ACID SULFATE SOILS

CORIO BAY AREA

CENTRAL QUEENSLAND COAST

D J Ross

Queensland Government
Natural Resources and Water

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Acid Sulfate Soil Sampling Sites (1:50 000 scale).

Acid Sulfate Soils (1:50 000 scale).

Summary

Medium intensity 1:50 000 scale acid sulfate soil mapping has been undertaken for a section of the Central Queensland coast at Corio Bay, north of Yeppoon. The Corio Bay study area comprises marine plains fringed by back barrier tea tree swamps between elevated sand ridges. The mapping identifies areas of both actual acid sulfate soils and potential acid sulfate soils and their depth of occurrence. Most of the acid sulfate soils are situated on tidal and former tidal lands.

Within the Corio Bay survey area, there are 2,689 ha of land mapped with acid sulfate soils. Actual acid sulfate soils total 1,146 ha, and potential acid sulfate soils 1,542 ha. A further 1,019 ha of land with limited field assessment is likely to contain acid sulfate soils.

Descriptions of the acid sulfate soil map units are presented in this report. Chemical data for selected depth samples are appended. Sample site location is illustrated on the accompanying Sampling Sites map. The distribution of acid sulfate soils is shown on the Acid Sulfate Soils map.

The acid sulfate soils are largely clay soils and sediments, and saturated with a shallow or perched watertable. Actual acid sulfate soils are greyish brown in colour with pale yellow mottles overlying grey to greenish grey substrate materials. Soil surface layers are typically black and organic enriched. Potential acid sulfate soils are commonly dark grey in colour with organic materials.

Fifty six percent of the area assessed with actual and potential acid sulfate soils has acid sulfate soil layers within 1 m depth from the soil surface. Layers of moderate acid generation potential occur within 1m depth from the soil surface over much of the area.

Oxidisable sulfur levels of up to 4.6% and potential acidities up to 2,828 mol H^+/t were recorded on an intertidal flat. At slightly higher elevations, the marine couch flats have up to 3.4% oxidisable sulfur and potential acidities to 2,369 mol H^+/t. These levels are similar to the levels previously recorded for survey areas in the Yeppoon area.

Six piezometers or shallow groundwater monitoring bores were installed to determine the characteristics of the shallow groundwater of this largely modified landscape. Field results indicate very low to low levels of dissolved oxygen during the sampling period, and elevated electrical conductivity readings in most of the standing waters of the bores.

1. Introduction

A mapping project to identify the extent of acid sulfate soils (ASS) at six coastal locations in Central Queensland has been initiated by the Fitzroy Basin Association, Mackay Whitsunday Natural Resource Management Group, and the Department of Natural Resources and Water (NRW) with funding support from the Natural Heritage Trust (NHT). Priority areas for mapping are centred around the Rockhampton and Mackay districts. As well as providing substantial in kind support, NRW was contracted to assist in identifying areas for mapping, undertaking field surveys and to provide laboratory analysis of soil and water samples.

The Corio Bay area is the third and final area of the three priority areas to be mapped along the southern Central Queensland coast. It is situated north of Yeppoon (Figure 1) and extends previous acid sulfate soil mapping to Corio Bay. The survey area is largely characterised by marine plains, and back barrier tea tree swamps between elevated sandridges. The dominant land uses are grazing and recreational uses. The survey area is approximately 4,500 ha in area.

Reconnaissance sampling of acid sulfate soils along the southern part of the Central Queensland coast (Ross 2002) had identified acid sulfate soils and strongly acidic groundwater in the current survey area. The landscape has been modified by pondage banks and there have been fish kills in tidal creeks draining into the estuary (Hyland 2002). Marine blue green algae (Lyngbya) blooms occur occasionally in Corio Bay and iron release from disturbed ASS has been implicated with increased Lyngbya growth (Ahern *et al*. 2007). This mapping project extends the Yeppoon North acid sulfate soil mapping to Corio Bay. It has been undertaken at 1:50 000 scale and represents a medium intensity survey with the map and report intended for planning purposes. Map unit description and chemical data from laboratory analyses are presented in this report.

Acid sulfate soils (ASS) are soils or sediments containing iron sulfides (primarily pyrite) or an acid producing layer as the result of the oxidation of sulfides. They commonly occur on tidal land and low-lying very poorly drained coastal land at elevations less than 5m AHD (Australian Height Datum). Excavating soil or sediment, extracting groundwater or filling land may cause disturbance of ASS. When exposed to air, iron sulfides oxidise to produce sulfuric acid. Disturbed land can release acid, aluminium, iron and heavy metals into drainage waters affecting aquatic plants and animals. Concrete and steel infrastructure including pipes, foundations and bridges are susceptible to acidic corrosion leading to accelerated structural failure (Ahern *et al*. 1988, Powell and Martins 2005). Other potential impacts include the deoxygenation of waterways (Bush *et al*. 2004) and the excess iron stimulating blooms of cyanobacteria such as *Lyngbya majuscula* or fireweed (Ahern *et al*. 2007).

Both actual acid sulfate soil (AASS) and potential acid sulfate soils (PASS) occur throughout the survey area. AASS are soils or sediments containing highly acidic soil horizons or layers caused by the oxidation of soil materials that are rich in iron sulfides, primarily pyrite. This oxidation produces hydrogen ions in excess of the sediments capacity to neutralise the acidity, resulting in soils or sediments of pH 4 or less. PASS are soils or sediment containing iron sulfides or sulfidic materials that have not been exposed to air and oxidised. The field pH of these soils or sediment in

their undisturbed state is pH 4 or more, and may be neutral or slightly alkaline (Anon. 2002).

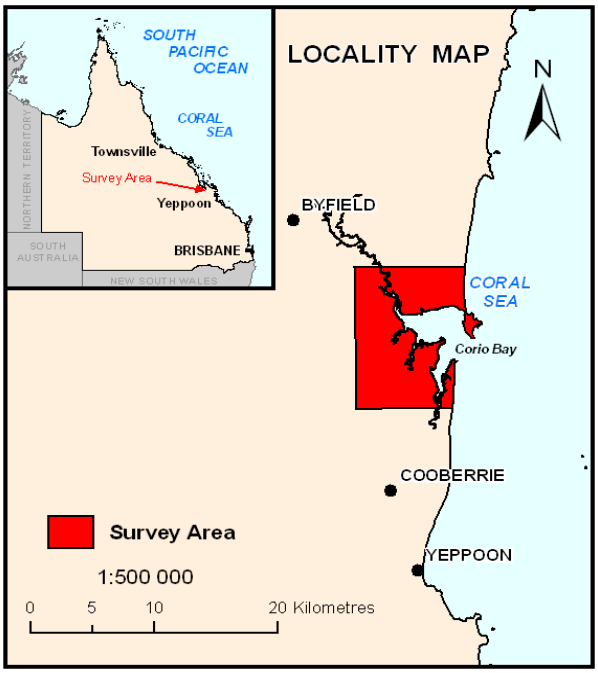

Figure 1. Location of the survey area.

2. Survey Area

North of Yeppoon the coastline along the northern section of Farnborough Beach to Sandy Point consists of a narrow strip of foredune sand. Landward of the coastline lies the estuaries of Fishing, Deep and Sandfly Creeks. A series of beach ridge plains separated by tea tree swamps extend some six kilometres inland and lie parallel to the present coastline. Situated north-west of the prominent rocky headland of Waterpark Point and behind the Nine Mile Beach parabolic sand dunes, is a large marine plain and an extensive area of mangrove flats.

Accurate elevation data for the survey area is not available. The highest astronomical tide (HAT) level or predicted tide level for the survey area is approximately 2.5m AHD. A storm surge level of 3.4m AHD was recorded at Sandy Point inside Corio Bay in 1976 (Beach Protection Authority 1979). The elevation at which sulfidic sediments or acid sulfate soils are likely to be found can be higher than HAT. Levelling to determine the likely highest elevation for ASS occurrence confirmed ASS layers at depth on land above 5m AHD during a previous survey (Ross 2002).

Broad scale geological mapping has been undertaken for the survey area (Beach Protection Authority 1979). The local country rock or pre-Quaternary bedrock consists mainly of sandstone, mudstone and chert of Curtis Island Group. The sulfidic sediments are mostly contained in Quaternary (Holocene) estuarine mud and sand deposits. They also occur in older Quaternary (Pleistocene) sand deposits.

3. Methods

Sites for description and assessment were selected using a free survey technique (Reid 1988) with the aid of 1:25 000 scale black and white aerial photographs. The accompanying acid sulfate soil map has been compiled at 1:50 000 scale and meets the sampling requirements for medium intensity soil mapping. Areas with actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) at various depths are shown on the map from field observation and interpretation. Acid sulfate soil information collected during a previous survey (Ross 2002) is used in the compilation. The map reference was adopted from the Queensland Acid Sulfate Soil Investigation Team (QASSIT) system used in previous Departmental ASS surveys. Site and soil description follows the Australian Soil and Land Survey Field Handbook (McDonald *et al*. 1990).

Much of the sampling was undertaken using stainless steel Dormer hand augers. Saturated clays or silt layers from mangrove mudflats and back barrier swamps were sampled to 1.8m depth or to the depth of hand penetration by gouge auger (Figure 2). Sands at beach ridge sites were hand augered to the watertable or to 6m depth where the watertable was absent. Hydraulically driven stainless steel push tubes (75mm diameter) combined with tapered gouge augers (73, 60 and 48mm diameter) and push rods were used to sample sites with clay sediments and vehicle access (Figure 3). Deep sampling was undertaken using Geoprobe® percussion coring equipment (Figure 4).

