

**Coastal acid sulfate soil
processes in Barker Inlet, South
Australia**

Doctor of Philosophy

The University of Adelaide












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Map unit 5 - Moist (winter): moderately well drained, open low scrub and grasses – lower former intertidal floodplain. Profile BG 15 (Table 2-6 and Figure 2-5)

Table 2-6 Summary of soil morphology for profile BG 15: *Moist (winter) moderately well drained, open low scrub and grasses*. Soil colour was determined on moist samples and consistence was determined on dry samples. Photos are of dried bulk samples.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (frame size: 5 x 2.5 cm)
Oe (BG 15-188)	0-5	Brown to greyish brown (10YR3/2) silty loam without mottles; moderate coarse subangular blocky structure; strong consistency; some fine roots; gradual and diffuse boundary	
A (BG 15-189)	5-15	Greyish brown (10YR4/2) clay loam with common fine, very faint, yellow (10YR7/8) mottles penetrating peds; strong subangular blocky structure; strong consistency; few fine roots; diffuse boundary	
E (BG 15-190)	15-25	Pale yellow (5Y7/3) silty clay with strong brown (7.5YR5/6) mottles (10% volume) impregnating matrix of peds. Strong, subangular blocky structure; very few living roots, diffuse boundary	
2Ey1 (BG 15-191)	25-30	Pale yellow (5Y7/3) silty clay with strong brown (7.5YR5/6) mottles (15% volume) impregnating matrix of peds. Strong, subangular blocky structure; very few living roots, diffuse boundary. Few gypsum crystals	
2Ey2 (BG 15-192)	30-40	Pale yellow (5Y7/3) silty clay with strong brown (7.5YR5/6) mottles (20% volume) impregnating matrix of peds. Strong, subangular blocky structure; very few living roots, diffuse boundary. Some gypsum crystals	
3Bty (BG 15-193)	40-65	Greyish brown (10YR5/2) medium sandy clay with few brown (7.5YR5/4) mottles of Fe-ox coating or infilling root channels (mangrove pneumatophores and seagrass); weak, medium subangular blocky structure; very few living roots, graded, sharp boundary	
4Bjy (BG 15-194)	65-95	Dark greyish brown (10YR3/2) clayey peat with many pale brown (10YR6/3) mottles (25% volume) of jarosite around root channels, up to 5 mm thick, and some distinct dark brown (7.5YR4/4) mottles of Fe-ox coating root channels; weak, subangular blocky structure; non calcareous; no living roots, common dead roots; sharp and smooth boundary	
5Oijg (BG 15-250)	95-110	Dark greyish brown (10YR3/2) organic sandy peat with many pale brown (10YR6/3) mottles (20% volume) of jarosite impregnating matrix; weak; layered mat structure (dominated seagrass fragments); non calcareous; no living roots; sharp and smooth boundary	
6Bijg/W1 (BG 15-196)	110-120	Light brownish grey (10YR6/2) medium sand with prominent light brownish grey (2.5Y6/2) jarosite mottles (5% volume) along root channels and seagrass fibres up to 5 mm thick; sand texture; weak single grain structure; non calcareous; no roots; diffuse boundary	
6Bg/W2 (BG 15-251)	120-150	Dark greyish brown (10YR4/2) medium sand with no mottles; weak single grain structure; non calcareous; no roots and diffuse boundary	
7Bg/W1 (BG 15-252)	150-170	Dark greyish brown (10YR4/2) (gleyed) sandy clay no mottles; strong blocky structure; non calcareous; no roots	

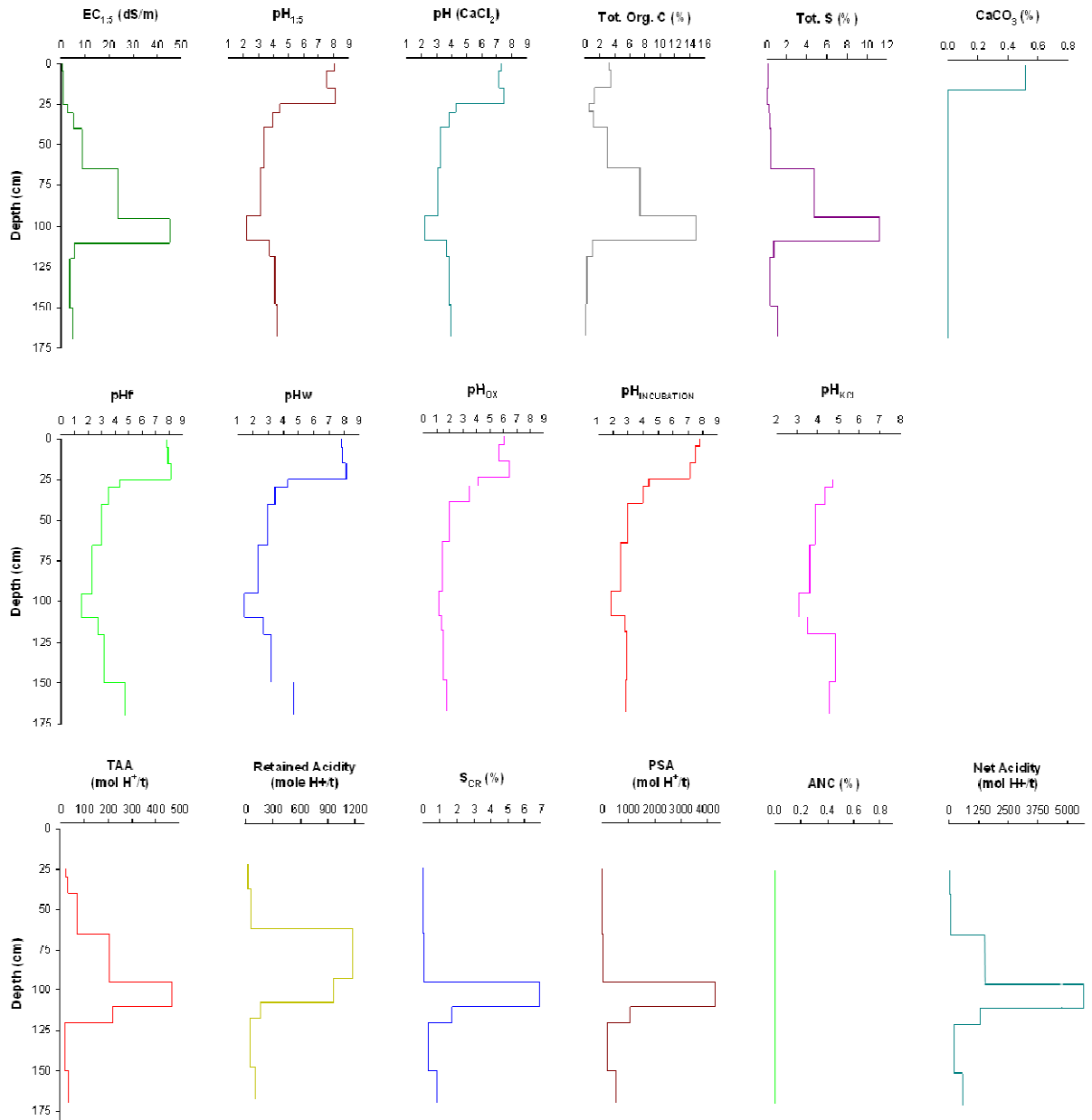








Figure 2-5 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 15.

Map unit 3 - Wet (winter): poorly drained, open depression –bare salt scalded mud flats. Profile BG 17 (Table 2-7 and Figure 2-6).

Table 2-7 Summary of soil morphology for profile BG 17: *Moist, poorly drained, bare salt scalded mud flat*. Soil colour was determined on moist samples and consistence was determined on dry samples. Photos are of dried bulk samples.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (frame size: 5 x 2.5 cm)
AE (BG 17-236)	0-10	Very dark greyish brown (10YR3/2) sandy loam with some dark yellowish brown (10YR4/4) mottles; friable structure; weak consistency without coarse fragments; abundant fine roots; gradual and smooth boundary	
2Bjg1 (BG 17-238)	10-25	Dark greyish brown (10YR4/2) sandy loam some diffuse light yellowish brown (2.5Y6/4) mottles (5%:volume) penetrating peds; weak consistency without coarse fragments; no roots; diffuse wavy boundary	
2Bjg2 (BG 17-239)	25-40	Dark greyish brown (10YR4/2) loamy sand with common prominent light yellowish brown (2.5Y6/4) mottles (20%:volume) penetrating peds; weak consistency without coarse fragments; no roots; diffuse wavy boundary	
3Bjg1 (BG 17-240)	40-60	Very dark greyish brown (10YR3/2) loamy sand with common prominent light yellowish brown (2.5Y6/4) mottles (20%:volume) penetrating peds and forming along macropores up to 5 mm thick (mangrove pneumatophores) and organic matter and some distinct dark brown (7.5YR4/4) mottles of Fe-ox in the centre of root channels; weak consistency without coarse fragments; no roots; diffuse wavy boundary	
3Bg/W2 (BG 17-241)	60-100	Very dark grey (10YR3/1) medium organic rich sand with no mottles; weak single grain structure; non calcareous; no roots; gradual and smooth boundary	
4Bg/W1 (BG 17-242)	100-120	Dark greyish brown (10YR4/2) medium sand with no mottles; weak single grain structure; non calcareous; no roots	

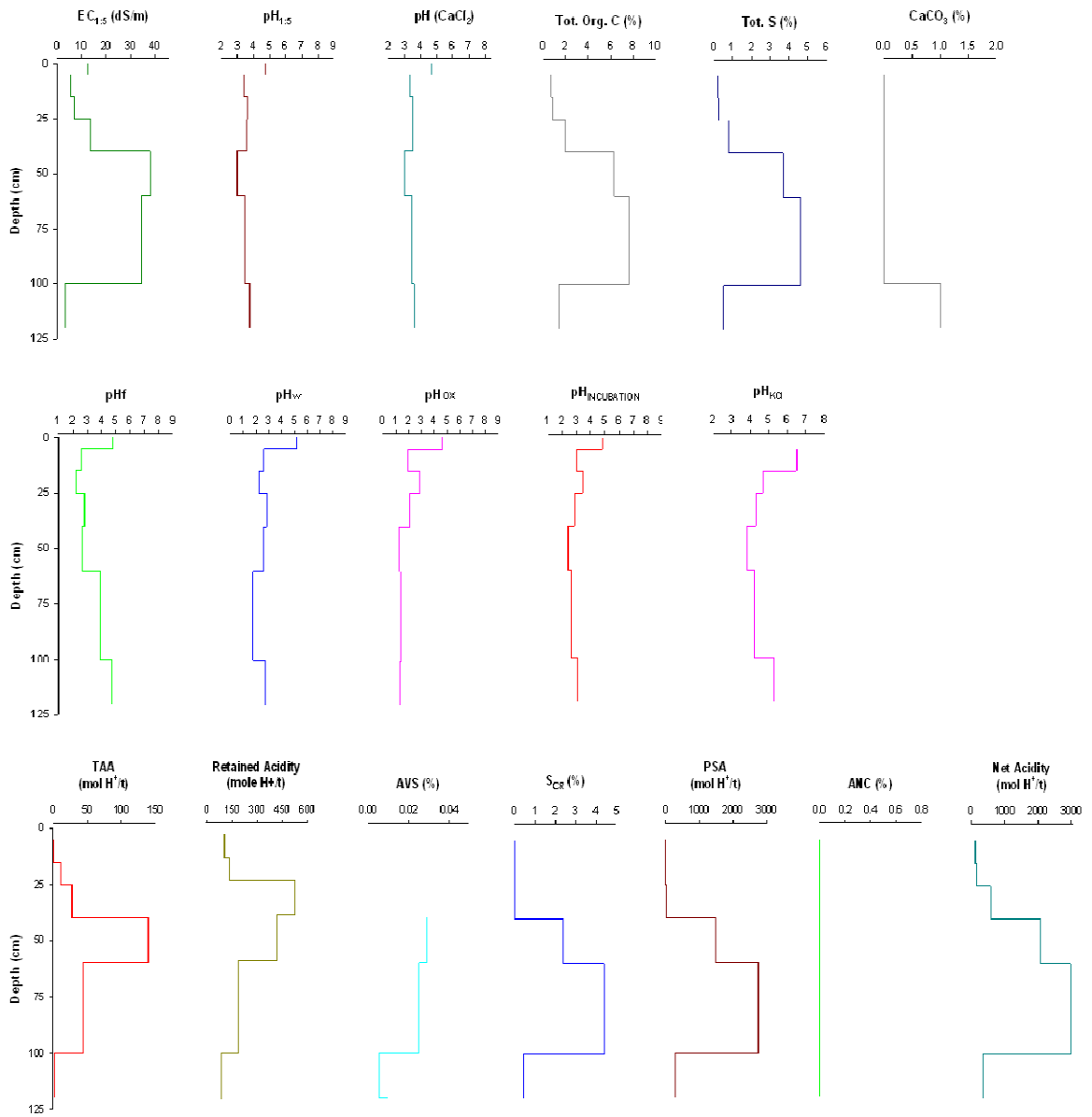






Figure 2-6 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 17.

Map unit 1 - Wet (subaqueous): poorly drained, erosional channel – water. Profile BG P 5 (Table 2-8 and Figure 2-1).

Table 2-8 Summary of soil morphology for profile BG P 5: *Wet, saturated (subaqueous) soil in saline groundwater discharge pond*. Soil colour was determined on moist samples and consistence was determined on dry samples. Photos are of **moist** bulk samples.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (frame size: 5 x 2.5 cm)
Oa/W1 (BG P 5-310)	0-5	Black (5Y2.5/1) without mottles; massive structure; weak (gel-like when wet) consistency without coarse fragments; no roots; gradual and smooth boundary	
Ag/W1 (BG P 5-307)	5-10	Very dark grey (5Y3/1) without mottles; massive structure; weak (gel-like when wet) consistency without coarse fragments; no roots; gradual and diffuse boundary	
2Bg/W1 (BG P 5-308)	10-25	Dark olive grey (5Y3/2) medium clay without mottles; massive structure; weak consistency without coarse fragments; non calcareous; no roots; diffuse boundary	
3Bg/W1 (BG P 5-309)	25-60	Olive grey (5Y4/2) heavy clay with some pale olive (5Y6/4) mottles (10% volume); massive structure; firm consistency without coarse fragments; non calcareous; no roots	

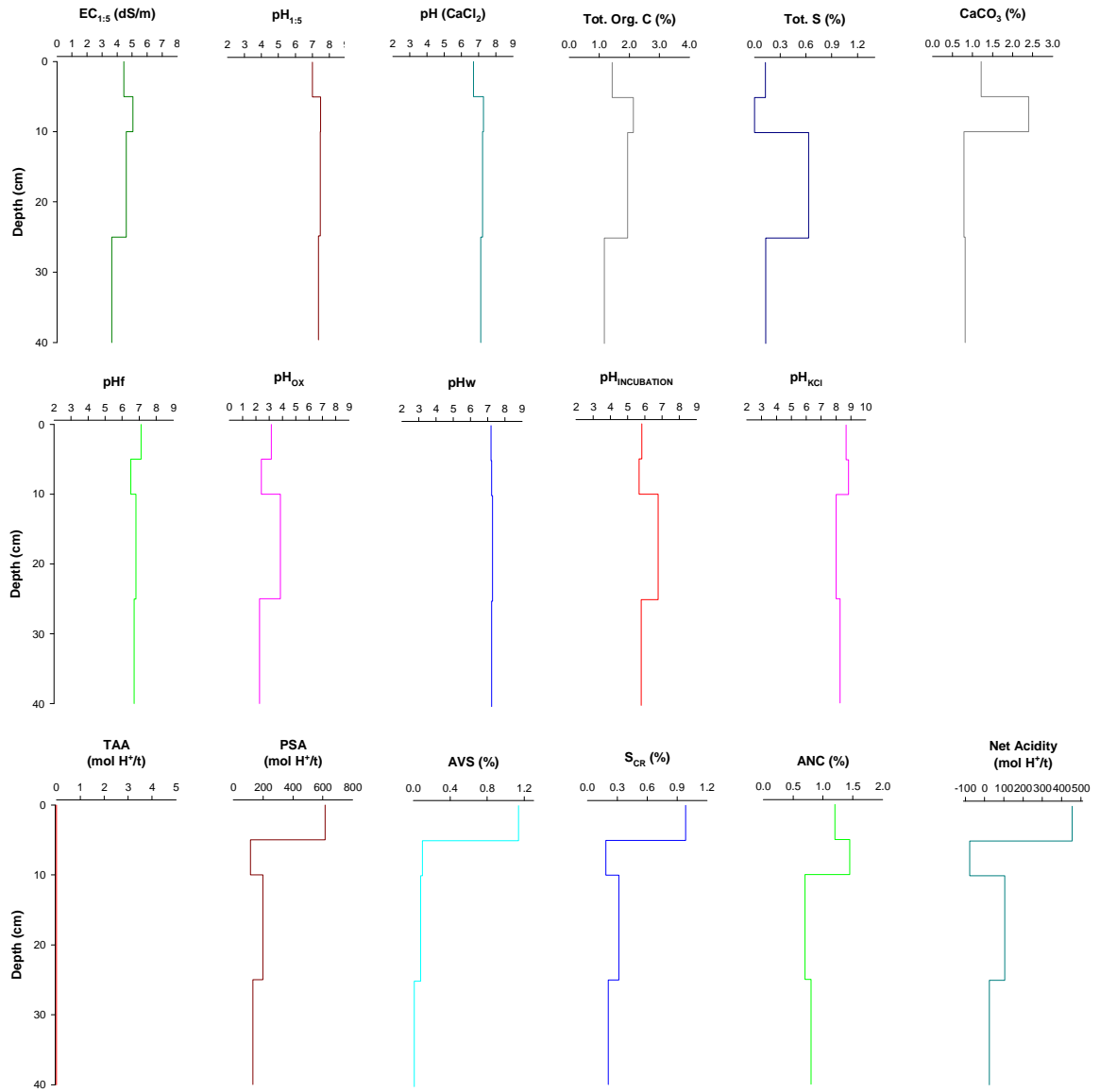


Figure 2-7 Down profile soil chemistry and acid sulfate soil characteristics of profile BG P 5.

