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Anglesea Acid Sulfate Soil Investigation

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Draft Report

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Executive Summary

The Anglesea River frequently suffers from low pH conditions during and after high intensity rainfall events which results in fish kills, closure of the estuary to recreational activities, and subsequent downturn in the local economy. Acidic discharges to the Anglesea River can be potentially sourced from acidic peat swamps located in Salt Creek and Marshy Creek in the upper catchment of the Anglesea River, natural coal seams, or acid sulfate soils. The sources and relative contributions of acid into the Anglesea River from the upper catchment and sulfidic peat swamps is currently not well understood.

This study describes an investigation into the distribution and characterisation of acid sulfate soils in the Salt Creek and Marshy Creek Swamplands, also known as the Anglesea Swamplands. This study addresses the Acid Sulfate Soils (ASS) Investigations as part of the requirement for Barwon Water's Monitoring and Assessment Program (MAP) for the Anglesea Borefield. The MAP is required under the Bulk Entitlement (Anglesea Groundwater) Order 2009 and the Water Act 1989.

The Anglesea Swamplands are located to the north of Anglesea and supported by groundwater, however, the connectivity between the underlying aquifers, perched water table (PWT) and the Swamplands is not well understood. Groundwater has historically been extracted by Alcoa (1969 - 2016) from the Upper Eastern View Formation (UEVF) aquifer and more recently by Barwon Water from the Lower Eastern View Formation (LEVF) aquifer (2009 – 2012, and 2019).

The sites investigated followed the course of the Anglesea Swamplands with additional sites located in the tributaries of both Salt Creek and Marshy Creek, and in the Lower Channel of Salt Creek. This study identified three pools of acidity at each site: i) potential sulfidic acidity, sourced from sulfidic sediments containing pyrite and monosulfides; ii) labile acidity, which is existing acidity and can be rapidly mobilised; and iii) retained acidity, which is existing latent acidity usually stored in minerals such as jarosite. In addition, acid neutralising capacity was also analysed and net acidity determined.

Both Salt Creek and Marshy Creek contain substantial volumes of acidity in a form that can be mobilised rapidly. Marshy Creek contains higher concentrations of labile acidity which can be transported readily in surface water and groundwater, whereas Salt Creek contains higher concentrations of retained acidity which can be slowly released over time.

The swamplands of Marshy Creek were all acidic, saline and had high concentrations of soil organic carbon (SOC). Conversely, the sites located in the tributaries had higher pH values, lower electrical conductivity (EC; a measure of salinity) and SOC concentrations. The Marshy Creek Swamplands were characterised by:

- Extremely high net acidity values of up to 7168 mol H^+/t (note that an Acid Sulfate Soil Management Plan is triggered when net acidity > 18 mol H^+/t)
- Significant acidification, metal mobilisation and monosulfide formation hazard
- Evidence of previous sulfide oxidation identified from SO_4^{2-}:Cl^- > 0.5 in most sites
- Extremely high concentrations of soluble metals including Al, Cu, Fe, Mn, Ni and Zn which can directly contribute to shallow groundwater chemistry and deleteriously impact on aquatic ecosystems
- A preliminary estimate of up to 2.58×10^8 mol H^+ in net acidity in the surface 0 – 10 cm of soil in the 224 ha swamplands area which would require a liming rate of up to 76 t/ha of Ag lime (including 1.5 safety factor) to neutralise at MSC26 which had the highest net acidity

The swamplands, tributary and lower channel of Salt Creek were all acidic, but were not saline ($EC_{1:5}$ < 400 μS/cm). While some sites had high concentrations of SOC, SOC concentrations were generally lower than those found at Marshy Creek

The Salt Creek Swamplands were characterised by:

- Extremely high net acidity values of up to 609 mol H^+/t
- Significant acidification, metal mobilisation and monosulfide formation hazard
- Evidence of previous sulfide oxidation identified from SO_4^{2-}:Cl^- > 0.5 in most sites, with the ratio much higher than those found at Marshy Creek , and at values high enough to suggest significant historical oxidation which may be more extensive than what has occurred at Marshy Creek
- Extremely high concentrations of soluble metals including Al, Cu, Fe, Mn, Ni and Zn, which can directly contribute to shallow groundwater chemistry and deleteriously impact on aquatic ecosystems
- A preliminary estimate of up to 6.18 x 10^8 mol H^+ in net acidity in the surface 0 – 10 cm of soil in the 93 ha swamplands area which would require a liming rate of up to 100 t/ha of Ag lime (including 1.5 safety factor) to neutralise at SCK13 which had the highest net acidity

The effect of extraction of groundwater from the LEVF in terms of future acid generation in both Salt Creek and Marshy Creek cannot be determined with certainty without further information about the connectivity between the LEVF, aquitard, UEVF and the PWT.

The sampling protocol and analytical methods used in this study can be repeated in a monitoring program to determine changes over time in both Salt Creek and Marshy Creek. It is recommended that additional monitoring should include:

- Determining the connectivity between the PWT and underlying aquifers of the UEVF and LEVF
- Determining the depth and thickness of the peat layer and sulfidic materials across the width of the Swamplands, focusing on the Mid-Swamplands of both Salt Creek and Marshy Creek where feasible
- Continue to review groundwater data, trigger levels and modelling with a longer term dataset
- Review groundwater trigger levels specific to the Salt Creek Swamplands by determining the relationship to changes between the LEVF, UEVF and their effects on PWT levels similar to those already established for the swamplands in Marshy Creek
- Increasing the frequency of monitoring of surface water quality monitoring sites in the Upper, Mid- and Lower Swamplands in both Salt Creek and Marshy Creek, where possible, as part of a strategy to monitor the effects of acid sulfate soils on surface water quality

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List of abbreviations

ANC	Acid neutralising capacity
ASS	Acid sulfate soils
AVS-S	Acid volatile sulfide
BE	Bulk entitlement
CRS-S	Chromium reducible sulfur
EC	Electrical conductivity
EVF	Eastern View Formation
GMA	Groundwater management area
ICP-MS	Inductively coupled plasma-mass spectroscopy
LEVF	Lower Eastern View Formation
MAP	Monitoring and assessment program
MEVF	Middle Eastern View Formation
PWT	Perched Water Table
RIS	Reduced inorganic sulfur
SOC	Soil organic carbon
TAA	Titratable actual acidity
UEVF	Upper Eastern View Formation

1. Introduction

1.1 Background

Access to groundwater from the Anglesea Borefield by Barwon Water is governed by a bulk entitlement issued by the Victorian Government. This study addresses the Acid Sulfate Soils (ASS) Investigations as required for the Monitoring and Assessment Program (MAP) for the Anglesea Borefield. The MAP is required for the Bulk Entitlement (Anglesea Groundwater) Order 2009 under the Water Act 1989. The purpose of the MAP is to provide data about the long-term sustainability of groundwater resources in the Lower Eastern View Formation (LEVF) to ensure the protection of environmental values and health of ecosystems in the region.

The Salt Creek and Marshy Creek (also known as the Anglesea) Swamplands contain substantial accumulations of organic peat materials and sulfidic materials, which can include sulfidic coal measures. Sulfidic materials have the potential to oxidise and generate acidity and mobilise trace metals when exposed to the atmosphere as a function of decreasing watertable levels. Under the MAP, the potential for acid generation as a result of drawdown from groundwater extraction will be assessed via a soil sampling program to identify the spatial distribution of sulfidic materials in the Salt Creek and Marshy Creek Swamplands, their potential oxidation and further monitoring and management options if required.

1.2 The Anglesea Borefield

The Anglesea Borefield is located in the Jan Juc Groundwater Management Area (GMA). The current licenced groundwater volume in the GMA is 11,250 ML/year (i.e. fully allocated to the Permissible Consumptive Volume limit).The GMA has three main aquifer systems within this study area; i) the perched water table PWT; ii) the regionally extensive Upper Eastern View Formation (UEVF) at a depth of around 180 m, and iii) the Lower Eastern View Formation (LEVF) at a depth of around 230 m. The PWT is primarily recharged by rainfall and runoff and is present along the downstream sections of the primary watercourses in the study area and supports the Anglesea Swamplands (GHD 2019b). The LEVF aquifer is separated from the UEVF aquifer system by the Middle Eastern View Formation (MEVF) aquitard, which is around 40-60 m thick (GHD 2019b). However, connectivity between the PWT and the LEVF and UEVF aquifers is uncertain in the Anglesea swamplands. The Jan Juc aquifer outcrop and cross section are shown in Figure 1.1Error! Reference source not found. and Figure 1.2.

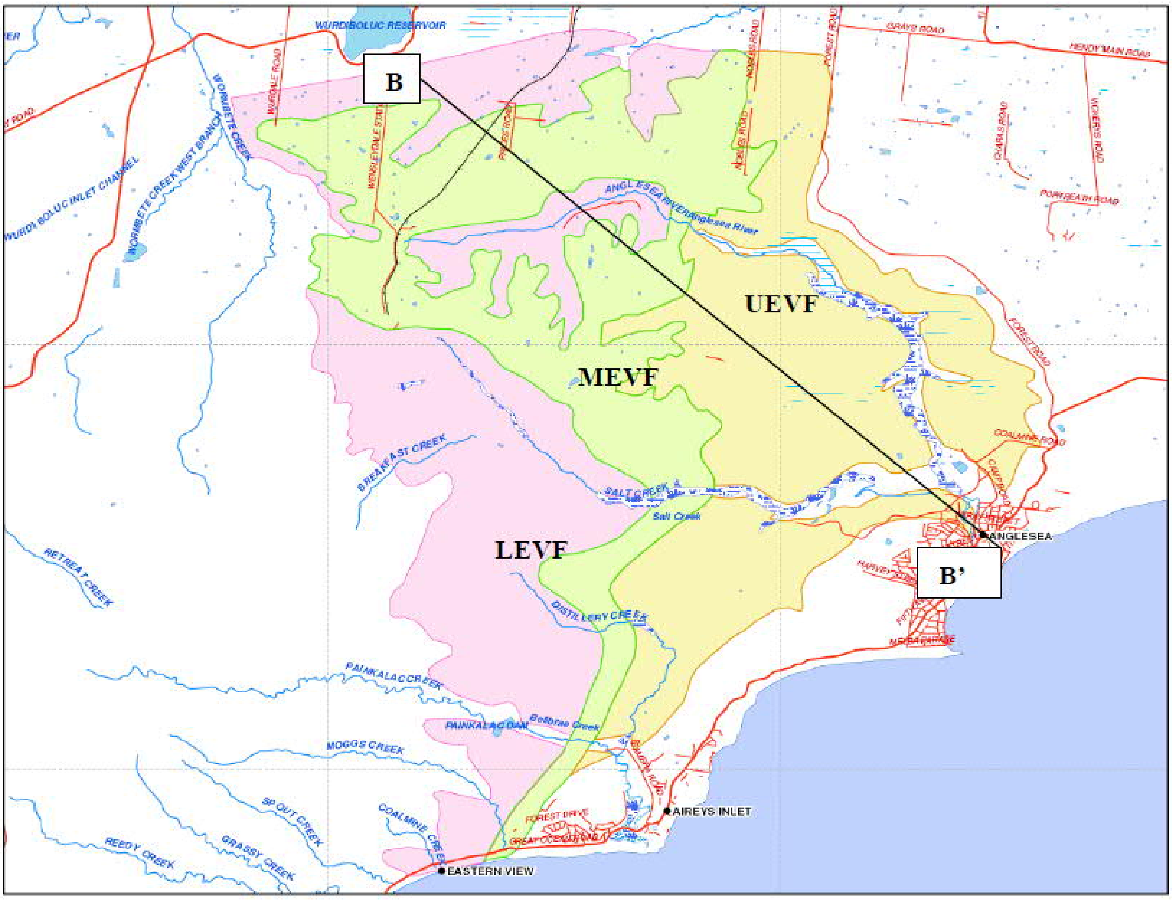


Figure 1.1. Jan Juc GMA interpreted aquifer outcrop (GHD 2019)

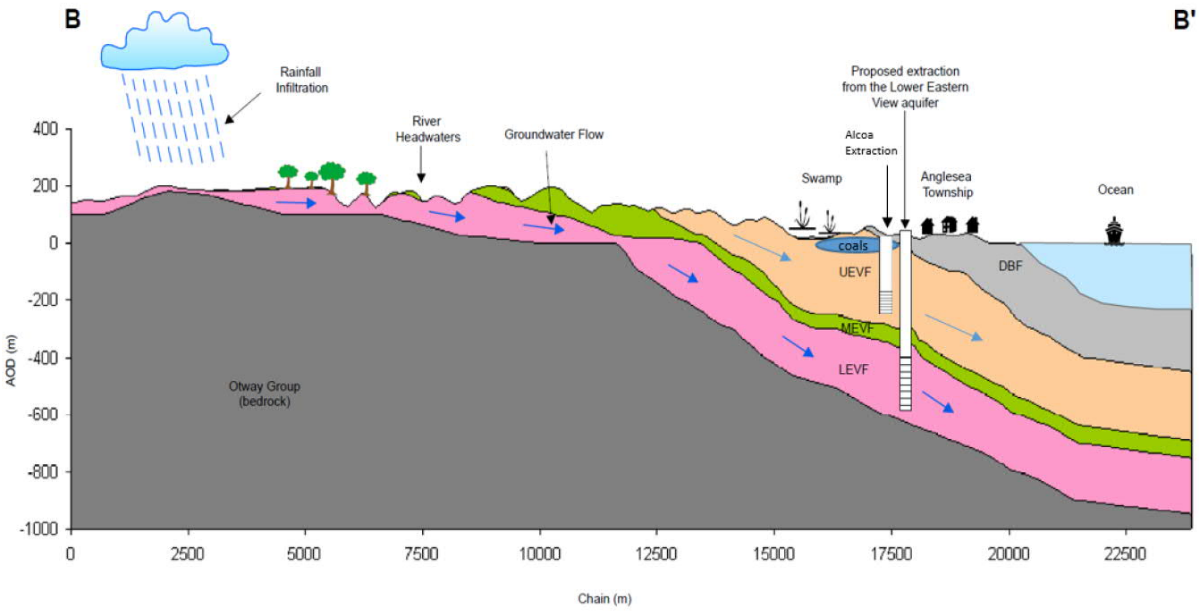


Figure 1.2. Jan Juc GMA aquifer cross section (GHD 2019)

The Anglesea power station was operated by Alcoa and extracted groundwater from the UEVF for use in power generation from 1969 until 2016 following the closure of the power station in 2015. Alcoa was licensed to extract a maximum of 4,000 ML annually.

Barwon Water has extracted groundwater from the LEVF aquifer system intermittently since 2009 when the Bulk Entitlement (BE) was granted. There was no groundwater extraction by Barwon Water in the Anglesea Borefield between July 2012 – July 2019. Between August - October 2019, a small amount of groundwater was extracted as part of the re-commissioning process. The operation of the Anglesea Borefield recommenced in November 2019 to supplement the water supply for the townships of Anglesea, Aireys Inlet, Torquay, the Bellarine Peninsula and parts of Geelong. Under the terms of the bulk entitlement, Barwon Water is licensed to extract a maximum of:

- 40 ML per day,
- 10,000 ML in any year, and
- 35,000 ML in any 5-year period.

A review of numerical modelling by GHD (2013) identified a drawdown risk in the PWT aquifer caused by extraction from the deeper LEVF aquifer. Drawdown of the PWT can impact surface water flows and acid generation. Protective groundwater trigger levels were implemented through Barwon Water's Bulk Entitlement in response to this risk and to limit the occurrence of significant drawdowns in the PWT and prevent potential damage to groundwater dependent ecosystems (Clause 9, Schedules 2 and 4; Bulk Entitlement).

1.3 Acid sulfate soils in the Anglesea Region

Acid sulfate soils are soils or sediments which contain oxidisable, or partly oxidised sulfide minerals (van Breemen 1975). Acid sulfate soils and sulfidic material frequently underlie coastal and estuarine floodplains in Australia, or found in wetlands, swamps or marshes which are not influenced by coastal or estuarine processes. Sulfidic material is determined by the presence of reduced inorganic sulfur (RIS), which is frequently dominated by iron disulfide minerals (primarily pyrite; FeS_2), marcasite, monosulfides (eg. FeS) and elemental S^0.

Sulfuric acid is formed when sulfidic material is exposed to oxygen and oxidised, which can occur when the water table is lowered during periods of drought (Grealish et al. 2014; Mosley et al. 2014a), through artificial drainage of waterlogged land, excavation of waterlogged sediments (Mosley et al. 2014b; Sammut et al. 1995; Sammut et al. 1996) or via groundwater extraction. The complete oxidation of pyrite can be summarised according to Equation 1.

$$FeS_2 + 3.75O_2 + 3.5H_2O \rightarrow Fe(OH)_3 + 4H^+ + 2SO_4^{2-} \quad \text{Equation 1.}$$

Acid sulfate soils have been identified on the Anglesea River estuarine floodplain and surrounding region (Fitzpatrick et al. 2007; Yau et al. 2016). Acid sulfate soils have also been identified in the upper catchment of the Anglesea River (Glover 2014, Latimer 2015, Roussety 2014). The Anglesea River frequently suffers from low pH conditions during and after high intensity rainfall events which results in the closure of the estuary to recreational activities and subsequent downturn in the local economy. The acidification events have caused fish deaths in 2001, 2007 and 2010, with the most serious fish kill event occurring in 2001 (ASSAY 2010). The fish kill events were attributed to the discharge of highly acidic river water and high concentrations of trace metals such as Al in the water column (Maher 2011). Acidity and trace metals can be discharged to adjacent waterways by both surface runoff and groundwater seepage resulting in degradation of adjacent terrestrial and aquatic ecosystems (Johnston et al. 2004; White et al. 1997).

Acidic discharges can be potentially sourced from acidic peat swamps located in Salt Creek and Marshy Creek in the upper catchment of the Anglesea River, natural coal seams, or acid sulfate soils (Maher 2011). Organic-rich soils, similar to those which occur in Salt Creek and Marshy Creek, are frequently naturally acidic due to the presence of organic acids, exchangeable H^+ and Al^{3+}, in addition to accumulations of sulfidic materials and other oxidisable sulfur compounds {Osman, 2018 #2659}.

The two tributaries in the upper catchment, Salt Creek and Marshy Creek, flow ephemerally following periods of high rainfall. It is likely that acidity, in the form of organic acids, acidic cations and oxidation products, accumulates in Salt Creek and Marshy Creek during drier periods when there is no or limited surface water flow. Acidification events in the Anglesea River estuary have usually occurred when extended dry periods have preceded high rainfall events causing accumulated acidity to be flushed from the upper catchment swamps in to Salt Creek and Marshy Creek, which is then transported downstream. While acidic events can occur naturally in Salt Creek and Marshy Creek, reduced groundwater levels in the UEVF aquifer has historically contributed to increased drying events and oxidation of sulfidic materials to form acid sulfate soils. In the past, acidic events have occurred during periods when Barwon Water have not been pumping from the LEVF ie. outside of the period 2009 – 2012 and 2019 (Site A5 Anglesea River Estuary; EstuaryWatch, 2020).

This study will conduct the acid sulfate soil investigation required for the Monitoring Assessment Program (MAP) required by Barwon Water for groundwater extraction. The terms of reference for this study are to:

a) undertake a soil sampling program to complete a Potential Acid Sulfate Soil (PASS) investigation of Salt Creek and Anglesea Swamplands;
b) assess the perched groundwater chemistry within the swamplands to quantify the level of acidity currently present;
c) provide preliminary estimates of acid runoff from the swampland;
d) if possible, determine the contribution to the total acid flux present in the swamplands;
e) where necessary, identify any additional monitoring requirements and developing management options to manage or mitigate any potential impacts of taking groundwater under the bulk entitlement.

2. Field Site

Salt Creek and Marshy Creek (also known as the Anglesea Swamplands) are located to the north of the main Anglesea township, which is approximately 115 km southwest of Melbourne. The geology of the area is dominated by the Eastern View Formation (EVF); a highly variable mixture of fluvial and alluvial sediments containing abundant silts, quartz sands, coals, and carbonaceous clays (Hancock, 1967). The catchment contains significant sulfur reserves with extensive pyritic shale and siltstone strata, and coal sulfur levels exceeding 5% (w/w dry basis) in places (Holdgate, 2001). It is likely that the pyritic coals and sediments, in combination with tea tree marshes (swamps) are a source of acid generation in the catchment (Maher 2011).

The Anglesea River is 17.5 km long with a catchment area of 125 km^2. Salt Creek and Marshy Creek are the two primary tributaries of the Anglesea River, which flow intermittently and have a seasonal discharge. The two tributaries comprise half of the riverine catchment area and are approximately similar in length (Pope 2006). Both tributaries support extensive swampland areas. The swamplands of Salt Creek can be up to 190 m wide, while those of Marshy Creek are up to 430 m wide. The estimated area of the swampland areas of Marshy Creek and Salt Creek are 224 ha and 93 ha, respectively (Glover 2014). The confluence of Salt Creek and Marshy Creek is located upstream of Alcoa's decommissioned power station The two tributaries join the Anglesea River approximately 1 km upstream of the estuarine limit with the length of the Anglesea River estuary estimated to be 2.6 km (Pope 2006). The lower reaches of Salt Creek have been diverted around a decommissioned open-cut brown coal mine previously operated by Alcoa via a concrete channel.

The dominant Ecological Vegetation Classes (EVCs) in the Salt Creek and Marshy Creek swamplands include Swamp Scrub, Aquatic Sedgeland and Heathy Woodland (Rodda et al. 2017)

Salt Creek and Marshy Creek are ephemeral waterways, which do not flow for approximately 65% and 50% of the year, respectively, with Marshy Creek contributing a greater proportion of baseflow to the Anglesea River compared to Salt Creek. The flow regimes during high rainfall events differ between the two waterways. Peak flows are higher with a shorter duration in Salt Creek, while peak flows are lower and of longer duration in Marshy Creek. Average daily flow in both Salt Creek and Marshy Creek has been decreasing since 1975. The Millennium Drought (1996-2010) significantly reduced surface water flows, and these have also been further impacted by groundwater drawdown from mine dewatering (GHD 2019b).

3. Materials and Methods

3.1 Field Sampling

Field sampling of the Marshy Creek sites was undertaken in November 2017 and sampling of the Salt Creek sites occurred in January 2018. Sites were located along the course of the two creeks, however, could not be established every 100 m, as recommended by the National Guidelines (Sullivan et al. 2018b) due to limitations in accessing the swamp. Instead, sites were located where access was available.

Where possible, the sites were sampled with a gouge auger to the maximum depth where resistance occurred. In those sites where sampling with a gouge auger was not possible, samples were collected using a Russian D-section auger, and in drier sites, a standard bucket auger was used. Samples were taken every 0.5 m, as stated by the National Guidelines, or where there was a change in horizon or facies. Samples were placed in to a freezer and kept frozen until analysis.

The location of the field site is shown in Figure 3.1.

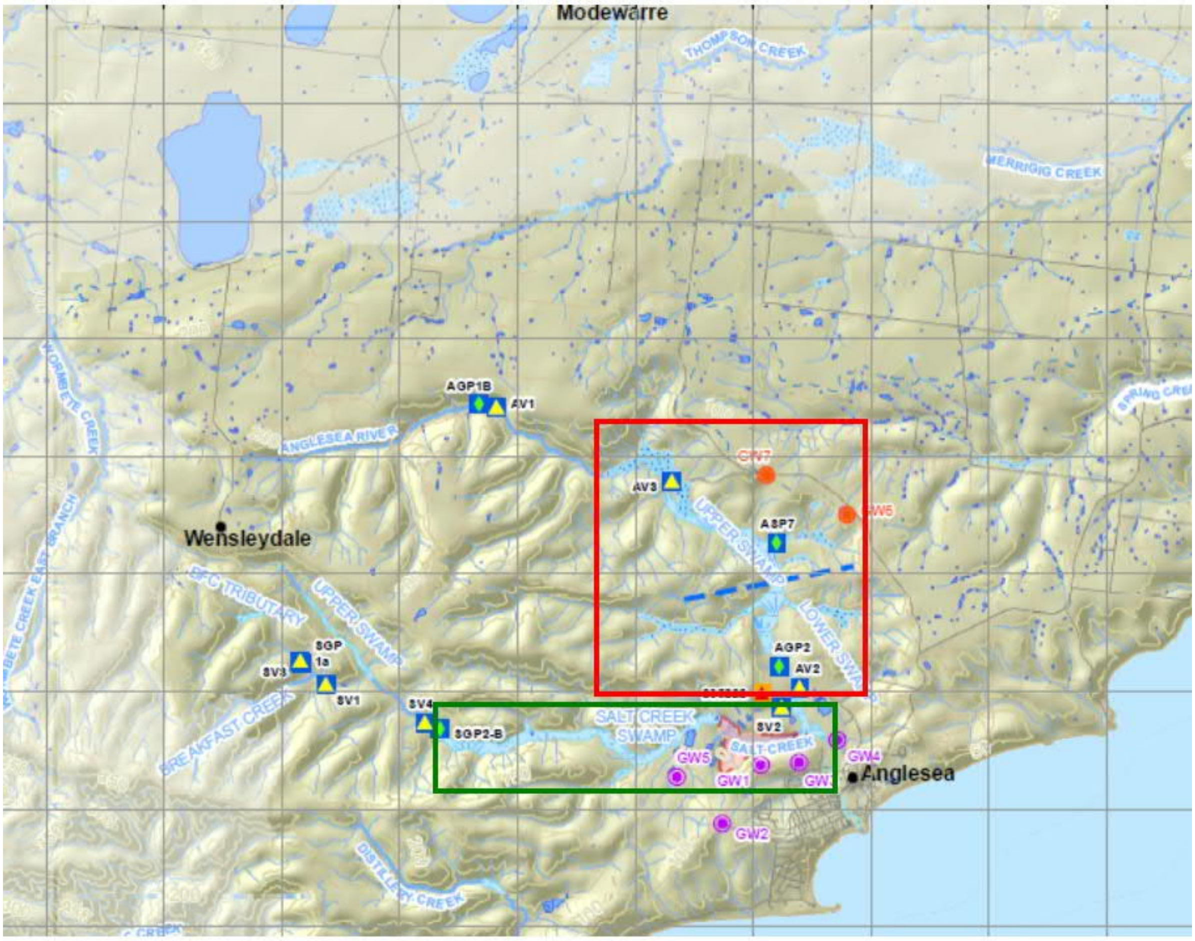


Figure 3.1. Location of Marshy Creek (red) and Salt Creek (green) relative to groundwater monitoring bores managed by Barwon Water

3.2 Laboratory Analysis

Samples were thawed under N_2 atmosphere, dried at 80ºC, lightly crushed and sieved to <2mm prior to geochemical characterisation. Soil pH, electrical conductivity (EC) and soluble cations (metals and salts) and anions were determined on 1:5 soil:water extracts. Exchangeable cations (metals and salts) were extracted with 1M ammonium acetate (NH_4OAc) at a ratio of 1:5 soil:extract (Rayment and Lyons 2011). Soluble and exchangeable cations and anions were analysed by inductively coupled plasma-mass spectroscopy (ICP-MS). Soil organic carbon (SOC) and total N were determined by high combustion analysis on a total carbon and nitrogen analyser. Particle size distribution (i.e. sand, silt and clay distribution) was determined by laser diffraction on a Beckman Coulter Mastersizer following pre-treatment with 5% tetra-sodium pyrophosphate to remove organic matter.

Titratable actual acidity (TAA) and acid neutralising capacity (ANC) were determined on oven-dried samples. TAA was determined by titration with 0.05M NaOH to pH 7.0 on 1:40 soil:1M KCl extracts after shaking for 4 h where the pH_{KCl} < 6.5 (Rayment and Lyons 2011). Where the pH > 6.5, ANC was determined by titration with 0.25 M NaOH to pH 7.0 on 1:25 soil:0.1 M HCl suspensions (Rayment and Lyons 2011).

Reduced inorganic sulfur (RIS) was determined based on a sequential extraction process (Burton et al. 2008)). Acid volatile sulfide (AVS-S, which quantifies monosulfides), and chromium reducible sulfur

(CRS-S, which quantifies pyrite and elemental S^0) were determined using this sequential extraction process.

Net acidity was calculated by acid-base accounting to evaluate the potential for soil and sediments materials to generate acidity from sulfide oxidation and the neutralisation potential of the sediments (Ahern et al. 2004).

Net acidity was calculated according to the Equation 2.

Net acidity = Potential sulfidic acidity + actual acidity + retained acidity – acid neutralising capacity Equation 2.

The environmental hazards associated with acidification, metal mobilisation and deoxygenation of surface water were then classified into hazard levels using criteria set out in Dear et al. (2002) and Ahern et al. (1998), shown in Table 3.1

Table 3.1. ASS hazard levels (Dear et al. (2002) and Ahern et al. (1998).

Hazard type	Criteria	Hazard level
Acidification	pH > 4; negative net acidity	Low
	pH > 4; positive net acidity	Medium
	pH < 4; positive net acidity	High
Metal Mobilisation	pH > 4; negative net acidity	Low
	pH > 4; positive net acidity	Medium
	pH < 4; positive net acidity	High
Deoxygenation	surface soils (0-20 cm) contain ⩽ 0.10% AVS-S	Low
	surface soils (0-20 cm) contain≥ 0.10% AVS-S	High
Monosulfide formation		
	Surface soils ≥ 100 mg/kg SO_4^{2-})	Potential

4. Marshy Creek (Anglesea Swamplands)

28 sites were sampled in Marshy Creek to a maximum depth of 140 cm (Figure 4.1). Sites are grouped and discussed according to location along Marshy Creek:

- Upper Swamplands Tributary (MSC1 – 3)
- Upper Swamplands (MSC4 – 11)
- Mid-Swamplands Tributary (MSC12-15)
- Mid-Swamplands (MSC16-19)
- Lower Swamplands Tributary (MSC20 and 27)
- Lower Swamplands (MSC21-26; MSC28)

Site access in the swamplands was impeded by dense vegetation, and therefore, sites were selected as far as practicable from the edge of the swamp. At the time of sampling, the depth to the watertable varied from surface water to > 103 cm (Table 4.1).

Data for individual sites can be found in Appendix 1.