Field pH tests and Electrical Conductivity (EC) tests were carried out using a WP81 pH-conductivity meter fitted with an IJ44 pH electrode. Field pH (pH_F) and field pH peroxide (pH_{FOX}) measurements were determined at 0.25m intervals or less to the depth of sampling in accordance with QASSIT guidelines (Ahern *et al*. 1998). Dissolved oxygen of piezometer waters was measured using a WP82Y Dissolved Oxygen-Temperature meter fitted with a YSI 5739 field probe. Piezometer installation followed the standards outlined in Minimum Construction Requirements for Water Bores in Australia (Anon. 2004).

Following field pH tests, samples for laboratory analysis at each site were selected from the upper depth of occurrence of the acid sulfate soil layer, for confirmation of the depth category for mapping. The lower depth of occurrence of the ASS layer was also usually sampled at each site. More frequent sampling down the soil profile occurred at Geoprobe cored sites. Selected samples were placed in a portable refrigerator / freezer and packed frozen for dispatch to Brisbane by overnight air express.

Selected soil samples from each site were analysed for peroxide oxidisable sulfur, titratable actual acidity and titratable potential acidity using the Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) method (Ahern *et al*. 2004). Laboratory results are given in Appendix 1. Selected samples with jarosite were analysed for retained acidity by the Net Acid Soluble Sulfur (S_{NAS}) method (Ahern *et al*. 2004), and the results listed in Appendix 2.

Figure 2. Gouge auger sampling, mangrove forest, Deep Creek.

Figure 3. Push tube sampling, marine plain, Windmill Plains.

Figure 4. Geoprobe core sampling, beach ridge plain, Windmill Plains.

4. Description of the soil map units

The depth to an actual acid sulfate soils (AASS) layer and/or potential acid sulfate soils (PASS) layer on relatively undisturbed land is shown on the accompanying soil map by an alphanumeric code. The alpha component A refers to an AASS layer, the alpha component S to a PASS layer while the numerical component (for example 0,1,2 etc) refers to the depth at which these layers occur. The alphanumeric codes are used separately (for example A0) or combined (for example A0S0) where the map unit contains AASS layers overlying PASS layers. Where there is varying depth to an acid sulfate soil layer within a mapping unit a forward slash is used, for example S1/S2. The acid sulfate soil map units, of relatively undisturbed land, depict varying depths to the acid sulfate soil layer, are coloured using shades of red and are overlain with yellow dots where AASS is present.

Additional information is provided (by code) for areas of soils with a strongly acid soil layer (pH >4 to 5), for example a1S1 and for those associated with wetlands (subscript w). Other map units indicate ASS in areas where there was limited assessment due to restricted access (S_{LA}). The distribution of land where there is a low probability of ASS occurring above an elevation of 5m AHD (LP5) is also shown on the map.

There are 2,689.1 ha of ASS mapped within the survey area. This area contains approximately 1,146.6 ha of land with AASS and 1,542.5 ha of land with PASS (Table 1). Other map units ($S_{LA,}$ S_{LAW}) indicating areas of land where ASS are likely to occur, total 1,019.4 ha.

4.1 *Actual Acid Sulfate Soils on Relatively Undisturbed Land*

A0S1 (AASS layer within 0.5m depth, PASS layer 0.5 to 1m depth)

The A0S1 map unit occupies an area of 429.1 ha and represents much of the marine couch plain of Windmill Plains. Freshwater couch is the dominant ground cover of the plain above a more recently constructed pondage bank. The unit also contains some small areas of bare saltpan where it merges into mangrove thicket or forest, seasonal pools around Bird Island and along the supratidal channels and pools associated with Sandfly Creek. A network of relict low pondage banks extend throughout the map unit from Cod Creek to Sandfly Creek

These extratidal flats of marine couch (*Sporobolus virginicus*) appear to be only marginally elevated to the adjoining mangroves with potential acid sulfate soils. The major soils have a black or dark, strongly structured, medium clay surface horizon overlying grey or greyish brown clay subsoils with orange mottles, and yellow jarositic mottles (Figure 5). At less than 1m depth the potential acid sulfate soil layers are dark grey silty or fine sandy medium clays with some organic fragments. At some locations the lower substrate below 1.5m depth consists of dark grey, single grain loamy fine sand.

The levels of oxidisable sulfur in the actual acid sulfate soil layers range from 0.02 to 0.08% and actual acidity from <10 to 64 mol H^+/t. Retained acidity values range from negligible to significant levels (<10 to 132 mol H^+/t). Oxidisable sulfur values in the unoxidised (PASS) substrate range from 0.6 to 3.4%S, but are commonly >1.5%S, with corresponding Net Acidities of 393 to 2,210 mol H^+/t.

Table 1. Area of map units.

Map Unit	Map Unit Area (ha)	Percentage of Area Assessed (%)
Actual acid sulfate soils		
A0S1	429.1	9.5
A0S2	110.0	2.4
A0S2w	590.0	13.1
A1S1	17.5	0.4
Total	**1,146.6**	**25.4**
Potential acid sulfate soils		
S0	584.1	12.9
S0/S1	792.4	17.6
S1/S2	11.6	0.3
S3	9.99	0.2
S^P3	87.4	1.9
S^P5+	57.1	1.3
Total	**1,542.5**	**34.2**
Acid sulfate on undisturbed land		
S_{LA}	755.5	16.7
S_{LAw}	263.9	5.8
Total	**1,019.4**	**22.5**
Low probability ASS land		
a0LP5	7.8	0.2
LP5	797.9	17.7
Total	**805.7**	**17.9**
Total area	**4,514.2**	**100**

A0S2 (AASS layer within 0.5m depth, PASS layer 1 to 2m depth)

The marine couch or extratidal flats situated between the Wetlands and Kellys Landing comprise this mapping unit. Paper-barked tea tree (*Melaleuca quinquenervia*) and blue gum (*Eucalyptus tereticornis*) woodland occupy the landward margin of the map units, along with mangroves in supratidal channels and pools. Relict low pondage banks (< 0.5m in height) occur throughout the unit adjoining the Wetlands.

The soils throughout the map units are strongly acid (field pH <4.5), with some fully oxidised acid sulfate profiles occurring along the landward margins. Seasonally wet areas of the map units (Figure 6) have soils with a peaty surface horizon containing

very high levels of Titratable Potential Acidity (1,229 to 1,382 mol H^+/t) indicated by the SPOCAS method of analysis.

The top 1 to 2m of the soils contain a thick clay layer with jarosite and low levels of actual acidity (<10 to 33 mol H^+/t). Retained acidity ranges from zero to 330 mol H^+/t. Peroxide oxidisable sulfur in the grey to greenish grey potential acid sulfate soil layers at depth is generally <1%S with a range of 0.23 to 2.47%S.

A0S2w (AASS layer within 0.5m depth, PASS layer 1 to 2m depth, wetlands)

Two large areas of non-tidal wetland were assigned the A0S2w map code. They occur south of Windmill Plains mostly as back swamps between beach ridge plains. The dominant vegetation is paper-barked tea tree (Figure 7). Swamp mahogany (*Lophostemon suaveolens*) and cabbage tree palm (*Livistona decipiens*) occupy slightly elevated areas within the swamps.

The soils are strongly acid throughout with a thick (0.4 to 0.5m), black, organic enriched surface layer overlying mottled grey clay with some jarosite to 1.5m depth. Below this, dark grey silty clays or fine sandy loams were recorded to 3m depth.

Peroxide oxidisable sulfur in the black surface layers range from 0.05 to 0.6%S, with potential acidities of up to 2,154 mol H^+/t. The mottled clay subsoils contain low to moderate levels of actual acidity (15 to 111 mol H^+/t). Retained acidity values of layers with jarosite range from zero to 206 mol H^+/t. Peroxide oxidisable sulfur in the permanently waterlogged substrate ranged from 0.06%S in sandy sediments to 1.45%S in clayey sediments.

A1S1 (AASS layer and PASS layer 0.5 to 1m depth)

This map unit represents relatively small areas of marine couch or extratidal flat adjacent to Sandfly Creek. The areas contain some paper-barked tea tree along the drier landward margins adjacent to beach ridge sands or local country rock. Tidal flow is not restricted by pondage banks.

The soils are acid or strongly acid grey or dark grey medium clays with a black organic enriched surface layer. Peroxide oxidisable sulfur in the surface layers range from 0.06 to 0.21%S. At less than one metre depth the potential acid sulfate soil layers have peroxide oxidisable sulfur values ranging from 0.27 to 2.78%S, with corresponding net acidities of 178 to 1,800 mol H^+/t.

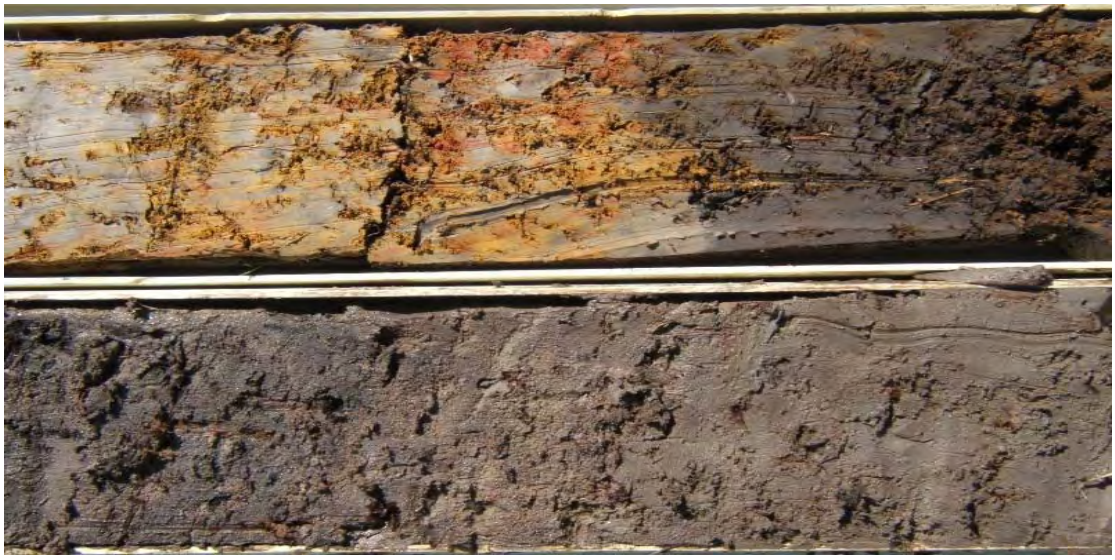

Figure 5. AASS layer with yellow jarosite over grey PASS layer, A0S1 map unit.