1.4.2. Gillman Focus area B

Focus area B is sited at former tidal creek that forms a subtle erosion gully in the geomorphically-controlled, relic sandy shore face facies (Figure 2-1). The sandy shore face facies forms a north-east projecting ridgeline (topographic high). The ridgeline and tidal creek depression are evident in aerial photography and on the digital elevation map of Gillman. Prior to the construction of the bund walls in 1935 the sandy ridgeline was supratidal and covered by samphire vegetation (Belperio and Rice 1989).

Focus Area B encompasses two soil profiles located on a northeast trending toposequence that traverses from a relatively high sand ridge (profile BG 5) to a lower lying, seasonally inundated creek channel (profile BG 4) (Figure 2-8). Soil profile BG 4 is representative of map unit 2 (Benthic mat and bare salt scalded mud flats) while soil profile BG 5 is representative of map unit 6 (Open grass plain and scrub) (refer to Table 2-9 and Figure 2-9).

Table 2-10 provides a summary of the soil taxonomy for each of the profiles in Gillman focus area B.

Table 2-9 Soil profiles selected to be representative of map units occurring within focus area B, and along toposequence transect B-B' in Figure 2-8 and Figure 2-9.

Soil profile numbers	Elevation	Map unit no.	Landform	Water State, ponding and drainage
Disturbed intertidal to supratidal areas (Gillman study site)				
BG 4	0.6 m AHD	2. Benthic mat and bare salt scalded mud flats	Erosional channel stranded tidal creek channel	Wet (winter), poorly drained – seasonally inundated > 2 cm (and following storm event)
BG 5	2.1 m AHD	6. Open grass plain and scrub	Open flat plain – upper former intertidal floodplain	Moist (winter), well drained

Table 2-10 Gillman Focus area B soil profiles are classified according to Australian Soil Classification (Isbell 2002), Soil Taxonomy (Soil Survey Staff 2010) and using acid sulfate soil terminology (Sullivan *et al.* 2010).

Soil profile number	Map unit no.	Aust. Soil Classification (Isbell 2002)	Soil Taxonomy (Soil Survey Staff 2010)	Acid Sulfate Soil materials	Significant net acidity occurrence
BG 5	6. Open grass plain and scrub	Sulfuric Hypersalic Hydrosol*	Salidic Sulfaquepts	Sulfuric material, hypersulfidic and hyposulfidic materials	160 cm @ 115 mole H ⁺ /t from 30 cm depth
BG 4	2. Benthic mat and bare salt scalded mud flats	Sulfuric Salic Hydrosol	Typic Sulfaquepts	Hypersulfidic material, hyposulfidic and monosulfidic materials	35 cm @ 2785 mole H ⁺ /t from 30 cm depth, including an AVS content of 3.5%

*Proposed New Great group for (Isbell 2002).

A description of these profiles is provided in this Appendix. Tabulated soil chemical data is provided in Appendix C.

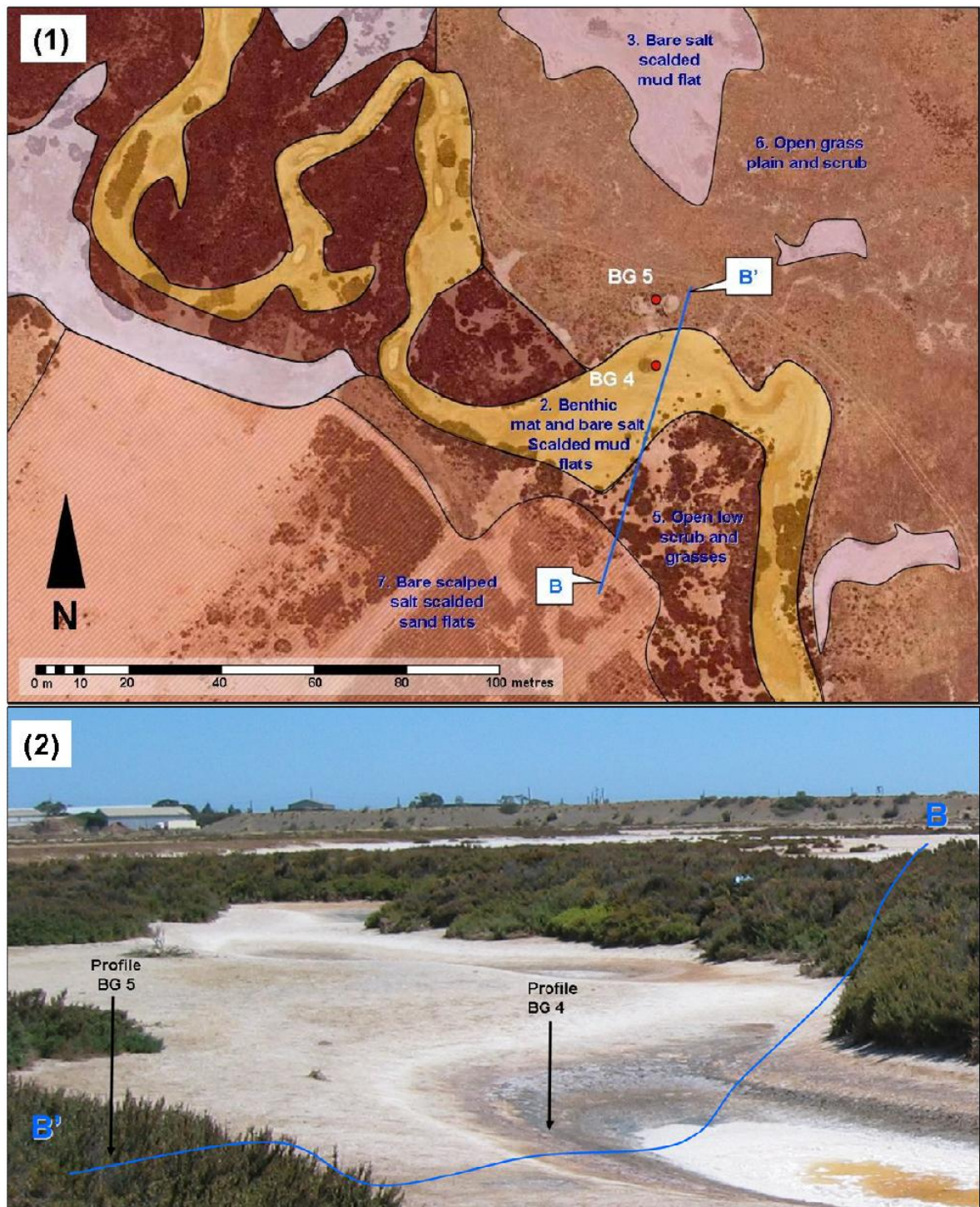


Figure 2-8 Aerial photo (1) with a transparent map indicating map units and the position of representative soil profiles BG 5 within map unit 6 (Open grass plain and scrub) and soil profile BG 4 within map unit 2 (Benthic mat and bare salt scalded mud flats). Landscape photo (2) shows the position of the soil profiles along toposequence transect B-B'.

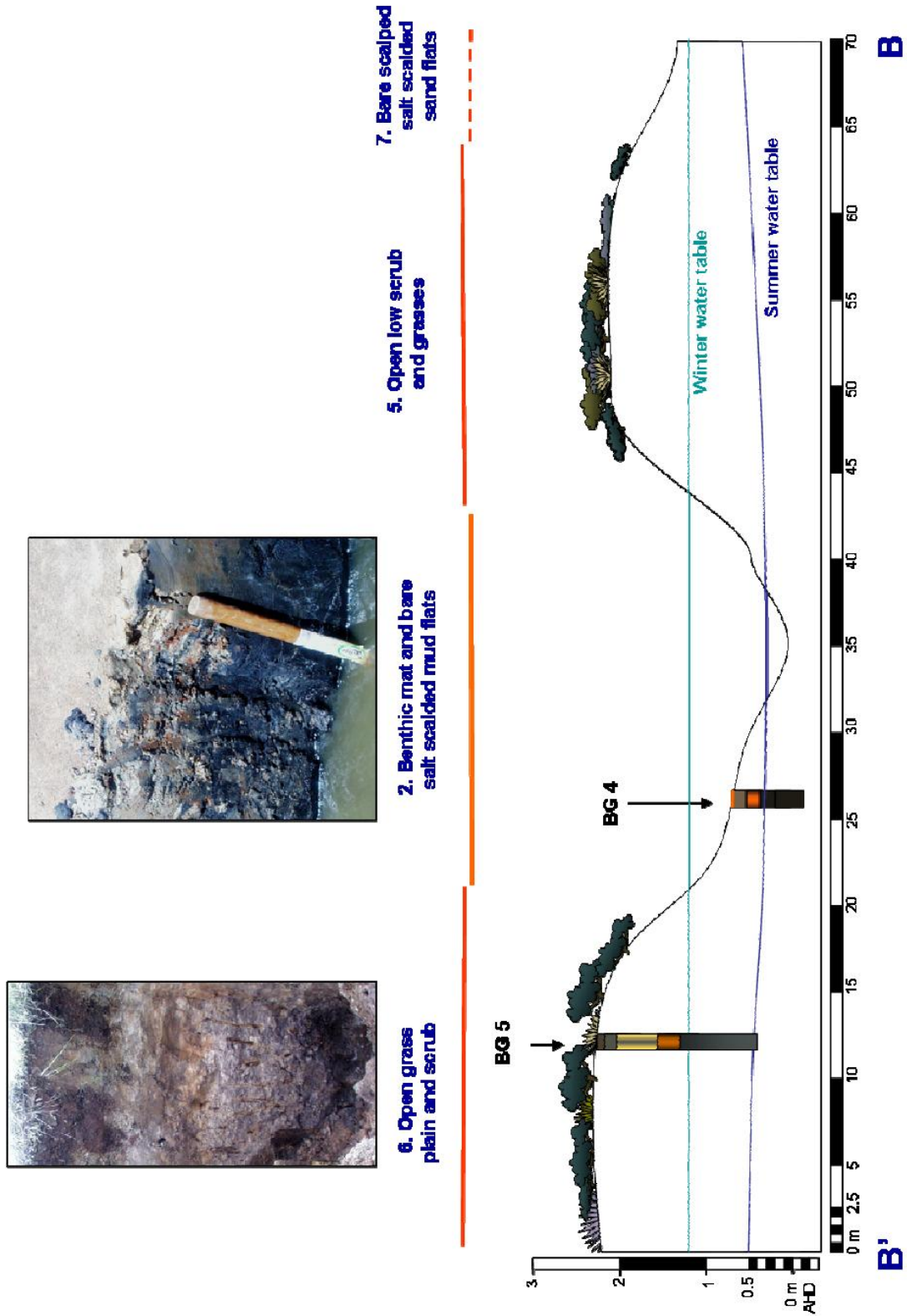














Figure 2-9 Descriptive soil-regolith toposequence model (cross section B-B' shown in Figure 2-8) indicating map units, position of representative soil profiles with colour photographs and average water table depth.

Wet (winter): poorly drained - inundated (> 2 cm) seasonally and following large storm events; benthic mat and bare salt scalded mud flats in a stranded tidal creek channel (erosional). Profile BG 4 – (Table 2-11 and Figure 2-8)

Table 2-11 Summary of soil morphology for profile BG 4: *Wet (winter) soil in a stranded tidal creek depression.* (Soil colour determined moist and consistence dry). Sample photos are of dried sample.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe (BG 4-276)	0-1	Pale yellow (2.5Y7/3) loamy medium sand with fibrous organic matter (filamentous algae). No mottles; friable structure; weak consistency without coarse fragments; no roots; distinct boundary	
AE (BG 4-158)	1-5	Pale yellow (2.5Y7/3) loamy medium sand with some diffuse strong brown (7.5YR5/6) mottles (2-5% volume) impregnating matrix of peds. Single grain structure; weak consistency without coarse fragments; non calcareous; no roots; gradual and irregular boundary	
2Bg1 (BG 4-159)	5-10	Greyish brown (2.5Y5/2) loamy medium sand with strong brown (7.5YR5/6) mottles (20% volume) impregnating matrix of peds. Single grain structure; very weak consistency without coarse fragments; non calcareous; no roots; gradual and irregular boundary	
2Bg2 (BG 4-160)	10-15	Greyish brown (2.5Y5/2) loamy medium sand with strong brown (7.5YR5/6) mottles (20% volume) impregnating matrix of peds. Some black (2.5Y2.5/1) mottles (5% volume) impregnate sandy matrix Single grain structure; very weak consistency without coarse fragments; non calcareous; no roots; gradual and irregular boundary	
2Bg3 (BG 4-161)	15-20	Greyish brown (2.5Y5/2) loamy medium sand with strong brown (7.5YR5/6) mottles (10% volume) impregnating matrix of peds. Black (2.5Y2.5/1) mottles (10% volume) impregnate sandy matrix. Single grain structure; very weak consistency without coarse fragments; non calcareous; no roots; gradual and irregular boundary	
3Bg1 (BG 4-162)	20-30	Very dark grey (2.5Y3/1) loamy medium sand with black (2.5Y 2.5/1) mottles (40% volume) impregnating matrix. Faint, dark yellowish brown (10YR4/4) mottles (<5% volume) also occur through the matrix. Single grain structure; very weak consistency without coarse fragments; non calcareous; no roots; gradual and irregular boundary	
3Bg2 (BG 4-163)	30-40	Very dark grey (2.5Y3/1) loamy medium sand with black (2.5Y 2.5/1) mottles (40% volume) impregnating matrix. Some fibrous organic matter is interbedded. Single grain structure; very weak consistency without coarse fragments; some calcareous medium sand grains occur in matrix; no roots; gradual and irregular boundary	
3Bg3 (BG 4-164)	40-45	Greyish brown (2.5Y5/2) loamy medium sand with many black (2.5Y 2.5/1) mottles (40% volume) impregnating matrix. Minor fibrous organic matter is interbedded. Single grain structure; very weak consistency without coarse fragments; minor calcareous medium sand grains occur in matrix; no roots; gradual and irregular boundary	

3Bg/W1 (BG 4-279)	45-55	Dark greyish brown (2.5Y4/2) loamy medium sand with many black (2.5Y 2.5/1) mottles (45% volume) impregnating matrix. Single grain structure; very weak consistency without coarse fragments; minor calcareous fine sand grains occur in matrix; no roots; gradual and irregular boundary	
4Bg/W1 (BG 4-280)	55-65	Very dark greyish brown (2.5Y3/2) loamy medium sand with some black (2.5Y 2.5/1) mottles (10% volume) impregnating matrix. Common interbedded fibrous organic matter. Single grain structure; very weak consistency without coarse fragments; calcareous medium sand grains are common in matrix; no roots; gradual and irregular boundary	
5Bg/W1 (BG 4-281)	65-80	Light brownish grey (2.5Y6/2) clayey medium sand without mottles; single grain structure; very weak consistency without coarse fragments; minor medium calcareous sand grains in matrix; no roots; gradual and irregular boundary	
6Bg/W1 (BG 4-282)	80-85	Greyish brown (2.5Y5/2) loamy medium sand with no mottles. Single grain structure; very weak consistency without coarse fragments; minor calcareous medium sand grains occur in matrix; no roots.	

