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Lower Lakes & Coorong Recovery

Acid Sulfate Soils Research Program

The Potential for Contaminant Mobilisation Following Acid Sulfate Soil Rewetting : Field Experiment

Report 3 | November 2009

Australian Government

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For further information please contact:

Email: cllmm@deh.sa.gov.au

Phone: 1800 226 709 (free call during normal business hours)

Post: Coorong, Lower Lakes and Murray Mouth Program
Department of Environment and Natural Resources
Reply paid 1047
ADELAIDE SA 5001

Website: www.environment.sa.gov.au/cllmm

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Cover image

Boggy Creek, showing mesocosms, July 2010 (DENR 2010)

The Potential for Contaminant Mobilisation Following Acid Sulfate Soil Rewetting: Field Experiment

W.S. Hicks, N. Creeper, J. Hutson, R.W. Fitzpatrick, S. Grocke and P. Shand

Prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land and Water for the SA Department of Environment and Natural Resources

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Photography: P. Shand and W.S. Hicks

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1 Executive summary

The effect on contaminant mobilisation and water quality of rewetting Lower Lakes' acid sulfate soils (ASS; sulfuric material) was studied in a field experiment. Two sites with contrasting soil materials, sand and clay were selected and two rewetting treatments of sea water and River Murray water (fresh water) were used, providing the end members of ASS and surface water interactions. The study was carried out in mesocosms constructed from modified 5000 litre water tanks.

The study showed that while these materials behaved differently due to different water seepage rates and acid stores, in both materials sea water mobilised more acidity because the higher salt content could more effectively displace acid from the soil into the water column. In the clay soil, the water column of one of the sea water tanks became acid around 60 days after rewetting, while in the other sea water tank and both freshwater tanks the alkalinity continued to decrease and by 100 days was <0.25 meq/L (<12.5 mg CaCO3/L).

The experimental design enabled the measurement of solute and water fluxes between the soil and surface water for both soil materials, providing critical parameters for modelling studies. In the case of the clay soil, the seepage flux of water into the soil profile is low (<1 mm/d) and the stored acidity is higher resulting in a net flux of solutes from the soil to the water column. In the case of the sea water treatment, this resulted in the acidification of the water column around 60 days after rewetting. In contrast, the sandy material has a higher seepage flux (~10 mm/d). This resulted in piston flow, displacing acid pore water deeper into the soil profile with a potential for interaction with shallow ground water. There is a net flux of water and solutes from the water column into the soil profile.
Both soil materials had shallow pore water of poor quality with low pH values (~3) and exceedances of ANZECC and ARMCANZ (2000) water quality guidelines for a range of toxicants. While surface water quality was initially maintained, further changes that will affect acid fluxes and water quality have been observed since the completion of this initial study; these include dissolution of precipitates into the acidic water column in the case of the clay soil and a sharp drop in soil and water column redox potential for both soil materials. Both these events will result in major changes to the geochemistry of the system and it is important they are incorporated into the management of any ASS rewetting events. Monitoring these transformations will provide important information for modelling ASS rewetting and for the risk evaluation of management options.

2 Background

The Murray-Darling Basin is currently experiencing the worst drought conditions in recent record, and the Coorong, Lower Lakes and Murray Mouth (CLLMM) are under extreme stress resulting from a combination of low water levels, salinity increases and the exposure of acid sulfate soils (ASS)(Fitzpatrick and Shand 2008). ASS can impact on the surrounding ecosystems in a variety of ways following their oxidation. Release of acid and metals can lead to acidification of water bodies and toxic impacts on aquatic biota and human health (ANZECC and ARMCANZ 2000). Mobilisation of black monosulfidic materials or monosulfidic black ooze (MBO) can also deoxygenate surface waters (Bush *et al.* 2004).

The most significant risks are likely to occur during reflooding of sulfuric materials, largely due to potential mobilisation of acidity and trace elements made available during previous oxidation of sulfidic soils. This report addresses one of the two primary components of acid mobilisation research (comprising laboratory and field mobilisation experiments), focussing on the field experimentation and monitoring study. The transport and fate of acidity and bioavailable metals is poorly understood in the Murray-Darling Basin (MDB) wetland and lake systems. The complexities in the local geology, soil type and landscape position etc. means that metal mobilisation characteristics are likely to be site specific, and will also be governed by re-wetting scenarios (i.e. rate, wetting cycles, water source, water depth and period).

The South Australian Environmental Protection Authority (SA EPA) has requested that both laboratory- and field-based mobilisation experiments be undertaken to quantify the potential for mobilisation of contaminants from ASS in the Lower Lakes following rewetting with sea water or fresh water. It is intended that the results of the experiments be used to inform the Environmental Impact Statement (EIS) being prepared for the possible introduction of sea water in the Lower Lakes system. In order to meet the tight deadline of this EIS, this report presents the available results acquired to date from the field experiment.

The broad objective of this project was to assess the potential environmental impact resulting from mobilisation of constituents of interest (acid, metals, metalloids, and nutrients) following rewetting of acid sulfate soils with seawater or freshwater.

3 Methodology

3.1 Project Objectives

3.1.1 Site Selection

To review of existing spatial and laboratory information from CSIRO Land and Water ASS Reports (Fitzpatrick *et al.* 2008b,c,d) and other data. In collaboration with SA Department of Environment and Natural Resources (DENR) and SA EPA and local landholders, to undertake field visits to select two representative sites and present to the Acid Sulfate Soils Research Committee for review.

3.1.2 Baseline soil assessment

To conduct detailed field and analytical baseline soil assessment of the chosen areas to quantify:

(i) Total actual and potential acid store within soil profiles.

(ii) Mineralogy and chemistry of soils and salt efflorescences.

3.1.3 Field site setup

To install two small scale water containment structures at each site, and within these, install monitoring, automatic logging and water sampling infrastructure, including:

(i) Redox probes: up to 16 redox probes per site installed ranging in depth from the surface to below the water table – and linked to data loggers

(ii) Soil samplers at defined intervals in the soil profile

(iii) Soil physical measurements:

a. Conduct Guelph permeameter measurements to determine local and spatial soil hydraulic conductivity, especially at different depths.

b. Collect several undisturbed cores for pore water measurements (retention, conductivity etc.) and future possible redox measurements in the laboratory.

(iv) Collect undisturbed cores for laboratory-based metal release experiments.

3.1.4 Field experiments

To flood the soils in the water containment structures with sea water and fresh water. Then monitor surface and sub-surface waters and then to determine acid and metal contents to predict possible upward, downward and lateral water and solute fluxes. Initially sensor stability will be established, followed by automatic data logging of redox, soil moisture and water use combined with hourly, then daily followed by weekly soil and fortnightly water sampling.

3.1.5 Desktop experiments

Run soil-water balance models using the LEACHM program (Hutson 2003) for predicting water and solute transport in soils.

3.1.6 Modelling

To integrate hydrochemical and physical data using LEACHM to predict hydraulic dynamics and fluxes in the study sites for the sea water and fresh water reflooding scenarios.

3.2 Site Selection

The work focuses on two key areas of Lake Alexandrina: (a) Boggy Creek which is on Hindmarsh Island, close to the barrages and where sulfuric materials have formed in the sandy clays of drier areas; and (b) on the south side of Point Sturt peninsula where sulfuric materials formed in sands. The soils at both these sites have been exposed for some time because of low water levels in the lake. Prior to site setup, heavy rain resulted in some rewetting of soils with free water detected at around 0.5 m bgl in both soils. The extensive cracks at Boggy Creek had also been partially infilled by the outwash of sandy material from the creek banks. The materials at these sites provided a contrast in soil physical and chemical properties and are considered representative end members of material textures likely to be encountered in Lake Alexandrina. The location of the experiment sites is shown in Figure 1.

Figure 1 Map of Boggy Ck. and Pt. Sturt trial sites. GPS coordinates are provided in Appendix 1 Site information.

Previous work by CSIRO in wetlands along the River Murray has highlighted problems in isolating small areas for such reflooding studies (Figure 2 and Figure 3) caused by sub-surface losses of water. The success of the field based component of the present study relies on maintaining in-situ flooding conditions in the study plots and will provide the basis for establishing a template methodology for further such studies.

Figure 2 Reflooding experiment conducted along the River Murray (Swanport wetland) in January 2008, showing a small isolated area, which was bunded using thick plastic sheeting buried to a depth of 1,5 meters, with installation of 3 piezometers and 16 redox probes (see Figure 3) connected to a data logger - being rewetted with River Murray water using a fire hose (left) and after being ponded /reflooded (right). NOTE the area only remained ponded for 1 to 3 hours due to water leakage via macro-pores.

Figure 3 Installation of redox probes (Pt electrodes) in an SA wetland prior to rewetting (left) and following rewetting (right)

3.3 Tanks (mesocosms)

An experiment with mesocosms at 10×10 m was costed at >$290 000 per site for the construction of the containment structure without other infrastructure costs such as water supply. Furthermore an experiment to simulate three dimensional flows would need to be at a scale of tens of metres. Consequently it was decided to construct the mesocosms at the metre scale using 5 000 L commercial water tanks. This design has limitations as the side walls of the tank prevent lateral flow. While this restricts the ability to simulate lateral fluxes, during a whole of lake water level rise, flow is largely restricted to the vertical and the experimental setup adequately simulates one dimensional transport and the geochemistry of the water-solute-solid interactions is unaffected by the limitations.

The water tanks were manufactured from recycled polyvinyl chloride (PVC) and custom fabricated with thicker walls. The top and bottom of the tanks were cut out and they were pushed 1 m into the soil using an excavator (Figure 4). The tanks were fitted with a float valve set to maintain a constant water height of 0.50 m. Water was fed from header tanks to the mesocosms using standard PVC irrigation pipe and fittings.

Fresh water and sea water were used in two flooding treatments at each site. Each treatment was replicated so that at each site there were two tanks of seawater and two tanks of freshwater. Water for the experiments was sourced from the River Murray at Wellington (fresh water) and the seaward (Coorong) side of the Mundoo Island Barrage, Coorong (sea water). Water was transported to the sites and stored on-site in a 5 000 L header tank for each type of water (i.e. two tanks at each site).

Figure 4 Tank installation at the Boggy Ck. site

3.4 Site Characterisation

For each site a representative soil profile was described and sampled using a combination of soil pits and hand auger borings. The soils were described and samples were prepared and analysed for the purposes of acid base accounting and geochemistry using standard protocols developed for acid sulfate soil research in the Murray-Darling Basin (e.g. Fitzpatrick *et al.*, 2008e). Brief details and some definitions are provided in Appendices 6 and 7.

The definitions of acid sulfate soils can be confusing and the Acid Sulfate Soil Working Group of the International Union of Soil Sciences has recently agreed in principle to adopt changes to the classification of acid sulfate soil materials and horizons (Sullivan *et al.*, 2009). This report follows these recommendations. Acid sulfate soils are essentially soils containing detectable sulfide minerals, principally pyrite (FeS_2) or monosulfides (FeS). The definitions used in this report are:

Sulfidic: soils containing detectable sulfide.
Hypersulfidic: Sulfidic soil material that is capable of severe acidification (pH <4) as a result of oxidation of contained sulfides.
Hyposulfidic: Sulfidic soil material that is not capable of severe acidification (pH <4) as a result of oxidation of contained sulfides.
Sulfuric: Soil material that has a pH less than 4 (1:1 by weight in water, or in a minimum of water to permit measurement) when measured in dry season conditions as a result of the oxidation of sulfidic materials.
Monosulfidic: Soil material containing ≥ 0.01% acid volatile sulfide.

3.5 Monitoring

3.5.1 Soil physics and hydrology

Guelph permeameter measurements were conducted to determine local and spatial soil hydraulic conductivity at different soil depths.
Several undisturbed cores were collected for pore water measurements (retention, conductivity etc.)

3.5.1.1 Piezometers

Piezometers were installed up slope and down slope of the water tanks at intervals of 0.1, 1.0 and 10 m and two piezometers were installed in one of the tanks for each of the treatments. The external piezometers were screened at 1.50 m below ground level (bgl), while the piezometers in the tank were screened at 0.50 and 1.50 m bgl. The screens were 0.10 m in length. The piezometers were constructed of 25 mm uPVC and installed by drilling with a hand auger. Each piezometer was surveyed to the Australian Height Datum (AHD). Water levels were read using a tape and water whistle.

3.5.1.2 Sentek soil moisture probes

Sentek soil moisture probes were installed at each site. These probes utilise frequency domain reflectometry to measure pore water content. One of the probes at the Boggy Ck. site and the telemetry station is illustrated in Figure 5.

3.5.1.3 Water usage

The water supply tanks were fitted with dataloggers to measure water level changes in the reservoirs to provide a method of estimating seepage or infiltration from the mesocosms.

3.5.1.4 Rainfall and evaporation

Rain gauges were installed at each site. Collection of pan evaporation data ceased at the Goolwa Meteorological Station in 2003, since this time values are interpolated daily observations. Consequently, data from Silo Data Drill (Jeffrey *et al.* 2001) was used to obtain estimates of Class A pan evaporation values to use in seepage rate calculations. A comparison of measured and interpolated evaporation values from 1987–2003 showed that for the months of year covering the period of investigation, the difference between measured and interpolated values is ±0.2 mm/d. Results for the months of the year that interpolated data was used in this report is given in Table 1.

Table 1 Comparison of 28 day daily average estimated and measured class A pan evaporation for Goolwa Meteorological Station for the years 1987–2003 (source: Bureau of Meteorology)

	July				August				September			
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
Estimated –Measured (mm)	–0.60	0.20	–0.23	0.23	–0.40	1.00	0.08	0.40	–0.50	1.60	0.15	0.52

3.5.1.5 Seepage measurement

The actual seepage rate was measured from the amount of water supplied to the experiment tanks from the supply reservoirs to maintain the constant head of 0.5 m. The tanks used for both the supply and the experiment where the same diameter so that height changes could be related directly to seepage without the need for volume calculations. In this case:

$$Seepage = \frac{\left(\frac{\Delta supply\ tank\ height}{2} + rainfall - pan\ evaporation\right)}{period} \quad (mm/d) \qquad 1$$

3.5.2 Flux measurements and calculations

3.5.2.1 Measured flux

The experimental design used in this experiment maintained a constant water height (and therefore volume) of 0.5 m and a supply reservoir with the same diameter as the experiment tanks so the terms in the net flux of a solute are:

$A_{t_2-t_1}$ the change in the amount of solute between measurements at times t_1 and t_2;
A_s the amount of solute in leaving the tank as seepage;
A_r the amount of recharge from the reservoir; and
A_d the amount of solute entering the tank by diffusion.

So that the net change in the amount of a solute:

$$(A_{t_2-t_1}) = A_r - A_s + A_d \qquad 2$$

but for alkalinity as the solute and a diffusive flux of acid

$$A_{H^+} = -A_d$$
$$A_{H^+} = -(A_{t_2-t_1}) + A_r - A_s \qquad 3.$$

Assuming a linear change in concentration between t_1 and t_2 and reformulating the equation in terms of an acid flux rate (mol/m^2/d):

$$F_{H^+} = \frac{-(C_{t_2} - C_{t_1})h}{(t_2 - t_1)} + rC_r - s\frac{(C_{t_2} + C_{t_1})h}{2} \qquad 4$$

where C_t is the measured concentration(mol/m^3) in the experiment tanks at time t (d), C_r the concentration in the reservoir, h = 2 (factor to correct for the depth of water at 0.5 m), s the seepage rate (m/d)and r is the supply rate from the reservoir where $r = s$ + evaporation – rainfall (m/d).

3.5.2.2 Calculated flux

The equation for the flux across the sediment water boundary can be formulated according to the equation (Stumm and Morgan 1996):

$$F_{z=0} = F_d + F_a + F_s \qquad 5$$

where the flux due to:

molecular diffusion in pore water $$F_d = -\varphi D \frac{dC}{dz}$$ 6

advection in pore water $$F_a = \varphi UC$$ 7

accumulation of solids due to sedimentation $$F_s = \varphi U_s C_s$$ 8

so that $$F_{z=0} = \varphi(-D\frac{dC}{dz} + UC + U_s C_s)$$ 9.

Where:
φ is the sediment porosity
C and C_s are the concentrations in the solution and solid
U and U_s are the rates of pore water advection and of sedimentation
D is the sediment diffusion coefficient (Stumm and Morgan 1996).
In the case of rewet soils the flux due to sedimentation can be replaced by the flux due to the dissolution of precipitates U_pC_p.
Krom and Berner (1980) use the following equation to convert from diffusion at infinite dilution D_0 to sediment diffusion D_s:

$$\frac{D_0}{D_s} = \varphi F \qquad 10$$

where F is the formation factor which can be estimated using Archie's factor (Manheim 1970) so that $F=\varphi^{-2}$ and substituting and rearranging:
$D_s=\varphi D_0$ and equation so that

$$F_{z=0} = \varphi(-D\frac{dC}{dz} + UC + U_s C_s) \qquad 11$$

becomes

$$F_{z=0} = -D_s\frac{dC}{dz} + \varphi(UC + U_p C_p) \qquad 12$$

If C_d is the concentration at depth d where the concentration becomes constant and C_0 is the concentration at the sediment water interface,

$$F_{z=0} = -D_s\frac{C_d - C_0}{d} + \varphi(UC + U_p C_p) \qquad 13$$

a further simplification can be introduced by assuming $D_0=10^{-9}$ m/s for simple electrolytes (Appelo and Postma 2005). D_0 is adjusted for temperature using the equation:

$$D_{0,T} = \frac{D_{0,298} T \eta_{298}}{298 \eta_T} \qquad 14$$

where η is the viscosity of water (Mortimer *et al.* 1999).
The rate of pore water advection or linear interstitial advection velocity (LIV) is obtained by dividing the measured seepage flux by the sediment porosity (Mortimer *et al.* 1999) so that:

$$U = \frac{measured\ seepage}{\varphi} \qquad 15.$$

Values for C_d and d for each species were determined from dialysis chamber sampler concentration profiles.

3.5.3 Geochemistry

3.5.3.1 Redox

For each treatment, duplicate platinum redox electrodes were installed in one of the tanks at 1.5, 1.0, 0.5, 0.2, 0.1 and 0.0 m bgl as well as 0.1 m above the soil-water interface. Electrodes were also installed external to the tanks as a control at 1.5, 1.0, 0.5, 0.2 m bgl. An Ionode intermediate junction silver/silver chloride electrode was used as the reference electrode for each set of electrodes and data was recorded on a data logger.

3.5.3.2 Surface water

Surface water samples were grab samples collected in 125 mL acid washed polyethylene bottles. The bottles were rinsed with Type 1 reagent grade water (APHA 1995) and then rinsed three times with sample prior to sample collection.

3.5.3.3 Soil solution

For each treatment, quartz-impregnated Teflon™ soil solution samplers (Prenart Super Quartz, Prenart Equipment Aps) were installed in one of the tanks at 1.5, 1.0, 0.5, and 0.2 m bgl. Soil solution was obtained by placing the devices under an initial vacuum of –80 kPa for 24 h using a high density polyethylene vacuum bottle fitted with a Teflon™ closure and fittings (Figure 6). The bottle also acts as the sample collection vessel. Sample was then transferred to acid washed and rinsed 125 mL polyethylene bottles which were rinsed three times with sample. Soil solution samplers have a number of advantages over tube wells for sampling soil water, they extract water from both saturated and unsaturated soils, work in low permeability soils, have better spatial resolution, are certified trace element free (in the case of Prenart samplers) and they avoid the exposure of reduced waters to oxygen. However like all non displacement water sampling methods they disturb the equilibrium of dissolved gases e.g. alkalinity (carbon dioxide) and hydrogen sulfide. Photographs of the fully fitted out sites are shown in Figure 7 and detail of the mesocosm fittings including redox and soil solution samplers is shown in Figure 8.

A once off deployment of dialysis chamber samplers (peepers; Batley *et al.* 1993) that have a vertical resolution of 1 cm was carried out on the 18th August 2009 approximately one month after the commencement of the filling the experiment tanks (Figure 9). Peepers were constructed of polymethylmethacrylate with a 0.45μm polysulfone dialysis membrane (Pall Scientific). Assembled peepers were placed in acid washed plasticiser free polyvinylchloride (uPVC) transport cylinders that were filled with reagent grade water and flushed with nitrogen for 72 h prior to transport under a nitrogen atmosphere. The peepers were deployed for 14 days to ensure sufficient time for equilibration (Grigg *et al.* 1999)and provided water samples from the overlying water column, the sediment water interface and then at 0.01 m intervals to around 0.31 m, depending on the depth to which they could be inserted. Following retrieval, the peepers were cleaned of biological growth and adhering sediment, rinsed with deionised water, the chambers pierced and the filling solution transferred to acid washed vials. Dialysis chamber samplers are best suited to monitoring sediments where advective solute transport is low and diffusion dominates. In deployments such as Point Sturt with seepage of ~10 mm/d the diffusion chambers will reflect the average composition of the pore water over the deployment.

3.5.3.4 Water sample preparation

Where the sample volume allowed, two 125 mL bottles were collected. Samples were transported back to the laboratory within four hours of collection and were either stored overnight at 4 °C or immediately filtered through 0.22 μm membrane filters. One sample was acidified with sufficient analytical reagent grade hydrochloric acid to achieve a pH value of <1 for trace metal analysis. The unacidified sample was used for nutrient, anion, alkalinity/acidity, pH and electrical conductivity determinations. Filtered samples were stored at 4 °C prior to analysis. All samples were analysed within the APHA (1995) storage requirements for regulatory samples. Water samples from peepers for ICP-OES and ICP-MS analysis were acidified with reagent grade hydrochloric acid to achieve a pH value of <1. Samples were stored at 4 °C prior to analysis.

Figure 5 Sentek probe and telemetry station

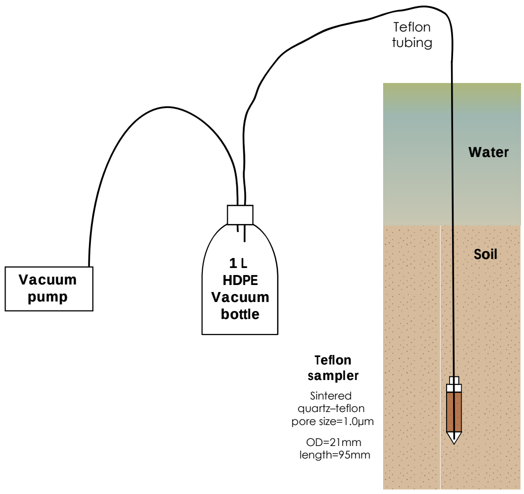


Figure 6 Diagrammatic representation of Teflon™ sampler deployment

Figure 7 Fitted out experiment sites at Boggy Ck. (left) and Point Sturt (right)

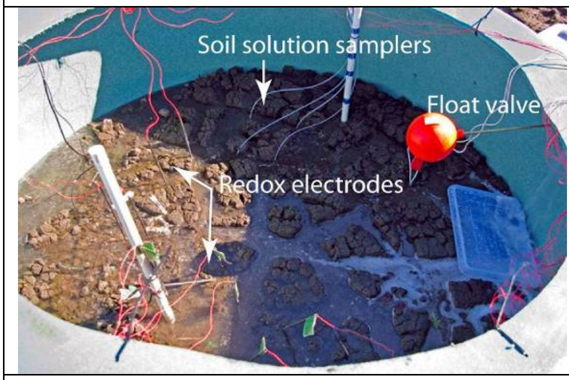


Figure 8 Mesocosm showing monitoring devices during flooding

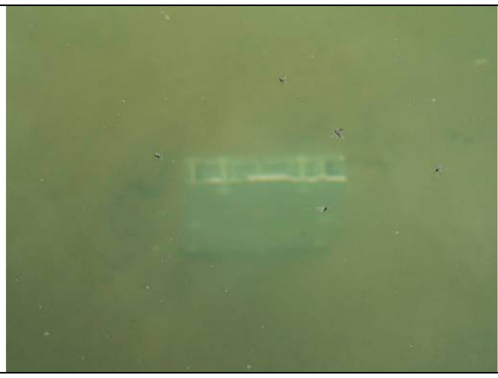


Figure 9 Deployed (underwater) dialysis chamber sampler (peeper)

3.6 Modelling

The LEACHM model (Hutson 2003) was adapted to simulate two different scenarios relevant to acid sulfate soils. Site soil physical data was used to parameterise LEACHM and possible geochemical processes were explored in simulations to determine whether the model can predict hydraulic dynamics and fluxes in the study sites for the sea water and fresh water rewetting scenarios.

4 Results and Discussion

4.1 Soil description and site characterisation

Soils were described and classified according to the Australian Soil Classification (Isbell 1996). They were also assigned to a class using the plain language key developed for the Atlas of Australian Soils (Fitzpatrick *et al*. 2008f) which has been used to deliver soil-specific land development and soil management packages to advisors, planners and engineers working in the Murray Basin.

The Boggy Creek site is in a dry river bed and the soil is a sulfuric (pH <4) cracking clay soil according to the Atlas of Australian Soils classification. The soil texture varies from a sandy clay loam in the top 0.03 m through a fine sandy clay to a light clay from 0.2 to 0.38 m, then a fine clayey sand to the limit of sampling at 1.8 m.