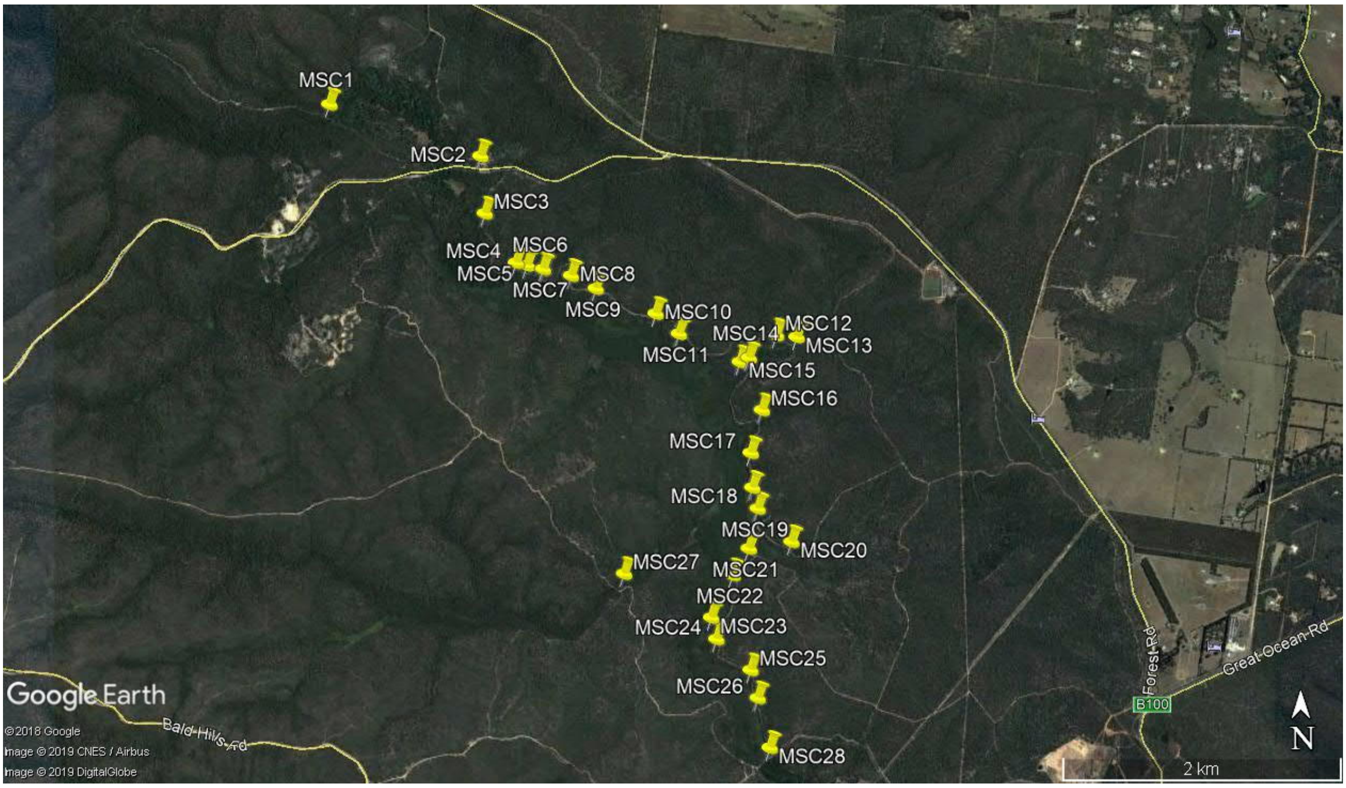


Figure 4.1 Location of Marshy Creek Sampling sites

Table 4.1. Mean depth to watertable at time of sampling (November 2017)

Sites	Mean depth to watertable (cm)
Upper swamplands tributary	26
Upper swamplands	29
Mid-swamplands tributary	Did not reach watertable
Mid swamplands	51.5 (watertable intercepted only at Sites MSC18-19)
Lower swamplands tributary	MSC20: 85 MSC27: 40
Lower swamplands	43

4.1 Soil characterisation

Generally, the soils in the Swamplands sites were all acidic, saline and had high concentrations of soil organic carbon (SOC). The sites located in the tributaries varied, however, and the highest pH, lowest EC and lowest SOC concentrations were generally found at those sites.

4.2 Acidification hazard and potential

The net acidity values in all sites at all depths were all positive which was primarily in the form of labile or existing acidity, measured by titratable actual acidity (TAA). The action criteria triggering the need for the development of an Acid Sulfate Soil Management Plan is 18 mol H^+/t for peat sites (Sullivan et al. 2018a), which all of the sites exceed. The sites generally contain extremely high net acidity values, which show a general increase downstream towards the estuary. The tributary sites have the lowest net acidity values. There were limited sites where reduced acidity (measured as CRS) was identified, and the sites with CRS content were primarily found in the Mid-Swampland sites. No acid neutralising capacity was found in these sites as pH_{KCl} < 6.5 in all samples.

The mean net acidity (Table 4.2) in the Upper Swamplands Tributary sites ranged from 33 – 72 mol H^+/t, in the Mid-Swamplands Tributary sites from 77- 242 mol H^+/t, and Lower Swampland Tributary sites ranged from 85 – 252 mol H^+/t. In the main swampland sites, the mean net acidity of the Upper Swampland sites ranged from 152 – 3046 mol H^+/t, in the Mid Swamplands sites ranged from 123 – 361 mol H^+/t, and in the Lower Swamplands sites ranged from 221 – 429 mol H^+/t.

Table 4.2 Mean net acidity ranges in Marshy Creek

Sites	Mean net acidity range
Upper Swamplands Tributary	33 – 72 mol H^+/t
Mid-Swamplands Tributary	77- 242 mol H^+/t
Lower Swampland Tributary	85 – 252 mol H^+/t
Upper Swampland	152 – 3046 mol H^+/t
Mid Swamplands	123 – 361 mol H^+/t
Lower Swamplands	221 – 429 mol H^+/t

RIS concentrations were detected at depth and were dominated by CRS-S, which is a measure of pyrite, was found at sites throughout the sampled area. Concentrations of CRS-S were up to 11% indicating an extremely high potential for acidification.

A strong indicator of an additional source of SO_4^{2-} from RIS oxidation is where the $SO_4^{2-}:Cl^-$ > 0.5 (Mulvey 1993). The $SO_4^{2-}:Cl^-$ ratios of all of the sites in the main Swampland sites were generally all greater than 0.5 (Table 4.3). The $SO_4^{2-}:Cl^-$ ratio of the Upper Swampland Tributary sites ranged from 0.7 – 3.1, in the Mid-Swampland Tributary sites ranged from 0.2 – 5.0, and the Lower Swampland Tributary sites ranged from 0.5 – 1.6. The $SO_4^{2-}:Cl^-$ ratio of the Upper Swampland sites ranged from 0.4 – 5.0, in the Mid-Swampland sites ranged from 0.5 – 1.5, and the Lower Swampland sites ranged from 0.5 – 11.9.

Table 4.3 SO_4^{2-}:Cl ratios in Marshy Creek

Sites	SO_4^{2-}:Cl ratio range
Upper Swampland Tributary	0.7 – 3.1
Mid-Swampland Tributary	0.2 – 5.0
Lower Swampland Tributary	0.5 – 1.6
Upper Swampland	0.4 – 5.0
Mid-Swampland	0.5 – 1.5
Lower Swampland	0.5 – 11.9

These sites pose a significant acidification hazard, with high concentrations of acidity present in the profiles throughout the swamp. The environmental hazards associated with acidification, metal mobilisation and deoxygenation of surface water according to criteria set out in Dear et al. (2002) and Ahern et al. (1998) of each site is shown in Table 4.4. The hazard levels were identified according to criteria described in Table 3.1. The potential for monosulfide formation was high at all sites except MSC2 due to the high concentrations soluble SO_4^{2-}.

Table 4.4 Acidification, metal mobilisation, deoxygenation of surface water and monosulfide formation hazard

Site	Hazard Type and Condition			
	Acidification	Metal Mobilisation	Deoxygenation	Monosulfide Formation
MSC1	High (Current)	High (Current)	Low	Potential
MSC2	High (Current)	High (Current)	Low	-
MSC3	High (Current)	High (Current)	Low	Potential
MSC4	High (Current)	High (Current)	Low	Potential
MSC5	High (Current)	High (Current)	Low	Potential
MSC6	High (Current)	High (Current)	Low	Potential
MSC7	High (Current)	High (Current)	Low	Potential
MSC8	High (Current)	High (Current)	Low	Potential
MSC9	High (Current)	High (Current)	Low	Potential
MSC10	High (Current)	High (Current)	Low	Potential
MSC11	High (Current)	High (Current)	Low	Potential
MSC12	High (Current)	High (Current)	Low	Potential
MSC13	High (Current)	High (Current)	Low	Potential
MSC14	High (Current)	High (Current)	Low	Potential
MSC15	High (Current)	High (Current)	Low	Potential
MSC16	High (Current)	High (Current)	Low	Potential
MSC17	High (Current)	High (Current)	Low	Potential
MSC18	High (Current)	High (Current)	Low	Potential
MSC19	High (Current)	High (Current)	Low	Potential
MSC20	High (Current)	High (Current)	Low	Potential
MSC21	High (Current)	High (Current)	Low	Potential
MSC22	High (Current)	High (Current)	Low	Potential
MSC23	High (Current)	High (Current)	Low	Potential
MSC24	High (Current)	High (Current)	Low	Potential
MSC25	High (Current)	High (Current)	Low	Potential
MSC26	High (Current)	High (Current)	Low	Potential
MSC27	High (Current)	High (Current)	Low	Potential
MSC28	High (Current)	High (Current)	Low	Potential

4.3 Metal and metalloid mobilisation

Metal concentrations shown in Appendix 1 are soluble metals which have been extracted with water ie. the concentration of metals that are soluble in water in a 1:5 soil:water extract. This can provide useful information on the water soluble metal concentrations in the sampled soils and represents the metal pool that can be readily dissolved, mobilised and transported via channels in to surface waters and shallow groundwater following rainfall events.

The trigger values for freshwater systems in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality are shown in Table 4.5 (ANZECC/ARMCANZ 2000) and are the trigger levels for surface waters. There is the potential to exceed these trigger values following episodic high rainfall events due to the high concentrations of soluble metals and metalloids in the soils in acidic conditions (Table 4.6).

Table 4.5 Australian and New Zealand Water Quality Guidelines Trigger values for freshwater systems.

Metal/Metalloid	Level of Protection (% of species) (Concentrations in μg/L)			
	99	95	90	80
Al (pH > 6.5)	27	55	80	150
As (as As III)	1	224	94	360
As (as As V)	0.8	13	42	140
Cu	1.0	1.4	1.8	2.5
Fe	ID	ID	ID	ID
Mn	1200	1900	2500	3600
Ni	8	11	13	17
Zn	2.4	8.0	15	31

ID – There is insufficient data is available to derive a reliable trigger value. The current Canadian guideline level is 300 μg/L, which could be used as an interim indicative working level but further data are required to establish a figure appropriate for Australian and New Zealand Waters ((ANZECC/ARMCANZ 2000).

Metal and metalloid concentrations were generally higher in the main Swampland sites compared to the Tributary sites. A summary of the maximum concentration of selected metals and metalloids in each section of Marshy Creek is shown in Table 4.6.

Table 4.6 Maximum concentration of selected soluble metals and metalloids in Marshy Creek

Site	Al (mg/kg)	As (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)
Upper Swampland Tributaries	28.43	0.02	0.05	18.05	1.09	0.68	2.18
Mid-Swampland Tributaries	87.80	0.05	0.04	923.00	15.84	1.79	3.24
Lower Swampland Tributaries	28.43	0.01	0.05	82.80	3.55	0.17	0.77
Upper Swamplands	486.90	0.60	0.05	490.90	18.02	21.60	25.58
Mid-Swamplands	122.00	0.02	0.06	178.90	2.96	0.32	1.11
Lower Swamplands	1295.00	0.17	0.06	1357.00	22.14	35.32	12.80

5. Salt Creek

25 sites were sampled in Salt Creek to a maximum depth of 140 cm (Figure 5.1). Sites will be grouped and discussed according to location along Salt Creek:

- Tributary sites (STC1, 6 and 18)
- Upper Swamplands (STC2-5)
- Mid-Swamplands (STC7-17)
- Lower Swamplands (STC19-21)
- Lower Channel (STC22-25)

Site access in the swamplands was impeded by limited tracks, poor conditions of the track and dense vegetation. Therefore, sites were selected where access was available and as far as practicable from the edge of the swamp. At the time of sampling, the depth to the watertable varied from surface water to > 103 cm (Table 5.1).

Data for individual sites can be found in Appendix 2.

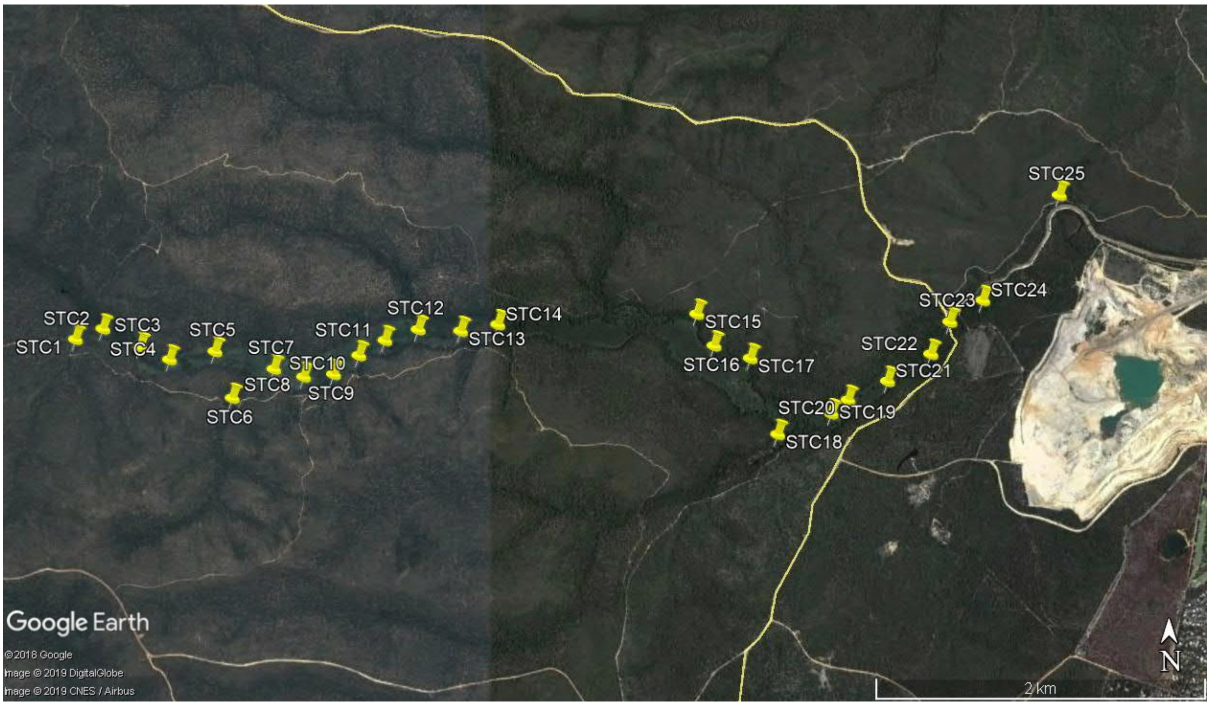


Figure 5.1 Location of Salt Creek Sampling sites

Table 5.1. Mean depth to watertable at time of sampling (January 2018)

Sites	Mean depth to watertable (cm)
Tributary sites	STC1: 75 STC6: did not reach watertable STC18: 72
Upper Swamplands	68
Mid Swamplands	84 (watertable intercepted only at Sites STC7, 8, 9 and 11)
Lower Swamplands	Did not reach watertable
Lower Channel	STC22: did not reach watertable STC23: surface water STC24: did not reach watertable STC25: did not reach watertable

5.1 Soil characterisation

The soils in the Swamplands sites were all acidic (pH <5). However, in contrast to the sites sampled in Marshy Creek, the soils would not be considered saline ($EC_{1:5}$ < 400 μS/cm). While some sites had high concentrations of SOC, the SOC concentrations in the Salt Creek sites were generally lower than those found at Marshy Creek.

5.2 Acidification hazard and potential

The net acidity values in all sites at all depths were in the positive (Table 5.2), and was generally dominated by labile or existing acidity, measured by titratable actual acidity (TAA). The action criteria triggering the need for the development of an Acid Sulfate Soil Management Plan is 18 mol H^+/t for peat sites (Sullivan et al. 2018a), which is exceeded at all of the sites. The sites generally contain extremely high net acidity values, with the highest values found in the Mid-Swamplands sites. The lowest net acidity values were found at the upstream and downstream extremes of the sampled sites, at STC1 and STC25, with net acidity generally < 100 mol H^+/t. A number of sites contained measurable concentrations of retained acidity, in contrast to the Marshy Creek sites. Only the Lower Swampland sites had no measurable retained acidity. Sites with AVS and CRS content were primarily found in the Lower Channel sites. No acid neutralising capacity was found in these sites as pH_{KCl} < 6.5 in all samples.

The mean net acidity in the Tributary sites ranged from 71 – 255 mol H^+/t and t and Lower Channel sites ranged from 43 - 101 mol H^+/t. In the main Swampland sites, the mean net acidity in the Upper Swamplands sites ranged from 137- 285 mol H^+/t, Mid Swampland sites ranged from 205 – 381 mol H^+/t, Lower Swamplands sites ranged from 252- 362 mol H^+/t. The Mid-Swampland sites all contained appreciable concentrations of retained acidity, with the highest concentrations (> 90 mol H^+/t) found at depth (110 – 130 cm) at STC17 suggesting oxidation of sulfidic sediments had occurred at depth.

Table 5.2 Mean net acidity at Salt Creek

Sites	Mean net acidity range
Tributary sites	71 – 255 mol H^+/t
Upper Swamplands	137- 285 mol H^+/t
Mid Swamplands	205 – 381 mol H^+/t
Lower Swamplands	252- 362 mol H^+/t
Lower Channel	43 - 101 mol H^+/t

For a number of sites across the sample area RIS concentrations were detected at depth and were dominated by CRS-S, which is a measure of pyrite,. AVS-S, a measure of monosulfides, was found at the Tributary sites and the Lower Channel sites. The presence of AVS-S, particularly at the surface, suggests formation of new sulfidic material and a source of acidity which can be rapidly oxidised if watertables decrease. Concentrations of CRS-S were up to 0.05%-S and AVS-S were up to 0.02%-S.

A strong indicator of an additional source of SO_4^{2-} from RIS oxidation is where the SO_4^{2-}:Cl^- > 0.5 (Mulvey 1993). The ratios of all of the sites in the main Swampland sites were all greater than 0.5 (Table 5.3). The SO_4^{2-}:Cl^- in the Salt Creek sites were all substantially higher than those found at the Marshy Creek sites, indicating an excess of SO_4^{2-} which is supported by the retained acidity values.

Table 5.3 SO_4^{2-}:Cl^- ratios at Salt Creek

Sampling group	SO_4^{2-}:Cl ratio range
Tributary sites	0.2 – 14.1
Upper Swamplands	0.6 – 4.5
Mid Swamplands	0.1 – 20.5
Lower Swamplands	8.7 – 13.9
Lower Channel	0 – 9.8

The SO_4^{2-}:Cl^- ratio of the Tributary sites ranged from 0.2 – 14.1, in the Lower Channel sites ranged from 0, where no SO_4^{2-} was detected, to 9.8. The SO_4^{2-}:Cl^- ratio of the Upper Swampland sites ranged from 0.6 – 4.5, in the Mid-Swampland sites ranged from 0.1 – 20.5, and the Lower Swampland sites ranged from 8.7 – 13.9.

The Salt Creek sites, much like the Marshy Creek sites, pose a significant acidification hazard due to the high concentrations of acidity present in the profiles throughout the swamp (Table 5.4). The environmental hazards associated with acidification, metal mobilisation and deoxygenation of surface water according to criteria are described in Table 3.1

Table 5.4 Acidification, metal mobilisation, deoxygenation of surface water and monosulfide formation hazard

Site	Hazard Type and Condition			
	Acidification (High: pH <4; +ve net acidity Medium: pH>4; +ve net acidity)	Metal Mobilisation (High: pH <4; +ve net acidity Medium: pH>4; +ve net acidity)	Deoxygenation (surface soils ≤ 0.10% AVS-S)	Monosulfide Formation (surface soils ≥ 100 mg/kg SO_4^{2-})
STC1	Medium	Medium	Low	-
STC2	Medium	Medium	Low	Potential
STC3	High (Current)	High (Current)	Low	Potential
STC4	High (Current)	High (Current)	Low	Potential
STC5	Medium	Medium	Low	Potential
STC6	Medium	Medium	Low	Potential
STC7	High (Current)	High (Current)	Low	Potential
STC8	High (Current)	High (Current)	Low	Potential
STC9	High (Current)	High (Current)	Low	Potential
STC10	High (Current)	High (Current)	Low	Potential
STC11	High (Current)	High (Current)	Low	Potential
STC12	High (Current)	High (Current)	Low	Potential
STC13	High (Current)	High (Current)	Low	Potential
STC14	High (Current)	High (Current)	Low	Potential
STC15	High (Current)	High (Current)	Low	Potential
STC16	High (Current)	High (Current)	Low	Potential
STC17	High (Current)	High (Current)	Low	Potential
STC18	High (Current)	High (Current)	Low	Potential
STC19	High (Current)	High (Current)	Low	Potential
STC20	High (Current)	High (Current)	Low	Potential
STC21	High (Current)	High (Current)	Low	Potential
STC22	High (Current)	High (Current)	Low	Potential
STC23	High (Current)	High (Current)	Low	Potential (at depth)
STC24	High (Current)	High (Current)	Low	Potential
STC25	High (Current)	High (Current)	Low	Potential

5.3 Metal and metalloid mobilisation

The metal concentrations shown in Appendix 2 are soluble metals which have been extracted with water ie. the concentration of metals that are soluble in water in a 1:5 soil:water extract. This can provide useful information on the water soluble metal concentrations in the sampled soils and represents the metal pool that can be readily dissolved, mobilised and transported via channels in to surface waters and shallow groundwater following rainfall events.

Metal and metalloid concentrations were generally higher in the Mid-Swampland sites compared to the other sampled sites. A summary of the maximum concentration of selected metals and metalloids in each section of Salt Creek is shown in Table 5.5.

Table 5.5 Maximum concentration of selected soluble metals and metalloids in Salt Creek

Site	Al (mg/kg)	As (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)
Salt Creek Tributaries	41.74	0.02	0.04	22.47	4.12	0.72	1.85
Lower Channel	94.50	0.03	0.06	45.47	3.82	1.95	3.66
Upper Swamplands	54.60	0.05	0.05	93.20	0.55	0.44	2.44
Mid-Swamplands	260.00	0.05	0.08	247.20	56.90	3.74	4.92
Lower Swamplands	131.1	0.03	0.03	163.40	7.19	2.19	4.24

6. Acidity in the Salt Creek and Anglesea Swamplands

This study identified three pools of acidity at each site: i) potential sulfidic acidity, sourced from sulfidic sediments containing pyrite and monosulfides; ii) labile acidity, which is existing acidity and can be rapidly mobilised; and iii) retained acidity, which is existing latent acidity usually stored in minerals such as jarosite.

Both Salt Creek and Marshy Creek contain substantial volumes of acidity in a form that can be mobilised rapidly. Marshy Creek contains higher concentrations of labile acidity which can be transported readily in surface water and groundwater, whereas Salt Creek contains higher concentrations of retained acidity which can be slowly released over time. Both sites contain sulfidic acidity which can be oxidised when watertables are lowered.

Labile acidity quantifies existing acidity and is the volume of acidity that has previously oxidised. Retained acidity is slowly released by hydrolysis of insoluble SO_4^{2-} salts. These insoluble salts include jarosite, aluminium hydroxy-sulfate minerals, schwertmannite and natrojarosite while potential sulfidic acidity is a latent acidity (Ahern et al. 2004).

High concentrations of SO_4^{2-} throughout the sampling areas of both Salt Creek and Marshy Creek suggest that oxidation of sulfidic materials have occurred in the past. This may have been the result of historic wetting and drying cycles, as suggested by GHD (2013). The SO_4^{2-}:Cl^- ratios in Salt Creek were generally higher than those found at Marshy Creek, which suggests that oxidation may have been more extensive in the Salt Creek catchment. The high SO_4^{2-} concentrations can increase the potential monosulfide formation hazard, particularly if a labile source of organic carbon is available. Iron monosulfides (FeS) can form rapidly under waterlogged conditions, in the order of weeks to months, and are highly reactive. Mobilisation and oxidation of sediments which contain monosulfides can rapidly deoxygenate and acidify surface waters and adversely affect aquatic ecosystems.

Both Salt Creek and Marshy Creek contain soils with metal concentrations which are high enough to result in ANZECC Water Quality Guidelines being exceeded downstream. Only the soluble metal pool was quantified in this study, which represents a pool which can be easily dissolved and mobilised, particularly in conjunction with the low pH conditions in the study area. The primary metals to note are Al, Cu, Fe, Mn, Ni and Zn. These soluble metals can be readily transported laterally, and with depth to the perched aquifers which underlie the swamps and are therefore likely to be significant contributions to shallow groundwater chemistry. This is supported by high EC values in the sites located in the swamplands, and low EC values in the tributary and channel sites. Dissolution of salts and mobilisation of metals will increase salinity, reflected in high EC values.

Using the upper and lower estimates of net acidity determined in the Mid-Swamplands sites in both Salt Creek and Marshy Creek, the volume of acidity contained across the swamplands can be estimated to a depth of 10 cm, and assuming a bulk density of 1 Mg/m^3 for peat sites (Sullivan et al. 2018a). Marshy Creek has an area of 224 ha which contains between 2.58 x 10^6– 2.18 x 10^8 mol H^+ in the surface 0 – 10 cm of soil which would require a liming rate of up to 76 t/ha of Ag lime (including 1.5 safety factor) to neutralise at MSC26 which had the highest surface net acidity. Salt Creek with an area of 93 ha, contains between 6.18 x 10^6– 1.19 x 10^8 mol H^+ in the surface 0 – 10 cm of soil which would require a liming rate of up to 100 t/ha of Ag lime (including 1.5 safety factor) to neutralise at SCK13 which had the highest surface net acidity. It should be noted that these figures are an estimate of the acidity in the surface 10 cm only, and that the peat layers in both Salt Creek and Marshy Creek can exceed 100 cm in depth in some areas. Labile acidity, measured by TAA, generally increased with increasing SOC concentrations (Figure 6.1). Labile acidity is acidity that can be readily mobilised with rainfall.

It is assumed that the acidity quantified is underestimated due to the challenges in accessing the middle of the swamplands. It is likely that the thalweg of the swamps contains higher concentrations of RIS and therefore, higher volumes of potential acidity. Furthermore, the variations in peat depth and acidity concentrations laterally across the width of the swamp are unknown. Current investigations in a similar environment at Big Swamp (also known as Yeodene Swamp; P. Cook pers comm.) have suggested that peat depth and RIS concentrations are likely to be highly heterogenous across the swamplands, both laterally and with depth

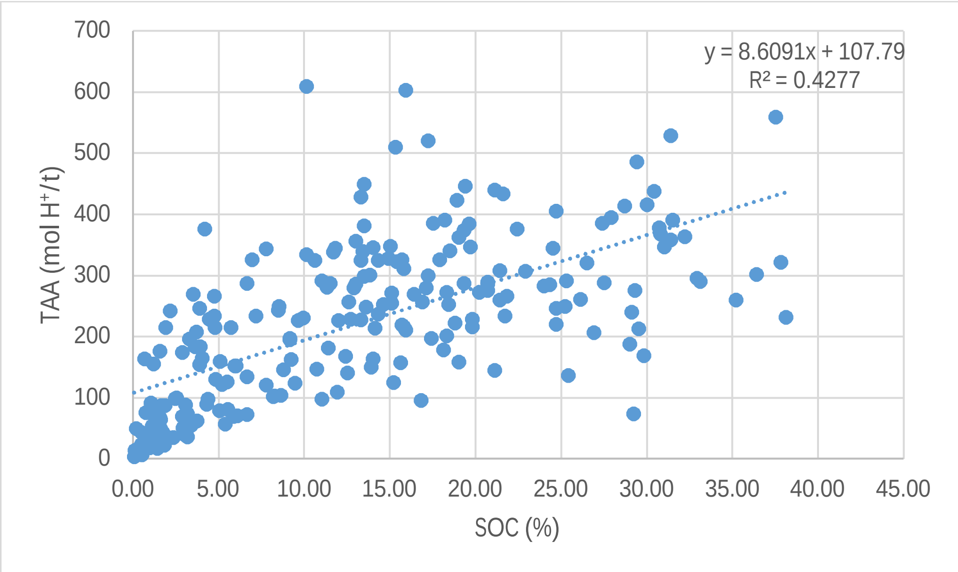


Figure 6.1. Relationship between SOC concentrations and TAA in both Marshy Creek and Salt Creek

7. Impacts of Groundwater Extraction

Connectivity between the perched water table aquifer (PWT), and the Lower Eastern View Formation (LEVF) and Upper Eastern View Formation (UEVF) aquifers is uncertain in the Anglesea swamplands (both Salt Creek and Marshy Creek). Future data collection from continued monitoring and potential additional monitoring bores will address this gap. The locations of the monitoring bores are biased towards accessible locations. This is particularly important the Mid-Swamplands of both Salt Creek and Marshy Creek, which contain appreciable concentrations of RIS which can oxidise during lower watertable conditions.

The effect of extraction of groundwater from the Anglesea Borefield in terms of acid generation in both Salt Creek and Marshy Creek cannot be determined with certainty without further information about the connectivity between the PWT and other aquifers. Whilst the swamplands are separated from the underlying aquifer systems by the MEVF aquitard, GHD (2013) identified that baseflow from underlying aquifers may contribute to the recharge of the perched watertable in the Marshy Creek Swamplands, which have a higher acid generating potential compared to the Salt Creek Swamplands. Lower groundwater levels in the UEVF in the past will have contributed to lower levels of soil moisture and oxidation of sulfidic materials (GHD 2019b). Pumping from the LEVF aquifer can also slow the recovery in the UEVF aquifer (GHD 2015).

It should be noted that the thalweg of these swamps is inaccessible without the construction of tracks, and it is possible that RIS concentrations are most likely higher towards the middle of the channels and closer to the surface. GHD (2013) modelled a drawdown of up to 8 m under a dry climate scenario, which can affect oxidation across the Swamplands. Protective groundwater trigger levels were implemented through Barwon Water's Bulk Entitlement to minimise this risk and limit the occurrences of significant PWT drawdowns. Furthermore, given the relationship between SOC and acidity (Figure 6.1), an understanding of the depth of the peat layers and the depth to the RIS layers needs to confirmed to ascertain acidification as a function of decreasing water levels.

Some of the RIS layers occur either at or near the land surface. Therefore, prolonged periods of lower PWT levels, which may be caused by seasonal variations or prolonged dry periods, can also oxidise shallow (ie. those at or near the land surface) RIS layers leading to acidic discharges in subsequent flushing events.

8. Additional Management and Monitoring

The sampling protocol and analytical methods are consistent with the National Acid Sulfate Soil Guidance (Sullivan et al. 2018a; Sullivan et al. 2018b) and can therefore be repeated in a monitoring program. The locations of the sampling sites are reasonably accessible for repeated sampling to determine changes over time in both Salt Creek and Marshy Creek. Wetting and drying regimes as a function of climate variations or groundwater extraction will affect formation of sulfidic materials and their oxidation, and the acidification of and metal mobilisation within soils, surface water and groundwater at timescales relevant to a monitoring program.

Current monitoring can only identify acidification events during or after oxidation has occurred. An understanding of the relationship between the lower aquifers and PWT as a function of extraction, and additional monitoring sites located within the Swamplands are required to monitor risks of acidification. Current monitoring relies on groundwater trigger levels at two bores located in Marshy Creek (Bores P19 and P8) with levels established using a short term dataset covering 3-4 years (GHD 2015). It is recommended that the trigger levels and groundwater data and modelling are reviewed with a longer term calibrated dataset. The Salt Creek Swamplands are distinct from the Marshy Creek Swamplands in terms of the soil geochemistry and geomorphology. It is recommended that the relevance of the groundwater trigger levels established for Marshy Creek are reviewed in terms of their relevance to the Salt Creek Swamplands, and establish groundwater trigger levels specific to the Salt Creek Swamplands

Acidification events in the Anglesea River estuary can occur naturally, and management actions can also alter the frequency and magnitude of acidification events. It is recommended that higher frequency monitoring of surface water locations be undertaken (eg. Lower Swamplands) in both Salt Creek and Marshy Creek, and establishment of an additional monitoring site in the Mid-Swamplands for Salt Creek for pH and EC where possible. This will allow for an adaptive approach to managing acidification events within the Anglesea River catchment as a whole in collaboration with other relevant natural resource management organisations. Where possible, the frequency of monitoring for surface water quality parameters should be increased to weekly, particularly in the Lower Swampland monitoring sites.