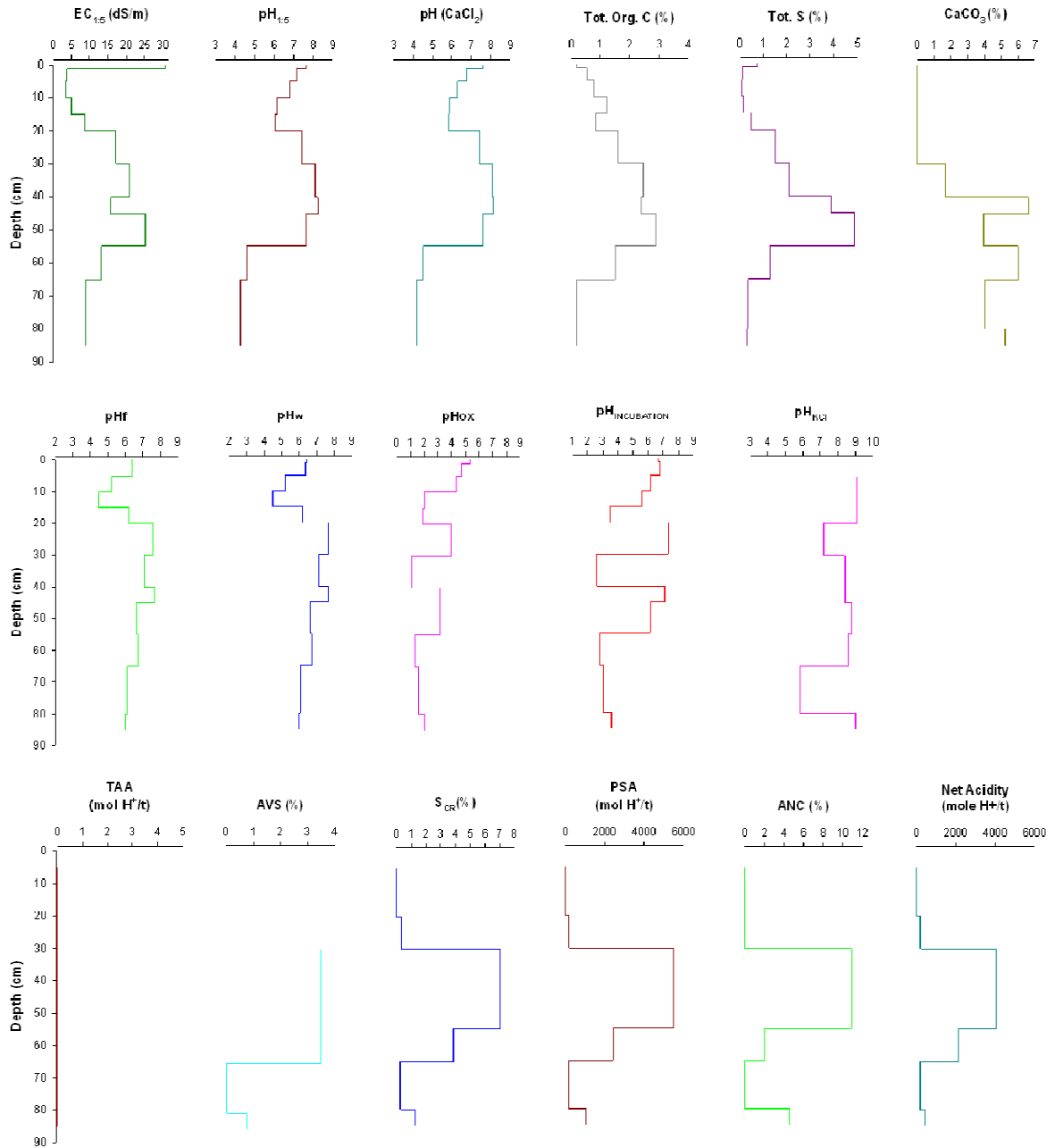














Figure 2-10 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 4

Moist (winter): well drained, open grass plain and scrub – upper former intertidal floodplain

Profile BG 5 – (Table 2-18 and Figure 2-8)

Table 2-12 Summary of soil morphology for profile BG 5: Moist (winter) well drained sandy soil covered by open grass plain and scrub. Soil-sediment profile BG 5 was deposited in an upper former intertidal floodplain setting. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe (BG 5-165)	0-5	Olive brown (2.5Y4/4) clay loam without mottles; moderately coarse subangular blocky structure; firm consistency without coarse fragments; abundant fine roots; gradual and undulating boundary	
A (BG 5-166)	5-10	Olive brown (2.5Y4/4) clay loam with minor yellowish red (5YR5/8) mottles (2-5% volume) impregnating matrix of peds; moderately coarse subangular blocky structure; firm consistency without coarse fragments; common fine roots; gradual boundary	
2A/E1 (BG 5-167)	10-15	Light olive brown (2.5Y5/3) medium sand with minor yellowish red (5YR5/8) mottles (2-5% volume) impregnating matrix of peds and some strong brown (7.5YR 4/6) mottles (5% volume) on ped surfaces; rounded blocky structure; weak consistency without coarse fragments; non calcareous; very few roots; gradual diffuse boundary	
2A/E2 (BG 5-168)	15-20	Light brown grey (2.5Y6/2) loamy sand with diffuse, strong brown (7.5YR5/6) mottles along coarse root channels (50% volume); minor yellowish red (5YR5/8) mottles (2-5% volume) impregnating matrix of peds; rounded blocky structure; weak consistency without coarse fragments; non calcareous; very few roots; gradual diffuse boundary	
3Bj1 (BG 5-169)	20-30	Greyish brown (2.5Y5/2) medium sand with some prominent yellow (2.5Y 7/6) mottles (10%:volume) forming along vertical, elongate (up to 50 mm) macropores (mangrove pneumatophores) that have light yellowish brown (2.5Y6/4) cores associated with organic matter. Minor yellowish red (5YR5/8) mottles (2-5% volume) impregnating matrix of peds. Weak consistency without coarse fragments; no roots; diffuse wavy boundary	
3Bj2 (BG 5-170)	30-40	Greyish brown (2.5Y5/2) medium sand with common, prominent, yellow (2.5Y 7/6) mottles (15%:volume) forming along vertical, elongate (up to 50 mm) macropores (mangrove pneumatophores) that have light yellowish brown (2.5Y6/4) cores associated with organic matter. Weak consistency without coarse fragments; no roots; diffuse wavy boundary	
3Bj3 (BG 5-171)	40-50	Greyish brown (2.5Y5/2) medium sand with some, prominent, yellow (2.5Y 7/6) mottles (10%:volume) forming along vertical, elongate (up to 50 mm) macropores (mangrove pneumatophores) that have light yellowish brown (2.5Y6/4) cores associated with organic matter. Weak consistency without coarse fragments; no roots; diffuse wavy boundary	

3Bjg4 (BG 5-172)	50-70	Greyish brown (2.5Y5/2) medium sand with some diffuse yellow (2.5Y 7/6) mottles (10%:volume) forming along vertical, elongate macropores Weak consistency without coarse fragments; no roots; diffuse wavy boundary	
4Bjg1 (BG 5-173)	70-90	Very dark grey (2.5Y3/1) medium sand with minor black (2.5Y 2.5/1) mottles (5% volume) impregnating matrix. Some fibrous organic matter is interbedded. Single grain structure; very weak consistency without coarse fragments; some calcareous medium sand grains occur in matrix; no roots; gradual and irregular boundary	
4Bjg2 (BG 5-174)	90-110	Grey (10YR6/1) medium sand with minor black (2.5Y 2.5/1) mottles (2% volume) impregnating matrix. Single grain structure; weak consistency without coarse fragments; some calcareous medium sand grains occur in matrix; no roots; gradual and irregular boundary	
5Bkg/W1 (BG 5-175)	110- 130	Grey (10YR6/1) medium sand with no mottles. Single grain structure; weak consistency with some coarse calcareous fragments (calcrete); some shell fragments; no roots; irregular boundary	
5Bkmg/ W2 (BG 5-176)	130- 190	Light brown grey (10YR6/2) medium sand with no mottles. Single grain structure; weak consistency with common coarse calcareous fragments (calcrete); some shell fragments; no roots	

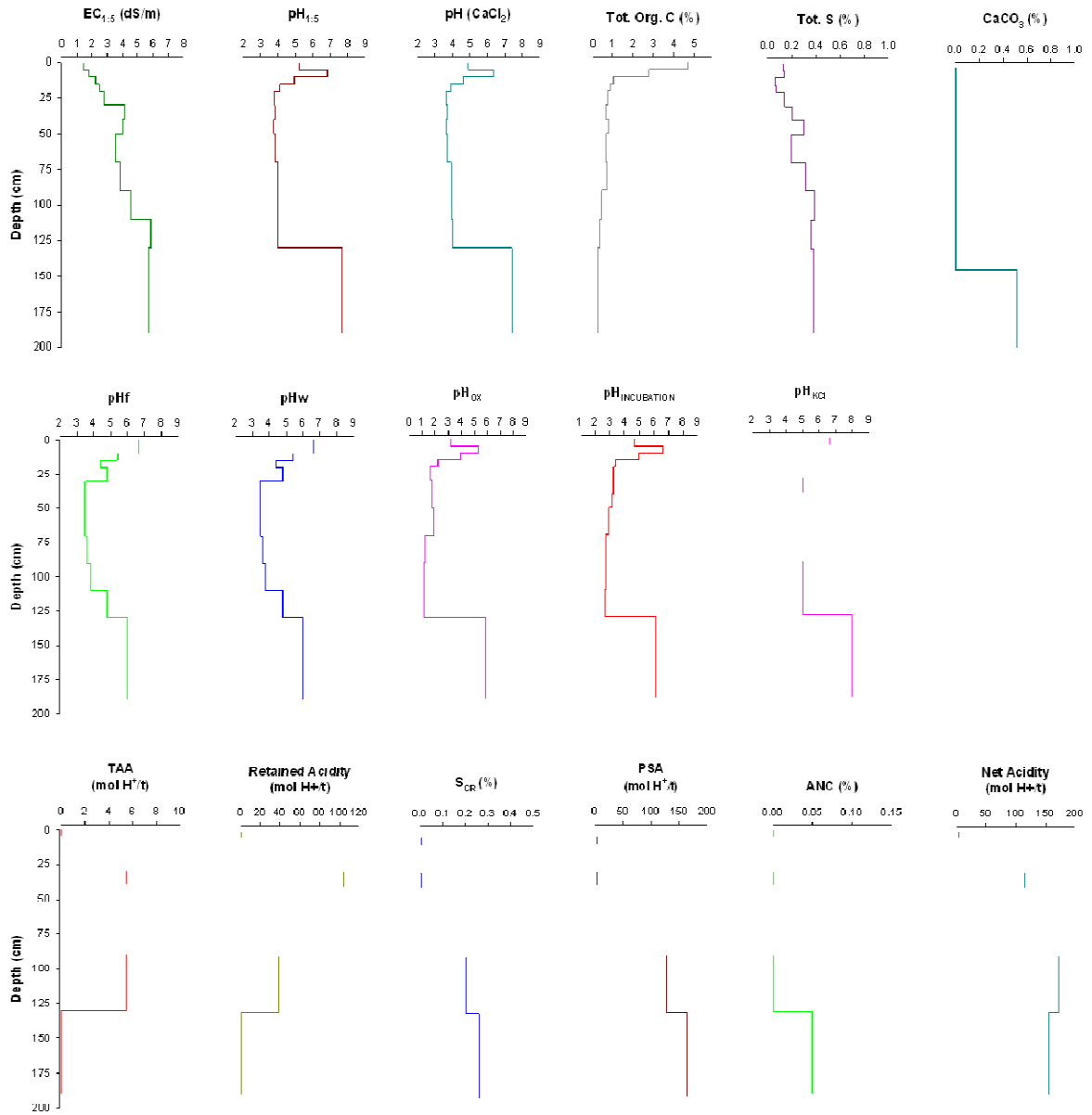


Figure 2-11 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 5.

1.4.3. Gillman Focus area C

Focus area C is situated at the northern end of Gillman and covers the undrained (intertidal) and drained (formerly intertidal) zones on either side of the bund wall (Figure 2-12 and Figure 2-13). The undisturbed area to the north of the bund wall is covered by thick intertidal samphire and mangrove vegetation that is generally flooded each day. The drained part of Focus area C was formerly covered by intertidal samphire and mangrove vegetation.

Focus Area C encompasses **eight soil profiles** located on a 550 m long, north-south trending toposequence. The toposequence C'-C traverses across the bund wall from tidal samphire and mangrove vegetation to drained samphire vegetation and across relatively low lying seasonally and permanently inundated creek channel soils (Figure 2-13).

The tidal zone contains 3 map which includes: units 9 (Water), 10 (Mangrove woodlands) and 11 (Low growing salt marsh plants). These are represented by soil profiles BG 24, BG 21 and BG 20 respectively (Table 2-13).

Four map units occur on the southern (drained) side of the bund wall and include 1 (Water), 2 (Benthic mat and bare salt scalded mud flats), 3 (Bare salt scalded mud flats) and 4 (Dense low heath-samphire shrublands). These map units are represented by soil profiles BG 30, BG 28, BG 32 and BG 22 respectively (refer to Figure 2-12 and Table 2-13).

Table 2-18 provides a summary of soil taxonomy for all 'type' profiles occurring in Gillman Focus area C.

Table 2-13 Soil profiles selected to be representative of map units occurring within focus area C, and along toposequence transect C-C' in Figure 2-12 and Figure 2-13.

Soil profile numbers	Elevation	Map unit no.	Landform	Water State, ponding and drainage
Intertidal to supratidal areas (Gillman study site)				
BG 20	1.6 m AHD	11. Low growing salt marsh plants	Open flat – intertidal to supratidal zone	Wet, poorly to moderately well drained
BG 21	1.2 m AHD	10. Mangrove woodlands	Open flat – intertidal floodplain	Wet, moderately to poorly drained
BG 24	-0.1 m AHD	9. Water	Erosional channel - tidal creek channel	Wet, poorly drained
Disturbed intertidal to supratidal areas (Gillman study site)				
BG 28	0.8 m AHD	2. Benthic mat and bare salt scalded mud flats	Erosional channel stranded tidal creek channel	Wet (winter), poorly drained –seasonally inundated > 2 cm (and following storm event)
BG 22	1.2 m AHD	4. Dense low heath - samphire shrublands	Open flat plain – lower former intertidal floodplain	Moist (winter), moderately well drained
BG 32	0.8 m AHD	3. Bare salt scalded mud flats	Open depression - transition from stranded tidal creek to open, flat plain	Wet (winter), poorly drained – rarely inundated
BG 31	0.5 m AHD	2. Benthic mat and bare salt scalded mud flats	Erosional channel stranded tidal creek channel	Wet (winter), poorly drained –seasonally inundated > 2 cm (and following storm event)
BG 30	-0.3 m AHD	1. Water	Erosional channel – stranded tidal creek channel	Wet, poorly drained – permanently inundated >5 cm, (subaqueous soils)

Table 2-14 Gillman Focus area C soil profiles classified according to Australian Soil Classification (Isbell 2002), Soil Taxonomy (Soil Survey Staff 2010) and using acid sulfate soil terminology (Sullivan *et al.* 2010).