The Point Sturt site is located on the now dry bed of Lake Alexandrina on the property of Mr and Mrs South, Point Sturt peninsula. The soil is a sulfuric soil (pH <4). The texture is a sand to 0.6 m then a sandy clay to the limit of sampling at 1.6 m.

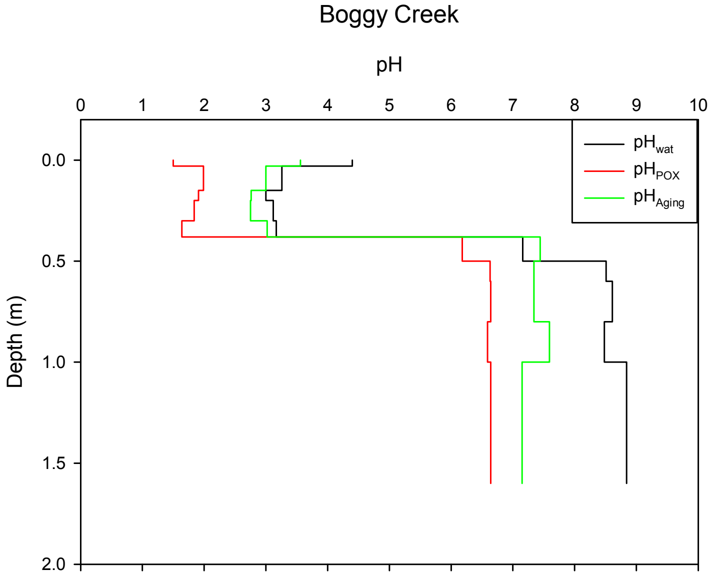
Photographs of the sites and soil profiles are shown in Figure 10 and Figure 11. Detailed site information and profile descriptions are given in Table 2 and Table 3.

Figure 10 Acid sulfate soil (Sulfuric cracking clay soil) in the dry river bed of Boggy Creek, South Australia showing: sulfuric material (depth 0 to 38 cm with pH <4.0) with pale yellow patches or mottles of natrojarosite with minor orange-yellowish mottles comprising schwertmannite overlying dark greyish hypersulfidic material (> 38 cm). The top photograph also shows hydraulic conductivity measurements being conducted with a Guelph permeameter.

Figure 11 Acid sulfate soil (Sulfuric soil) on the dry bed of Lake Alexandrina on the South's property, Point Sturt peninsula, South Australia showing: sulfuric material (depth 0 to 50 cm with pH <4.0) with hypersulfidic material (> 50 cm) occurring below the current water table

4.2 *Soil Chemistry and Acid-Base Accounting*

The results of the soil analyses for the two representative profiles (Figure 12) show that the soil material is sulfuric to around 0.4 m depth in the case of Boggy Creek and 0.5 m depth in the case of Point Sturt. Below 0.4 m depth at Boggy Ck., the soil profile contains >0.1% reduced inorganic sulfur (RIS) and there is sufficient acid neutralising capacity (ANC) so that there is no net acidity (NA) i.e. net acidity <0 mol H^+/t. Consequently the remainder of the profile to the maximum sampling depth of 1.8 m is hyposulfidic. The Point Sturt profile has an acid generating potential (AGP) that is an order of magnitude smaller than Boggy Ck., although there is little neutralising capacity and below the sulfuric horizon (0 to 0.5 m depth), the net acidity is >0 mol H^+/t so that the profile hypersulfidic from 0.5 m to 1.6 m depth (Table 23, and Figure 14). The results for the acid base accounting (ABA) are mirrored by the measurements of pH after aging and pH after rapid oxidation (Figure 12), so that when NA >0, pH_{Aging} and pH_{POX} are both <4 i.e. indicating either sulfuric (if pH_{wat} <4) or hypersulfidic material (if pH_{wat} >4). See Fitzpatrick ***et al.***, 2008e and Appendices 6 and 7 for a detailed explanation of ASS assessment and acid-base accounting.



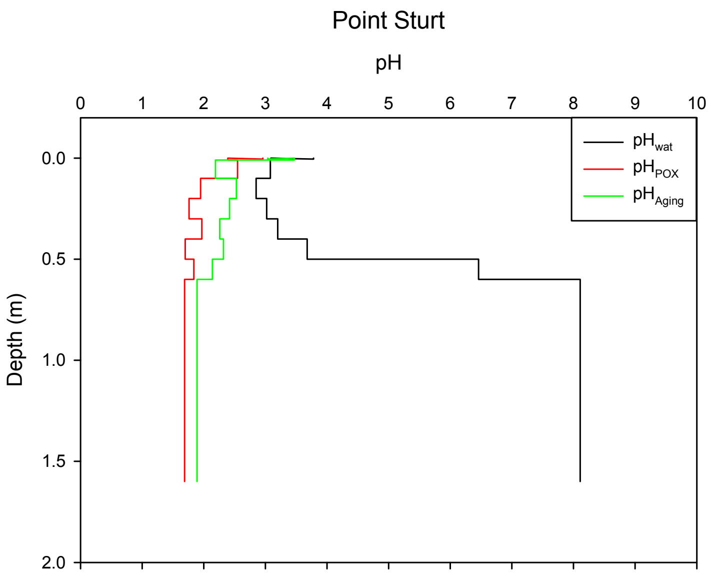


Figure 12 Soil pH profiles. If pH_{wat} <4 the soil material is sulfuric, if pH_{POX} or pH_{Aging} <4 the material is hypersulfidic

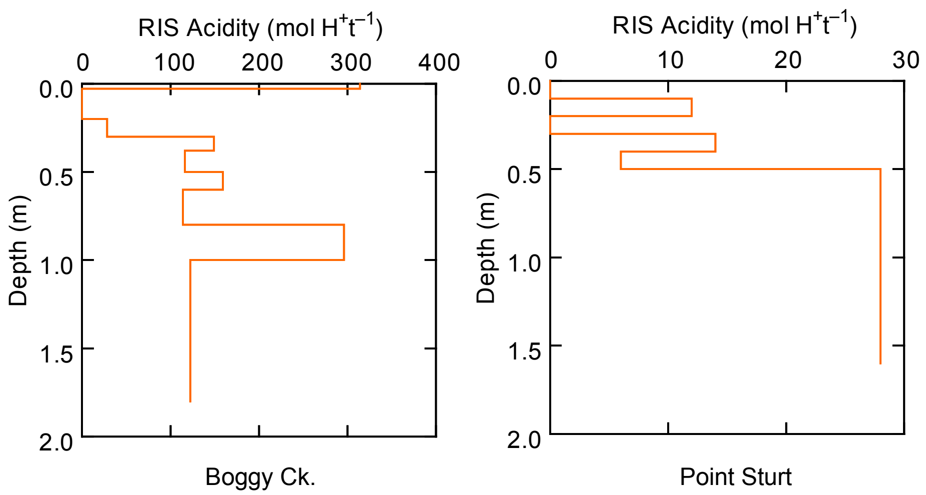


Figure 13 Reduced inorganic sulfur (CRS) profiles

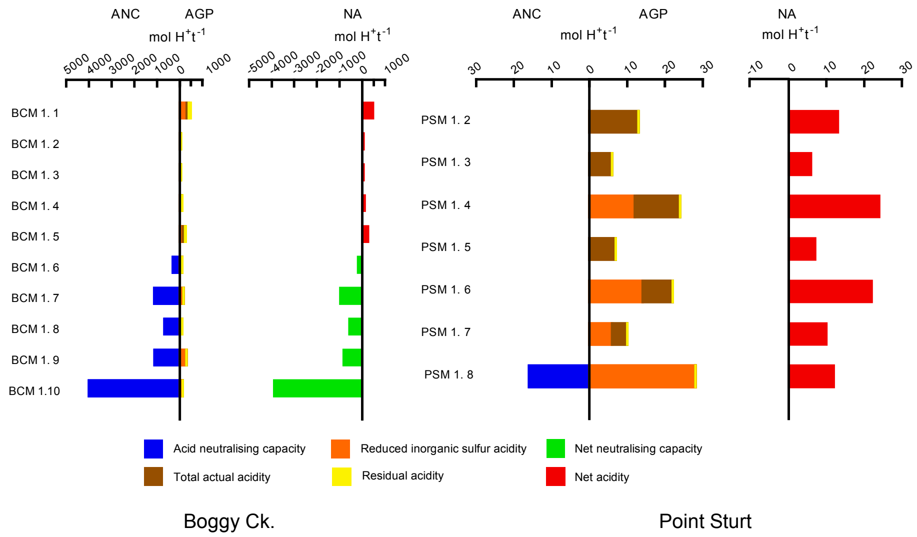


Figure 14 Acid-base accounting profiles. Vertical axis indicates layer ID number see Table 2 and Table 3 for layer interval.

4.3 Sediment Quality

The soils at each site were assessed using the interim sediment quality guidelines (ISQG; ANZECC and ARMCANZ 2000). The concentrations were below the ISQG trigger value for chromium, copper, zinc and nickel, except for the surface to 0.03 m layer at Boggy Creek where the nickel value was at the ISQG trigger value. Detection limits were above the ISQG trigger value for silver, arsenic and antimony. All concentrations were below the ISQG high value. The total elemental analysis values by X-ray fluorescence (XRF) are provided in Table 25 and Table 26.

All available data for soil chemistry is given in Appendix 4 Soil analyses.

4.4 Soil Profile Descriptions

Table 2 Boggy Creek site on Hindmarsh Island (Date sampled: 21st July 2009)
GPS Location of sample site: (WGS84, zone 54 south) E: 0311143 N: 6065859
Soil Classification: Sulfuric cracking clay soil (Atlas of Australian Acid Sulfate Soils: Fitzpatrick *et al*. 2008f)
Redoxic Sulfuric Bleached-Vertic Hydrosol; medium, non-gravelly, clay loamy, clayey, very deep (Australian Soil Classification: Isbell 1996)

Layer ID No.	Horizon Depth Upper (m)	Horizon Depth Lower (m)	Soil Colour - moist	Texture Modifiers	Texture Class	Moisture State	Redoximorphic Features - Quantity (%)	Redoximorphic Features - Colour	Structure - Type	Consistence - Rupture Resistance	Comments
BCM 1.1	0.00	0.03	2.5Y 2.5/1	fine	sandy clay loam	moist	5	7.5YR 6/8	angular blocky	friable	Algae on surface, MBO in cracks; dries to very firm strong angular blocky (polyhedral) peds
BCM 1.2	0.03	0.15	2.5Y 5/2	fine	sandy clay	moist	0	/	massive	friable	
BCM 1.3	0.15	0.20	2.5Y 4/2	fine	sandy clay	moist	0	/	single grain	soft	Large (10 mm diameter) hard relict woody root fragments
BCM 1.4	0.20	0.30	2.5Y 5/3	light	clay	moist	10 5 2	2.5Y 7/4 2.5Y 7/6 7.5YR 6/8	massive	firm	bright yellow jarosite mottles (pH <3.5);few orange mottles.
BCM 1.5	0.30	0.38	2.5Y 5/2	light	clay	moist	10 5	2.5Y 7/4 2.5Y 7/6	massive	firm	yellow jarosite mottles (pH <3.5)
BCM 1.6	0.38	0.50	5Y 5/1	fine	clayey sand	moist	0	/	massive	friable	contains clay lenses
BCM 1.7	0.50	0.60	5Y 5/1	fine	clayey sand	wet		/	massive	friable	contains clay lenses
BCM 1.8	0.60	0.80	5Y 4/1	fine	clayey sand	wet	0	/	massive	very friable	contains clay lenses
BCM 1.9	0.80	1.00	5Y 4/2	fine	clayey sand	wet	0	/	massive	very friable	contains few large shell and calcrete fragments; contains clay lenses
BCM 1.10	1.00	1.60	5Y 5/1	fine	clayey sand	wet	0	/	massive	very friable	contains few large shell and calcrete fragments; contains few clay lenses
BCM 1.11	1.60	1.80	5Y 4/1	fine	clayey sand	wet	0	/	massive	very friable	contains many small shell fragments contains few clay lenses

Table 3 Point Sturt site on South's property (Date sampled: 21st July 2009)
GPS Location of sample site: (WGS84, zone 54 south) E: 314769 N: 6069693
Soil Classification: Sulfuric soil (Atlas of Australian Acid Sulfate Soils: Fitzpatrick *et al*. 2008f)
Redoxic Sulfuric Acidic Hydrosol; thick, non-gravelly, sandy, very deep (Australian Soil Classification: Isbell 1996)

Layer ID No.	Horizon Upper (m)	Depth Lower (m)	Soil Colour - moist	Texture Modifiers	Texture Class	Moisture State	Redoximorphic - Quantity (%)	Features - Colour	Structure - Type	Consistence - Rupture Resistance	Comments
PSM 1.1	0.00	0.005	2.5Y 5/3		crystals	moist	0	/	single grain	loose	surface white crystals of epsomite
PSM 1.2	0.00	0.01	2.5Y 5/1		crystals	moist	10	2.5Y 6/4	single grain	loose	green coloured sideronatrite
PSM 1.3	0.01	0.10	2.5Y 6/2		sand	moist	5	2.5Y 6/4	single grain	loose	
PSM 1.4	0.10	0.20	2.5Y 6/2		sand	moist	0	/	single grain	loose	
PSM 1.5	0.20	0.30	2.5Y 6/2		sand	moist	0	/	single grain	loose	
PSM 1.6	0.30	0.40	2.5Y 6/2		sand	moist	0	/	single grain	very soft	
PSM 1.7	0.40	0.50	2.5Y 7/1		sand	wet	0	/	single grain	very soft	
PSM 1.8	0.50	0.60	2.5Y 7/1		sand	wet	0	/	massive	very soft	
PSM 1.9	0.60	1.60	2.5Y 5/2		sandy clay	wet	0	/	massive	very soft	

4.5 Hydrology

Results for the monitoring of piezometers screened at 1.5 m bgl (Figure 15 and Figure 16) show that the piezometric pressure increased in all piezometers within a 1 m radius of the tanks. Point Sturt has shown a more elevated piezometric response than at the Boggy Creek site. The time series plots illustrate the effect of the head of water in the tank for Point Sturt with the piezometric pressure increasing towards the tank from both directions and are highest in the tank. At Boggy Creek the effect of slope position on piezometric response outweighs the effect of the tank head. This is consistent with the observed soil properties (e.g. soil texture inferred hydraulic conductivity and measured seepage).

Rainfall at both sites results in a piezometric pressure response of a few centimetres or maintenance of piezometric pressure. A dry period of several weeks resulted in a decrease in piezometric pressure. These results indicate that in the case of the shallow water table monitored by these piezometers, local responses to rainfall and evaporation are dominant.

A comparison of piezometric pressure with relative water content (Figure 17) shows a response in relative water content to piezometric pressure to 0.4 m bgl for the clay soil and 0.3 m bgl for the sandy soil. The exact response depends on the height of the capillary fringe.

For the clay soil at Boggy Creek the relative water content of the soil responds to rainfall to a depth of 0.4 m bgl, with stronger responses at shallower depths. For the sandy soil at Point Sturt the response in limited to 0.1 and 0.2 m bgl (Figure 18).

IMPORTANT NOTE: As the moisture probes were not calibrated when this data was analysed it is not possible to compare results between sites, for example a raw data value of ~50% at Point Sturt may indicate field capacity explaining the lack of response to rainfall below 0.2 m bgl.

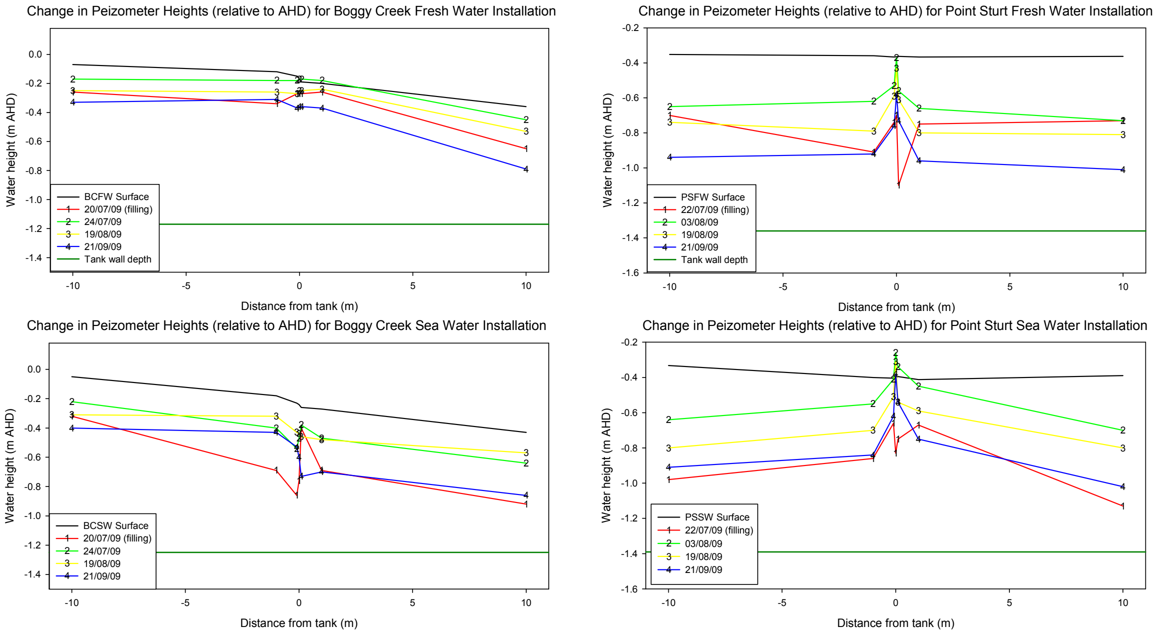


Figure 15 Piezometer heights along transects. Negative distance value means towards the bank or shore line from the installations, whereas positive distance value means towards the channel or lake edge. The black line indicates the ground elevation of the piezometer. The dark green line indicates the depth of the tank wall

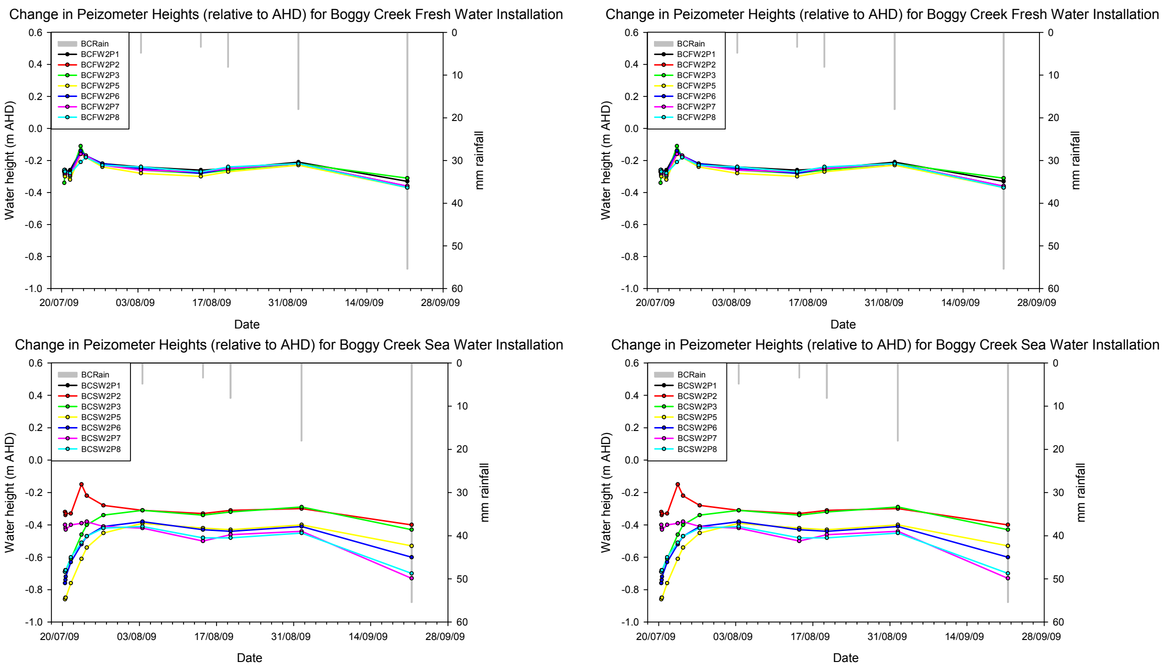
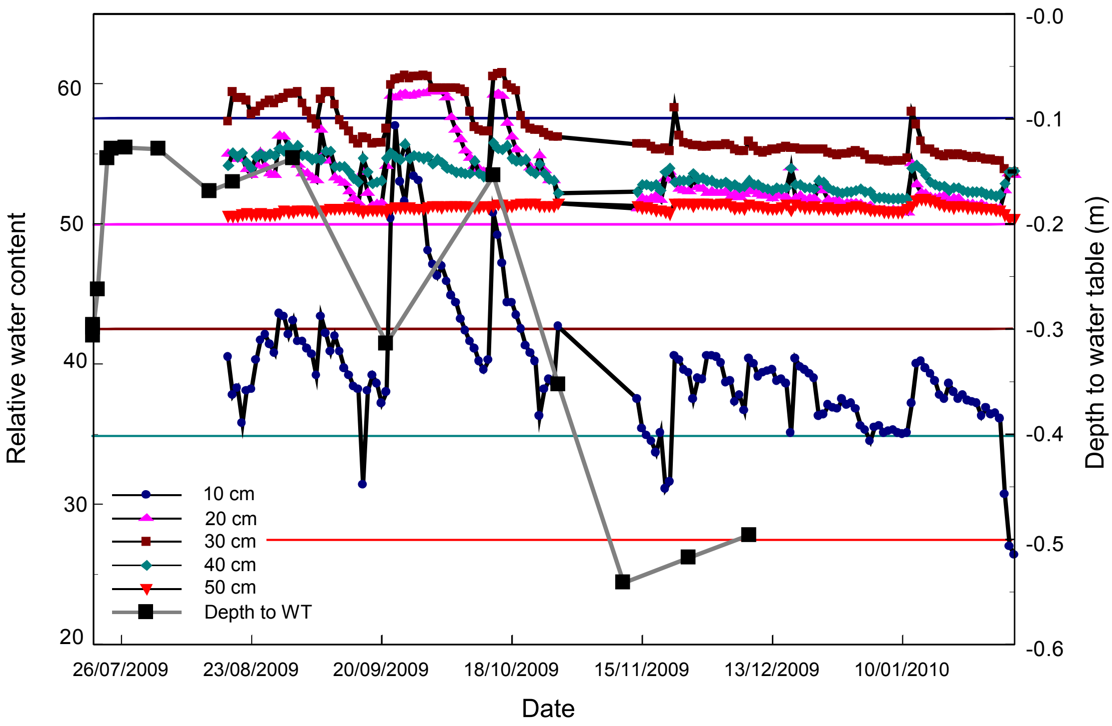


Figure 16 Time series of piezometer heights and measured rainfall. Piezometers P1 & P8 are 10m from the tank, P2 & P7 1m, P3 & P6 0.1m and P4/5 inside the tank.

(a) Relative water content and depth to water table: Boggy Creek



(b) Relative water contents and depth to water table: Point Sturt

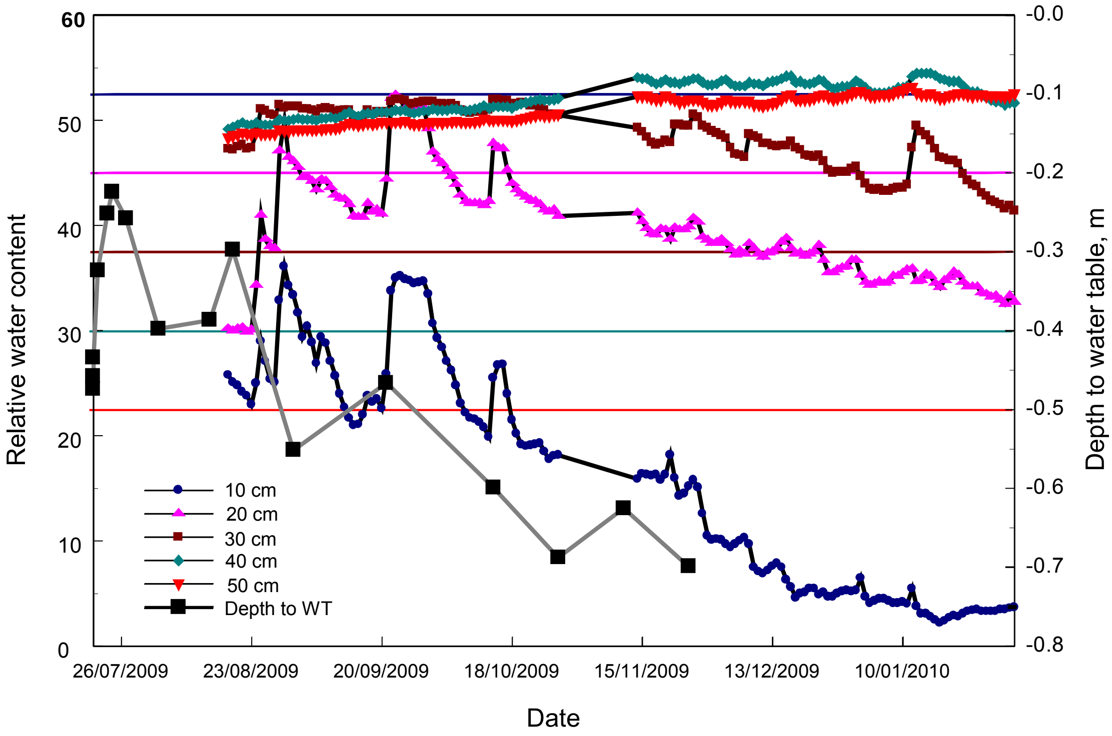


Figure 17 Relative water contents and depth to water table. Horizontal lines represent sensor depths and are colour keyed to corresponding relative water content scatter plot. Relative water contents are uncalibrated raw data and only trends and relative change can be inferred, for example this means that in plot (b) ~50% may represent field capacity.

