8.04	8.8	6.56	0.00	<0.01	..	0.50	-67	other soil material
8.W1	60-0														surface water
8.1	0-5	Fine	125	6.38	2.12	6.74	4.20	14	5.58	18.56	0.22	..	..	159	hyposulfidic (S_{CR}≥0.10%)
8.2	5-10	Fine	129	6.62	2.11	6.49	4.78	49	5.41	23.08	0.17	..	..	132	hyposulfidic (S_{CR}≥0.10%)
8.3	10-20	Fine	97	7.35	6.01	7.11	5.96	41	5.77	14.55	0.04	..	..	40	hyposulfidic (S_{CR}<0.10%)
8.4	20-40	Fine	156	7.49	6.69	7.21	6.54	23	5.86	13.05	0.01	..	..	21	hyposulfidic (S_{CR}<0.10%)

Table 13-5. Summary of hydrochemical field measurements for Lyrup East (Wetland ID. 12566).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=1)	7.14	417	10.06	-129	73	99

Table 13-6. Summary of hydrochemical field measurements for Lyrup East (Wetland ID. 12566).

Parameter	units	ANZECC Guidelines	Site 8 (SW)
Na	mg l^{-1}		53
K	mg l^{-1}		3.3
Ca	mg l^{-1}		11.6
Mg	mg l^{-1}		9.02
Si	mg l^{-1}		3.91
Br	mg l^{-1}		0.2
Cl	mg l^{-1}		75
NO_3	mg l^{-1}	0.7	<0.022
NH_4-N^K	mg l^{-1}	0.01	**0.05**
PO_4-P^E	mg l^{-1}	0.005	**0.008**
SO_4	mg l^{-1}		8.7
Ag	µg l^{-1}	0.05	<0.01
Al^A	µg l^{-1}	55	**180**
As^B	µg l^{-1}	13	1.2
Cd	µg l^{-1}	0.2	0.04
Co	µg l^{-1}	2.8	0.17
Cr^C	µg l^{-1}	1	0.2
Cu^H	µg l^{-1}	1.4	1.4
Fe	µg l^{-1}	300	284
Mn	µg l^{-1}	1700	12.59
Ni^H	µg l^{-1}	11	1.0
Pb^H	µg l^{-1}	3.4	0.48
Se	µg l^{-1}	11	<0.06
Zn^H	µg l^{-1}	8	**98**
DOC	mg l^{-1}		10.1

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

14. DISHER CREEK (WETLAND ID. 12254)

14.1. Location and setting description

Disher Creek (Wetland ID. 12254) is situated on the western side of the River Murray, about midway between the towns of Berri and Remark, approximately 10 kilometres directly each way. The wetland is in two parts with a crescent in shape formed from an oxbow lake and a linear creek line. It is about 4 kilometres in length and about 200 metres at its widest, with a total surface area of 110 hectares. The wetland is bounded by a raised floodplain that separates it from other wetlands and the river.

The wetland is probably connected to the river at the southern end by a creek line inlet. 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 and Samphire 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 14-1.

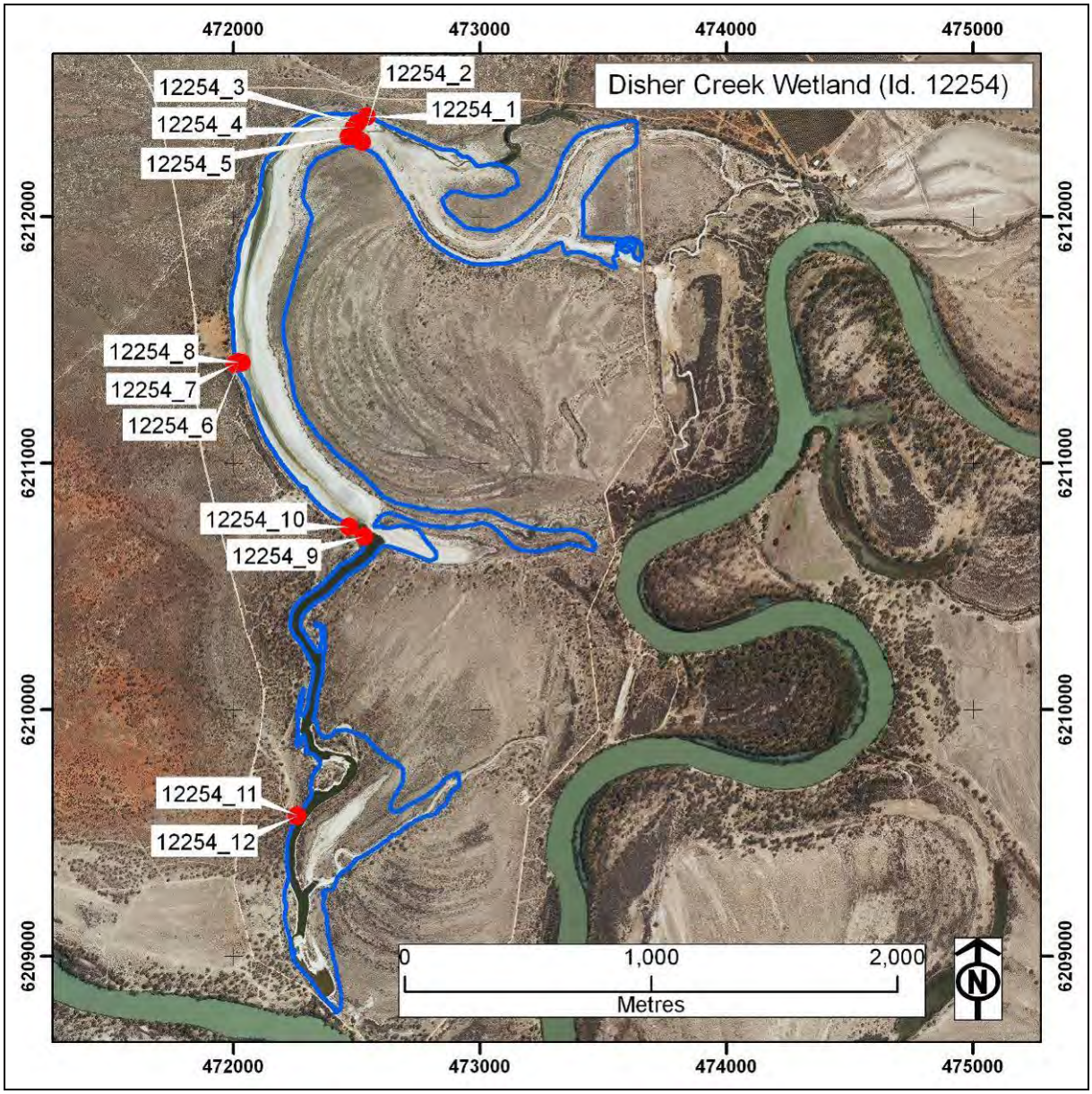


Figure 14-1. Disher Creek (Wetland ID. 12254) and sample site locations.

14.2. Soil profile description and distribution

Twelve sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 14-1. Sites were distributed along four transects placed around the wetland, with transects at the northern end (Sites 1, 2, 3, 4 and 5), western side (Sites 6, 7 and 8), near the junction where the oxbow and creek meet (Sites 9 and 10), and southern end (Sites 11 and 12) 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 5-2.

Northern transect

Site 1 (Figure 14-3) occurred on the margin parallel with the dead tree line, the water table was about 30 cm deep, and the soil consisted of a greyish brown, weak, loamy sandy, over a dark grey, very weak, clay. Site 2 (Figure 14-4) occurred in the surface water (5 cm deep), and the soil consisted of a greyish brown, very weak, clay, over a dark grey, firm, clay. Site 3 (Figure 14-5) occurred in a flowing water channel associated with the surface water (10 cm deep), and the soil consisted of a black, very weak, monosulfidic material, over a very dark grey, weak to firm with depth, clay. Site 4 (Figure 14-6) occurred at the waters edge in shallow surface water (3 cm deep), and the soil consisted of a greyish brown, weak, clay, over a very dark greyish brown, very weak, clay. Site 5 (Figure 1-7) occurred on the margin parallel with an old shoreline, and the soil consisted of a greyish brown, firm, sandy clay loam, over a dark grey, very firm, clay.

Western transect

Site 6 (Figure 1-8) occurred mid way between the margin and surface water, the water table was about 45 cm deep, and the soil consisted of a very dark grey, firm clay, over a very dark grey, weak, clay. Site 7 (Figure 5-9) occurred at the higher elevation on the wetland margin where saltbush was growing, and the soil consisted of a brown, firm, sand, over a very dark greyish brown, firm, clay. Site 8 (Figure 1-9) occurred in water (2 cm deep), and the soil consisted of a black, very weak, monosulfidic material, over a dark grey, very weak, mucky clay.

Junction transect

Site 9 (Figure 1-10) occurred in water (30 cm deep), and the soil consisted of a thick, black, very weak, monosulfidic material, over a dark grey, firm, sandy clay loam. Site 10 (Figure 5-12) occurred on the slope of the margin, and the soil consisted of a olive grey, firm, sandy loam, over a dark greyish brown, firm, clay.

Southern transect

Site 11 (Figure 5-13) occurred in water (30 cm deep), and the soil consisted of a black, very weak monosulfidic material, over a dark grey, firm, clay. Site 12 (Figure 5-14) occurred on the side of the bank, and the soil consisted of a dark grey, weak, clay loam, over a dark grey, very firm, clay.

Table 14-1. Soil identification, subtype and general location description for Disher Creek (Wetland ID. 12254).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12254_1	472542	6212407	Other Soil (clayey)	mid to high elevation, in line with dead trees
12254_2	472522	6212304	Subaqueous Soil (clayey)	low elevation, near centre
12254_3	472502	6212377	Subaqueous Soil (clayey)	low elevation, in channel 1m wide, with running water
12254_4	472490	6212362	Subaqueous Soil (clayey)	in water, adjacent to shoreline
12254_5	472467	6212326	Other Soil (clayey)	high elevation, adjacent to old shoreline before sand dunes
12254_6	472021	6211409	Other Soil (clayey)	mid elevation
12254_7	472006	6211404	Other Soil (loamy)	high elevation, sand covered clay surface
12254_8	472035	6211408	Subaqueous Soil (clayey)	low elevation, 3m into water
12254_9	472532	6210703	Subaqueous Soil (clayey)	low elevation, in open water
12254_10	472469	6210742	Other Soil (clayey)	high elevation
12254_11	472259	6209570	Subaqueous Soil (clayey)	mid to low elevation, 1m into open water
12254_12	472258	6209568	Other Soil (clayey)	side of bank

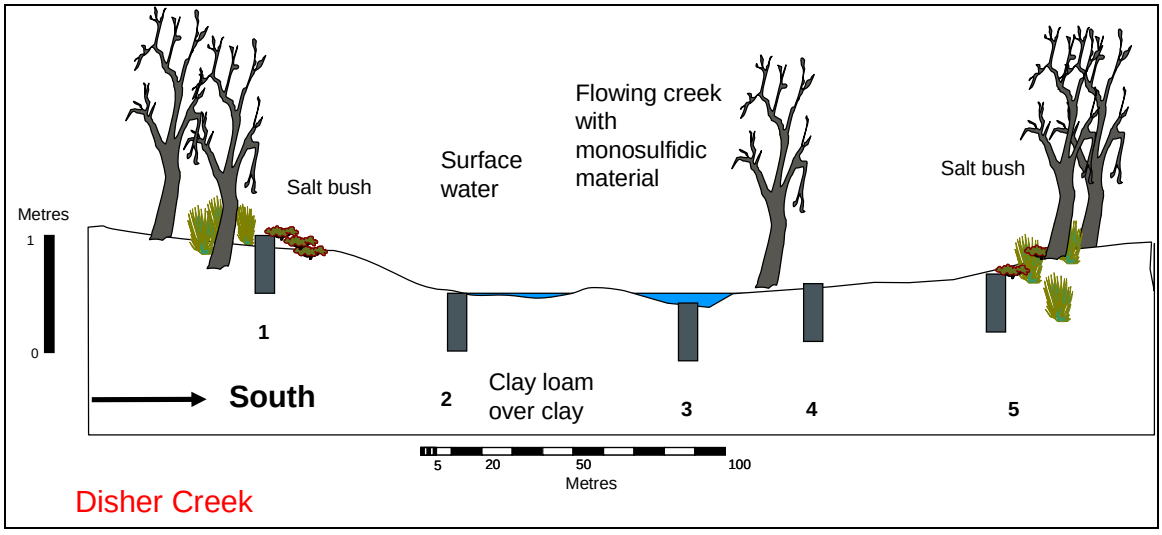


Figure 14-2. Conceptual cross-section diagram.

Figure 14-3. Photographs of Site 1, showing the site location on the wetland margin above the water, and the soil profile.

Figure 14-4. Photograph of Site 2, showing the site location on the edge of surface water.

Figure 14-5. Photograph of Site 3, showing the site location in a flowing water channel that is part of the surface water area.

Figure 14-6. Photograph of Site 4, showing the site location on the shoreline of the surface water.

Figure 14-7. Photograph of Site 5, showing the site location at the margin where vegetation begins to grow.

Figure 14-8. Photograph of Site 6, showing the site location on the margin.

Figure 14-9. Photograph of Site 7, showing the site location mid way between the margin and surface water.

Figure 14-10. Photographs of Site 8, showing the site location placed in the surface water, and looking back along the transect showing the blue bag at Site 7 with Site 6 on the sandy slope adjacent to the vegetation.

Figure 14-11. Photograph of Site 9, showing the site location placed in the water, the ground was very weak and the logs were used to reach the water.

Figure 14-12. Photograph of Site 10, showing the site location placed on the margins before the slope up.

Figure 14-13. Photograph of Site 11 showing the site location placed in open water marked by the auger, and Site 12 marked by the yellow shovel handle on the bank above the water.

Figure 14-14. Photograph of Site 12, showing the site location on the bank marked by the yellow shovel handle, and Site 11 marked by the auger in the water.

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 14-15. The pH_W data ranged from 4.88 to 8.97 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.65 to 7.68 and identified that layers in Profiles 1, 6, 7, 8, 11 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 4.22 and 7.91 and identified that no samples on incubation declined below the critical values of pH <4.

14.3.2. Acid base accounting

The acid base accounting data is provided in Table 14-4 and summarised in Figure 14-16.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 1.70 $\%S_{CR}$ and sulfidic materials were detected in all profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 17.50 mole H^+/tonne and were detected in samples from Profiles 2, 6, 7, 10 and 12.

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 32.67 $\%CaCO_3$ and were measured in samples from all profiles.

Net acidity

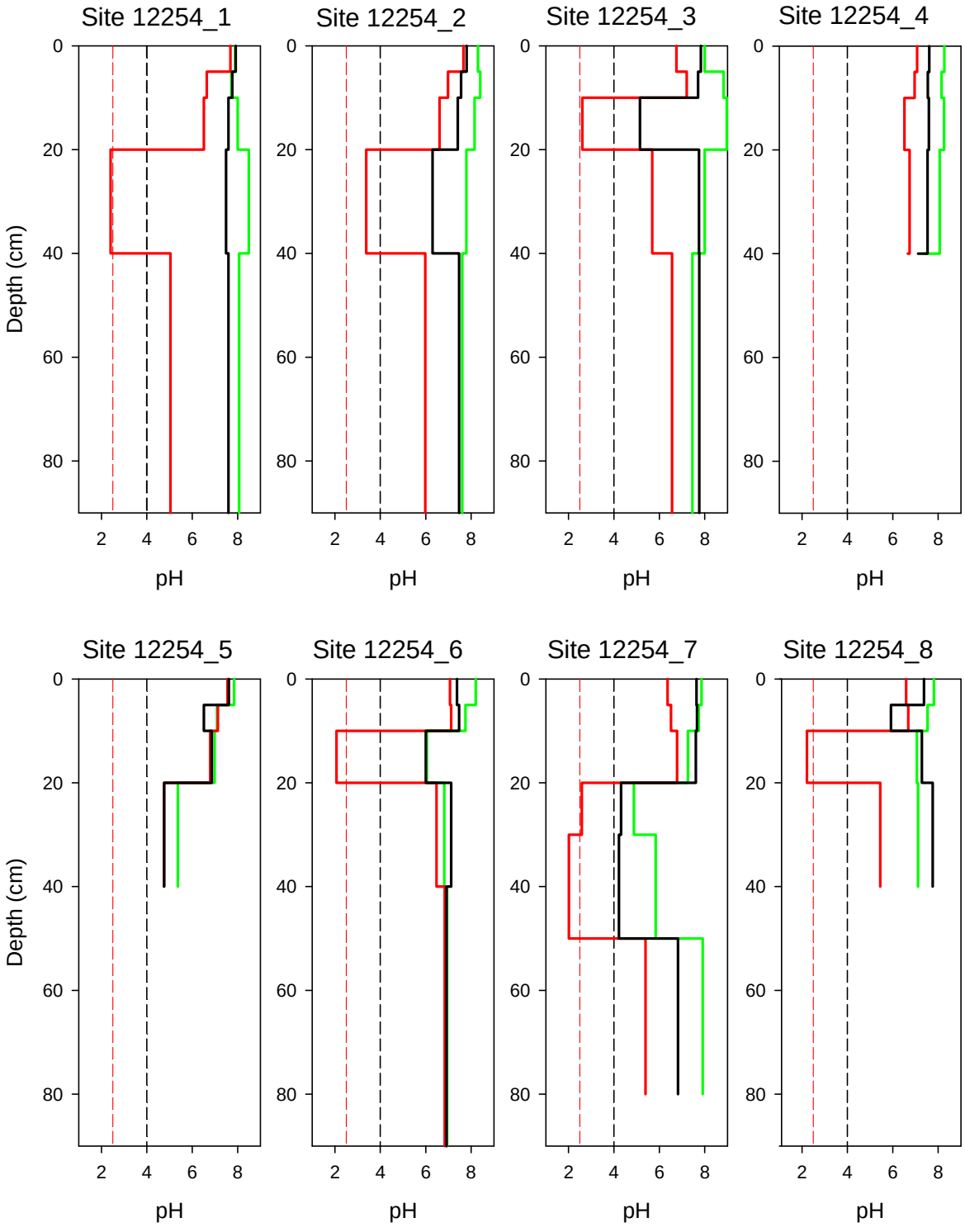
Net acidity values ranged from -4213 to 842 mole H^+/tonne. Values tended to be negative in all surface layers and became moderate or high net acidity values with depth in the profile, the exception was Profile 12 that was a high value at the surface and decreased with depth to a negative value.