9. Summary

This study investigated the distribution and characterisation of acid sulfate soils in the Salt Creek and Marshy Creek Swamplands, also known as the Anglesea Swamplands.

The swamplands of Marshy Creek were all acidic, saline and had high concentrations of soil organic carbon (SOC). Conversely, the sites located in the tributaries had the higher pH vales, lower EC and SOC concentrations. The Marshy Creek Swamplands were characterised by:

- Extremely high net acidity values of up to 7168 mol H^+/t (note that an Acid Sulfate Soil Management Plan is triggered when net acidity > 18 mol H^+/t)
- Significant acidification, metal mobilisation and monosulfide formation hazard
- Evidence of previous sulfide oxidation identified from SO_4^{2-}:Cl^- > 0.5 in most sites
- Extremely high concentrations of soluble metals including Al, Cu, Fe, Mn, Ni and Zn which can directly contribute to shallow groundwater chemistry and deleteriously impact on aquatic ecosystems
- A preliminary estimate of up to 2.58 x 10^8 mol H^+ in the surface 0 – 10 cm of soil in the 224 ha swamplands area which would require a liming rate of up to 76 t/ha of Ag lime (including 1.5 safety factor) to neutralise

The swamplands, tributary and lower channel of Salt Creek were all acidic, but were not saline ($EC_{1:5}$ < 400 µS/cm). Some sites had high concentrations of SOC, however, SOC concentrations were generally lower than those found at Marshy Creek

The Salt Creek Swamplands were characterised by:

- Extremely high net acidity values of up to 609 mol H^+/t
- Significant acidification, metal mobilisation and monosulfide formation hazard
- Evidence of previous sulfide oxidation identified from SO_4^{2-}:Cl^- > 0.5 in most sites, with the ratio much higher than those found at Marshy Creek
- Extremely high concentrations of soluble metals including Al, Cu, Fe, Mn, Ni and Zn which can directly contribute to shallow groundwater chemistry and deleteriously impact on aquatic ecosystems
- A preliminary estimate of up to 6.18 x 10^8 mol H^+ in the surface 0 – 10 cm of soil in the 93 ha swamplands area which would require a liming rate of up to 100 t/ha of Ag lime (including 1.5 safety factor) to neutralise

It is recommended that additional monitoring should include:

- Determining the connectivity between the PWT, UEVF aquifer and LEVF aquifer with continued data collection to improve current understanding
- Determining the depth and thickness of the peat layer and sulfidic materials across the width of the Swamplands, focusing on the Mid-Swamplands of both Salt Creek and Marshy Creek where feasible
- Review groundwater data, trigger levels and modelling with a longer term dataset
- Establish groundwater trigger levels specific to the Salt Creek Swamplands
- Increasing the frequency of monitoring of surface water quality monitoring sites in the Upper, Mid- and Lower Swamplands in both Salt Creek and Marshy Creek where possible to monitor future acidification events in collaboration with relevant natural resource management organisations

References

Ahern CR, Stone Y, Blunden B (1998) Acid sulfate soils assessment guidelines. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW Australia.

Ahern CR, Sullivan LA, McElnea AE (2004) Laboratory methods guidelines 2004 - acid sulfate soils. In 'Queensland Acid Sulfate Soil Technical Manual.' (Department of Natural Resources, Mines and Energy: Indooroopilly, Queensland)

ANZECC/ARMCANZ (2000) 'Australian and New Zealand guidelines for fresh and marine water quality.' (Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand: Canberra)

Burton ED, Sullivan LA, Bush RT, Johnston SG, Keene AF (2008) A simple and inexpensive chromium-reducible sulfur method for acid-sulfate soils. Applied Geochemistry 23(9), 2759-2766.

Dear SE, Moore NG, Dobos SK, Watling KM, Ahern CR (2002) Soil management guidelines. In 'Queensland Acid Sulfate Soil Technical Manual. Department of Natural Resources and Mines, Indooroopilly.

Fitzpatrick RW, Hicks WS, Marvanek SP, Dahlhaus PG, Cox JW (2007) Scoping study of coastal and inland acid sulfate soil in the Corangamite CMA. CSIRO, Adelaide.

GHD (2013) Review of the numerical model outputs and an assessment of the implications of potential acid generation processes.

GHD (2015) Anglesea Borefield Project Sustainable Yield Assessment. Report for Barwon Water. 31/32799

GHD (2016) Anglesea Borefield Project Groundwater Quality Monitoring Results: 2015 (Year 6). Report for Barwon Water. 31/32669

GHD (2019a) Anglesea Borefield Operation Advice. Draft report prepared by GHD for Barwon Water

GHD (2019b) Angelsea Integrated Water Management Plan Anglesea Mine - High Level Concept Report prepared by GHD for Barwon Water

Glover F (2014) Characterisation of acid sulfate soils in south-western Victoria. Unpublished PhD thesis. La Trobe University

Grealish GJ, Fitzpatrick RW, Shand P (2014) Regional distribution trends and properties of acid sulfate soils during severe drought in wetlands along the lower River Murray, South Australia: Supporting hazard assessment. Geoderma Regional 2–3(0), 60-71.

Johnston SG, Slavich P, Hirst P (2004) The acid flux dynamics of two artificial drains in acid sulfate soil backswamps on the Clarence River floodplain, Australia. Australian Journal of Soil Research 42(6), 623-637.

Latimer JO (2015) Identifying sources of acidity in Salt Creek: an Anglesea River Tributary, Victoria. Australia. Unpublished honours thesis. Monash University

Maher W (2011) Anglesea River Water Quality Review. An Independent Review. . Geelong.

Mosley LM, Fitzpatrick RW, Palmer D, Leyden E, Shand P (2014a) Changes in acidity and metal geochemistry in soils, groundwater, drain and river water in the Lower Murray River after a severe drought. Science of The Total Environment 485–486(0), 281-291.

Mosley LM, Palmer D, Leyden E, Cook F, Zammit B, Shand P, Baker A, W. Fitzpatrick R (2014b) Acidification of floodplains due to river level decline during drought. Journal of Contaminant Hydrology 161(0), 10-23.

Mulvey P Pollution, prevention and management of sulphidic clays and sands. In 'Proceedings of the National Conference on Acid Sulphate Soils', 1993, Coolangatta,

Pope A (2006) Freshwater influences on hydrology and seagrass dynamics of intermittent estuaries. Deakin University,

Rayment GE, Lyons DJ (2011) 'Australian Laboratory Handbook of Soil and Water Chemical Methods.' (CSIRO Press: Australia)

Rodda A, Brook L, McMahon A (2017) Anglesea Borefield 2016 Terrestrial Ecology revised Monitoring Assessment Program. Ecology Australia, Fairfield, VIC.

Roussety HR (2014) Identifying sources of acidity in the upper catchment of the Anglesea River. Unpublished honours thesis. Monash University

Sammut J, White I, Melville MD (1995) Estuarine acidification: impacts on aquatic biota of draining acid sulphate soils. Australian Geographical Studies 33, 89-100.

Sammut J, White I, Melville MD (1996) Acidification of an estuarine tributary in eastern Australia due to drainage of acid sulfate soils. Marine and Freshwater Research 47(5), 669-684.

Sullivan L, Ward N, Toppler N, Lancaster G (2018a) National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual. Department ment Agriculture and Water Resources, Canberra, ACT.

Sullivan LA, Ward N, Toppler N, Lancaster G (2018b) National Acid Sulfate Soils Guidance: National acid sulfate soils sampling and identification methods manual. Department of Agriculture and Water Resources, Canberra, ACT.

van Breemen N (1975) Acidification and Deacidification of Coastal Plain Soils as a Result of Periodic Flooding. Soil Science Society of America Journal 39(6), 1153-1157.

White I, Melville MD, Wilson BP, Sammut J (1997) Reducing acidic discharges from coastal wetlands in eastern Australia. Wetlands Ecology and Management 5(1), 55-72.

Yau CC, Wong VNL, Kennedy DM (2016) Soil chemistry and acidification risk of acid sulfate soils on a temperate estuarine floodplain in southern Australia. Soil Research 54, 787-796.

Appendix 1

Table A1.1 Site Coordinates for Marshy Creek sampling sites

Site	Latitude	Longitude	Elevation (m AHD from GPS)	Depth to Watertable (cm)
MSC1	38° 20.529' S	144° 08.366' E	60	20
MSC2	38° 20.732' S	144° 09.110' E	41	0
MSC3	38° 20.953' S	144° 09.130' E		60
MSC4	38° 21.144' S	144° 09.283' E	31	28
MSC5	38° 21.154' S	144° 09.337' E	40	60
MSC6	38° 21.169' S	144° 09.416' E	38	30
MSC7	38° 21.169' S	144° 09.417' E		28
MSC8	38° 21.245' S	144° 09.676' E	35	n/a
MSC9	38°21'14.70"S	144° 9'40.56"E	32	
MSC10	38°21'20.58"S	144° 9'58.26"E	33	
MSC11	38°21'25.26"S	144°10'5.10"E	35	
MSC12	38°21'25.68"S	144°10'33.90"E	30	n/a
MSC13	38° 21.436' S	144° 10.666' E	38	0
MSC14	38° 21.515' S	144° 10.430' E	39	n/a
MSC15	38° 21.531' S	144° 10.385' E	30	2
MSC16	38° 21.717' S	144° 10.493' E	34	n/a
MSC17	38° 21.882' S	144° 10.437' E	33	n/a
MSC18	38° 22.016' S	144° 10.444' E	22	43
MSC19	38° 22.097' S	144° 10.470' E	25	60
MSC20	38° 22.226' S	144° 10.636' E	22	85
MSC21	38° 22.251' S	144° 10.425' E	9	45
MSC22	38° 22.353' S	144° 10.345' E	35	63
MSC23	38° 22.517' S	144° 10.238' E	24	100
MSC24	38° 22.600' S	144° 10.263' E	14	60
MSC25	38° 22.720' S	144° 10.431' E	15	35
MSC26	38° 22.828' S	144° 10.466' E	14	40
MSC27	38° 22.346' S	144° 09.809' E	22	40
MSC28	38° 23.020' S	144° 10.524' E	16	0

A1.1 Upper Swamplands Tributaries

The pH of the Upper Swamplands Tributary sites were all acidic and varied between $pH_{1:5}$ 3.42 and 4.11. The sites were not saline and $EC_{1:5}$ ranged from 34.3 μS/cm to 228 μS/cm. SOC and total nitrogen concentrations were lower in these sites compared to the Swampland sites further downstream, with the highest concentration of 11% and 0.49%, respectively, found at the surface of MSC1.

A1.2 Upper Swamplands

The pH of the Upper Swamplands ranged from 2.03 to 4.17. These sites were generally saline ($EC_{1:5}$ > 400 μS/cm), with highest EC found at MSC10 ($EC_{1:5}$ = 2430 μS/cm). These sites had very high SOC concentrations of up to 38%. In some sites (MSC4, MSC5, MSC7, MSC8 and MSC11), sampling of the profile had penetrated beyond the base of the peat layer, indicated by the large decrease in SOC concentrations (eg. From 21.4% in the 50-83 cm depth layer to 3.41% in the 83 -104 cm depth layer at MSC11)

A1.3 Mid-Swamplands Tributaries

The pH and EC of the sites in in the Mid-Swamplands Tributary varied according to location. The two sites further upstream (MSC12 and MSC13) were generally less acidic (3.58 < pH < 4.17) and less saline (30 < EC (μS/cm) < 139). The two sites further downstream, and closer to the main swamp were more acidic (2.27 < pH < 3.19) and more saline (203 < EC (μS/cm) < 1684). High SOC concentrations were found at the surface in MSC12 and MSC14 (up to 21.70%) and throughout the sampled profile at MSC15. Conversely, MSC13 had low concentrations of SOC throughout the profile with a maximum concentration of 3.03% at the surface.

A1.4 Mid-Swamplands

The pH of the Mid-Swamplands sites were all acidic (2.45 < pH < 3.38) and salinity increased downstream to a maximum of 1482 μS/cm. MSC16 had relatively low concentrations of SOC and N, with a maximum of 5.17% and 0.20 %, respectively, while MSC 18 and MSC19 had high concentrations of SOC with a maximum of 37.8% at MSC18.

A1.5 Lower Swamplands Tributaries

The pH of the Lower Swamplands Tributary sites were both acidic (3.02 < pH < 4.72). At MSC20, there was a large decrease in EC with depth from 1438 μS/cm to 238 μS/cm, while at MSC27, the profile was non-saline (EC < 400 μS/cm). MSC20 had high SOC concentrations (up to 37.50%) to a depth of 75 cm while MSC27 had much lower SOC concentrations (2.46% - 8.18%).

A1.6 Lower Swamplands

The Lower Swampland sites were all acidic (2.15 < pH < 3.48) and generally highly saline with EC up to 3870 μS/cm. The SOC concentrations at these sites were all high with SOC concentrations > 13.00% with the peat layers all extending to the depth of sampled profile.

Table A1.2 pH, EC and soluble metal concentrations at Marshy Creek

Site	Upper Depth (cm)	Lower Depth (cm)	$EC_{1:5}$ (µS/cm)	$pH_{1:5}$	Al (mg/kg)	As (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	B (mg/kg)	Co (mg/kg)	Ba (mg/kg)
MSC1	0	10	228	3.44	28.426	0.022	0.042	0.049	18.047	1.087	0.677	2.179	0.430	0.493	0.188
MSC1	10	42	105.5	3.34	3.179	0.004	0.012	0.032	3.968	0.491	0.133	0.348	0.200	0.088	0.119
MSC1	42	65	104.2	3.04	1.583	0.002	0.006	0.030	7.530	0.416	0.183	0.525	0.144	0.139	0.081
MSC2	0	18	57.6	3.42	7.100	0.008	0.036	0.037	8.540	0.242	0.027	0.142	0.223	0.018	0.133
MSC2	18	28	46.4	3.57	6.866	0.005	0.048	0.011	9.605	0.019	0.007	0.099	0.136	0.007	0.052
MSC2	28	40	49.2	3.64	5.904	0.006	0.026	0.009	7.037	0.029	0.005	0.009	0.141	0.006	0.045
MSC2	40	65	34.2	3.96	8.312	0.004	0.036	0.008	6.701	0.018	0.006	0.005	0.096	0.004	0.056
MSC3	0	20	66.8	3.54	4.743	0.004	0.016	0.039	3.581	1.391	0.123	0.417	0.199	0.154	0.125
MSC3	20	60	123.2	3.87	2.608	0.001	0.004	0.027	1.137	3.543	0.060	0.106	0.223	0.172	0.050
MSC3	60	100	121.3	4.11	1.891	0.001	0.003	0.023	0.873	0.280	0.011	0.033	0.213	0.020	0.044
MSC4	0	14	686	3.33	20.872	0.018	0.040	0.059	4.461	8.685	0.411	0.975	0.464	0.616	0.220
MSC4	14	30	713	3.46	13.902	0.017	0.029	0.051	2.735	1.203	0.383	0.893	0.394	0.347	0.172
MSC4	30	40	606	3.34	11.200	0.011	0.036	0.030	4.397	0.596	0.266	0.669	0.392	0.222	0.154
MSC4	40	65	407	3.03	2.023	0.003	0.025	0.020	3.108	0.284	0.081	0.295	0.288	0.099	0.108
MSC4	65	85	375	2.99	1.480	0.003	0.014	0.018	1.755	0.398	0.073	0.141	0.156	0.121	0.102
MSC5	0	35	408	2.2	121.023	0.066	0.103	0.086	136.064	1.801	0.892	2.177	0.775	0.816	0.237
MSC5	35	65	940	2.39	64.103	0.022	0.041	0.038	22.324	0.774	0.715	1.009	0.226	0.689	0.154
MSC5	65	85	392	2.61	27.212	0.006	0.023	0.028	16.145	0.455	0.269	0.659	0.121	0.292	0.181
MSC6	0	32	651	2.51	113.079	0.026	0.054	0.031	82.887	3.242	0.863	2.436	0.910	0.588	0.448
MSC6	32	53	633	2.32	141.886	0.014	0.047	0.027	198.626	7.297	1.283	2.328	0.692	0.969	0.466
MSC6	53	100	27.1	2.92	47.733	0.016	0.027	0.022	114.794	16.487	1.126	2.970	1.138	2.251	0.574
MSC6	100	130	1727	2.75	85.191	0.456	0.034	0.001	375.164	18.018	3.466	3.841	1.266	8.625	0.413
MSC7	0	24	771	2.64	37.331	0.025	0.053	0.013	18.828	1.168	0.222	0.561	0.590	0.358	0.246
MSC7	24	60	765	2.03	78.304	0.083	0.080	0.024	74.330	1.996	0.450	0.453	0.254	0.703	0.376
MSC7	60	82	940	2.1	271.317	0.602	0.056	0.002	375.259	5.448	8.481	2.066	0.216	20.411	0.279
MSC7	82	95	399	3.28	2.524	0.493	0.008	0.002	8.017	2.112	0.652	0.140	0.167	2.444	0.352

MSC8	0	28	648	2.63	57.514	0.023	0.042	0.012	32.009	0.526	0.135	0.194	0.350	0.127	0.229
MSC8	28	85	835	2.87	60.448	0.384	0.029	0.010	35.071	6.162	0.469	0.799	0.775	0.918	0.550
MSC8	85	130	121.5	3.74	0.926	0.169	0.008	0.001	2.023	0.569	0.003	0.012	0.135	0.003	0.035
MSC9	0	25	786	3.7	19.103	0.048	0.011	0.056	2.268	0.980	0.097	0.180	0.518	0.053	0.291
MSC9	25	50	416	3.27	335.264	0.089	0.012	0.009	136.229	3.989	13.646	7.068	0.685	12.392	0.946
MSC9	50	75	846	3.49	178.417	0.095	0.008	0.007	78.627	2.832	11.339	3.769	0.647	11.569	0.692
MSC9	75	120	781	3.54	97.777	0.092	0.005	0.003	17.971	2.122	4.215	1.724	0.588	5.482	0.471
MSC10	0	18	202.1	3.88	20.211	0.005	0.013	0.004	20.346	2.851	0.148	0.363	0.674	0.064	0.252
MSC10	18	28	1474	3.92	25.243	0.005	0.010	0.002	26.259	4.523	0.396	0.585	0.637	0.241	0.379
MSC10	28	55	2430	3.43	720.863	0.087	0.021	0.001	490.888	13.532	21.337	13.285	0.741	8.793	0.549
MSC10	55	80	958	3.46	486.906	0.057	0.023	0.001	418.236	11.719	21.601	8.179	0.610	11.732	0.374
MSC10	80	110	19.3	3.37	1152.953	0.123	0.044	0.003	837.481	11.193	57.041	25.581	0.662	26.460	0.461
MSC11	0	25	363	3.59	40.676	0.013	0.023	0.021	70.412	1.142	0.107	0.273	0.245	0.048	0.089
MSC11	25	50	331	3.57	32.988	0.073	0.016	0.010	4.995	0.296	0.090	0.217	0.268	0.030	0.181
MSC11	50	83	408	3.36	74.905	0.036	0.046	0.009	32.728	0.746	0.315	0.728	0.217	0.182	0.458
MSC11	83	104	167.1	3.61	50.734	0.038	0.009	0.003	31.470	0.150	0.464	0.329	0.080	0.480	0.443
MSC11	104	129	53	4.17	3.992	0.033	0.006	0.002	2.156	0.033	0.060	0.047	0.081	0.049	0.327
MSC12	0	16	41.1	3.86	34.985	0.006	0.020	0.038	41.801	2.764	0.034	0.166	0.459	0.016	0.208
MSC12	16	40	100.1	3.94	14.568	0.004	0.016	0.018	14.362	0.305	0.023	0.065	0.158	0.007	0.095
MSC12	40	66	112.4	3.58	0.633	0.001	0.004	0.003	2.499	0.063	0.010	0.031	0.173	0.003	0.023
MSC13	0	5	75	3.74	7.160	0.020	0.037	0.020	7.680	0.239	0.015	0.056	0.448	0.011	0.274
MSC13	5	21	30	4.24	5.306	0.014	0.024	0.025	7.115	0.025	0.008	0.014	0.150	0.003	0.115
MSC13	21	45	114.7	4.31	46.685	0.028	0.110	0.028	20.605	0.048	0.024	0.003	0.475	0.017	0.311
MSC13	45	50	139.5	4.01	0.177	0.001	0.001	0.003	0.308	0.002	0.001	0.010	0.374	0.001	0.007
MSC14	0	35	1046	2.27	55.746	0.049	0.038	0.019	44.806	1.259	0.083	0.605	0.492	0.056	0.132
MSC14	35	60	203.8	2.82	2.382	0.004	0.005	0.013	4.047	0.125	0.013	0.053	0.080	0.006	0.026
MSC14	60	83	131.5	2.95	1.494	0.004	0.007	0.026	2.088	0.178	0.013	0.077	0.075	0.007	0.024
MSC15	0	10	1451	2.64	66.888	0.007	0.034	0.009	77.433	2.416	0.192	0.550	0.723	0.166	0.214
MSC15	10	55	480	2.71	220.505	0.015	0.026	0.004	922.928	15.842	1.792	3.244	3.357	1.443	0.310
MSC15	55	100	1684	3.09	36.079	0.007	0.010	0.003	161.718	8.011	0.376	0.782	1.701	0.360	0.365

MSC15	100	110	1280	3.19	27.958	0.006	0.012	0.003	119.962	6.711	0.190	0.421	1.700	0.213	0.540
MSC16	0	15	622	2.97	6.836	0.004	0.014	0.009	4.092	0.780	0.030	0.121	0.588	0.011	0.052
MSC16	15	35	435	2.94	4.628	0.002	0.009	0.012	4.460	0.266	0.021	0.103	0.546	0.007	0.029
MSC16	35	64	179.1	3.53	5.611	0.001	0.006	0.017	2.059	0.186	0.018	0.142	0.668	0.005	0.053
MSC17	0	46	331	2.97	10.481	0.005	0.029	0.010	23.352	0.568	0.093	0.202	0.158	0.050	0.173
MSC17	46	90	570	2.79	10.584	0.003	0.011	0.011	23.990	0.862	0.053	0.192	0.347	0.021	0.206
MSC17	90	103	490	2.97	15.697	0.007	0.011	0.014	100.089	1.497	0.112	0.417	0.498	0.051	0.220
MSC18	0	20	729	2.72	28.132	0.016	0.041	0.048	100.624	1.532	0.111	0.639	0.718	0.030	0.159
MSC18	20	45	1482	2.45	49.001	0.021	0.036	0.056	178.903	2.864	0.199	0.944	0.635	0.046	0.186
MSC18	45	60	1186	2.51	50.986	0.016	0.036	0.032	166.916	2.956	0.178	0.756	0.593	0.047	0.202
MSC19	0	45	1268	3.38	92.778	0.018	0.013	0.037	43.241	1.716	0.229	0.825	0.852	0.064	0.169
MSC19	45	85	1338	3.33	109.054	0.020	0.014	0.027	8.748	2.505	0.253	0.608	1.010	0.068	0.183
MSC19	85	120	1226	3.38	121.960	0.024	0.015	0.022	36.421	2.402	0.324	1.114	1.006	0.120	0.252
MSC20	0	43	1436	3.02	87.837	0.009	0.026	0.050	82.834	3.546	0.171	0.773	1.576	0.028	0.124
MSC20	43	75	987	3.1	21.947	0.003	0.012	0.014	23.432	1.631	0.079	0.235	0.708	0.011	0.044
MSC20	75	112	238.3	3.55	1.319	0.001	0.004	0.015	1.790	0.400	0.009	0.117	0.405	0.002	0.013
MSC21	0	10	1120	2.86	26.807	0.007	0.005	0.025	83.297	1.782	0.348	0.544	1.049	0.086	0.313
MSC21	10	37	1807	2.79	53.564	0.012	0.009	0.014	71.605	3.053	0.245	0.677	1.143	0.025	0.251
MSC21	37	56	2190	2.98	140.539	0.017	0.017	0.019	80.994	3.373	0.924	1.114	1.403	0.664	0.277
MSC21	56	72	2361	3.2	460.507	0.035	0.016	0.015	321.836	3.855	7.681	3.241	1.440	2.148	0.331
MSC21	72	140	2950	3.33	577.093	0.059	0.016	0.025	429.214	5.650	13.736	10.960	1.808	6.317	0.446
MSC22	0	30	633	3.13	12.592	0.008	0.009	0.042	76.495	10.002	0.057	0.369	1.149	0.023	0.280
MSC22	30	45	1796	3.65	16.086	0.012	0.012	0.018	5.193	1.139	0.058	0.165	1.700	0.016	0.151
MSC22	45	63	2640	3.74	19.480	0.010	0.010	0.063	4.237	1.664	0.065	0.195	1.755	0.018	0.250
MSC22	63	80	1200	3.78	4.457	0.004	0.009	0.007	0.939	0.551	0.029	0.064	1.162	0.008	0.112
MSC22	80	120	686	3.99	1.510	0.003	0.007	0.015	0.561	0.217	0.014	0.032	1.000	0.007	0.122
MSC23	0	20	1339	2.8	14.932	0.008	0.011	0.028	44.683	5.342	0.132	0.386	1.208	0.136	0.177
MSC23	20	50	1675	2.55	50.670	0.011	0.012	0.019	53.933	2.853	0.334	0.639	1.076	0.106	0.163
MSC23	50	95	1553	2.73	184.148	0.016	0.019	0.010	76.781	3.717	0.540	1.066	1.061	0.256	0.167
MSC23	95	100	2035	3.05	564.808	0.066	0.036	0.020	283.839	5.501	1.397	2.840	1.547	1.435	0.286

MSC23	100	135	1834	3.76	21.755	0.010	0.011	0.025	27.387	12.667	0.109	0.286	1.636	0.070	0.350
MSC24	0	50	2375	2.88	94.986	0.015	0.024	0.057	200.473	21.935	0.220	1.573	2.896	0.218	0.359
MSC24	50	70	2204	2.52	107.670	0.019	0.026	0.041	187.797	7.498	0.367	0.715	1.758	0.153	0.198
MSC24	70	120	3110	2.72	246.031	0.032	0.033	0.043	138.567	9.014	0.545	1.292	1.862	0.231	0.246
MSC25	0	5	351	3.28	49.825	0.006	0.009	0.050	52.383	7.954	0.103	1.094	1.269	0.061	0.444
MSC25	5	23	1255	3.07	140.044	0.016	0.015	0.062	26.426	1.664	0.597	1.985	1.269	0.206	0.209
MSC25	23	35	2869	3.26	488.498	0.041	0.024	0.021	76.533	5.250	1.815	7.084	1.806	0.448	0.271
MSC25	35	55	2050	3.13	561.750	0.037	0.023	0.043	83.119	6.124	1.240	4.309	1.821	0.307	0.241
MSC25	55	76	3250	2.93	1148.387	0.054	0.057	0.019	2010.513	13.074	6.153	12.803	2.763	2.818	0.549
MSC25	76	135	3870	3.43	127.326	0.026	0.018	0.034	919.531	22.145	2.586	6.975	4.315	1.395	0.949
MSC26	0	5	307	3.48	73.680	0.013	0.020	0.061	103.823	4.476	0.032	0.441	1.219	0.019	0.136
MSC26	5	37	538	3.4	25.601	0.008	0.009	0.040	31.837	1.197	0.132	0.350	0.710	0.036	0.061
MSC26	37	67	1267	3.32	129.773	0.014	0.012	0.025	92.853	3.308	0.879	1.831	1.097	0.704	0.165
MSC26	67	105	1806	3.22	648.938	0.063	0.019	0.040	579.264	14.106	9.184	5.474	1.498	5.402	0.546
MSC27	0	8	168.3	4.45	14.347	0.013	0.055	0.046	16.896	0.153	0.056	0.073	1.013	0.030	0.198
MSC27	8	20	129.5	4.72	8.148	0.007	0.031	0.038	8.187	0.061	0.022	0.053	0.738	0.014	0.110
MSC27	20	30	143.7	4.35	0.788	0.003	0.005	0.025	1.298	0.059	0.017	0.031	0.324	0.015	0.102
MSC27	30	70	129.2	4.16	1.495	0.002	0.008	0.038	2.888	0.028	0.012	0.055	0.276	0.009	0.087
MSC27	70	90	138.2	4.26	3.299	0.003	0.009	0.025	4.266	0.013	0.008	0.043	0.328	0.005	0.124
MSC28	0	20	1303	2.15	171.692	0.021	0.076	0.031	112.798	10.934	1.448	1.916	0.820	0.367	0.257
MSC28	20	65	843	2.48	236.529	0.020	0.039	0.034	79.911	4.760	2.752	2.287	0.734	1.508	0.316
MSC28	65	105	1630	2.48	1295.179	0.171	0.095	0.018	1356.895	6.979	35.324	9.798	0.944	19.163	0.386

Table A1.3 Soluble and exchangeable salts, SO_4^{2-} :Cl^-, soil organic carbon (SOC), total N and retained acidity at Marshy Creek
Note: nd = not detected

Site	Upper Depth (cm)	Lower Depth (cm)	Soluble (mg/kg)							Exchangeable ($cmol_c^+$/kg)					SOC (%)	Total N (%)	Retained Acidity (mol H+/t)
			Ca^{2+}	Mg^{2+}	K^+	Na^+	Cl^-	SO_4^{2-}	SO_4^{2-}:Cl^-	Ca^{2+}	Mg^{2+}	K^+	Na^+	Al^{3+}			
MSC1	0	10	11.809	63.331	44.901	232.903	235.814	297.764	1.263	0.311	1.690	0.331	1.004	3.127	11.000	0.487	nd
MSC1	10	42	5.520	25.993	20.491	94.206	94.936	160.576	1.691	0.174	0.732	0.193	0.453	1.804	2.910	0.105	nd
MSC1	42	65	5.659	25.494	14.376	79.029	76.922	162.769	2.116	0.126	0.585	0.129	0.365	1.114	0.891	0.044	nd
MSC2	0	18	8.214	12.870	8.016	56.748	48.307	45.312	0.938	0.477	1.012	0.178	0.354	3.160	3.070	0.164	nd
MSC2	18	28	2.876	4.329	2.273	66.510	32.942	27.586	0.837	0.489	1.303	nd	0.412	2.838	1.870	0.139	nd
MSC2	28	40	3.891	6.413	1.729	67.381	44.404	35.807	0.806	1.102	2.179	0.202	0.699	2.827	4.350	0.209	nd
MSC2	40	65	2.605	5.672	0.910	49.590	24.215	16.765	0.692	0.460	1.357	nd	0.333	1.270	1.310	0.068	nd
MSC3	0	20	3.522	12.893	15.672	65.806	55.143	100.639	1.825	0.169	0.676	0.174	0.318	1.526	0.872	0.052	nd
MSC3	20	60	2.427	15.838	7.426	151.518	73.839	230.843	3.126	0.329	3.445	0.228	1.010	0.350	1.530	0.084	nd
MSC3	60	100	1.299	9.071	4.909	189.272	130.029	222.187	1.709	0.419	5.117	0.249	1.680	0.438	0.984	0.055	nd
MSC4	0	14	21.292	154.068	64.922	867.049	1090.348	883.387	0.810	0.539	3.747	0.626	5.237	7.963	19.800	0.831	nd
MSC4	14	30	18.166	144.638	41.775	943.173	1180.941	800.731	0.678	0.272	2.194	0.436	5.285	6.229	18.300	0.817	nd
MSC4	30	40	14.361	114.790	22.331	805.350	896.899	673.996	0.751	0.341	3.265	0.378	4.828	6.073	12.400	0.544	nd
MSC4	40	65	8.950	62.399	11.163	495.238	477.798	576.256	1.206	0.315	3.641	0.336	3.240	4.005	2.520	0.117	nd
MSC4	65	85	10.860	64.155	10.286	444.280	512.096	461.919	0.902	0.319	2.860	0.265	2.563	2.849	1.290	0.072	nd
MSC5	0	35	23.754	264.260	98.419	1127.537	1853.787	1259.795	0.680	0.186	2.680	0.416	5.420	11.232	30.700	1.230	nd
MSC5	35	65	11.766	201.657	19.180	1077.432	1510.702	1144.291	0.757	0.089	1.710	0.148	4.628	7.096	10.700	0.436	nd
MSC5	65	85	8.614	85.653	6.423	388.505	486.755	562.880	1.156	0.077	0.785	nd	1.648	2.426	1.760	0.062	nd
MSC6	0	32	40.429	430.770	110.664	2465.517	3724.995	1526.839	0.410	0.287	4.305	0.421	13.236	11.232	30.800	1.420	nd
MSC6	32	53	65.209	531.509	52.184	3067.181	4747.255	2343.560	0.494	1.709	6.869	0.184	8.530	5.173	32.900	1.570	nd
MSC6	53	100	219.169	760.936	34.868	2093.349	2928.168	3617.970	1.236	2.877	9.739	0.211	9.730	3.282	29.100	1.400	nd
MSC6	100	130	404.358	1246.993	50.399	1457.896	1397.094	8410.058	6.020	1.103	5.253	nd	4.967	3.096	29.800	1.040	nd
MSC7	0	24	31.140	248.534	55.841	1229.613	1963.368	846.984	0.431	0.506	4.303	0.597	7.112	9.531	24.500	1.140	nd
MSC7	24	60	20.144	227.738	25.806	1341.254	1935.227	1575.377	0.814	0.168	2.102	0.183	6.990	10.109	31.000	1.190	nd