Soil profile no.	Map unit no.	Aust. Soil Classification (Isbell 2002)	Soil Taxonomy (Soil Survey Staff 2010)	Acid Sulfate Soil materials	Significant net acidity occurrence
Intertidal zone - Gillman					
BG 21	11. Low growing salt marsh plants	Hemic, Sulfidic, Intertidal Hydrosol	Sulfic Hydrowassents	Hypersulfidic, Hyposulfidic, monosulfidic (minor)	35 cm @ 221mole H ⁺ /t from 5 cm depth
BG 20	10. Mangrove woodlands	Hemic, Sulfidic, Intertidal Hydrosol	Sulfic Hydrowassents	Hypersulfidic, Hyposulfidic, monosulfidic (minor)	35 cm @ 100 mole H ⁺ /t from 5 cm depth
BG 24	9 Water	Hemic, Epicalcareous, Intertidal Hydrosol	Typic Hydrowassents	Hyposulfidic, monosulfidic	20 cm @ -1175 mole H ⁺ /t from 0 cm depth including an AVS of 0.32%
Former intertidal zone -Gillman					
BG 28	2. Benthic mat and bare salt scalded mud flats	Epicalcareous Hypersalic Hydrosol	Typic Halaquepts	Hyposulfidic, monosulfidic	5 cm @ -72 mole H ⁺ /t from 20 cm depth, including an AVS content of 0.25%
BG 22	4. Dense low heath - samphire shrublands	Haplic Hypersalic Hydrosol	Aeric Halaquepts	Hyposulfidic	40 cm @ 12 mole H ⁺ /t from 0 cm depth
BG 32	3. Bare salt scalded mud flats	Haplic Hypersalic Hydrosol	Aeric Halaquepts	Hyposulfidic	60 cm @ 25 mole H ⁺ /t from 0 cm depth
BG 31	2. Benthic mat and bare salt scalded mud flats	Haplic Hypersalic Hydrosol	Aeric Halaquepts	Hyposulfidic	10 cm @ -92 mole H ⁺ /t from 15 cm depth
BG 30	1. Water	Sodosolic Salic Hydrosol	Typic Hydrowassents	Hyposulfidic, monosulfidic	30 cm @ -2367 mole H ⁺ /t from 0 cm depth, including an AVS content of 1.1%

Detailed morphological descriptions of these eight soil profiles, including photographs of soil samples and plotted soil chemical data, are provided in this Appendix. Refer to Appendix C for tabulated soil chemical data.

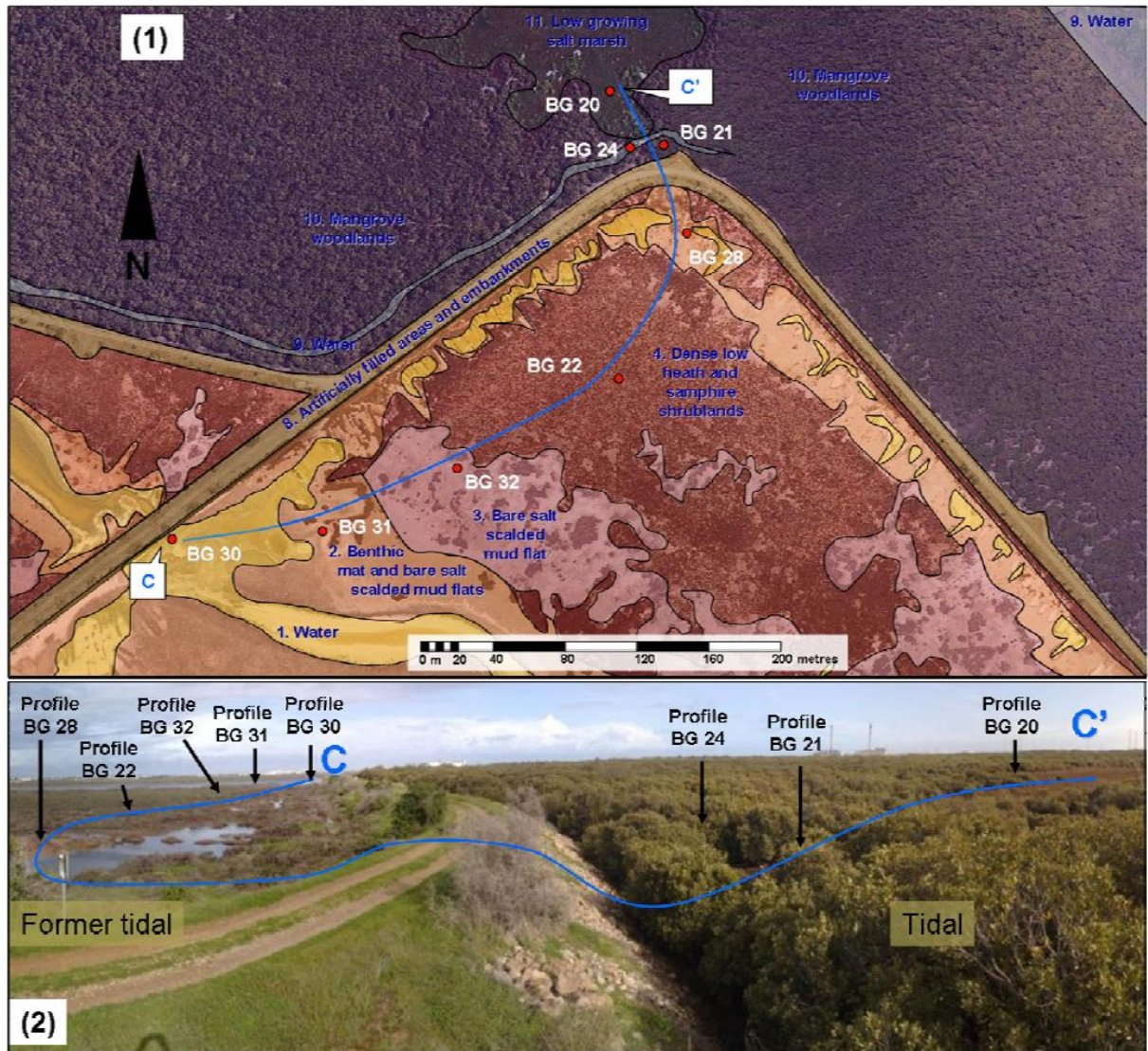


Figure 2-12 Aerial photo of focus area C (1) with a transparent map indicating map units and the position of representative soil profiles along transect C'-C, from an intertidal zone covered by thick samphire and mangrove vegetation to drained former intertidal and tidal areas on the southern side of the bund wall, which was constructed in 1935. Landscape photo (2) shows the position of the soil profiles along toposequence transect C'-C.

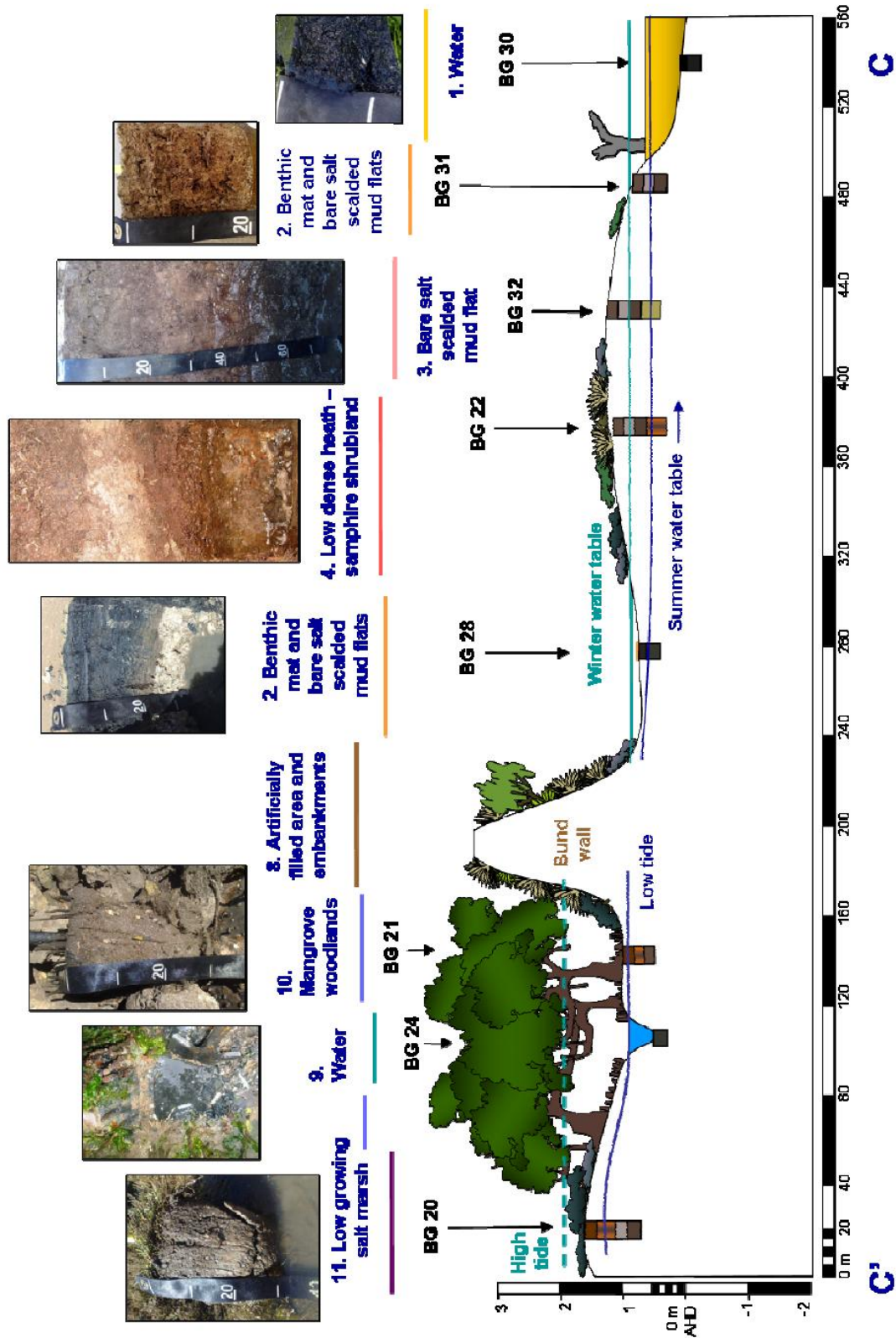





Figure 2-13 Descriptive soil-regolith toposequence model (cross section C-C' see Figure 2-12) indicating map units, position and photographs of representative soil profiles with colour photographs of each profile, average water table depth and groundwater flow direction.

Intertidal areas of Gillman focus area C

Wet: moderately well drained, low growing salt marsh, open flat intertidal floodplain. Profile BG 20 – (Table 2-15 and Figure 2-13)

Table 2-15 Summary of soil morphology for profile BG 20: Wet, moderately well drained peaty soil from a area covered by low growing salt marsh in an open flat intertidal floodplain. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe/W1 (BG 20-317)	0-5	Very dark greyish brown (10YR3/2) peaty clay (10% mineral, 90% organic matter) with abundant (50%) fine, live roots. No mottles; gradual wavy boundary	
Oe/W2 (BG 20-318)	5-15	Dark greyish brown (10YR4/2) organic rich clay (20% mineral, 80% organic matter) with abundant (40%) fine live roots. Minor yellowish red (5YR5/8) mottles (2-5% volume) along root channels; gradual wavy boundary	
Oeg/W3 (BG 20-319)	15-40	Dark greyish brown (10YR4/2) clay with abundant (20%) fine, live roots. Some yellowish red (5YR5/8) mottles (5% volume) along root channels and minor black (2.5Y2.5/1) mottles (2-5% volume) impregnating matrix.	

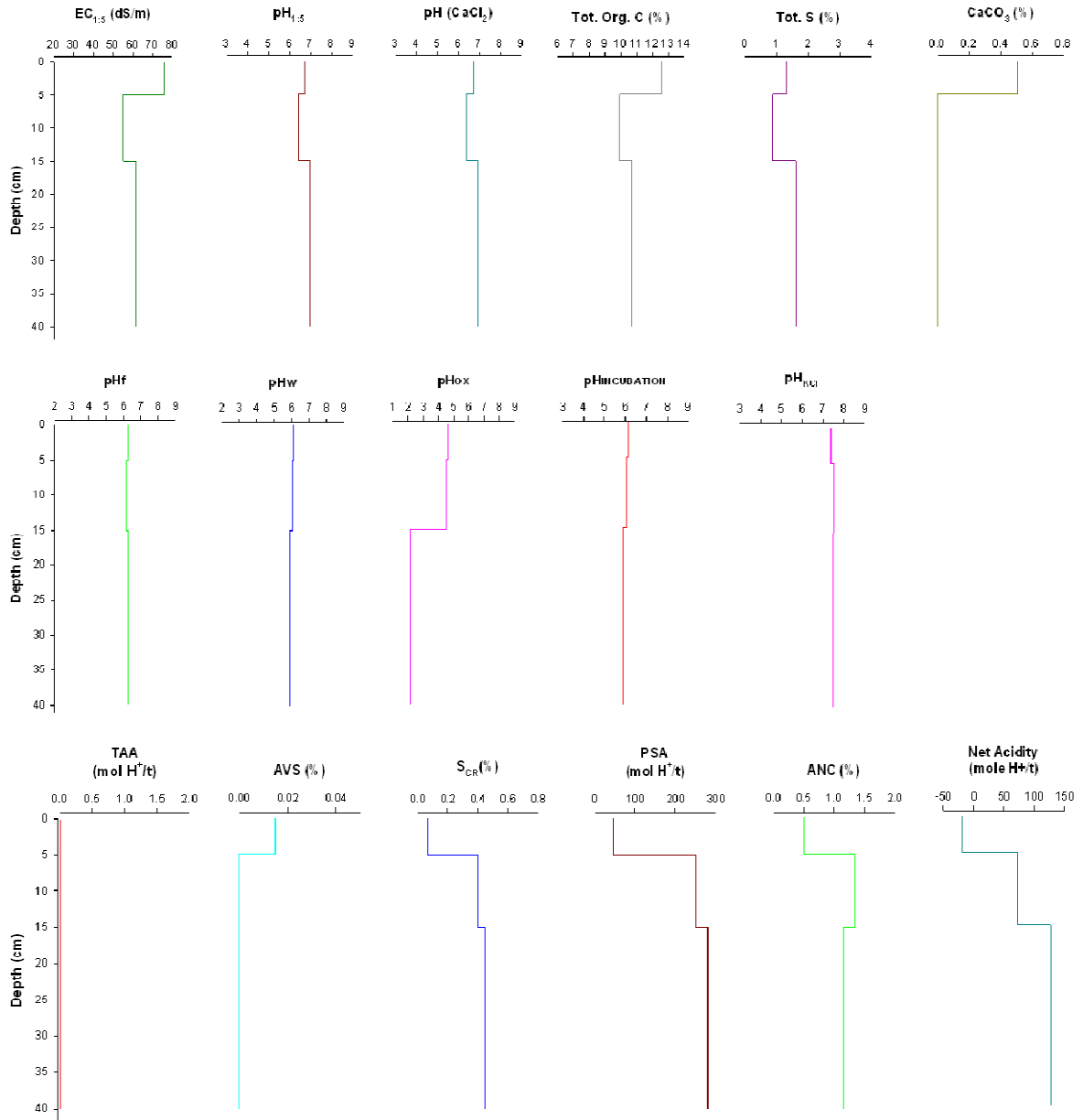





Figure 2-14 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 20

Wet: moderately to poorly drained, mangrove woodland – open flat intertidal floodplain

Profile BG 21 – (Table 2-16 and Figure 2-15)

Table 2-16 Summary of soil morphology for profile BG 21: Moist (winter), poorly drained soil in mangrove woodland. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe/W1 (BG 21-320)	0-5	Very dark greyish brown (10YR3/2) peat (5% mineral, 95% organic matter) with abundant (50%) fine and coarse, live roots. No mottles; gradual wavy boundary	
Oe/W2 (BG 21-321)	5-15	Dark greyish brown (10YR4/2) organic rich clay (15% mineral, 85% organic matter) with abundant (40%) fine and coarse live roots. Minor yellowish red (5YR5/8) mottles (2-5% volume) along root channels; gradual wavy boundary	
Oe/W3 (BG 21-322)	15-40	Dark greyish brown (10YR4/2) clayey peat (20% mineral, 80% organic matter) with abundant (30%) fine, and some coarse live and dead roots. Some yellowish red (5YR5/8) mottles (5% volume) along root channels.	