14.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 14-4 identified all profiles had surface layers that were above the criterion trigger value of 100 mg/kg SO_4.

14.3.4. Acid volatile sulfur

Monosulfidic materials were observed in the upper layers of Profiles 3 and 9 and sampled for analysis. The values shown in Table 14-4 were all above S_{AV} ≥0.01% S, the criteria value for identifying monosulfidic material.



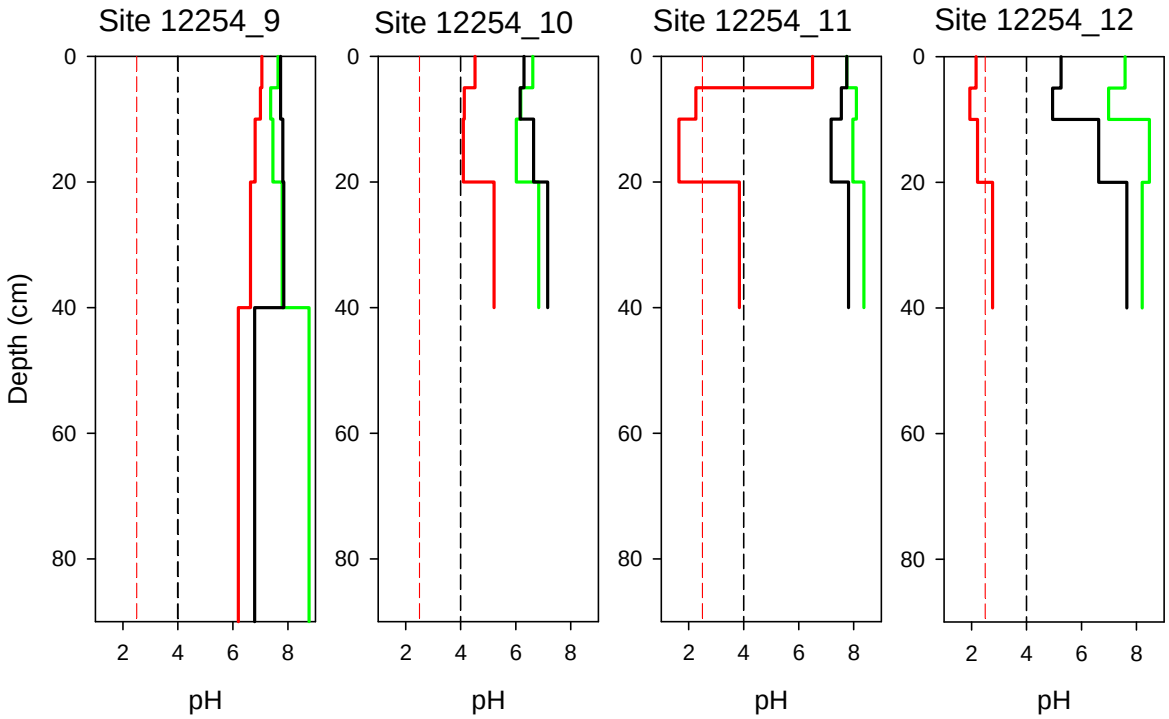
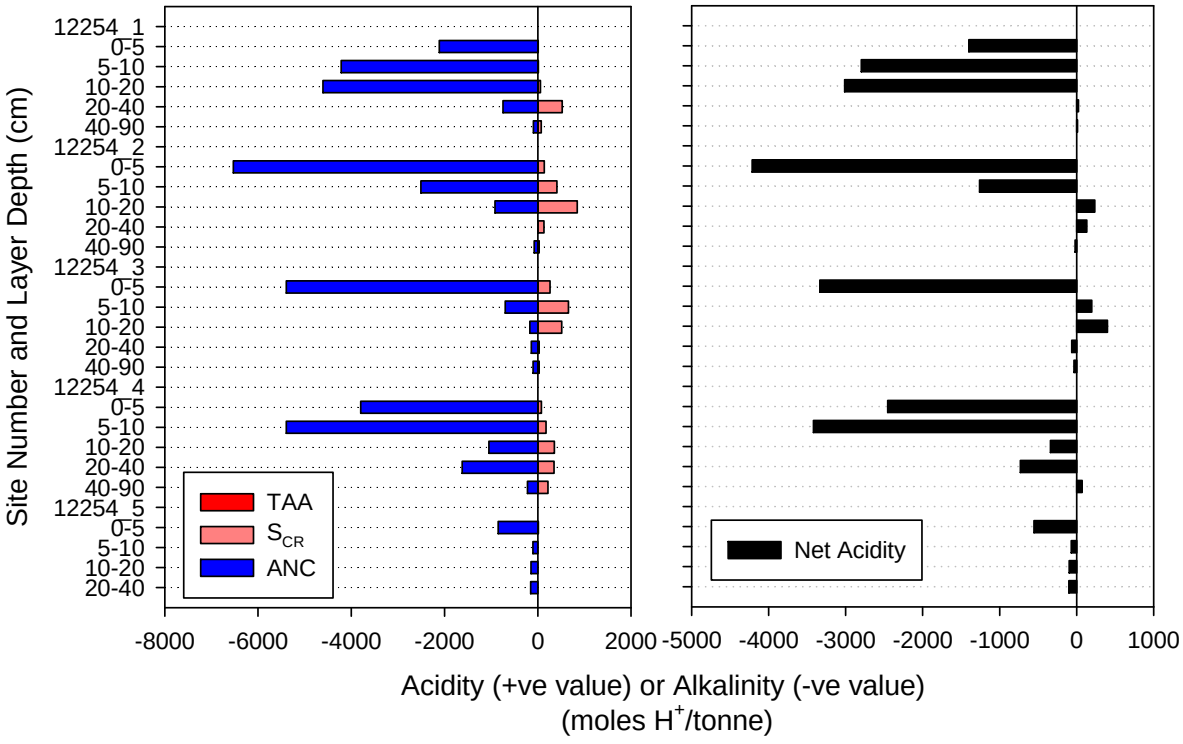


Figure 14-15. Depth profiles of soil pH for Disher Creek (Wetland ID. 12254), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).



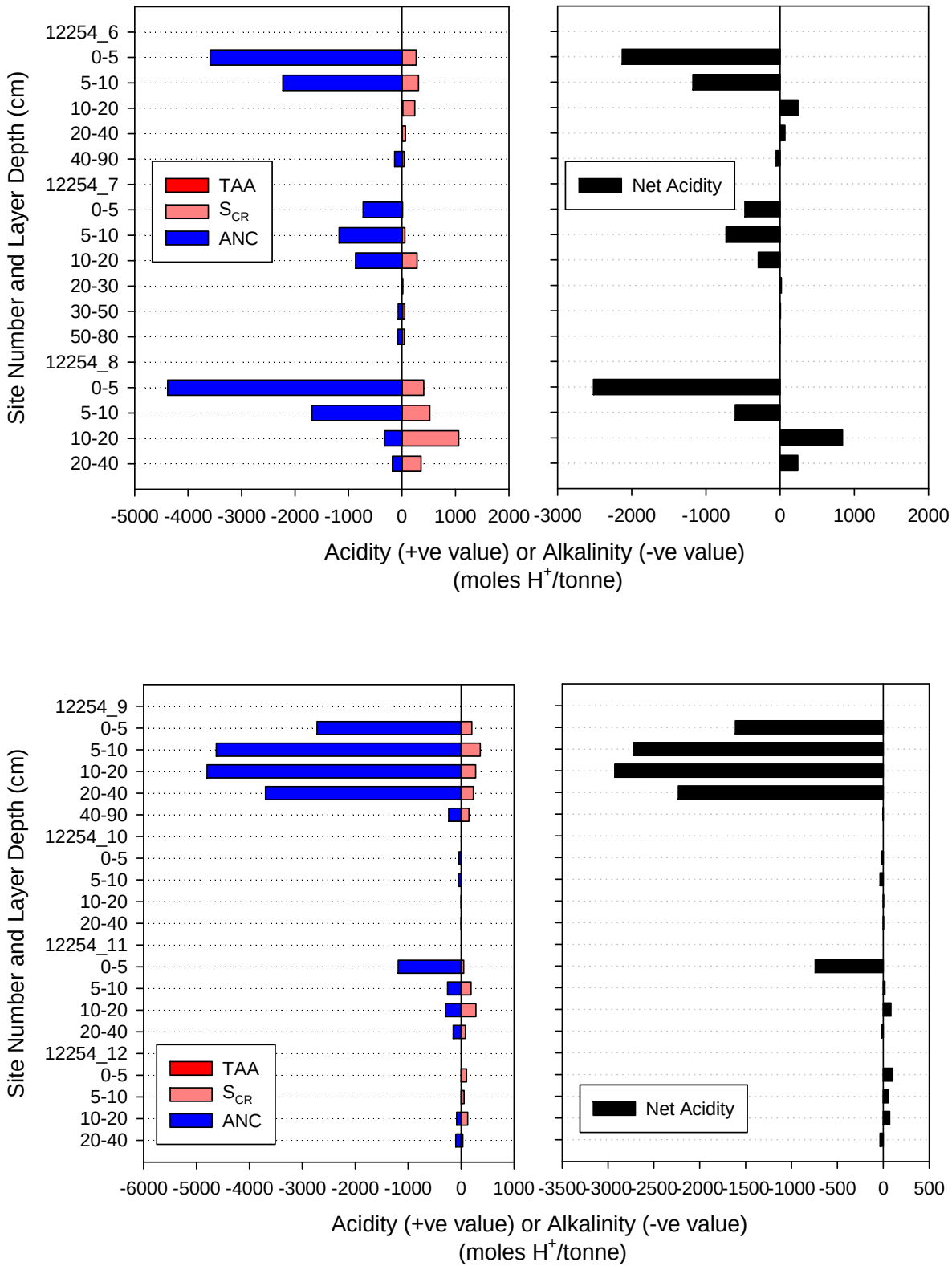


Figure 14-16. Acid base accounting depth profiles for Disher Creek (Wetland ID. 12254). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

14.3.5. Hydrochemistry

Three surface waters and one pit water were collected from each of the transects in this saline wetland. Surface water was shallow with large dried parts of the wetland. Field parameters are shown in Table 14-5. The surface waters had slightly to moderately alkaline pH and were very saline. The waters contained variable dissolved oxygen and turbidity was low. Alkalinity was high in all samples, particularly in the pit water sample.

The SEC in the pit waters was also high (Table 14-5), but pH was lower than the surface waters. DO and Eh were low (but have likely been modified by contact with the atmosphere). Alkalinity in the pit water sample was higher than in the surface waters.

All waters were of Na-Cl type (Table 14-6, Figure 14-17). Sulfate concentrations in the surface waters varied from 3300 to 19000 mg l^{-1}, and in the pit waters the concentration was 8000 mg l^{-1}. The SO_4/Cl ratio in the pit water sample (0.16) was similar to seawater (0.142), whilst the surface waters had higher ratios (0.26-0.3). Nitrate concentrations were relatively high in the pit water and one of the surface water waters. The concentrations of NH_4 and PO_4 were also high, particularly in the pit water which greatly exceeded ANZECC Guideline values (Table 14-6). Manganese was high in all waters, but the detection limit for Fe was very high due to the dilutions required were present at high concentration in the pit waters. Most trace metals were present at low concentrations, although Zn was slightly elevated as was Co in one sample. Organic C concentrations were very high in some samples.

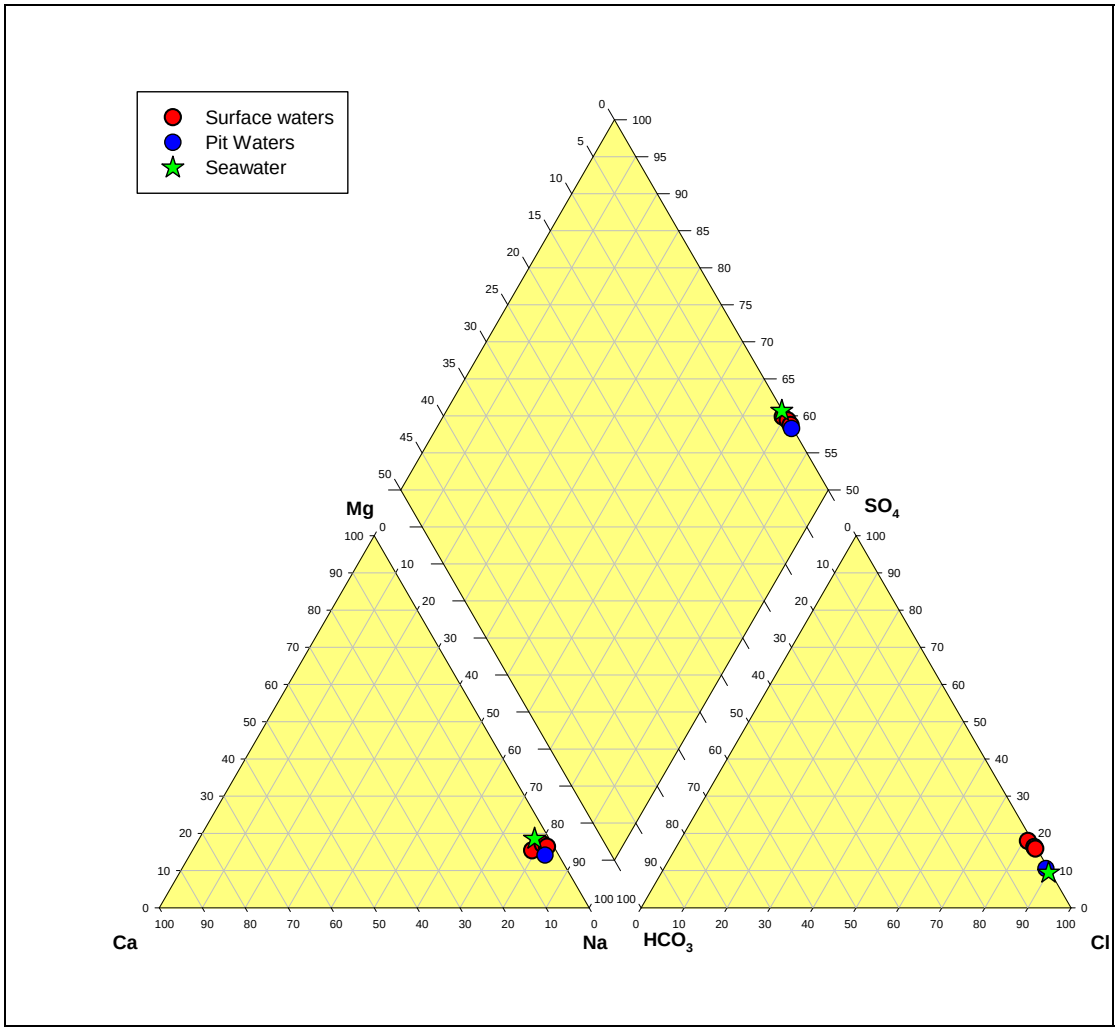


Figure 14-17. Piper diagram of hydrochemical data for Disher Creek (Wetland ID. 12254).