MSC7	60	82	121.896	294.472	20.635	685.964	803.773	4063.740	5.056	0.225	1.031	nd	1.660	6.698	15.800	0.462	nd
MSC7	82	95	48.305	180.298	10.833	263.525	222.957	1116.187	5.006	0.965	4.523	0.141	1.527	1.370	5.360	0.141	nd
MSC8	0	28	6.804	132.938	26.506	824.864	930.689	884.910	0.951	nd	2.095	nd	5.302	10.254	28.700	1.230	nd
MSC8	28	85	108.146	498.568	22.514	1073.058	1293.046	2558.057	1.978	1.500	6.513	0.217	4.480	2.571	25.400	1.070	nd
MSC8	85	130	10.724	42.761	10.726	176.354	109.835	392.273	3.571	0.441	2.117	0.169	0.742	0.623	1.830	0.070	1.136
MSC9	0	25	30.186	191.801	41.936	1114.449	1578.034	655.890	0.416	0.482	2.531	0.238	3.190	8.455	29.300	1.160	nd
MSC9	25	50	83.452	269.164	56.904	1342.978	1857.434	3072.488	1.654	0.303	1.390	0.181	2.941	11.079	33.100	1.130	nd
MSC9	50	75	61.391	241.002	74.077	1455.061	2100.610	1817.509	0.865	nd	0.360	0.289	3.536	10.990	35.200	1.180	nd
MSC9	75	120	45.885	173.012	41.795	1095.001	1714.646	937.894	0.547	0.124	0.492	0.157	2.097	10.234	38.100	1.040	nd
MSC10	0	18	133.470	346.023	84.009	1900.324	2977.064	1201.640	0.404	1.472	3.999	0.420	10.374	6.996	24.000	1.070	nd
MSC10	18	28	208.916	462.162	68.502	1975.810	2986.780	2107.713	0.706	1.712	3.653	0.305	6.494	6.607	24.700	0.959	nd
MSC10	28	55	627.721	688.307	77.502	2310.745	2926.298	8996.960	3.075	0.771	1.299	0.159	2.589	12.151	27.500	0.904	nd
MSC10	55	80	534.184	607.676	74.027	2033.001	2531.289	7310.479	2.888	0.733	1.316	0.179	2.849	13.752	26.100	0.862	nd
MSC10	80	110	495.499	586.226	79.001	2320.678	2921.600	11599.416	3.970	0.556	1.197	0.135	3.050	16.910	26.500	0.789	nd
MSC11	0	25	10.253	39.484	98.091	380.695	514.342	380.396	0.740	0.645	1.654	0.995	2.789	9.676	27.400	1.190	nd
MSC11	25	50	7.167	48.815	47.411	467.554	664.150	404.080	0.608	0.220	1.081	0.389	2.938	13.789	31.400	1.390	nd
MSC11	50	83	18.751	77.336	46.013	407.392	469.464	1028.929	2.192	0.164	0.896	0.318	2.624	12.122	21.400	0.896	nd
MSC11	83	104	5.763	17.452	4.160	86.385	93.032	456.413	4.906	0.059	0.152	nd	0.470	4.472	3.410	0.131	6.263
MSC11	104	129	3.165	8.079	2.801	59.675	84.867	84.780	0.999	nd	0.098	nd	0.342	1.937	1.280	0.065	nd
MSC12	0	16	50.316	43.497	107.290	110.574	330.696	57.013	0.172	2.323	1.685	0.546	0.651	3.405	16.800	0.503	nd
MSC12	16	40	9.378	13.019	19.608	83.776	90.480	103.184	1.140	0.745	0.684	0.250	0.503	2.571	5.050	0.161	nd
MSC12	40	66	7.852	12.844	7.623	85.668	90.631	146.082	1.612	0.283	0.572	0.184	0.478	1.893	1.100	0.060	nd
MSC13	0	5	19.955	15.166	25.691	54.740	43.929	91.717	2.088	1.536	1.390	0.296	0.336	1.084	3.030	0.162	nd
MSC13	5	21	3.593	4.044	4.681	45.017	35.341	7.267	0.206	2.797	0.947	0.125	0.280	0.373	0.551	0.026	nd
MSC13	21	45	6.453	27.755	7.993	178.453	140.133	194.410	1.387	0.621	4.820	0.243	1.799	0.748	0.678	0.029	nd
MSC13	45	50	0.729	3.924	2.112	191.649	63.104	317.783	5.036	0.458	4.499	0.267	1.898	0.631	0.492	nd	nd
MSC14	0	35	63.095	188.090	80.861	1289.977	2014.282	705.065	0.350	0.771	2.380	0.526	6.646	1.893	21.700	0.518	nd
MSC14	35	60	10.305	23.597	7.018	208.390	299.067	102.925	0.344	0.124	0.251	nd	0.923	0.191	1.420	nd	nd
MSC14	60	83	11.328	16.660	10.178	119.405	200.247	87.360	0.436	0.096	0.145	nd	0.433	0.230	0.497	nd	nd
MSC15	0	10	255.727	311.266	55.029	1749.945	2354.353	2325.721	0.988	1.458	2.194	0.217	5.389	10.990	18.900	0.896	nd

MSC15	10	55	2178.679	1325.665	73.086	2701.911	3514.713	14577.151	4.147	4.557	4.872	0.192	5.972	2.204	29.500	1.100	nd
MSC15	55	100	811.531	682.373	49.068	1481.871	1914.821	5532.638	2.889	2.152	2.351	0.130	2.522	1.150	19.000	0.733	nd
MSC15	100	110	623.691	606.292	42.798	1146.458	1400.374	4776.213	3.411	5.734	7.280	0.271	7.047	0.598	15.600	0.546	nd
MSC16	0	15	99.624	104.724	30.415	650.814	936.426	649.811	0.694	1.228	1.646	0.307	3.324	2.426	5.170	0.200	nd
MSC16	15	35	66.181	71.846	19.626	375.206	563.776	477.480	0.847	0.871	1.298	0.271	2.241	1.815	1.635	0.066	nd
MSC16	35	64	59.856	71.024	30.323	468.560	759.068	369.138	0.486	0.805	1.348	0.329	2.448	2.493	1.180	0.048	nd
MSC17	0	46	60.240	43.199	12.911	207.769	307.505	475.485	1.546	0.386	0.469	nd	1.226	0.705	1.470	0.037	nd
MSC17	46	90	110.040	110.212	23.475	685.450	1021.012	766.988	0.751	0.660	1.023	0.186	3.478	0.333	11.900	0.254	nd
MSC17	90	103	122.147	81.801	57.802	419.817	628.494	901.754	1.435	1.340	0.869	0.365	1.551	2.493	15.300	0.581	nd
MSC18	0	20	105.240	116.235	87.626	657.515	1023.882	909.016	0.888	0.669	0.910	0.349	2.108	1.882	27.900	0.938	nd
MSC18	20	45	230.105	265.860	86.869	1532.670	2505.438	1811.816	0.723	0.458	0.635	0.161	2.378	0.619	37.800	1.080	nd
MSC18	45	60	223.517	256.332	75.178	1475.997	2453.577	1707.631	0.696	1.124	2.381	0.368	8.095	0.902	25.300	0.765	nd
MSC19	0	45	223.156	223.208	81.214	1426.918	2252.359	1539.976	0.684	1.225	2.020	0.389	7.834	5.273	30.000	0.885	nd
MSC19	45	85	336.728	327.043	80.806	2108.982	3598.487	1858.079	0.516	1.706	2.356	0.396	11.157	2.437	36.400	0.824	nd
MSC19	85	120	267.520	256.960	92.960	1681.141	2816.985	1671.791	0.593	0.871	1.168	0.322	6.190	5.417	32.200	0.917	nd
MSC20	0	43	367.739	330.620	159.422	1878.409	3743.878	1867.851	0.499	3.398	3.997	0.996	10.770	7.897	37.500	1.050	nd
MSC20	43	75	245.837	183.245	49.185	1172.599	1906.396	1108.906	0.582	1.288	1.357	0.328	3.674	3.182	15.200	0.372	nd
MSC20	75	112	46.148	32.087	20.004	229.852	313.878	292.536	0.932	1.000	0.980	0.353	1.325	2.437	1.600	0.039	nd
MSC21	0	10	268.640	140.624	67.921	1165.112	2031.768	969.190	0.477	1.524	1.272	0.319	6.116	1.982	11.800	0.464	nd
MSC21	10	37	556.079	342.466	71.358	1880.704	3307.568	2156.930	0.652	2.475	2.423	0.283	8.099	1.615	7.750	0.376	nd
MSC21	37	56	769.752	434.114	80.683	2471.935	4169.312	3349.855	0.803	4.451	4.278	0.401	14.180	6.896	13.500	0.574	nd
MSC21	56	72	815.286	403.606	70.057	2255.233	3927.380	5819.355	1.482	4.055	3.809	0.319	12.793	10.787	13.300	0.517	nd
MSC21	72	140	1166.589	587.143	96.827	3144.343	5619.692	7188.862	1.279	6.592	6.882	0.519	22.653	4.617	19.300	0.701	nd
MSC22	0	30	355.444	146.973	65.468	355.966	647.048	1542.036	2.383	3.318	2.052	0.336	3.376	2.348	13.500	0.489	nd
MSC22	30	45	645.795	395.644	100.777	2013.626	3317.112	2434.839	0.734	5.120	3.984	0.452	9.234	4.072	14.300	0.709	nd
MSC22	45	63	1131.609	812.346	152.250	4320.990	7515.016	3710.430	0.494	4.766	4.147	0.369	10.731	3.429	26.900	1.260	nd
MSC22	63	80	398.861	250.606	52.323	1368.298	2298.829	1403.219	0.610	4.299	3.818	0.460	8.465	1.637	6.630	0.218	nd
MSC22	80	120	166.435	104.971	41.925	710.822	1042.993	793.563	0.761	3.402	3.008	0.516	4.645	1.225	1.580	0.078	nd
MSC23	0	20	485.437	304.272	75.693	1227.418	1927.019	2266.601	1.176	2.872	2.645	0.291	6.011	1.030	9.450	0.430	nd
MSC23	20	50	439.523	268.188	61.319	1375.772	2339.686	2078.438	0.888	2.102	2.151	0.242	6.881	1.748	7.160	0.355	nd

MSC23	50	95	522.956	296.797	56.802	1487.766	2458.874	3031.873	1.233	2.484	2.529	0.261	7.760	5.439	11.000	0.443	nd
MSC23	95	100	896.554	375.823	62.983	1751.034	2849.383	6566.839	2.305	1.993	1.432	0.193	4.261	10.679	16.900	0.627	nd
MSC23	100	135	1690.102	611.536	86.845	1950.841	3086.653	5977.800	1.937	5.838	3.037	0.263	6.229	4.016	21.100	0.624	nd
MSC24	0	50	1309.880	904.615	237.396	3601.985	6405.440	5718.556	0.893	9.192	8.587	0.837	17.690	6.851	30.400	1.140	nd
MSC24	50	70	701.475	445.895	103.530	2182.235	3662.484	3625.094	0.990	4.190	4.734	0.537	13.006	3.927	13.000	0.606	nd
MSC24	70	120	1067.717	692.309	132.834	3609.191	6154.514	5174.160	0.841	4.456	5.205	0.465	15.368	7.074	18.200	0.841	nd
MSC25	0	5	133.498	105.804	175.066	432.659	1664.785	674.039	0.405	2.089	2.051	0.703	3.576	10.276	31.500	0.954	nd
MSC25	5	23	302.160	231.570	106.124	1387.555	2295.815	1910.673	0.832	1.606	2.073	0.437	7.281	8.063	11.700	0.607	nd
MSC25	23	35	936.835	670.882	170.216	4132.893	6985.349	5625.481	0.805	1.154	1.398	0.193	5.263	17.950	21.100	1.160	nd
MSC25	35	55	882.702	591.452	133.976	3679.209	5970.137	6062.682	1.016	3.199	3.919	0.385	14.598	16.124	17.200	0.843	nd
MSC25	55	76	1736.207	584.868	214.508	2541.143	3613.177	16473.433	4.559	5.230	4.457	0.335	13.415	22.239	15.900	0.693	nd
MSC25	76	135	3125.227	1214.335	151.033	3763.386	5126.066	17123.051	3.340	16.033	9.878	0.552	18.138	7.063	19.800	0.788	nd
MSC26	0	5	90.329	98.221	308.336	250.322	1079.753	687.984	0.637	2.726	2.311	0.923	1.805	10.034	29.400	0.849	nd
MSC26	5	37	97.249	81.810	139.955	525.695	811.745	727.271	0.896	0.888	0.685	0.558	2.171	5.328	11.300	0.524	nd
MSC26	37	67	302.448	254.873	98.714	1537.043	2378.163	2189.518	0.921	1.462	1.931	0.396	7.838	6.774	15.100	0.713	nd
MSC26	67	105	530.634	320.785	113.575	2005.671	3160.616	6558.732	2.075	2.078	2.896	0.421	10.726	13.122	24.700	0.996	nd
MSC27	0	8	5.656	26.921	39.743	221.683	520.146	260.713	0.501	0.640	4.271	0.534	1.529	2.282	8.180	0.410	nd
MSC27	8	20	1.663	14.710	29.632	206.521	307.493	158.481	0.515	0.317	3.715	0.497	1.599	1.904	5.510	0.251	nd
MSC27	20	30	1.820	23.476	19.319	186.870	155.123	237.893	1.534	0.143	2.386	0.428	1.254	1.548	3.150	0.083	nd
MSC27	30	70	0.991	12.172	14.137	175.372	157.685	172.100	1.091	0.105	2.222	0.305	1.265	1.070	2.870	0.083	nd
MSC27	70	90	0.897	6.163	10.366	189.600	121.913	199.934	1.640	0.103	3.106	0.405	1.615	1.515	2.460	0.077	nd
MSC28	0	20	178.824	304.971	61.506	1411.361	2003.132	2771.046	1.383	0.739	1.369	0.174	2.901	12.458	31.400	1.470	nd
MSC28	20	65	172.872	146.639	36.258	579.552	840.247	2345.215	2.791	0.718	0.998	0.163	2.377	9.598	10.600	0.423	nd
MSC28	65	105	298.201	186.668	49.532	710.787	927.862	11034.534	11.892	0.987	1.330	0.241	3.033	10.765	19.400	0.773	nd

Table A1.4 Particle size distribution at Marshy Creek

Site	Upper Depth (cm)	Lower Depth (cm)	Clay (< 2 µm; %)	Silt (2-62.5 µm; %)	Sand (62.5 – 2000 µm; %)
MSC1	0	10	30.80	69.20	0.00
MSC1	10	42	10.90	33.60	55.50
MSC1	42	65	8.67	21.93	69.40
MSC2	0	18	29.00	71.00	0.00
MSC2	18	28	27.20	72.80	0.00
MSC2	28	40	20.20	79.50	0.30
MSC2	40	65	13.40	68.10	18.50
MSC3	0	20	17.20	51.10	31.70
MSC3	20	60	45.50	54.50	0.00
MSC3	60	100	45.00	55.00	0.00
MSC4	0	14	7.66	25.74	66.60
MSC4	14	30	24.40	75.60	0.00
MSC4	30	40	30.50	69.50	0.00
MSC4	40	65	15.00	82.30	2.70
MSC4	65	85	14.00	85.20	0.80
MSC5	0	35	14.00	83.20	2.80
MSC5	35	65	20.80	78.10	1.10
MSC5	65	85	25.70	74.30	0.00
MSC6	0	32	23.80	76.20	0.00
MSC6	32	53	13.30	53.30	33.40
MSC6	53	100	11.00	38.40	50.60
MSC6	100	130	20.30	79.70	0.00
MSC7	0	24	16.30	81.50	2.20
MSC7	24	60	26.70	73.30	0.00
MSC7	60	82	10.20	82.80	7.00
MSC7	82	95	13.60	77.80	8.60
MSC8	0	28	9.00	82.10	8.90
MSC8	28	85	10.20	73.50	16.30
MSC8	85	130	12.00	56.70	31.30
MSC9	0	25	11.90	78.40	9.70
MSC9	25	50	7.71	85.59	6.70
MSC9	50	75	12.10	57.50	30.40
MSC9	75	120	9.94	66.86	23.20
MSC10	0	18	3.61	36.39	60.00
MSC10	18	28	4.02	54.88	41.10
MSC10	28	55	7.62	77.58	14.80
MSC10	55	80	23.10	74.70	2.20
MSC10	80	110	35.30	64.70	0.00
MSC11	0	25	6.14	46.46	47.40
MSC11	25	50	17.30	76.30	6.40
MSC11	50	83	11.10	51.00	37.90

MSC11	83	104	28.50	71.50	0.00
MSC11	104	129	12.90	79.50	7.60
MSC12	0	16	11.80	69.70	18.50
MSC12	16	40	5.36	31.64	63.00
MSC12	40	66	7.19	27.31	65.50
MSC13	0	5	11.20	46.70	42.10
MSC13	5	21	14.20	51.60	34.20
MSC13	21	45	18.00	38.00	44.00
MSC13	45	50	17.80	54.00	28.20
MSC14	0	35	6.02	32.78	61.20
MSC14	35	60	10.20	43.00	46.80
MSC14	60	83	12.10	43.70	44.20
MSC15	0	10	14.60	70.70	14.70
MSC15	10	55	3.22	15.28	81.50
MSC15	55	100	5.42	23.58	71.00
MSC15	100	110	51.10	48.90	0.00
MSC16	0	15	23.80	65.20	11.00
MSC16	15	35	17.50	74.40	8.10
MSC16	35	64	9.45	71.05	19.50
MSC17	0	46	29.60	70.40	0.00
MSC17	46	90	25.60	73.00	1.40
MSC17	90	103	17.30	40.00	42.70
MSC18	0	20	7.08	25.72	67.20
MSC18	0	20	7.93	48.97	43.10
MSC18	20	45	6.81	74.79	18.40
MSC19	0	45	15.50	82.70	1.80
MSC19	45	85	8.93	78.17	12.90
MSC19	85	120	10.50	76.00	13.50
MSC20	0	43	31.90	68.10	0.00
MSC20	43	75	11.90	70.30	17.80
MSC20	75	112	11.00	72.60	16.40
MSC21	0	10	4.23	66.17	29.60
MSC21	10	37	9.83	63.67	26.50
MSC21	37	56	8.18	45.12	46.70
MSC21	56	72	19.00	80.50	0.50
MSC21	72	140	63.40	36.60	0.00
MSC22	0	30	44.90	55.10	0.00
MSC22	30	45	45.60	54.40	0.00
MSC22	45	63	19.70	73.70	6.60
MSC22	63	80	5.59	47.61	46.80
MSC22	80	120	23.70	73.70	2.60
MSC23	0	20	8.39	46.11	45.50
MSC23	20	50	10.50	52.80	36.70
MSC23	50	95	18.50	54.00	27.50
MSC23	95	100	68.50	31.50	0.00

MSC23	100	135	75.50	24.50	0.00
MSC24	0	50	62.10	37.90	0.00
MSC24	50	70	28.50	71.50	0.00
MSC24	70	120	60.80	39.20	0.00
MSC25	0	5	7.23	67.57	25.20
MSC25	5	23	18.50	50.40	31.10
MSC25	23	35	12.20	36.40	51.40
MSC25	35	55	33.20	66.80	0.00
MSC25	55	76	23.00	68.40	8.60
MSC25	76	135	44.10	55.90	0.00
MSC26	0	5	49.80	50.20	0.00
MSC26	5	37	43.60	56.40	0.00
MSC26	37	67	42.80	57.20	0.00
MSC26	67	105	20.30	78.90	0.80
MSC27	0	8	32.80	67.20	0.00
MSC27	8	20	21.60	53.30	25.10
MSC27	20	30	35.90	64.10	0.00
MSC27	30	70	25.30	74.70	0.00
MSC27	70	90	24.70	75.30	0.00
MSC28	0	20	15.40	59.50	25.10
MSC28	20	65	16.80	53.10	30.10
MSC28	65	105	27.60	72.40	0.00