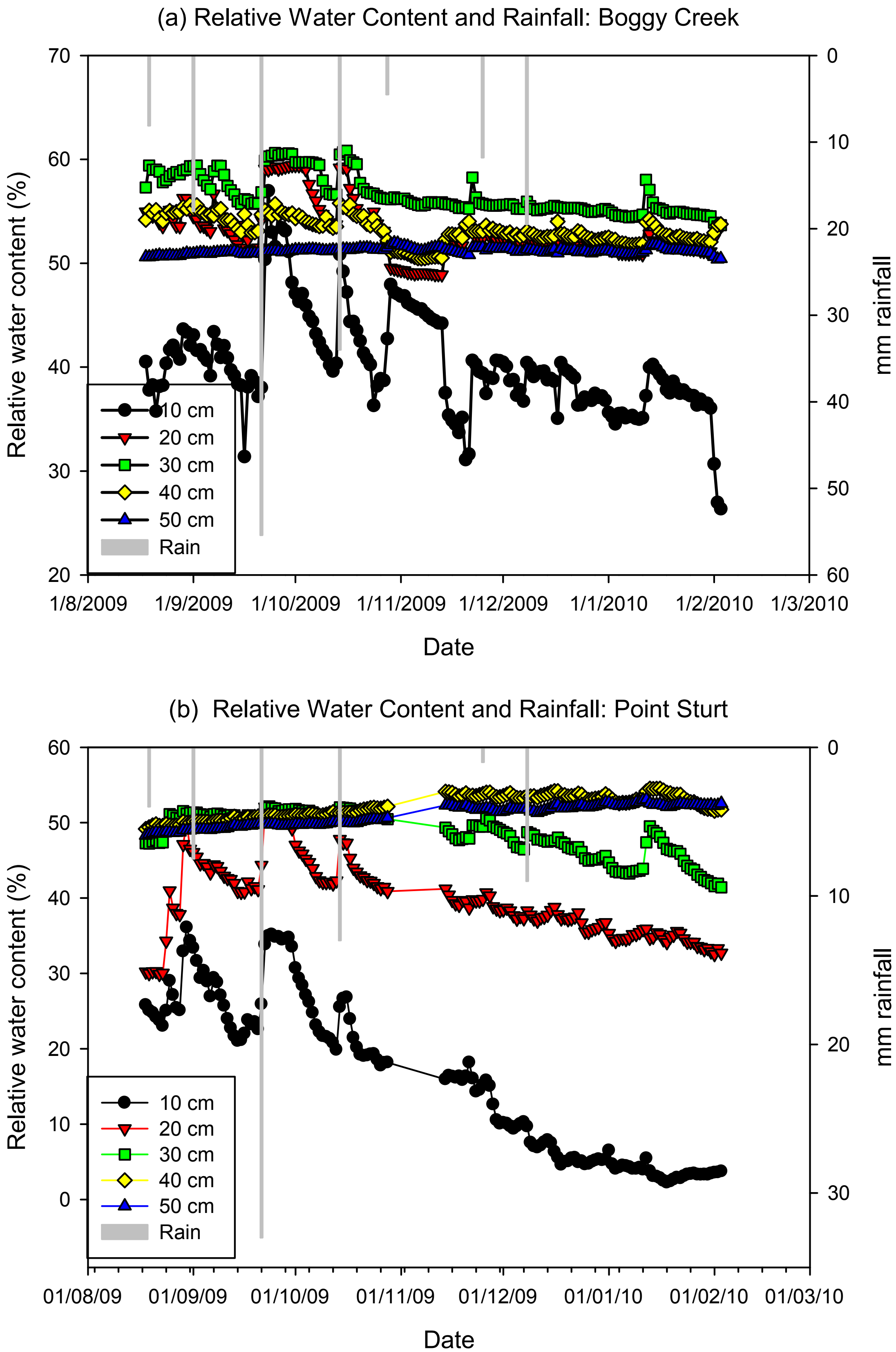


Figure 18 Relative water content and rainfall. Relative water contents are uncalibrated raw data and only trends and relative change can be inferred, for example this means that in plot (b) ~50% may represent field capacity and that comparison between sites cannot be made.

Soil Physics

Initial characterisation of the sites is provided below (Table 4). Values are in agreement with the observed extent of profile oxidation (Table 2and Table 3).

Table 4 Soil physical characteristics of the Boggy Creek and Point Sturt experiment sites

Site	Upper layer depth (cm)	Lower layer depth (cm)	BD vol. fraction (t/m^3)	Calculated porosity	Field saturation (%)
Boggy Ck.	0	5	0.88	0.669	45.7
Boggy Ck.	5	10	1.22	0.538	66.5
Boggy Ck.	10	15	1.35	0.49	87.8
Boggy Ck.	25	30	1.29	0.512	96.3
Boggy Ck.	45	50	1.24	0.531	97.7
Point Sturt	3	8	1.53	0.422	68.6
Point Sturt	22	27	1.52	0.426	86.9
Point Sturt	45	50	1.58	0.402	94.8
Point Sturt	60	65	1.48	0.442	95.3

4.5.1 Seepage rates

Seepage rates where very low for the Boggy Creek installations and rates were similar for both tanks. At Point Sturt there is an approximately twofold difference between the fresh water and sea water seepage rates. These differences can be observed in the chemical data. Sampling notes document difficultly obtaining water from shallow (0.2 m bgl) pore water sampler for the sea water treatment and precipitates were observed on the surface of the flooded soil. This indicates that there may have been precipitation reactions that partially blocked the soil pores decreasing seepage for the sea water treatment. Several reactions are likely, for example at pH > 7 and redox potentials greater than around 0 mV, iron will precipitate as the $Fe(OH)_3$, at pH values between 6 and 8, the solubility of aluminium hydroxide is at a minimum (Stumm and Morgan 1996) and iron, aluminium and silica gels are commonly associated at the interface between ASS leachate and neutral waters (Dent 1986).

Table 5 Measured seepage rates

Site	Treatment	Seepage (m/d)	LIV (m/d)
Boggy Creek	Fresh water	8.5×10^{-4}	1.6×10^{-3}
	Sea water	8.0×10^{-4}	1.6×10^{-3}
Point Sturt	Fresh water	1.47×10^{-2}	1.6×10^{-2}
	Sea water	8.3×10^{-3}	2.8×10^{-2}

4.6 Soil Redox Measurements

The results of the soil redox measurements are shown in Figure 19 and Figure 20. For the Boggy Creek site, the redox response to water introduction (21/7/09) can be observed in the surface water and at 0.1 and 0.2 m bgl as a decrease in redox potential. By 14 days after rewetting all shallow electrodes for both treatments displayed a steady decline in redox potential. By 45 days after rewetting (4/9/09) the redox potential at the soil-water interface was fluctuating around the Fe^{2+}/Fe^{3+} boundary ($Eh=59\cdot(pFe^{2+}+16.02–3pH)$; Stumm and Morgan 1996; pFe^{2+} range 4 to 5). The redox potential of the overlying water remained oxidising. For the freshwater treatment the redox potential decreased below the Fe^{2+}/Fe^{3+} boundary around 30 days after rewetting at 0.2 m bgl (pH~3) but remained above at 0.5 m bgl (pH~8). For the sea water treatment the redox potential at 0.1 and 0.2 m bgl decreased to around the Fe^{2+}/Fe^{3+} boundary although the duplicate electrodes at 0.2 m bgl had different Eh values of around –100 and +150 mV. The decrease at 0.1 m bgl is may be related to soil properties with a sandy surface horizon to around 0.05 m. The different response in the sea water treatment may be related to carbon and nutrient availability in the water column.

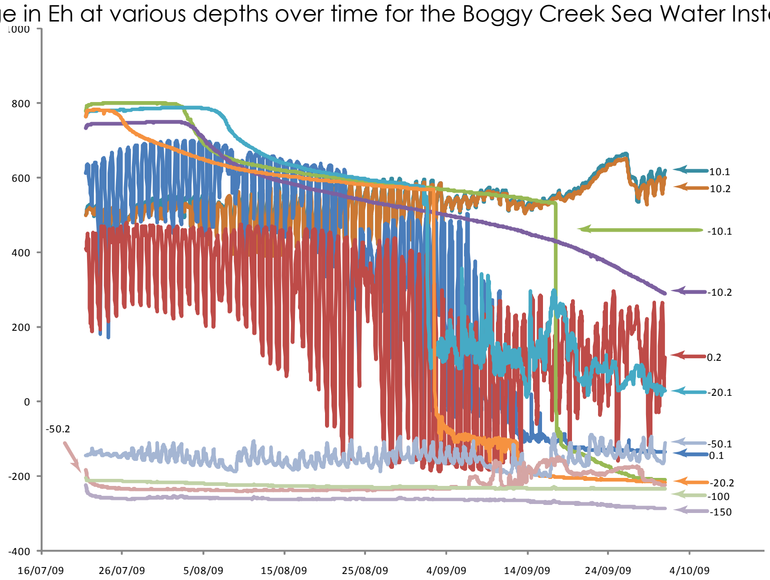
The electrodes at the soil-water interface (0 m) and at 0.1 m in the water column show a 12 h out-of-phase diurnal variation. It is likely that this is due to microbial respiration in the soil and water. While diurnal temperature change will cause changes in redox values these are around 0.4%/K (Nernst Equation) and much smaller than the observed changes. Vorenhout *et al.* (2004) described variations in soil redox and ascribed then to various factors, depth, temperature, water pressure, oxygen diffusion rate and biological activity. To determine the cause and effect would require substantial resources and is outside the scope of this investigation.

The Point Sturt site shows redox response to filling in the shallow electrodes as well as the diurnal variation in the electrodes situated in the water column. There is also some variation in the redox potential for the shallow electrodes in the external control installation, which is likely to be due to variation in the soil moisture content due to rainfall. Similar to the Boggy Creek installation there is a trend to lower Eh values which is stronger in the sea water treatment.

The lower Eh values were not mirrored in the solution chemistry changes, however analysis for the full set of parameters had ceased prior to the stronger trend commencing and basic measures such as alkalinity/acidity, pH and EC may not immediately reflect the change in redox status.

Change in Eh at various depths over time for the Boggy Creek Fresh Water Installation

Change in Eh at various depths over time for the Boggy Creek Sea Water Installation



Change in Eh at various depths over time for the Boggy Creek External Installation

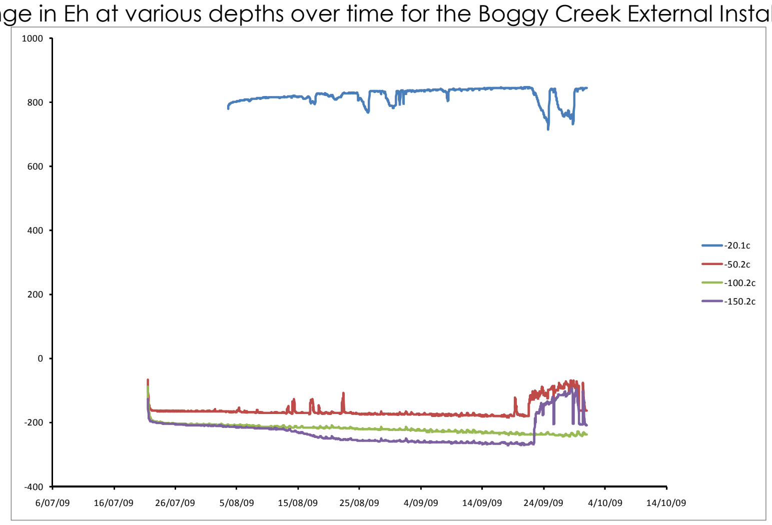


Figure 19 Time series for soil redox potential at the Boggy Ck. site. The tanks were filled on 21/7/09. Values for Eh are mV. Numbers to the left of the decimal in the legend indicate depth in cm and numbers to the right indicate electrode number. The letter 'c' indicates an external 'control' electrode.

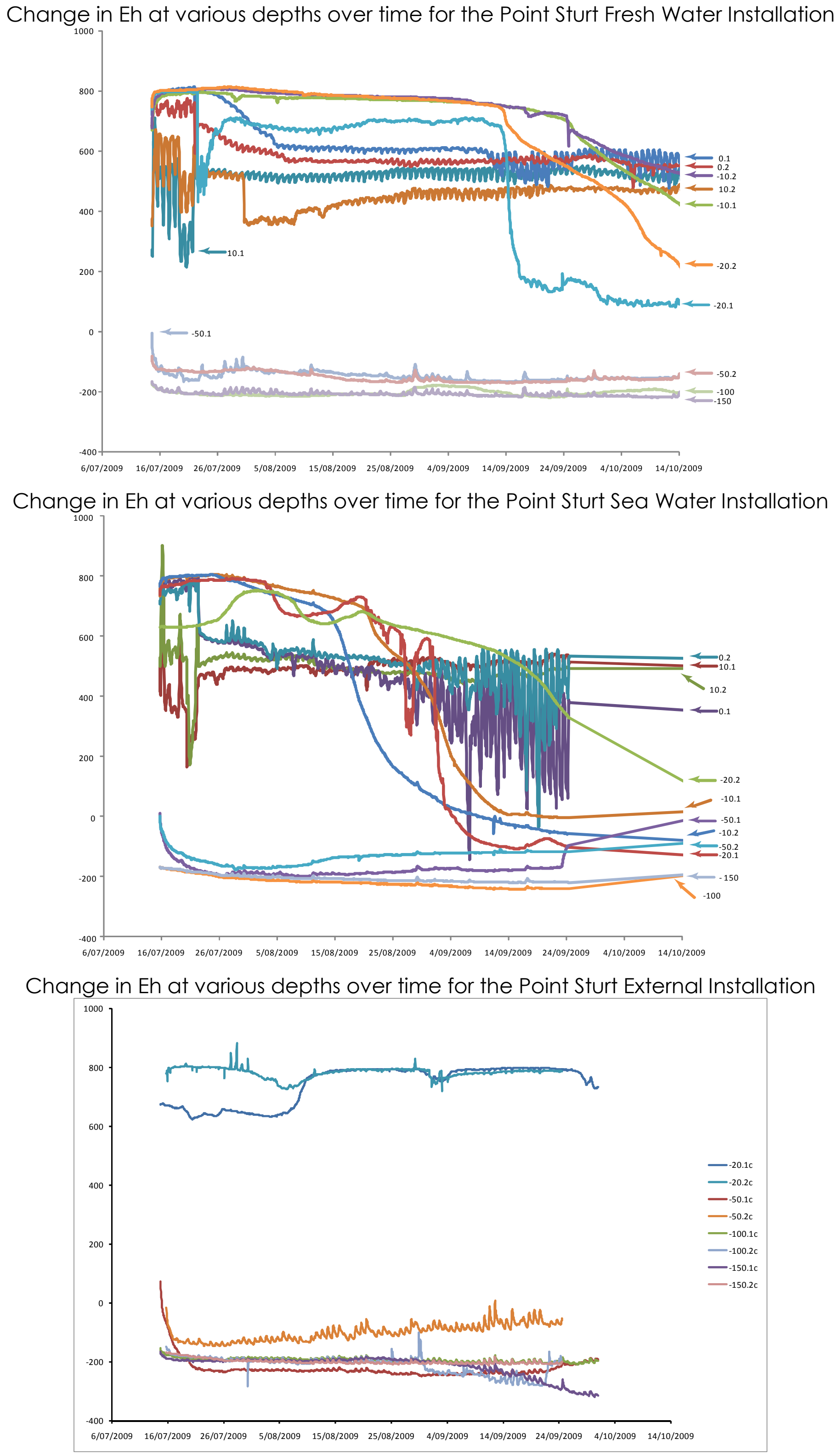


Figure 20 Time series for soil redox potential at the Pt. Sturt site. The tanks were filled on day 23/7/09. Values for Eh are mV. For the sea water installation there is a gap in the redox data commencing 24/9/09. Numbers to the left of the decimal in the legend indicate depth in cm and numbers to the right indicate electrode number. The letter 'c' indicates an external 'control' electrode.

4.7 Water Chemistry

4.7.1 Cumulative soil acidity versus water column neutralising capacity

When the cumulative soil profile actual acidity is compared to the cumulative water column neutralising capacity (Figure 21) it is evident that 0.5 m of water only provides enough neutralising capacity for around 0.1 m of the soil profile and that even 2 m of sea water would only provide enough neutralising capacity for 0.5 m of sand or 0.2 m of the clay at the Boggy Ck. soil profile. This means that a single charge of water is insufficient to neutralise the stored soil profile acidity. In the Lakes system, water exchange would occur (e.g. seiching) and potentially allow for much greater neutralisation than that occurring in the field trails that are 'constrained' with respect to lateral water flows, however in areas with restricted exchange the amount of acidity in the soil profile compared with the water column may be an issue.

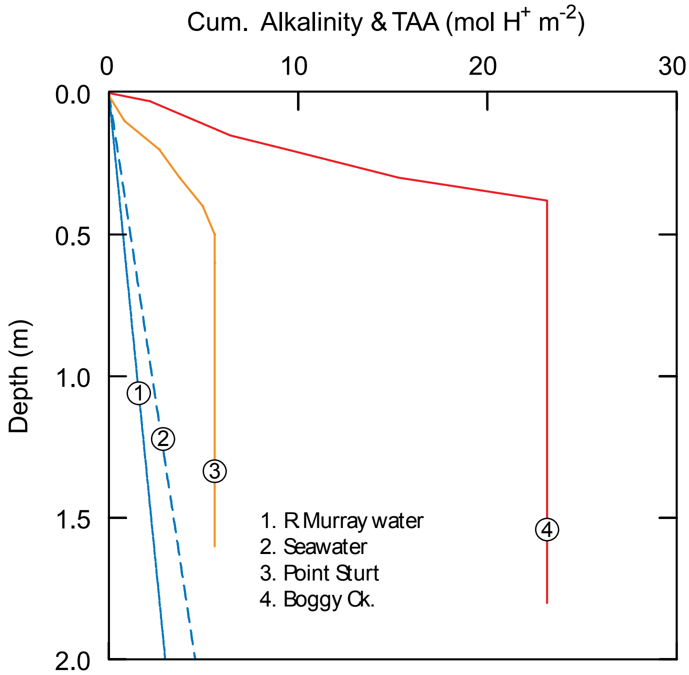


Figure 21 Cumulative neutralising capacity of the water column (blue lines 1 and 2) and cumulative actual acidity of the soil profile (red lines 3 and 4)

4.7.2 Surface water column and pore water pH and alkalinity trends

4.7.2.1 Boggy Ck.

4.7.2.1.1 Surface water

The water column alkalinity in the sea water treatment at Boggy Creek tank 2 decreased from an initial value of 2.2 meq/L on filling (20/07/09) to 0.0 meq/L on the 10/09/09 (Figure 24) with an acidity of 0.55 meq/L and pH of 4.6. On the 30/10/09, the pH was 3.6 with an acidity of 3.4 meq/L (Figure 22). At this time, the pH and alkalinity of the water in tank 1 had decreased to a pH value of 6.1 and an alkalinity of 0.25 meq/L (Figure 22 and Figure 24). In tank 1, the rate of alkalinity decrease was slower particularly in the period 7 to 21 days after rewetting indicating some variation in the acid flux into the tanks. The water in tank 1 is yet to become acid although the alkalinity is decreasing.

The fresh water treatment has shown a smaller alkalinity change in particular immediately after rewetting, decreasing from 1.4 to 0.1 meq/L by the 30/10/09, 102 days after rewetting. The pH has decreased from a value of 8.0 to 5.6 in the same period. However, while the initial rate of alkalinity decrease is lower for the fresh water treatment the longer term rate is similar to that of the sea water treatment (Table 8 and

Figure 25). The behaviour of both tanks was similar.

The decrease in alkalinity over time indicates that the net flux is from the sediment to the water column (Table 8) and that the diffusive flux is dominant. This is consistent with the low seepage rate (0.8 mm/d).

The main difference in behaviour for the two sea water treatments is in the initial consumption of alkalinity on rewetting, thereafter the acid flux rates are similar (

Figure 25). This may be due to variability in the amount of acidic surface precipitates. The between treatment differences can be explained in terms of the soil properties. Acid sulfate soils contain a range of acid oxidation products in precipitates on the surface (Fitzpatrick and Shand 2008; Fitzpatrick *et al. 2008a–e)*, and on exchange sites and weakly bound to metal oxides (van Breeman 1975). Rewetting ASS will result in the dissolution of precipitates. This will be common to both fresh and sea water. However, both the high ionic strength of sea water and the 'sea-salt effect' will alter the cation exchange equilibria where marine basic cations (sodium and magnesium) cause the displacement of adsorbed acid cations such as hydrogen ions and labile aluminium (Harriman and Wells 1985). This will result in both a greater initial flux of acid to the water column and the creation of a larger concentration gradient, initially producing a greater diffusive flux of acid from the soil to the water compared to the fresh water treatment.

4.7.2.1.2 Pore water

The pore water composition following initial rewetting is unknown as more specialised techniques such as thin gel films (DET/DGT) which have much shorter deployment times (hours) are required to provide this information. A detailed profile of the pore water acidic cation composition was provided at 28–42 days after rewetting by dialysis chamber samplers. This showed that iron and aluminium are the major contributors to the acidity, with iron the greatest contributor until around 0.2 and 0.15 m bgl in the case of the fresh and seawater treatments respectively when aluminium becomes the dominant acidic cation for around 0.1 m (Figure 30). The profile also shows the sharp boundary in iron concentration at the sediment-water interface caused by the change to oxidising conditions.

At the coarser vertical resolution provided by soil solution samplers, the alkalinity/acidity of the pore water remains stable from 0.5 m bgl for both treatments and for the external control (Figure 26 and Table 20). There has been an increase in acidity for pore water from 0.2 m bgl for the two rewetting treatments but not in the pore water from the external control sample. The aluminium concentration does not vary greatly over time (Figure 36) and the acidity increase is due to an increase in the dissolved iron concentration (Figure 29). This may be due to the dissolution of iron(III) solid phases following the onset of more reducing conditions around 45 days after rewetting (4/9/09; Figure 19).

In ASS subject to wetting and drying, iron cycles between oxidised and reduced forms resulting in the dissolution and then the reformation of precipitates as the redox status fluctuates. In ASS environments, iron can be present in many forms, such as residual pyrite, precipitated iron oxyhydroxides, precipitated acid oxidation products (e.g. sideronatrite, natrojarosite and schwertmannite). Iron oxyhydroxides may also contain adsorbed sulfate and H^+ (van Breemen 1975). Van Breemen (1975) proposed a conceptual model of the flooding processes where inundation and subsequent reduction of iron oxyhydroxides results in the release of Fe^{2+}as well as adsorbed ions such as Al^{3+}, H^+ and SO_4^{2-} and the hydrolysis of precipitated basic sulfates, freeing stored acidity and leading to a sharp drop in pH followed by an increase due to consumption of protons by iron reduction. Subsequent to the collection of data for this report, a further drop in the redox potential has occurred at the Boggy Creek. One confounding factor for the applicability of van Breemen's model is the lack of increase in the relative amount of sulfate (Figure 27). This may be a function of differences in the geochemical environment but detailed geochemical investigations are required before any conclusions can be drawn.

4.7.2.2 Point Sturt

4.7.2.2.1 Surface water

The higher seepage rate (15 and 8 mm/d for fresh and sea water respectively) means the direction of water and solute fluxes are from the overlying water to the soil, thus water chemistry of both the surface and pore water will be dominated by the supply water chemistry and any changes in the supply water chemistry due to evapoconcentration. Water column alkalinity was relatively stable with a small initial decrease likely due to the dissolution of surface precipitates followed by a later increase due to evapoconcentration (Figure 22 and Figure 24). Tanks 1 and 2 for each treatment are behaving similarly. The pH of the freshwater treatment has remained around that of the supply water (7.9) with a maximum of 8.5 and a minimum of 7.3, while the pH of the sea water treatment has remained in a narrower band of 7.5 to 8.2 with a supply sea water pH of 7.8.