14.4. Discussion

Acid sulfate soil materials at Disher Creek (Wetland ID. 12254) were identified as hyposulfidic and occurred throughout all twelve profiles, other samples were characterised as other acidic. The acid sulfate soil subtype classes identified were Subaqueous Soil (clayey) that occurred throughout the wetland and Other Soil (clayey or loamy) that occurred on the wetland margins.

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

Monosulfidic material was observed throughout the wetland below the surface water and in some areas as a dried material above water and water soluble sulfate data identified that surface layers for all 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 Disher Creek (Wetland ID. 12254) are:

- Acidification hazard: The data identified negative net acidity values in the surface layers and moderate or high net acidity values in the deeper subsoil 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 all soils, monosulfidic material was observed throughout the wetland where sites occurred below surface water. There is a high level of concern.
- Metal mobilisation: The medium acidification hazard indicates that the soil acidification potential may increase the solubility of metals. There is a medium level of concern.

Summary of key findings Disher Creek (Wetland ID. 12254):

Soil materials:	The soil layers throughout the wetland were hyposulfidic for all profiles. Soils were clayey or loamy textured at the surface and clayey textured in the subsoil. Most profiles had negative net acidity values for the surface samples that tended to become moderate or high values with soil depth and pH_{OX} data for a few samples indicated a potential for acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (clayey) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent. • Other Soil (clayey or loamy) – occurring on the wetland margins above the water shoreline. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – medium level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – medium level of concern

Table 14-2. Site description data for Disher Creek (Wetland ID. 12254).

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	15/04/2010	472542	6212407	-30	sandy	bare	mid to high elevation, in line with dead trees
2	15/04/2010	472522	6212304	5	algae mat, soft	bare, isolate vegetation	low elevation, near centre
3	15/04/2010	472502	6212377	10	soft	bare	low elevation, in channel 1m wide, with running water
4	15/04/2010	472490	6212362	3	water, soft	water	in water, adjacent to shoreline
5	15/04/2010	472467	6212326	not reached	cracking, thin white salt crust	salt bush	high elevation, adjacent to old shoreline before sand dunes
6	15/04/2010	472021	6211409	-45	sealed, sandy	bare	mid elevation
7	15/04/2010	472006	6211404	not reached	sandy	salt bush	high elevation, sand covered clay surface
8	15/04/2010	472035	6211408	2	water	water	low elevation, 3m into water
9	15/04/2010	472532	6210703	30	water, soft	water	low elevation, in open water
10	15/04/2010	472469	6210742	not reached	sealed, salt crust	salt bush	high elevation
11	15/04/2010	472259	6209570	30	water, soft	water	mid to low elevation, 1m into open water
12	15/04/2010	472258	6209568	not reached	sandy, soft	bare	side of bank

Table 14-3. Soil profile description data for Disher Creek (Wetland ID. 12254).

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	greyish brown (2.5Y5/3)	loamy sand	moist	20% reddish brown In the matrix	massive	weak	
1_2	5 - 10	small pit	light olive brown (2.5Y5/4)	clay loam	moist	15% reddish brown In the matrix	massive	weak	
1_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	moist	10% reddish brown In the matrix	massive	very weak	
1_4	20 - 40	push tube	dark grey (5Y4/1)	clay	wet	5% black In the matrix	massive	very weak	
1_5	40 - 90	push tube	dark grey (5Y4/1)	clay	wet		massive	very weak	
1_W1	-	pit water							water sampled
2_W1	5 - 0	surface water							water sampled
2_1	0 - 5	small pit	greyish brown (2.5Y5/2)	clay	wet		massive	very weak	thin algae mat on surface
2_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet	5% reddish brown infused into the matrix along faces of peds	angular blocky	very weak	
2_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		angular blocky	very weak	
2_4	20 - 40	push tube	dark grey (5Y4/1)	clay	wet		angular blocky	very weak	
2_5	40 - 90	push tube	dark grey (5Y4/1)	clay	moist		massive	firm	
3_1	0 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
3_2	5 - 10	small pit	very dark grey (5Y3/1)	clay	wet		massive	very weak	
3_3	10 - 20	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	weak	
3_4	20 - 40	small pit	very dark grey (5Y3/1)	clay	wet		angular blocky	weak	
3_5	40 - 90	push tube	very dark grey (5Y3/1)	clay	moist		massive	firm	
4_W	3 - 0	water							
4_1	0 - 5	small pit	greyish brown (2.5Y5/2)	clay	wet		platy	weak	
4_2	5 - 10	small pit	greyish brown (2.5Y5/2)	clay	wet		angular blocky	weak	
4_3	10 - 20	small pit	very dark greyish brown (2.5Y3/2)	clay	wet		angular blocky	very weak	
4_4	20 - 40	small pit	very dark greyish brown (2.5Y3/2)	clay	wet		angular blocky	very weak	
4_5	40 - 90	push tube	very dark greyish brown (2.5Y3/2)	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
5_1	0 - 5	small pit	greyish brown (10YR5/2)	sandy clay loam	moist		platy	firm	
5_2	5 - 10	small pit	dark grey (10YR4/1)	clay	moist		angular blocky	firm	
5_3	10 - 20	small pit	dark grey (10YR4/1)	clay	moist	5% yellowish brown infused into the matrix along faces of peds	angular blocky	very firm	
5_4	20 - 40	small pit	dark grey (10YR4/1)	clay	moist	15% yellowish brown In the matrix	angular blocky	very firm	
6_1	0 - 5	small pit	very dark grey (10YR3/1)	clay	dry	5% brown infused into the matrix along faces of peds	angular blocky	firm	
6_2	5 - 10	small pit	very dark grey (10YR3/1)	clay	moist	10% red infused into the matrix along faces of peds	angular blocky	firm	
6_3	10 - 20	small pit	very dark grey (10YR3/1)	clay	moist	10% red infused into the matrix along faces of peds	massive	firm	
6_4	20 - 40	small pit	very dark grey (10YR3/1)	clay	moist		massive	weak	
6_5	40 - 90	push tube	very dark grey (10YR3/1)	clay	wet		massive	weak	
7_1	0 - 5	small pit	brown (10YR5/3)	sand	dry	5% red In the matrix	single grain	firm	
7_2	5 - 10	small pit	brown (10YR5/3)	sandy loam	moist		massive	firm	contains lenses of clay and sand
7_3	10 - 20	small pit	very dark grey (10YR3/1)	sandy clay loam	moist		angular blocky	firm	contains lenses of clay and sand
7_4	20 - 30	small pit	dark yellowish brown (10YR4/4)	loamy sand	moist		single grain	firm	
7_5	30 - 50	small pit	very dark greyish brown (10YR3/2)	clay	moist		massive	firm	
7_6	50 - 80	push tube	very dark greyish brown (10YR3/2)	clay	wet		massive	firm	
8_W	2 - 0	water							
8_1	0 - 5	small pit	dark grey (5Y4/1)	monosulfidic black ooze	wet		gel	very weak	thin algae mat on surface, sulfurous odour
8_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		angular blocky	weak	
8_3	10 - 20	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
8_4	20 - 40	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	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
9_W1	30 - 0	surface water							water sampled
9_1	0 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour
9_2	5 - 10	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour
9_3	10 - 20	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
9_4	20 - 40	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
9_5	40 - 90	push tube	dark grey (5Y4/1)	sandy clay loam	moist		massive	firm	
10_0	0 - 0.2	surface salt scrap	white (10YR8/1)	salt	dry		crystalline	weak	salt crust
10_1	0 - 5	small pit	olive grey (5Y5/2)	sandy loam	moist	5% strong brown In the matrix	platy	firm	
10_2	5 - 10	small pit	brown (10YR5/3)	sandy clay loam	moist	15% strong brown In the matrix	angular blocky	firm	
10_3	10 - 20	small pit	brown (10YR5/3)	clay	moist	15% strong brown infused into the matrix adjacent to pores	angular blocky	firm	
10_4	20 - 40	small pit	dark greyish brown (10YR4/2)	clay	moist	10% strong brown infused into the matrix adjacent to pores	angular blocky	firm	
11_W1	30 - 0	surface water							water sampled
11_1	0 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
11_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
11_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	weak	
11_4	20 - 40	small pit	dark grey (5Y4/1)	clay	moist		massive	firm	
12_1	0 - 5	small pit	dark grey (2.5Y4/0)	clay loam	moist	50% brown In the matrix	massive	weak	
12_1DUP	0 - 5	small pit	dark grey (2.5Y4/0)	clay loam	moist	50% brown In the matrix	massive	weak	
12_2	5 - 10	small pit	dark greyish brown (2.5Y4/2)	clay loam	moist	20% yellowish brown In the matrix	massive	firm	
12_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay loam	moist	20% yellowish brown In the matrix	massive	firm	
12_4	20 - 40	small pit	grey (5Y5/0)	clay	moist		massive	very firm	too clayey to auger

Table 14-4. Laboratory data for acid sulfate soil assessment of Disher Creek (Wetland ID. 12254).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav)	Acid Sulfate Soil Material Classification
1.W1	-	..	..	..	..	..	..	..	..	..	..	..	..		surface water
1.1	0-5	Medium	18,660	7.89	7.68	7.44	7.91	5,300	9.33	0.00	0.01	10.56	-1399		hyposulfidic (S_{CR}<0.10%)
1.2	5-10	Fine	14,280	7.72	6.64	7.06	7.76	3,400	8.66	0.00	0.02	21.10	-2797		hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	14,100	8.00	6.51	7.20	7.59	2,700	8.50	0.00	0.09	23.05	-3012		hyposulfidic (S_{CR}<0.10%)
1.4	20-40	Fine	12,810	8.49	2.40	6.90	7.49	2,200	8.50	0.00	0.84	3.73	26		hyposulfidic (S_{CR}≥0.10%)
1.5	40-90	Fine	3,670	8.06	5.04	7.01	7.59	470	8.13	0.00	0.12	0.46	12		hyposulfidic (S_{CR}≥0.10%)
2.W1	5-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
2.1	0-5	Fine	7,230	8.30	7.66	7.35	7.80	3,000	8.39	0.00	0.22	32.67	-4213		hyposulfidic (S_{CR}≥0.10%)
2.2	5-10	Fine	9,900	8.40	6.98	7.03	7.56	2,100	8.32	0.00	0.66	12.55	-1261		hyposulfidic (S_{CR}≥0.10%)
2.3	10-20	Fine	6,650	8.15	6.61	7.03	7.41	2,200	7.98	0.00	1.36	4.59	237		hyposulfidic (S_{CR}≥0.10%)
2.4	20-40	Fine	5,560	7.79	3.38	6.70	6.30	1,000	6.15	4.90	0.21	0.00	133		hyposulfidic (S_{CR}≥0.10%)
2.5	40-90	Fine	4,690	7.61	5.98	6.58	7.47	610	6.79	0.00	0.05	0.38	-19		hyposulfidic (S_{CR}<0.10%)
3.1	0-5	Medium	7,790	8.00	6.75	7.17	7.83	320	8.46	0.00	0.42	26.99	-3332	0.16	hyposulfidic (S_{CR}≥0.10%) monosulfidic
3.2	5-10	Fine	4,220	8.83	7.21	7.76	7.71	690	6.97	0.00	1.06	3.47	197		hyposulfidic (S_{CR}≥0.10%)
3.3	10-20	Fine	3,380	8.97	2.61	7.30	5.15	670	7.01	0.00	0.82	0.85	401		hyposulfidic (S_{CR}≥0.10%)
3.4	20-40	Fine	2,560	8.00	5.69	6.80	7.75	370	7.01	0.00	0.05	0.69	-63		hyposulfidic (S_{CR}<0.10%)
3.5	40-90	Fine	3,060	7.46	6.56	6.70	7.76	400	6.63	0.00	0.05	0.50	-34		hyposulfidic (S_{CR}<0.10%)
4.1	0-5	Fine	12,750	8.27	7.07	7.23	7.61	6,700	8.29	0.00	0.12	19.00	-2453		hyposulfidic (S_{CR}≥0.10%)
4.2	5-10	Fine	19,580	8.15	6.96	6.96	7.54	2,300	8.38	0.00	0.29	26.99	-3416		hyposulfidic (S_{CR}≥0.10%)
4.3	10-20	Fine	21,110	8.26	6.51	6.97	7.59	2,300	8.11	0.00	0.57	5.24	-340		hyposulfidic (S_{CR}≥0.10%)
4.4	20-40	Fine	8,520	8.07	6.74	7.02	7.53	1,900	7.81	0.00	0.56	8.12	-730		hyposulfidic (S_{CR}≥0.10%)
4.5	40-90	Fine	5,980	7.38	6.66	6.66	7.11	760	7.58	0.00	0.35	1.10	71		hyposulfidic (S_{CR}≥0.10%)
5.1	0-5	Medium	18,840	7.84	7.55	7.03	7.61	3,100	8.36	0.00	0.02	4.24	-553		hyposulfidic (S_{CR}<0.10%)
5.2	5-10	Fine	14,520	7.09	7.13	5.34	6.51	1,200	7.51	0.00	<0.01	0.52	-69		other acidic
5.3	10-20	Fine	8,880	6.98	6.79	6.44	6.86	520	7.14	0.00	<0.01	0.71	-95		hyposulfidic (S_{CR}<0.10%)
5.4	20-40	Fine	6,220	5.36	4.76	4.30	4.76	990	6.95	0.00	<0.01	0.75	-99		other acidic
6.1	0-5	Fine	25,900	8.20	7.07	6.93	7.38	3,900	8.24	0.00	0.42	17.96	-2128		hyposulfidic (S_{CR}≥0.10%)
6.2	5-10	Fine	25,800	7.75	7.12	6.80	7.47	4,500	8.24	0.00	0.50	11.15	-1176		hyposulfidic (S_{CR}≥0.10%)
6.3	10-20	Fine	20,110	6.05	2.07	5.73	6.00	2,500	5.52	17.50	0.36	..	241		hyposulfidic (S_{CR}≥0.10%)
6.4	20-40	Fine	11,010	6.82	6.48	6.30	7.12	1,300	6.39	3.40	0.10	0.00	68		hyposulfidic (S_{CR}≥0.10%)
6.5	40-90	Fine	8,700	6.94	6.84	5.91	6.92	860	6.62	0.00	0.06	0.69	-52		hyposulfidic (S_{CR}<0.10%)