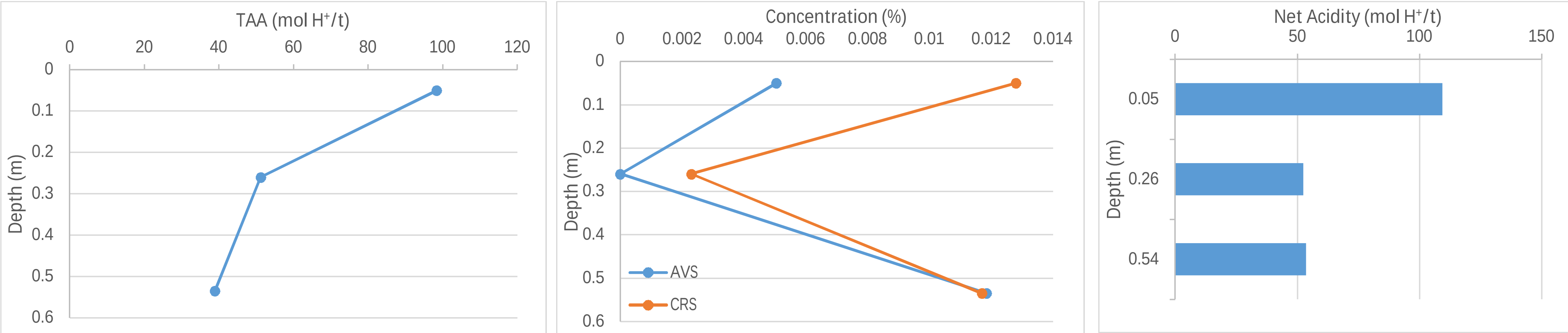


Figure A1.1 TAA, RIS and Net Acidity at MSC1

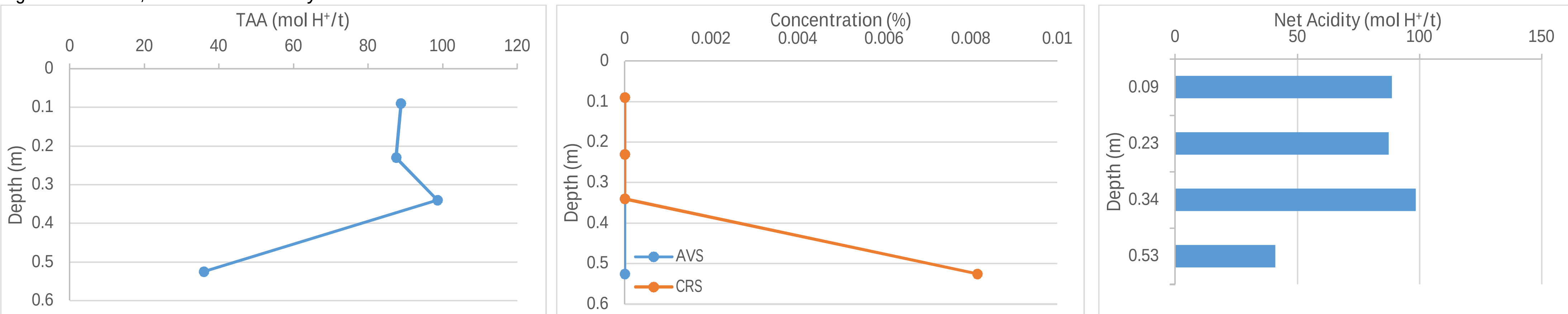


Figure A1.2 TAA, RIS and Net Acidity at MSC2

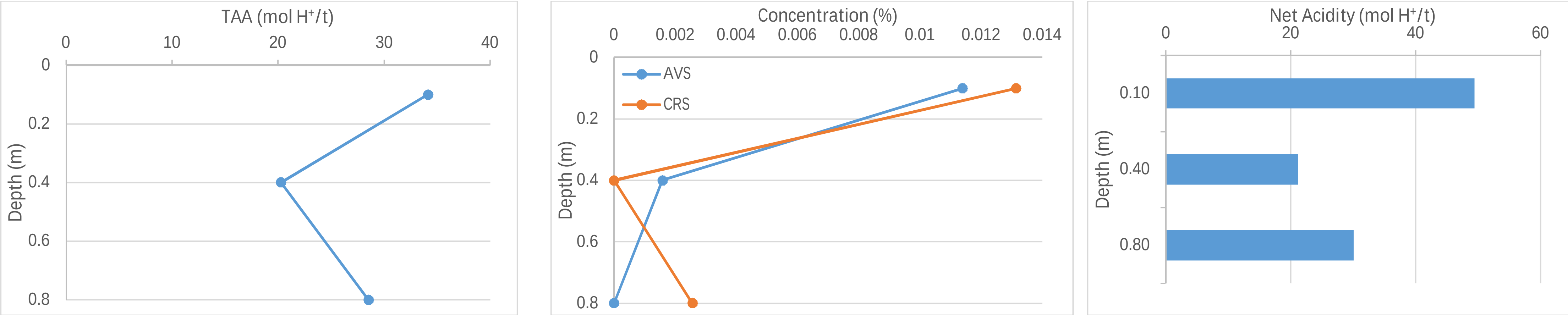


Figure A1.3 TAA, RIS and Net Acidity at MSC3

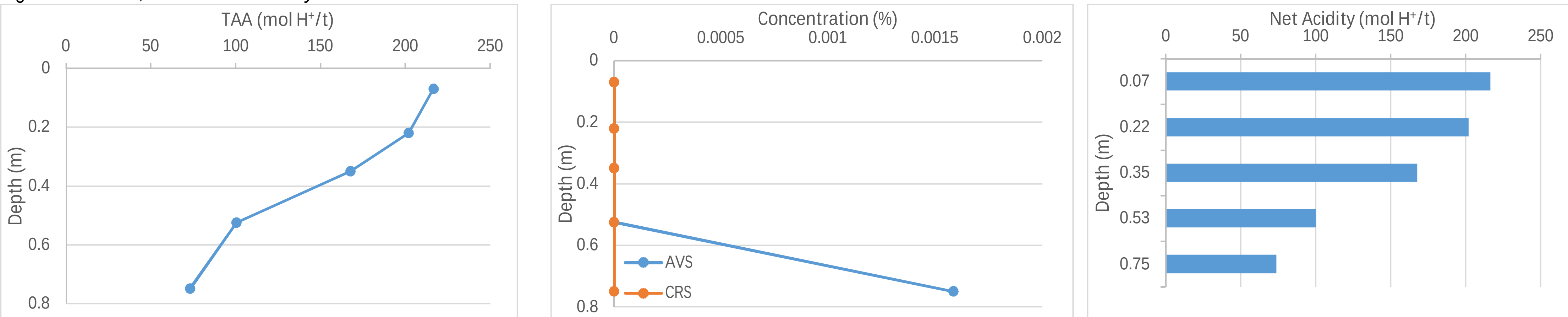


Figure A1.4 TAA, RIS and Net Acidity at MSC4

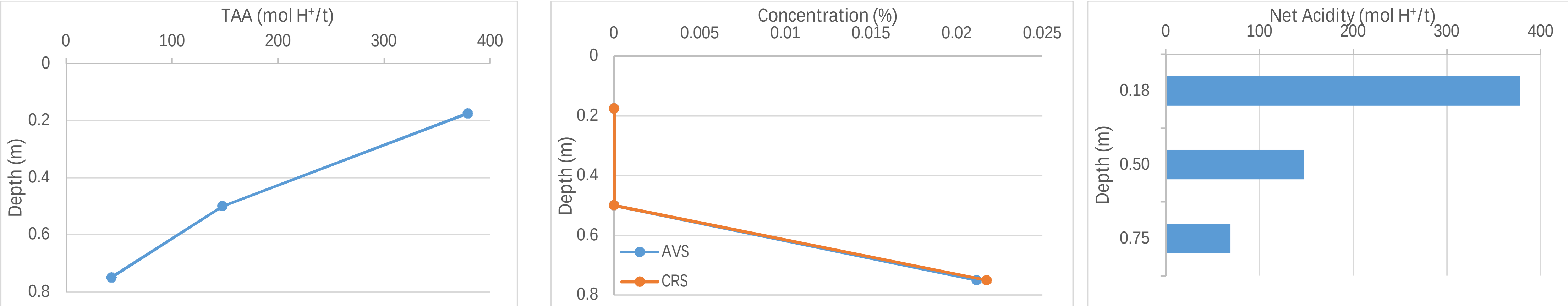


Figure A1.5 TAA, RIS and Net Acidity at MSC5

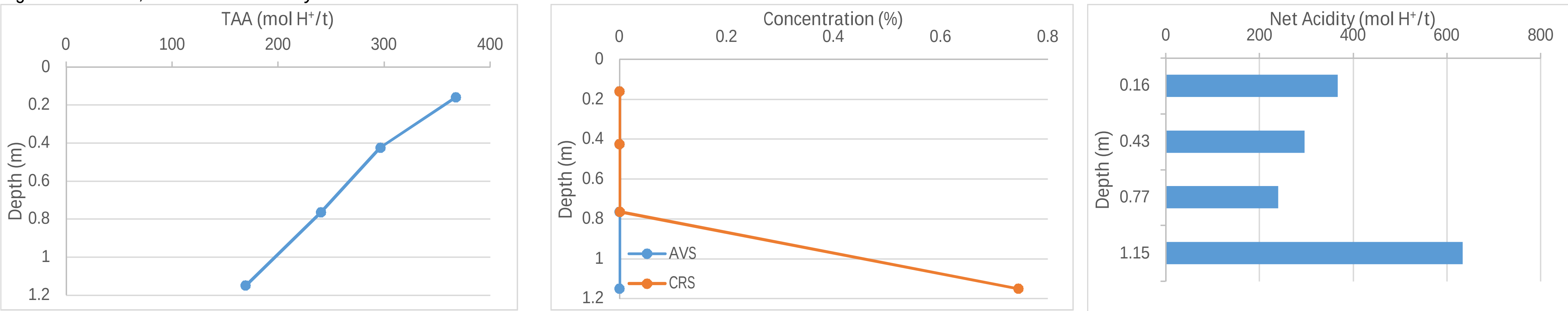


Figure A1.6 TAA, RIS and Net Acidity at MSC6

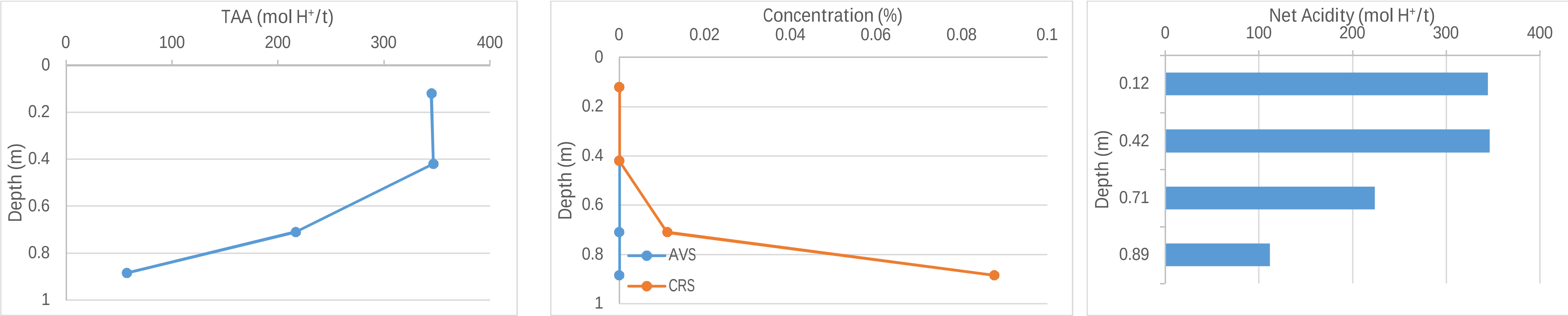


Figure A1.7 TAA, RIS and Net Acidity at MSC7

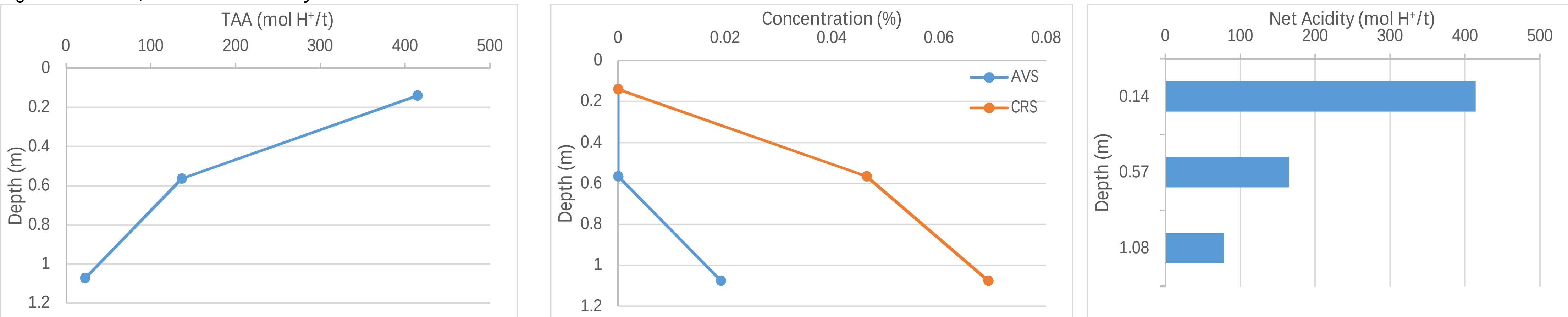


Figure A1.8 TAA, RIS and Net Acidity at MSC8

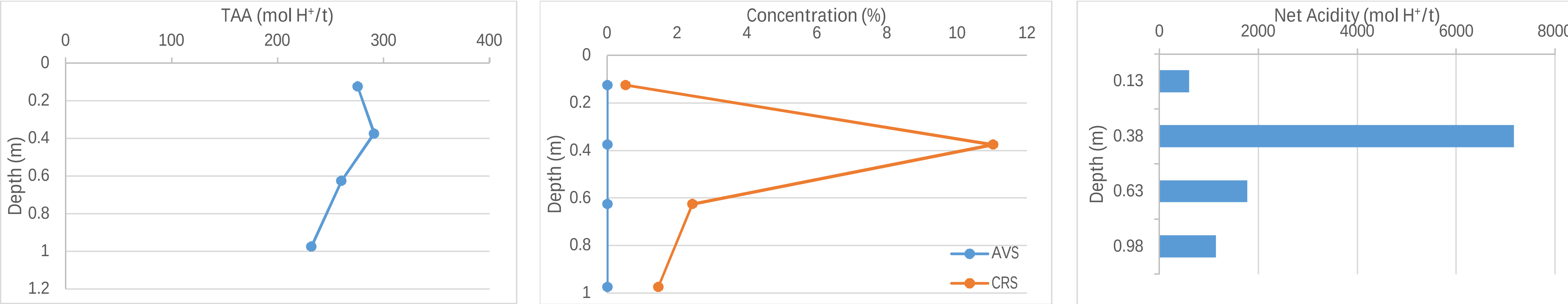


Figure A1.9 TAA, RIS and Net Acidity at MSC9

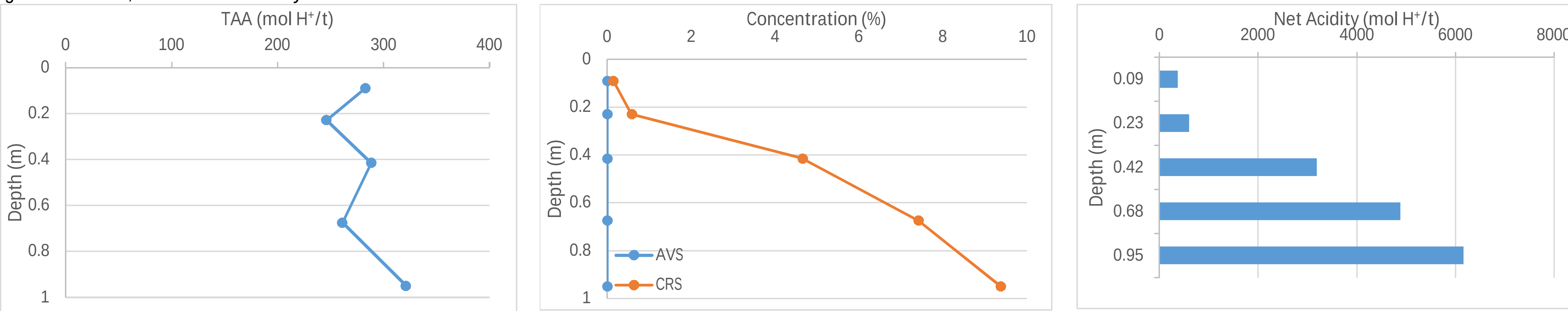


Figure A1.10 TAA, RIS and Net Acidity at MSC10

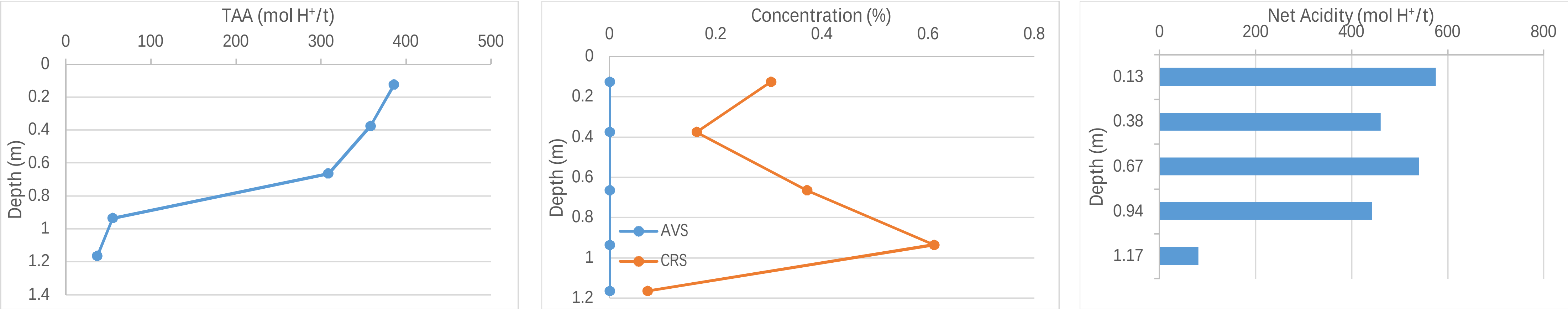


Figure A1.11 TAA, RIS and Net Acidity at MSC11

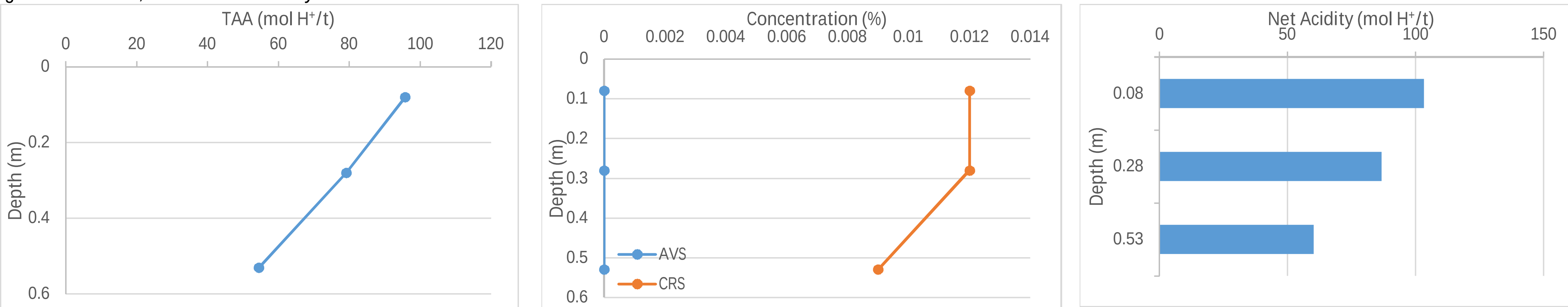


Figure A1.12 TAA, RIS and Net Acidity at MSC12

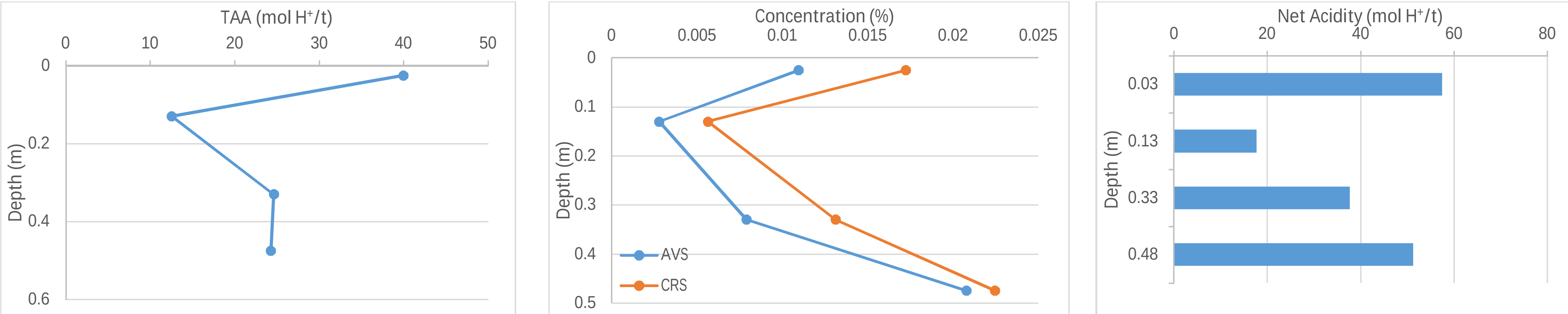


Figure A1.13 TAA, RIS and Net Acidity at MSC13

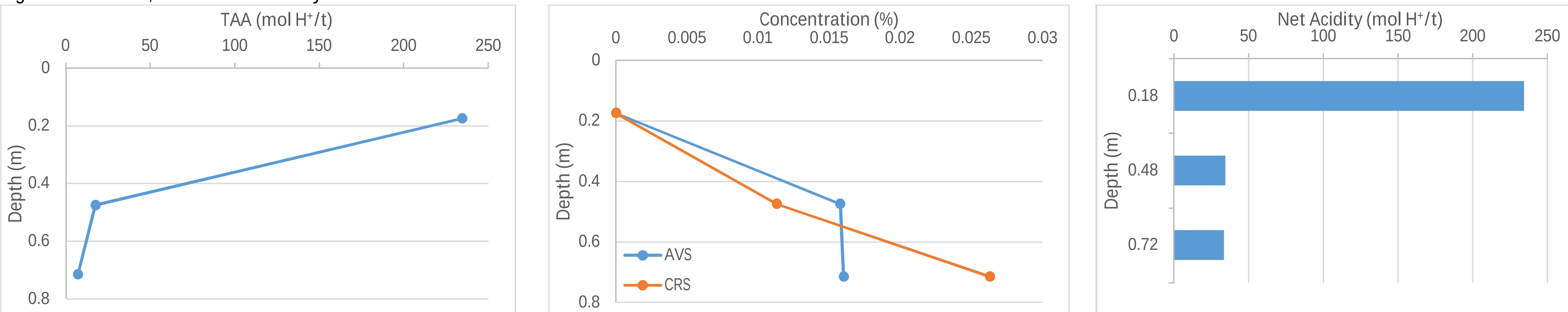


Figure A1.14 TAA, RIS and Net Acidity at MSC14

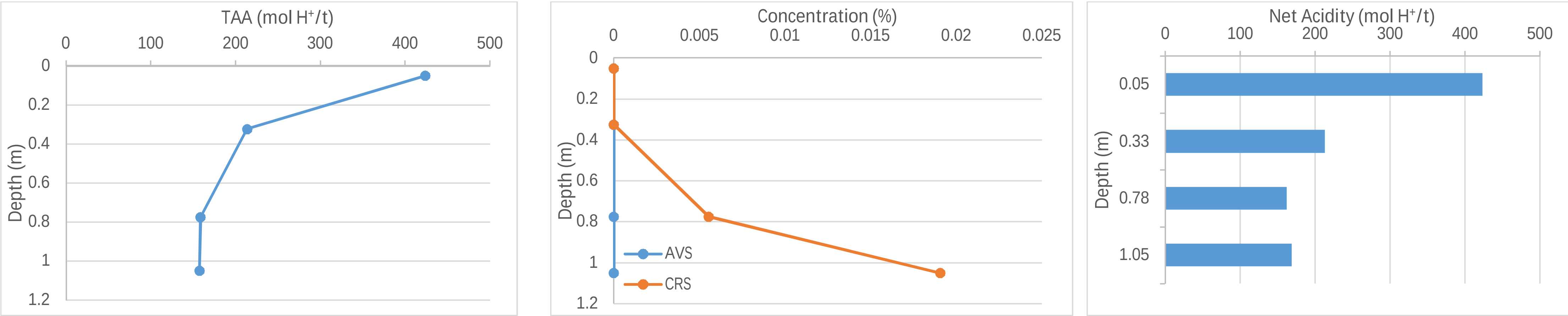


Figure A1.15 TAA, RIS and Net Acidity at MSC15

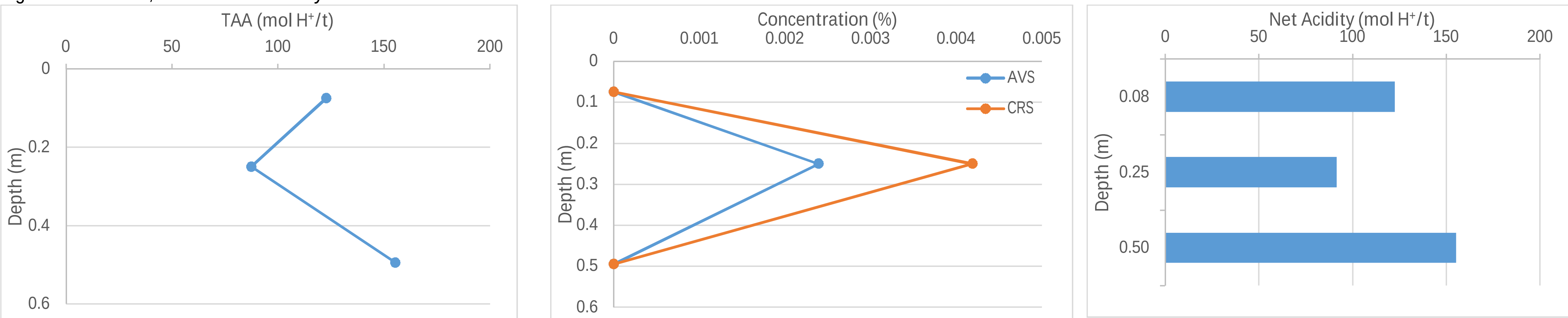


Figure A1.16 TAA, RIS and Net Acidity at MSC16

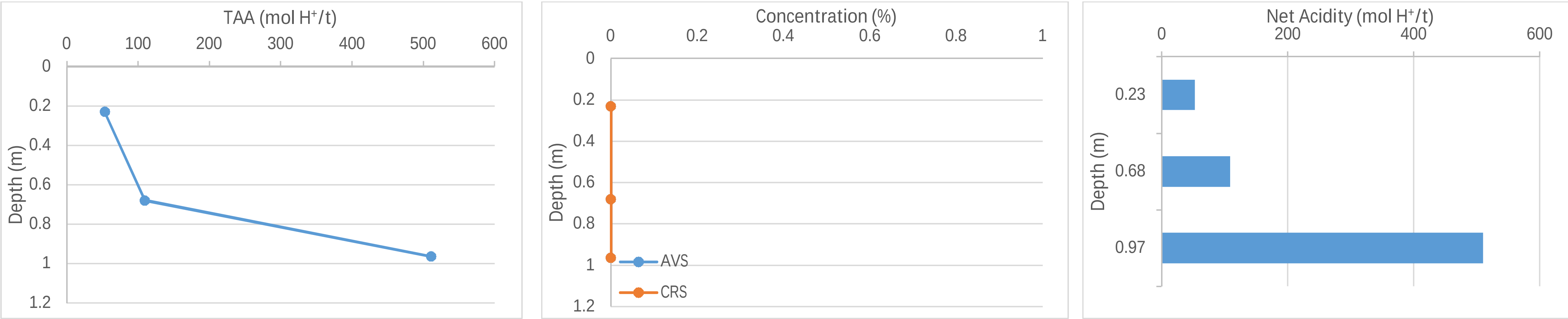


Figure A1.17 TAA, RIS and Net Acidity at MSC17

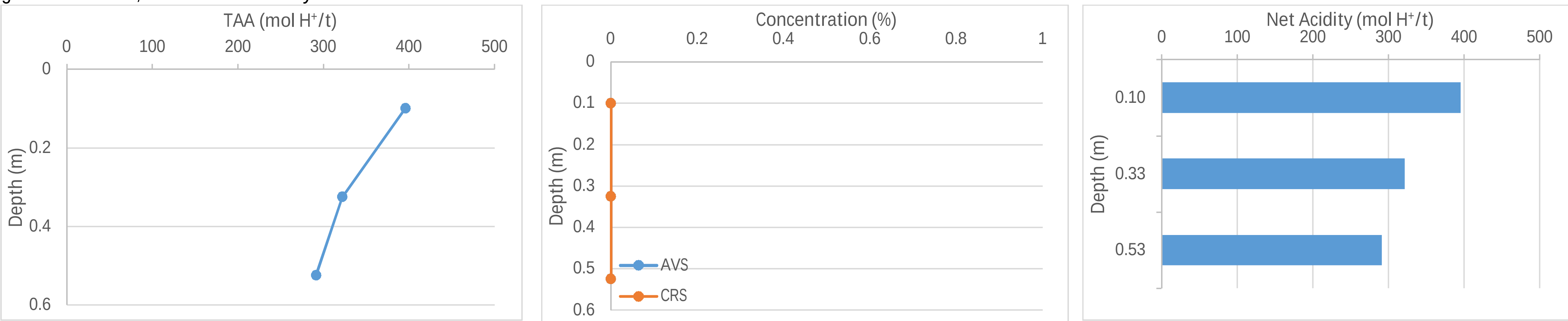


Figure A1.18 TAA, RIS and Net Acidity at MSC18

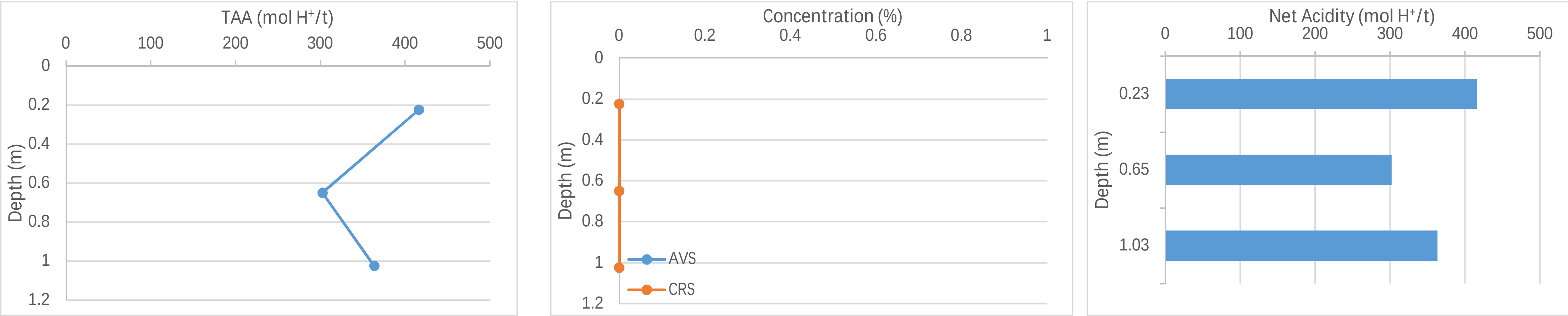


Figure A1.19 TAA, RIS and Net Acidity at MSC19

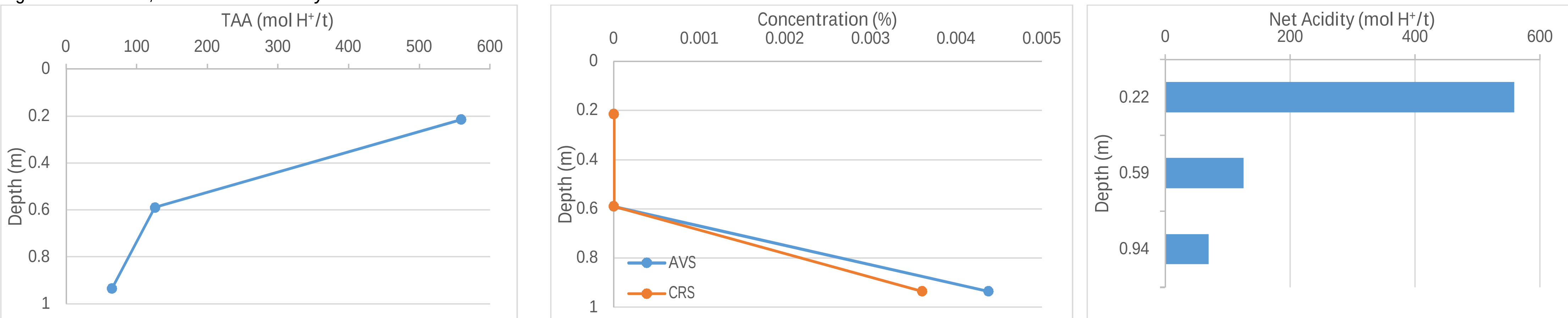


Figure A1.20 TAA, RIS and Net Acidity at MSC20

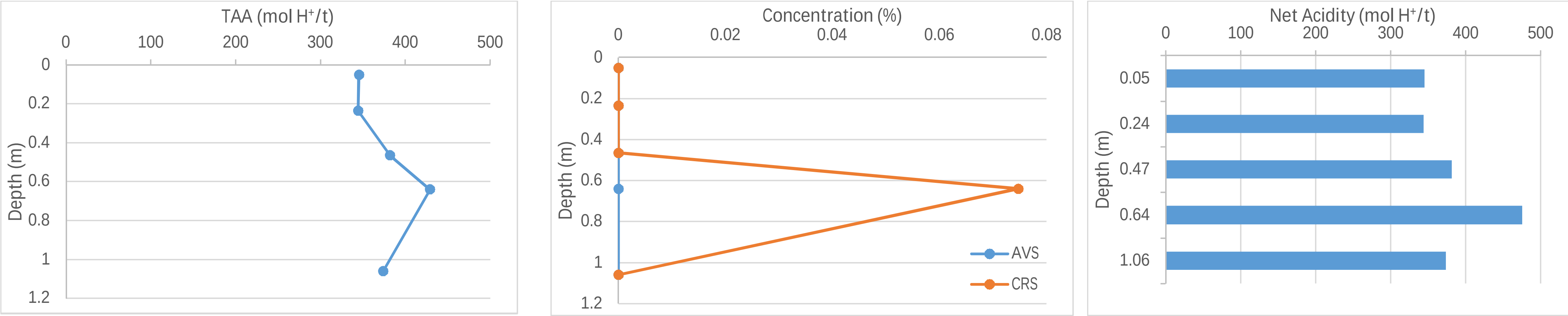


Figure A1.21 TAA, RIS and Net Acidity at MSC21

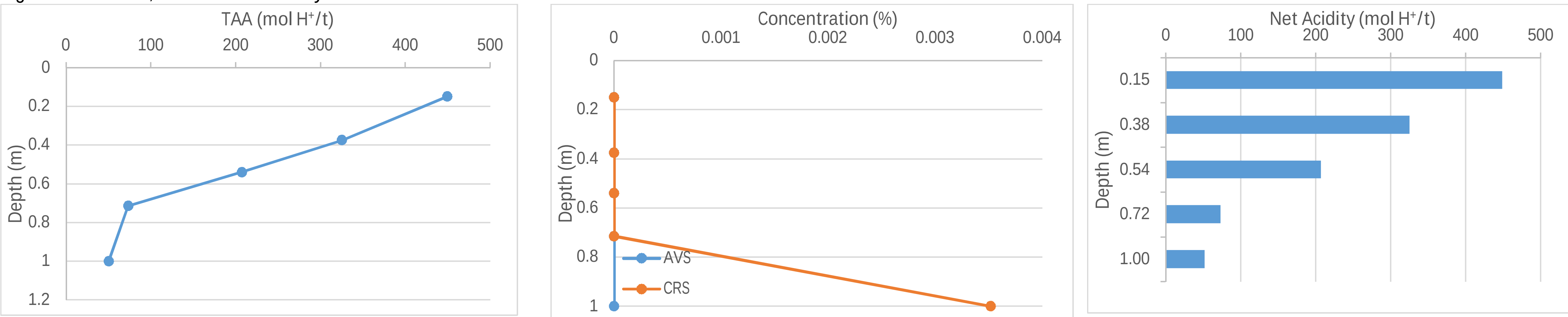


Figure A1.22 TAA, RIS and Net Acidity at MSC22

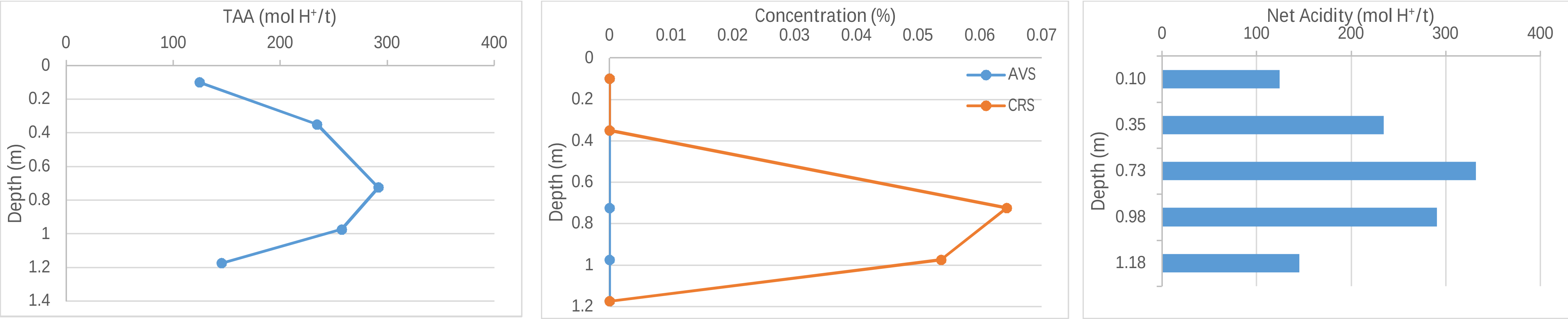


Figure A1.23 TAA, RIS and Net Acidity at MSC23

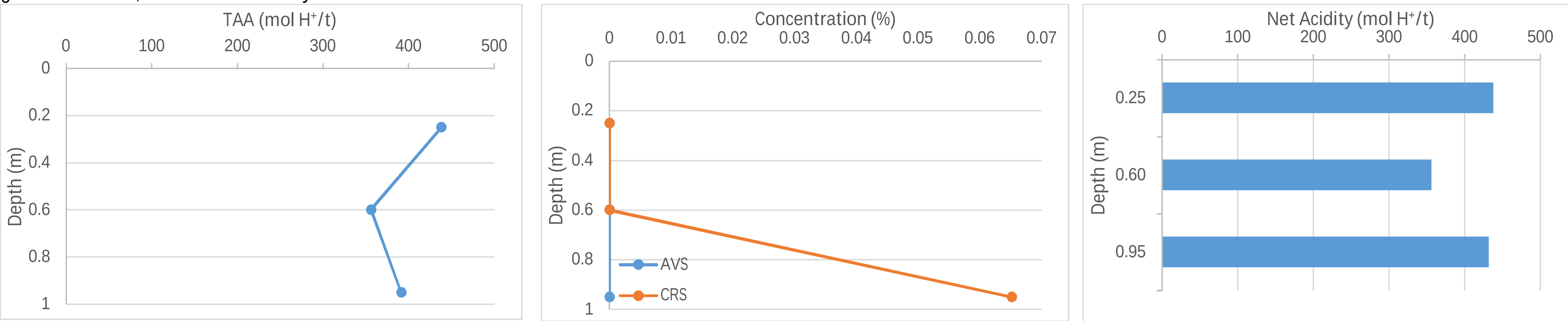


Figure A1.24 TAA, RIS and Net Acidity at MSC24

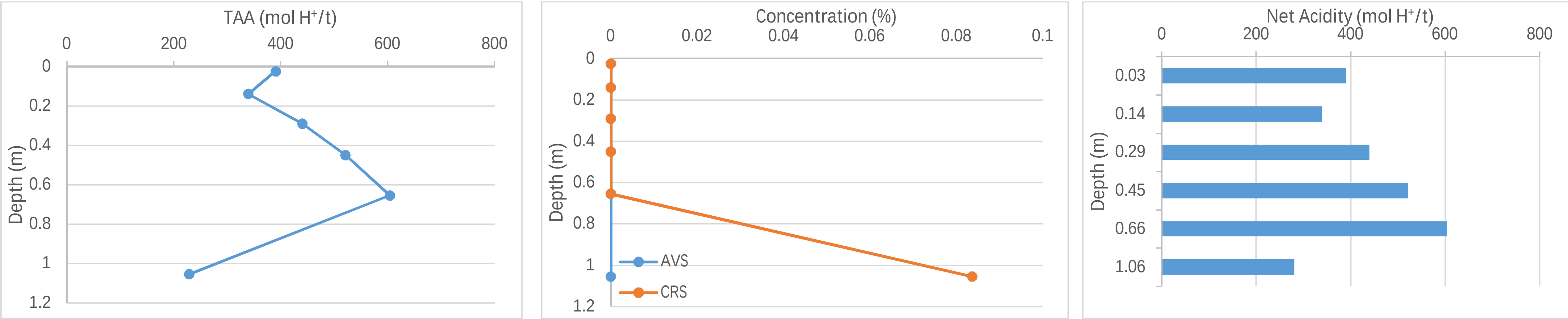


Figure A1.25 TAA, RIS and Net Acidity at MSC25

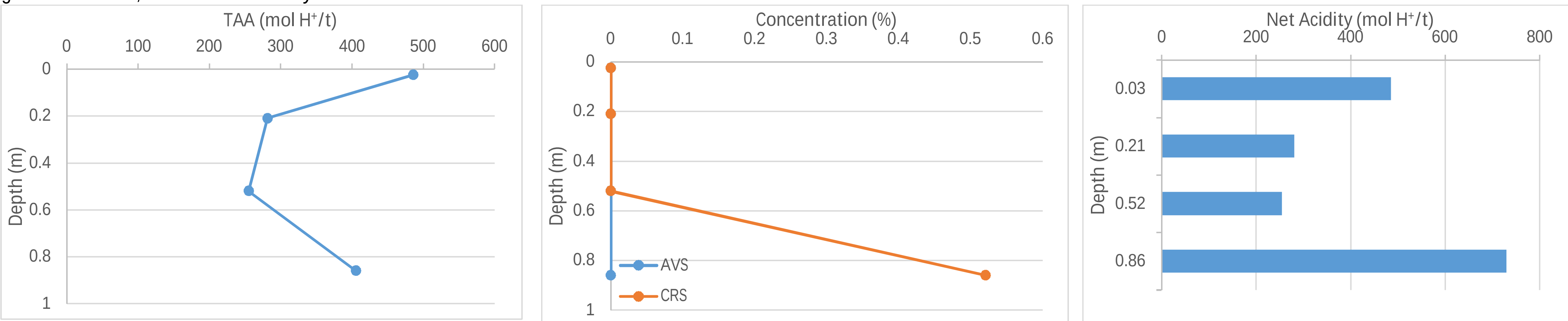


Figure A1.26 TAA, RIS and Net Acidity at MSC26

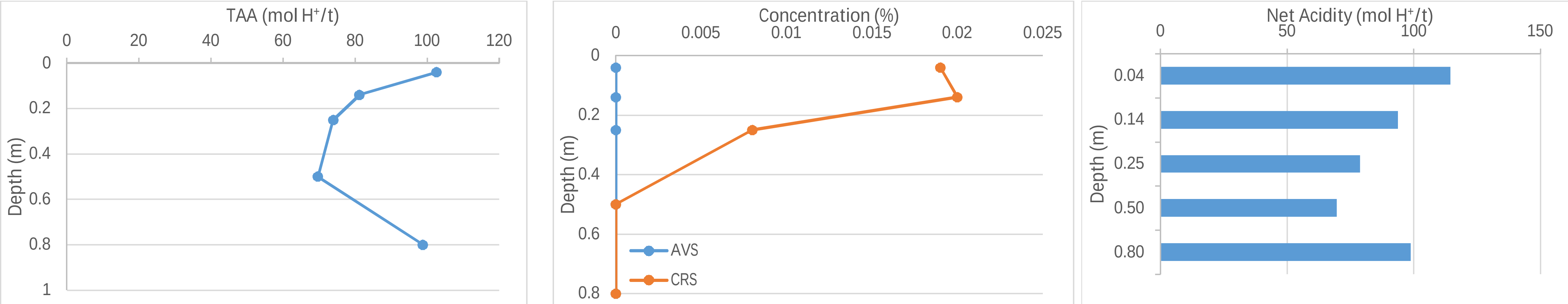


Figure A1.27 TAA, RIS and Net Acidity at MSC27

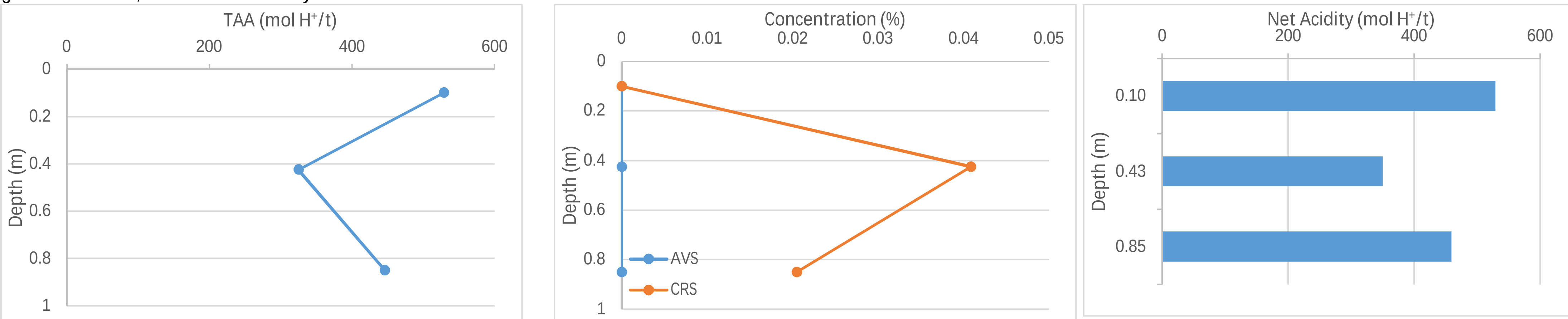


Figure A1.28 TAA, RIS and Net Acidity at MSC28

Appendix 2

Table A2.1 Site Coordinates for Salt Creek sampling sites

Site	Latitude	Longitude	Elevation (m AHD from GPS)	Depth to Watertable (cm)
STC1	38° 23.692' S	144° 05.272' E	75	42
STC2	38° 23.658' S	144° 05.387' E	79	72
STC3	38° 23.717' S	144° 05.542' E	64	78
STC4	38° 23.760' S	144° 05.664' E	68	45
STC5	38° 23.734' S	144° 05.854' E	59	68
STC6	38° 23.887' S	144° 05.925' E	64	n/a
STC7	38° 23.793' S	144° 06.099' E	49	58
STC8	38° 23.819' S	144° 06.223' E	59	78
STC9	38° 23.811' S	144° 06.348' E	63	90
SCT10	38° 23.750' S	144° 06.454' E	58	n/a
STC11	38° 23.701' S	144° 06.563' E	59	119
STC12	38° 23.666' S	144° 06.702' E	54	n/a
STC13	38° 23.672' S	144° 06.879' E	55	n/a
STC14	38° 23.651' S	144° 07.034' E	50	n/a
STC15	38°23'37.20"S	144° 7'51.84"E	52	n/a
STC16	38°23'43.44"S	144° 7'56.10"E	55	n/a
STC17	38°23'45.96"S	144° 8'5.16"E	54	n/a
STC18	38° 24.015' S	144° 08.199' E	30	n/a
STC19	38° 23.948' S	144° 08.422' E	30	n/a
STC20	38° 23.904' S	144° 08.493' E	23	n/a
STC21	38° 23.843' S	144° 08.658' E	24	n/a
STC22	38° 23.755' S	144° 08.839' E	24	n/a
STC23	38° 23.650' S	144° 08.919' E	23	0
SCT24	38° 23.580' S	144° 09.057' E	27	n/a
STC25	38° 23.237' S	144° 09.378' E	23	n/a

A2.1 Salt Creek Tributaries

The pH of the Tributary sites were all acidic and varied between $pH_{1:5}$ 3.18 and 4.51. The $EC_{1:5}$ ranged from 24.5 μS/cm to 210 μS/cm and the highest soil organic carbon (SOC) and total nitrogen concentrations were 14% and 0.67%, respectively, found at the surface of STC6.

A2..2 Upper Swamplands

The pH of the Upper Swamplands ranged from pH 3.06 to 4.18. The $EC_{1:5}$ of sites was variable, both between sites and within profiles, ranging from 59.5 μS/cm to 214.8 μS/cm. These sites had very high SOC concentrations of up to 25.2%.

A2..3 Mid-Swamplands

The pH of the sites in the Mid-Swamplands ranged from pH 2.81 to 4.88. $EC_{1:5}$ ranged from 62.1 μS/cm to 395 μS/cm. High SOC concentrations were found at the surface in STC7, 12 and 14 (up to 29.20%) and higher concentrations of total N were found in at these sites compared to Marshy Creek (up to 1.46%). In some sites, sampling of the profile had penetrated beyond the base of the peat layer, indicated by the large decrease in SOC concentrations at STC7, 15 and 16 (e.g. From 21.6% in the 0-12 cm depth layer to 4.19% in the 12 -23 cm depth layer at STC7)

A2..4 Lower Swamplands

The pH of the sites in the Lower Swamplands ranged from pH 2.99 to 3.26. $EC_{1:5}$ was consistent and ranged from 196.1 μS/cm to 347 μS/cm. SOC concentrations were slightly lower at these sites and ranged from 2.87% - 19.7%. The peat layer at these sites was thinner, and decreased downstream from a thickness of 80 cm to a thickness of 20 cm at STC21.

The pH of the Lower Channel sites ranged from pH 3.17 to 4.86. $EC_{1:5}$ ranged from 21.6 μS/cm to 169.5 μS/cm. SOC concentrations were much lower at these sites and ranged from 0.72% - 4.72% at sites STC22 and 23. At STC24, SOC concentrations were all less than 0.17%.

Table A2.2 pH, EC and soluble metal concentrations at Salt Creek

Site	Upper Depth (cm)	Lower Depth (cm)	$EC_{1:5}$ (µS/cm)	$pH_{1:5}$	Al (mg/kg)	As (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	B (mg/kg)	Co (mg/kg)	Ba (mg/kg)
STC1	0	18	60	4.44	15.680	0.012	0.029	0.037	12.712	0.051	0.020	0.024	0.171	0.008	0.129
STC1	18	28	74.5	4.38	16.685	0.015	0.038	0.022	21.750	0.049	0.024	0.039	0.183	0.009	0.112
STC1	28	52	72.1	4.34	13.579	0.015	0.034	0.020	11.044	0.036	0.016	0.032	0.198	0.006	0.090
STC1	52	81	24.5	4.5	7.603	0.008	0.023	0.013	3.655	0.004	0.004	0.009	0.098	0.001	0.036
STC1	81	117	31	4.45	14.468	0.013	0.057	0.017	3.502	0.003	0.005	0.037	0.122	0.001	0.047
STC2	0	25	100.1	4.12	25.926	0.014	0.042	0.029	19.203	0.260	0.036	0.575	0.222	0.018	0.166
STC2	25	72	100.7	4.06	18.994	0.022	0.032	0.023	10.421	0.109	0.025	0.026	0.203	0.011	0.137
STC2	72	90	59.5	4.15	13.222	0.022	0.028	0.015	4.451	0.038	0.013	0.019	0.143	0.005	0.057
STC2	90	127	54.8	4.18	9.677	0.017	0.023	0.014	5.183	0.051	0.010	0.029	0.126	0.005	0.046
STC3	0	22	214.8	3.28	54.605	0.017	0.038	0.029	44.629	0.546	0.161	0.453	0.422	0.095	0.348
STC3	22	59	186.8	3.26	42.139	0.032	0.037	0.024	30.580	0.395	0.149	0.409	0.253	0.090	0.407
STC3	59	90	127.8	3.34	18.174	0.051	0.018	0.019	2.562	0.237	0.096	0.395	0.239	0.069	0.448
STC3	90	120	121.5	3.37	16.764	0.047	0.015	0.015	2.015	0.237	0.099	0.362	0.225	0.076	0.422
STC3	120	142	217.8	3.4	31.456	0.031	0.026	0.026	10.866	0.446	0.118	0.366	0.331	0.091	0.421
STC4	0	13	188	3.28	41.625	0.017	0.026	0.028	13.435	0.303	0.211	1.201	0.626	0.094	0.281
STC4	13	50	208.1	3.09	20.816	0.018	0.014	0.011	1.746	0.134	0.245	1.256	0.270	0.078	0.297
STC4	50	74	248	3.06	24.843	0.019	0.017	0.011	2.005	0.290	0.374	2.199	0.253	0.117	0.380
STC4	74	115	130.6	3.05	23.224	0.039	0.014	0.008	1.076	0.234	0.441	2.439	0.224	0.120	0.318
STC4	115	138	315	3.79	2.994	0.027	0.006	0.007	0.679	0.432	0.132	0.114	0.258	0.036	0.143
STC5	0	25	151.5	4.09	39.222	0.017	0.044	0.046	93.228	0.401	0.186	0.238	0.874	0.194	0.369
STC5	25	50	189.8	3.8	16.344	0.010	0.027	0.015	53.074	0.543	0.158	0.308	0.264	0.193	0.357
STC5	50	65	118.5	4.04	8.923	0.007	0.017	0.015	6.963	0.301	0.082	0.168	0.183	0.105	0.276
STC5	65	92	58.2	3.99	5.152	0.006	0.018	0.006	3.324	0.162	0.049	0.508	0.179	0.039	0.195
STC6	0	10	98.6	4.23	20.741	0.014	0.027	0.030	9.650	0.358	0.079	0.220	0.328	0.032	0.176
STC6	10	29	70	4.51	14.328	0.009	0.025	0.040	9.332	0.076	0.130	0.200	0.270	0.040	0.090
STC6	29	46	59.8	4.39	8.763	0.009	0.023	0.033	6.196	0.055	0.092	0.079	0.266	0.024	0.050

STC6	46	59	40.8	4.37	8.427	0.007	0.023	0.036	6.085	0.030	0.070	0.075	0.224	0.020	0.047
STC6	59	86	32.6	3.26	5.665	0.007	0.036	0.031	4.500	0.011	0.040	0.057	0.174	0.015	0.063
STC7	0	12	282	3.29	133.505	0.010	0.070	0.036	153.724	1.038	2.015	3.945	0.450	0.717	0.246
STC7	12	23	255	3.04	133.970	0.010	0.066	0.022	91.964	0.895	3.556	5.857	0.359	0.978	0.162
STC7	23	58	222	3.13	73.046	0.017	0.027	0.014	25.150	0.866	2.255	4.536	0.143	0.666	0.127
STC7	58	80	146.5	3.38	34.667	0.016	0.014	0.027	17.910	0.528	1.096	2.423	0.082	0.335	0.134
STC8	0	30	155.6	3.26	60.594	0.012	0.071	0.034	94.784	0.976	0.658	1.547	0.342	0.263	0.415
STC8	30	53	176.7	3.28	39.400	0.009	0.051	0.022	74.893	0.921	0.926	2.044	0.260	0.435	0.200
STC8	53	90	140.3	3.3	22.619	0.011	0.041	0.014	26.180	0.559	0.782	1.598	0.222	0.324	0.166
STC9	0	16	203.9	3.7	51.399	0.008	0.036	0.050	47.444	6.028	0.400	0.877	0.719	0.202	0.250
STC9	16	25	140.5	3.56	41.884	0.007	0.030	0.030	29.805	1.542	0.443	0.916	0.519	0.174	0.220
STC9	25	45	155.3	3.45	32.664	0.009	0.033	0.020	35.331	1.460	0.663	2.737	0.313	0.268	0.181
STC9	45	70	203.5	3.31	37.571	0.016	0.036	0.020	67.859	2.254	0.946	1.907	0.251	0.385	0.163
STC9	70	95	168.9	3.27	30.019	0.021	0.027	0.017	28.492	1.411	0.933	2.426	0.209	0.386	0.155
STC10	0	8	65.1	3.73	46.918	0.007	0.044	0.040	41.885	2.699	0.240	0.408	0.548	0.129	0.227
STC10	8	36	85	3.82	22.344	0.006	0.029	0.023	20.449	0.368	0.151	0.268	0.297	0.070	0.165