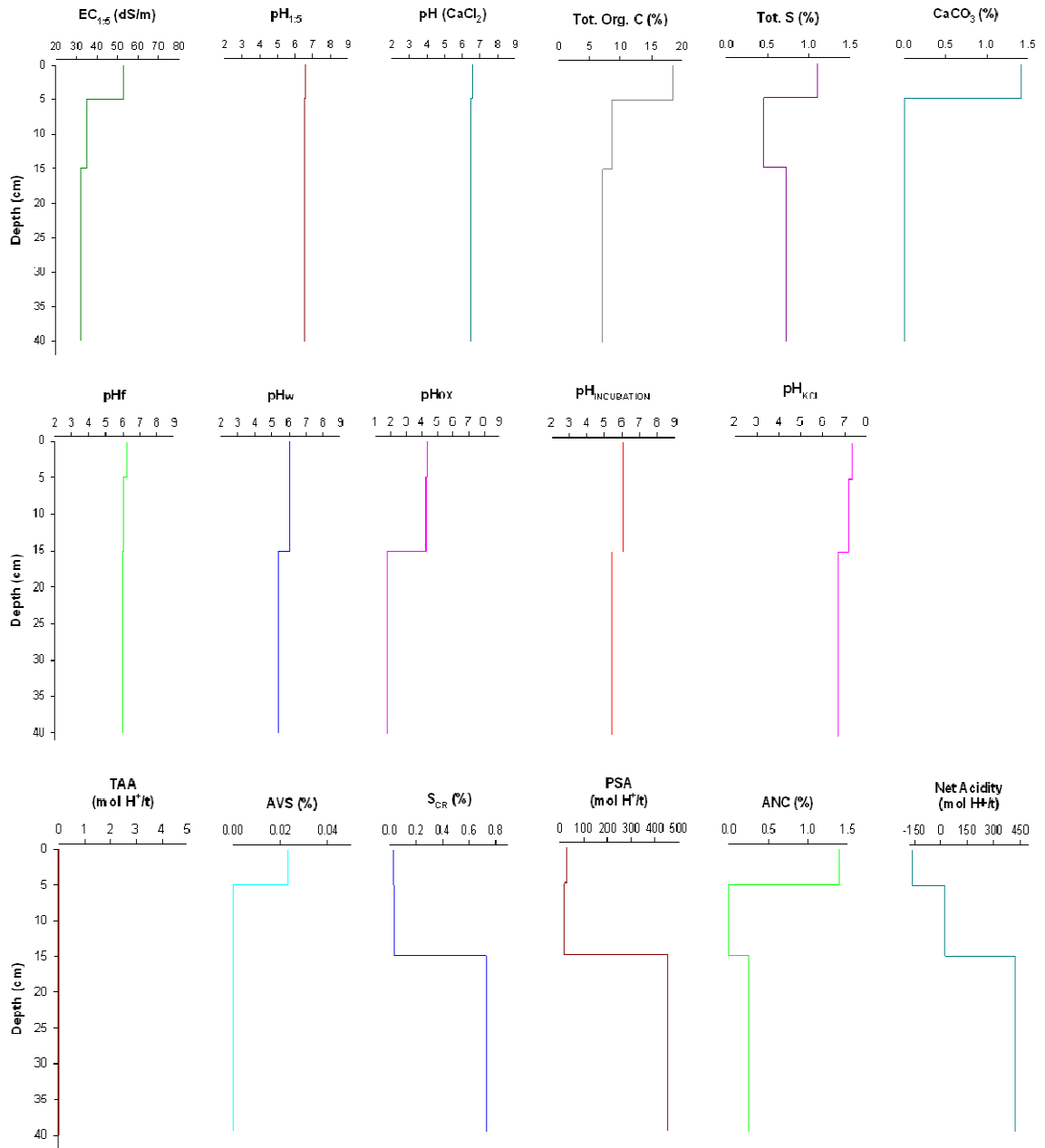




Figure 2-15 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 21

Wet (subaqueous): poorly drained, permanently inundated erosional tidal channel
 – **water Profile BG 24** – (Table 2-17 and Figure 2-16)

Table 2-17 Summary of soil morphology for profile BG 24: *Wet, (subaqueous) soil in tidal creek depression.* (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oi/W1 (BG 24-331)	0-5	Very thin (1-2 mm), pale yellow (2.5Y7/3) medium to coarse sand at the surface with some sapric (<i>Ulva</i> sp.) organic matter. Dark brownish grey (10YR3/2) medium to coarse sand; friable single grain structure; with some very coarse live roots (mangrove pneumatophores); diffuse boundary	
Ag/W1 (BG 24-332)	5-20	Dark greyish brown (10YR4/2) clayey sand with some coarse live roots. Black (2.5Y2.5/1) mottles (10% volume) impregnate sandy matrix and are associated with organic matter along root channels. Angular blocky structure; weak consistency with fine and coarse shell fragments	

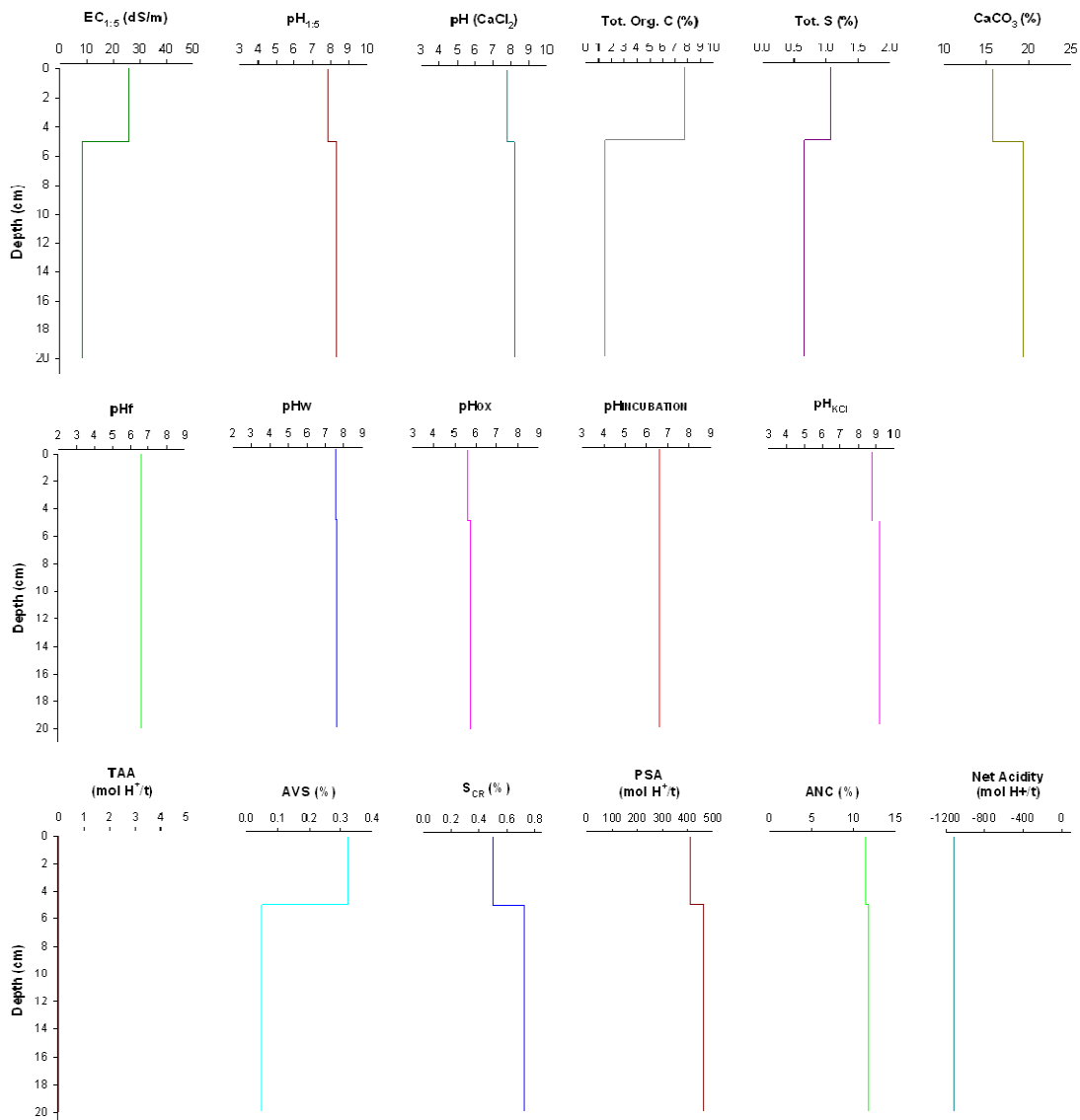






Figure 2-16 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 24.

Non-tidal areas, Gillman Focus area C

Map unit 2 - Wet (winter): poorly drained, seasonally inundated erosional channel – with a surface cover of benthic mat and bare salt scalded mud flats. Profile BG 28 - (Table 2-18 and Figure 2-17). The parent material consists of several layers of tidal sediments deposited under mangrove and samphire vegetation.

Table 2-18 Summary of soil morphology for profile BG 28: Moist (winter), poorly drained saline groundwater discharge pond. Soil colour was determined on moist samples and consistence was determined on dry samples. Photos are of **moist** samples.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Az1 (BG 28-328.1)	0-1	Very thin (1-2 mm), pale yellow (2.5Y7/3) fine sand surface at the surface with some fibrous organic matter (filamentous algae). Small halite and gypsum crystals evident just below the surface.	
Ag2 (BG 28-328.2)	1-20	Black (N 2.5/), medium sandy clay with minor grey (2.5Y5/1) mottles (2-5% volume); friable structure; weak consistency without coarse fragments; no roots	
Ag3 (BG 28-328.3)	20-25	Dark greyish brown (10YR4/2) highly organic loam (50% mineral, 50% hemic organic matter) with no live roots. No mottles; some medium grain sized broken shell fragments; gradual wavy boundary	
2Bg/W1	25-40	Olive grey (5Y4/2) clayey medium sand; slight H ₂ S smell; many medium to coarse broken shell fragments.	

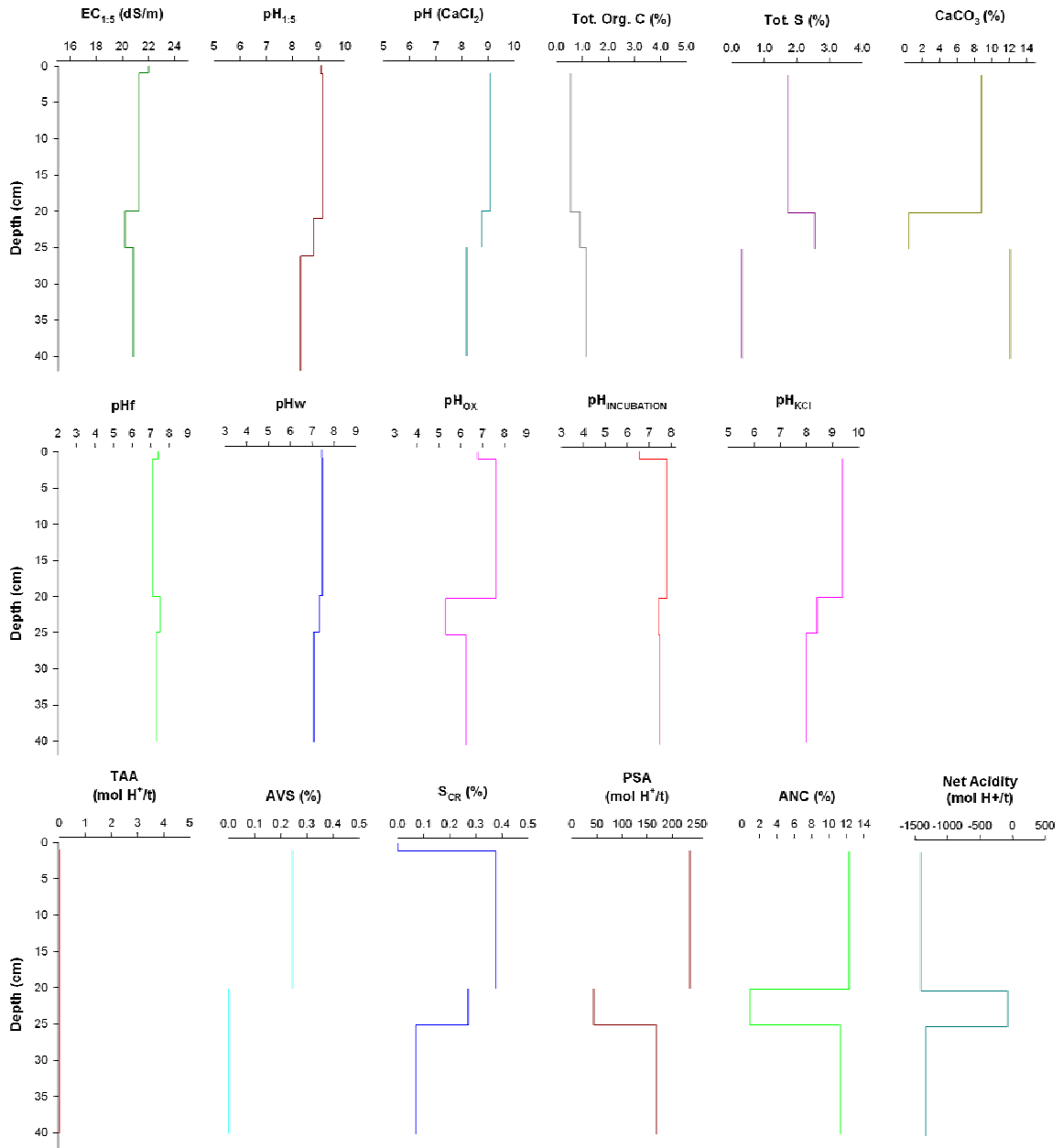







Figure 2-17 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 28.

Map unit 4 - Moist (winter): moderately well drained, open flat plain in the lower former intertidal floodplain with a surface cover of dense low heath and samphire shrublands. Profile BG 22 - (Table 2-19 and Figure 2-18).

Table 2-19 Summary of soil morphology for profile BG 22: Moist (winter), moderately well drained peaty soil. Soil colour was determined on moist samples and consistence was determined on dry samples. Photos are of dry samples.