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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav)	Acid Sulfate Soil Material Classification
7.1	0-5	Medium	18,940	7.86	6.36	7.24	7.64	2,900	8.99	0.00	0.02	3.63	-473		hyposulfidic (S_{CR}<0.10%)
7.2	5-10	Medium	17,740	7.74	6.51	7.13	7.66	2,300	8.89	0.00	0.09	5.88	-728		hyposulfidic (S_{CR}<0.10%)
7.3	10-20	Fine	20,910	7.26	6.78	6.89	7.61	3,900	8.35	0.00	0.46	4.34	-293		hyposulfidic (S_{CR}≥0.10%)
7.4	20-30	Medium	10,480	4.88	2.59	4.44	4.32	790	6.37	2.92	0.02	0.00	17		hyposulfidic (S_{CR}<0.10%)
7.5	30-50	Fine	8,580	5.84	2.02	4.96	4.22	860	5.30	13.13	0.06	0.35	7		hyposulfidic (S_{CR}<0.10%)
7.6	50-80	Fine	4,990	7.91	5.39	6.99	6.82	410	6.60	0.00	0.07	0.39	-10		hyposulfidic (S_{CR}<0.10%)
8.1	0-5	Fine	23,080	7.81	6.59	7.08	7.37	4,400	8.42	0.00	0.65	21.94	-2515		hyposulfidic (S_{CR}≥0.10%)
8.2	5-10	Fine	11,550	7.53	6.68	6.80	5.92	1,700	8.03	0.00	0.83	8.43	-603		hyposulfidic (S_{CR}≥0.10%)
8.3	10-20	Fine	7,550	7.06	2.22	6.52	7.28	1,300	7.28	0.00	1.70	1.64	842		hyposulfidic (S_{CR}≥0.10%)
8.4	20-40	Fine	9,950	7.11	5.45	6.63	7.76	1,000	7.04	0.00	0.57	0.90	239		hyposulfidic (S_{CR}≥0.10%)
9.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
9.1	0-5	Medium	26,700	7.64	7.05	6.79	7.73	4,500	8.73	0.00	0.33	13.63	-1612	0.19	hyposulfidic (S_{CR}≥0.10%) monosulfidic
9.2	5-10	Medium	31,700	7.37	7.00	6.90	7.73	4,700	8.75	0.00	0.58	23.16	-2723	0.30	hyposulfidic (S_{CR}≥0.10%) monosulfidic
9.3	10-20	Medium	23,520	7.45	6.81	7.10	7.81	2,400	8.89	0.00	0.44	24.02	-2926	0.15	hyposulfidic (S_{CR}≥0.10%) monosulfidic
9.4	20-40	Medium	17,820	7.79	6.64	6.98	7.85	1,600	8.94	0.00	0.37	18.50	-2234	0.12	hyposulfidic (S_{CR}≥0.10%) monosulfidic
9.5	40-90	Fine	4,780	8.77	6.20	7.43	6.79	390	8.61	0.00	0.24	1.17	-5		hyposulfidic (S_{CR}≥0.10%)
10.0	0-0.2	..	..	..	..	5.96	7.16	..	..	..	..	..	..		salt crust
10.1	0-5	Fine	15,370	6.62	4.52	6.23	6.30	1,500	7.58	0.00	0.01	0.22	-22		hyposulfidic (S_{CR}<0.10%)
10.2	5-10	Fine	16,940	6.18	4.13	5.80	6.16	1,300	7.08	0.00	<0.01	0.27	-36		other soil material
10.3	10-20	Fine	14,220	6.02	4.10	5.73	6.65	1,000	6.39	2.43	<0.01	0.00	2		other soil material
10.4	20-40	Fine	9,490	6.84	5.21	6.50	7.16	680	6.34	2.92	<0.01	0.00	3		other soil material
11.W1	30-0	..	..	..	..	..	..	..	..	..	..	..	..		surface water
11.1	0-5	Medium	43,300	7.75	6.50	7.33	7.75	7,700	8.59	0.00	0.08	5.95	-742		hyposulfidic (S_{CR}<0.10%)
11.2	5-10	Fine	16,220	8.10	2.26	6.99	7.55	1,500	8.16	0.00	0.30	1.28	17		hyposulfidic (S_{CR}≥0.10%)
11.3	10-20	Fine	14,590	7.97	1.65	6.69	7.18	1,800	7.58	0.00	0.45	1.48	83		hyposulfidic (S_{CR}≥0.10%)
11.4	20-40	Fine	6,780	8.37	3.84	7.03	7.81	1,300	7.12	0.00	0.13	0.75	-18		hyposulfidic (S_{CR}≥0.10%)
12.1	0-5	Fine	17,320	7.58	2.17	6.21	5.26	3,400	5.56	10.70	0.15	..	103		hyposulfidic (S_{CR}≥0.10%)
12.2	5-10	Fine	19,010	6.98	1.94	5.76	4.95	1,900	5.51	12.15	0.07	..	57		hyposulfidic (S_{CR}<0.10%)
12.3	10-20	Fine	8,350	8.47	2.22	6.57	6.62	720	6.52	0.00	0.20	0.42	69		hyposulfidic (S_{CR}≥0.10%)
12.4	20-40	Fine	5,340	8.21	2.77	6.92	7.65	350	6.74	0.00	0.05	0.51	-35		hyposulfidic (S_{CR}<0.10%)

Table 14-5. Summary of hydrochemical field measurements for Disher Creek (Wetland ID. 12254).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=3)	7.71-8.52	32200-169121	3.9-16.1	-137- -40	2-17	223-365
Pit waters (n = 1)	6.29	117900	2.4	-157		482

Table 14-6. Summary of hydrochemical field measurements for Disher Creek (Wetland ID. 12254).

Parameter	units	ANZECC Guidelines	Site 1 (PW)	Site 2 (SW)	Site 9 (SW)	Site 11 (SW)
Na	mg l^{-1}		25700	5840	25900	39200
K	mg l^{-1}		258.0	94.4	352.0	491.0
Ca	mg l^{-1}		867	362	644	681
Mg	mg l^{-1}		2340	608	2920	4180
Si	mg l^{-1}		11.9	<0.5	<2.5	<2.5
Br	mg l^{-1}		150.0	30.0	140.0	220.0
Cl	mg l^{-1}		50000	11000	49000	74000
NO_3	mg l^{-1}	0.7	**1.058**	**1.523**	<0.022	<0.022
NH_4-N^K	mg l^{-1}	0.01	**2.88**	**0.111**	**0.583**	**0.656**
PO_4-P^E	mg l^{-1}	0.005	**4.416**	**0.038**	**0.200**	**0.604**
SO_4	mg l^{-1}		8000	3300	13000	19000
Ag	µg l^{-1}	0.05	<0.1	<0.02	<0.1	<0.1
Al^A	µg l^{-1}	55	<60	<10	<60	<80
As^B	µg l^{-1}	13	<9	<2	<9	<10
Cd	µg l^{-1}	0.2	<0.3	<0.06	<0.3	<0.4
Co	µg l^{-1}	2.8	**5.6**	0.58	1.3	1.4
Cr^C	µg l^{-1}	1	<2	<0.5	<2	<3
Cu^H	µg l^{-1}	1.4	<6	3	<6	<8
Fe	µg l^{-1}	300	<5000	<1000	<5000	<5000
Mn	µg l^{-1}	1700	**4600**	22.86	1487	**1951**
Ni^H	µg l^{-1}	11	**12.0**	4.2	3.0	4.0
Pb^H	µg l^{-1}	3.4	0.6	<0.1	1.2	<0.8
Se	µg l^{-1}	11	<2	0.8	<2	<2
Zn^H	µg l^{-1}	8	**100**	**21**	**40**	**40**
DOC	mg l^{-1}		39.1	11.1	73.2	113.0

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

15. PARINGA PADDOCK (WETLAND ID. 12086)

15.1. Location and setting description

Paringa Paddock (Wetland ID. 12086) is situated on the western side of the River Murray, adjacent to the town of Renmark and Lock 5. The wetland is crescent in shape formed as the outer oxbow lake and is part of a wetland complex that occurs on the outside of a bend in the river. It is about 3 kilometres in length and about 150 metres at its widest, with a total surface area of 25 hectares. The wetland is bounded by a raised a floodplain that separates the wetland from the river to the east and farmland to the west. The other associated wetland in the complex is wetland ID. 12087.

The wetland is permanently connected to the river at the southern end. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is not managed. Sedgeland and grassland were growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Eight sites were sampled as shown in Figure 15-1.

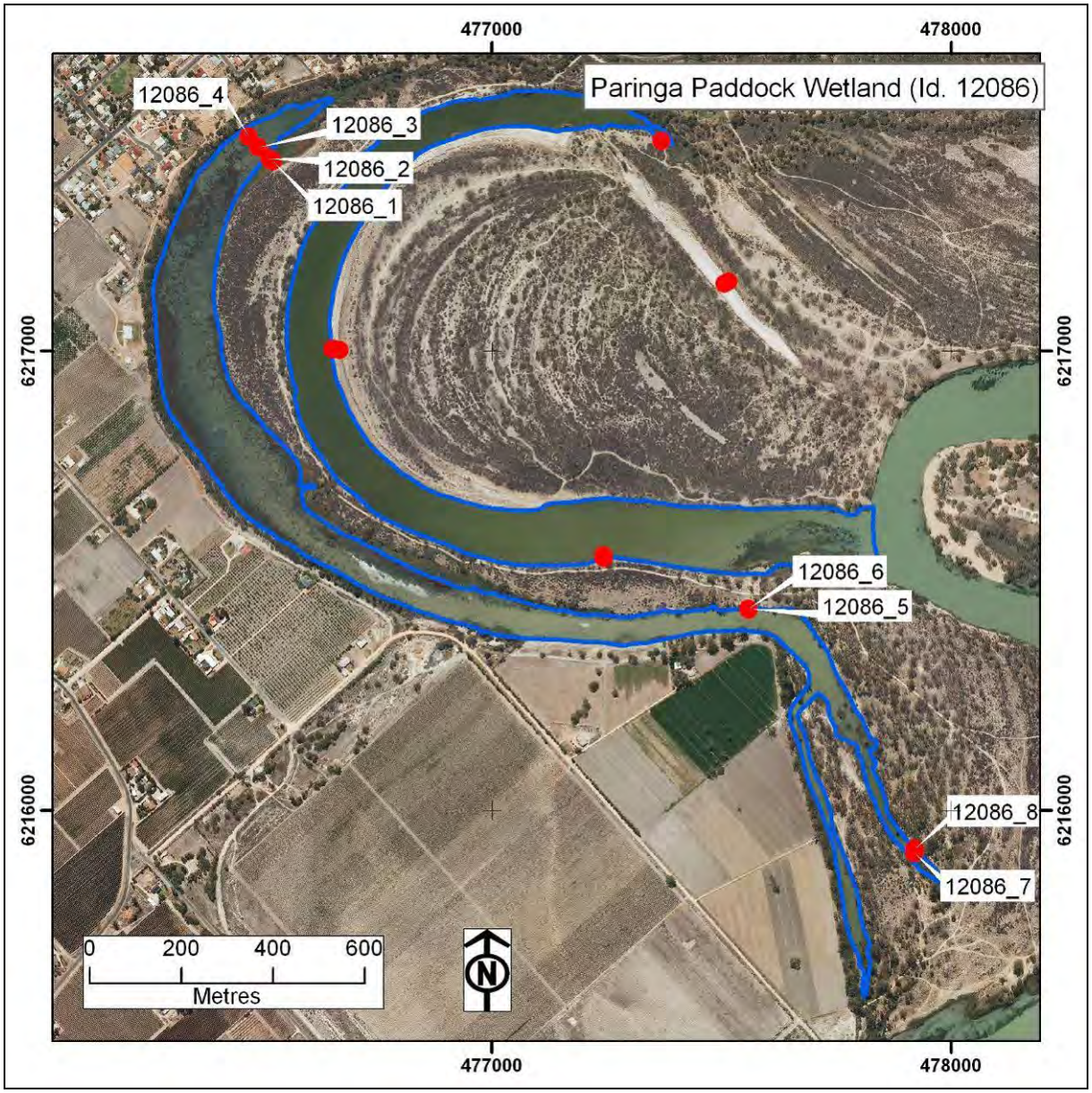


Figure 15-1. Paringa Paddock (Wetland ID. 12086) and sample site locations.

15.2. Soil profile description and distribution

Eight sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 15-1. Sites were distributed along the wetland to capture different features, with one transect in water at the northern end (Sites 1, 2, 3 and 4), and two pairs of sites at the eastern bend (Sites 5 and 6) and southern end (Sites 7 and 8) of the wetland. The site and soil profile descriptions are presented in Table 15-2 and Table 15-3, and a conceptual cross-section diagram in Figure 15-2.

Northern transect

Site 1 (Figure 2-3) occurred on the wetland margin in water (15 cm deep), and the soil consisted of a dark grey, firm, clay with many roots. Site 2 (Figure 15-4) occurred adjacent to reeds in open water (60 cm deep), and the soil consisted of a dark grey, very weak, mucky clay, over a dark grey, very firm, clay. Site 3 (Figure 15-5) occurred near the centre of the wetland in open water (70 cm deep), and the soil consisted of a dark grey, very weak, mucky clay, over a dark greyish brown, firm, clay. Site 4 (Figure 15-6) occurred near the bank on the western side in open water (120 cm deep), and the soil consisted of a dark grey, very weak, mucky clay, over dark grey, very weak, clay.

Eastern transect

Site 5 (Figure 15-7) occurred adjacent to the bank in water (40 cm deep), and the soil consisted of a dark grey, very firm, sand, over a very dark greyish brown, very firm, clay. Site 6 (Figure 15-8) occurred in open water (110 cm deep), and the soil consisted of a grey, very weak, sand, over a dark grey, very firm, clay.

Southern transect

Site 7 (Figure 15-9) occurred adjacent to the bank amongst Typha in water (40 cm deep), and the soil consisted of brown, weak, plant roots with little soil material, over a dark grey, very firm, clay. Site 8 (Figure 15-10) occurred out from the bank in open water (100 cm deep), and the soil consisted of a dark grey, very firm clay, over a greyish brown, very firm, clay.

Table 15-1. Soil identification, subtype and general location description for Paringa Paddock (Wetland ID. 12086).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12086_1	476524	6217413	Subaqueous Soil (clayey)	high elevation in reeds and water
12086_2	476517	6217419	Subaqueous Soil (clayey)	adjacent to bank step down from reeds into open water
12086_3	476492	6217444	Subaqueous Soil (clayey)	low elevation, middle of wetland in water
12086_4	476471	6217467	Subaqueous Soil (clayey)	mid elevation, in water
12086_5	477559	6216439	Subaqueous Soil (clayey)	open water, adjacent to step down from bank
12086_6	477560	6216437	Subaqueous Soil (sandy)	low elevation, 5m from shoreline
12086_7	477920	6215908	Subaqueous Soil (clayey)	in water next to step down to reeds
12086_8	477922	6215917	Subaqueous Soil (clayey)	open water adjacent to bank

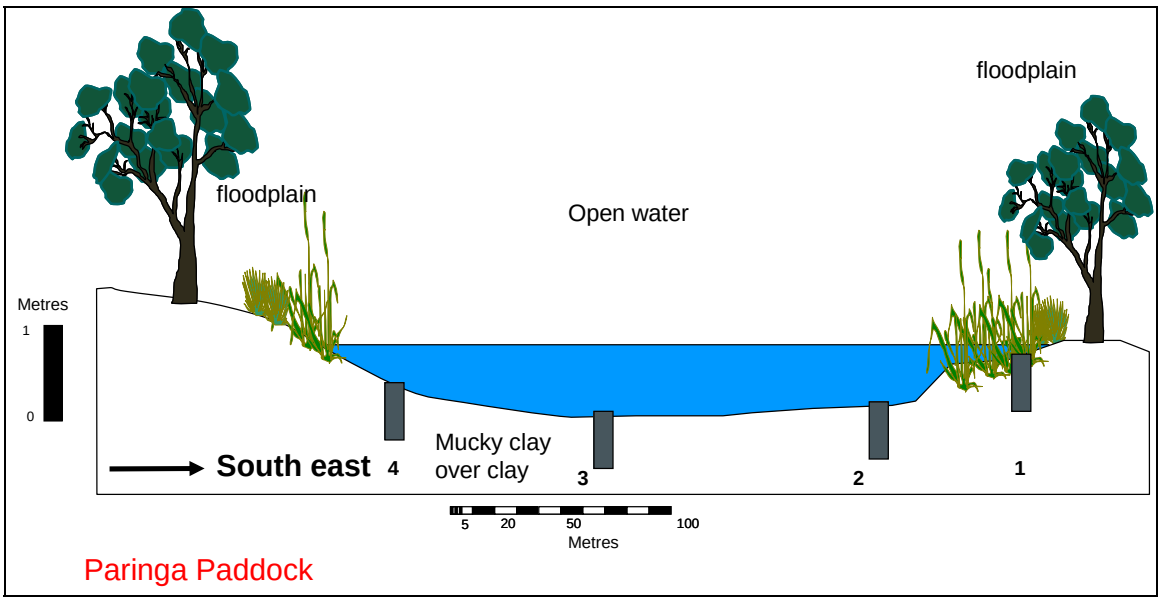


Figure 15-2. Conceptual cross-section diagram, showing locations for Sites 1 to 4.

Figure 15-3. Photograph of Site 1, showing the site location on the wetland margin in thick reeds on the eastern side of the wetland.

Figure 15-4. Photograph of Site 2, showing the site location in open water adjacent to the reeds.

Figure 15-5. Photograph of Site 3, showing the site location near the centre of the wetland.

Figure 15-6. Photograph of Site 4, showing the site location in open water near reeds on the western side of the wetland.

Figure 15-7. Photograph of Site 5, showing the site location placed in water adjacent to the bank.

Figure 15-8. Photograph of Site 6, showing the site location placed in deep open water.

Figure 15-9. Photograph of Site 7, showing the site location placed in water, adjacent to the bank amongst thick reeds.

Figure 15-10. Photograph of Site 8, showing the site location placed in deep water.

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 15-11. The pH_W data ranged from 4.63 to 7.87 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.69 to 7.30 and identified that surface samples of open water sites of Profiles 2, 3, 4, 5 and 6 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 4.27 to 6.64 and identified no samples on incubation declined below the critical values of pH <4.