STC10	36	70	62.1	3.93	12.983	0.022	0.028	0.014	2.888	0.097	0.141	0.216	0.281	0.057	0.180
STC10	70	105	57.5	3.78	7.099	0.012	0.016	0.008	3.279	0.166	0.180	0.287	0.188	0.115	0.197
STC11	0	30	92.2	3.81	21.251	0.013	0.024	0.036	16.669	4.615	0.339	0.701	0.327	0.284	0.167
STC11	30	60	133.8	3.54	22.783	0.011	0.033	0.034	34.624	10.724	0.513	1.125	0.333	0.399	0.269
STC11	60	90	81.7	3.29	41.500	0.009	0.046	0.028	128.569	1.344	0.884	1.694	0.360	0.407	0.239
STC11	90	110	286	3.28	51.342	0.009	0.047	0.032	150.118	18.219	0.832	1.930	0.335	0.542	0.346
STC11	110	130	270	3.12	34.495	0.007	0.036	0.037	140.526	1.116	0.748	1.513	0.276	0.357	0.198
STC12	0	5	0	3.91	16.936	0.008	0.042	0.059	5.098	26.570	0.079	0.274	0.793	0.062	1.159
STC12	5	10	258	4.52	34.896	0.009	0.029	0.055	15.640	11.075	0.207	0.297	0.654	0.180	0.657
STC12	10	30	68.5	4.88	4.823	0.006	0.011	0.034	4.230	2.498	0.038	0.077	0.300	0.041	0.123
STC12	30	60	87	4.63	2.867	0.004	0.009	0.016	1.729	2.308	0.055	0.077	0.243	0.066	0.296
STC12	60	80	213.1	3.62	23.452	0.007	0.025	0.032	58.356	3.494	0.478	0.881	0.351	0.353	0.334
STC12	80	100	340	3.11	43.366	0.009	0.037	0.038	205.623	2.030	0.702	1.374	0.374	0.401	0.244
STC12	100	139	293	3.12	32.681	0.010	0.038	0.036	162.201	1.404	0.562	1.069	0.396	0.289	0.255

STC13	0	30	253	3.33	45.061	0.012	0.054	0.074	151.239	56.853	0.485	1.064	0.487	2.160	0.244
STC13	30	57	263	3.27	53.379	0.012	0.058	0.078	183.678	48.185	0.526	1.056	0.461	1.847	0.279
STC13	57	68	300	3.18	39.640	0.009	0.054	0.054	274.572	7.392	0.514	0.946	0.355	0.501	0.307
STC13	68	105	394	3.08	52.927	0.011	0.073	0.048	320.754	1.934	0.675	1.157	0.309	0.368	0.280
STC13	105	120	395	3.09	64.725	0.013	0.070	0.042	347.247	5.751	0.889	1.420	0.322	0.547	0.273
STC14	0	30	213.4	3.65	43.491	0.010	0.032	0.058	20.384	32.987	0.277	0.413	0.970	0.756	0.455
STC14	30	56	241	3.38	59.951	0.010	0.036	0.039	82.126	21.513	0.947	1.098	0.450	1.148	0.428
STC14	56	78	170.9	3.35	48.052	0.011	0.039	0.030	82.101	15.282	0.799	1.030	0.369	0.809	0.305
STC14	78	115	251	3.2	41.010	0.010	0.063	0.046	139.060	2.364	0.564	0.769	0.276	0.348	0.220
STC14	115	130	289	3.13	40.474	0.011	0.059	0.030	247.362	1.848	0.532	0.812	0.276	0.295	0.163
STC15	0	30	109.6	3.41	34.483	0.019	0.062	0.026	31.558	2.295	0.574	0.844	0.488	0.261	0.427
STC15	30	60	49.8	3.12	61.941	0.030	0.070	0.033	136.304	3.256	1.667	2.053	0.478	0.837	0.382
STC15	60	80	338	2.98	117.394	0.029	0.061	0.028	81.872	3.142	3.738	4.922	0.437	1.875	0.187
STC15	80	105	298	3.02	123.783	0.026	0.075	0.024	48.653	2.395	3.657	5.225	0.350	1.772	0.143
STC15	105	134	282	3.09	72.661	0.027	0.054	0.022	35.704	1.930	1.899	4.458	0.232	1.071	0.175
STC16	0	30	247	3.18	56.143	0.017	0.074	0.055	158.389	4.459	0.990	1.504	0.469	0.533	0.109
STC16	30	70	319	3.08	69.958	0.017	0.083	0.067	243.836	2.473	1.350	2.139	0.451	0.659	0.146
STC16	70	90	299	3.09	60.129	0.017	0.075	0.050	209.840	2.727	1.336	2.012	0.406	0.629	0.174
STC16	90	120	235	3.08	34.558	0.010	0.048	0.026	79.144	1.241	0.789	1.542	0.342	0.396	0.292
STC17	0	30	115.8	3.84	18.799	0.011	0.028	0.016	5.687	5.093	0.231	0.473	0.460	0.159	0.369
STC17	30	50	164	3.61	34.210	0.014	0.041	0.024	25.687	3.769	0.566	0.953	0.401	0.327	0.317
STC17	50	70	192.5	3.42	49.944	0.015	0.048	0.027	80.448	2.648	0.856	1.381	0.420	0.508	0.273
STC17	70	92	173.9	3.48	29.983	0.014	0.067	0.025	27.261	1.176	0.457	1.524	0.293	0.277	0.232
STC17	92	102	150.2	3.5	16.144	0.009	0.044	0.011	17.420	0.808	0.302	1.125	0.254	0.221	0.260
STC17	102	122	151.9	3.65	33.668	0.019	0.054	0.019	19.655	1.135	0.376	1.532	0.235	0.284	0.231
STC18	0	30	272	3.03	128.197	0.018	0.069	0.014	154.139	0.652	1.017	2.530	0.425	0.279	0.135
STC18	30	60	371	2.81	135.589	0.030	0.130	0.018	242.601	0.770	1.427	3.382	0.437	0.352	0.126
STC18	60	95	338	2.83	160.791	0.038	0.109	0.014	101.407	0.776	1.646	3.779	0.397	0.399	0.134
STC18	95	110	327	2.98	211.964	0.042	0.091	0.019	70.233	0.671	1.809	4.071	0.395	0.416	0.152
STC18	110	120	363	3.08	260.039	0.050	0.093	0.022	55.939	0.539	1.606	4.219	0.288	0.418	0.133

STC18	120	130	303	2.87	136.521	0.022	0.070	0.014	81.009	0.425	1.412	3.066	0.380	0.369	0.112
STC19	0	10	123.5	3.81	5.437	0.005	0.008	0.011	6.994	4.121	0.060	0.157	0.396	0.038	0.108
STC19	10	33	123.6	3.54	19.690	0.012	0.042	0.018	12.553	2.970	0.268	0.543	0.359	0.090	0.333
STC19	33	55	149.1	3.37	30.295	0.015	0.045	0.010	17.229	1.858	0.504	1.084	0.259	0.178	0.258
STC19	55	90	210.5	3.18	41.737	0.011	0.039	0.011	22.466	1.906	0.720	1.851	0.219	0.337	0.183
STC20	0	65	312	2.99	131.072	0.017	0.036	0.015	58.284	6.910	1.879	2.738	0.265	0.942	0.098
STC20	65	80	303	3.05	99.940	0.018	0.039	0.016	134.275	4.995	2.296	2.799	0.272	0.960	0.122
STC20	80	130	196.1	3.06	42.484	0.010	0.018	0.014	49.754	1.966	1.202	1.968	0.199	0.503	0.165
STC21	0	25	347	3.18	125.708	0.026	0.049	0.030	163.363	7.191	2.913	4.247	0.319	1.560	0.205
STC21	25	45	300	3.24	130.251	0.027	0.046	0.026	80.461	4.695	2.603	3.936	0.296	1.269	0.153
STC21	45	70	239	3.22	67.333	0.019	0.029	0.016	24.516	2.324	1.391	2.841	0.236	0.673	0.140
STC21	70	98	243	3.19	64.142	0.013	0.027	0.013	23.049	2.421	1.459	2.593	0.220	0.695	0.143
STC22	0	20	287	3.26	72.805	0.020	0.036	0.033	70.660	3.196	1.962	2.591	0.571	0.998	0.142
STC22	20	38	233.3	3.2	58.026	0.015	0.030	0.023	49.192	2.785	1.601	2.291	0.272	0.735	0.152
STC22	38	82	218.6	3.2	39.833	0.012	0.024	0.016	27.513	2.835	1.215	1.925	0.262	0.559	0.148
STC23	0	20	294	3.37	94.528	0.028	0.030	0.014	36.491	3.820	1.945	3.659	0.271	0.985	0.158
STC23	20	55	285	3.17	36.038	0.010	0.016	0.015	45.573	2.936	1.334	2.747	0.267	0.816	0.181
STC23	55	90	248	3.21	12.740	0.005	0.016	0.027	9.350	3.534	0.976	2.165	0.208	0.774	0.138
STC23	90	110	169.5	3.34	3.921	0.002	0.008	0.011	3.890	1.739	0.452	1.029	0.154	0.349	0.140
STC24	0	6	57.3	4.45	12.447	0.014	0.051	0.032	13.026	1.304	0.039	0.106	0.263	0.012	0.290
STC24	6	20	21.6	4.59	4.919	0.005	0.012	0.023	5.198	1.365	0.032	0.063	0.150	0.013	0.089
STC24	20	40	49.6	3.99	12.616	0.005	0.036	0.050	11.884	0.049	0.026	0.082	0.425	0.018	0.169
STC24	40	60	55	3.94	15.329	0.006	0.036	0.043	13.696	0.024	0.025	0.171	0.563	0.020	0.166
STC24	60	75	64	3.9	28.434	0.009	0.066	0.057	37.479	0.026	0.043	0.112	0.635	0.029	0.209
STC24	75	86	124.5	3.56	4.299	0.003	0.008	0.011	15.175	0.220	0.190	0.288	0.703	0.084	0.757
STC24	86	107	109	3.6	7.548	0.007	0.018	0.020	14.040	0.252	0.161	0.415	0.719	0.069	0.634
STC25	0	15	3.6	4.06	0.909	0.000	0.001	0.018	0.807	0.030	0.015	0.051	0.049	0.008	0.080
STC25	15	20	83.7	3.56	0.779	0.001	0.008	0.012	0.353	0.382	0.104	0.295	0.087	0.076	0.173
STC25	20	40	68.9	4.12	0.100	0.001	0.004	0.026	0.112	0.117	0.016	0.034	0.120	0.010	0.054
STC25	40	65	78.3	4.86	0.378	0.001	0.004	0.002	0.095	0.041	0.003	0.003	0.182	0.001	0.008

Table A2.3 Soluble and exchangeable salts, SO_4^{2-} :Cl^-, soil organic carbon (SOC), total N and retained acidity at Salt Creek
Note: nd = not detected

Site	Upper Depth (cm)	Lower Depth (cm)	Soluble (mg/kg)							Exchangeable ($cmol_c^+$/kg)					SOC (%)	Total N (%)	Retained Acidity (mol H^+/t)
			Ca^{2+}	Mg^{2+}	K^+	Na^+	Cl^-	SO_4^{2-}	SO_4^{2-}:Cl^-	Ca^{2+}	Mg^{2+}	K^+	Na^+	Al^{3+}			
STC1	0	18	1.950	18.221	12.666	51.460	49.095	44.600	0.908	0.130	1.266	0.159	0.228	1.759	3.15	0.136	1.120
STC1	18	28	2.129	21.943	13.253	61.547	48.381	54.269	1.122	0.164	1.901	0.209	0.377	2.560	5.84	0.283	2.973
STC1	28	52	1.818	18.073	12.972	77.422	49.638	57.306	1.154	0.152	2.018	0.215	0.451	3.894	8.26	0.391	1.697
STC1	52	81	0.357	3.582	3.226	30.768	27.477	6.001	0.218	0.053	0.888	0.135	0.189	1.259	2.34	0.07	0.151
STC1	81	117	0.525	5.085	3.938	41.331	25.084	23.229	0.926	0.062	1.297	0.199	0.345	2.982	1.4	0.063	1.743
STC2	0	25	4.001	32.137	21.832	104.348	44.055	126.906	2.881	0.262	3.324	0.351	0.859	2.893	13.9	0.673	10.871
STC2	25	72	1.591	25.406	14.922	125.907	95.450	157.104	1.646	0.088	2.721	0.291	0.988	7.318	17.4	0.827	5.390
STC2	72	90	0.675	11.965	7.529	72.988	49.142	49.548	1.008	0.058	1.751	0.229	0.573	4.072	8.62	0.362	1.544
STC2	90	127	0.766	9.575	6.357	67.697	31.186	46.950	1.505	0.088	2.396	0.209	0.522	2.515	6.08	0.22	1.682
STC3	0	22	6.445	34.385	44.866	147.215	164.585	327.646	1.991	0.132	1.110	0.440	0.892	10.899	18.4	0.859	9.563
STC3	22	59	5.920	37.819	22.825	164.234	180.054	360.912	2.004	0.156	1.308	0.329	1.081	13.011	20.7	0.927	7.882
STC3	59	90	4.451	26.835	15.754	181.389	185.198	281.672	1.521	0.151	1.515	0.279	1.205	14.012	20.7	0.913	4.424
STC3	90	120	3.954	28.867	13.387	172.016	166.685	301.894	1.811	0.174	1.764	0.336	1.247	13.901	22.9	0.979	4.351
STC3	120	142	7.520	43.614	24.255	193.968	208.418	360.982	1.732	0.370	2.461	0.189	0.795	10.810	21.4	0.899	3.654
STC4	0	13	5.278	31.652	47.005	119.788	120.464	310.726	2.579	0.157	1.453	0.387	0.758	10.576	20.7	0.99	5.652
STC4	13	50	2.701	42.537	10.397	150.923	172.786	385.948	2.234	0.076	1.468	0.203	1.181	13.901	24.7	0.88	2.272
STC4	50	74	4.102	63.892	11.914	196.829	218.185	503.051	2.306	0.076	1.355	0.271	1.092	14.123	25.2	0.848	2.525
STC4	74	115	4.493	67.318	13.149	172.605	196.269	501.812	2.557	0.103	1.290	nd	0.390	12.680	24.3	0.855	0.000
STC4	115	138	15.770	156.187	24.465	198.908	193.313	867.818	4.489	0.315	3.752	0.226	0.683	8.388	18.1	0.648	0.000
STC5	0	25	12.776	70.750	45.555	237.489	379.322	213.773	0.564	0.340	3.442	0.564	1.234	8.775	14.3	0.759	11.783
STC5	25	50	8.277	40.799	31.150	195.993	227.893	297.992	1.308	0.180	0.668	0.893	1.168	8.664	9.13	0.49	5.398
STC5	50	65	5.234	36.603	15.377	132.751	163.985	186.424	1.137	0.109	0.423	0.465	0.754	6.006	6.65	0.385	19.347
STC5	65	92	3.836	13.573	8.511	76.001	64.899	93.858	1.446	0.151	0.755	0.287	0.465	3.905	4.03	0.23	4.431