4.7.2.2.2 Pore water

The acid pore water at 0.2 m bgl is decreasing in acidity/increasing in pH and the pore water from 0.5 m bgl is decreasing in alkalinity and pH, becoming acidic in the case of the sea water treatment (Figure 23 and Figure 26). There are two possibilities for the infiltration of the surface water into the soil profile, mixing with existing pore water or piston flow and displacement. The decrease in acidity of the pore water from 0.2 m bgl could be from mixing, however the simultaneous decrease in alkalinity of the deeper pore water indicates that the acid pore water that was originally at shallow depth is being displaced downward ahead of a piston front of infiltrating water. There is also some indication of acidic water at 1 m bgl where the alkalinity is decreasing (Figure 26). If mixing and reaction dominated the infiltration processes, then previously alkaline waters would be unlikely to become acidic. Examination of the $Cl:SO_4$ ratio (Figure 27) confirms the hypothesis of piston flow dominating. At 0.2 m bgl, the ratio has increased and is approaching the supply water value. For pore water at 0.2 m bgl at 0.5 and 1.0 m bgl, the ratios are decreasing and are approaching to the starting value for the water from 0.2 m bgl. Deeper pore water from 1.5 m bgl is also showing a decrease in alkalinity and a decrease in $Cl:SO_4$ ratio. Both treatments are behaving similarly with differences explainable by seepage rates that differ by a factor of approximately two.

The rewetting took place following a period of substantial rainfall when the surface of the soil was at around 70% of the field capacity, rising to approximately 90% by 0.2 m bgl (Table 4). Groundwater was 0.5 m bgl or higher (Figure 15) throughout the period covered by this report. This limited the effect of the design to the prevention of lateral flow above 0.2 m bgl. While the groundwater level remains above the tank bottom, enhanced seepage due to drainage out of the tank bottom into empty pore space will also not occur. Thus piston flow is unlikely to be an artefact of the experiment design and the experiment provided a good one dimensional representation of rewetting and surface-pore water interactions.

Soil ANC below 0.6m bgl (Figure 14) does not appear to be neutralising acidic pore water as there are good correlations between alkalinity/acidity and $Cl:SO_4$ ratios for pore water from depths above and below 0.6 m bgl (Table 6 and Figure 28). If acidic pore waters were being neutralised, $Cl:SO_4$ ratios would still decrease but alkalinity would not decrease at the same rate. Further monitoring is necessary to determine any longer term buffering capacity.

Table 6 Pearson product moment correlation† for alkalinity/acidity and $Cl:SO_4$ ratio for pore water from Point Sturt

	0.5 m bgl	1.0 & 1.5 m bgl	0.5 to 1.5 m bgl
Correlation Coefficient	0.681	0.952	0.871
P Value	0.0210	0.000144	0.000000000829
Number of Samples	11	18	29

†Calculated using Sigma Plot for Windows V11.0

Despite the advective flux of surface water into the soil profile, the pH of the pore water at 0.2 m bgl remains acid with a pH value of around 3 and an acidity of approximately 1 meq/L for the fresh water treatment and 3 meq/L for the sea water treatment (Figure 26). In both instances the major component of the acidity at 0.2 m bgl is the hydrogen ion (Figure 30) although there is some contribution from aluminium and iron in the case of the sea water treatment. The source of these ions is unclear. It is unlikely to be from cation exchange as these reactions are rapid occurring on a timescale of seconds to minutes (Sparks and Jardine 1984). Residual acidity may be a source, however soil analyses show that the residual is zero (pH_{KCl}>4.5; Ahern *et al.* 2004).

Detailed data for electrical conductivity, pH and alkalinity and acidity are presented in Appendix 3 Water analyses and the detailed (14 d average) composition of the acidity obtained from dialysis chamber samplers deployed 28 days after rewetting is shown in Figure 30. Note that due to the seepage (average rate over two treatments =12 mm/d) an element of water will have moved approximately 168 mm between chamber deployment and removal.

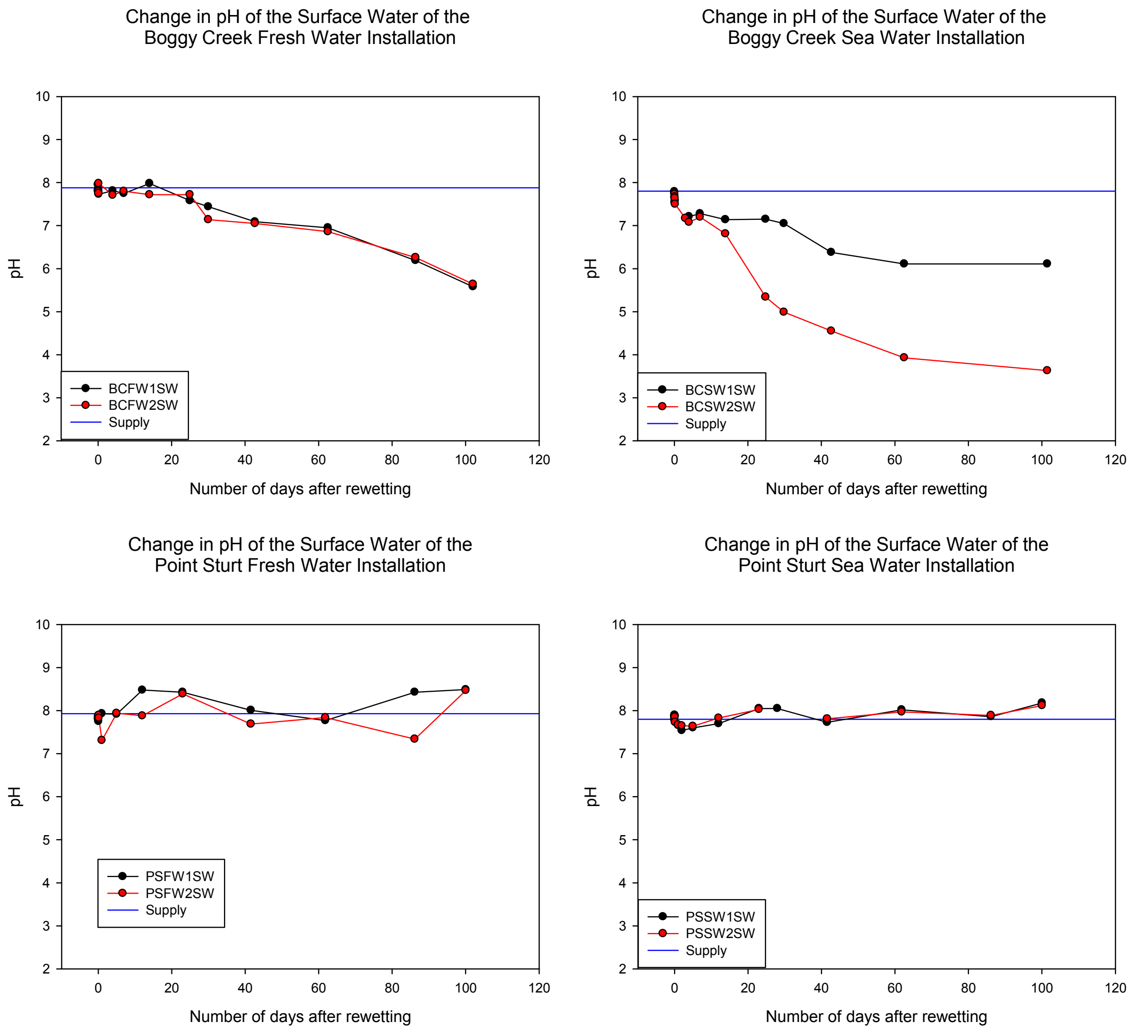


Figure 22 Time series for surface water pH
Legend decode: BC=Boggy Creek, PS=Point Sturt; FW=fresh water, SW=sea water; 1or 2=treatment number; SW indicates samples taken 0.05m below the water surface.

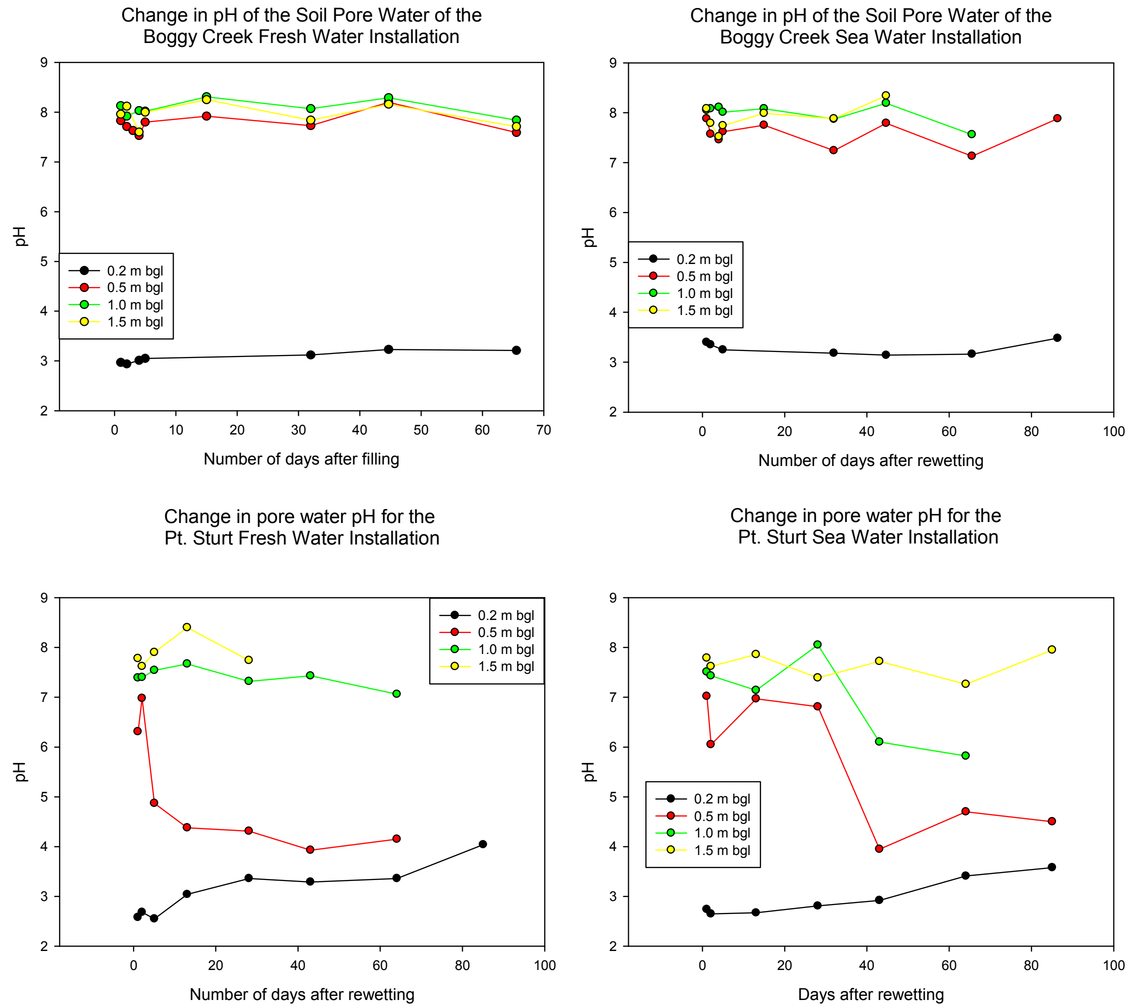


Figure 23 Time series for pore water pH

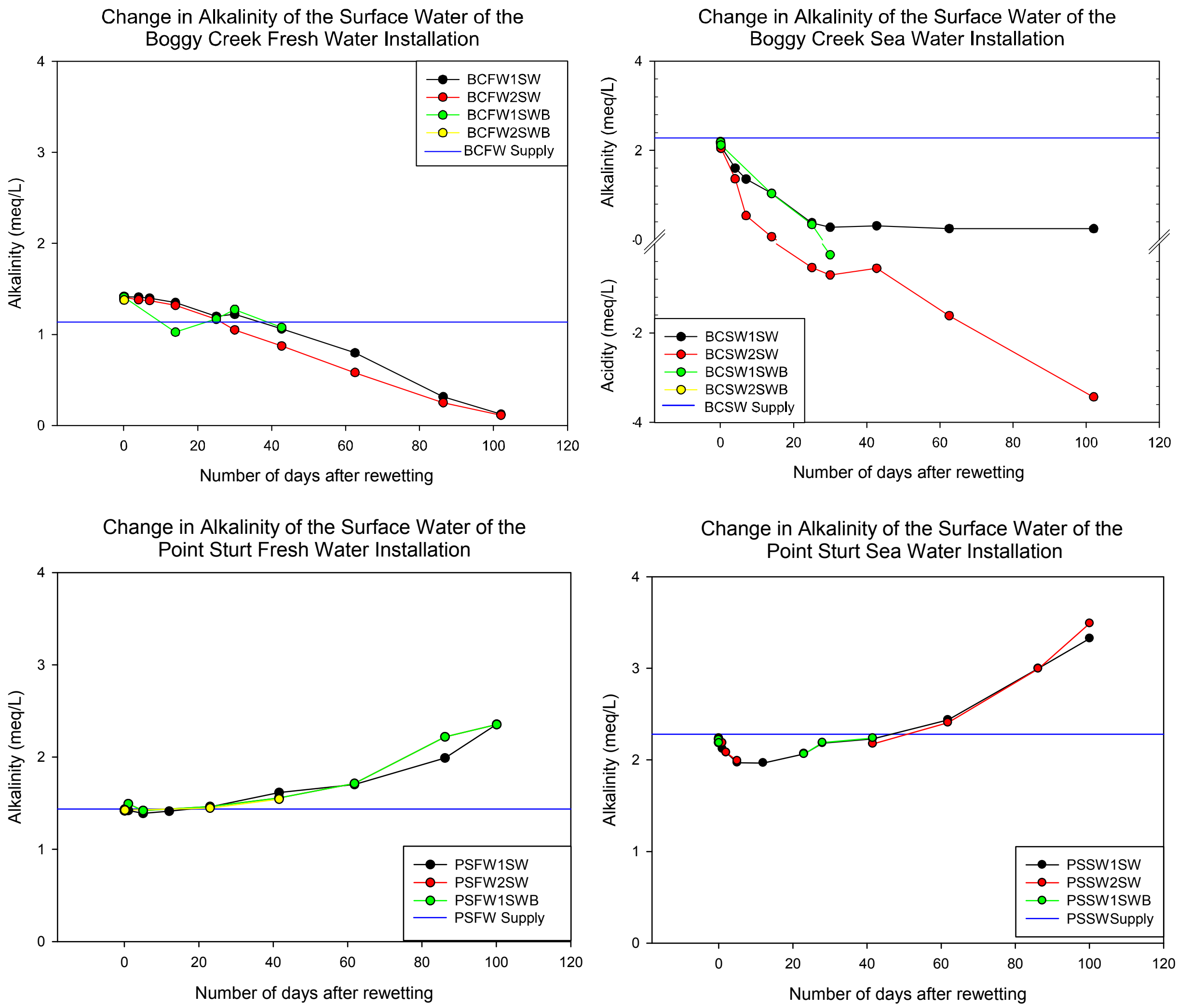
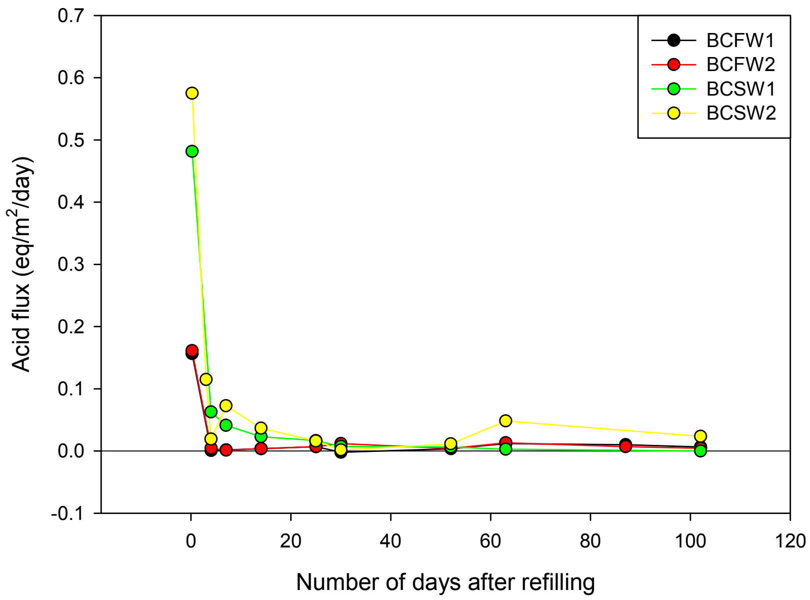


Figure 24 Time series for surface water alkalinity.
Legend decode: BC=Boggy Creek, PS=Point Sturt; FW=fresh water, SW=sea water; 1or 2=treatment number; SW indicates samples taken 0.05m below the water surface and SWB indicates samples taken 0.05 m above the soil-water interface.

Boggy Creek clay soil



Point Sturt sandy soil

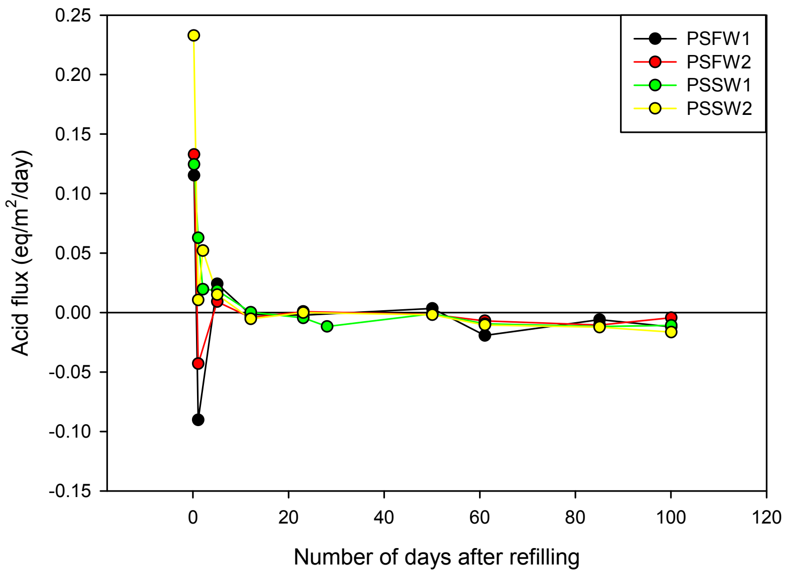


Figure 25 Acid flux rate from soil to surface water for the two soil materials
Legend decode: BC=Boggy Creek, PS=Point Sturt; FW=fresh water, SW=sea water; 1or 2=treatment number; SW indicates samples taken 0.05m below the water surface.

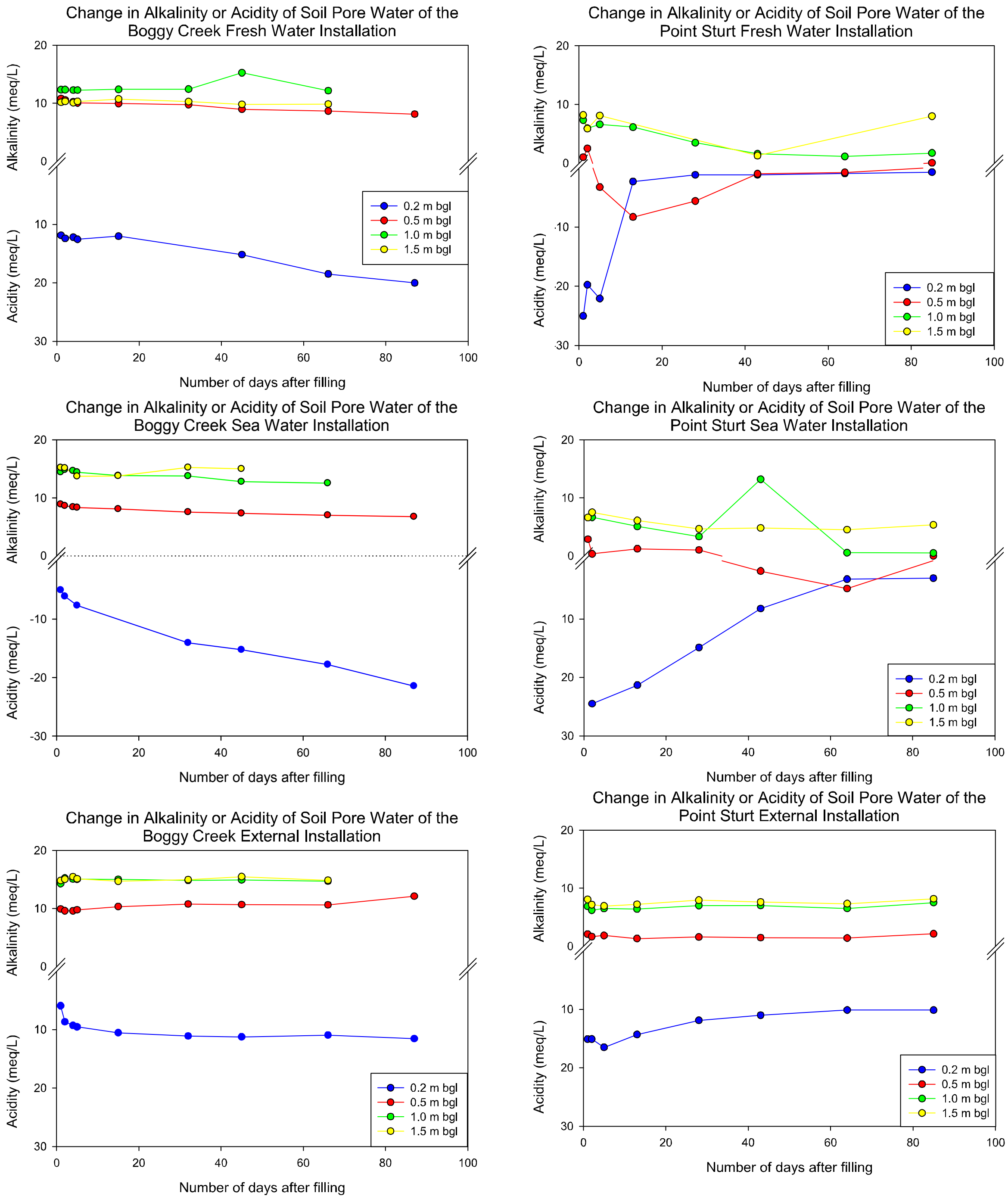


Figure 26 Time series for pore water alkalinity/acidity.

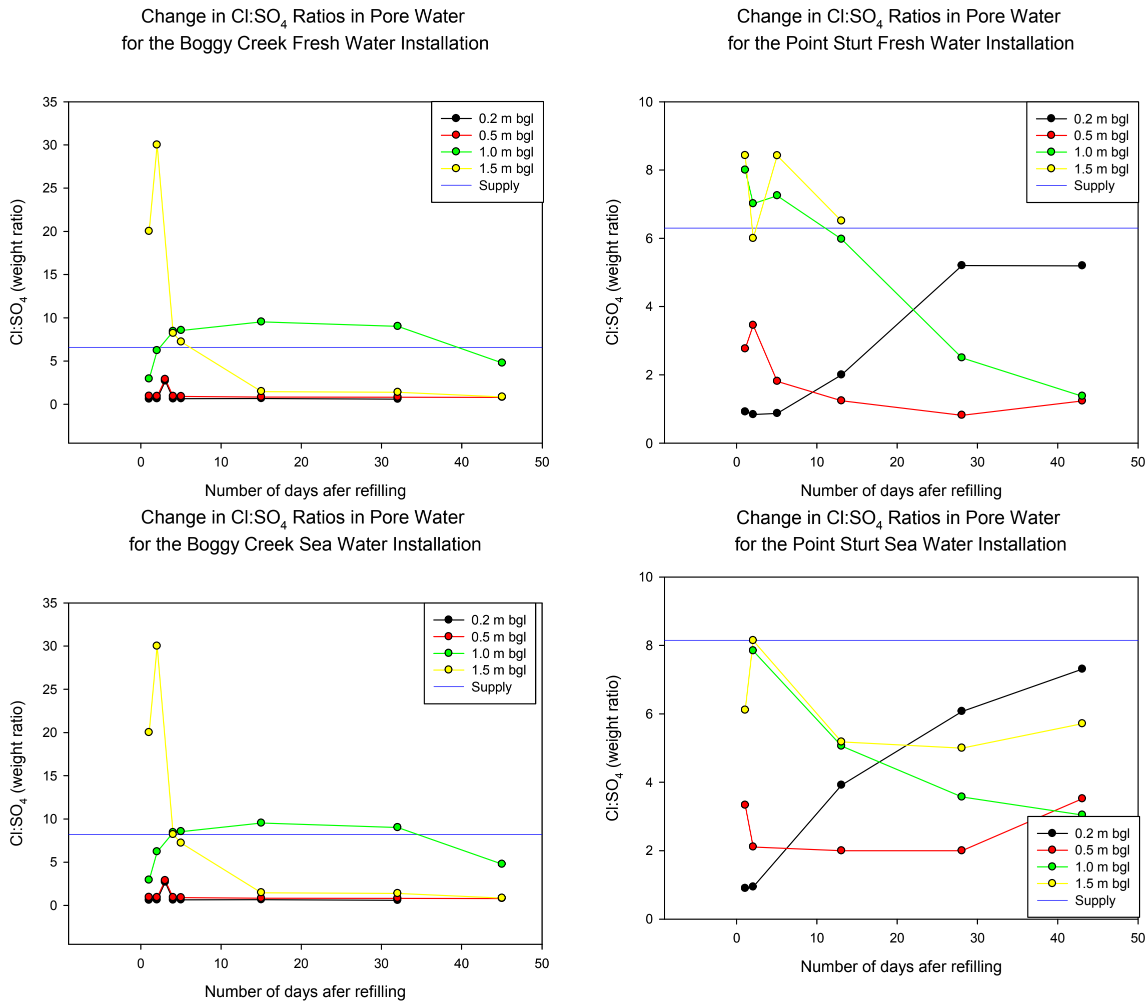


Figure 27 Time series for Cl:SO_4 ratios

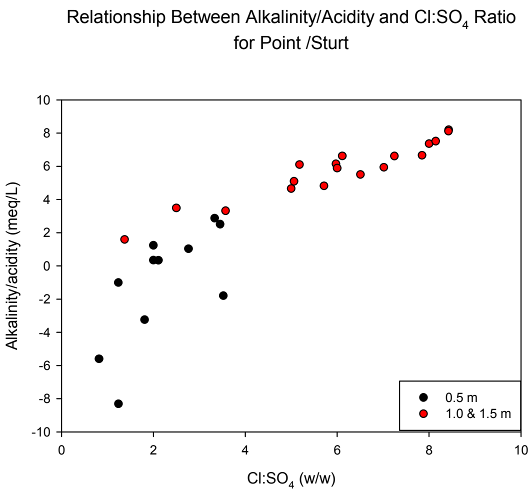


Figure 28 Relationship between alkalinity/acidity and Cl:SO_4 ratio
Acidity values are expressed as negative numbers, alkalinity positive numbers.