Figure 6. Marine couch flat with peaty surface soils, A0S2 map unit.

Figure 7. Paper-barked tea tree back barrier swamp, A0S2w map unit.

4.2 *Potential Acid Sulfate Soils on Relatively Undisturbed Land*

S0 (PASS layer within 0.5m depth)

The S0 map units are located within the Fishing Creek and Sandfly Creek inlets and along the narrow tidal margin of the lower section of Waterpark Creek at Kellys Landing. They are associated with frequently inundated intertidal mangrove mudflats and comprise 38% of the PASS map units in the study area. Small areas of bare saltpan occur within the Fishing Creek and Sandfly Creek inlets.

The soils are either dark grey medium clays, fine sandy loams or coarse sandy clays with a brown or dark grey surface layer. Fine sandy loams are common within the Fishing Creek inlet and coarse sandy clays at Kellys Landing. The potential acid sulfate soil layer can occur in or just below the soil surface layer with a moderate level of acid generation potential. For example, the 0-0.2m depth sample of site CQA1067 at Kellys Landing contains 0.38% oxidisable sulfur and titratable potential acidity of 330 mol H^+/t.

Soil profiles of fine sandy loam texture at Fishing Creek have oxidisable sulfur values ranging from 0.08 to 1.03%. Much higher levels of oxidisable sulfur, generally >2%S, occur in clayey sediments associated with Sandfly Creek, and at Kellys Landing. The map unit at Sandfly Creek contains the highest level of oxidisable sulfur (4.57%S) and acid generation potential (2,870 mol H^+/t) recorded in the survey area.

S0/S1 (PASS layer 0 to 1m depth)

This map unit area with varying depth to the PASS layer (0 to 1m), is substantial in size (792.4 ha) and represents 51% of the area of potential acid sulfate soils. It is associated with the frequently inundated intertidal flats or mangrove mudflats of Deep and Cod Creeks, and small areas of bare saltpan and marine couch flat along the landward margin. The unit contains the larger stands of mangrove forest (Figure 2, Figure 8) found in the survey area.

The soils are dark grey, occasionally greenish grey, medium clays with a brown, greyish brown or dark greyish brown surface layer. Organic materials are a feature of the saturated clayey sediment to 3m depth. The levels of oxidisable sulfur at sites with mangrove cover are generally >1% with a range from 0.72 to 3.27%. Lower levels, generally <1%S and a range from 0.25 to 1.28%S were recorded at sites with a bare surface or marine couch cover.

S1/S2 (PASS layer 0.5 to 2m depth)

The small area of low-lying beach ridge plain at Cod Creek represents this map unit. It consists of an association of sand ridges (beach ridges) and sandy depressions (swales). Moreton Bay ash (*Corymbia tessellaris*) and paper-barked tea tree are major vegetation components of the sandridges, with isolated paper-barked tea tree occupying the wetter swale.

The soils are acidic fine sands with a brown subsoil layer overlying saturated grey or greyish brown fine sand. The levels of oxidisable sulfur in the swale are very low 0.02 to 0.06%S with net acidities of 16 to 45 mol H^+/t. Slightly higher levels are recorded for the adjoining sand ridge 0.5 to 0.12 %S with 35 to 80 mol H^+/t.

S3 (PASS layer 2 to 3m depth)

This unit represents the small area of elevated sand ridge of Bird Island, and a much larger area of low-lying sand deposit in the south east corner of the survey area. Moreton Bay ash, paper barked tea tree, and quinine berry (*Petalostigma pubescens*) are the main tree types on Bird Island. Paper-barked tea tree is dominant in the sandy depressions or swales of the larger sand deposit.

The soil profile at Bird Island is essentially a deep (1.8m) bleached fine sand overlying layers of grey and dark grey marine clay (PASS) to 3.6 m depth. Peroxide oxidisable sulfur in the organic enriched clay sediments range from 0.48 to 2.06%S. Previous sampling within the larger sand deposits east of Fishing Creek indicates lower levels of oxidisable sulfur (0.2%S) at 2 to 3m depth (Ross *et al*. 2000).

S^P3 (PASS layer 2 to 3m depth, Pleistocene age sediments)

The landform of this map unit is the flat to gently sloping drainage depression which forms part of the upper section of Sandfly Creek. The dominant vegetation is paper-barked tea tree and swamp mahogany. Some cabbage tree palm is associated with slightly elevated areas and broad-leaved Banksia (*Banksia robur*) with the wetter areas.

The soils are mottled greyish brown or grey clays with a dark or black surface layer. Below 1m depth, these are mostly underlain by layers of pale brown, greyish brown or grey, loamy fine sand. The levels of oxidisable sulfur in the fine sand substrate below 2m depth range from 0.03 to 0.2%S. Soils with a clayey substrate at 2 to 3m depth contain up to 0.58% oxidisable sulfur.

S^P5+ (PASS layer >5m depth, Pleistocene age sediments)

This map unit is situated adjacent to and immediately west of the S^P3 unit. The landform is a flat to gently sloping sandplain with some low sandridges and clayey drainage lines. Most of the unit has an elevation of more than 5m AHD. Paper-barked tea tree and swamp mahogany are the dominant tree species (Figure 9). Pink bloodwood (*Corymbia intermedia*), coastal Banksia (*Banksia integrifolia*) and blue gum occupy the low sandridges.

Figure 8. Mangrove forest with die-back, Deep Creek, S0/S1 map unit.

Figure 9. Paper-barked tea tree and swamp mahogany woodland, S^P5+ map unit.

Figure 10. Dark grey fine sandy PASS layer at 6m depth, S^P5+ map unit.

The soils on the sandplain consist of a thick layer (2m) of bleached fine sand overlying reddish brown cemented fine sand, which in turn is underlain by dark brown single grain fine sand with some rounded gravels to 6m depth. The grey and dark grey fine sandy to loamy potential acid sulfate soil layers continue to below 7.2m depth (Figure 10). Sandy soils with a cemented brown subsoil and bleached subsurface horizon in the survey area were previously named Kellys (Ross 1999). Levels of oxidisable sulfur in the fine sandy PASS layers below 6m depth range from 0.19 to 0.3%S.

4.3 *Acid Sulfate on Relatively Undisturbed Land*

S_{LA} (Limited field assessment and landform indicating ASS)

The S_{LA} map units total 755.5 ha in area. They represent intertidal flats, supratidal flats, extratidal flats, and a marine plain indicating the presence of acid sulfate soils. Limited sampling was undertaken on the extratidal flat with low sand ridges at Sandy Point. Negligible levels of oxidisable sulfur and net acidity (<0.01%, <10 mol H^+/t) were found in saturated yellowish brown fine sand sediments to 1m depth.

At Greenslopes Point, clayey sediments from the intertidal mangrove mudflats contained up to 3.06% oxidisable sulfur and net acidities of up to 2,063 mol H^+/t, at relatively shallow depth <1m. The slightly elevated supratidal flat at this location had 0.49% oxidisable sulfur and net acidity of 326 mol H^+/t at 1.5 to 1.8m depth. The landward margin of the adjoining marine plain (Figure 11) has actual acid sulfate soils with jarosite at <0.5m depth. Actual acidity (27 mol H^+/t) and retained acidity (37 mol H^+/t) of the layer with jarosite is low. A potential acid sulfate soil layer at 1.8 to 2m depth contained a moderate level (0.95%) of oxidisable sulfur and net acidity (614 mol H^+/t).

S_{LAW} (Limited field assessment and landform indicating ASS, wetlands)

This man made wetland or swamp (Figure 12) adjacent to Kellys Landing Road occupies the middle section of Sandfly Creek and is enclosed by beach ridge sands, country rock and a pondage bank that allows vehicle access. Spring tides extending to the pondage wall indicate the wetland was partially constructed over tidal flats. Much of the wetland contains tall paper-barked tea tree with free standing surface water. Acid sulfate soils recorded upstream of the wetland along Sandy Creek would indicate acid sulfate soils would underlie this wetland.

Limited sampling immediately above the pondage bank wall indicates potential acid sulfate soils with 0.48 to 0.88% oxidisable sulfur at 0.7 to 1.8m depth. Limited sampling along the wetland margin adjacent to Kellys Landing Road indicates both non-acid sulfate soils, and almost fully oxidised acid sulfate soils, to the depth sampled (3m).

4.4 *Land with a Low Probability of Acid Sulfate Soil Occurrence*

a0LP5 (Land predominantly >5m AHD with low probability of ASS occurrence, strongly acid soil layer within 0.5m depth)

Gravelly beach ridges and a back swamp at Kellys Landing comprise this map unit. Moreton Bay ash is common on the low beach ridges with paper-barked tea tree and cabbage tree palm occupying the seasonal swamp. The soils of the beach ridges are coarse sands with abundant quartz gravel and overlie non-sulfidic heavy clay at 2m depth. Dark grey grading to grey mottled, acid (field pH 4.4 to 4.5), heavy clay soils occupy the back swamp. The levels of oxidisable sulfur below the organic enriched surface layers are negligible <0.1%S, and net acidity is very low, 20 to 44 mol H^+/t.