STC6	0	10	3.779	22.076	34.633	97.977	53.080	111.623	2.103	0.299	2.345	0.467	0.680	4.828	14	0.674	4.229
STC6	10	29	1.185	17.533	22.027	79.306	57.910	76.991	1.329	0.135	1.978	0.485	0.718	5.473	11.4	0.496	5.044
STC6	29	46	0.980	13.506	14.829	66.500	42.873	73.350	1.711	0.067	0.986	0.253	0.400	4.494	8.78	0.388	6.228
STC6	46	59	0.573	9.466	9.147	54.060	47.755	53.363	1.117	nd	0.716	0.127	0.248	3.849	4.83	0.162	4.033
STC6	59	86	0.326	5.497	6.883	44.264	24.298	36.518	1.503	0.289	1.416	0.209	0.369	0.278	1.55	0.066	1.606
STC7	0	12	6.617	34.254	154.485	94.340	152.351	830.594	5.452	nd	0.063	nd	nd	1.559	21.6	0.808	54.244
STC7	12	23	5.706	21.474	52.516	71.989	95.316	941.697	9.880	nd	0.134	0.344	0.263	4.583	4.19	0.152	51.960
STC7	23	58	5.440	14.812	17.901	35.566	42.965	608.226	14.156	nd	0.176	0.154	0.250	0.325	3.87	0.139	2.881
STC7	58	80	3.398	7.976	9.179	19.885	25.064	320.634	12.793	nd	0.029	nd	nd	1.041	2.02	0.045	0.617
STC8	0	30	7.299	20.070	56.951	29.873	88.958	317.329	3.567	0.082	0.273	0.365	0.150	3.149	15.8	0.6115	18.054
STC8	30	53	9.152	24.799	35.266	41.248	76.771	404.815	5.273	0.082	0.265	0.307	0.169	0.336	12.6	0.456	22.280
STC8	53	90	6.417	21.170	18.724	55.188	74.725	268.015	3.587	0.055	0.252	0.178	0.241	1.359	5.94	0.192	3.926
STC9	0	16	36.773	31.871	106.945	71.012	119.709	310.728	2.596	0.359	0.264	0.212	0.143	2.104	19.3	0.806	25.428
STC9	16	25	10.956	14.700	53.575	38.421	62.439	254.562	4.077	0.233	0.254	0.395	0.232	0.919	15.1	0.638	10.946
STC9	25	45	12.100	26.229	34.942	55.715	65.646	373.123	5.684	0.100	0.245	0.185	0.221	0.922	13.3	0.563	12.335
STC9	45	70	20.881	38.329	30.592	75.752	86.941	537.125	6.178	0.177	0.345	0.211	0.288	0.305	12	0.541	8.878
STC9	70	95	12.907	30.187	22.543	67.041	74.324	402.684	5.418	0.075	0.280	0.148	0.319	0.310	9.16	0.4245	8.640
STC10	0	8	13.479	52.217	45.305	99.067	114.264	14.549	0.127	0.318	1.128	0.183	0.373	0.953	17.1	0.832	12.195
STC10	8	36	2.456	17.419	22.841	64.535	47.671	128.535	2.696	0.086	0.428	0.167	0.328	1.837	15.7	0.569	7.786
STC10	36	70	1.205	9.807	21.067	47.320	40.023	96.549	2.412	nd	0.279	0.263	0.335	6.449	9.23	0.411	4.434
STC10	70	105	1.393	11.863	13.375	42.901	46.169	105.515	2.285	nd	0.338	0.164	0.258	3.847	5.48	0.21	2.682
STC11	0	30	10.211	13.001	38.441	26.376	44.802	168.784	3.767	0.305	0.479	0.535	0.204	13.009	13.6	0.82	12.649
STC11	30	60	18.494	23.546	32.940	38.458	38.954	291.096	7.473	0.444	0.714	0.499	0.270	14.232	11.5	0.698	10.707
STC11	60	90	16.418	38.208	27.213	97.031	78.034	673.908	8.636	0.220	0.660	0.329	0.540	13.231	13.8	0.702	21.209
STC11	90	110	45.266	47.494	39.393	85.846	110.266	823.741	7.470	0.349	0.685	0.303	0.646	10.040	17.2	0.681	64.347
STC11	110	130	14.565	37.330	23.118	84.204	93.203	705.153	7.566	0.164	0.575	0.230	0.479	7.527	8.49	0.357	28.212
STC12	0	5	125.186	63.229	253.149	116.358	326.188	137.470	0.421	9.945	4.899	1.647	0.666	1.517	29.2	1.12	5.262
STC12	5	10	109.498	66.520	156.545	68.757	140.325	80.182	0.571	13.069	7.829	1.473	0.625	4.058	29	1.46	14.852
STC12	10	30	18.842	28.069	35.825	36.555	48.766	66.827	1.370	1.009	1.283	1.244	0.335	1.924	3.73	0.228	nd
STC12	30	60	20.992	39.390	39.171	40.763	43.188	187.143	4.333	0.638	0.987	1.160	0.349	3.191	4.3	0.266	nd

STC12	60	80	27.409	44.704	50.106	50.820	52.004	406.703	7.821	0.521	1.192	0.540	0.353	14.121	13.3	0.797	12.677
STC12	80	100	24.406	45.227	37.454	98.063	140.499	892.575	6.353	0.301	0.841	0.382	0.574	11.786	17.5	0.943	48.274
STC12	100	139	18.961	34.110	32.825	82.044	102.447	667.818	6.519	0.293	0.842	0.408	0.510	14.565	14.9	0.789	34.802
STC13	0	30	20.578	31.762	50.573	66.581	94.263	632.329	6.708	0.395	0.671	0.399	0.460	8.483	18.5	1.03	33.727
STC13	30	57	20.307	32.744	46.114	79.538	101.968	682.470	6.693	0.232	0.365	0.220	0.254	10.229	19.6	1.04	25.260
STC13	57	68	20.011	35.979	32.891	98.477	146.732	828.929	5.649	0.307	0.778	0.368	0.659	9.940	17.9	0.991	15.249
STC13	68	105	23.132	47.309	33.053	140.047	201.637	1064.886	5.281	0.267	0.816	0.304	0.742	9.973	19	1.02	11.601
STC13	105	120	28.441	61.097	39.066	164.037	244.713	1274.622	5.209	0.254	0.512	0.180	0.645	8.539	22.4	1.07	31.598
STC14	0	30	80.543	41.106	101.590	60.401	109.739	401.599	3.660	2.833	1.671	1.106	0.501	8.016	20.2	1.1	14.712
STC14	30	56	47.220	40.088	46.270	63.250	89.638	493.091	5.501	0.398	0.628	0.566	0.466	14.454	13.5	0.846	8.607
STC14	56	78	42.633	38.855	43.661	77.402	96.251	495.523	5.148	0.531	0.660	0.605	0.499	13.676	13	0.754	7.859
STC14	78	115	19.249	29.457	27.143	81.599	107.652	559.214	5.195	0.228	0.514	0.263	0.494	9.740	12.9	0.675	16.933
STC14	115	130	15.714	32.548	26.330	84.866	105.117	794.677	7.560	0.211	0.578	0.266	0.589	9.139	15	0.698	45.468
STC15	0	30	20.245	25.010	59.645	28.684	44.514	218.600	4.911	0.305	0.476	0.479	0.172	9.940	14.1	0.755	6.483
STC15	30	60	28.358	28.545	67.406	31.015	78.344	579.915	7.402	0.261	0.351	0.392	0.152	8.595	21.8	0.869	29.708
STC15	60	80	27.477	40.637	34.623	59.773	93.145	922.934	9.909	0.149	0.355	0.221	0.270	12.008	18.8	0.684	18.061
STC15	80	105	21.051	36.400	28.889	62.657	78.415	1015.776	12.954	0.208	0.397	0.260	0.313	11.085	9.64	0.395	8.705
STC15	105	134	17.539	34.890	30.586	58.469	43.423	753.470	17.352	0.117	0.446	0.373	0.314	11.674	3.68	0.135	2.250
STC16	0	30	18.379	21.031	77.371	70.130	97.857	629.149	6.429	0.202	0.270	0.456	0.341	9.562	18.3	0.809	29.989
STC16	30	70	18.575	25.892	36.689	53.342	78.485	878.730	11.196	0.153	0.293	0.259	0.253	10.251	16.4	0.789	38.643
STC16	70	90	18.714	24.347	29.509	51.858	81.995	765.031	9.330	0.172	0.334	0.251	0.277	11.452	14.6	0.763	23.651
STC16	90	120	12.651	21.518	18.800	61.399	56.244	543.776	9.668	0.130	0.393	0.304	0.360	12.786	4.45	0.181	25.358
STC17	0	30	57.228	30.407	55.227	43.661	78.733	262.502	3.334	1.347	0.684	0.629	0.290	7.372	12.5	0.63	13.734
STC17	30	50	42.659	38.171	44.150	61.502	67.885	415.826	6.125	0.466	0.538	0.440	0.344	10.551	15.9	0.618	15.161
STC17	50	70	30.569	44.483	34.289	55.828	57.404	522.729	9.106	0.349	0.620	0.317	0.310	10.774	12.7	0.436	34.059
STC17	70	92	13.634	34.978	23.158	67.394	46.757	440.562	9.422	0.142	0.571	0.373	0.393	11.563	3.61	0.153	0.613
STC17	92	102	9.366	26.470	21.099	66.332	27.438	355.784	12.967	0.143	0.652	0.530	0.430	11.786	1.57	0.099	-0.182
STC17	102	122	15.523	33.226	19.758	70.586	40.665	473.769	11.651	0.139	0.591	0.476	0.452	12.119	3.91	0.144	8.004
STC18	0	30	6.776	11.588	14.438	44.368	51.150	956.427	18.699	0.061	0.142	0.300	0.290	10.054	8.51	0.381	nd
STC18	30	60	7.547	14.186	19.649	64.917	78.274	1288.210	16.458	0.092	0.137	0.268	0.417	10.521	15.7	0.526	nd

STC18	60	95	8.472	13.429	16.865	65.395	78.166	1212.492	15.512	0.062	0.118	0.216	0.386	12.344	14	0.507	nd
STC18	95	110	9.316	13.158	15.254	70.763	91.184	1347.021	14.773	0.053	0.103	0.237	0.398	13.678	13.4	0.535	nd
STC18	110	120	9.931	11.675	12.006	82.075	94.269	1604.621	17.022	0.059	0.093	0.232	0.472	12.566	6.96	0.287	96.279
STC18	120	130	7.430	10.300	9.289	55.089	51.598	1057.767	20.500	nd	0.114	0.241	0.378	12.010	6.65	0.254	89.908
STC19	0	10	27.004	38.440	69.518	34.698	61.062	324.975	5.322	0.373	0.547	0.615	0.179	4.083	7.77	0.462	nd
STC19	10	33	21.873	26.979	46.737	41.658	47.261	297.897	6.303	0.307	0.406	0.699	0.341	11.343	9.93	0.532	nd
STC19	33	55	15.547	23.451	33.155	47.616	36.830	385.508	10.467	0.180	0.375	0.596	0.354	12.789	4.78	0.233	nd
STC19	55	90	17.456	41.584	32.425	64.803	42.455	601.745	14.174	0.234	0.799	0.575	0.505	14.457	2.16	0.103	nd
STC20	0	65	28.837	56.748	31.401	105.956	150.338	1167.171	7.764	0.189	0.662	0.451	0.594	11.788	4.74	0.299	nd
STC20	65	80	32.115	51.499	27.984	87.903	119.562	1127.546	9.431	0.200	0.547	0.394	0.520	12.789	10.1	0.432	nd
STC20	80	130	19.013	31.739	25.102	50.805	66.317	579.134	8.733	0.158	0.407	0.276	0.296	9.109	2.87	0.151	nd
STC21	0	25	34.162	50.890	71.432	93.419	129.052	1385.418	10.735	0.181	0.437	0.476	0.464	14.457	15.4	0.767	nd
STC21	25	45	40.695	58.091	44.786	108.870	130.196	1231.967	9.462	0.217	0.483	0.524	0.560	13.567	10.1	0.516	nd
STC21	45	70	28.484	46.487	31.603	89.347	78.014	799.651	10.250	0.310	0.676	0.649	0.683	14.345	3.49	0.172	nd
STC21	70	98	28.090	46.901	30.572	83.115	73.057	764.670	10.467	0.233	0.696	0.618	0.568	13.456	3.86	0.163	nd
STC22	0	20	32.517	49.368	72.033	74.895	109.287	952.294	8.714	0.250	0.545	0.463	0.389	15.124	19.7	0.829	nd
STC22	20	38	28.891	47.671	36.633	65.463	56.180	779.800	13.880	0.221	0.535	0.425	0.435	10.921	5.7	0.348	nd
STC22	38	82	25.418	42.267	30.915	70.176	46.609	620.179	13.306	0.233	0.618	0.482	0.449	10.676	3.29	0.181	nd
STC23	0	20	38.377	72.900	33.605	95.315	106.743	1045.010	9.790	0.239	0.815	0.420	0.494	10.298	4.72	0.289	nd
STC23	20	55	30.964	77.587	32.491	86.527	95.633	762.125	7.969	0.344	1.338	0.425	0.520	8.964	1.915	0.114	7.388
STC23	55	90	37.003	152.058	39.090	100.017	94.331	908.346	9.629	0.558	3.447	0.425	0.575	6.840	0.678	0.06	nd
STC23	90	110	19.451	84.268	20.966	54.859	51.055	493.325	9.663	0.225	1.673	0.194	0.253	2.304	0.485	0.035	nd
STC24	0	6	19.559	18.138	18.643	35.188	22.844	16.577	0.726	1.987	3.192	0.287	0.377	1.036	1.96	0.109	0.000
STC24	6	20	6.604	7.303	10.996	17.127	14.735	0.000	0.000	0.892	1.260	0.131	0.124	0.271	0.95	0.0415	0.000
STC24	20	40	4.645	11.465	12.128	42.679	38.682	37.324	0.965	1.055	4.764	0.417	0.492	2.001	1.03	0.048	0.000
STC24	40	60	5.860	13.154	11.742	42.559	18.491	60.846	3.291	1.452	6.455	0.491	0.530	2.824	0.724	0.043	0.000
STC24	60	75	6.627	18.014	12.417	46.234	35.210	66.036	1.875	1.479	7.000	0.534	0.604	3.058	1.04	0.053	0.000
STC24	75	86	14.392	32.363	19.242	50.023	54.335	222.956	4.103	0.334	1.239	0.208	0.347	4.636	5.08	0.229	31.201
STC24	86	107	13.037	26.081	18.894	64.101	73.703	173.935	2.360	0.618	0.856	0.191	0.366	5.793	6.01	0.296	13.870
STC25	0	15	0.885	0.770	1.080	1.202	15.507	0.000	0.000	nd	0.013	nd	nd	0.195	0.069	nd	nd

STC25	15	20	7.727	20.423	10.885	34.740	36.762	169.652	4.615	0.271	1.067	0.140	0.264	2.691	0.172	0.022	0.000
STC25	20	40	4.243	13.930	5.518	59.592	35.179	137.889	3.920	0.555	2.493	0.137	0.367	0.530	0.11	<0.02	0.000
STC25	40	65	3.278	13.439	2.613	81.424	30.763	177.875	5.782	0.532	2.941	nd	0.528	0.061	0.097	<0.02	nd

Table A2.4 Particle size distribution at Salt Creek

Site	Upper Depth (cm)	Lower Depth (cm)	Clay (< 2 µm; %)	Silt (2-62.5 µm; %)	Sand (62.5 – 2000 µm; %)
STC1	0	18	7.82	36.08	56.10
STC1	18	28	12.90	75.50	11.60
STC1	28	52	16.70	80.00	3.30
STC1	52	81	9.90	62.00	28.10
STC1	81	117	13.20	61.30	25.50
STC2	0	25	7.84	59.56	32.60
STC2	25	72	19.80	78.80	1.40
STC2	72	90	9.99	57.71	32.30
STC2	90	127	8.91	51.09	40.00
STC3	0	22	23.60	76.00	0.40
STC3	22	59	21.40	78.10	0.50
STC3	59	90	19.30	80.30	0.40
STC3	90	120	23.50	76.50	0.00
STC3	120	142	19.20	80.30	0.50
STC4	0	13	21.00	78.50	0.50
STC4	13	50	23.40	76.60	0.00
STC4	50	74	18.80	80.50	0.70
STC4	74	115	24.20	75.80	0.00
STC4	115	138	27.10	72.90	0.00
STC5	0	25	23.20	76.80	0.00
STC5	25	50	25.90	74.10	0.00
STC5	50	65	23.60	75.60	0.80
STC5	65	92	24.90	75.10	0.00
STC6	0	10	17.60	81.40	1.00
STC6	10	29	22.10	77.80	0.10
STC6	29	46	15.90	83.70	0.40
STC6	46	59	14.70	83.30	2.00
STC6	59	86	16.50	83.50	0.00
STC7	0	12	10.10	64.10	25.80
STC7	12	23	16.90	82.60	0.50
STC7	23	58	5.73	32.47	61.80
STC8	0	30	12.60	78.90	8.50
STC8	30	53	12.80	66.90	20.30
STC8	53	90	27.90	72.10	0.00
STC9	0	16	24.80	75.00	0.20
STC9	16	25	11.90	82.90	5.20
STC9	25	45	15.10	83.40	1.50
STC9	45	70	12.30	86.30	1.40
STC9	70	95	17.90	81.70	0.40
STC10	0	8	13.80	74.40	11.80
STC10	8	36	6.91	68.99	24.10

STC10	36	70	16.30	76.40	7.30
STC10	70	105	11.50	67.90	20.60
STC11	0	30	19.50	78.70	1.80
STC11	30	60	18.80	79.80	1.40
STC11	60	90	19.10	80.50	0.40
STC11	90	110	16.60	82.70	0.70
STC11	110	130	28.00	72.00	0.00
STC12	0	5	29.20	70.80	0.00
STC12	5	10	17.50	81.40	1.10
STC12	10	30	5.03	18.77	76.20
STC12	30	60	11.50	35.40	53.10
STC12	60	80	24.60	75.40	0.00
STC12	80	100	31.50	68.50	0.00
STC12	100	139	38.30	61.70	0.00
STC13	0	30	28.80	71.20	0.00
STC13	30	57	27.90	72.10	0.00
STC13	57	68	21.90	77.70	0.40
STC13	68	105	26.90	72.70	0.40
STC13	105	120	14.20	80.40	5.40
STC14	0	30	18.20	77.10	4.70
STC14	30	56	21.40	78.00	0.60
STC14	56	78	24.00	75.80	0.20
STC14	78	115	22.60	77.10	0.30
STC14	115	130	23.20	76.50	0.30
STC15	0	30	19.50	80.10	0.40
STC15	30	60	23.60	75.60	0.80
STC15	60	80	22.90	76.40	0.70
STC15	80	105	18.50	81.00	0.50
STC15	105	134	20.00	79.70	0.30
STC16	0	30	13.90	40.80	45.30
STC16	30	70	28.40	71.60	0.00
STC16	70	90	34.90	65.10	0.00
STC16	90	120	28.70	71.30	0.00
STC17	0	30	20.20	79.00	0.80
STC17	30	50	20.30	78.90	0.80
STC17	50	70	25.70	74.30	0.00
STC17	70	92	22.80	76.70	0.50
STC17	92	102	30.90	69.10	0.00
STC17	102	122	19.20	80.50	0.30
STC18	0	30	21.00	78.50	0.50
STC18	30	60	16.50	81.30	2.20
STC18	60	95	19.50	79.70	0.80
STC18	95	110	20.20	78.90	0.90
STC18	110	120	25.60	74.40	0.00
STC18	120	130	20.10	79.40	0.50

STC19	0	10	12.50	38.00	49.50
STC19	10	33	29.50	70.50	0.00
STC19	33	55	38.90	61.10	0.00
STC19	55	90	25.70	74.30	0.00
STC20	0	65	8.24	42.96	48.80
STC20	65	80	35.60	64.40	0.00
STC20	80	130	24.80	75.20	0.00
STC21	0	25	19.10	79.60	1.30
STC21	25	45	17.70	58.30	24.00
STC21	45	70	26.10	73.90	0.00
STC21	70	98	27.30	72.70	0.00
STC22	0	20	23.70	75.30	1.00
STC22	20	38	35.70	64.30	0.00
STC22	38	82	21.80	77.30	0.90
STC23	0	20	13.40	67.30	19.30
STC23	20	55	34.60	65.40	0.00
STC23	55	90	21.70	77.80	0.50
STC23	90	110	13.40	53.10	33.50
STC24	0	6	11.40	85.40	3.20
STC24	6	20	13.00	40.20	46.80
STC24	20	40	22.50	77.40	0.10
STC24	40	60	22.60	77.40	0.00
STC24	60	75	27.90	72.10	0.00
STC24	75	86	34.00	66.00	0.00
STC24	86	107	32.30	67.70	0.00
STC25	0	15	1.24	3.93	94.83
STC25	15	20	17.70	54.30	28.00
STC25	20	40	16.30	48.20	35.50
STC25	40	65	13.00	44.80	42.20