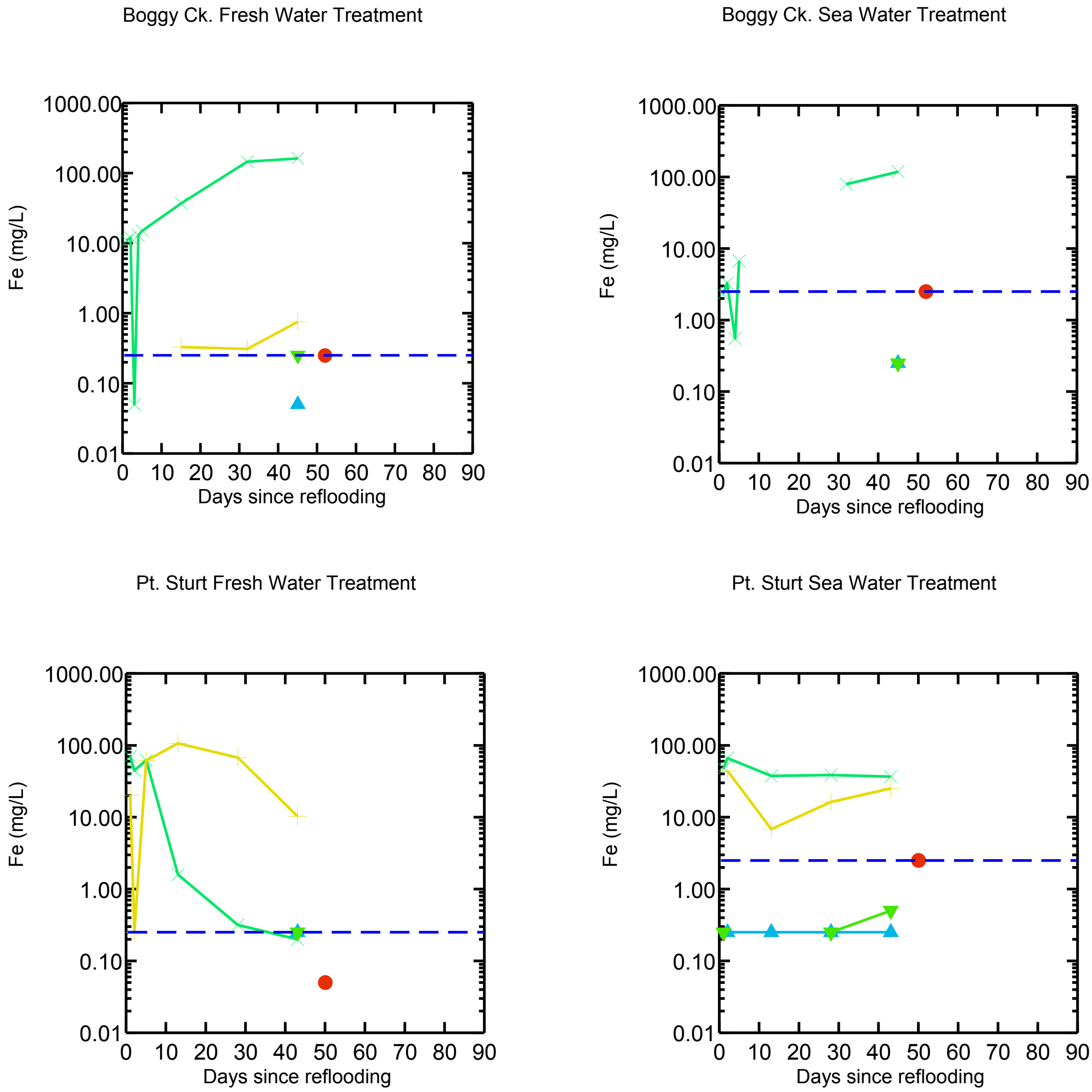


Figure 29 **Time series for total iron concentration. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl, ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination; in some cases this may be lower depending on sample ionic strength (salinity).**

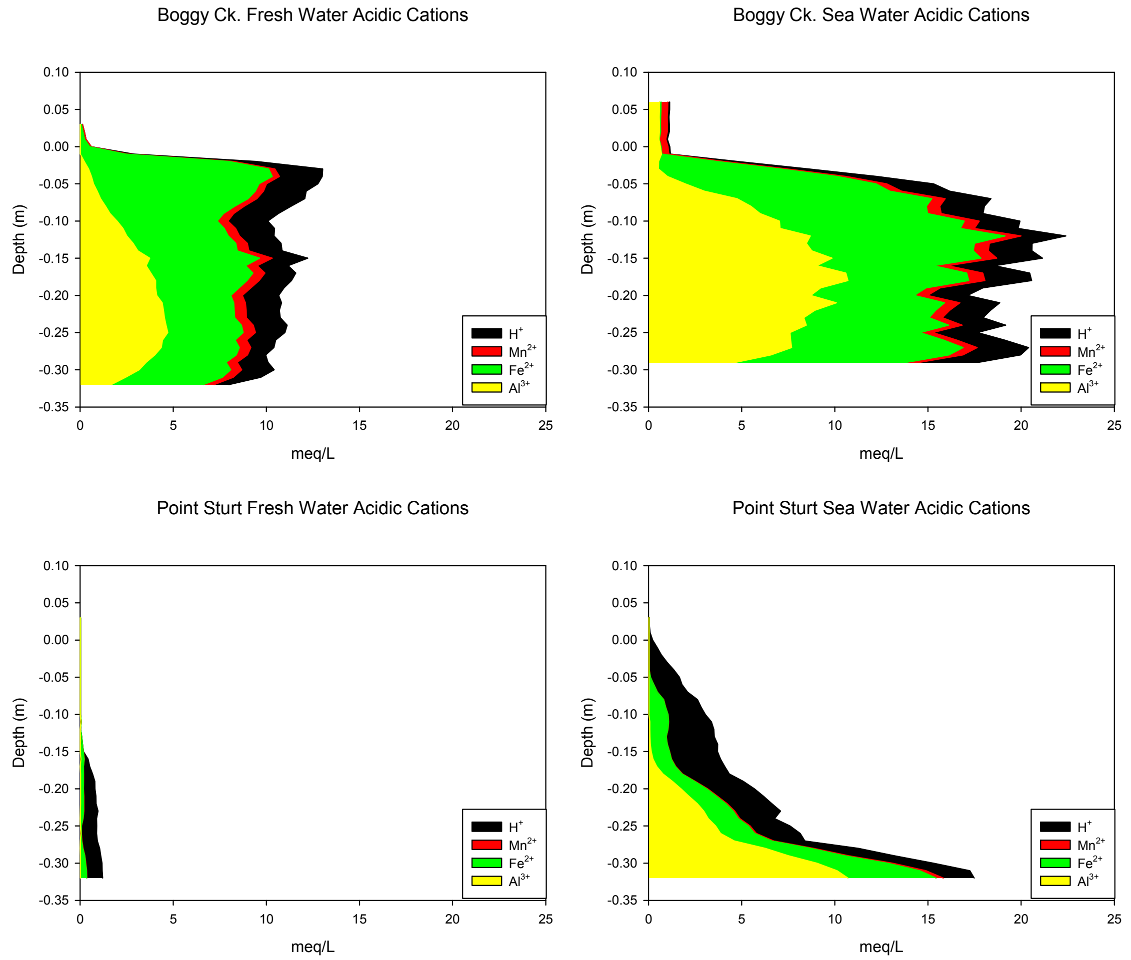


Figure 30 Soil profile of total acidic cations from dialysis chamber samplers deployed for the period 18/08/09 to 03/09/09. The profiles show the contribution of each cation. The horizontal width of the coloured band represents the concentration of that species. The distance from the vertical axis to the right hand edge of the band represents the total of acid cations for all species included in that horizontal slice.

4.7.3 Solute flux measurements and modelling

4.7.3.1 Flux measurements

The acidity stored in the exposed acid sulfate soils of the Lower Lakes is present in a number of forms in both the dry soil and in the unsaturated and saturated zones. In the solid phase, these include sparingly soluble 'acidic' oxyhydroxide and oxyhydroxy sulfate minerals that can accumulate as concentrated surface precipitates as well as more diffusely in the bulk soil. Acidic cations also exist adsorbed to oxides and on cation exchange sites. Acidity can also be present in saturated and unsaturated zones as hydrogen ions, dissolved iron, manganese and aluminium (Cook *et al.* 2000). Following rewetting this acidity can be transported into the water column or the soil profile. The precipitates have different solubilities and dissolution rates (e.g. see Bigham and Nordstrom 2000) so that the acid flux on rewetting will have a number of sources that vary in their difficulty to identify and measure. The decrease in water column alkalinity provides a simple direct measure of the net acid flux to the water column. The acid flux was calculated from measured alkalinities, storage tank supply rates, seepage rates, evaporation and rainfall according to equation 4. Data are provided in Appendix 3, Table 18. The variation in acid flux over time for the Boggy Creek clay soil and the Point Sturt sandy soil is shown graphically in Figure 27.

4.7.3.2 Flux estimates

The flux equation (12) was parameterised with the available measured values. Values of d and C_d (Table 7) used to estimate the concentration gradients were obtained from dialysis chamber concentration profiles. Fluxes of individual cations were calculated and summed to determine the total flux. Examination of the dialysis chamber profiles (Figure 31) shows that the major contributors to the acid flux differ between sites. For the clay soil, iron is the major contributor to the acid flux.

Aluminium is the major component of the acidity from around 0.15 to 0.25 m bgl. For the sandy soil the hydrogen ion is the major contributor to around 0.22 m bgl where aluminium becomes the dominant acidic cation. The dialysis chambers were deployed for 14 days commencing 28 days after the soils were rewetted so that the data from them represents the composition of the longer term acid flux components rather than the initial components.

Table 7 Values for the depth of constant concentration (D) and the concentration (C_d) used to parameterise the flux equation.

		H^+		Al^{3+}		Fe^{2+}		Mn^{2+}	
		D (m)	C_d (mol/m³)	D (m)	C_d (mol/m³)	D (m)	C_d (mol/m³)	D (m)	C_d (mol/m³)
Boggy Ck. Clay	Fresh water	0.04	1.0	0.04	1.5	0.04	5.0	0.04	0.4
	Sea water	0.06	1.0	0.14	3.0	0.05	5.0	0.07	0.3
Pt. Sturt Sand	Fresh water	0.19	1.0	0.50	0.03	0.11	0.50	0.17	0.004
	Sea water	0.10	0.15	0.10	0.30	0.10	0.08	0.10	0.22

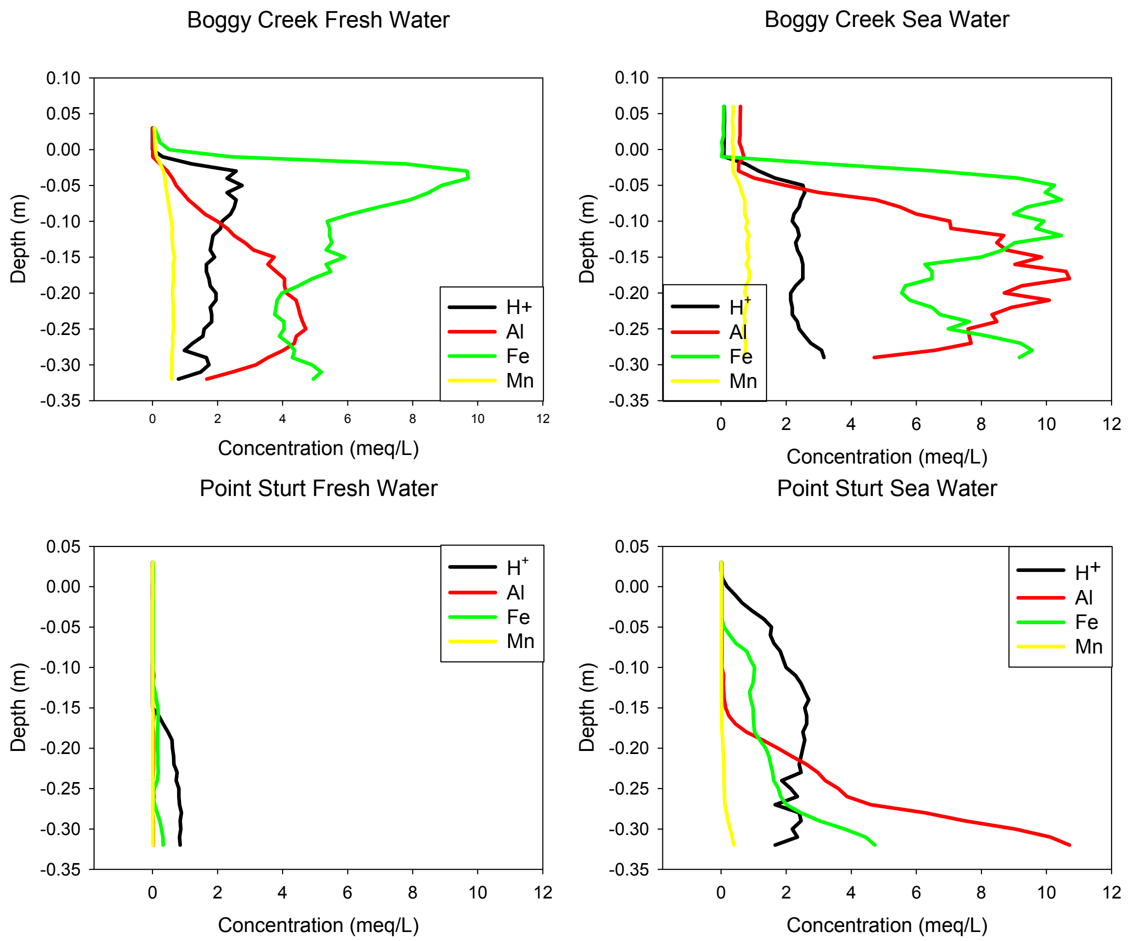


Figure 31 Dialysis chamber profiles for 'acidic' cations

Calculations predict the flux for the clay soils reasonably well (Table 8). The long term measured and calculated flux rates for the clay soil at Boggy Creek are around four times the calculated value for both treatments. At Point Sturt, the predicted values from applying the flux equation are that there will be a net flux from the overlying water into the soil. The measured values are in agreement with the direction, but are an order-of-magnitude less. A possible explanation is that sparingly soluble acid oxidation products such as natrojarosite in the near surface (the third term in equation 5) provide an ongoing flux of acidity. It should be noted that the measured flux rates are variable and that at low flux rates, the water supply inputs and seepage losses are the major terms in the mass balance equation, making more precise measurement of the acid flux rate difficult.

The initial flux rate is two orders of magnitude higher than the long term flux rate. This is likely due to dissolution of precipitates (the third term in equation 5). In the case of sea water the initial flux is higher again. This is probably because the higher ionic strength of sea water displaces exchangeable and adsorbed acidic cations present on the solid phase resulting in a higher concentration gradient and thus diffusive flux. While some information is available in the literature for the exchange reactions, little information is available for dissolution rates of acidic minerals and no attempt was made to parameterise and incorporate this term in the calculated flux.

Table 8 Calculated and measured flux rates (mol $H^+/m^2/d$). Negative values indicate flux from the soil to the water column and positive values flux from the water column to soil. The range for the long term measured values is shown in brackets.

Location	Calculated			Measured	
	Acid	Alkalinity	Net (Acid + Alkalinity)		
Boggy Creek				Day 1	Day 7–102
Fresh water	-1.5×10^{-2}	2.2×10^{-3}	-1.3×10^{-3}	$-1.61\pm0.02\times10^{-1}$	-6 (-13 to 2)$\times10^{-3}$
Sea water	-1.1×10^{-2}	2.1×10^{-3}	-8.5×10^{-3}	$-5.3\pm0.5\times10^{-1}$	-22 (-73 to 0)$\times10^{-3}$
Point Sturt				Day 1	Day 12–100
Fresh water	-5.4×10^{-4}	3.6×10^{-2}	3.5×10^{-2}	$-1.38\pm0.09\times10^{-1}$	5 (-3 to 19)$\times10^{-3}$
Sea water	-6.1×10^{-4}	2.1×10^{-2}	2.0×10^{-2}	$-2.8\pm0.3\times10^{-1}$	7 (0 to17) $\times10^{-3}$

4.8 Water Quality

For the purposes of this work the Lower Lakes have been assessed as highly disturbed ecosystems and the ANZECC and ARMCANZ (2000) values for protection at 80th percentile level applied (SA EPA pers. comm.). For ecosystems classified as highly disturbed, the 95% protection trigger values can still apply. However, depending on the state of the ecosystem, the management goals and the approval of the appropriate state or regional authority in consultation with the community, it can be appropriate to apply a less stringent guideline trigger value, say protection of 90% of species, or in this instance 80% (ANZECC and ARMCANZ 2000). These values should be seen as intermediate targets for water quality improvement. If the trigger values have been calculated using assessment factors, there is no reliable way to predict what changes in ecosystem protection are provided by an arbitrary reduction in the factor (ANZECC and ARMCANZ 2000). Sea water or freshwater guidelines have been applied according to treatment. Time series plots of concentrations showing the guideline trigger value and covering each parameter have been provided at the end of the section. Where no or only low reliability values are available data has not been presented graphically and no discussion included.

Hardness corrections for extremely hard water (400 mg $CaCO_3$/L) were applied to metals whose toxicity is known to be influenced by hardness, and for which hardness algorithms are available (i.e. Cd, Cr(III), Cu, Ni, Zn, and Pb). The hardness algorithms (ANZECC and ARMCANZ, 2000) were derived using effects data for fish using toxicity data spanning water hardness from 25-400 mg $CaCO_3$/L. Their applicability at higher hardness is unknown. The toxicity of other metals such as manganese, is known to be reduced as water hardness increases, however, no algorithms were available for hardness corrections.

For fresh water physical and chemical stressors, ANZECC and ARMCANZ WQ guideline trigger values for south central Australian lakes have been applied.

Guideline values applied to the data are listed below (Table 9 and

Table 10). The complete data set for water samples with both guideline and low reliability values have been provided along with other major and minor element chemical data in Appendix 3 Water analyses.

Table 9 Guideline trigger values for physical and chemical stressors for south central Australia lakes applied to data

Parameter	Guideline value (mg/L)
pH	6.5–9
Total ammonia–N	0.025
NO_x–N	0.1
PO_4–P	0.01

Table 10 Guideline trigger values for toxicants applied to data (80th percentile). ID means that no or only low reliability data is available and no guideline value has been recommended.

Toxicant	Guideline value (μ g/L)	
	Fresh water	Sea water
Ammonia§	2 300	1 700
Nitrate+nitrite	17 000[A]	ID
Ag	0.2	2.6
Al pH>6.5, <6.5	150, ID	ID
As (III), (V)	360, 140	ID
B	1 300	ID
Cd	4.56	36
Co	ID	150
Cr (III), (VI)	ID, 40	90.6, 85
Cu	13	8
Mn	3600	ID
Ni	88	560
Pb	111	12
Se (T), (IV)	34, ID	ID
V	ID	280
Zn	161	43

§WQ values quoted for pH 8 must be adjusted for the pH of the water being assessed.
[A] Figure may not protect key test species from acute toxicity (and chronic) — check ANZECC and ARMCANZ (2000) Section 8.3.7 for spread of data and its significance. 'A' indicates that trigger value > acute toxicity figure; note that trigger value should be <1/3 of acute figure (Section 8.3.4.4).

4.8.1 Physical and chemical stressors (fresh water treatments)

4.8.1.1 Nutrients

A summary table of the guidelines for physical and chemical stressors applied to water collected from the surface and pore water of the mesocosms is provided below. A more detailed discussion follows.

Table 11 Summary table of exceedances for physical and chemical stressors.
× = exceedance ✓= no exceedance

	pH	Total ammonia–N	Nitrate + nitrite–N	PO_4–P
Boggy Creek (clay)				
Surface water	✓	×	×	×
Pore water 0.2 m bgl	×	×	✓	×
Point Sturt (sand)				
Surface water	✓	×	✓	✓
Pore water 0.2 m bgl	×	×	✓	×

In the surface water of the Boggy Creek trial, concentrations of total ammonia-nitrogen, nitrate-nitrogen and free reactive phosphate (FRP) are above guideline values recommended for lakes in south central Australia. At Point Sturt, surface water concentrations of ammonia-nitrogen exceed recommended values. Other nutrients while initially slightly exceeding guideline values have decreased over time.

In the pore water at 0.2 m bgl, concentrations of ammonia-nitrogen are highly elevated, particularly in the clay soil at Boggy Creek. Nitrate plus nitrite - nitrogen is near to or slightly above the guideline value although the concentration appears to be decreasing over time. FRP concentrations are increasing in the pore water of the clay soil. This is consistent with the increasing iron concentration (Figure 29) and decreasing redox potential (Figure 19) with retained phosphorus being released following iron reduction. For the sandy soil material at Point Sturt, FRP remains above guideline values but may be showing a lowering value trend. While the aquatic ecosystems of the Lower Lakes are considered to be highly disturbed, concentrations of nutrients are particularly elevated for the surface water overlying the clay soil. This could favour algal blooms that in turn will provide a source of labile organic carbon which will enhance the formation of monosulfidic black ooze (Bush et. al. 2004). Time series for nutrients are shown in Figure 32**,** Figure 33 and Figure 34**.**

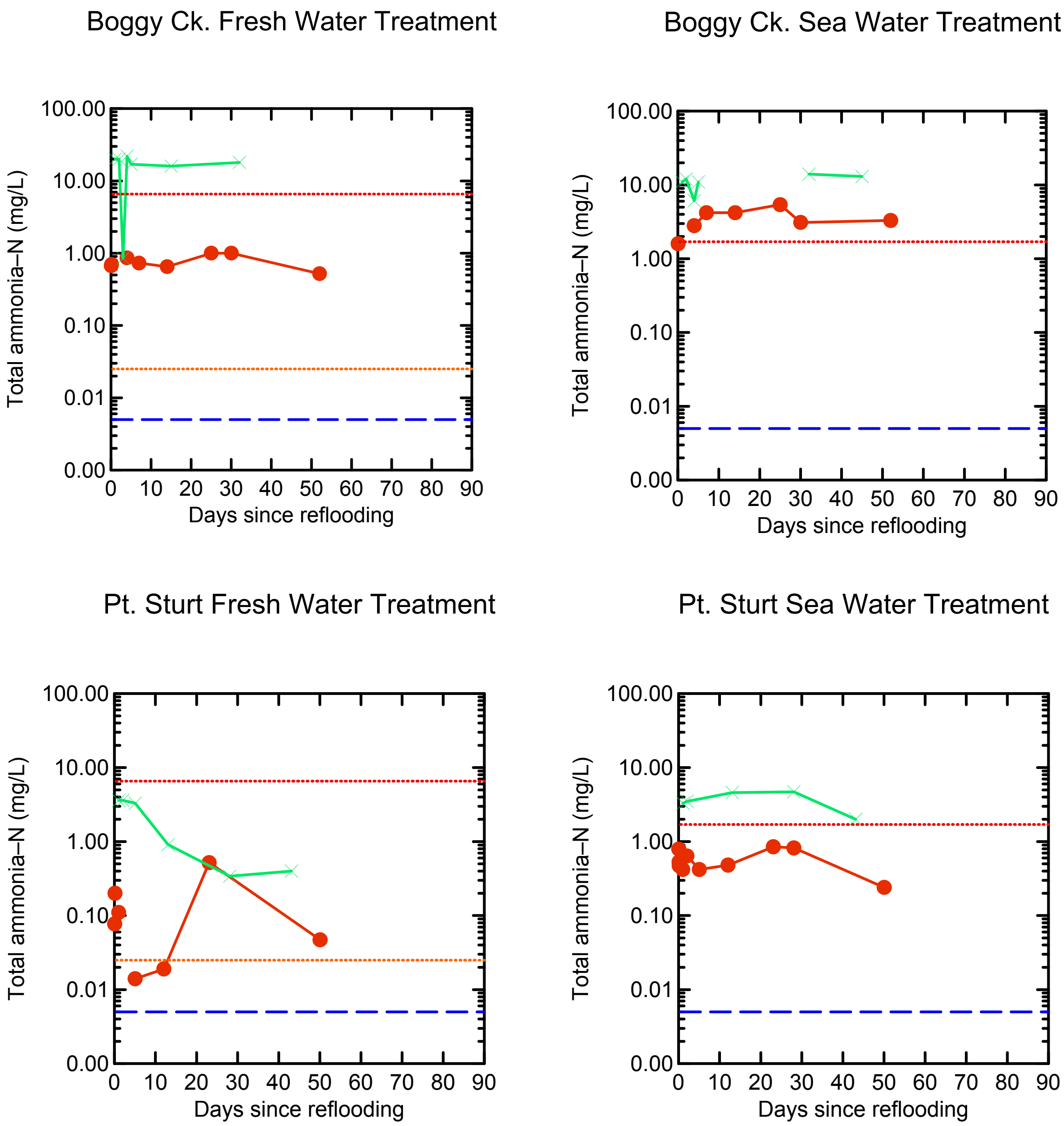


Figure 32 Total ammonia-N. Surface Water = O, Pore Water: x = 0.2 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination; in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. The orange dotted line the represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for physical and chemical stressors for south central Australian lakes. Toxicant WQ values for pH=8 have been used. Values should be adjusted for pH according to ANZECC and ARMCANZ (2000) section 8.3.7.2.