LP5 (Land predominantly >5m AHD with low probability of ASS occurrence)

Most of the land is represented by elevated areas of beach ridge sand. A small area of alluvial plain is situated in the south west corner of the survey area. The younger (Holocene) foredune sands occupy the complex foreshore area of Farnborough Beach to Sandy Point. The sand deposits immediately west of Fishing Creek and north of Cod Creek have been identified as Holocene to Pleistocene in age (Beach Protection Authority 1979). Landward of these lie older (Pleistocene) sand deposits.

The soil profile of the foredune area at Sandy Point with coastal shea-oak (*Casuarina equisetifolia*) is essentially a neutral pale brown fine sand with shell fragments and a watertable at 3m depth. Oxidisable sulfur and net acidity are negligible (<0.1%, <10 mol H^+/t).

Of the five sites sampled on the beach ridge plain adjacent to Fishing Creek, only one site (CQA1084) had an oxidisable sulfur level (0.04%) and net acidity (36 mol H^+/t) indicative of potential acid sulfate soils at 2.8 to 3m depth. Dominant tree species at this site were paper-barked tea tree, swamp mahogany, Moreton Bay ash and black wattle (*Acacia aulacocarpa*).

Acid sulfate soils were not found to the depth sampled in the remaining older beach ridge plains. The soils are slightly acid to acid, and have well developed profiles with bleached fine sand layers overlying cemented dark brown, or yellowish brown fine sand. Below 3 to 4m depth there is often further bleached fine sand over yellowish brown and pale brown fine sand. Deep drilling and sampling to 10 m depth at two sites indicated non acid sulfate soils at these sites. The vegetation (Figure 13) varies from dwarf bloodwood (*Corymbia intermedia*) with wattles and heath to tall bloodwood forest with softwood scrub understory.

Figure 11. Marine plain, Greenslopes Point, S_{LA} map unit.

Figure 12. Man-made wetland, Kellys Landing Road, S_{LAW} map unit.

Figure13. Bloodwood open forest, beach ridge plain, LP5 map unit.

5. Water Quality Monitoring

Six piezometers or shallow groundwater monitoring bores were installed to determine the characteristics of the shallow groundwater draining into Corio Bay (Figure 14). During installation of the six piezometers watertable depth ranged from 0 to 1.2m. Over the sampling period, the piezometers have yielded adequate water for sampling with significant rainfall events occurring during January and particularly February 2008. Two piezometers are located at Fishing Creek (A and B), one on a relatively undisturbed flat of Sandfly Creek (C), one adjacent to Kellys Landing Road (D), and two in older Pleistocene age sediments along Kellys Landing Road (E and F).

Five piezometers are installed in acid sulfate soils, three of these soils contain actual acid sulfate soil layers (A, B and D). The soil profile at each site has been sampled for a comprehensive chemical analysis to assist in the interpretation of the water quality results. Field testing and water sampling was undertaken on a monthly basis since September 2007. Field tests are pH, Electrical Conductivity (EC) and Dissolved Oxygen (DO).

Field results (Table 2) indicate very low to low dissolved oxygen (2.1 to 28.9% saturation) in all of the standing waters of the bores since September 2007. Acidic water (field pH 3.3 to 5.5) was associated with most of the six piezometers during the sampling period. The waters are largely brackish with elevated conductivity readings. The shallow groundwater composition of piezometer A is likely to be influenced by groundwater movement from the adjacent sand ridge. Piezometer E was not sampled in late February 2008 due to inundation by pondage waters.

Figure 14. Installation of piezometer A, Fishing Creek.

Table 2. Field measurements of shallow groundwater monitoring bores.

Piezometer	Locality	Date sampled	pH	EC (dS/m)	DO (%sat)
A	Fishing Creek	19-09-07	4.5	4.91	2.1
		9-10-07	3.9	9.80	6.4
		13-11-07	4.6	2.85	3.1
		4-12-07	4.7	2.94	9.9
		30-01-08	5.1	4.84	7.2
		26-02-08	6.1	0.19	7.2
B	Fishing Creek	19-09-07	3.6	24.4	5.9
		9-10-07	3.6	28.7	28.9
		13-11-07	3.5	23.0	4.9
		4-12-07	3.3	23.8	14.8
		30-01-08	3.4	23.3	5.7
		26-02-08	3.4	19.5	5.4
C	Sandfly Creek	19-09-07	5.4	61.3	3.4
		9-10-07	5.4	61.5	6.8
		13-11-07	5.3	40.2	3.6
		4-12-07	5.2	38.1	7.6
		30-01-08	5.1	33.9	11.9
		26-02-08	5.1	33.4	8.1
D	Kellys Landing Road	19-09-07	4.6	31.5	2.1
		9-10-07	4.0	37.3	6.4
		13-11-07	3.7	27.8	3.9
		4-12-07	3.6	26.8	7.2
		30-01-08	3.6	27.7	3.6
		26-02-08	3.7	27.5	9.1
E	Kellys Landing Road	19-09-07	5.4	26.1	10.5
		9-10-07	5.5	26.7	17.1
		13-11-07	5.5	18.9	10.4
		4-12-07	5.5	19.4	11.2
		30-01-08	5.5	19.0	12.3
F	Kellys Landing Road	19-09-07	4.6	0.58	2.4
		9-10-07	4.9	0.49	4.2
		13-11-07	4.8	0.57	3.6
		4-12-07	4.5	0.57	4.3
		30-01-08	4.9	1.58	4.8
		26-02-08	4.9	0.37	5.4

6. Discussion

Most of the acid sulfate soils of the survey area situated above the mangrove mudflats have an acidic, black, organic enriched surface layer indicative of seasonal wetness. This soil surface feature is not common to soils of similar landforms of the southern Central Queensland coast area. The acid sulfate soils are classified within the Australian Soil Classification (Isbell 2002) as Hydrosols. Sulfidic Hydrosols (or potential acid sulfate soils) typically occur on the intertidal or mangrove mudflats. Sulfuric Hydrosols, containing both actual and potential acid sulfate soil layers, are associated with extratidal or marine couch flats, marine plains and back-barrier swamps. The beach ridge sands overlying sulfidic materials are Podosols. The occurrence of shell within soil profiles or sediments is restricted to a few locations.

Forty surface samples were analysed by the SPOCAS method (Ahern *et al*. 2004) to determine the levels of Actual, Potential and Net acidity. These surface samples were taken from drainage depressions, swamps, extratidal flats and marine plains. The samples were dark to black in colour, organic enriched, occasionally peaty, and several had a field pH of four units or less. Titratable actual acidity values ranged from very low (11 mol H^+/t) to very high (396 mol H^+/t), with several >100 mol H^+/t, which are uncharacteristically high for the southern Central Queensland Coast area (Ross 2002, 2003, 2004, 2005, 2007; Ross *et al*. 2000). The titratable potential acidity values of the surface samples ranged from negligible levels (<10 mol H^+/t) to extremely high levels (2,154 mol H^+/t). Calculated net acidity was generally much lower than the measured potential acidity of the surface samples, indicating high levels of organic sulfur.

For this survey, net acidity (moles H^+/tonne) is calculated as follows and the results listed in Appendix 1:

pH KCL $\geq$ 6.5, Net Acidity = 623.7 x S_{POS} – (332.7 x CaA + 548.4 x MgA);

pH KCL < 6.5, Net Acidity = 623.7 x S_{POS} + TAA + (467.8 x S_{NAS});

pH KCL < 6.5, Net Acidity = 623.7 x S_{POS} + TAA.

The absence of saltpans and the occurrence of strongly acidic shallow groundwater throughout the survey area are likely to be caused by pondage banks constructed across the marine plains. The series of low earthern banks (Figure 15) extending from Cod Creek to Sandfly Creek were thought to have been established in the 1960's (Hyland 2002), but some local anecdotal evidence indicates these low banks (< 0.5m in height) were constructed much earlier. A large portion of Windmill Plains and the freshwater couch plain situated above the larger, more recently constructed pondage banks with vehicle access are likely to have been former tidally affected saltpan flats. It is unlikely that the low pondage banks were constructed for a purpose other than for the reclamation of saltpans to promote pasture growth for grazing. Alternatively, there may be sufficient freshwater draining from the extensive areas of back barrier swamps to maintain a permanent grass cover, or a different tidal / rainfall regime, resulting in a marine couch mangrove interface to the intertidal zone (Figure 16).

Sampling at Corbetts Landing indicates potential acid sulfate soils or sulfidic sediments are likely to extend upstream along the tidal sections of Waterpark and Sandy Creeks. The narrow strips with mangrove vegetation along the banks of Waterpark Creek were too small to map at 1:50 000 scale. The narrow intertidal flat with mangrove cover immediately south of the boat ramp at Corbetts Landing had moderate levels of oxidisable sulfur and net acidity (0.49%S, 311 mol H^+/t respectively) at 0.8 to 1m depth. Slightly higher levels (0.76%S, 480 mol H^+/t) are recorded within the stream channel sediments adjacent to the boat ramp.

Figure 15. Low pondage bank adjacent to tidal zone, Windmill Plains.

Figure 16. Marine couch mangrove tidal interface, Deep Creek.