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe1 (BG 22-323)	0-5	Dark greyish brown (10YR4/2) organic rich loam (25% mineral, 75% organic matter) with abundant (20%) fine live and dead roots. No mottles; friable structure; weak consistency without coarse fragments; gradual wavy boundary	
Oe2 (BG 22-324)	5-15	Dark greyish brown (10YR4/2) organic rich clay-loam (45% mineral, 55% organic matter) with abundant (20%) fine and coarse live and dead roots. Minor strong brown (7.5Y4/6) mottles (5% volume) along root channels and ped surfaces; subrounded blocky structure; weak consistency without coarse fragments; gradual wavy boundary	
Oe3 (BG 22-325)	15-25	Dark greyish brown (10YR4/2) organic rich clay-loam (50% mineral, 50% organic matter) with abundant (20%) fine dead roots. Minor strong brown (7.5Y4/6) mottles (5% volume) along root channels and ped surfaces; subangular blocky structure; weak consistency without coarse fragments; sharp wavy boundary	
2Bw (BG 22-326)	25-40	Greyish brown (10YR5/2) medium loamy sand with minor yellowish red (5YR5/8) mottles (5% volume) impregnating matrix of peds and on fine root channels. Subrounded blocky structure; weak consistency without coarse fragments; non calcareous; very few roots; gradual diffuse boundary	
3Bg/W1 (BG 22-327)	40-65	Olive grey (5Y4/2) medium sandy clay with minor yellowish red (5YR5/8) mottles (2-5% volume) impregnating matrix of peds and on shell surfaces. Subangular blocky structure; weak consistency with medium to coarse shell fragments; calcareous; no roots.	

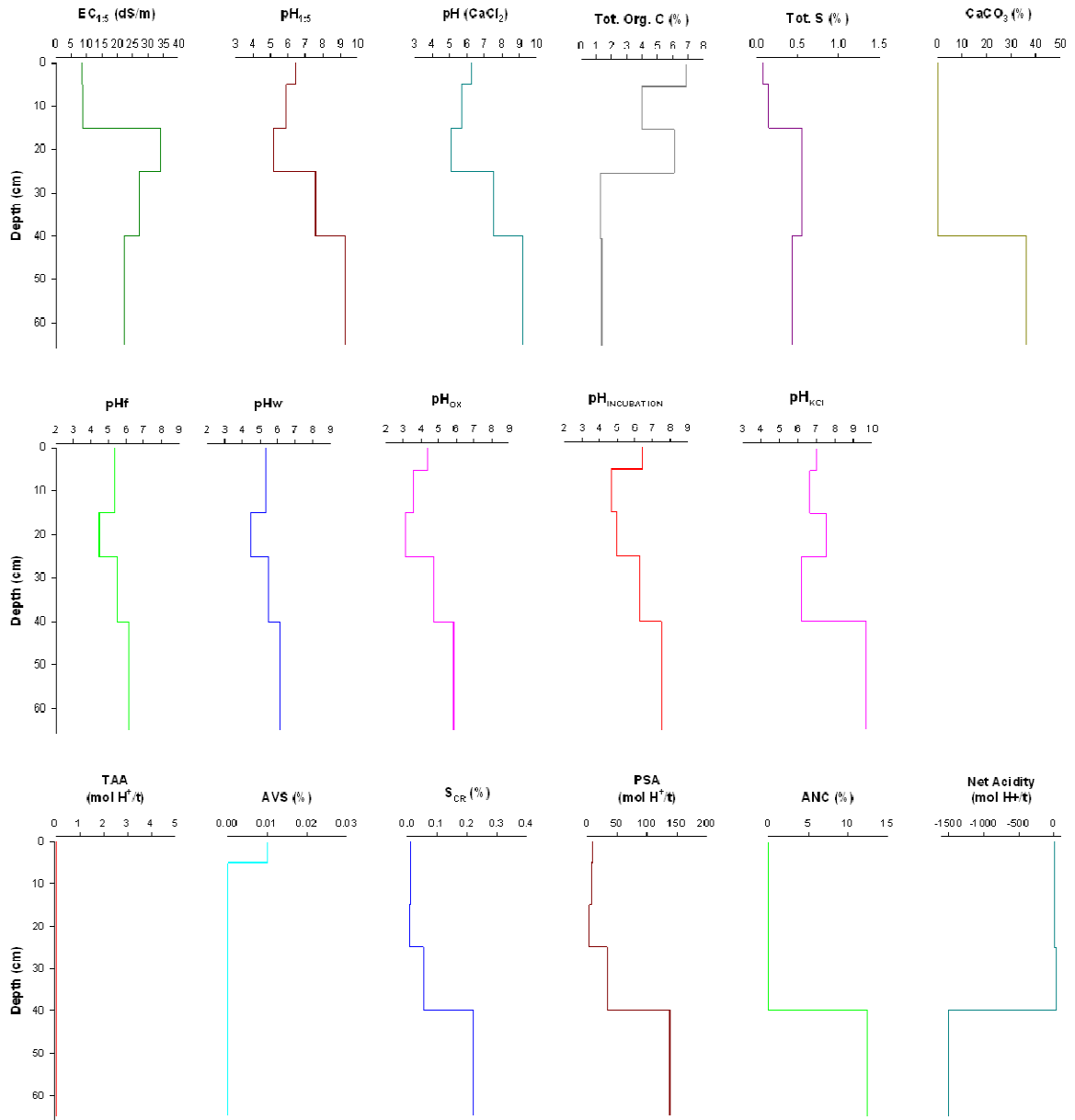



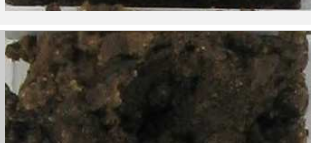




Figure 2-18 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 22.

Wet (winter): poorly drained (rarely inundated), open depression in the former intertidal floodplain with a surface cover of bare salt scalded mud flats

Profile BG 32 – (Table 2-20 and Figure 2-19).

Table 2-20 Summary of soil morphology for profile BG 32: Wet (winter), poorly drained former intertidal soil-sediment from an open depression with a surface expression of bare salt scalded mud flats. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe1 (BG 32-420)	0-1	Dark greyish brown (10YR4/2) fine sandy clay; no mottles; laminated friable structure; weak consistency without coarse fragments; sharp boundary	
Oe2 (BG 32-415)	0-15	Dark greyish brown (10YR4/2) organic silty loam (15% mineral, 85% organic matter) with few (5%) fine live and dead roots. No mottles; friable structure; weak consistency without coarse fragments; gradual wavy boundary	
Oe3/W1 (BG 32-416)	15-25	Dark greyish brown (10YR4/2) organic clayey loam (10% mineral, 90% organic matter) with minor (5%) fine and coarse dead roots. Minor strong brown (7.5Y4/6) mottles (5% volume) along root channels; subrounded blocky structure; weak consistency without coarse fragments; gradual wavy boundary	
Oe4/W2 (BG 32-417)	25-40	Dark greyish brown (10YR4/2) organic sandy loam (20% mineral, 80% organic matter) with few (5%) roots. Some strong brown (7.5Y4/6) mottles (5-10% volume) along root channels and ped surfaces; subangular blocky structure; weak consistency without coarse fragments; diffuse, gradual boundary	
2Bg/W1 (BG 32-418)	40-60	Greyish brown (10YR5/2) medium loamy sand with minor yellowish red (5YR5/8) mottles (2% volume) impregnating matrix of peds and on fine root channels. Single grain structure; weak consistency with minor coarse shell fragments; calcareous; no roots; clear boundary	
3Bg/W1 (BG 32-419)	60-80	Olive grey (5Y4/2) medium sandy clay with medium to coarse shell fragments (calcareous). No mottles; subangular blocky structure; weak consistency; with no roots.	

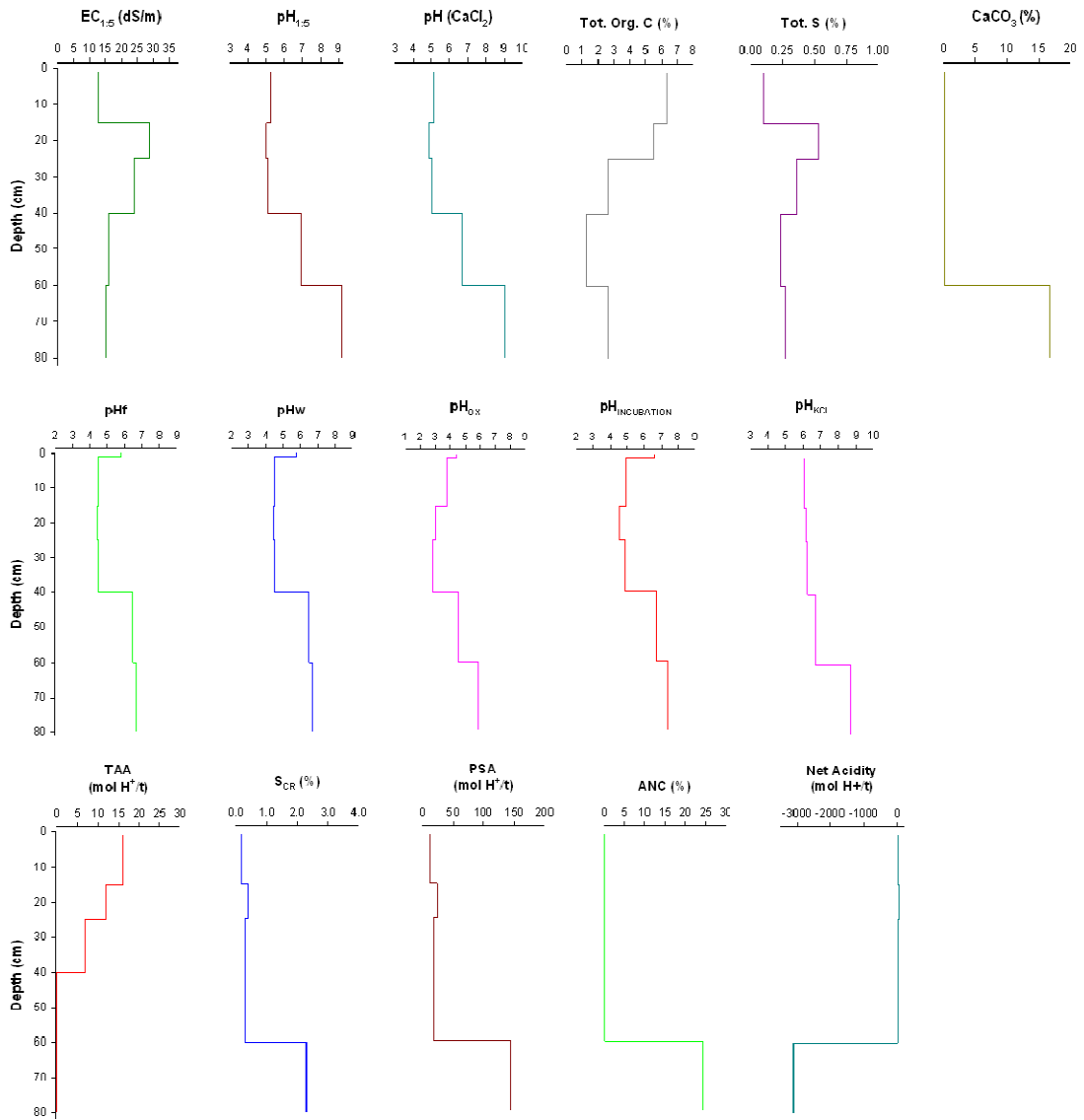





Figure 2-19 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 32

Wet (winter), poorly drained (seasonally inundated) erosional channel soil-sediment covered by a benthic mat and bare salt scalded mud flats.

Profile BG 31 – (Table 2-21 and Figure 2-20)

Table 2-21 Summary of soil morphology for profile BG 31: Wet (winter), poorly drained (seasonally inundated) erosional channel soil-sediment covered by benthic mat and bare salt scalded mud flat. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe1 (BG 31-412)	0-5	Very thin (1-2 mm), pale yellow (2.5Y7/3) fine sand at surface with some fibrous organic matter (filamentous algae). Below surface layer is a very dark brown (10YR 3/2) medium organic rich clay with minor strong brown (7.5Y4/6) mottles (2-5% volume) along former root channels. Subangular blocky structure; weak consistency without coarse fragments; no roots; diffuse boundary	
Oe2 (BG 31-413)	5-15	Dark greyish brown (10YR4/2) organic clay (15% mineral, 85% organic matter). Minor strong brown (7.5Y4/6) mottles (5% volume) along former root channels; friable structure; very weak consistency without coarse fragments; gradual wavy boundary	
Oe3/W1 (BG 31-414)	15-25	Dark greyish brown (10YR4/2) clayey peat (20% mineral, 80% organic matter). Few strong brown (7.5Y4/6) mottles (2% volume) along former root channels; friable structure; very weak consistency without coarse fragments.	

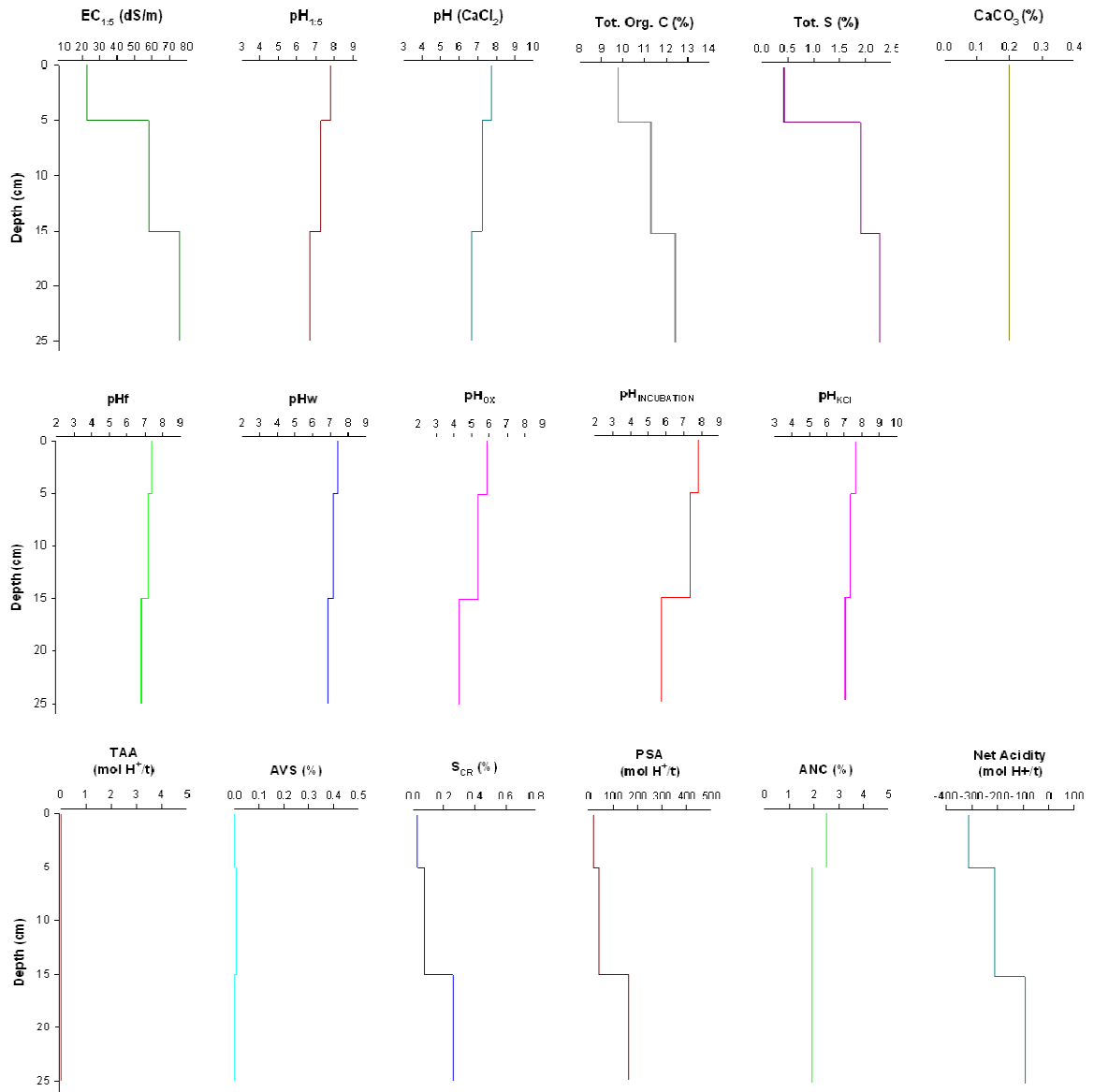




Figure 2-20 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 31

Wet: poorly drained (permanently inundated – subaqueous soil) from a former tidal creek erosion gully. Profile BG 30 – (Table 2-22 and Figure 2-21)

Table 2-22 Summary of soil morphology for profile BG 30: Wet (subaqueous), poorly drained soil in stranded former tidal creek. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oa1/W1 (BG 30-410)	0-5	Black (N2.5/1) without mottles; massive structure; weak gel-like consistency without coarse fragments; some live filamentous algae; diffuse boundary	
Oa2/W2 (BG 30-411)	5-30	Black (N2.5/1) without mottles; massive structure; weak, spongy gel-like consistency; minor medium to coarse shell fragments; calcareous; no roots.	