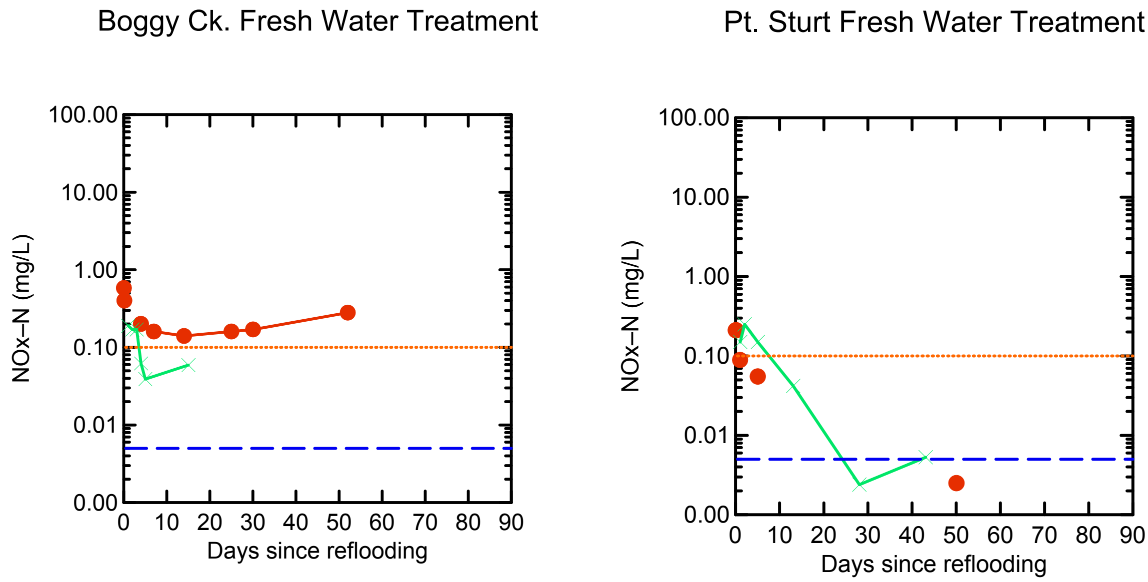


Figure 33 Nitrate+Nitrite-N. Surface Water = O, Pore Water: x = 0.2 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination; in some cases this may be lower depending on sample ionic strength (salinity). The orange dotted line the represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for physical and chemical stressors for south central Australian lakes.

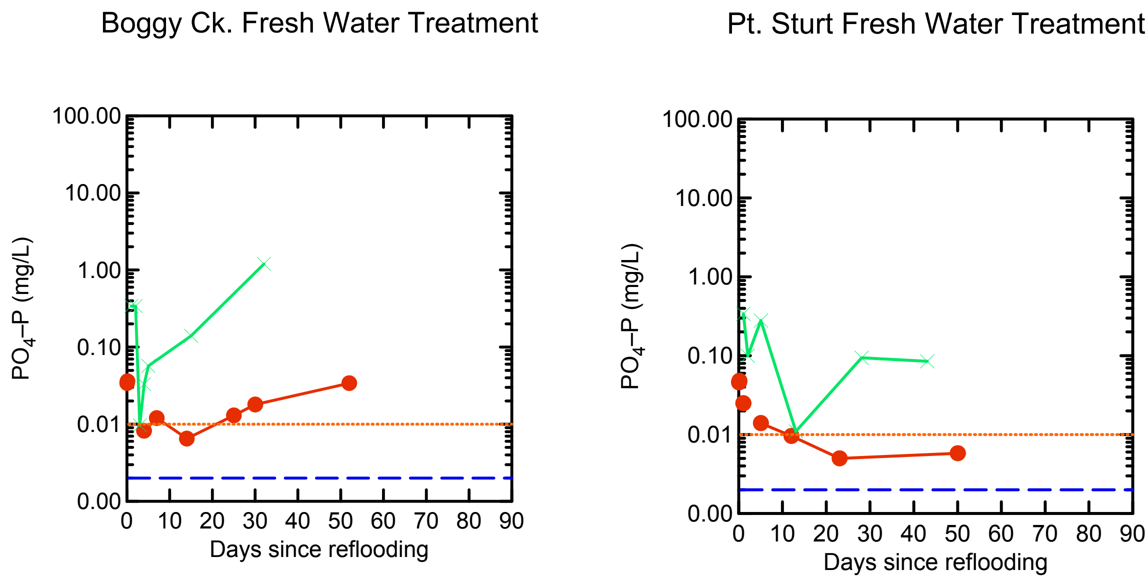


Figure 34 Free reactive phosphate. Surface Water = O, Pore Water: x = 0.2 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination; in some cases this may be lower depending on sample ionic strength (salinity). The orange dotted line the represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for physical and chemical stressors for south central Australian lakes.

4.8.2 Toxicants

A summary table of the guidelines for toxicants applied to water collected from the surface and pore water of the mesocosms is provided below. A more detailed discussion follows and the full dataset is provided in Appendix 3.

Table 12 Summary table of exceedances for toxicants in fresh water treatments.
× = Exceedance ✓= no exceedance

	Total NH_3–N	Nitrate+ nitrite–N	Ag	Al	As	B	Cd	Co	Cr	Cu	Mn	Ni	Pb	Se	V	Zn
Boggy Creek (clay)																
Surface water	✓	✓	✓	✓	✓	✓	✓		✓	×	✓	✓	✓	✓	✓	×
Pore water 0.2 m bgl	✓	✓	✓	×	✓	✓	✓		×	✓	×	×	✓	✓	×	×
Pore water 0.5 m bgl	n.a.	n.a.	✓	×	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Pore water 1.0 m bgl	n.a.	n.a.	✓	✓	✓	✓	✓		✓	×	✓	✓	✓	✓	✓	✓
Pore water 1.5 m bgl	n.a.	n.a.	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	×
Point Sturt (sand)																
Surface water	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Pore water 0.2 m bgl	✓	✓	✓	×	✓	✓	×		×	×	×	×	✓	✓	×	×
Pore water 0.5 m bgl	n.a.	n.a.	✓	×	✓	✓	✓		✓	×	×	×	✓	✓	✓	×
Pore water 1.0 m bgl	n.a.	n.a.	✓	✓	✓	×	✓		✓	×	✓	✓	✓	✓	✓	×
Pore water 1.5 m bgl	n.a.	n.a.	✓	✓	✓	×	✓		✓	×	✓	✓	✓	✓	✓	×

Table 13 Summary table of exceedances for toxicants in sea water treatments.
× = Exceedance ✓= no exceedance

	Total NH_3–N	Nitrate+ nitrite–N	Ag	Al	As	B	Cd	Co	Cr	Cu	Mn	Ni	Pb	Se	V	Zn
Boggy Creek (clay)																
Surface water	×		✓				✓	✓	✓	×		✓	✓		✓	×
Pore water 0.2 m bgl	✓		✓				✓	×	✓	×		✓	✓		✓	✓
Pore water 0.5 m bgl	n.a.		✓				✓	✓	✓	✓		✓	✓		✓	✓
Pore water 1.0 m bgl	n.a.		✓				✓	✓	✓	✓		✓	✓		✓	×
Pore water 1.5 m bgl	n.a.		✓				✓	✓	✓	✓		✓	✓		✓	×
Point Sturt (sand)																
Surface water	✓		✓				✓	✓	✓	✓		✓	✓		✓	×
Pore water 0.2 m bgl	✓		✓				✓	×	×	×		×	✓		✓	×
Pore water 0.5 m bgl	n.a.		✓				✓	✓	✓	✓		✓	✓		✓	×
Pore water 1.0 m bgl	n.a.		✓				✓	✓	✓	✓		✓	✓		✓	✓
Pore water 1.5 m bgl	n.a.		✓				✓	✓	✓	×		✓	✓		✓	×

4.8.2.1 Ammonia nitrogen

As well as being a nutrient, ammonia nitrogen may be a toxicant at high concentrations. The concentration of dissolved ammonia nitrogen is highly pH dependent and WQ values quoted for pH 8 must be adjusted for the pH of the water being assessed.

In surface water, measured concentrations are below the guideline trigger value for the fresh water treatment at Boggy Creek and both treatments at Point Sturt. However concentrations exceed guideline trigger values for the Boggy Creek sea water treatment.

Concentrations in pore water were above the above the pH 8 guideline trigger value for both treatments at Boggy Creek and for the seawater treatment at Point Sturt. However, as the pH value decreases the trigger value increases as less of the nitrogen is in the toxic un-ionised form of $NH_{3\ (aq)}$. At a pH value of 6.0 the value is 5.96 mg/L total ammonia-N for sea water and 2.57 mg/L for fresh water. The concentration of un-ionised ammonia-N at pH values of 3 to 4 is low and the concentration of total ammonia-N increases to several thousand mg/L consequently despite elevated concentrations of total ammonia-N guideline concentrations are not exceeded. Details of the relationship are given in ANZECC and ARMCANZ (2000) section 8.3.7.2. A plot of the time series for ammonia nitrogen is given in Figure 32.

4.8.2.2 Nitrate+nitrite nitrogen

Nitrate plus nitrite nitrogen can also be a toxicant at very high concentrations. Measured concentrations in both surface and pore water are below the guideline trigger value for the fresh water treatment at Boggy Creek and at Point Sturt (Figure 33). There are no guideline values for sea water.

4.8.2.3 Silver

4.8.2.3.1 Surface water and pore water

Concentrations in surface water are difficult to assess as the concentration in the supply water varied and was sometimes above the trigger value (Table 22). In addition, exceedances were small and within the limit of quantitation (10×limit of detection). In contrast to other toxicants, the pore water had the lowest concentrations of silver and these were below the trigger values in both fresh water and sea water.

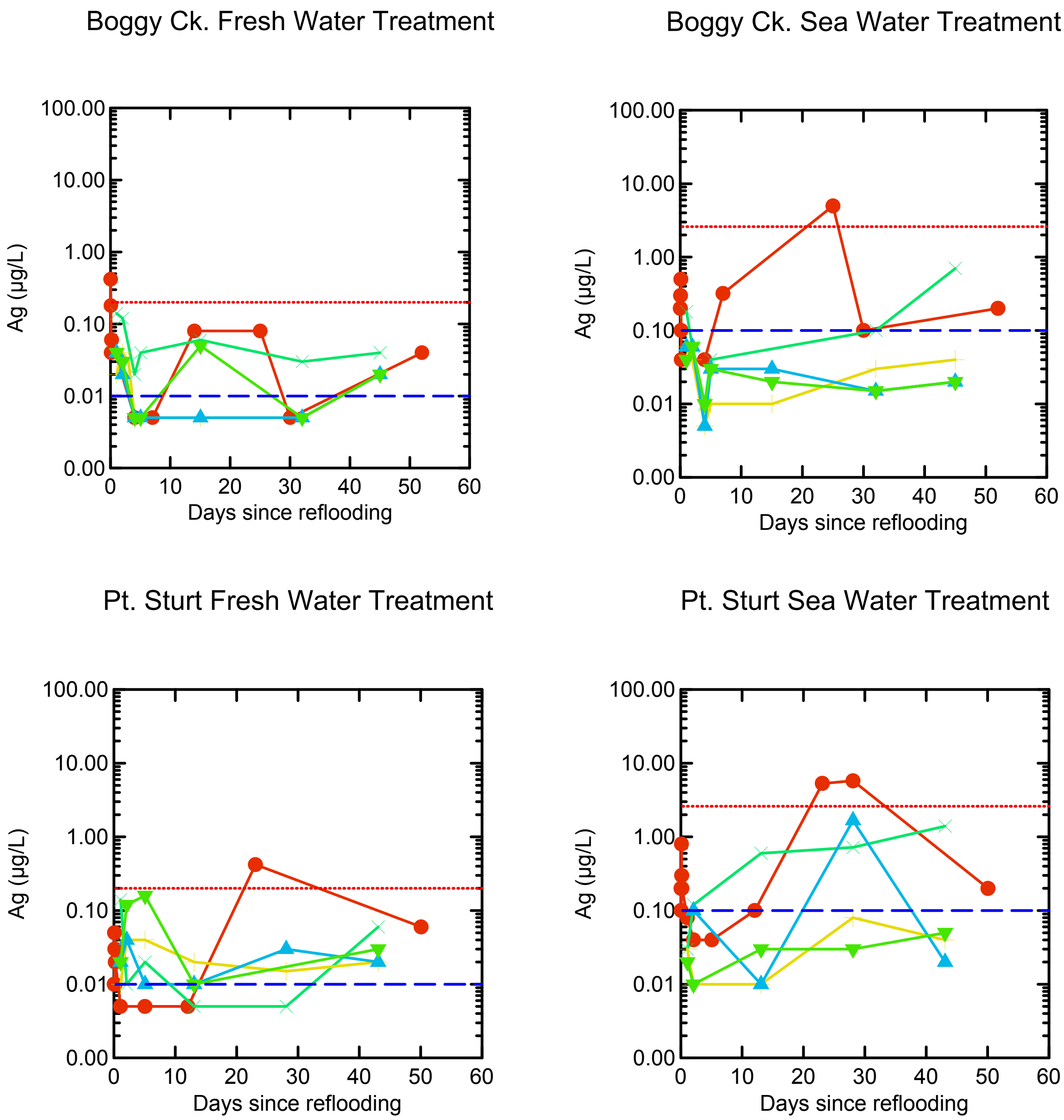


Figure 35 Silver. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples.

4.8.2.4 Aluminium

4.8.2.4.1 Surface water

The concentration of aluminium remained around the ANZECC and ARMCANZ 80% guideline trigger value (hereafter referred to as the trigger value) for approximately 25 days after rewetting at the Boggy Creek clay soil installation. This is some 10^6 times higher than would be expected from solubility data at the observed pH values of 7.6 to 8.0. This may be due to the presence of polynuclear aluminium hydroxy species that can pass through the 0.22 µm membrane filter used in the sample preparation. These may have formed during the neutralisation of aluminium in the initial acid flux. At Point Sturt, concentrations of aluminium in surface water samples were below the detection limit over the monitoring period and would be expected to remain at these levels as diffusive fluxes of acidic cations from the sediment to the overlying water are small (<0.001 mol/m²/day) and less than alkalinity inputs and net solute flux is from the surface water into the soil.

4.8.2.4.2 Pore water

Aluminium concentrations in pore water follow the expected relationship with pH and show a response to the pH changes at the Point Sturt site caused by seepage and piston flow. At lower pH values there are order of magnitude exceedances, however trigger values for pH values <6.5 are considered unreliable (ANZECC and ARMCANZ 2000).

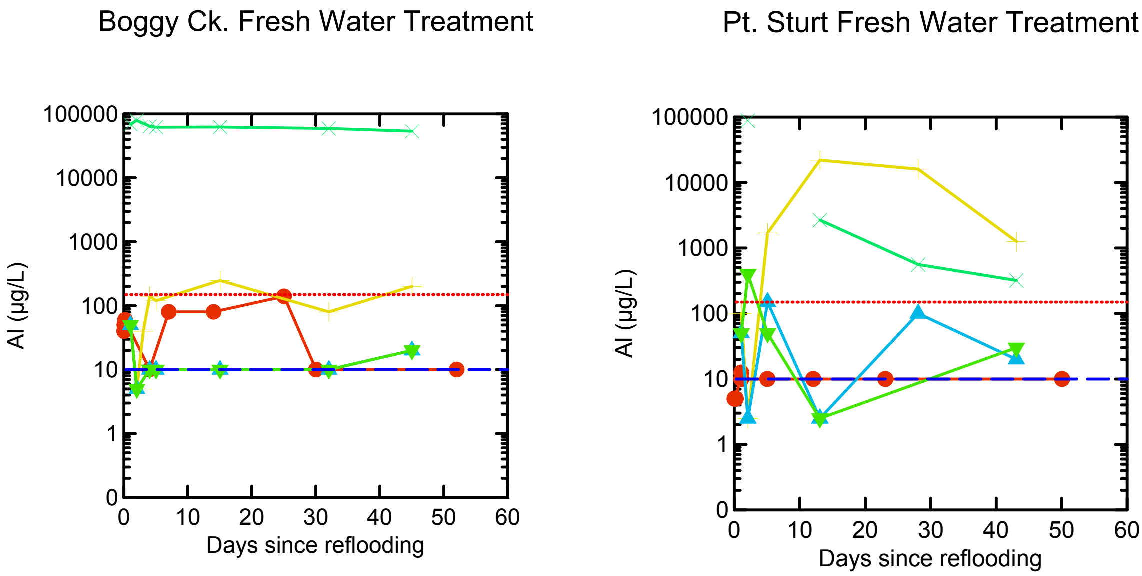


Figure 36 Aluminium. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, ∆= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination; in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Only low reliability values are available for sea water and have not been presented. WQ values for pH>6.5 have been used.

4.8.2.5 Arsenic

There are no exceedances for arsenic in either surface or pore waters.

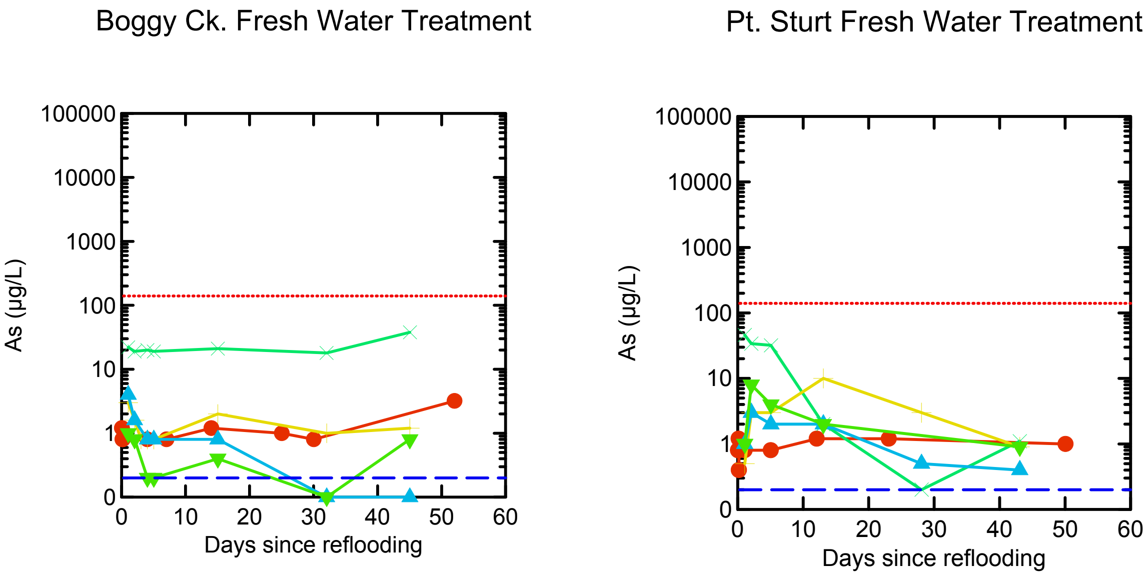


Figure 37 Arsenic. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Only low reliability values are available for sea water and have not been presented. Analyses are for total As and WQ values for As(V) have been used.

4.8.2.6 Boron

There are no exceedances for surface water from either treatment.
Concentrations of boron were around or slightly in excess of guideline values in the pore waters of both sites. However concentrations are around the recommended values for a range of plant species and below the concentrations where plant boron toxicity is of concern (Bell 1999).

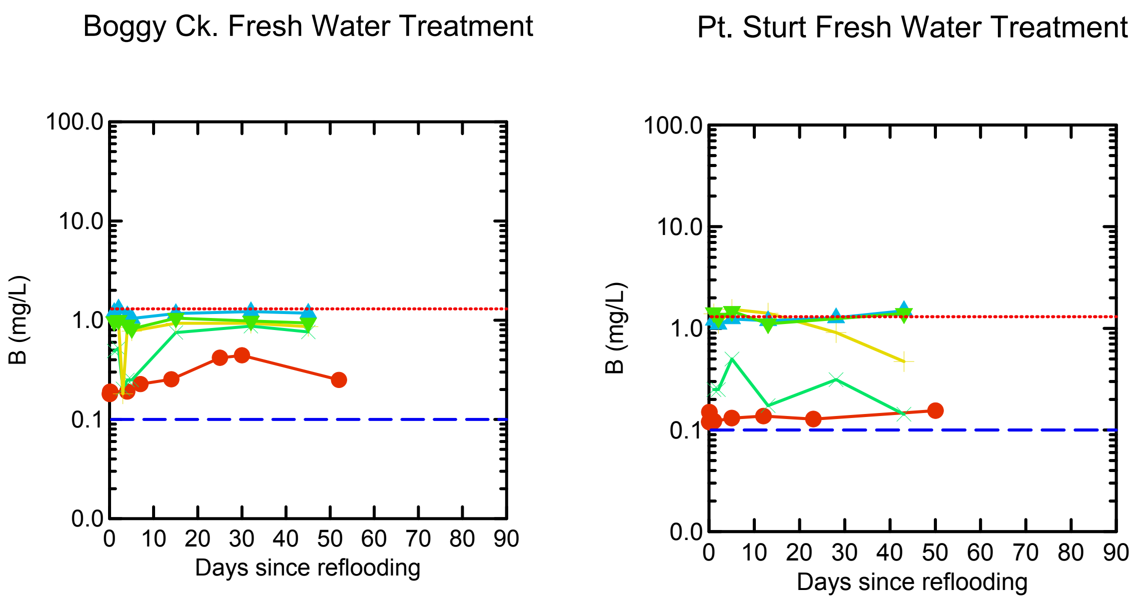


Figure 38 Boron. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.7 Cadmium

There are no exceedances for surface water from either treatment.

There was a small initial exceedance for cadmium in the Point Sturt pore water from 0.2 m bgl for the freshwater treatment.