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APPENDIX 1

SPOCAS data for samples at selected depths

ABBREVIATIONS

Spos Peroxide oxidisable sulfur

TAA Titratable actual acidity

TPA Titratable potential acidity

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1055	0.3-0.5	Fishing	Supratidal	0.73	<10	363	436
	0.8-1.0	Creek	Flat	1.23	<10	756	779
	1.6-1.8			0.34	<10	<10	<10
1056	0.0-0.2	Fishing	Intertidal	0.11	<10	<10	51
	0.3-0.5	Creek	Flat	0.42	<10	134	229
	0.8-1.0			2.26	<10	1477	1420
	1.6-1.8			0.55	<10	278	340
1057	0.3-0.5	Cod	Intertidal	0.87	<10	505	555
	0.8-1.0	Creek	Flat	2.35	13	1509	1480
	1.6-1.8			1.51	<10	899	951
1058	0.2-0.4	Windmill	Marine	0.02	82	77	95
	0.4-0.6	Plains	Plain	0.01	62	52	532
	0.8-1.0			0.03	80	94	442
	1.3-1.5			0.81	84	583	586
	1.8-2.0			2.64	76	1768	1720
	2.3-2.5			2.00	64	1292	1310
	2.8-3.0			1.72	27	1084	1100
1059	0.3-0.5	Windmill	Marine	0.03	52	37	186
	0.6-0.8	Plains	Plain	0.02	54	27	112
	0.8-1.0			0.04	28	73	55
	1.8-2.0			1.09	30	722	707
1060	0.4-0.6	Windmill	Marine	0.02	34	18	108
	0.8-1.0	Plains	Plain	0.01	13	11	21
	1.3-1.5			0.03	<10	<10	31
	1.8-2.0			0.10	<10	52	73
1061	0.3-0.5	Cod	Supratidal	0.02	<10	10	25
	0.7-0.9	Creek	Flat	0.89	<10	467	563
	1.0-1.2			1.18	46	746	784
	1.3-1.5			1.28	39	829	839
	1.8-2.0			1.07	47	710	714
	2.8-3.0			0.96	<10	561	610
1062	0.6-0.8	Windmill	Extratidal	0.01	44	22	351
	1.2-1.5	Plains	Flat	1.37	74	968	927
	1.8-2.0			1.98	25	1301	1260
	2.0-2.2			1.15	25	729	740
	2.5-2.7			0.76	16	484	492
	2.8-3.0			0.24	10	108	159
1063	0.4-0.6	Sandfly	Supratidal	2.66	27	1781	1690
	0.801.0	Creek	Flat	1.72	16	1125	1090
	1.5-1.8			1.12	14	674	712
1064	0.3-0.5	Sandfly	Intertidal	0.39	<10	249	252
	0.8-1.0	Creek	Flat	2.07	19	1334	1310
	1.1-1.4			0.70	<10	408	448
1065	0.2-0.4	Sandfly	Tidal	2.01	13	1211	1270
	0.8-1.0	Creek	Creek	1.27	10	750	803
	1.3-1.5			1.34	19	784	855
1066	0.2-0.4	Deep	Intertidal	0.07	<10	<10	36
	0.6-0.8	Creek	Flat	2.40	15	1457	1510
	0.8-1.0			0.75	<10	363	478
	1.2-1.5			1.42	<10	774	898

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1067	0.0-0.2	Kellys	Intertidal	0.38	<10	330	249
	0.3-0.5	Landing	Flat	2.46	47	1586	1580
	0.8-1.0			2.06	<10	1283	1290
	1.6-1.8			1.91	<10	1136	1200
1068	0.0-0.2	Wetlands	Extratidal	0.12	17	427	90
	0.4-0.6		Flat	0.02	35	25	80
	1.0-1.2			0.05	18	66	51
1069	0.5-0.7	Wetlands	Extratidal	0.08	<10	64	58
	0.8-1.0		Flat	3.43	65	2369	2210
	1.6-1.8			1.75	24	1080	1120
1070	0.3-0.5	Wetlands	Extratidal	0.03	20	14	38
	0.8-1.0		Flat	1.46	27	843	935
	1.6-1.8			1.25	27	691	809
1071	0.1-0.2	Wetlands	Marine	0.20	62	372	190
	0.3-0.5		Plain	0.02	31	53	46
	0.8-1.0			2.34	68	1399	1530
	1.6-1.8			2.24	17	1329	1410
1072	0.4-0.6	Wetlands	Extratidal	0.02	<10	10	22
	0.8-1.0		Flat	0.13	<10	66	92
	1.6-1.8			0.61	<10	360	393
1073	0.0-0.2	Wetlands	Marine	0.11	34	127	102
	0.3-0.5		Plain	0.02	16	13	30
	0.8-1.0			0.61	12	349	391
	1.6-1.8			0.96	<10	567	608
1074	0.8-1.0	Bird	Sand Ridge	<0.01	<10	<10	13
	1.3-1.5	Island		<0.01	<10	<10	13
	1.8-2.0			0.03	10	12	30
	2.3-2.5			0.48	40	391	340
	2.8-3.0			2.06	45	1309	1330
	3.4-3.6			1.86	20	1231	1180
1075	0.3-0.5	Sandfly	Supratidal	0.03	22	15	65
	0.8-1.0	Creek	Flat	0.12	34	131	108
	1.5-1.8			1.56	59	1004	1030
1076	0.2-0.4	Sandfly	Extratidal	0.06	25	<10	63
	0.8-1.0	Creek	Flat	0.04	14	<10	37
	1.4-1.6			0.04	<10	<10	34
1077	0.1-0.3	Sandfly	Intertidal	0.64	<10	332	408
	0.3-0.5	Creek	Flat	2.80	17	1885	1760
	0.8-1.0			2.36	12	1460	1480
	1.5-1.8			1.51	<10	849	951
1078	0.0-0.2	Sandfly	Intertidal	0.37	<10	130	221
	0.3-0.5	Creek	Flat	2.28	<10	1239	1430
	1.3-1.5			4.57	19	2828	2870
1079	0.0-0.2	Sandfly	Intertidal	0.36	<10	364	197
	0.3-0.5	Creek	Flat	1.91	<10	1056	1200
	0.8-1.0			2.13	<10	1211	1340
	1.5-1.8			1.67	<10	919	1050
1080	0.3-0.5	Sandfly	Extratidal	0.03	21	67	43
	0.8-1.0	Creek	Flat	0.07	23	163	118
	1.2-1.4			1.88	45	1190	1220
	1.5-1.8			1.22	19	772	777

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1081	0.0-0.2	Kellys	Extratidal	0.45	177	1839	457
	0.3-0.5	Landing	Flat	0.03	16	10	50
	0.9-1.1	Road		0.02	14	<10	106
	1.3-1.5			0.01	11	10	19
1082	0.3-0.5	Kellys	Extratidal	<0.01	29	26	33
	0.8-1.0	Landing	Flat	0.34	21	253	234
	1.5-1.8	Road		1.51	36	887	979
1083	0.8-1.0	Fishing	Beach	<0.01	18	<10	21
	1.8-2.0	Creek	Ridge	<0.01	<10	11	13
	2.8-3.0			<0.01	<10	12	13
	3.6-3.8			<0.01	<10	<10	13
1084	0.8-1.0	Fishing	Swale	<0.01	20	<10	23
	1.8-2.0	Creek		0.01	<10	10	13
	2.8-3.0			0.04	<10	18	36
1085	0.8-1.0	Fishing	Beach	<0.01	<10	<10	13
	1.8-2.0	Creek	Ridge	<0.01	<10	30	13
	2.6-2.8			<0.01	<10	<10	13
1086	0.8-1.0	Kellys	Drainage	<0.01	<10	<10	13
	1.5-1.7	Landing	Depression	<0.01	<10	<10	<10
1087	0.8-1.0	Kellys	Beach	<0.01	10	<10	13
	1.8-2.0	Landing	Ridge	<0.01	<10	<10	13
	2.2-2.4	Road		<0.01	<10	<10	13
	2.4-2.6			<0.01	<10	<10	13
1088	0.8-1.0	Kellys	Drainage	<0.01	<10	10	13
	1.8-2.0	Landing	Depression	<0.01	10	<10	13
	2.3-2.5	Road		<0.01	16	<10	19
	2.8-3.0			0.03	16	21	33
	3.3-3.5			0.04	<10	11	33
1089	0.8-1.0	Kellys	Alluvial	<0.01	<10	<10	13
	1.8-2.0	Landing	Plain	<0.01	<10	<10	13
	2.3-2.5	Road		<0.01	<10	<10	13
	2.8-3.0			<0.01	<10	<10	13
1090	0.8-1.0	Kellys	Beach	<0.01	<10	<10	13
	1.6-1.8	Landing	Ridge	<0.01	<10	<10	13
1091	0.8-1.0	Wetlands	Drainage	<0.01	<10	<10	<10
	1.8-2.0		Depression	<0.01	<10	<10	<10
	2.3-2.5			<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	13
1092	0.0-0.2	Wetlands	Drainage	0.11	100	139	166
	0.2-0.4		Depression	0.03	75	34	91
	0.4-0.6			0.02	92	80	103
	0.7-0.9			0.03	112	96	151
	1.3-1.5			0.02	107	99	199
	1.8-2.0			0.03	81	75	87
	2.3-2.5			0.04	84	78	90
	2.8-3.0			0.05	56	43	62
1093	0.0-0.2	Wetlands	Drainage	0.05	46	48	74
	0.8-1.0		Depression	<0.01	<10	<10	13
	1.3-1.5			<0.01	<10	<10	13
	1.8-2.0			<0.01	14	<10	17