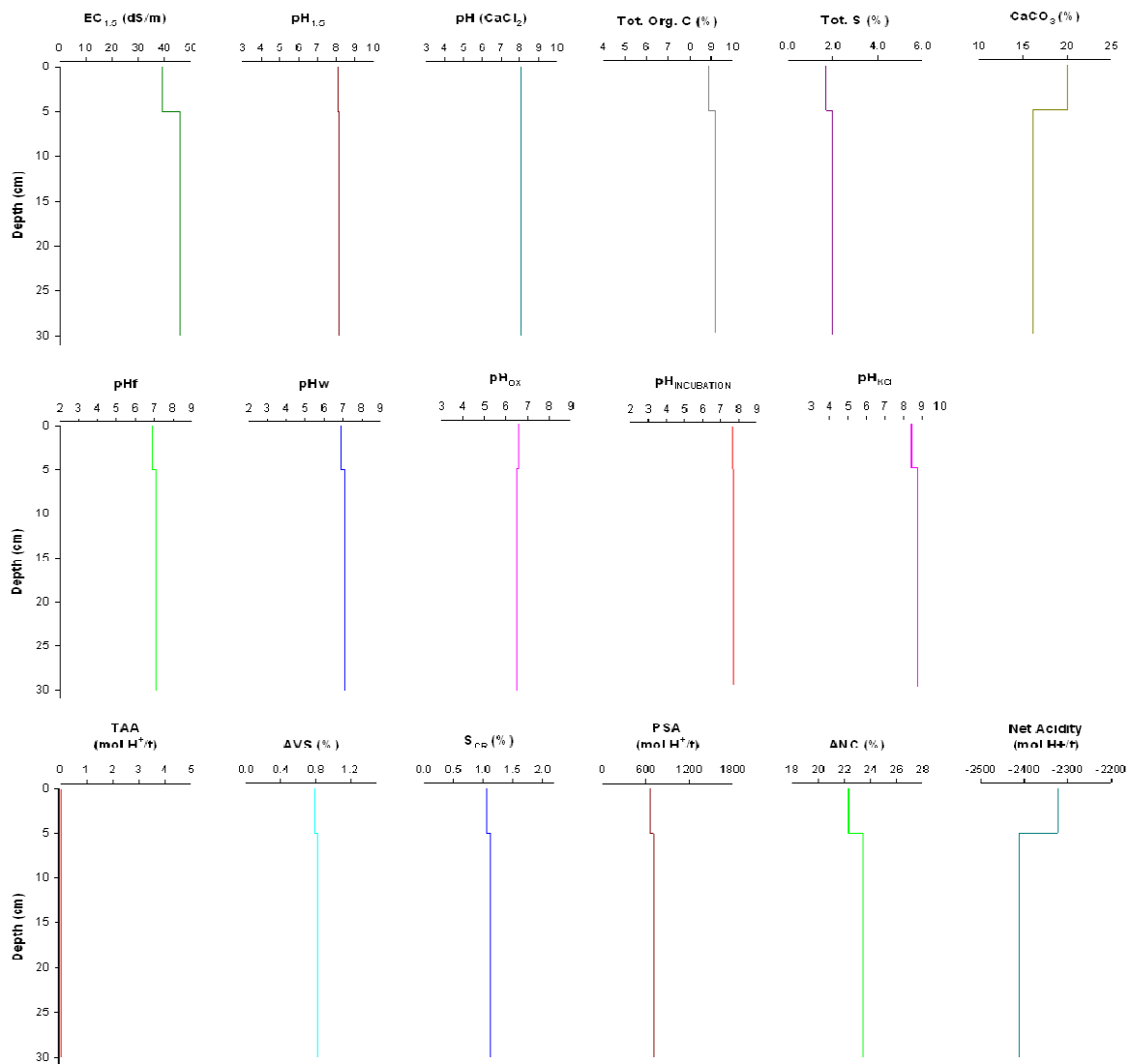


Figure 2-21 Down profile soil chemistry and acid sulfate soil characteristics of profile BG 30

1.4.4. Gillman Focus area D

Focus area D is situated on the eastern side of The Grand Trunkway (roadway) and on the southern side of the bund wall that runs parallel to North Arm of Barker Inlet (Figure 2-1). This section of the bund wall was constructed in 1965 and drained intertidal to supratidal soils covered with mangrove and samphire vegetation (Belperio and Rice 1989). Focus area D encompasses a toposequence that traverses from a high earthen mound (profile GGT 2) to low lying (0.5 m AHD) grasses and samphire vegetation covering organic rich loam (profile GGT 5) of the St Kilda Formation (Figure 2-22). Profile GGT 2 had an elevation of 4.4 m AHD and was covered by salt tolerant grasses (map unit 8). The natural soil level at profile GGT 5 was covered by dense low heaths and grasses (map unit 4) (Table 2-23). The earth mound was built in 1993 as part of the Multi-Function Polis (MFP) Development Feasibility Study to assess the geotechnical response of the St Kilda Formation to loading, mounding and pond stability (Coffey Partners International Pty Ltd 1990). The mound was constructed from layering imported fill material consisting of locally excavated St Kilda Formation soils and Port River dredgings (Thomas and Fitzpatrick 2006b). The mound has three levels; 1 m, 2.4 m and 4.4 m above natural ground surface (Figure 2-23). Full descriptions are provided for soil profile GGT 2 in this section as soil characteristics for map unit 8 have not been described previously. Soil profile GGT 5 is summarised in Table 2-24. Detailed morphological descriptions of profile GGT 5, including photographs of soil samples and plotted soil chemical data is provided in Table 2-25.

Table 2-23 Soil profiles selected to be representative of map units occurring within focus area D, and along toposequence transect D-D' in Figure 2-22 and Figure 2-23.

Soil profile numbers	Elevation	Map unit no.	Landform	Water State, ponding and drainage
Disturbed intertidal to supratidal areas (Gillman study site)				
GGT 2	4.4 m AHD	8. Artificially filled areas and embankments	Embankments and raised (filled) former intertidal to supratidal zone	Dry to moist (winter), moderately to poorly drained
GGT 5	0.5 m AHD	4. Dense low heath - samphire shrublands	Open flat plain – lower former intertidal floodplain	Moist (winter), moderately well drained

Soil profile GGT 5 has similar morphology and characteristics to other soil profiles located within map unit 4, such as profile BG 22, BG 32 (described for Gillman Focus area C) and BG 29 (refer to Appendix C).

Table 2-24 Gillman Focus area D soil profiles are classified according to Australian Soil Classification (Isbell 2002), Soil Taxonomy (Soil Survey Staff 2010) and using acid sulfate soil terminology (Sullivan *et al.* 2010).

Soil profile no.	Map unit no.	Aust. Soil Classification (Isbell 2002)	Soil Taxonomy (Soil Survey Staff 2010)	Acid Sulfate Soil materials	Significant net acidity occurrence
GGT 2	8. Artificially filled areas and embankments	Sulfidic, Dredgic Anthroposol	Haplic Xerarents	Hypersulfidic, Hyposulfidic, monosulfidic	20 cm @ 631 mole H ⁺ /t from 500 cm depth
GGT 5	4. Dense low heath - samphire shrublands	Sulfuric, Salic Hydrosol	Typic Sulfaquepts	Sulfuric, hyposulfidic	70 cm @ 272 mole H ⁺ /t from 0 cm depth

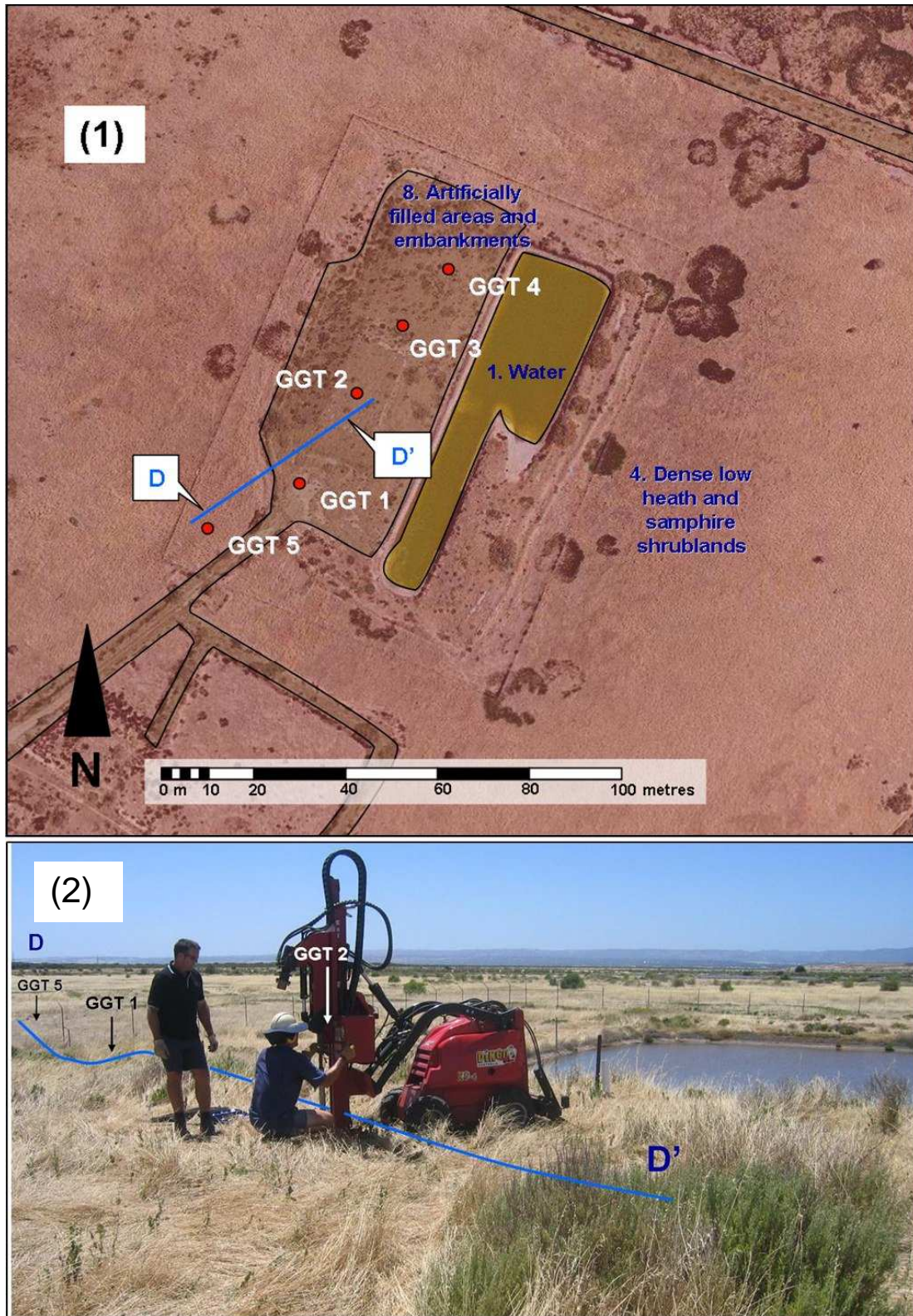


Figure 2-22 Transect D-D' indicating extent of map units and position of soil profiles. Soil profiles GGT 1, 2, 3 and 4 are located within map unit 8 and on the MFP test mound, having elevations of 1.5, 4.4, 2.4 and 2.3 m AHD respectively. Soil profile GGT 5 is located within map unit 4, on natural, formerly intertidal mangrove peat (0.5 m AHD).

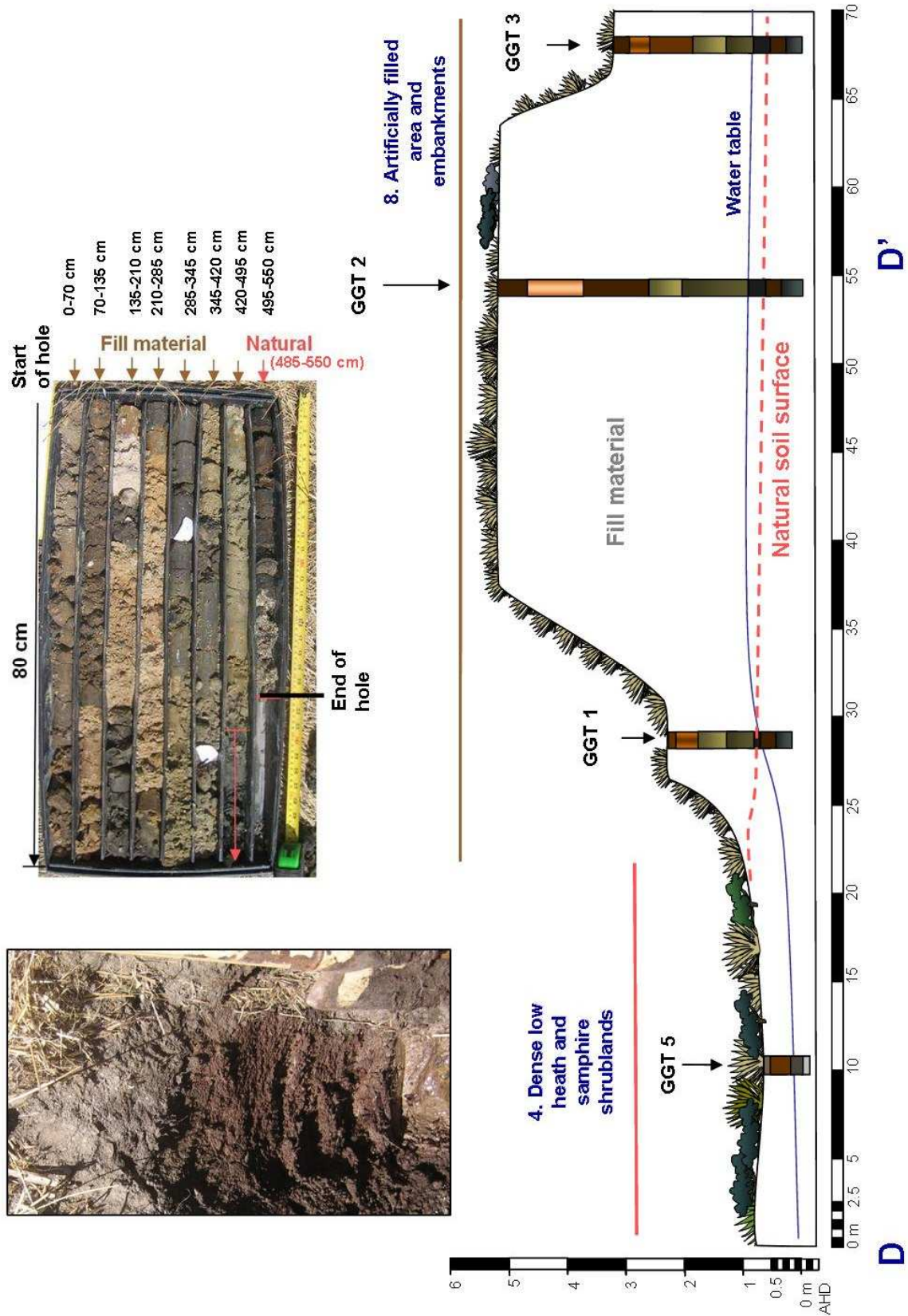














Figure 2-23 Descriptive soil-regolith toposequence model (cross section D-D' shown in Table 2-23) indicating map units, position and colour photographs of representative soil profiles or cores and average water table depth.