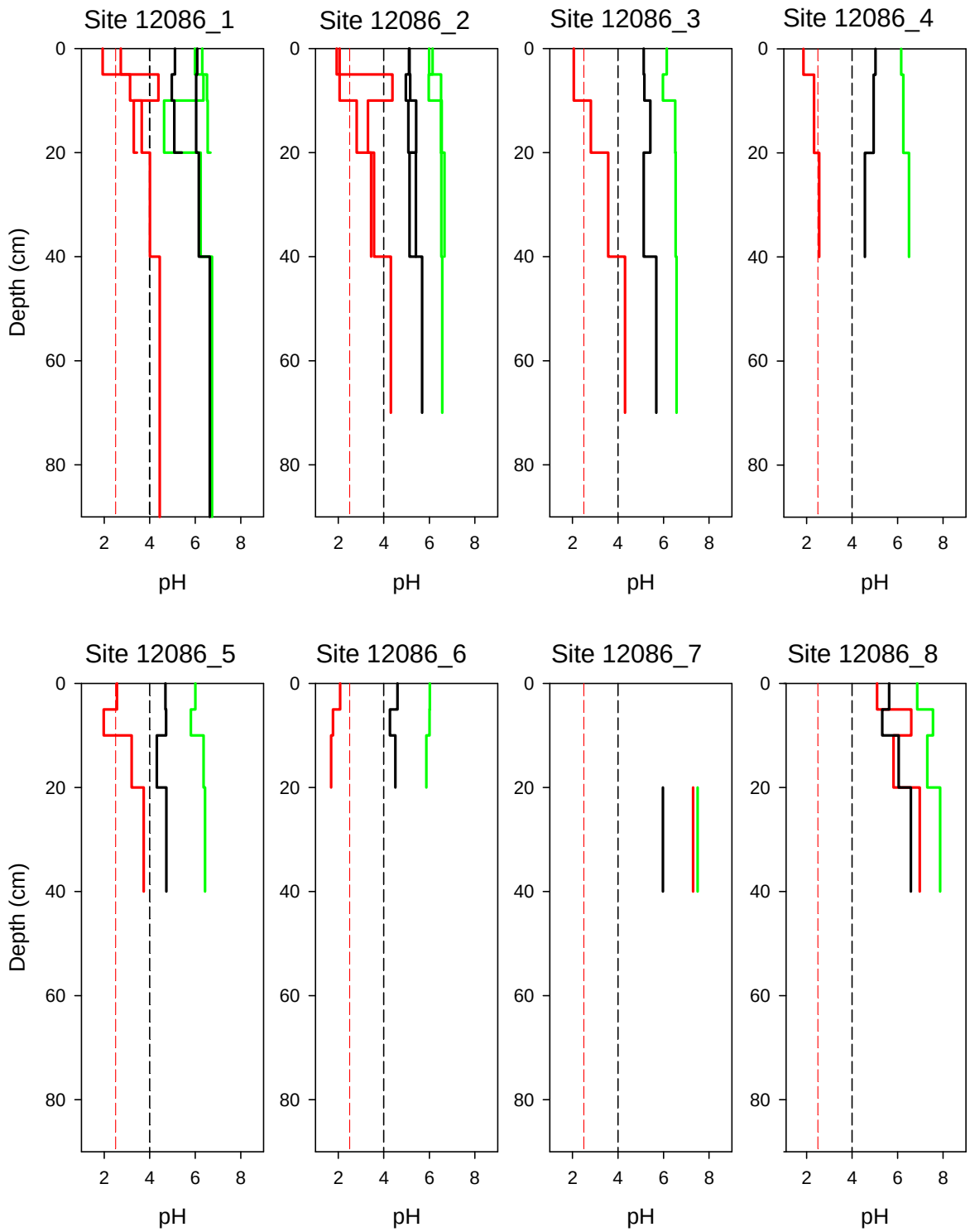


Figure 15-11. Depth profiles of soil pH for Paringa Paddock (Wetland ID. 12086), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value 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 15-12.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 0.30 $\%S_{CR}$ and sulfidic materials were detected in all soil profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 5.87 to 33.28 mole H^+/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_{KCl} of greater than 4.5.

Acid neutralising capacity

Acid neutralising capacity was not measured in and of the samples.

Net acidity

Net acidity values ranged from -33 to 223 mole H^+/tonne. All profile samples were generally moderate or high net acidity values.

15.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 15-4 identified that no surface layers were above the criterion trigger value of 100 mg/kg SO_4.

15.3.4. Acid volatile sulfur

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

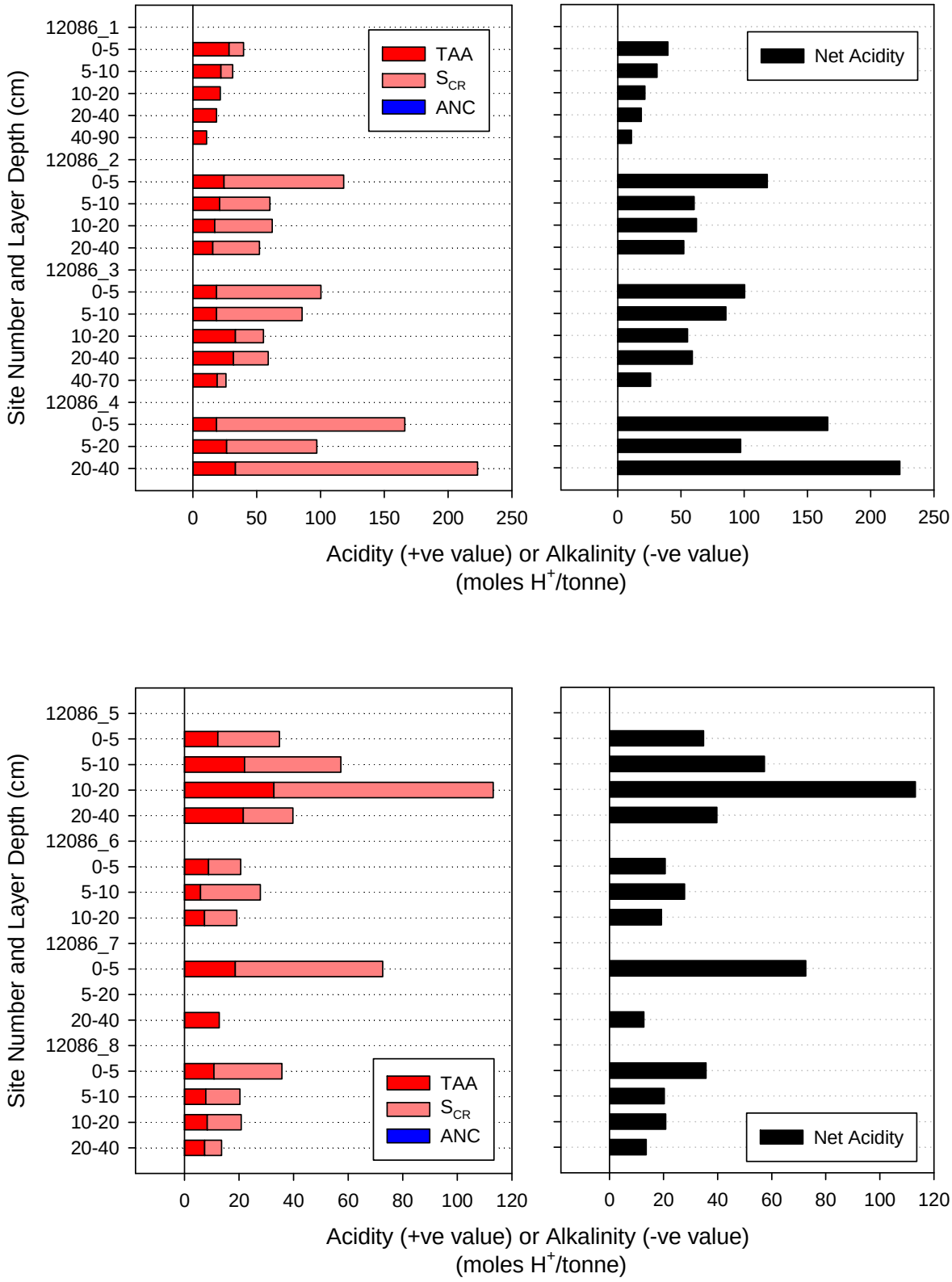


Figure 15-12. Acid base accounting depth profiles for Paringa Paddock (Wetland ID. 12086). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

15.3.5. Hydrochemistry

One surface water was collected from this small narrow wetland. Field parameters are shown in Table 3-5. The surface water had a slightly acidic pH and was very fresh. The water had moderately low dissolved oxygen and turbidity was high. Alkalinity was present, although at concentrations of the same magnitude as river water.

The water was of Na-Cl type, with a relative enrichment in HCO_3 compared to seawater composition (Table 15-6, Figure 15-13). Sulfate concentration in the surface water was relatively low at 12 mg l^{-1}. The SO_4/Cl ratio in the surface waters (0.10) was slightly lower than seawater (0.142). Nitrate concentrations were below detection limit, and PO_4 was slightly elevated above ANZECC Guideline values. Aluminium was relatively high possibly due to the presence of colloidal material with the high turbidity, and also Zn. The concentrations of other trace metals were low.

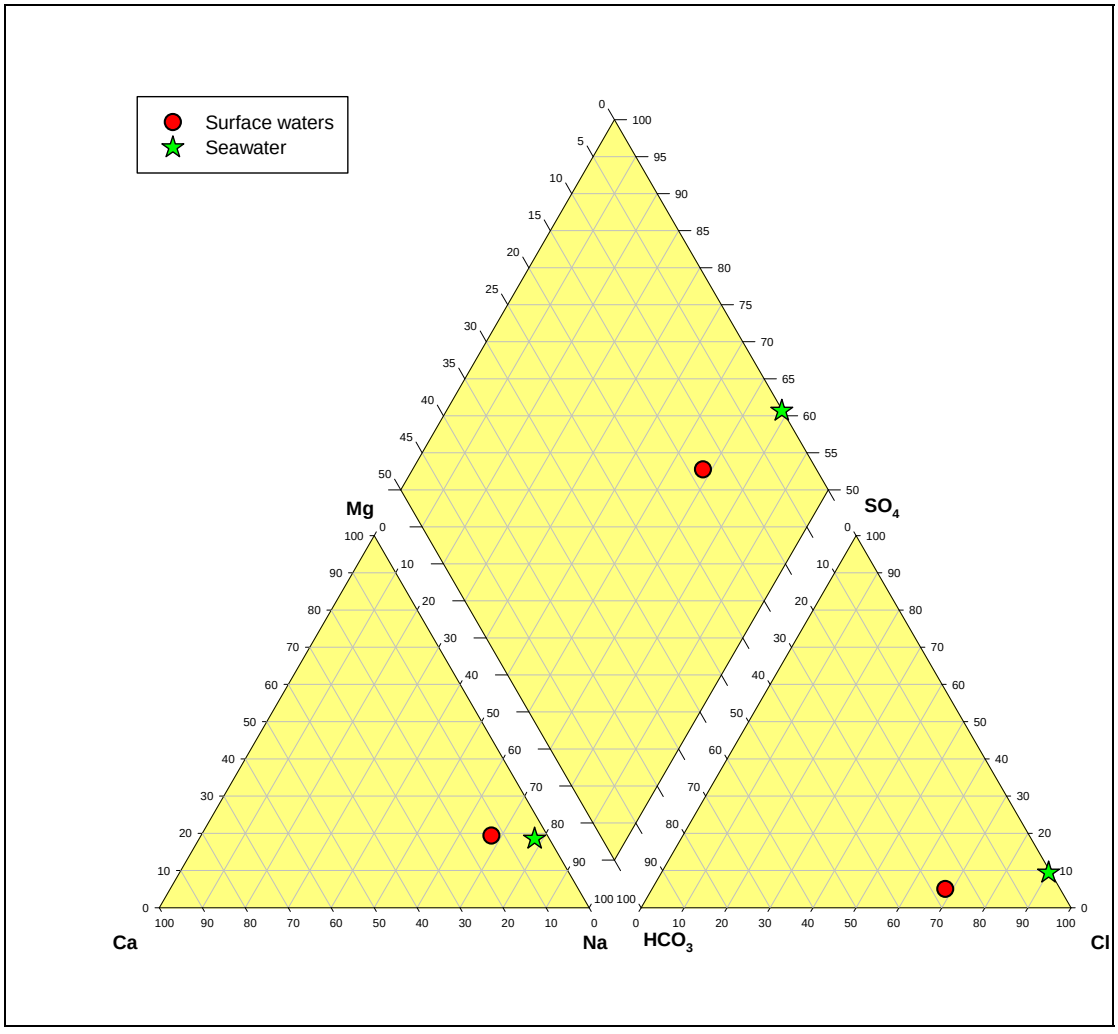


Figure 15-13. Piper diagram of hydrochemical data for Paringa Paddock (Wetland ID. 12086).

15.4. Discussion

Acid sulfate soil materials at Paringa Paddock (Wetland ID. 12086) were identified as hyposulfidic and they occurred throughout the soil profiles sampled. The acid sulfate soil subtype class identified was Subaqueous Soil (clayey or sandy).

The soils throughout the wetland were dominantly sandy or mucky clays in the surface layers and clayey in the subsoils.

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 Paringa Paddock (Wetland ID. 12086) are:

- Acidification hazard: The data identified moderate or high net acidity values generally for all samples and pH_{OX} 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 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 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 Paringa Paddock (Wetland ID. 12086):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic. Soils were generally loamy or mucky clay textured at the surface and clayey textured in the subsoil. Generally samples were high or moderate net acidity values and pH_{OX} data identified some samples that identified potential acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (clayey or sandy) – occurring where there was surface water throughout the wetland. Dominant (>50%) in extent.
Hazard assessment	• Acidification hazard – medium to high level of concern • De-oxygenation hazard – low level of concern • Metal mobilisation hazard – medium level of concern

Table 15-2. Site description data for Paringa Paddock (Wetland ID. 12086).

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	14/04/2010	476524	6217413	15	plant material	Phragmites	high elevation in reeds and water
2	14/04/2010	476517	6217419	60	water, firm	water	adjacent to bank step down from reeds into open water
3	14/04/2010	476492	6217444	70	water, firm	water	low elevation, middle of wetland in water
4	14/04/2010	476471	6217467	120	water, soft	water	mid elevation, in water
5	14/04/2010	477559	6216439	40	water, firm	water, Phragmites	open water, adjacent to step down from bank
6	14/04/2010	477560	6216437	110	water	water	low elevation, 5m from shoreline
7	14/04/2010	477920	6215908	40	water	water, Typha	in water next to step down to reeds
8	14/04/2010	477922	6215917	100	water	water	open water adjacent to bank

Table 15-3. Soil profile description data for Paringa Paddock (Wetland ID. 12086).