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1094	0.8-1.0	Windmill	Beach	<0.01	<10	<10	<10
	1.8-2.0	Plains	Ridge	<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
	4.8-5.0			<0.01	<10	<10	<10
	5.8-6.0			<0.01	<10	<10	<10
	6.8-7.0			<0.01	<10	<10	<10
	7.8-8.0			<0.01	<10	<10	<10
	8.8-9.0			<0.01	<10	<10	<10
	9.8-10			<0.01	<10	<10	<10
1095	0.0-0.2	Wetlands	Swamp	0.05	27	295	59
	0.3-0.5			0.01	22	34	30
	0.8-1.0			0.04	15	35	39
	1.6-1.8			1.19	14	757	767
1096	0.0-0.2	Wetlands	Swamp	0.09	127	246	182
	0.3-0.5			0.04	74	98	99
	0.8-1.0			0.08	84	169	133
	1.5-1.8			0.07	37	130	82
1097	0.8-1.0	Windmill	Beach	<0.01	<10	<10	<10
	1.8-2.0	Plains	Ridge	<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
1098	0.0-0.2	Windmill	Swamp	0.06	96	313	132
	0.5-0.7	Plains		0.02	54	98	71
	1.3-1.5			0.03	87	144	107
	1.8-2.0			0.06	31	147	71
1099	0.8-1.0	Sandfly	Beach	<0.01	<10	<10	<10
	1.8-2.0	Creek	Ridge	<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
	4.8-5.0			<0.01	<10	<10	<10
	5.8-6.0			<0.01	<10	<10	<10
	6.8-7.0			<0.01	<10	<10	<10
	7.8-8.0			<0.01	<10	<10	<10
	9.4-9.6			<0.01	<10	<10	<10
1100	0.0-0.2	Sandfly	Drainage	0.13	142	868	222
	0.8-1.0	Creek	Depression	<0.01	10	<10	<10
	1.8-2.0			<0.01	44	<10	47
1101	0.0-0.2	Sandfly	Drainage	0.09	246	655	305
	0.7-0.9	Creek	Depression	0.02	149	165	161
	1.3-1.5			<0.01	10	<10	13
1102	0.8-1.0	Sandfly	Beach	<0.01	<10	<10	<10
	1.8-2.0	Creek	Ridge	<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
	4.8-5.0			<0.01	<10	<10	<10
	5.8-6.0			<0.01	<10	<10	<10
1103	0.0-0.2	Wetlands	Swamp	0.03	94	459	110
	0.8-1.0			<0.01	127	217	127
	1.5-1.8			0.03	107	184	124

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1104	0.2-0.4	Wetlands	Swamp	0.07	59	750	101
	0.8-1.0			0.01	21	<10	30
	1.6-1.8			0.48	52	272	349
1105	0.0-0.2	Wetlands	Marine	0.62	238	2154	625
	0.5-0.7		Plain	0.02	48	140	63
	1.0-1.2			0.06	38	174	76
	1.8-2.0			1.36	34	893	885
1106	0.0-0.2	Kellys	Intertidal	0.03	22	<10	44
	0.8-1.0	Landing	Flat	0.05	<10	16	39
	1.5-1.7			1.29	16	782	823
1107	0.2-0.3	Kellys	Intertidal	0.02	<10	<10	20
	0.8-1.0	Landing	Flat	1.05	52	715	712
	1.3-1.5			1.32	45	861	868
1108	0.0-0.2	Kellys	Intertidal	0.02	<10	<10	<10
	0.3-0.5	Landing	Flat	0.18	<10	<10	72
	0.8-1.0			0.63	<10	390	291
	1.2-1.4			0.71	<10	424	380
	1.6-1.8			0.69	19	421	401
1109	0.3-0.5	Kellys	Extratidal	0.02	33	<10	46
	0.8-1.0	Landing	Flat	0.05	13	34	42
	1.6-1.8			1.40	39	958	914
1110	0.2-0.4	Kellys	Intertidal	0.06	<10	<10	39
	0.8-1.0	Landing	Flat	1.14	<10	732	719
	1.4-1.6			1.47	<10	831	920
1111	0.0-0.2	Fishing	Extratidal	<0.03	30	<10	51
	0.3-0.5	Creek	Flat	<0.01	<10	<10	<10
	0.8-1.0			<0.01	<10	<10	<10
	1.1-1.3			<0.01	<10	10	<10
	1.6-1.8			0.44	14	268	288
1112	0.0-0.2	Fishing	Marine	<0.01	<10	<10	<10
	0.3-0.5	Creek	Plain	<0.01	32	64	35
	0.8-1.0			<0.01	29	16	32
	1.3-1.5			<0.01	14	<10	31
1113	0.0-0.2	Kellys	Beach	0.03	<10	264	<10
	0.8-1.0	Landing	Ridge	<0.01	<10	<10	<10
	1.3-1.5			<0.01	<10	<10	<10
	1.8-2.0			<0.01	41	26	44
1114	0.0-0.2	Kellys	Swamp	0.05	63	<10	96
	0.8-1.0	Landing		0.01	18	<10	26
	1.6-1.8			<0.01	17	62	20
1115	0.0-0.2	Kellys	Intertidal	0.14	<10	315	90
	0.3-0.5	Landing	Flat	0.30	<10	185	194
	0.8-1.0			0.58	<10	323	370
	1.6-1.8			0.87	29	542	573
1116	0.0-0.2	Sandfly	Intertidal	0.42	<10	965	159
	0.3-0.5	Creek	Flat	0.74	<10	1105	333
	0.8-1.0			3.46	40	2191	2200
	1.5-1.8			2.67	69	1908	1740
1117	0.0-0.2	Kellys	Extratidal	0.13	109	937	190
	0.3-0.5	Landing	Flat	0.02	33	94	77
	0.8-1.0	Road		<0.01	18	70	21

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1118	0.0-0.2	Kellys	Extratidal	0.30	175	1438	209
	0.4-0.6	Landing	Flat	0.03	43	102	362
	0.8-1.0	Road		0.05	32	198	66
	1.6-1.8			0.32	17	185	217
1119	0.3-0.5	Deep	Intertidal	0.23	<10	406	137
	0.8-1.0	Creek	Flat	3.27	77	2074	2120
	1.5-1.8			1.61	21	1105	1020
1120	0.1-0.3	Deep	Extratidal	0.05	<10	<10	24
	0.3-0.5	Creek	Flat	<0.01	<10	<10	<10
	0.8-1.0			0.24	<10	133	156
	1.5-1.8			1.03	19	620	670
1121	0.8-1.0	Fishing	Swale	<0.01	<10	<10	<10
	1.8-2.0	Creek		<0.01	<10	<10	<10
1122	0.8-1.0	Fishing	Drainage	<0.01	<10	<10	<10
	1.8-2.0	Creek	Depression	<0.01	<10	<10	<10
	2.4-2.6			0.06	<10	16	42
1123	0-0.18	Fishing	Extratidal	0.04	30	<10	54
	0.2-0.4	Creek	Flat	<0.01	11	<10	14
	0.4-0.6			0.01	20	<10	27
	0.7-0.9			0.01	12	<10	18
	1.2-1.5			0.07	29	72	70
	1.8-2.0			0.89	15	500	567
	2.8-3.0			0.24	<10	112	157
	3.8-4.0			0.23	<10	102	149
	4.6-4.8			1.44	12	906	911
1124	0.0-0.2	Fishing	Marine	<0.01	<10	<10	<10
	0.3-0.6	Creek	Plain	<0.01	33	19	36
	0.8-1.0			<0.01	35	21	43
	1.1-1.3			<0.01	32	16	88
	1.4-1.7			0.02	13	<10	31
	1.8-2.0			0.08	<10	19	57
	2.7-3.0			0.06	<10	12	45
	3.7-4.0			0.06	<10	<10	42
	4.4-4.8			0.04	<10	<10	32
1125	0.0-0.2	Wetlands	Drainage	0.05	59	<10	92
	0.3-0.5		Depression	0.02	29	24	43
	0.6-0.8			<0.01	17	12	20
	1.8-2.0			<0.01	<10	<10	<10
	2.1-2.4			<0.01	<10	<10	<10
	2.4-2.7			<0.01	<10	<10	<10
	2.7-3.0			<0.01	<10	<10	<10
	3.2-3.5			<0.01	<10	<10	<10
	3.7-4.0			<0.01	<10	<10	<10
1126	0-0.19	Kellys	Plain	<0.01	<10	<10	<10
	0.3-0.5	Landing		<0.01	<10	<10	<10
	0.8-1.0	Road		<0.01	<10	<10	<10
	1.7-2.0			<0.01	14	<10	17
	2.2-2.4			0.06	29	60	66
	2.7-3.0			0.05	21	<10	54
	3.7-4.0			0.08	11	<10	63