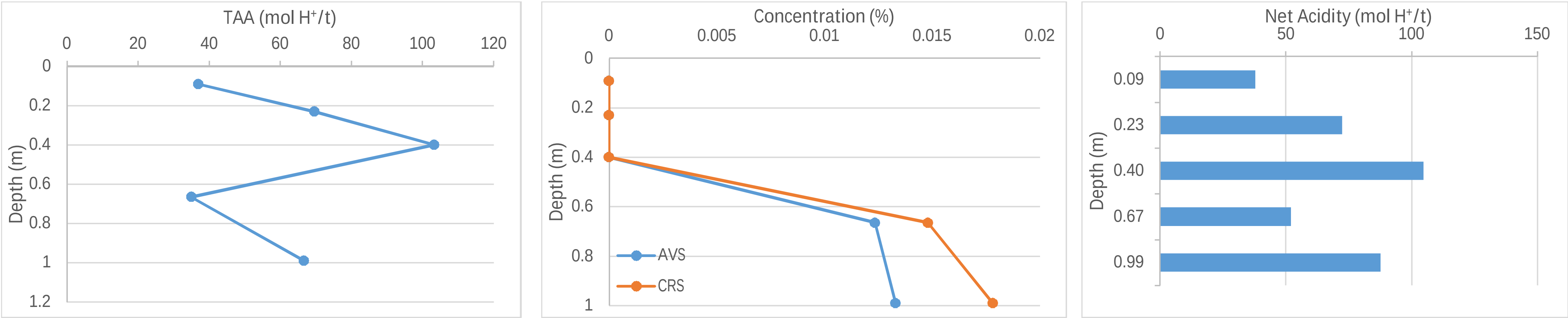


Figure A2.1 TAA, RIS and Net Acidity at STC1

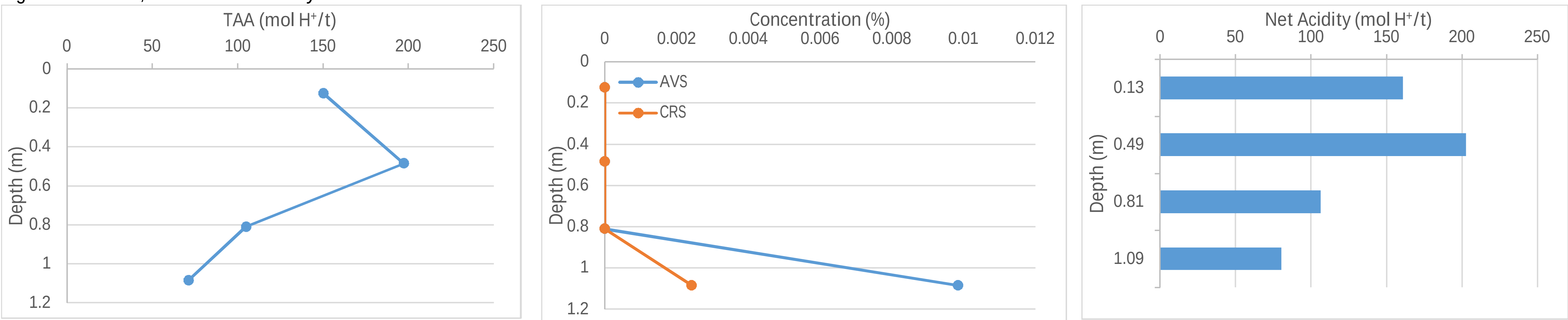


Figure A2.2 TAA, RIS and Net Acidity at STC2

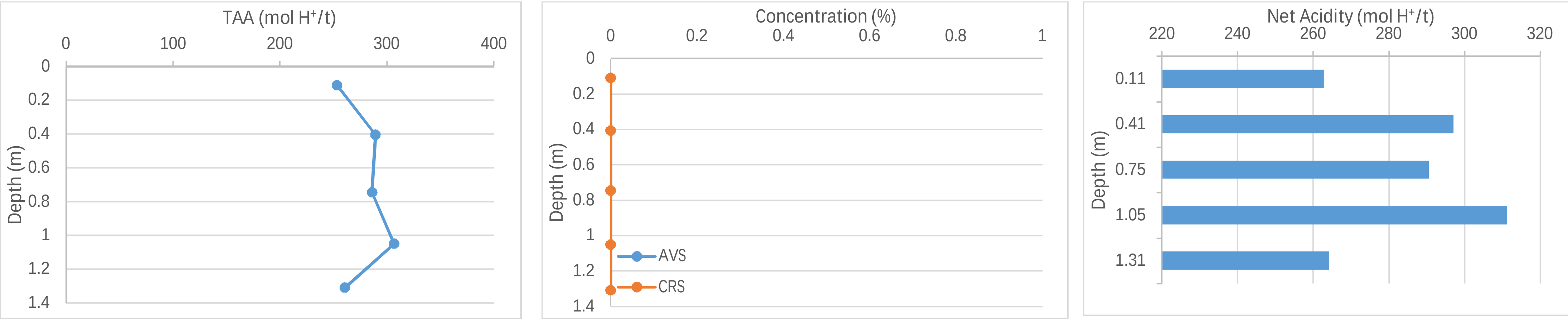


Figure A2.3 TAA, RIS and Net Acidity at STC3

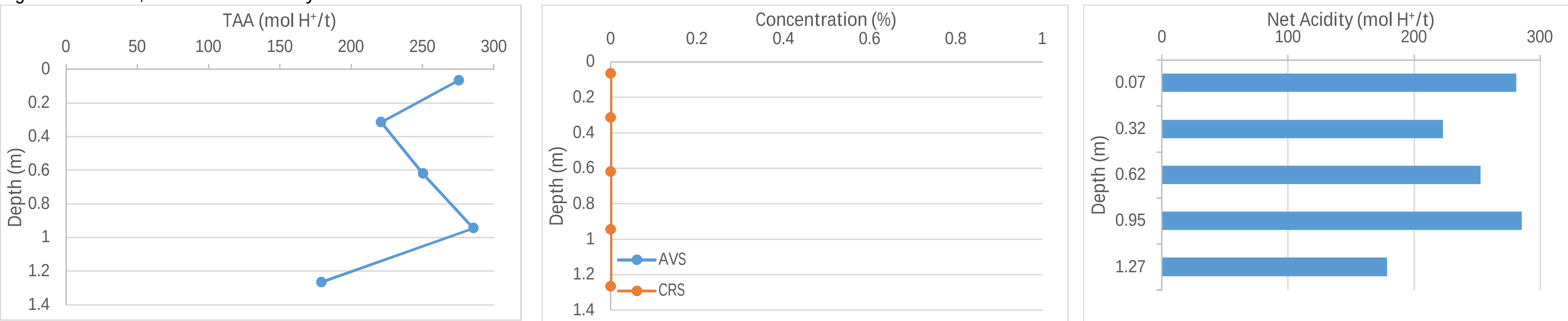


Figure A2.4 TAA, RIS and Net Acidity at STC4

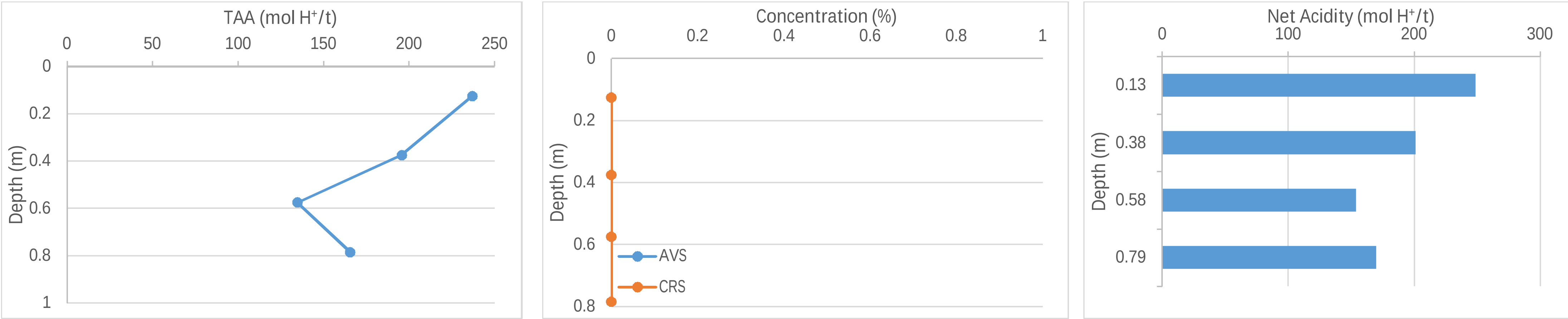


Figure A2.5 TAA, RIS and Net Acidity at STC5

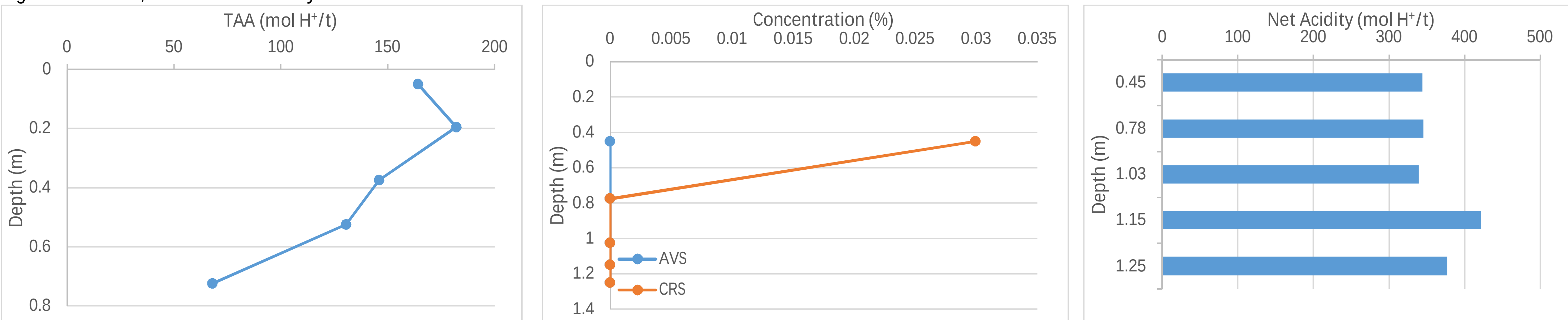


Figure A2.6 TAA, RIS and Net Acidity at STC6

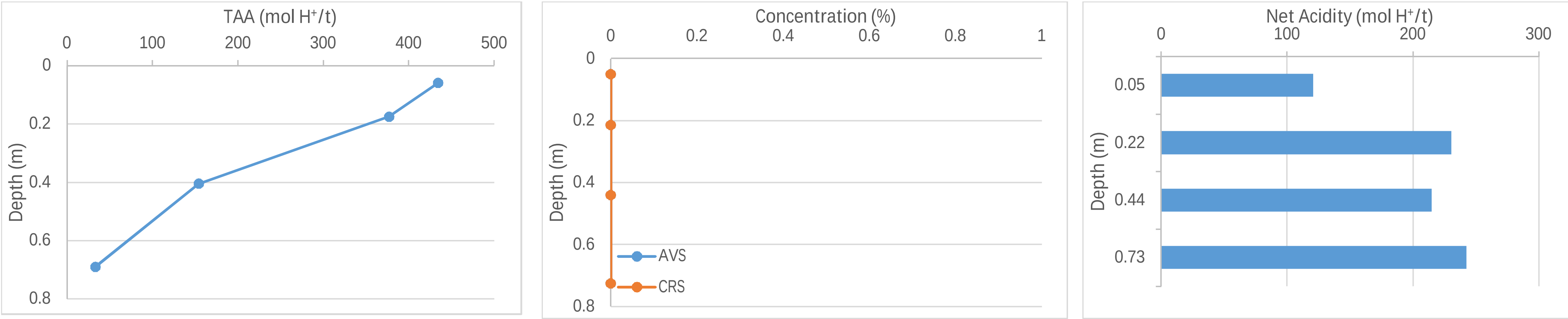


Figure A2.7 TAA, RIS and Net Acidity at STC7

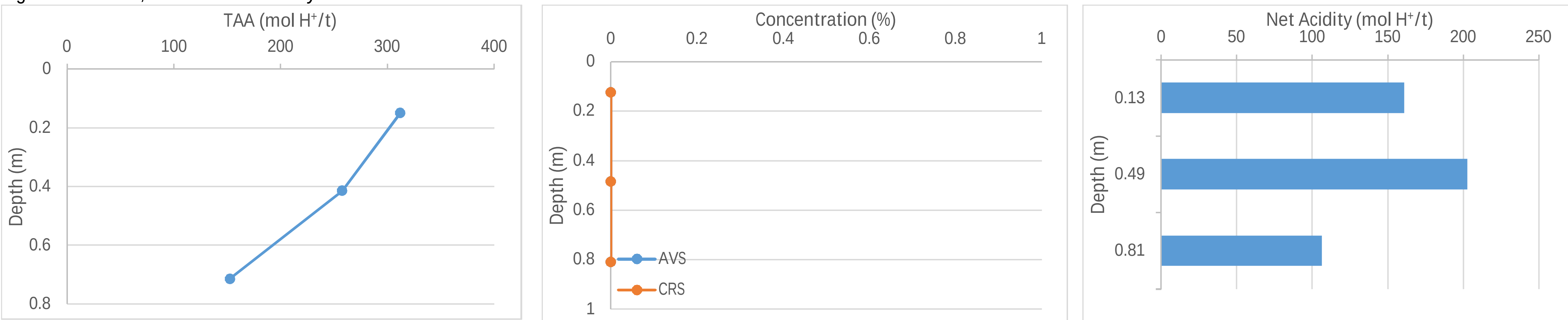


Figure A2.8 TAA, RIS and Net Acidity at STC8

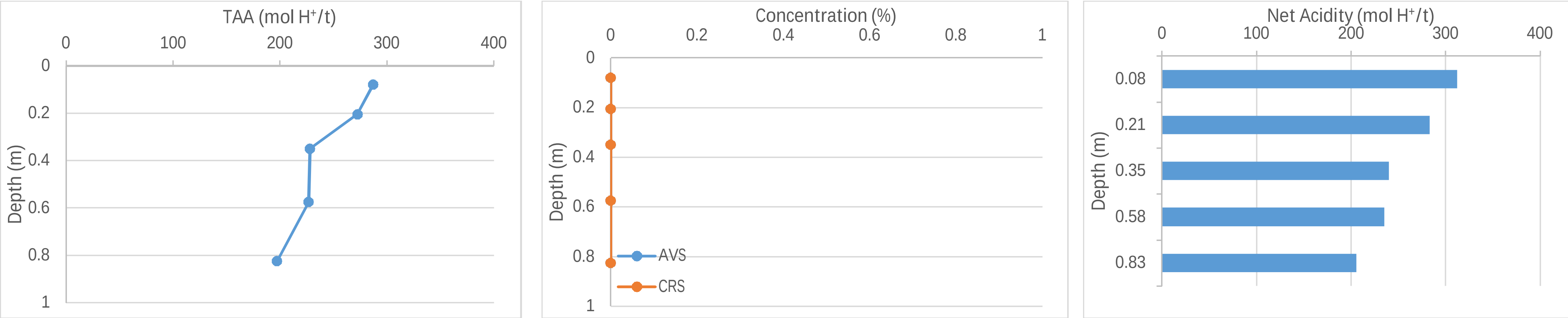


Figure A2.9 TAA, RIS and Net Acidity at STC9

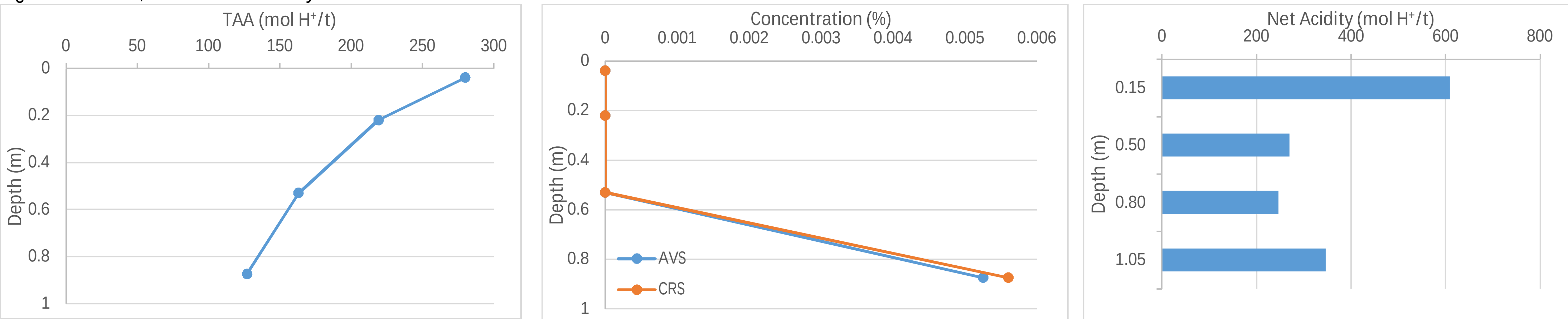


Figure A2.10 TAA, RIS and Net Acidity at STC10

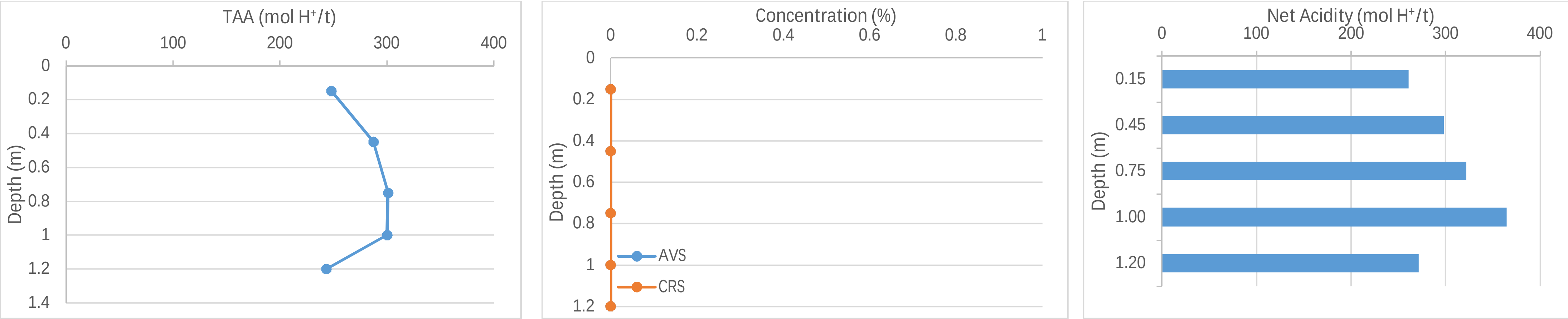


Figure A2.11 TAA, RIS and Net Acidity at STC11

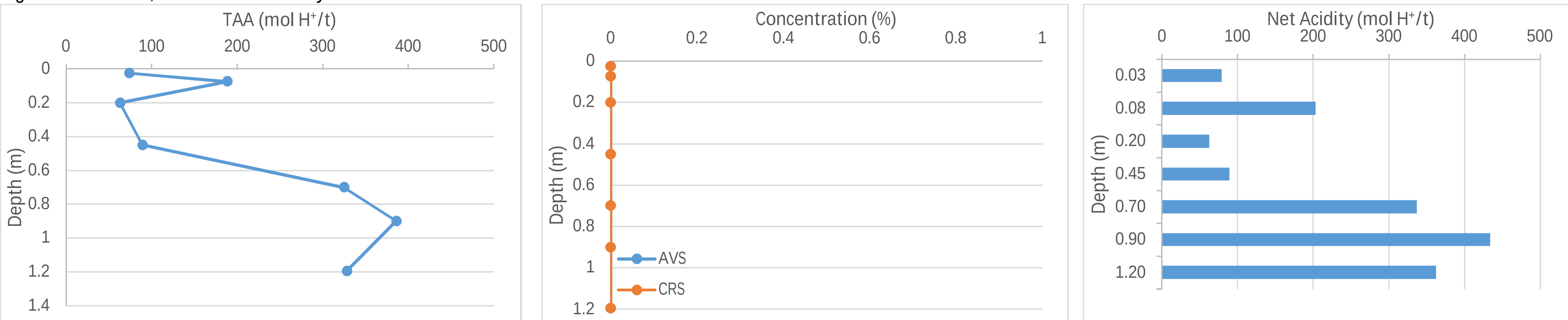


Figure A2.12 TAA, RIS and Net Acidity at STC12

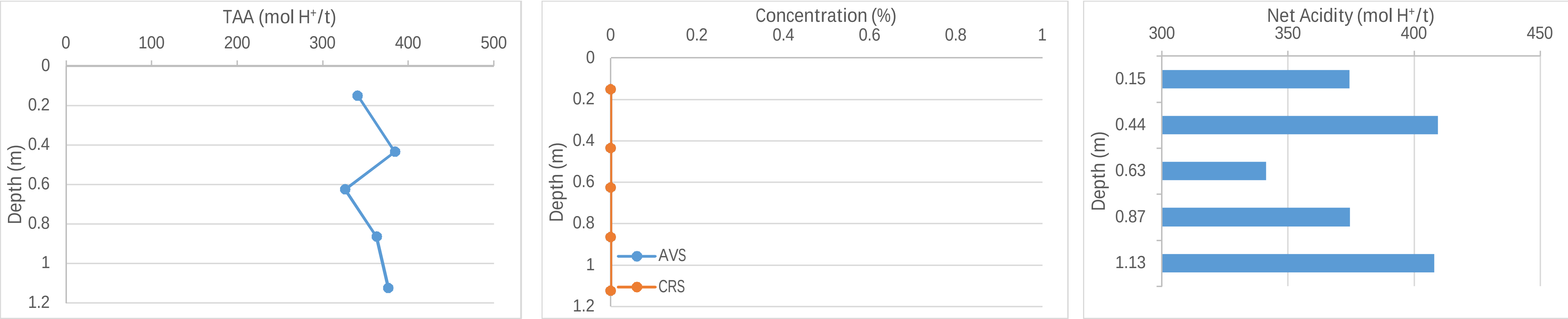


Figure A2.13 TAA, RIS and Net Acidity at STC13

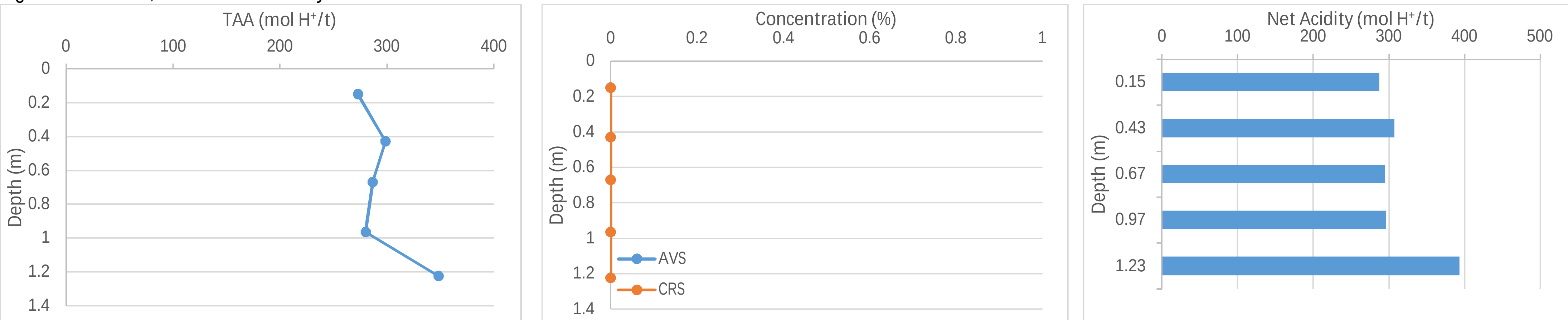


Figure A2.14 TAA, RIS and Net Acidity at STC14

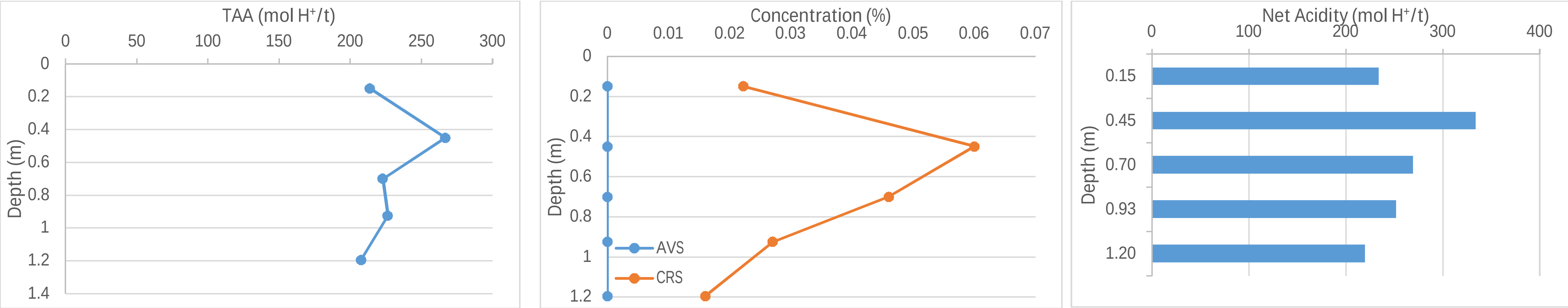


Figure A2.15 TAA, RIS and Net Acidity at STC15

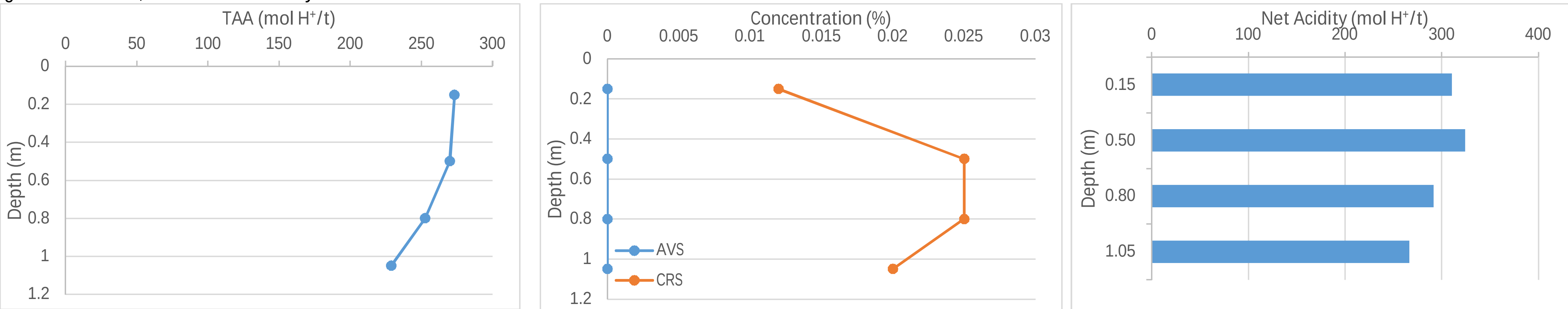


Figure A2.16 TAA, RIS and Net Acidity at STC16

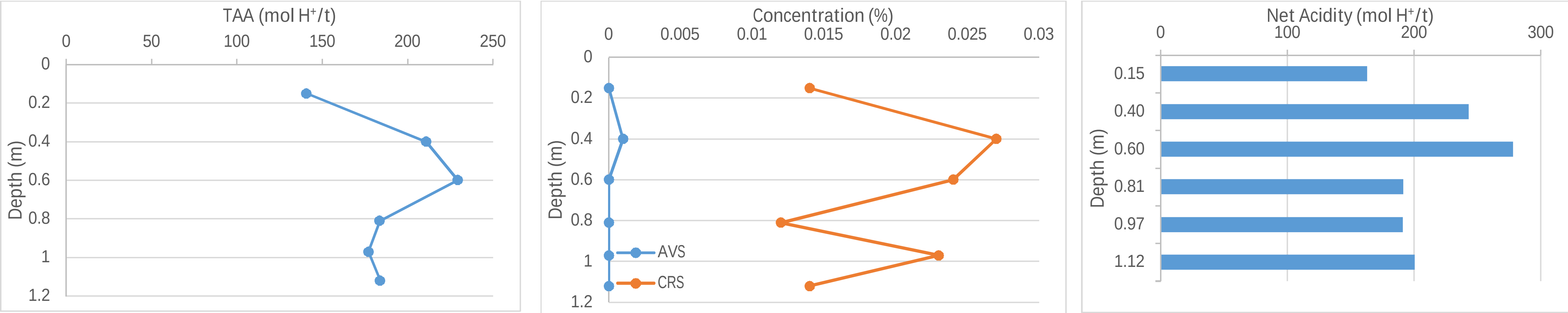


Figure A2.17 TAA, RIS and Net Acidity at STC17

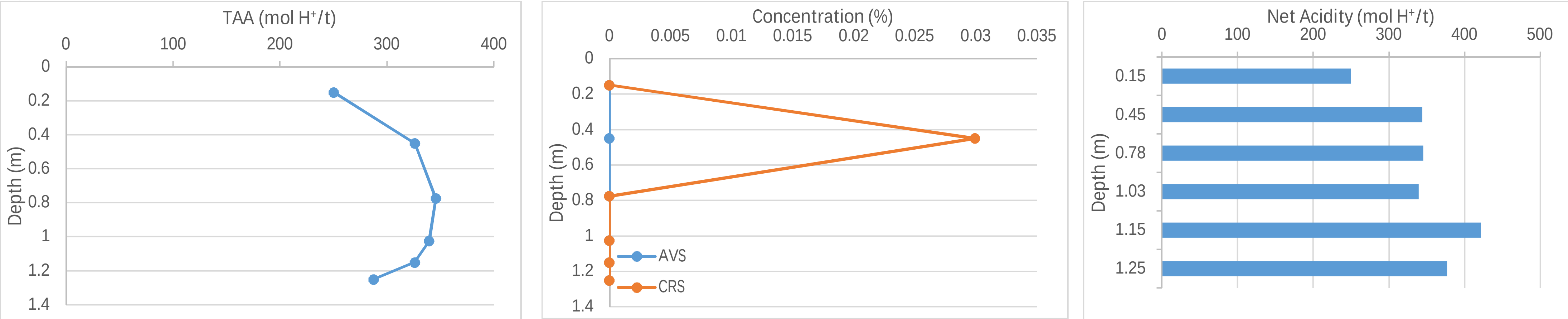


Figure A2.18 TAA, RIS and Net Acidity at STC18

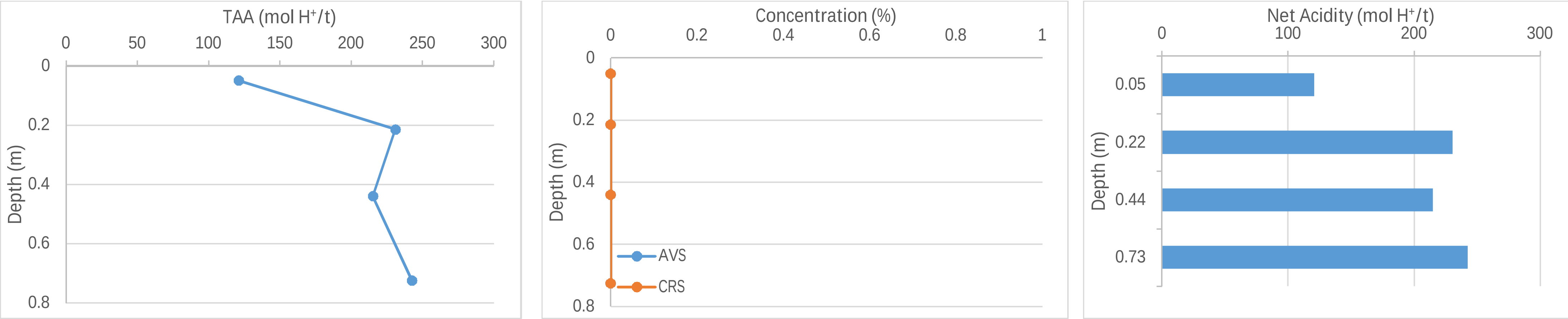


Figure A2.19 TAA, RIS and Net Acidity at STC19

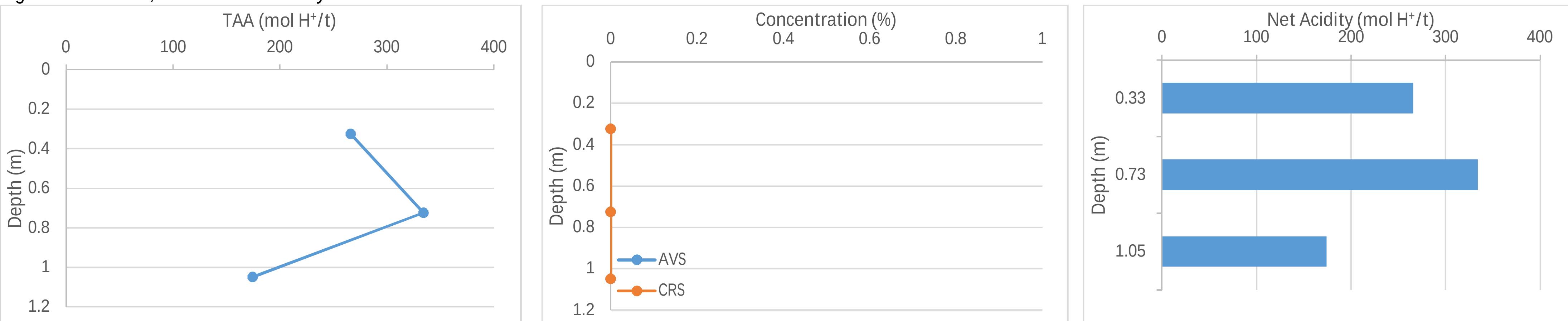


Figure A2.20 TAA, RIS and Net Acidity at STC20

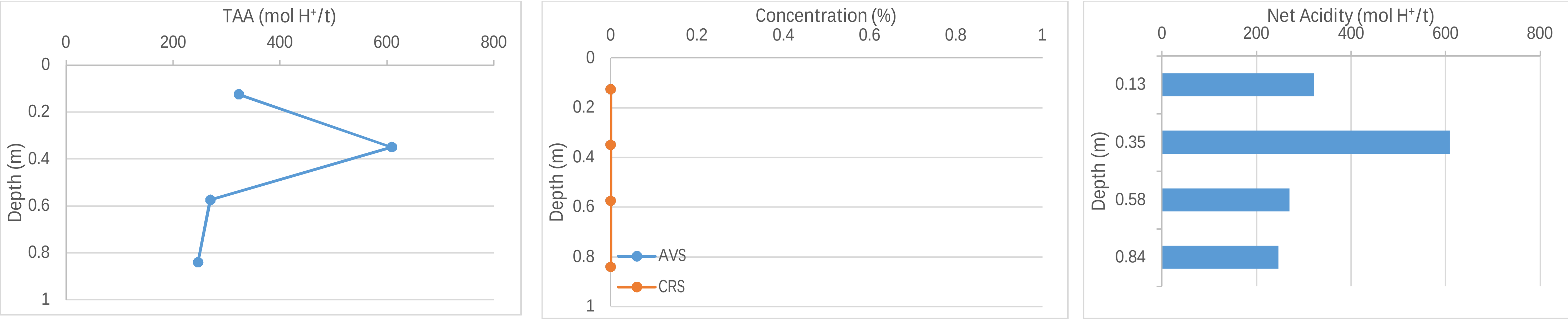


Figure A2.21 TAA, RIS and Net Acidity at STC21

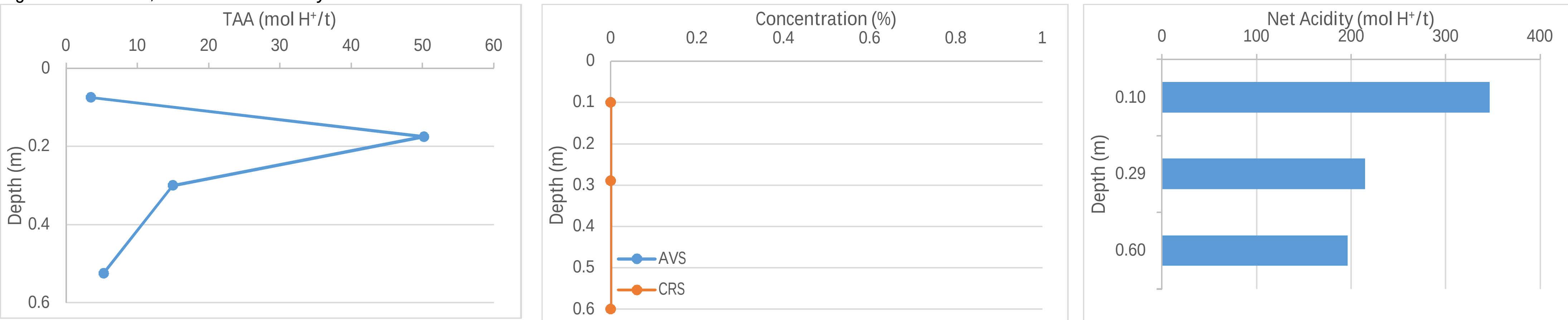


Figure A2.22 TAA, RIS and Net Acidity at STC22

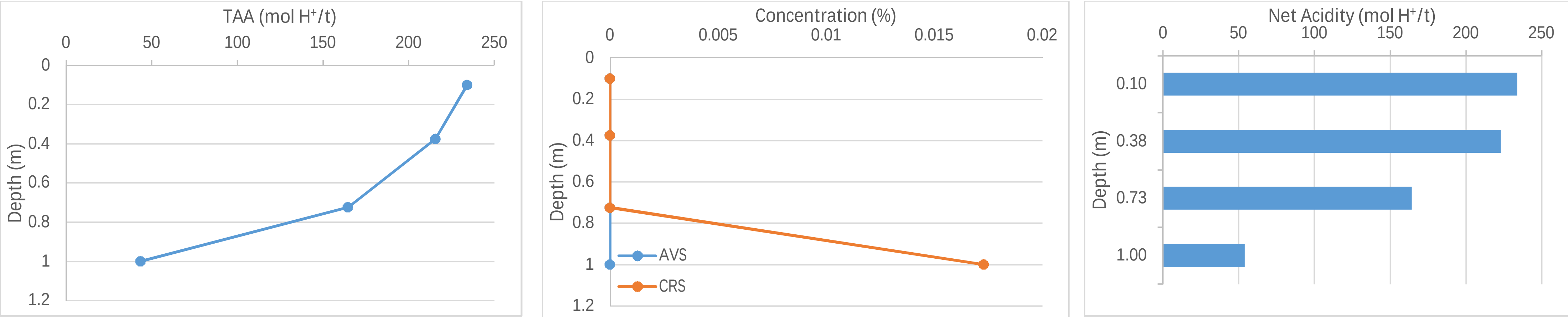


Figure A2.23 TAA, RIS and Net Acidity at STC23

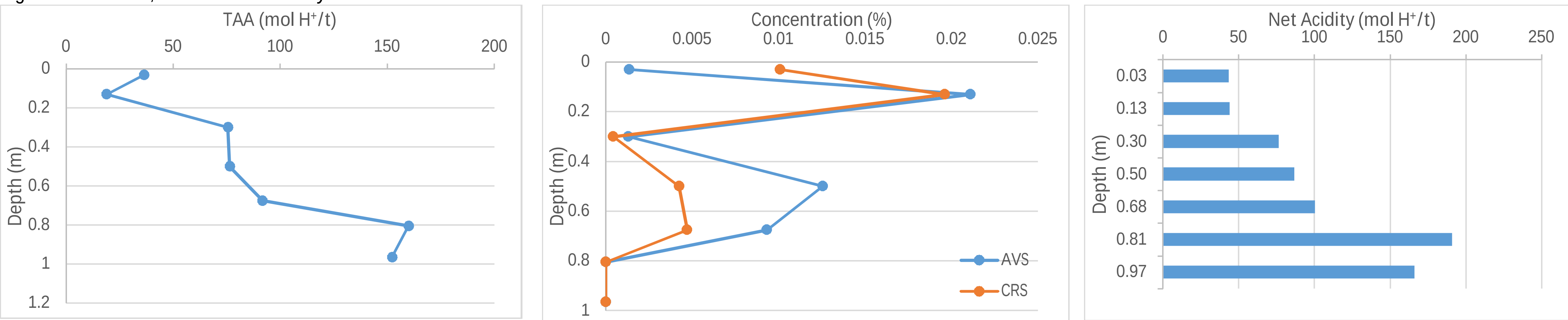
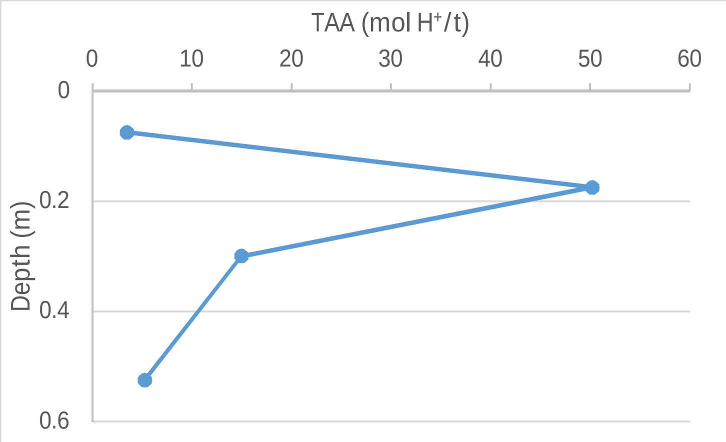
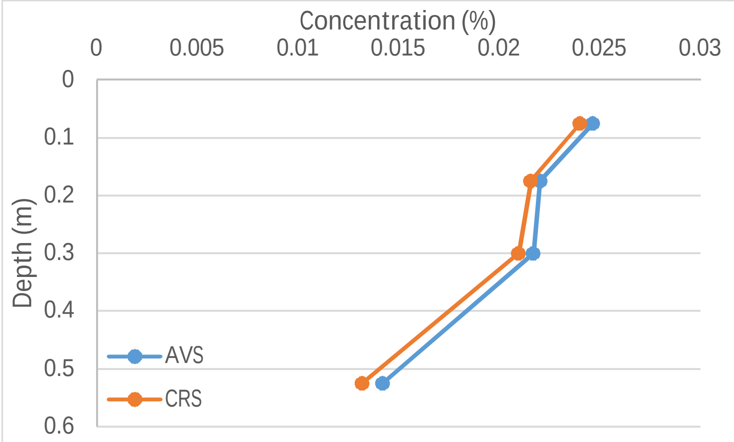


Figure A2.24 TAA, RIS and Net Acidity at STC24





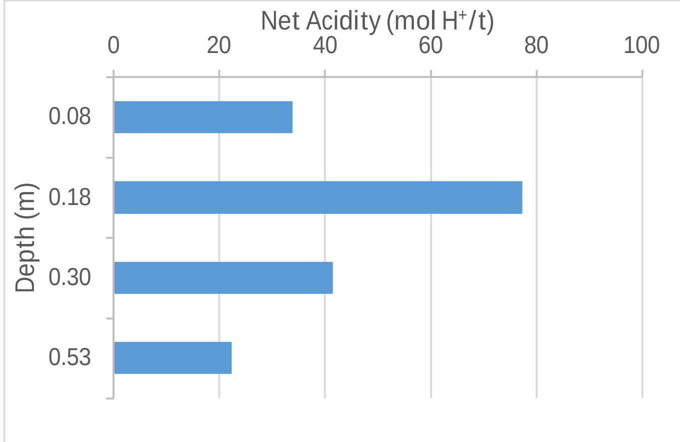


Figure A2.25 TAA, RIS and Net Acidity at STC25