Map unit 8 - Dry to Moist (winter): moderately well to poorly drained, embankment and artificially raised (filled) former intertidal and supratidal floodplain. Profile

GGT 2 – (Table 2-25 and Figure 2-24)

Table 2-25 Summary of soil morphology for profile GGT 2: Dry, moderately well drained, artificially filled former intertidal floodplain. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Ap GGT 2-1 371	0-5	Pale brown (10YR6/3) sandy clay loam without mottles; moderately coarse subangular blocky structure; firm consistency with coarse shell fragments; abundant fine roots; gradual boundary	
2Ap1 GGT 2-2 372	5-130	Very pale brown (10YR7/3) sandy clay loam without mottles; moderately coarse subangular blocky structure; firm consistency with some coarse shell fragments; many fine roots; gradual boundary	
2Ap2 GGT 2-3 373	140- 160	Yellow (10YR7/6) loam without mottles; moderately coarse subangular blocky structure; weak consistency without coarse fragments; few medium shall fragments; very few roots; gradual boundary	
2Ap3 GGT 2-4 374	175- 205	Yellow (10YR7/6) loam with some reddish yellow (7.5YR6/8) mottles (5% volume); medium subangular blocky structure; weak consistency without coarse fragments; few medium shall fragments; no roots; clear boundary	
2Ap4 GGT 2-5 375	205- 235	Dark brown (10YR3/3) organic sandy clay without mottles; rounded structure; very weak consistency with few coarse shell fragments; no roots; clear boundary	
2Ap5 GGT 2-6 376	295- 410	Pale brown (10YR6/3) sandy clay loam without mottles; medium subangular blocky structure; weak consistency with some coarse shell fragments; no roots; gradual boundary	
2Ap6	410- 490	Very pale brown (10YR8/4) sandy clay loam without mottles; moderately coarse subangular blocky structure; weak consistency with some coarse calcrete fragments; few medium shall fragments; no roots; diffuse boundary	
2Ap7/W1 GGT 2-8 378	490- 495	Very pale brown (10YR8/4) sandy clay loam with few very dark grey (10YR3/1) mottles (5% volume); moderately coarse subangular blocky structure; weak consistency with some coarse calcrete fragments; few medium shall fragments; no roots; diffuse boundary	
3Abg/W1 GGT 2-9 379	495- 500	Top of Natural St Kilda Formation. Dark brown (10YR3/3) organic loam Bbith few very dark grey (10YR3/1) mottles (10% volume); subrounded blocky structure; very weak consistency with no coarse fragments; non-calcareous; no roots; H ₂ S odour; clear boundary.	

4Bbg/W1 GGT 2- 10 380	500- 515	Brown (10YR4/3) organic sandy loam with few very dark grey (10YR3/1) mottles (5% volume); subrounded single grain structure; very weak consistency with no coarse fragments; non-calcareous; no roots; clear boundary	
5Bbg/W1 GGT 2-11 381	515- 530	Greyish brown (10YR5/2) sand with no mottles; single grain structure; very weak consistency some medium to coarse organic fragments; few medium shell fragments; no roots; clear boundary	
6Bb/W1 GGT 2-12 382	530- 550	White (10YR8/1) very coarse shell grit with few reddish yellow (7.5YR7/8) mottles (5% volume) as staining on shell surfaces; single grain structure; very weak; no roots	

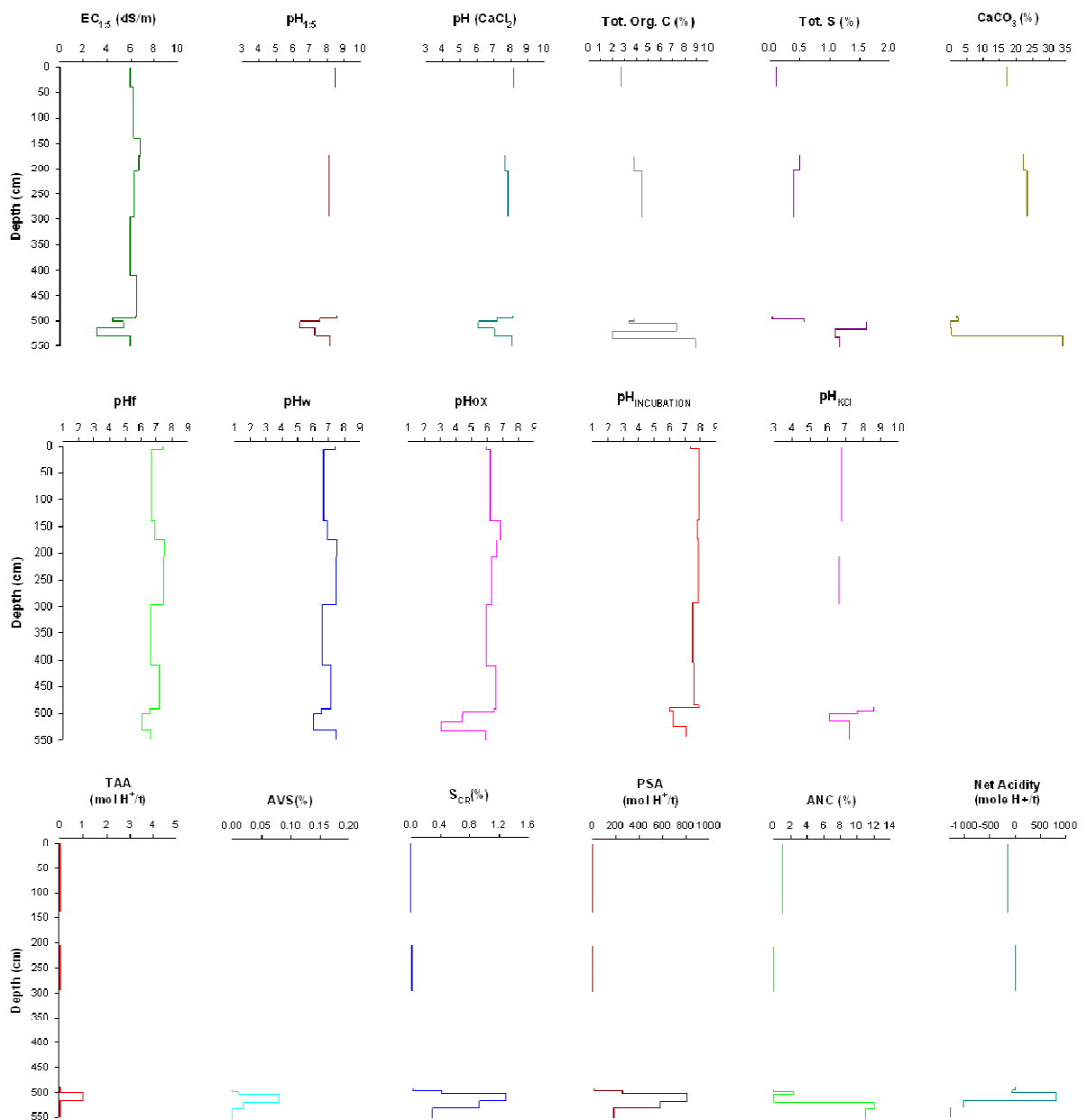







Figure 2-24 Down profile soil chemistry and acid sulfate soil characteristics of profile GGT 2.

Moist (winter): moderately well drained, open flat plain in the lower former intertidal floodplain with a surface cover of dense low heath and samphire shrublands. Profile GGT 5 – (Table 2-26 and Figure 2-25).

Table 2-26 Summary of soil morphology for profile GGT 5: Dry moderately well drained organic rich soil in former intertidal, mangrove woodland. (Soil colour determined moist and consistence dry).

Horizon (ID)	Depth (cm)	Soil morphology	Sample (5 x 2.5 cm)
Oe1 GGT 5-1 399	0-2	Light grey (10YR7/2) peaty loam (5% mineral, 95% fibric material) no mottles; subangular blocky structure; very weak consistency with no coarse fragments; non-calcareous; abundant fine roots; diffuse boundary	
Oe2 GGT 5-2 400	2-10	Dark brown (10YR3/3) organic rich loam (5% mineral, 95% histic material) with no mottles; subangular blocky structure; very weak consistency with no coarse fragments; non-calcareous; no roots; clear boundary	
A GGT 5-3 401	10-45	Brown (10YR4/3) organic rich sandy loam (40% mineral, 60% histic organic material) with no mottles; subrounded single grain structure; very weak consistency with no coarse fragments; non-calcareous; no roots; clear boundary	
2Bg1 GGT 5-4 402	45-70	Greyish brown (10YR5/2) sand with no mottles; single grain structure; very weak consistency some medium to coarse organic fragments; few medium shell fragments; no roots; clear boundary	
3B/W1 GGT 5-5 403	70-80	White (10YR8/1) very coarse shell grit with few reddish yellow (7.5YR7/8) mottles (5% volume) as staining on shell surfaces; single grain structure; very weak; no roots	

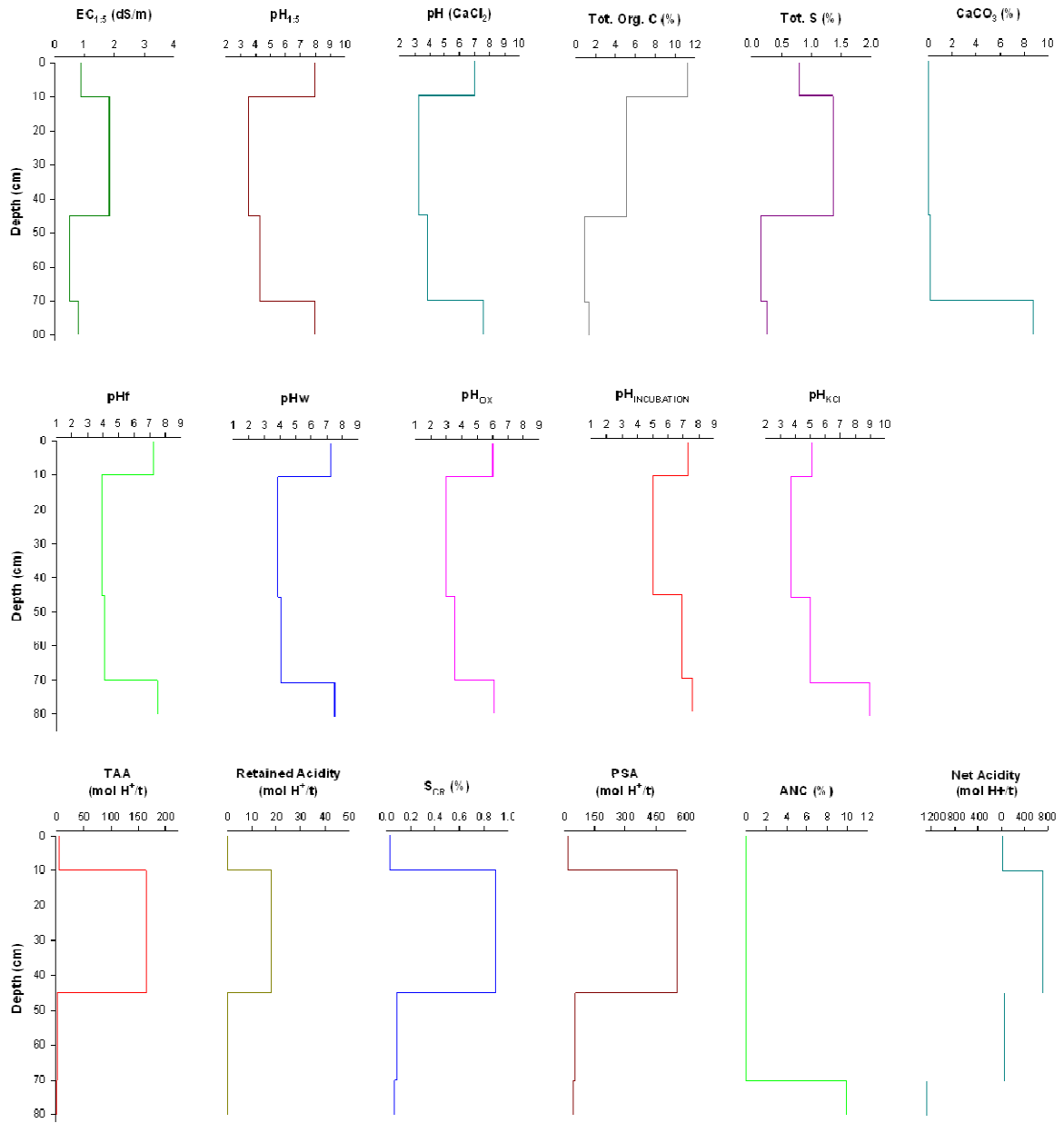


Figure 2-25 Down profile soil chemistry and acid sulfate soil characteristics of profile GGT 5

1.4.5. Summary – Soil taxonomy for soil profiles at St Kilda and Gillman study areas

Soil types and materials within intertidal areas

At the St Kilda site hyposulfidic materials were the dominant acid sulfate soil material due to the dominant geomorphic feature being a chenier ridgeline that contributed carbonate material to the surrounding organic rich soils. Soil proximal to the chenier classified as Epicalcareous, Intertidal Hydrosols (Isbell 2002) and Typic Endoaquents (Soil Survey Staff 2010). Soils formed under mangrove and samphire vegetation were rich in organic matter, which altered in content, type (e.g. fibric, sapric) state of decomposition and thickness depending on vegetative cover type and position in the landscape. Hypersulfidic material generally occurred as subsoil layers interbedded with hyposulfidic material in the older and thicker soils where mature mangrove tree dominated. Profiles in these areas contained mostly sapric material and classified as Sapric, Histic-Sulfidic, Intertidal Hydrosols (Isbell 2002) and Sulfic and Sapric Haplowassists (Soil Survey Staff 2010). Hypersulfidic material was more laterally extensive in areas covered by younger mangrove trees and samphire vegetation. In these areas soils classified as Hemic, Histic-Sulfidic, Intertidal Hydrosols (Isbell 2002) and Typic Sulfiwassists (Soil Survey Staff 2010) due to the presence of coarser organic material and thinner organic horizons. The occurrence of monosulfidic material was identified in subaqueous soils which classified as Sapric, Histic, Intertidal Hydrosols (Isbell 2002) and Sapric Haplowassists (Soil Survey Staff 2010) under dense mangrove vegetation, and as Sapric, Epicalcareous, Intertidal Hydrosols (Isbell 2002) and Typic Hydrowassents (Soil Survey Staff 2010) in areas where the chenier was intersected at shallow depth. The content of monosulfidic materials was greatest where tidal flushing was limited, allowing stagnant, eutrophic conditions to form.

Soil types and materials in disturbed areas

At Gillman the spatial distribution of acid sulfate soil materials was also controlled by the major geomorphic landform, however in this area the landform contained minimal acid buffering capacity. Land reclamation was therefore the major cause of sulfuric material formation within the Gillman study site. Soils in upland areas contain thick sulfuric horizons and classify as Sulfuric, Salic Hydrosols (Isbell 2002) and Typic

Sulfaquepts (Soil Survey Staff 2010). Lowland areas at Gillman act as an evaporation basin and soils have concentrated salts and pyrite oxidation products. Sub-aerial soils in these areas generally classify as Haplic and Epicalcareous, Hypersalic Hydrosols (Isbell 2002) and Aeris Halaquepts and Typic Halaquepts (Soil Survey Staff 2010). Seasonally flooded and subaqueous soils that receive waters draining from acid sulfate soils contained significant concentrations of monosulfides. Soils from these areas mainly classify as Sodosolic, Salic Hydrosols (Isbell 2002) and Typic Hydrowassents (Soil Survey Staff 2010).

However, in depression of former tidal creeks which traverse sulfuric materials, the soils classified as Sulfuric, Hypersalic Hydrosols (Isbell 2002) and Salidic Sulfaquepts (Soil Survey Staff 2010). **This soil type requires a new Great Group for Isbell (2002).**

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