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1126	4.7-5.0			0.03	<10	<10	22
	5.7-6.0			0.03	<10	<10	26
	6.0-6.5			0.19	<10	75	124
	6.5-7.0			0.30	<10	136	193
1127	0.0-0.1	Kellys	Extratidal	0.08	62	146	114
	0.2-0.5	Landing	Flat	0.02	79	<10	94
	0.7-1.0	Road		0.04	48	37	247
	1.4-1.6			0.06	45	78	120
	2.0-2.5			<0.01	<10	<10	<10
1128	0-0.12	Sandfly	Extratidal	0.21	22	44	151
	0.12-.4	Creek	Flat	0.03	11	<10	29
	0.4-.65			0.02	<10	<10	15
	0.7-1.0			0.27	10	122	178
	1-1.25			2.61	94	1867	1720
	1.3-1.5			0.32	12	158	211
	1.8-2.0			0.05	<10	<10	37
	2.3-2.6			<0.01	<10	<10	<10
1129	0.0-0.2	Windmill	Drainage	0.07	77	196	124
	0.3-0.5	Plains	Depression	0.01	47	92	261
	0.8-1.0			0.06	52	178	86
	1.6-1.9			0.64	61	466	458
1130	0.0-0.2	Windmill	Drainage	0.21	396	646	527
	0.4-0.6	Plains	Depression	0.02	60	76	84
	0.8-1.0			0.04	42	124	67
	1.6-1.9			0.71	43	483	468
1131	0.0-0.2	Windmill	Marine	0.09	83	407	136
	0.3-0.5	Plains	Plain	0.02	53	72	188
	1.0-1.2			0.04	49	179	77
	1.5-1.8			0.67	64	467	483
1132	0.3-0.4	Windmill	Marine	0.02	13	10	35
	0.5-0.7	Plains	Plain	0.90	<10	551	568
	0.8-1.0			1.56	19	1029	990
	1.5-1.8			0.66	<10	365	414
1133	0.1-0.3	Windmill	Intertidal	0.07	<10	<10	31
	0.3-0.5	Plains	Flat	0.12	<10	163	71
	0.8-1.0			1.16	<10	705	727
	1.5-1.8			0.92	<10	554	578
1134	0.0-0.2	Windmill	Intertidal	0.22	<10	<10	109
	0.4-0.6	Plains	Flat	0.03	<10	<10	25
	0.8-1.0			1.00	10	646	631
	1.5-1.8			1.50	10	958	946
1135	0.4-0.6	Windmill	Marine	0.03	57	80	197
	0.6-0.8	Plains	Plain	0.01	46	35	631
	1.0-1.2			0.03	28	93	49
	1.5-1.8			0.99	34	619	651
1136	0.3-0.5	Windmill	Marine	<0.01	<10	<10	<10
	0.6-0.8	Plains	Plain	0.61	17	357	369
	1.0-1.2			1.88	36	1311	1210
	1.5-1.8			2.87	26	1852	1820

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1137	0.2-0.3	Windmill	Marine	<0.01	43	23	64
	0.4-0.6	Plains	Plain	0.03	42	141	190
	0.8-1.0			2.58	116	1840	1730
	1.5-1.8			2.18	65	1462	1430
1138	0.3-0.4	Fishing	Marine	0.02	11	<10	21
	0.5-0.7	Creek	Plain	0.01	<10	<10	11
	0.9-1.0			0.40	16	216	264
	1.4-1.7			0.66	20	382	434
1139	0.0-0.2	Windmill	Marine	0.24	134	1152	282
	0.3-0.5	Plains	Plain	0.01	11	<10	26
	0.8-1.0			0.06	16	121	55
	1.3-1.5			0.94	45	667	629
	1.8-2.0			1.56	69	1078	1040
	2.3-2.5			1.31	66	924	885
1140	0-0.15	Windmill	Marine	0.04	11	227	35
	0.2-0.4	Plains	Plain	<0.01	17	11	152
	0.8-1.0			0.86	42	595	580
	1.6-1.9			2.04	74	1422	1350
1141	0.8-1.0	Sandfly	Beach	<0.01	10	<10	13
	1.8-2.0	Creek	Ridge	<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
	4.8-5.0			<0.01	<10	<10	<10
1142	0.8-1.0	Sandfly	Beach	<0.01	<10	<10	<10
	1.8-2.0	Creek	Ridge	<0.01	25	<10	28
	2.8-3.0			<0.01	12	<10	15
	3.8-4.0			<0.01	<10	<10	<10
1143	0.0-0.2	Sandfly	Extratidal	0.18	88	511	200
	0.3-0.5	Creek	Flat	<0.01	<10	<10	<10
	0.8-1.0			2.78	69	1862	1800
	1.5-1.8			1.29	27	919	832
1144	0.0-0.2	Wetlands	Extratidal	0.07	13	<10	57
	0.4-0.6		Flat	0.02	21	<10	38
	0.7-0.9			0.70	23	494	461
	1.4-1.7			1.93	75	1395	1280
1145	0.8-1.0	Deep	Beach	<0.01	<10	<10	<10
	1.8-2.0	Creek	Ridge	<0.01	14	<10	17
	2.8-3.0			<0.01	15	<10	18
	3.8-4.0			<0.01	<10	<10	<10
	4.8-5.0			<0.01	<10	<10	<10
1146	0.0-0.2	Deep	Intertidal	0.24	<10	<10	129
	0.3-0.5	Creek	Flat	1.22	<10	668	765
	0.8-1.0			3.29	27	2014	2080
	1.5-1.8			2.34	31	1469	1490
1147	0.4-0.6	Deep	Extratidal	0.02	<10	<10	14
	0.8-1.0	Creek	Flat	0.25	<10	84	158
	1.5-1.8			0.30	<10	104	192
1148	0.0-0.2	Wetlands	Extratidal	0.07	26	<10	67
	0.3-0.5		Flat	0.01	<10	<10	13
	0.8-1.0			0.86	25	458	560
	1.5-1.8			0.62	<10	313	391

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1149	0-0.15	Wetlands	Marine	0.05	18	10	47
	0.3-0.5		Plain	0.02	10	10	17
	0.8-1.0			0.20	18	83	146
	1.5-1.8			0.79	20	452	513
1150	0.0-0.2	Wetlands	Marine	0.14	80	111	170
	0.4-0.6		Plain	0.03	61	146	120
	0.8-1.0			0.48	156	410	452
	1.5-1.8			1.69	145	1158	1200
1151	0.0-0.3	Wetlands	Marine	0.07	35	<10	81
	0.4-0.6		Plain	<0.01	<10	<10	<10
	0.7-0.9			0.03	<10	<10	26
	1.5-1.8			1.14	<10	630	715
1152	0.0-0.2	Wetlands	Marine	0.16	89	130	189
	0.4-0.6		Plain	0.04	28	36	52
	0.9-1.0			0.26	62	206	223
	1.5-1.8			1.09	39	667	721
1153	0.0-0.2	Wetlands	Marine	0.09	44	32	97
	0.4-0.6		Plain	0.04	33	17	61
	0.8-1.0			2.32	50	1432	1500
	1.6-1.8			0.58	13	310	376
1154	0.0-0.2	Sandy	Intertidal	0.01	<10	<10	<10
	0.3-0.5	Point	Flat	0.47	<10	206	301
	0.8-1.0			0.97	<10	545	612
	1.5-1.8			0.62	<10	315	390
1155	0.3-0.5	Sandy	Intertidal	0.26	<10	96	169
	0.8-1.0	Point	Flat	0.30	<10	108	190
	1.5-1.8			0.47	<10	234	296
1156	0.3-0.5	Sandy	Intertidal	0.08	<10	<10	54
	0.8-1.0	Point	Flat	0.25	<10	78	163
	1.3-1.5			0.30	<10	106	195
1157	0.8-1.0	Sandy	Foredune	<0.01	<10	<10	<10
	1.8-2.0	Point		<0.01	<10	<10	<10
	2.8-3.0			<0.01	<10	<10	<10
1158	0.3-0.5	Sandy	Extratidal	<0.01	<10	<10	<10
	0.8-1.0	Point	Flat	<0.01	<10	<10	<10
1159	0.0-0.2	Sandy	Intertidal	0.13	<10	<10	83
	0.3-0.5	Point	Flat	0.16	<10	34	102
	0.8-1.0			0.19	<10	49	126
	1.5-1.8			0.20	<10	56	130
1160	0.3-0.5	Sandy	Extratidal	<0.01	<10	<10	<10
	0.8-1.0	Point	Flat	<0.01	<10	<10	<10
1161	0.3-0.5	Sandy	Intertidal	0.03	<10	<10	15
	0.8-1.0	Point	Flat	0.10	<10	<10	64
	1.5-1.8			0.03	<10	<10	14
1162	0.0-0.2	Sandy	Intertidal	0.43	<10	198	271
	0.3-0.5	Point	Flat	1.03	<10	627	647
	0.8-1.0			0.79	<10	457	499
	1.5-1.8			0.61	12	352	391
1163	0.0-0.2	Corbetts	Intertidal	0.04	<10	<10	30
	0.3-0.5	Landing	Flat	0.04	<10	<10	27
	0.8-1.0			0.49	<10	240	311
	1.5-1.8			0.56	<10	297	355

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1164	0.0-0.2	Corbetts	Stream	0.11	<10	<10	51
	0.3-0.5	Landing	Channel	0.07	<10	<10	48
	0.8-1.0			0.76	<10	418	480
	1.5-1.8			0.47	<10	231	299
1165	0.0-0.2	Wetlands	Swamp	0.20	249	521	374
	0.4-0.6			0.04	111	169	138
	0.9-1.1			0.08	89	167	139
	1.8-2.0			1.22	137	937	900
	2.3-2.5			1.35	165	1057	1010
	2.8-3.0			1.45	127	1099	1030
1166	0.0-0.1	Sandfly	Extratidal	0.09	<10	50	64
	0.1-0.3	Creek	Flat	<0.01	<10	<10	<10
	0.3-0.5			0.04	21	21	99
	0.8-1.0			0.85	40	593	572
	1.3-1.5			0.72	25	469	473
1167	0.3-0.5	Sandfly	Marine	<0.01	14	<10	18
	0.9-1.1	Creek	Plain	<0.01	<10	<10	<10
	1.4-1.7			0.23	<10	124	147
1168	0.0-0.1	Wetlands	Swamp	0.30	238	719	426
	0.1-0.3			0.20	167	502	294
	0.3-0.5			0.03	43	74	64
	0.8-1.0			0.09	45	148	101
	1.8-2.0			0.60	48	423	424
1169	0.0-0.2	Sandfly	Drainage	0.08	260	414	311
	0.3-0.5	Creek	Depression	0.03	159	182	176
	0.8-1.0			0.03	148	167	169
	1.8-2.0			0.11	156	227	228
	2.1-2.3			0.58	84	444	443
1170	0.0-0.2	Sandfly	Drainage	0.03	104	152	124
	0.3-0.5	Creek	Depression	0.01	118	109	129
	0.8-1.0			0.01	82	69	91
1171	0.8-1.0	Kellys	Beach	<0.01	<10	<10	<10
	1.8-2.0	Landing	Ridge	<0.01	37	<10	40
	2.8-3.0	Road		<0.01	<10	<10	<10
	3.8-4.0			<0.01	<10	<10	<10
1172	0.8-1.0	Wetlands	Drainage	<0.01	<10	<10	<10
	1.3-1.6		Depression	<0.01	17	<10	20
	1.8-2.0			<0.01	12	<10	15
	2.3-2.5			<0.01	10	<10	13
1173	0-0.15	Wetlands	Swamp	0.04	39	51	66
	0.3-0.5			0.04	19	<10	44
	0.8-1.0			<0.01	57	17	66
	1.2-1.4			0.03	74	67	122
	1.8-2.0			0.01	28	<10	35
1174	0.0-0.2	Wetlands	Swamp	0.02	11	<10	22
	0.4-0.6			<0.01	<10	<10	<10
	0.8-1.0			0.01	<10	<10	13
	1.4-1.6			<0.01	<10	<10	<10