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)	clay	wet		massive	firm	common plant roots
1_2	5 - 10	small pit	dark grey (2.5Y4/1)	clay	wet		massive	firm	common plant roots
1_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	wet		massive	firm	common plant roots
1_4	20 - 40	push tube	dark grey (10YR4/1)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	massive	firm	
1_5	40 - 90	push tube	dark grey (10YR4/1)	clay	moist	5% yellowish brown infused into the matrix adjacent to pores	massive	firm	
2_W	60 - 0	water							
2_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
2_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
2_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
2_4	20 - 40	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	
3_W	70 - 0	water							
3_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
3_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
3_3	10 - 20	small pit	very dark grey (5Y3/1)	clay	wet		massive	weak	
3_4	20 - 40	push tube	dark grey (5Y4/1)	clay	wet		massive	firm	
3_5	40 - 70	push tube	dark greyish brown (2.5Y4/2)	clay	moist		massive	firm	
4_W	120 - 0	water							
4_1	0 - 5	push tube	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	sulfurous odour
4_2	5 - 20	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
4_3	20 - 40	small pit	dark grey (5Y4/1)	clay	wet		massive	very weak	
5_W	40 - 0	water							
5_1	0 - 5	small pit	dark grey (5Y4/1)	sand	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	olive grey (5Y5/2)	clay	wet		massive	very firm	mica flakes observed
5_4	20 - 40	push tube	very dark greyish brown (2.5Y3/2)	clay	moist		massive	very firm	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
6_W1	110 - 0	surface water							water sampled
6_1	0 - 5	small pit	grey (2.5Y5/0)	sand	wet		single grain	very weak	weak sulfurous odour
6_2	5 - 10	small pit	dark grey (10YR4/1)	sand	wet		single grain	very weak	mica flakes observed
6_3	10 - 20	small pit	dark grey (10YR4/1)	sand	wet		single grain	very weak	mica flakes observed
7_W	40 - 0	water							
7_1	0 - 5	small pit	brown (10YR4/3)	plant material	wet		massive	weak	mainly plant root material
7_2	5 - 20	small pit	brown (10YR4/3)	plant material	wet		massive	weak	plant root material and a void
7_3	20 - 40	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
8_W	100 - 0	water							
8_1	0 - 5	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	smooth clay
8_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		massive	very firm	
8_3	10 - 20	push tube	dark grey (5Y4/1)	clay	moist		massive	very firm	10% charcoal
8_4	20 - 40	push tube	greyish brown (2.5Y5/2)	clay	moist		massive	very firm	10% charcoal, too clayey to auger below

Table 15-4. Laboratory data for acid sulfate soil assessment of Paringa Paddock (Wetland ID. 12086).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
1.1	0-5	Fine	93	6.31	2.73	6.08	6.09	24	4.98	28.38	0.02	..	..	40	hyposulfidic (S_{CR}<0.10%)
1.2	5-10	Fine	101	6.36	3.14	5.95	6.04	17	5.02	22.02	0.01	..	..	31	hyposulfidic (S_{CR}<0.10%)
1.3	10-20	Fine	161	4.63	3.65	5.84	6.04	28	5.15	21.53	<0.01	..	..	22	other soil material
1.4	20-40	Fine	190	6.24	4.01	5.79	6.16	41	5.39	18.60	<0.01	..	..	19	other soil material
1.5	40-90	Fine	244	6.74	4.44	6.47	6.64	43	5.68	10.77	<0.01	..	..	11	other soil material
2.1	0-5	Medium	59	5.99	1.93	6.30	5.11	71	5.15	24.47	0.15	..	..	118	hyposulfidic (S_{CR}≥0.10%)
2.2	5-10	Fine	40	6.52	4.38	6.30	4.97	30	5.05	21.04	0.06	..	..	60	hyposulfidic (S_{CR}<0.10%)
2.3	10-20	Fine	59	6.55	3.30	6.49	5.08	29	5.14	17.13	0.07	..	..	62	hyposulfidic (S_{CR}<0.10%)
2.4	20-40	Fine	46	6.67	3.44	6.55	5.41	33	5.28	15.66	0.06	..	..	52	hyposulfidic (S_{CR}<0.10%)
3.1	0-5	Medium	56	6.14	2.06	6.60	5.13	59	5.27	18.60	0.13	..	..	100	hyposulfidic (S_{CR}≥0.10%)
3.2	5-10	Medium	35	5.97	2.06	6.37	5.16	57	5.08	18.60	0.11	..	..	86	hyposulfidic (S_{CR}≥0.10%)
3.3	10-20	Fine	83	6.51	2.81	6.35	5.42	43	4.83	33.28	0.04	..	..	55	hyposulfidic (S_{CR}<0.10%)
3.4	20-40	Fine	65	6.53	3.57	6.07	5.13	46	4.74	31.81	0.04	..	..	59	hyposulfidic (S_{CR}<0.10%)
3.5	40-70	Fine	80	6.57	4.31	6.65	5.68	25	4.89	19.08	0.01	..	..	26	hyposulfidic (S_{CR}<0.10%)
4.1	5-20	Fine	100	6.25	2.33	6.39	4.95	62	5.06	26.43	0.11	..	..	97	hyposulfidic (S_{CR}≥0.10%)
4.2	20-40	Fine	151	6.50	2.56	6.45	4.56	91	4.98	33.28	0.30	..	..	223	hyposulfidic (S_{CR}≥0.10%)
4.3	0-5	Fine	82	6.16	1.86	6.56	5.03	81	5.26	18.60	0.24	..	..	166	hyposulfidic (S_{CR}≥0.10%)
5.1	0-5	Medium	21	6.01	2.56	6.29	4.69	32	5.19	12.23	0.04	..	..	35	hyposulfidic (S_{CR}<0.10%)
5.2	5-10	Medium	24	5.81	1.98	6.32	4.72	55	4.77	22.02	0.06	..	..	57	hyposulfidic (S_{CR}<0.10%)
5.3	10-20	Fine	34	6.37	3.21	6.32	4.31	74	4.51	32.79	0.13	..	..	113	hyposulfidic (S_{CR}≥0.10%)
5.4	20-40	Fine	29	6.43	3.74	6.41	4.73	47	4.79	21.53	0.03	..	..	40	hyposulfidic (S_{CR}<0.10%)
6.W1	110-0	..	..	..	..	..	..	..	..	..	..	..	..	..	surface water
6.1	0-5	Medium	30	6.02	2.08	6.40	4.60	30	5.21	8.81	0.02	..	..	21	hyposulfidic (S_{CR}<0.10%)
6.2	5-10	Coarse	21	6.01	1.77	6.34	4.27	27	5.54	5.87	0.04	..	..	28	hyposulfidic (S_{CR}<0.10%)
6.3	10-20	Coarse	26	5.87	1.69	6.26	4.51	27	5.52	7.34	0.02	..	..	19	hyposulfidic (S_{CR}<0.10%)
7.1	0-5	Medium	68	6.26	2.58	6.28	5.72	98	5.63	18.60	0.09	..	..	73	hyposulfidic (S_{CR}<0.10%)
7.2	5-20	..	..	..	..	..	..	..	..	..	..	..	..	..	not sampled
7.3	20-40	Fine	72	7.50	7.30	6.34	5.97	4	5.78	12.72	<0.01	..	..	13	other soil material

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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Sulfate Soil Material Classification
8.1	0-5	Fine	268	6.86	5.10	6.75	5.63	59	5.69	10.77	0.04	..	..	36	hyposulfidic (S_{CR}<0.10%)
8.2	5-10	Fine	74	7.55	6.60	6.53	5.33	35	5.90	7.83	0.02	..	..	20	hyposulfidic (S_{CR}<0.10%)
8.3	10-20	Fine	77	7.30	5.82	6.50	6.05	25	6.24	8.33	0.02	..	0.00	21	hyposulfidic (S_{CR}<0.10%)
8.4	20-40	Fine	48	7.87	6.97	6.72	6.58	21	6.15	7.35	0.01	..	0.00	14	hyposulfidic (S_{CR}<0.10%)

Table 15-5. Summary of hydrochemical field measurements for Paringa Paddock (Wetland ID. 12086).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=1)	6.72	214	5.5	-118	102	80

Table 15-6. Summary of hydrochemical field measurements for Paringa Paddock (Wetland ID. 12086).

Parameter	units	ANZECC Guidelines	Site 6 (SW)
Na	mg l^{-1}		67.4
K	mg l^{-1}		4.3
Ca	mg l^{-1}		11.8
Mg	mg l^{-1}		10.6
Si	mg l^{-1}		2.94
Br	mg l^{-1}		0.3
Cl	mg l^{-1}		120
NO_3	mg l^{-1}	0.7	<0.022
NH_4-N^K	mg l^{-1}	0.01	0.01
PO_4-P^E	mg l^{-1}	0.005	**0.048**
SO_4	mg l^{-1}		12
Ag	µg l^{-1}	0.05	<0.01
Al^A	µg l^{-1}	55	**126**
As^B	µg l^{-1}	13	1.2
Cd	µg l^{-1}	0.2	0.02
Co	µg l^{-1}	2.8	0.09
Cr^C	µg l^{-1}	1	0.2
Cu^H	µg l^{-1}	1.4	**1.6**
Fe	µg l^{-1}	300	<100
Mn	µg l^{-1}	1700	10.72
Ni^H	µg l^{-1}	11	1.0
Pb^H	µg l^{-1}	3.4	0.2
Se	µg l^{-1}	11	<0.06
Zn^H	µg l^{-1}	8	**104**
DOC	mg l^{-1}		7.9

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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*

16. PARINGA PADDOCK (WETLAND ID. 12087)

16.1. Location and setting description

Paringa Paddock (Wetland ID. 12087) is situated on the western side of the River Murray, adjacent to the town of Renmark and Lock 5. The wetland is crescent in shape formed as the inner oxbow lake and it is part of a wetland complex that occurs on the outside of a bend in the river. It is about 3 kilometres in length and about 100 metres at its widest, with a total surface area of 26 hectares. The wetland is bounded by a raised floodplain that separates the wetland from the river to the east and the outer oxbow lake to the west. The other associated wetland in the complex is wetland ID. 12086.

The wetland is permanently connected to the river at the eastern end. At the time when the soil survey was conducted in April 2010 the wetland had surface water. The wetland is not managed. Sedgeland and grassland were growing along the wetland margins, with open woodland and shrubland on the surrounding higher floodplain. Eight sites were sampled as shown in Figure 16-1.

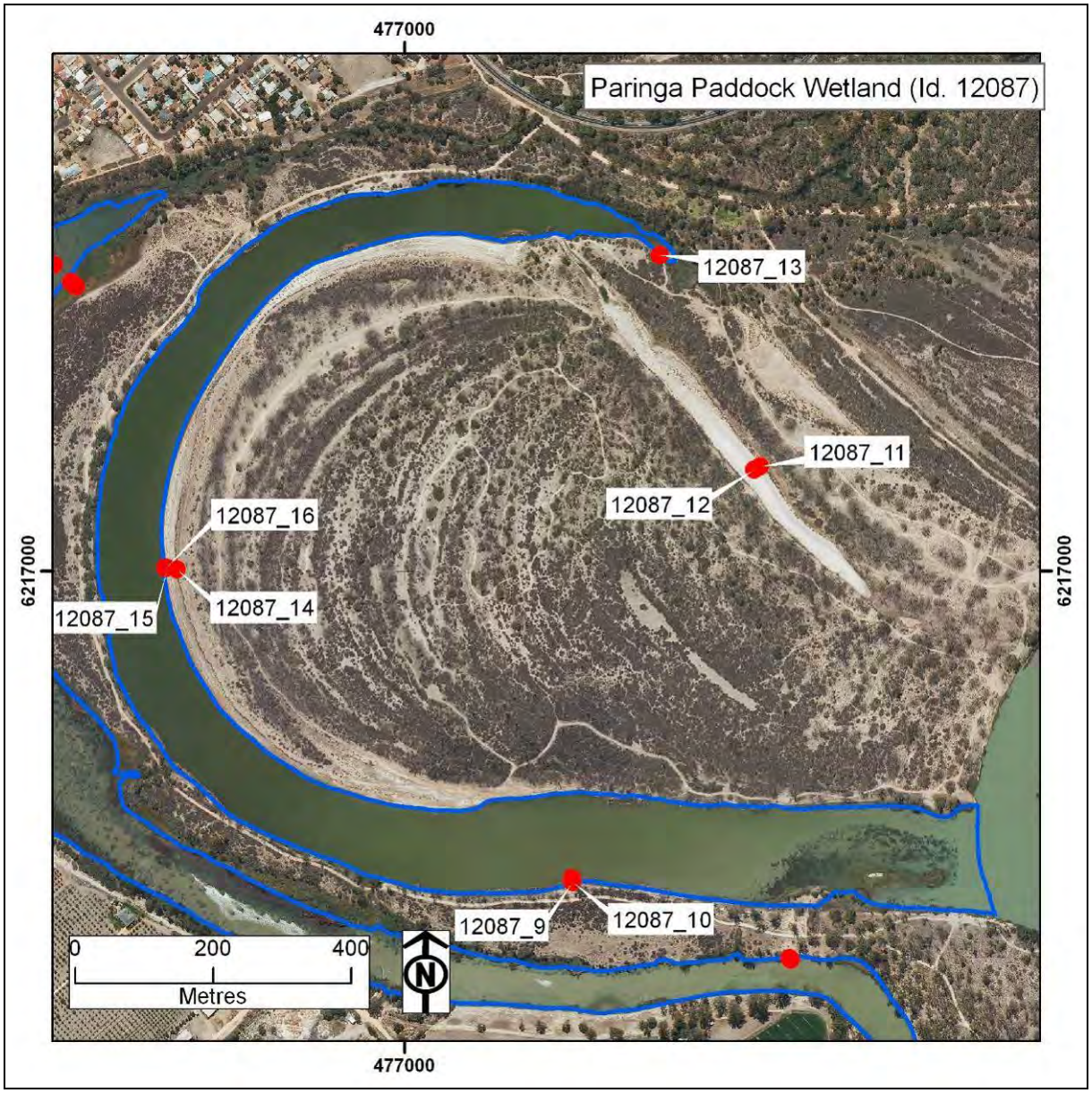


Figure 16-1. Paringa Paddock (Wetland ID. 12087) and sample site locations.

16.2. Soil profile description and distribution

Eight sites were described and sampled. The soil subtypes and general location descriptions are presented in Table 16-1. Sites were distributed along the wetland, with transects at the southern end (Sites 9 and 10), inner wet area not marked within the wetland boundary but potentially connected with soils of concern (Sites 11 and 12), northern end (Sites 13), and western end (Sites 14, 15 and 16) of the wetland. The site and soil profile descriptions are presented in Table 16-2 and Table 16-3, and a conceptual cross-section diagram in Figure 16-2.

Southern transect

Site 9 (Figure 16-3) occurred on the wetland margin between the bank and reeds in water (20 cm deep), and the soil consisted of a dark grey to black, very weak, monosulfidic material, over grey, very weak, sandy loam. Site 10 (Figure 16-4) occurred adjacent to reeds in open water (80 cm deep), and the soil consisted of a dark grey to black, very weak, monosulfidic material with strong sulfurous odour, over a dark grey, very weak, mucky clay.

Inner transect

Site 11 (Figure 16-5) occurred between the vegetation and surface water, the pit water was at 30 cm depth, and the soil consisted of a very dark greyish brown, very weak, sand, over a dark grey, weak, sandy clay loam with depth. Site 12 (Figure 16-6) occurred at low elevation near the centre with surface water (10 cm deep), and the soil consisted of thick, black, very weak, monosulfidic material, over a dark grey, firm, clay.

Northern site

Site 13 (Figure 16-7) occurred in open water (30 cm deep), and the soil consisted of a black, very weak, monosulfidic material and mucky clay, over a very dark grey, firm, sand.

Western transect

Site 14 (Figure 16-8) occurred on the wetland margin at a high elevation, the water table was at about 80 cm depth, and the soil consisted of a greyish brown, firm, sandy loam, over a dark grey, firm, sandy. Site 15 (Figure 16-9) occurred on the bank next to the water, the water table was at about 60 cm depth, and the soil consisted of a dark grey, firm sandy clay loam, over a very dark grey, weak, sandy loam. Site 16 (Figure 16-10) occurred in open water (50 cm deep), and the soil consisted of a dark grey, very weak, clay, over a dark grey, weak, sandy loam.

Table 16-1. Soil identification, subtype and general location description for Paringa Paddock (Wetland ID. 12087).

Wetland and Site ID	Easting zone 54H	Northing zone 54H	Acid sulfate soil subtype class	General location description
12087_9	477244	6216549	Hypersulfidic Subaqueous Soil (loamy)	wetland margin in water
12087_10	477243	6216555	Subaqueous Soil (clayey)	open water, edge of reeds, groundwater seep area
12087_11	477516	6217152	Other Soil (loamy)	mid elevation, between vegetation and water
12087_12	477507	6217147	Subaqueous Soil (clayey)	low elevation, middle of wetland in water
12087_13	477370	6217458	Subaqueous Soil (sandy)	open water, 3m from bank
12087_14	476670	6217003	Other Soil (loamy)	high elevation, above shoreline
12087_15	476656	6217005	Other Soil (loamy)	mid elevation, adjacent to water
12087_16	476654	6217005	Subaqueous Soil (clayey)	low elevation, open water 5m from shoreline

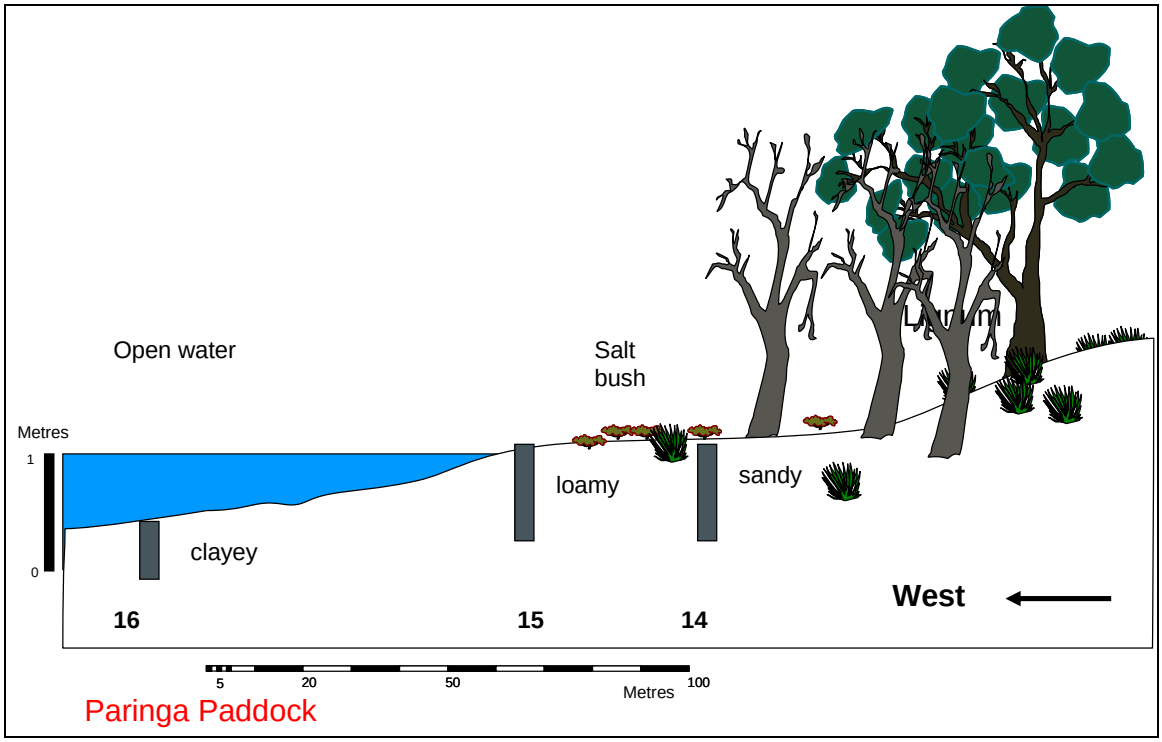


Figure 16-2. Conceptual cross-section diagram.