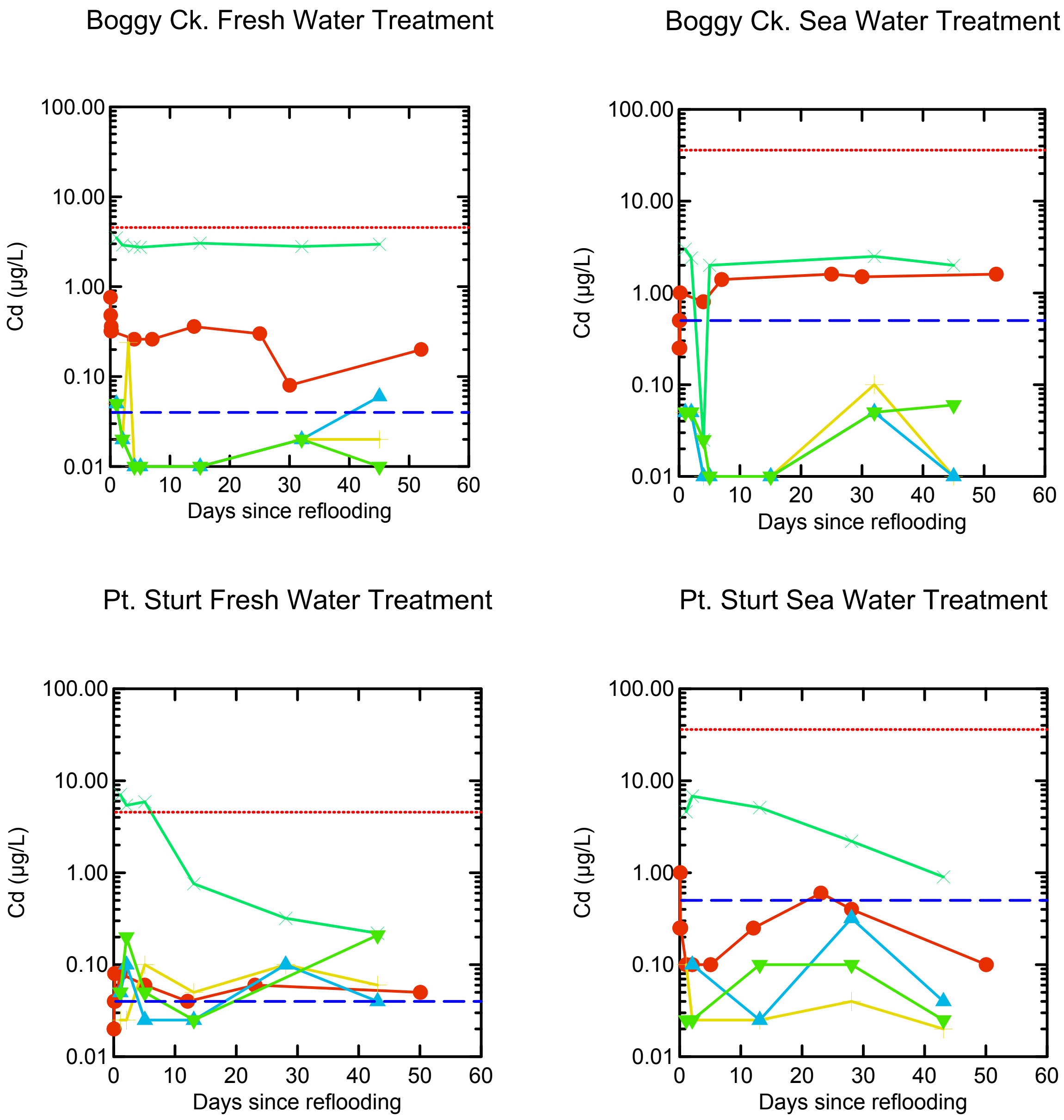


Figure 39 Cadmium. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.8 Cobalt

There are no exceedances for surface water from either site.
There are small exceedances in pore water from 0.2 m bgl at both Boggy Creek and Point Sturt. Concentrations at Point Sturt are decreasing as the pH of the pore water at 0.2 m bgl increases.

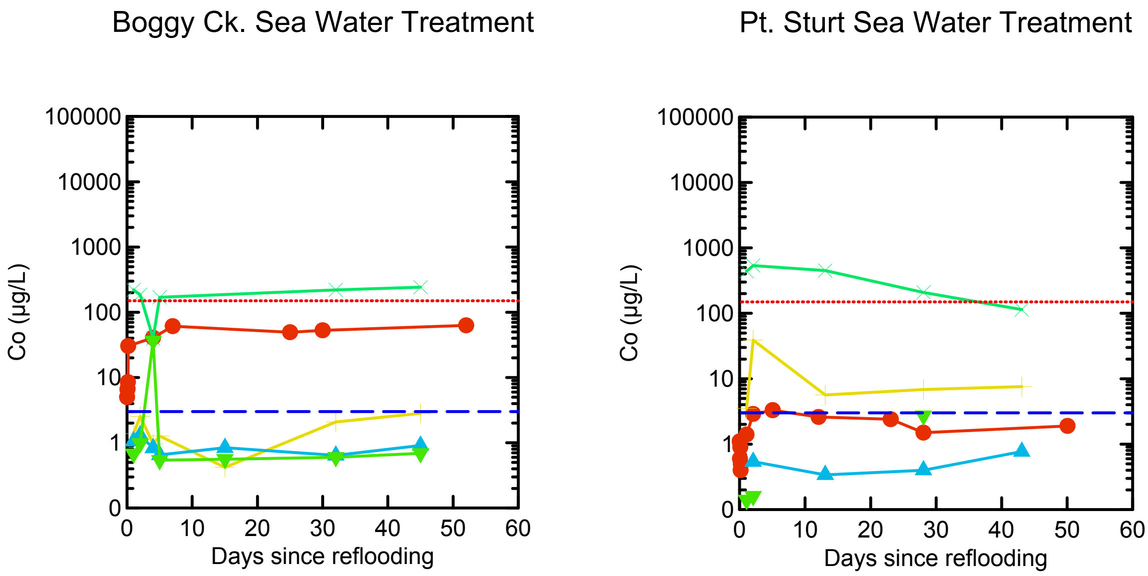


Figure 40 Cobalt. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Only low reliability values are available for fresh water and have not been presented.

4.8.2.9 Chromium

There are no exceedances for surface water from either site or treatment.

Chromium concentrations are slightly above guideline trigger values in pore waters at 0.2 m bgl for the Boggy Creek clay soil with a fresh water treatment and initially for both treatments for the sandy soil at Point Sturt. However over time the concentration at 0.2 m bgl has decreased with the downward advective flux, and concentrations at 0.5 m bgl, although increasing, did not reach the guideline trigger value.

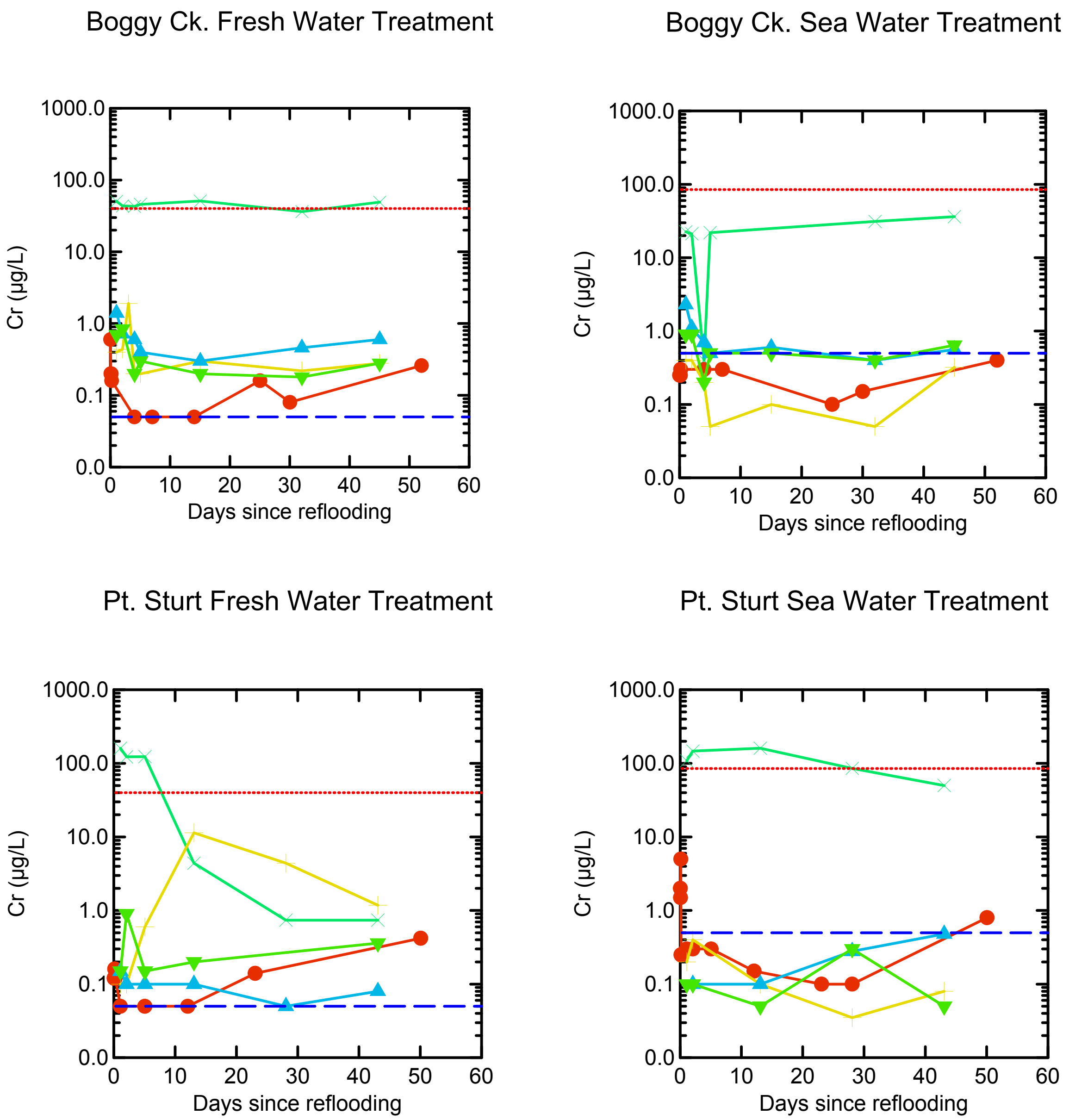


Figure 41 Chromium. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, ∆= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Where necessary, toxicant fresh water values have been corrected for hardness (extremely hard water). Analyses are for total Cr and WQ values for Cr(VI) have been used.

4.8.2.10 Copper

Copper intermittently exceeds the guideline trigger value in surface water for the seawater treatment at the Boggy Creek site.

Copper is several times the guideline trigger value in Boggy Creek pore water from 0.2 m bgl for both treatments. At Point Sturt the concentration in the pore water to 1.0 m bgl exceeds the guideline trigger value initially for the fresh water treatment and consistently by an order of magnitude for the sea water treatment.

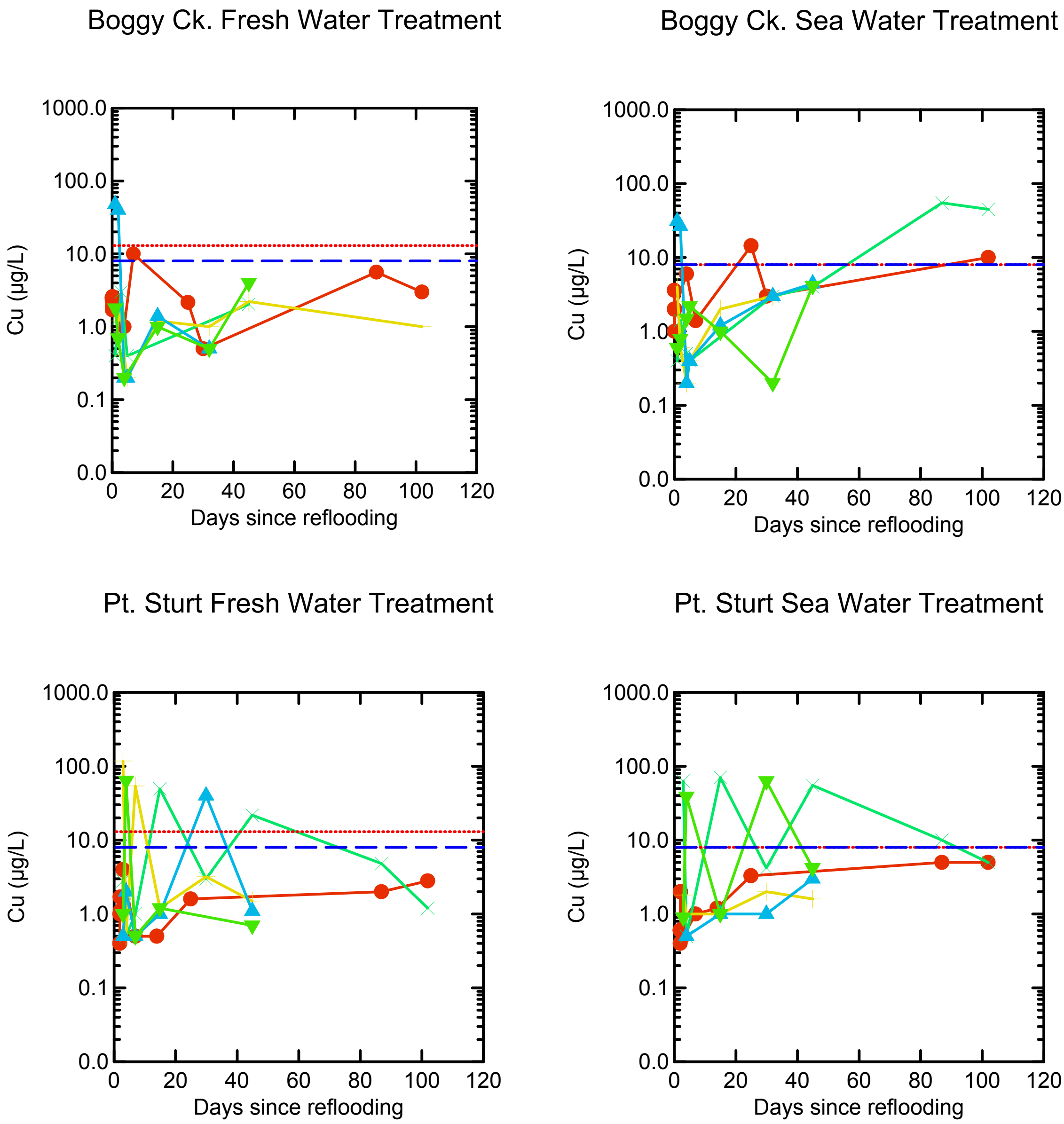


Figure 42 Copper. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the detection limit. The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Where necessary, toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.11 Manganese

Surface water concentrations are currently below the guideline trigger value for the Boggy Creek clay soil trial, albeit with an upward trajectory. Concentrations are below the guideline value for surface water from the Point Sturt sandy soil trial and are decreasing.

Manganese concentrations in pore water from 0.2 m bgl exceeds guideline trigger values for the Boggy Creek clay soil and surface water concentrations are increasing. At Point Sturt, concentrations have decreased at 0.2 m bgl and increased at 0.5 m bgl to be above the guideline trigger value for some of the period up to 50 days following the reflooding of the sediment.

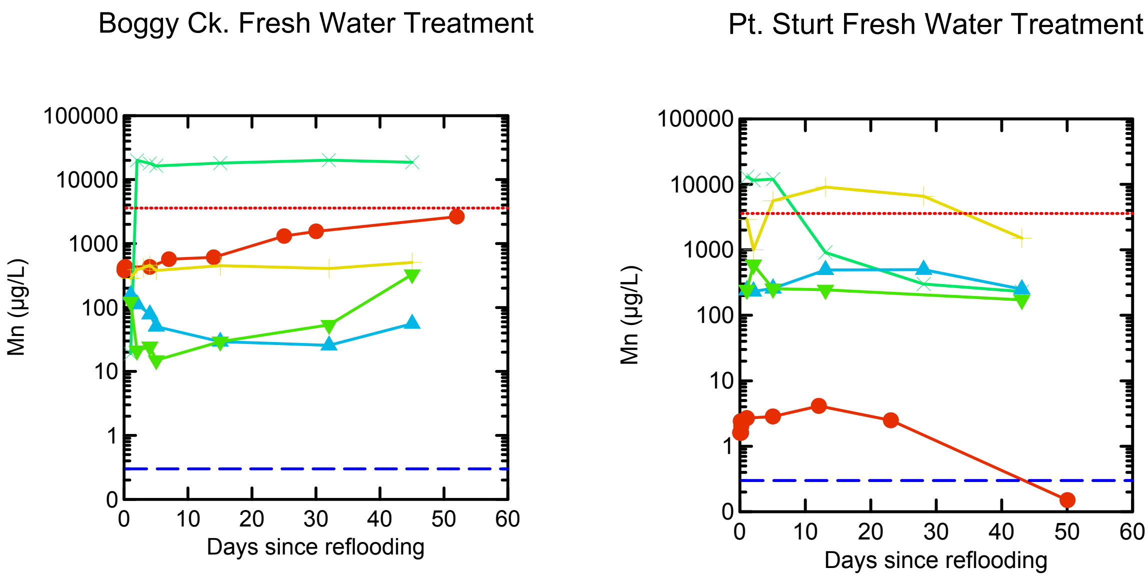


Figure 43 Manganese Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Only low reliability values are available for sea water and have not been presented.

4.8.2.12 Nickel

There were no exceedances in the surface water for either soil material or treatment.

In the pore water, nickel concentrations were in excess of guideline trigger values for the fresh water treatment, and are closely below but increasing for the sea water treatment for the clay soil at Boggy Creek. Point Sturt pore water concentrations from 0.2 m and 0.5 m bgl exceed guideline trigger values corresponding to the displacement of the pore water from 0.2 m bgl deeper into the soil profile.

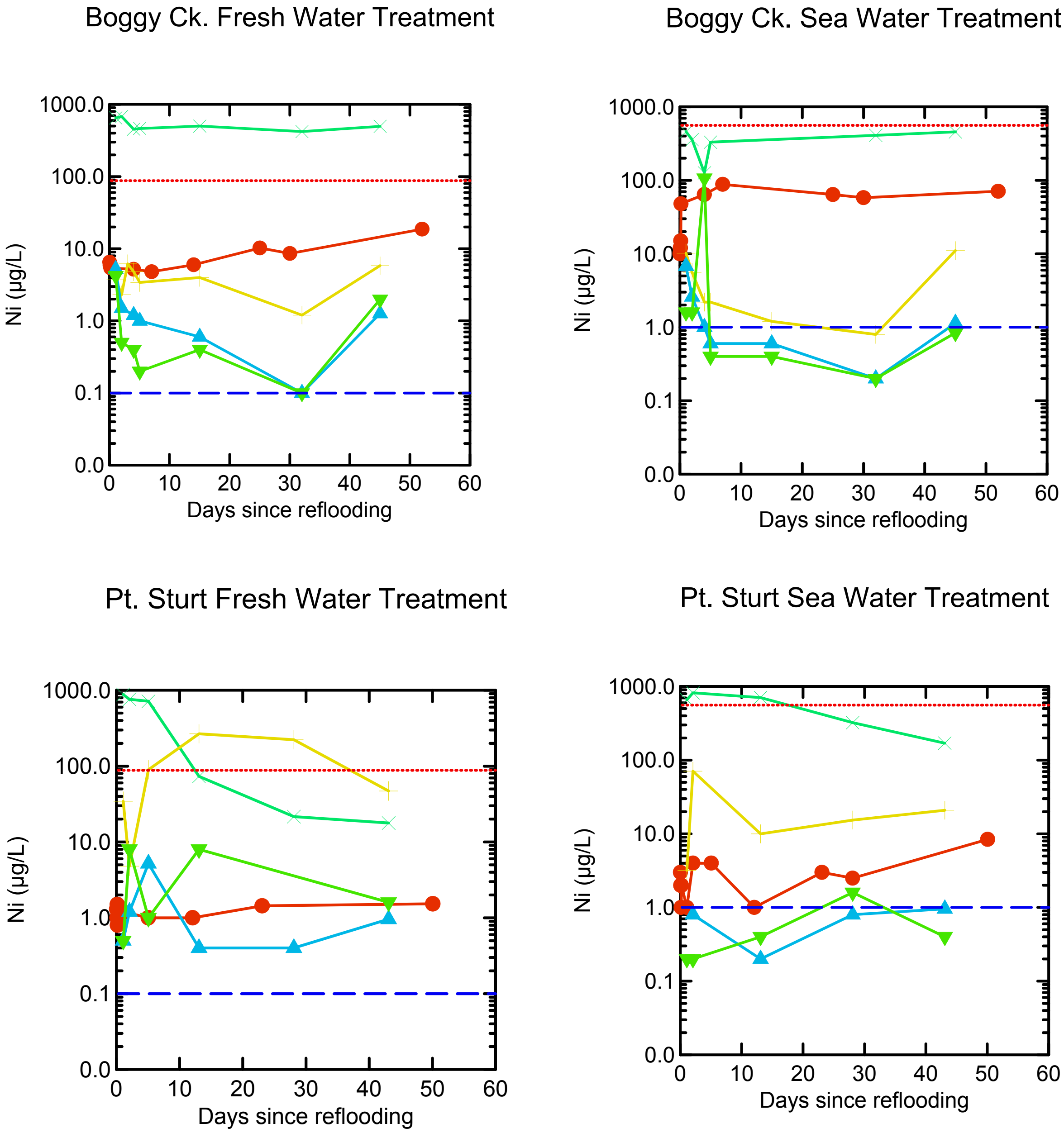


Figure 44 Nickel. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.13 Lead

There are no exceedances for lead in surface or pore water.

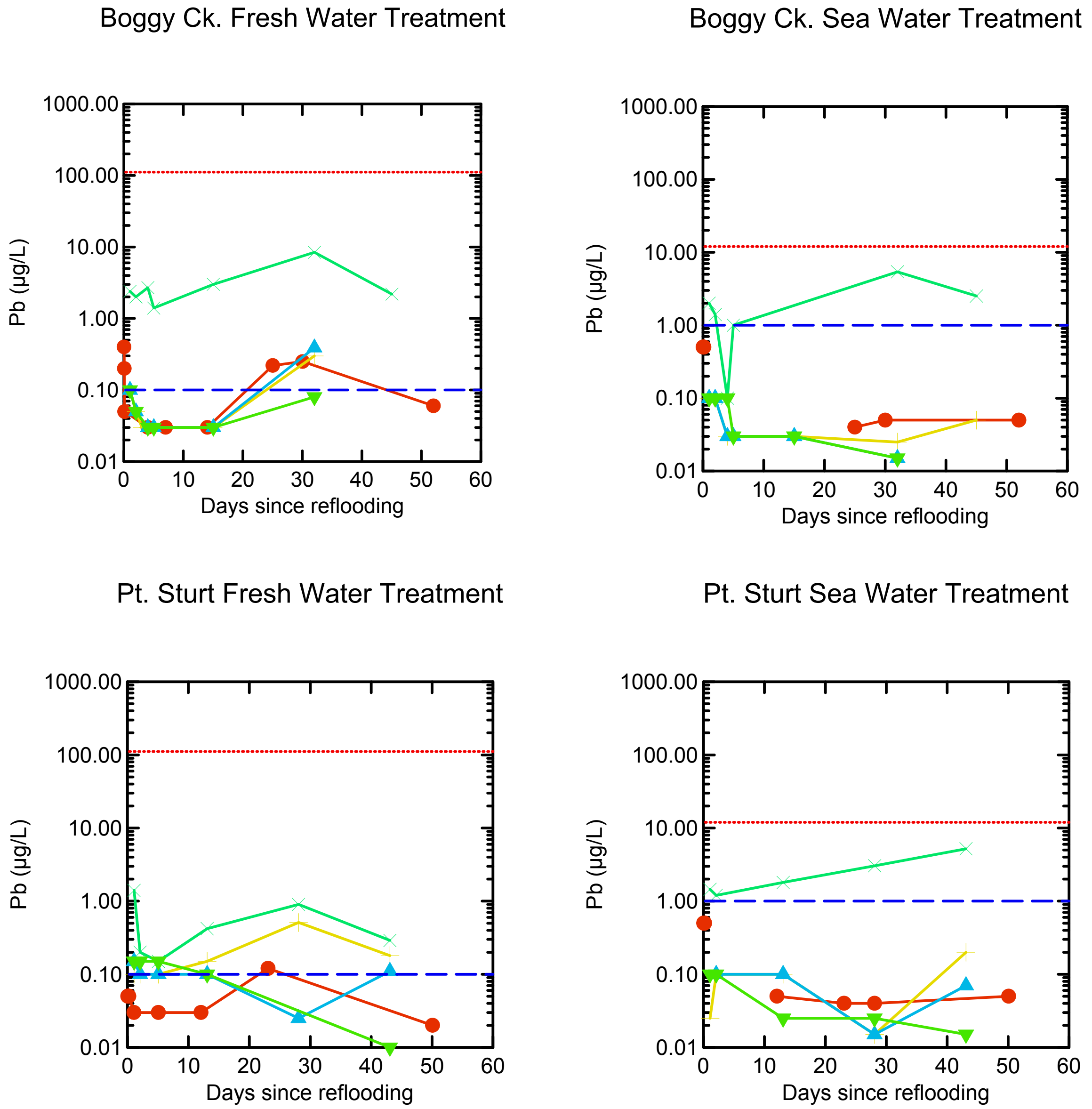


Figure 45 Lead. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.14 Selenium

There are no exceedances for selenium in either surface or pore water.