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1175	0-0.12	Wetlands	Swamp	0.07	51	86	92
	0.3-0.5			<0.01	<10	<10	<10
	0.8-1.0			<0.01	16	<10	20
	1.3-1.5			<0.01	17	<10	23
	1.6-1.8			<0.01	14	<10	23
1176	0-0.15	Wetlands	Swamp	0.06	25	27	64
	0.3-0.5			<0.01	<10	<10	<10
	0.8-1.0			<0.01	<10	<10	<10
	1.5-1.7			<0.01	<10	<10	<10
1177	0.0-0.2	Greenslopes	Marine	0.04	98	108	122
	0.3-0.5	Point	Plain	0.10	27	153	126
	0.8-1.0			0.04	11	<10	36
	1.5-1.8			0.04	11	<10	37
	18-2.0			0.95	23	589	614
1178	0.0-0.2	Greenslopes	Marine	0.10	96	245	156
	0.4-0.6	Point	Plain	<0.01	<10	<10	<10
	0.8-1.0			0.02	<10	<10	20
	1.5-1.8			0.02	<10	<10	18
1179	0-0.17	Greenslopes	Supratidal	0.10	33	144	98
	0.3-0.5	Point	Flat	0.07	<10	<10	47
	0.8-1.0			0.06	<10	<10	41
	1.5-1.8			0.49	22	303	326
1180	0.0-0.3	Fishing	Intertidal	0.05	<10	<10	36
	0.4-0.6	Creek	Flat	0.10	<10	<10	70
	0.8-1.0			0.13	<10	36	84
	1.5-1.8			0.07	<10	<10	47
1181	0-0.12	Fishing	Swale	0.06	<10	<10	41
	0.3-0.5	Creek		<0.01	<10	<10	<10
	0.8-1.0			0.02	<10	<10	16
	1.5-1.8			0.06	<10	<10	45
1182	0.8-1.0	Fishing	Beach	<0.01	<10	<10	<10
	1.8-2.0	Creek	Ridge	0.05	<10	<10	35
	2.8-3.0			0.12	<10	42	80
1183	0.0-0.2	Greenslopes	Intertidal	0.21	50	350	182
	0.0-0.5	Point	Flat	0.07	<10	14	46
	0.8-1.0			3.06	154	2283	2063
	1.5-1.8			1.49	49	1089	978
1184	0.0-0.2	Greenslopes	Intertidal	0.08	<10	<10	57
	0.3-0.5	Point	Flat	0.30	<10	167	191
	0.8-1.0			1.35	47	994	890
	1.5-1.8			1.01	34	698	666
1185	0-0.15	Windmill	Marine	0.16	189	373	286
	0.2-0.3	Plains	Plain	0.03	86	58	105
	0.3-0.5			0.02	66	51	105
	0.8-1.0			0.01	59	54	217
	1.3-1.5			0.02	56	60	70
	1.8-2.0			1.02	77	802	713
	2.3-2.5			1.55	61	1078	1030
	2.8-3.1			0.88	75	665	627

Site No	Depth (m)	Locality	Landform	S_{POS} %	TAA mol H^+/t	TPA mol H^+/t	Net Acidity mol H^+/t
1186	0.1-0.2	Windmill	Marine	0.02	51	27	65
	0.3-0.5	Plains	Plain	0.06	61	63	201
	0.8-1.0			0.01	20	<10	26
	1.3-1.5			0.55	15	321	356
	1.8-2.0			1.37	33	883	886

APPENDIX 2

Retained acidity for selected samples with jarosite.

Site No	Depth (m)	Texture[1] Category	Field pH[2]	S_{NAS}[3] (%)	s-S_{NAS}[4] (%)	a-S_{NAS}[5] (mol H^+/t)
CQA1058	0.4-0.6	Fine	2.9	0.997	0.747	466
CQA1058	0.8-1.0	Fine	2.9	0.737	0.553	345
CQA1059	0.3-0.5	Medium	3.1	0.248	0.186	116
CQA1059	0.6-0.8	Medium	3.1	0.125	0.094	58
CQA1060	0.4-0.6	Fine	3.0	0.135	0.101	63
CQA1062	0.6-0.8	Fine	3.3	0.649	0.486	304
CQA1068	0.4-0.6	Fine	3.6	0.078	0.058	36
CQA1070	0.3-0.5	Fine	4.0	<0.005	0	0
CQA1071	0.3-0.5	Fine	3.6	<0.005	0	0
CQA1072	0.4-0.6	Medium	3.9	<0.005	0	0
CQA1075	0.3-0.5	Fine	3.5	0.054	0.040	25
CQA1080	0.3-0.5	Fine	3.6	<0.005	0	0
CQA1080	0.8-1.0	Fine	3.5	0.115	0.086	54
CQA1081	0.3-0.5	Medium	3.8	0.030	0.022	14
CQA1081	0.9-1.0	Medium	3.8	0.167	0.125	78
CQA1082	0.3-0.5	Fine	3.8	<0.005	0	0
CQA1092	0.7-0.9	Fine	3.8	0.049	0.037	23
CQA1092	1.3-1.5	Fine	3.7	0.072	0.054	34
CQA1095	0.3-0.5	Medium	3.5	<0.005	0	0
CQA1096	0.3-0.5	Fine	3.6	<0.005	0	0
CQA1098	0.5-0.7	Fine	3.6	0.006	0.004	3
CQA1101	0.7-0.9	Fine	3.9	<0.005	0	0
CQA1105	0.5-0.7	Fine	3.9	<0.005	0	0
CQA1109	0.3-0.5	Fine	3.8	0.005	0.004	3
CQA1112	1.3-1.5	Coarse	3.0	0.029	0.022	14
CQA1117	0.3-0.5	Fine	3.8	0.074	0.055	35
CQA1118	0.4-0.6	Fine	3.5	0.647	0.485	303
CQA1119	0.8-1.0	Fine	3.6	<0.005	0	0
CQA1124	0.8-1.0	Medium	3.1	0.011	0.008	5
CQA1124	1.1-1.3	Medium	2.9	0.112	0.084	52
CQA1124	1.4-1.7	Coarse	2.9	0.019	0.014	9
CQA1127	0.7-1.0	Fine	3.2	0.375	0.281	175
CQA1127	1.4-1.6	Fine	3.4	0.074	0.055	35
CQA1129	0.3-0.5	Fine	3.3	0.441	0.331	206
CQA1130	0.4-0.6	Fine	3.6	0.027	0.020	13
CQA1131	0.3-0.5	Fine	3.6	0.265	0.198	124
CQA1132	0.3-0.4	Fine	3.8	0.026	0.019	12
CQA1135	0.4-0.6	Fine	3.4	0.254	0.190	119
CQA1135	0.6-0.8	Medium	3.2	1.230	0.922	575
CQA1137	0.2-0.3	Fine	3.6	0.038	0.028	18
CQA1137	0.4-0.6	Medium	3.4	0.281	0.211	131
CQA1139	0.3-0.5	Fine	3.3	0.016	0.012	7
CQA1140	0.2-0.4	Medium	3.0	0.282	0.211	132

Site No	Depth (m)	Texture[1] Category	Field pH[2]	S_{NAS}[3] (%)	s-S_{NAS}[4] (%)	a-S_{NAS}[5] (mol H^+/t)
CQA1144	0.4-0.6	Fine	3.9	0.007	0.005	3
CQA1150	0.4-0.6	Fine	3.5	0.080	0.060	37
CQA1153	0.4-0.6	Fine	3.5	0.007	0.005	3
CQA1166	0.3-0.5	Medium	3.3	0.111	0.083	39
CQA1167	0.3-0.5	Medium	3.5	<0.005	0	0
CQA1169	0.8-1.0	Fine	3.5	<0.005	0	0
CQA1169	1.8-2.0	Fine	3.4	<0.005	0	0
CQA1170	0.3-0.5	Fine	3.9	0.010	0.007	5
CQA1173	0.8-1.0	Fine	3.5	0.013	0.009	6
CQA1175	0.8-1.0	Fine	3.9	<0.005	0	0
CQA1175	1.3-1.5	Medium	3.7	0.007	0.005	3
CQA1175	1.6-1.8	Medium	3.3	0.013	0.009	6
CQA1177	0.3-0.5	Fine	3.3	0.080	0.600	37
CQA1185	0.3-0.5	Fine	3.3	0.540	0.405	253
CQA1185	0.8-1.0	Fine	3.1	0.317	0.237	148
CQA1186	0.3-0.5	Fine	3.5	0.225	0.168	105

[1]Ahern *et al.* (1998)
[2] Field pH before oxidation.
[3] Net acid soluble Sulfur (Ahern *et al.* 2004)
[4] Equivalent % pyrite Sulfur.
[5] Equivalent acidity units.