Figure 16-3. Photograph of Site 9, showing the site location on the wetland margin in water between the bank and reeds.

Figure 16-4. Photograph of Site 10, showing the site location in open water adjacent to the reeds.

Figure 16-5. Photographs of Site 11, showing the site location on the margin of the wet area and the soil profile with water in the pit.

Figure 16-6. Photograph of Site 12, showing the site location in open water at the centre of the wet area.

Figure 16-7. Photograph of Site 13, showing the site location placed in open water.

Figure 16-8. Photographs of Site 14, showing the site location placed on the wetland margin where samphire was growing, and the soil pit with a crusted soil surface.

Figure 16-9. Photograph of Site 15, showing the site location placed on the shoreline next to the open water.

Figure 16-10. Photograph of Site 16, showing the site location placed in deep water.

16.3. Laboratory data assessment

16.3.1. Soil pH testing (pH_W, pH_{OX}, pH_{INC})

The pH data are provided in Table 16-4 and pH profiles are presented in Figure 16-11. The pH_W data ranged from 6.35 to 9.13 and sulfuric materials with a pH_W <4 were not identified. The pH_{OX} data ranged from 1.52 to 7.46 and identified that surface samples of open water sites of Profiles 9, 10, 13, 16 and subsoil samples of dry land site of Profiles 14 and 15 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 3.98 to 7.98 and identified all samples where above and one sample in Profile 9 on incubation declined below the critical values of pH <4, indicating that these soils potentially would form sulfuric material on oxidation.

16.3.2. Acid base accounting

The acid base accounting data is provided in Table 16-4 and summarised in Figure 16-12.

Chromium reducible sulfur

Chromium reducible sulfur values ranged from 0.0 to 1.08 $\%S_{CR}$ and sulfidic materials were detected in all soil profiles.

Titratable actual acidity

Titratable actual acidity values ranged from 0.00 to 4.90 mole H^+/tonne and were detected in samples of Profiles 9, 15 and 16.

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 0.16 to 5.16 $\%CaCO_3$.and were measured in all samples.

Net acidity

Net acidity values ranged from -656 to 511 mole H^+/tonne. All profiles had at least one layer with positive high or moderate net acidity values, and negative values also occurred in at least one layer for most profiles.

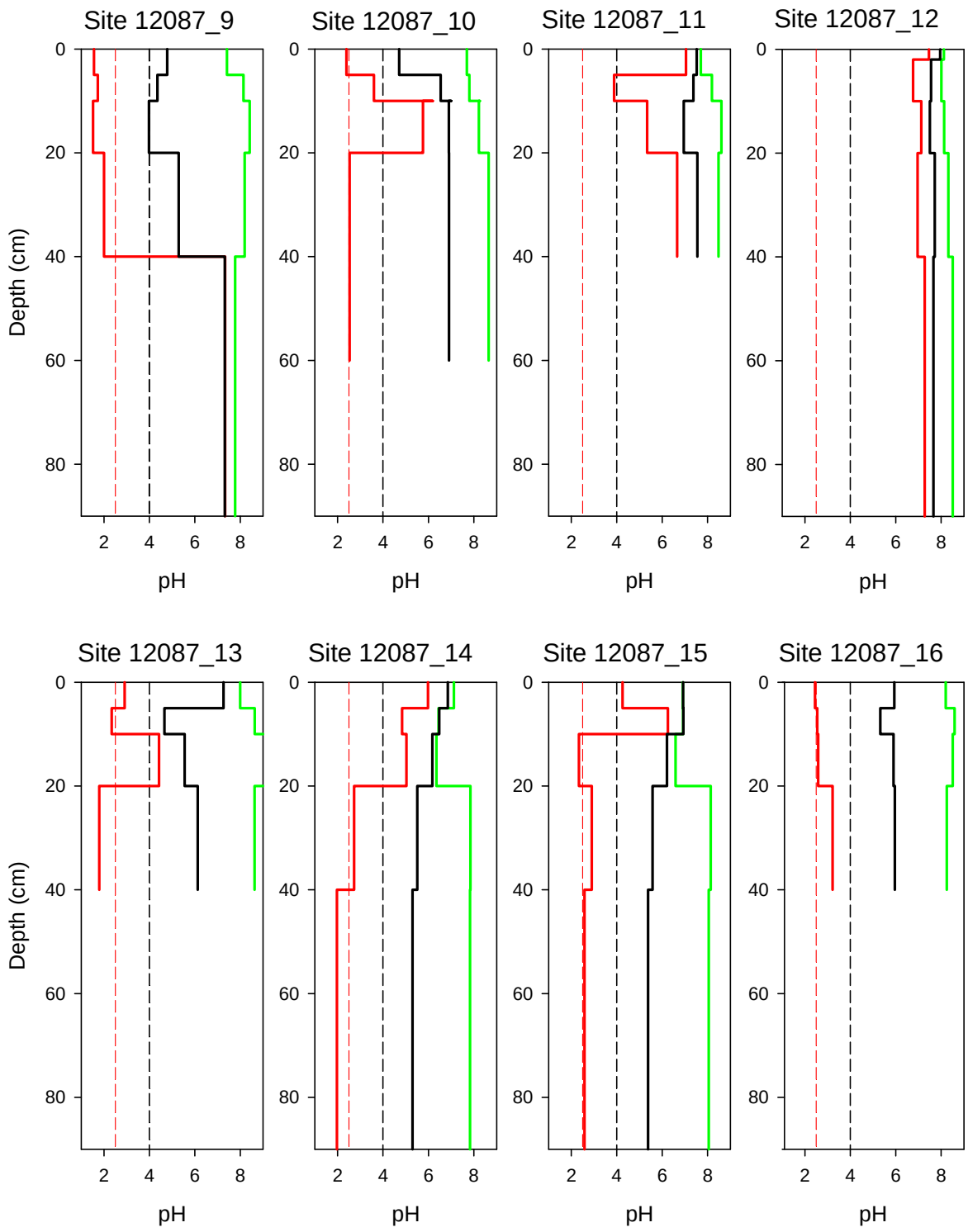


Figure 16-11. Depth profiles of soil pH for Paringa Paddock (Wetland ID. 12087), showing soil pH (pH_W as green line), peroxide treated pH (pH_{OX} as red line) and incubation pH (pH_{INC} after 8 weeks as black line). Critical pH_W and pH_{INC} value of 4 (black dashed line) and critical pH_{OX} value of 2.5 (red dashed line).

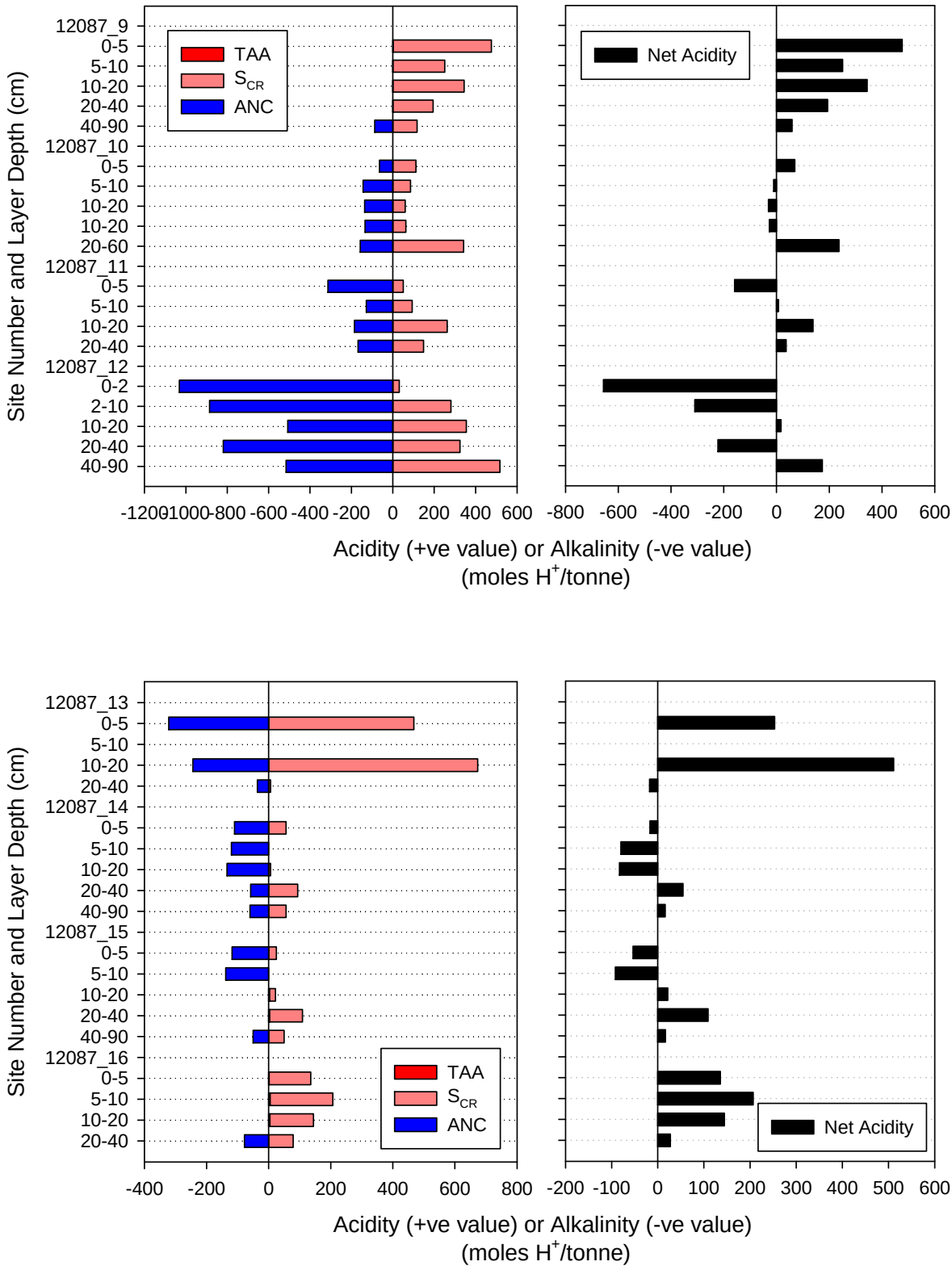


Figure 16-12. Acid base accounting depth profiles for Paringa Paddock (Wetland ID. 12087). Left side shows the components: Titratable actual acidity (TAA - red bar), acid generating potential (AGP as S_{CR} - pink bar), and acid neutralising capacity (ANC - blue bar), and right side shows net acidity.

16.3.3. Water soluble sulfate

Water soluble sulfate data values shown in Table 16-4 identified that all surface layers were above the criterion trigger value of 100 mg/kg SO_4.

16.3.4. Acid volatile sulfur

Monosulfidic materials were observed in Profiles 9, 10, 12 and 13, and samples were collected for analysis. The values were all above S_{AV} ≥0.01% S, the criteria value for identifying monosulfidic material.

16.3.5. Hydrochemistry

Two surface water samples were collected from the wetland. Field parameters are shown in Table 3-5. The surface waters had a slightly alkaline pH and SEC was very variable. Alkalinity was relatively high at both sites.

The waters differ in terms of major elements, varying from Na-Cl to Na-HCO_3 type (Table 16-6, Figure 16-13). Sulfate concentrations in the surface water varied from 12 to 34 mg l^{-1}. The SO_4/Cl ratio in the surface waters (0.10-0.17) was slightly lower than seawater (0.142). Nitrate concentrations were below detection limit, and PO_4 was slightly elevated above ANZECC Guideline values. The concentrations of most trace metals were low, with Zn exceeding the ANZECC guidelines in both samples.

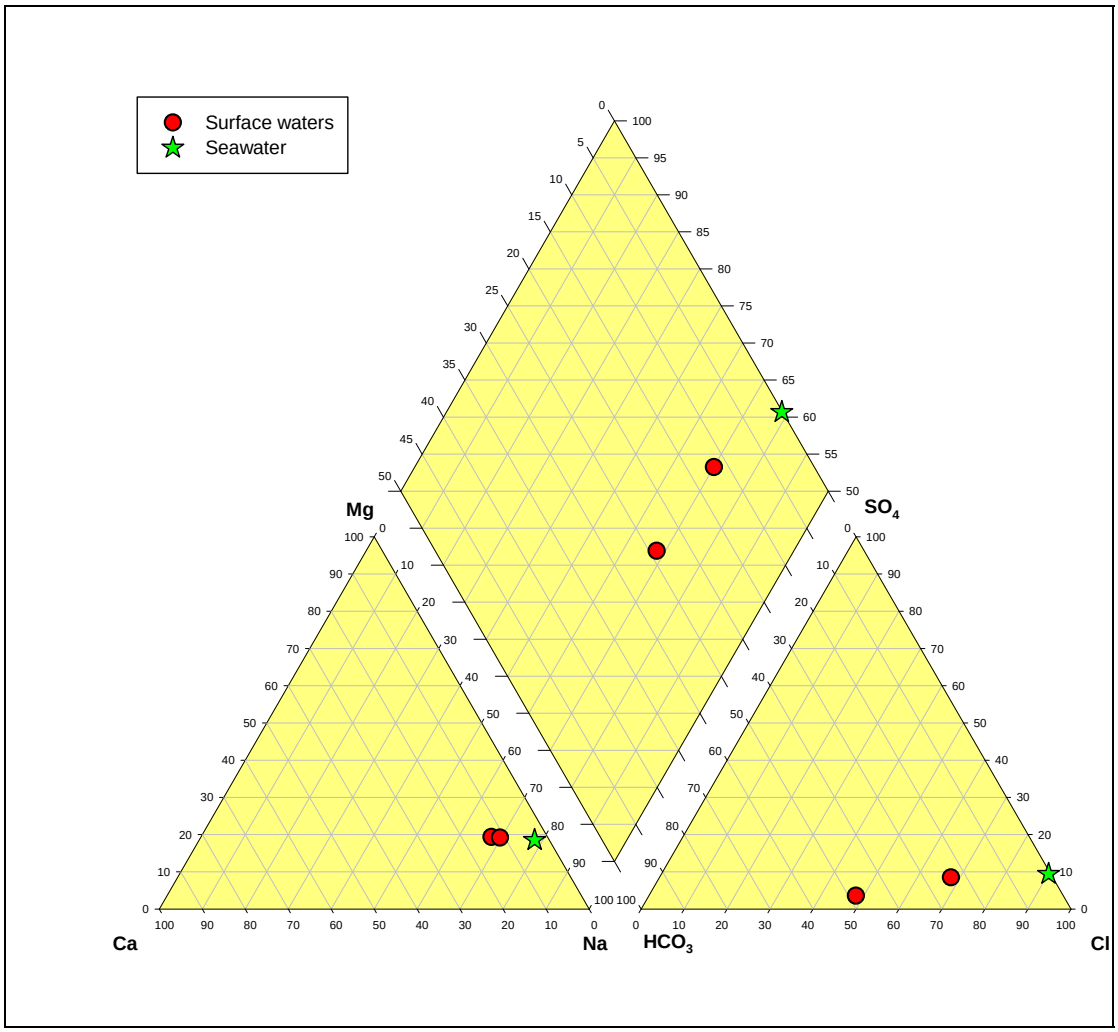


Figure 16-13. Piper diagram of hydrochemical data for Paringa Paddock (Wetland ID. 12087).

16.4. Discussion

Acid sulfate soil materials at Paringa Paddock (Wetland ID. 12087) were identified as hypersulfidic in one sample of Profile 9, and generally all other samples were hyposulfidic occurring throughout the soil profiles sampled. The acid sulfate soil subtype classes identified were Hypersulfidic Subaqueous Soil (loamy) that occurred as an isolated area adjacent to a saline groundwater seep, Subaqueous Soil (clayey or sandy) that occurred throughout the wetland, and Other Soil (loamy) that occurred on the wetland margins.

The soils throughout the wetland were had a range of textures in the surface and subsoil layers.

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

The potential hazards posed by acid sulfate soil materials at Paringa Paddock (Wetland ID. 12087) are:

- Acidification hazard: The data identified net acidity in the profiles varied from moderate, high or negative values and pH_{OX} data identified the 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 observed. There is a high 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 Paringa Paddock (Wetland ID. 12087):

Soil materials:	The soil layers throughout the wetland were generally hyposulfidic. Soil textures ranged from sandy or loamy or clayey in the surface and subsoil. All profiles had at least one layer with a moderate or high net acidity value and surface pH data indicated potential acidification due to oxidation.
Acid sulfate soil identification:	• Subaqueous Soil (sandy or clayey) – occurring where there was surface water. Dominant (>50%) in extent. • Hypersulfidic Subaqueous Soil (loamy) – occurring where there was a groundwater seep. Isolated (<10%) in extent. • Other Soil (loamy) – occurring on the wetland margins above the shoreline. Minor (<25%) in extent.
Hazard assessment	• Acidification hazard – medium to high level of concern • De-oxygenation hazard – high level of concern • Metal mobilisation hazard – medium level of concern

Table 16-2. Site description data for Paringa Paddock (Wetland ID. 12087).

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	14/04/2010	477244	6216549	20	water	water, Typha	wetland margin in water
10	14/04/2010	477243	6216555	80	water, soft	water	open water, edge of reeds, groundwater seep area
11	14/04/2010	477516	6217152	-30	salt crust, soft	bare	mid elevation, between vegetation and water
12	14/04/2010	477507	6217147	10	water, soft	water	low elevation, middle of wetland in water
13	14/04/2010	477370	6217458	30	water, soft	water	open water, 3m from bank
14	14/04/2010	476670	6217003	-80	white salts, sealed	salt bush	high elevation, above shoreline
15	14/04/2010	476656	6217005	-60	sealed, isolated salts	bare, spare saltbush	mid to high elevation, adjacent to shoreline
16	14/04/2010	476654	6217005	50	water, soft	water	mid elevation, open water 5m from shoreline

Table 16-3. Soil profile description data for Paringa Paddock (Wetland ID. 12087).

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	dark grey (10YR4/1)	monosulfidic black ooze	wet		gel	very weak	strong sulfurous odour
9_2	5 - 10	small pit	dark grey (2.5Y4/0)	sand	wet		single grain	very weak	
9_3	10 - 20	small pit	dark grey (2.5Y4/0)	sand	wet		single grain	very weak	
9_4	20 - 40	small pit	grey (5Y5/1)	sandy loam	wet		single grain	very weak	
9_5	40 - 90	push tube	grey (5Y5/1)	sandy loam	moist		single grain	very weak	
10_W1	80 - 0	surface water							water sampled
10_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	sulfurous odour
10_2	5 - 10	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	sulfurous odour
10_3	10 - 20	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	
10_3DUP	10 - 20	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	
10_4	20 - 60	small pit	dark grey (5Y4/1)	mucky clay	wet		massive	very weak	
11_1	0 - 5	small pit	dark greyish brown (2.5Y4/2)	sand	wet		massive	very weak	
11_2	5 - 10	small pit	dark grey (5Y4/1)	sand	wet	15% reddish brown In the matrix	massive	very weak	
11_3	10 - 20	small pit	dark grey (5Y4/1)	sandy loam	wet	15% reddish brown In the matrix	massive	very weak	
11_4	20 - 40	small pit	dark grey (5Y4/1)	sandy clay loam	wet		massive	weak	
11_0	0 - 0.2	small pit	pinkish grey (7.5YR7/2)	salt	dry		crystalline	very weak	salt crust
12_W	10 - 0	water							
12_1	0 - 2	small pit	greyish brown (10YR5/2)	monosulfidic black ooze	wet		gel	very weak	salt crust with monosulfidic materials amongst crystals
12_2	2 - 10	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
12_3	10 - 20	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
12_4	20 - 40	small pit	black (2.5Y2/0)	mucky clay	wet		gel	very weak	possibly monosulfidic material
12_5	40 - 90	push tube	dark grey (5Y4/1)	clay	moist		massive	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
13_W	30 - 0	water							
13_1	0 - 5	small pit	black (2.5Y2/0)	monosulfidic black ooze	wet		gel	very weak	
13_2	5 - 10	small pit	black (2.5Y2/0)	mucky clay	wet		gel	very weak	possibly monosulfidic material
13_3	10 - 20	small pit	very dark grey (2.5Y3/0)	mucky clay	wet		massive	very weak	
13_4	20 - 40	push tube	very dark grey (5Y3/1)	sand	moist		single grain	firm	
14_1	0 - 5	small pit	greyish brown (10YR5/2)	sandy loam	moist	3% red infused into the matrix adjacent to pores	massive	firm	
14_2	5 - 10	small pit	dark greyish brown (10YR4/2)	sandy clay loam	moist	10% red infused into the matrix adjacent to pores	massive	firm	
14_3	10 - 20	small pit	dark greyish brown (10YR4/2)	sandy clay loam	moist		massive	firm	
14_4	20 - 40	small pit	dark grey (5Y4/1)	sandy loam	moist		massive	firm	
14_5	40 - 90	push tube	dark grey (5Y4/1)	sand	moist		massive	firm	
15_1	0 - 5	small pit	dark grey (10YR4/1)	sandy clay loam	moist		massive	firm	
15_2	5 - 10	small pit	dark grey (10YR4/1)	clay loam	moist	20% reddish brown In the matrix	angular blocky	firm	
15_3	10 - 20	small pit	dark greyish brown (2.5Y4/2)	clay	moist	20% reddish brown In the matrix	angular blocky	firm	
15_4	20 - 40	small pit	very dark grey (5Y3/1)	clay	moist		angular blocky	firm	
15_5	40 - 90	push tube	grey (5Y5/1)	sandy loam	wet		massive	weak	
16_W1	50 - 0	surface water							water sampled
16_1	0 - 5	small pit	dark grey (5Y4/1)	mucky clay	wet		gel	very weak	
16_2	5 - 10	small pit	dark grey (5Y4/1)	clay	wet		angular blocky	weak	
16_3	10 - 20	small pit	dark grey (5Y4/1)	clay	wet		angular blocky	weak	
16_4	20 - 40	push tube	dark grey (5Y4/1)	sandy loam	wet		massive	weak	

Table 16-4. Laboratory data for acid sulfate soil assessment of Paringa Paddock (Wetland ID. 12087).

(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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav	Acid Sulfate Soil Material Classification
9.1	0-5	Medium	392	7.41	1.56	6.66	4.78	150	6.43	2.50	0.76	..	.000	477	0.03	hyposulfidic (S_{CR}≥0.10%) monosulfidic
9.2	5-10	Medium	857	8.14	1.73	7.04	4.35	220	6.31	1.47	0.40	..	0.00	251		hyposulfidic (S_{CR}≥0.10%)
9.3	10-20	Medium	993	8.41	1.52	7.83	3.98	320	6.46	0.98	0.55	..	0.00	344		Hypersulfidic
9.4	20-40	Medium	1,253	8.19	2.00	7.35	5.29	220	6.41	0.98	0.31	..	0.00	194		hyposulfidic (S_{CR}≥0.10%)
9.5	40-90	Fine	1,384	7.77	7.33	6.84	7.32	230	6.52	0.00	0.19	..	0.44	59		hyposulfidic (S_{CR}≥0.10%)
10.W1	80-0	..	..	..	..	..	..	..	..	..	..	..	..	..		surface water
10.1	0-5	Medium	860	7.69	2.39	7.10	4.71	170	6.73	0.00	0.18	..	0.32	69	0.04	hyposulfidic (S_{CR}≥0.10%) monosulfidic
10.2	5-10	Fine	1,390	7.80	3.60	7.27	6.54	87	7.14	0.00	0.14	..	0.72	-11	0.03	hyposulfidic (S_{CR}≥0.10%) monosulfidic
10.3	10-20	Fine	1,221	8.22	5.76	7.39	6.90	71	6.82	0.00	0.10	..	0.67	-27		hyposulfidic (S_{CR}≥0.10%)
10.3	10-20	Fine	1,730	8.26	6.19	7.75	7.00	67	6.89	0.00	0.10	..	0.68	-30		hyposulfidic (S_{CR}<0.10%)
10.4	20-60	Fine	2,420	8.65	2.53	7.78	6.91	250	7.73	0.00	0.55	..	0.79	237		hyposulfidic (S_{CR}≥0.10%)
11.1	0-5	Fine	25,300	7.70	7.05	7.28	7.52	890	8.19	0.00	0.08	..	1.57	-159		hyposulfidic (S_{CR}<0.10%)
11.2	5-10	Medium	18,320	8.19	3.88	7.25	7.38	380	8.39	0.00	0.15	..	0.64	8		hyposulfidic (S_{CR}≥0.10%)
11.3	10-20	Fine	11,340	8.61	5.34	7.30	6.95	570	7.62	0.00	0.42	..	0.93	139		hyposulfidic (S_{CR}≥0.10%)
11.4	20-40	Medium	6,570	8.48	6.66	7.35	7.55	470	8.75	0.00	0.24	..	0.84	37		hyposulfidic (S_{CR}≥0.10%)
11.0	0-0.2	..	..	..	..	7.82	7.98	..	..	..	..	..	..	..		salt crust
12.1	0-2	Medium	34,500	8.12	7.46	7.43	7.96	4,300	8.73	0.00	0.05	..	5.16	-656	0.02	hyposulfidic (S_{CR}<0.10%) monosulfidic
12.2	2-10	Fine	58,200	8.01	6.76	6.83	7.55	6,600	8.25	0.00	0.45	..	4.43	-309	0.24	hyposulfidic (S_{CR}≥0.10%) monosulfidic
12.3	10-20	Fine	44,100	8.13	7.12	6.78	7.50	2,600	8.23	0.00	0.57	..	2.54	17	0.22	hyposulfidic (S_{CR}≥0.10%) monosulfidic
12.4	20-40	Fine	25,300	8.32	6.96	7.22	7.72	1,600	8.49	0.00	0.52	..	4.10	-222		hyposulfidic (S_{CR}≥0.10%)
12.5	40-90	Fine	19,120	8.51	7.27	7.39	7.66	890	8.28	0.00	0.83	..	2.58	174		hyposulfidic (S_{CR}≥0.10%)
13.1	0-5	Medium	1,103	7.99	2.91	7.21	7.26	140	8.17	0.00	0.75	..	1.61	253	0.11	hyposulfidic (S_{CR}≥0.10%) monosulfidic
13.2	5-10	..	1,340	8.64	2.34	7.78	4.66	420	..	..	..	..	..	..		not sampled
13.3	10-20	Fine	1,446	9.13	4.42	7.81	5.55	520	7.59	0.00	1.08	..	1.22	511		hyposulfidic (S_{CR}≥0.10%)
13.4	20-40	Medium	338	8.63	1.79	7.63	6.13	250	7.32	0.00	0.01	..	0.18	-18		hyposulfidic (S_{CR}<0.10%)

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_4/kg)	pH KCl	Titratable Actual Acidity (mole H^+/ tonne)	Chromium Reducible Sulfur (%S_{CR})	Retained Acidity (mole H+/ tonne)	Acid Neutralising Capacity (%$CaCO_3$)	Net Acidity (mole H^+/ tonne)	Acid Volatile Sulfur (%Sav	Acid Sulfate Soil Material Classification
14.1	0-5	Fine	20,680	7.12	5.98	6.75	6.86	3,500	7.42	0.00	0.09	..	0.55	-17		hyposulfidic (S_{CR}<0.10%)
14.2	5-10	Fine	19,910	6.45	4.84	6.24	6.48	1,600	7.03	0.00	<0.01	..	0.60	-80		other soil material
14.3	10-20	Fine	17,690	6.35	5.03	6.03	6.17	1,100	6.59	0.00	0.01	..	0.67	-83		hyposulfidic (S_{CR}<0.10%)
14.4	20-40	Fine	6,950	7.85	2.73	6.43	5.51	560	6.63	0.00	0.15	..	0.29	55		hyposulfidic (S_{CR}≥0.10%)
14.5	40-90	Medium	3,220	7.83	1.97	6.42	5.30	390	6.55	0.00	0.09	..	0.30	16		hyposulfidic (S_{CR}<0.10%)
15.1	0-5	Fine	12,900	6.91	4.26	6.41	6.92	3,000	6.68	0.00	0.04	..	0.59	-54		hyposulfidic (S_{CR}<0.10%)
15.2	5-10	Fine	13,680	6.92	6.25	6.68	6.93	1,900	6.54	0.00	<0.01	..	0.69	-92		other soil material
15.3	10-20	Fine	13,940	6.59	2.34	6.22	6.21	1,000	6.46	2.94	0.03	..	0.00	22		hyposulfidic (S_{CR}<0.10%)
15.4	20-40	Fine	5,460	8.14	2.90	6.68	5.58	400	6.45	2.94	0.17	..	0.00	109		hyposulfidic (S_{CR}≥0.10%)
15.5	40-90	Fine	3,670	8.05	2.58	6.61	5.38	320	6.57	0.00	0.08	..	0.25	17		hyposulfidic (S_{CR}<0.10%)
16.W1	50-0	..	..	..	..	..	..	..	..	..	..	..	..	..		surface water
16.1	0-5	Fine	704	8.20	2.45	7.29	5.94	200	6.42	1.96	0.21	..	0.00	136		hyposulfidic (S_{CR}≥0.10%)
16.2	5-10	Fine	1,096	8.59	2.55	7.24	5.32	330	6.16	4.90	0.32	..	0.00	207		hyposulfidic (S_{CR}≥0.10%)
16.3	10-20	Fine	1,481	8.51	2.59	7.17	5.90	270	6.31	3.92	0.23	..	0.00	144		hyposulfidic (S_{CR}≥0.10%)
16.4	20-40	Fine	2,850	8.25	3.22	7.07	5.96	280	6.52	0.00	0.13	..	0.39	27		hyposulfidic (S_{CR}≥0.10%)

Table 16-5. Summary of hydrochemical field measurements for Paringa Paddock (Wetland ID. 12087).

	pH	SEC	DO	Eh	Turbidity	Alkalinity
		µS cm^{-1}	mg l^{-1}	mV	NTU	as HCO_3
Surface waters (n=2)	8.30-8.84	197-960	5.5-14.8	-61- -56		119-206

Table 16-6. Summary of hydrochemical field measurements for Paringa Paddock (Wetland ID. 12087).

Parameter	units	ANZECC Guidelines	Site 10 (SW)	Site 16 (SW)
Na	mg l^{-1}		67.4	128
K	mg l^{-1}		4.3	7.6
Ca	mg l^{-1}		11.8	18.5
Mg	mg l^{-1}		10.6	19.3
Si	mg l^{-1}		2.94	4.17
Br	mg l^{-1}		0.3	0.3
Cl	mg l^{-1}		120	200
NO_3	mg l^{-1}	0.7	<0.022	<0.022
NH_4-N[K]	mg l^{-1}	0.01	0.01	**0.018**
PO_4-P[E]	mg l^{-1}	0.005	**0.048**	**0.129**
SO_4	mg l^{-1}		12	34
Ag	µg l^{-1}	0.05	<0.2	<0.01
Al[A]	µg l^{-1}	55	**<100**	52
As[B]	µg l^{-1}	13	<20	1.8
Cd	µg l^{-1}	0.2	<0.6	0.03
Co	µg l^{-1}	2.8	2	0.25
Cr[C]	µg l^{-1}	1	<5	0.1
Cu[H]	µg l^{-1}	1.4	<10	1.6
Fe	µg l^{-1}	300	<100	<100
Mn	µg l^{-1}	1700	2755.2	4.64
Ni[H]	µg l^{-1}	11	6.0	1.0
Pb[H]	µg l^{-1}	3.4	<1	0.08
Se	µg l^{-1}	11	<4	0.06
Zn[H]	µg l^{-1}	8	**90**	**11.5**
DOC	mg l^{-1}		155	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_4 and PO_4, 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.

A *Trigger value for Aluminium in freshwater where pH > 6.5.*

B *Trigger value assumes As in solution as Arsenic (AsV).*

C *Trigger value for Chromium is applicable to Chromium (CrVI) only.*

E *Guideline is for filterable reactive phosphorous (FRP).*

H *Hardness affected (refer to Guidelines).*

K *Guideline for South-east Australia-Freshwater Lakes and reservoirs.*