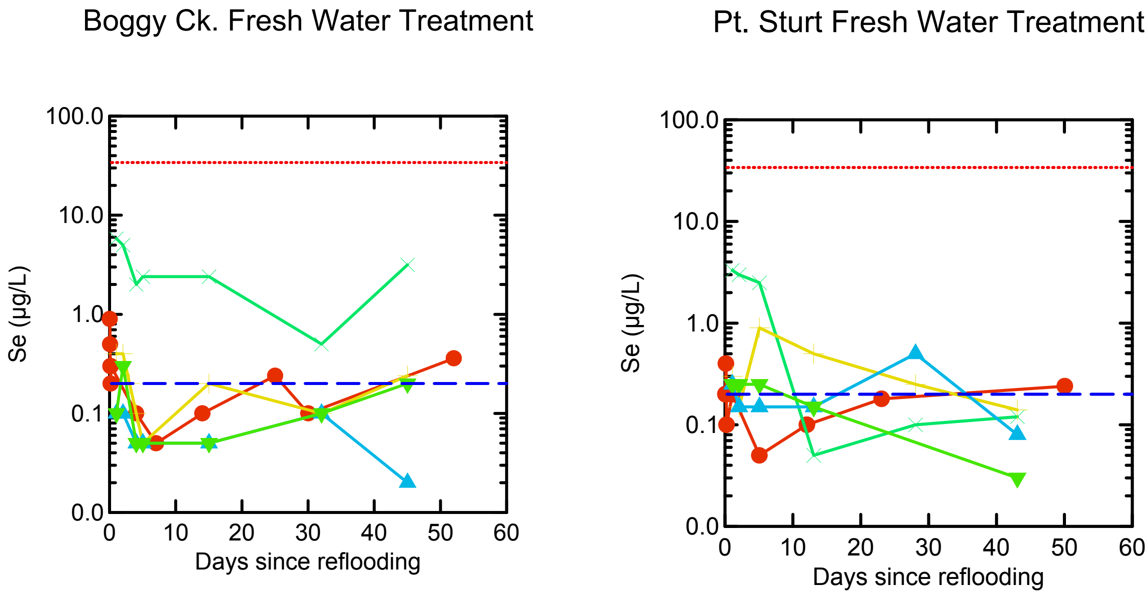


Figure 46 Selenium. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Only low reliability values are available for sea water and have not been presented. Analyses and WQ values for total Se have been used.

4.8.2.15 Zinc

Trigger values were exceeded for surface water in sea water treatments for both soil materials.

In pore water zinc exceeded guideline trigger values from various depths for both soil materials and treatments. Small exceedances for zinc need to be treated with caution however as zinc is a ubiquitous element and has numerous sources such as dust, plastics, and cosmetics. Consequently it is a difficult element to analyse as specialised clean techniques such as double gloving and bagging and sample filtration in laminar flow cabinets is required to prevent sample contamination. These facilities were not available for this work and blank values of around 60 µg/L were recorded.

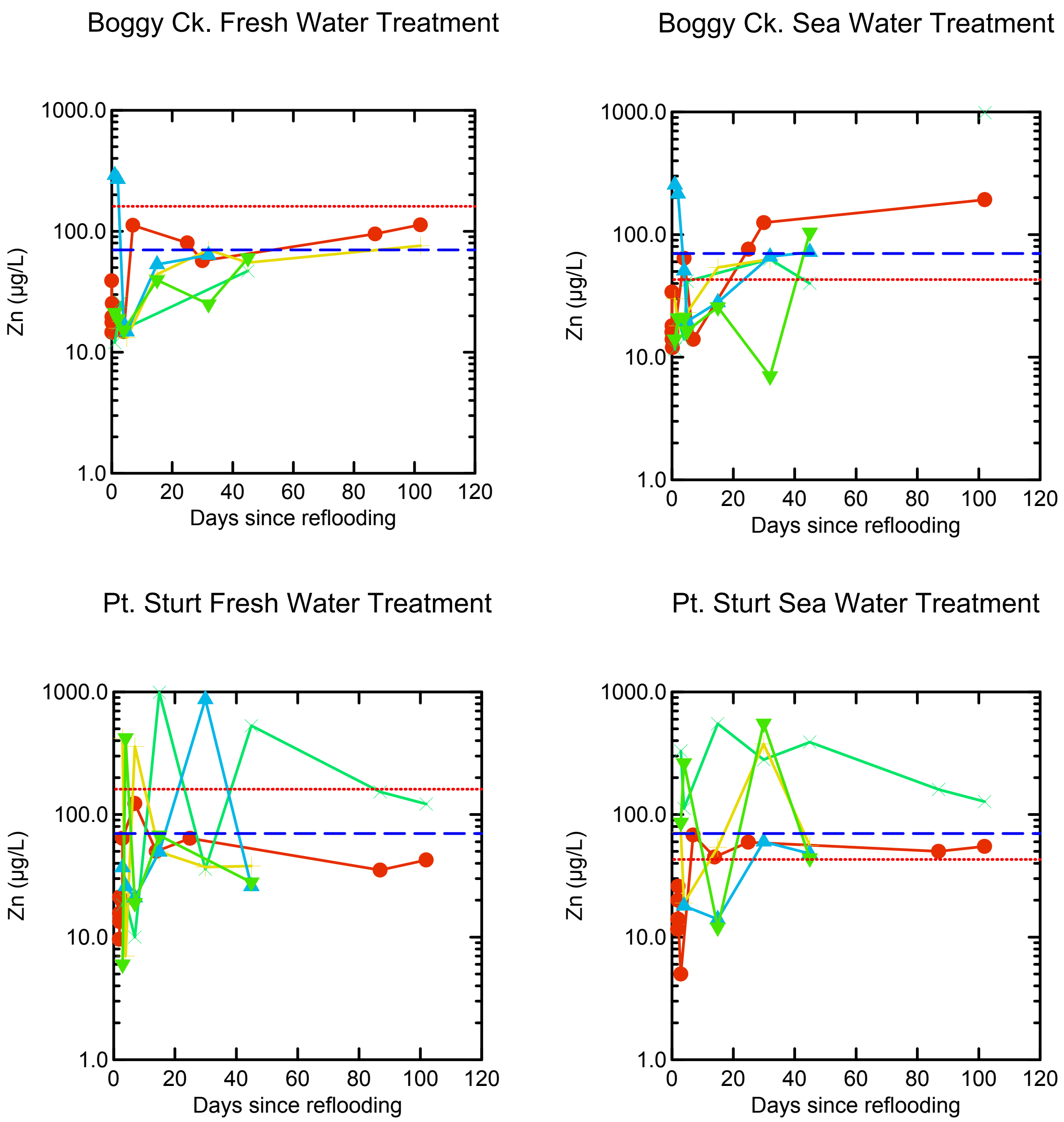


Figure 47 Zinc. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the detection. The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Toxicant fresh water values have been corrected for hardness (extremely hard water).

4.8.2.16 Vanadium

For the freshwater treatments vanadium in pore water from 0.2 m bgl exceeded guideline trigger values. In the case of the sandy soil at Point Sturt concentrations decreased. There were no exceedances for vanadium in either surface or pore water for the seawater treatments. However vanadium concentrations appear to be increasing in all but the pore water at 0.2 m bgl for the Point Sturt freshwater treatment.

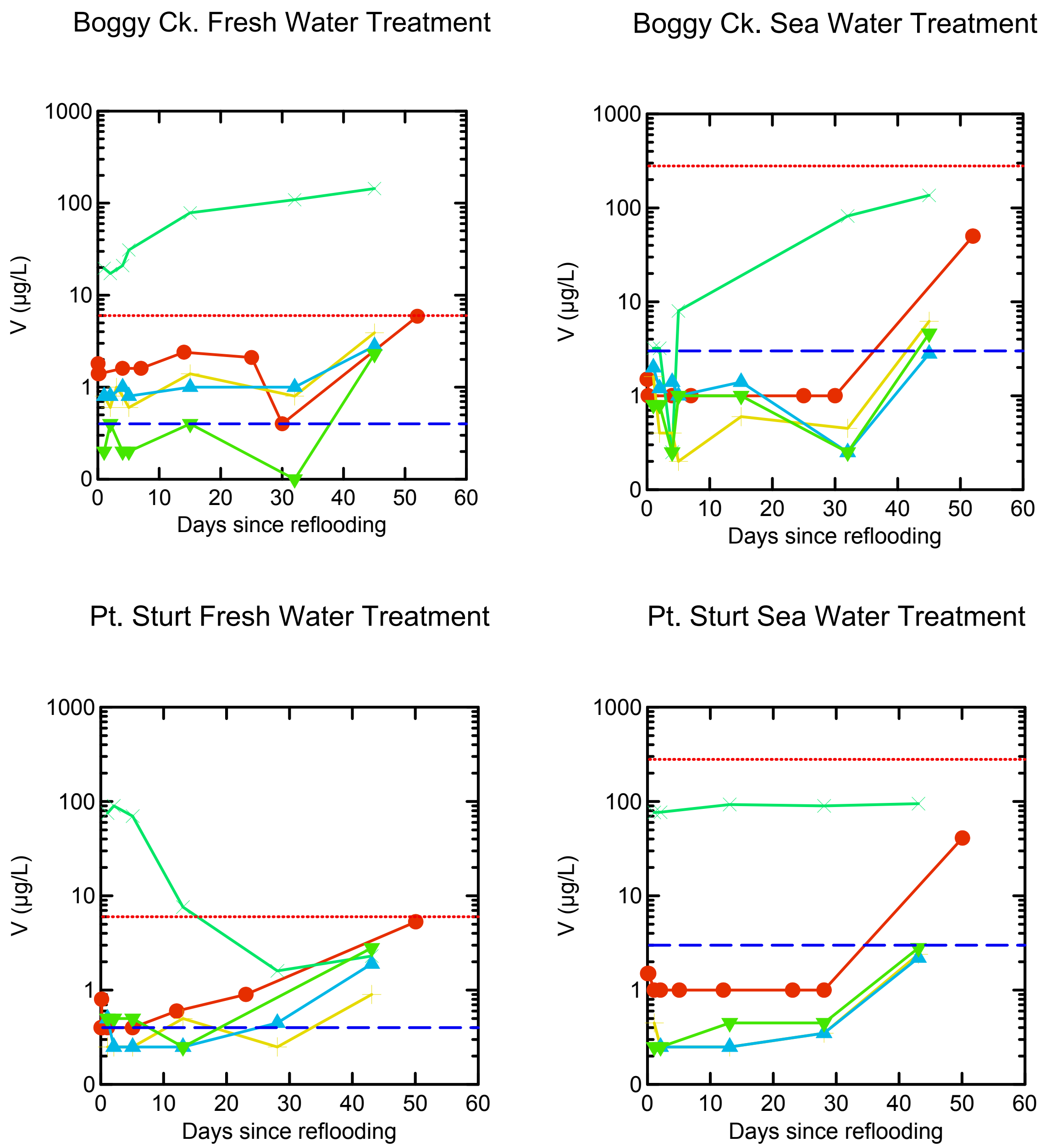


Figure 48 Vanadium. Surface Water = O, Pore Water: x = 0.2 m bgl, + = 0.5 m bgl, Δ= 1.0 m bgl ∇ = 1.5 m bgl. The blue dashed line represents the highest instrumental detection limit for the particular parameter-matrix combination however in some cases this may be lower depending on sample ionic strength (salinity). The red dotted line represents the relevant ANZECC and ARMCANZ WQ guideline trigger value for toxicants at the 80% protection level. Analyses were undertaken on <0.22 µm filtered samples. Where necessary, toxicant fresh water values have been corrected for hardness (extremely hard water). Only low reliability values are available for fresh water and have not been presented.

5 Conclusions

5.1 Project Objective

The project objective was to assess the potential for mobilisation of contaminants (acid, metals, metalloids, and nutrients) from acid sulfate soils in the Lower Lakes following rewetting with seawater or freshwater. We were able to make this assessment at the field scale and over time intervals of hours to months. However the duration of the first phase of the work was too short to capture the full range of geochemical conditions likely to be encountered.

The project was successful in attaining the various sub-objectives through:

i. Selecting representative sites and characterising the soil;
ii. Installing structures to contain water
iii. Monitoring soil and water conditions
    - Soil chemistry and geochemistry
    - Shallow groundwater levels
    - Soil moisture
    - Water chemistry;
iv. Measuring water and solute fluxes;
v. Assessing water quality;
vi. Investigating the application of a geochemical transport model novel to ASS application.

5.2 Potential for Mobilisation

When contaminants are mobilised it is useful to understand how they move, where they move and how much moves (the flux). When soil is rewet, the water enters the soil filling vacant pore spaces, displacing air and interacting with soil material and soil water. This results in a number of processes; minerals dissolve, surface exchange reactions occur and there is mixing of the soil water and the infiltrating water. This results in solute concentration gradients between the overlying water, the water in newly filled pores and the existing groundwater. The net flux of a solute is determined by the balance between advective transport in the water, in this case downward seepage due to the head of water, diffusion from high to low concentration (the direction can be different for different solutes) and any solid phase interactions. In areas of groundwater discharge the advective flow can be reversed i.e. from soil to overlying water.

The results of this project showed that rewetting with sea water results in a larger initial flux of acidity (acidic cations) for both soil materials. This was likely due to the displacement of adsorbed acid cations due to the 'sea-salt effect' at the soil-water interface, resulting in a higher initial flux due to the release of cations directly into the overlying water (third term in equation $F_{z=0} = F_d + F_a + F_s$ 5) and in the case of the clay soil a higher concentration gradient between pore water and overlying water, giving an increased diffusive flux (first term equation $F_{z=0} = F_d + F_a + F_s$ 5). The surface interaction term is difficult to quantify in models and flux calculations as both it and its components (actual and residual acidity) are poorly characterised.

After the initial rewetting, the contrasting texture of the soil materials provided contrasting acid fluxes. In the clay soil, the low seepage rate of 0.8 mm/day resulted in a net diffusive flux of acid (acidic cations) from the soil to the overlying water. In the sandy soil the seepage rate was an order-of-magnitude greater at 8 to 15 mm/day. This resulted in a net downward advective flux of overlying water plus solutes. This moved as a piston front‡ transporting the acidic pore water deeper into the soil profile. There was no evidence of neutralisation of displaced acidic pore water by interaction with neutralising material in the soil profile.

The observed piston flow for the sandy material at Point Sturt is unlikely to be an artefact of the experiment design because the groundwater remained above the bottom of the mesocosm walls at 0.5 m bgl or higher (Figure 15) throughout the period covered by this report. Therefore enhanced vertical flow due to lateral water loss did not occur. Additionally, for a fully reflooded lake the vertical flow component will be the dominant control. Therefore the experiment provided a good one-

‡ A simulation of soil rewetting can be seen in a CSIRO vodcast at http://www.youtube.com/watch?v=xb4DAJNbSE4, piston flow and the piston front that occurs when water flows in an already wet soil profile and can be seen around 6 min into the vodcast.

dimensional representation of rewetting and surface-pore water interactions for Lower Lakes sandy soil materials.

In the case of the clay soil, the long term acid flux was similar for both the sea water and fresh water rewetting and it appears that they will reach similar end points. However the greater initial flux for sea water may be a significant difference between sea water and fresh water because of enhanced contaminant mobilisation during periodic seiching events.

Our experiment design allowed us to quantify fluxes of water and solutes at the field scale and on time scales of hours to months. In analysing data we focussed on acidity and its components, hydrogen, aluminium, iron and manganese ions. Chloride:sulfate ion ratios were used as a tracer for water movement. We also assessed the impact of mobilisation on water quality.

Following the rewetting of the ASS, precipitates were observed in all tanks and treatments due to the interaction of the pH~8 water with the acidic ASS oxidation products. Many of these precipitates were expected to redissolve following acidification (dissolution of iron and aluminium minerals) or the onset of reducing conditions (reduction of iron minerals). Due to the short duration of this initial study we were unable to determine the effect of the observed acidification (Figure 22) on overlying water quality as the overlying water remained circum-neutral for the period where detailed water analyses where carried out. Similarly samples that track the changes in water chemistry due to the decrease in redox potential from strongly oxidising to reducing (Figure 19and Figure 20) have not been analysed.

A mass balance of the acidity in the soil profiles shows that a single charge of water to any achievable depth will be insufficient to neutralise stored soil profile acidity even for a site such as Point Sturt where the intensity of acidity is high (i.e. the pH is low) but the quantity relatively low. While there is likely to be exchange and mixing (e.g. from seiching) that will provide additional alkalinity, as well as longer term processes such as metal reduction (e.g. iron and manganese) and pyrite formation it is possible that sections of the lake will have poor exchange and be at risk of acidification on initial rewetting. This has implications for water management under rewetting conditions.

5.2.1 Water quality

5.2.1.1 Point Sturt Sandy Soil Material

The chemistry of the surface water is that of the supply water (as modified by evapoconcentration). There was a short term exceedance of the guideline trigger values (ANZECC and ARMCANZ 2000) for copper. The acid pore water from the freshwater treatment exceeded guideline trigger values (ANZECC and ARMCANZ 2000) for the protection of aquatic ecosystems at the 80th percentile for aluminium, boron, cadmium, chromium, copper, manganese, nickel, and zinc. The acid pore water from the seawater treatment exceeded guideline trigger values (ANZECC and ARMCANZ 2000) for the protection of aquatic ecosystems at the 80th percentile for total ammonia-N, cobalt, copper, nickel, and zinc.

The trigger values for physical and chemical stressors are exceeded for both surface and pore water for nutrients (NH_4-N, NO_x-N and PO_4-P). This may result in algal blooms and enhanced rates of MBO formation.

5.2.1.2 Boggy Creek Clay Soil Material

The acid pore water for the freshwater treatment on the clay soil at Boggy Creek exceeds guideline trigger values (ANZECC and ARMCANZ 2000) for the protection of aquatic ecosystems at the 80th percentile for total ammonia-N, aluminium, chromium, copper, manganese, nickel and zinc. The trigger values for physical and chemical stressors are exceeded for the surface (NH4-N, NOx-N and PO4-P) and pore waters (pH, NH4-N and PO4-P). This may result in algal blooms and enhanced rates of MBO formation.

The surface water of the seawater treatment on the clay soil at Boggy Creek exceeds guideline trigger values (ANZECC and ARMCANZ 2000) for the protection of aquatic ecosystems at the 80th percentile for total ammonia-N, copper and zinc. The acid pore water exceeds guideline trigger values (ANZECC and ARMCANZ 2000) for the protection of aquatic ecosystems at the 80th percentile for total ammonia-N, cobalt, copper and zinc.

5.2.2 Modelling (LEACHM)

Exploratory model runs indicate it is possible to adapt the LEACHM model for ASS (Appendix 5 Modelling), including the incorporation of soil–water exchange reactions and the effect of different ionic strength water. Notional solute profiles based on those experienced at the sites were generated and with further work these could be converted into predictive models for acid transport. The deployment of the soil moisture probes was successful and these will be able to provide data for the modelling studies.

6 Knowledge gaps

The short duration of the initial experiment means that some significant physio-chemical transformations fell outside the period covered by this report and data on their effect on water quality was not available for inclusion in this report. These transformations include the exhaustion of alkalinity and the onset of acid conditions in the water column, as well as the establishment of reducing conditions. Both these events will result in major changes to the geochemistry of the system including dissolution of precipitates and release of co-precipitated toxicants to the water column. It is important the effect on water quality of these events be incorporated into the management of any ASS rewetting events either planned or through natural occurrences. Monitoring these transformations will provide important information for modelling ASS rewetting events and for the risk evaluation of various management options.

Additional work to determine if the displacement and dissolution reactions that appear to occur on initial rewetting can be modelled in the Phreeqc program (Parkhurst and Appelo 1999) is worth pursuing. Synthesising the information provided by the laboratory studies and the field experiment is likely to provide better understanding of the processes.

Further work is required to incorporate the information obtained so far into conceptual models of rewetting and hydro-toposequences. Similarly notional flux profiles generated using the program LEACHM (Hutson 2003)could be matched with the experimental data and LEACHM used for predicting surface water–soil–pore water interactions.

7 References

Ahern CR, McElnea AE, Sullivan LA (2004) Acid sulfate soils laboratory methods guidelines. In *Queensland Acid Sulfate Soils Manual 2004*. Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia. http://www.nrw.qld.gov.au/land/ass/pdfs/lmg.pdf

Anderson, R.F. and Schiff, S.L. (1987). Alkalinity generation and the fate of sulfur in lake sediments. *Canadian Journal of Fisheries and Aquatic Sciences* **44**, 188–193.

ANZECC and ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy Paper No. 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra. http://www.mincos.gov.au/__data/assets/pdf_file/0019/316126/wqg-ch3.pdf

APHA (1995) 'Standard Methods for the Examination of Water and Wastewater.' 19th edn (American Public Health Association, American Water Works Association and Water Environment Federation: Washington, DC)

Appelo CAJ and Postma D. (2005) *Geochemistry, groundwater and pollution* (2nd edn) A.A. Balkema, Leiden, The Netherlands. p88.

Batley GE, Apte SC, Brockbank CI, Teasdale PR, and Yaru B (1993) *Application of sediment peepers to the study of metal mobilisation from marine sediments*. Proceedings of 3rd Environmental Chemistry conference, Royal Australian Chemical Institute Paper 49A

Bell RW (1999) Boron. In 'Soil analysis: an interpretation manual'. (Eds KI Peverill, LA Sparrow DJ Reuter) (CSIRO Publishing, Collingwood, Australia.) pp 309–316.

Berner, R.A., 1984. Sedimentary pyrite formation: an update. Geochimica et Cosmochimica Acta, 48: 605-615.

Bigham JM and Nordstrom DK (2000) Iron and aluminium hydroxysulfates from acid sulfate waters. *Reviews in Mineralogy and Geochemistry* **40**, 351–403.

Bush RT, Fyfe D, Sullivan LA (2004) Occurrence and abundance of monosulfidic black ooze in coastal acid sulfate soil landscapes. *Australian Journal of Soil Research* **42**, 609–616.

Connell WE, Patrick WH (1968) Sulfate reduction in soil - effects of redox potential and ph. *Science* **159**, 86–87.

Cook FJ, Hicks W, Gardner EA, Carlin GD, Froggatt DW (2000b) Export of Acidity in Drainage Water from Acid Sulphate Soils. Marine *Pollution Bulletin* **41**, 319–326.

Dear, S.E., Moore, N.G., Dobos, S.K., Watling, K.M. and Ahern, C.R., 2002. Soil management guidelines. In 'Queensland Acid Sulfate Soil Technical Manual.' Department of Natural Resources and Mines, Indooroopilly, Queensland, Australia.

Dent D (1986) 'Acid sulphate soils: a baseline for research and development'. ILRI Publication No. 39 (International Institute for Land Reclamation and Improvement/ILRI: Wageningen, The Netherlands) 250 p.

Fitzpatrick, R.W., Fritsch, E. and Self, P.G., 1996. Interpretation of soil features produced by ancient and modern processes in degraded landscapes; V, Development of saline sulfidic features in non-tidal seepage areas. Geoderma, 69: 1-29.

Fitzpatrick RW and Shand P (2008) Inland Acid Sulfate Soils: Overview and conceptual models. In 'Inland Acid Sulfate Soil Systems Across Australia'. (Eds RW Fitzpatrick, P Shand). pp 6-74. (CRC LEME Open File Report No. 249 (Thematic Volume) CRC LEME, Perth, Australia.) (http://crcleme.org.au/ and http://www.clw.csiro.au/acidsulfatesoils/index.html)

Fitzpatrick RW, Marvanek SP, Shand P, Merry RH, Thomas M, Raven MD (2008a) Acid Sulfate Soil Maps of the River Murray below Blanchetown (Lock 1) and Lakes Alexandrina and Albert when water levels were at pre- drought and current drought conditions. *CSIRO Land and Water Science Report 12/08*. CSIRO, Adelaide, 10 p There are 2 versions of the report – one without maps as appendix and one with maps: http://www.clw.csiro.au/publications/science/2008/sr12-08_withmaps.pdf, http://www.clw.csiro.au/publications/science/2008/sr12-08_nomaps.pdf

Fitzpatrick Rob, Bernie Powell, and Steve Marvanek (2008b) Atlas of Australian Acid Sulfate Soils. *In Inland Acid Sulfate Soil Systems Across Australia* (Eds Rob Fitzpatrick and Paul Shand). pp 75-89. CRC LEME Open File Report No. 249. (Thematic Volume) CRC LEME, Perth, Australia.

Fitzpatrick RW, Shand P, Marvanek S, Merry RH, Thomas M, Simpson SL, Raven MD and McClure S, (2008c) Acid sulfate soils in subaqueous, waterlogged and drained soil environments in Lake Albert, Lake Alexandrina and River Murray below Blanchetown (Lock 1): properties, distribution, genesis, risks and management. Prepared for Department of Environment and Heritage, SA. *CSIRO Land and Water Science Report 46/08*. CSIRO, Adelaide, 167. pp. http://www.clw.csiro.au/publications/science/2008/sr46-08.pdf

Fitzpatrick RW, Shand P, Merry RH, Thomas B, Marvanek S, Creeper N, Thomas M, Raven MD, Simpson SL, McClure S, Jayalath N (2008d) Acid sulfate soils in the Coorong, Lake Alexandrina and Lake Albert: properties, distribution, genesis, risks and management of subaqueous, waterlogged and drained soil environments. Prepared for Department of Water, Environment, Heritage and Arts. CSIRO Land and Water Science Report 52/08. CSIRO, Adelaide, 177. pp. http://www.clw.csiro.au/publications/science/2008/sr52-08.pdf

Fitzpatrick RW, Shand P, Thomas M, Merry RH, Raven MD, Simpson SL (2008e) Acid sulfate soils in subaqueous, waterlogged and drained soil environments of nine wetlands below Blanchetown (Lock 1), South Australia: properties, genesis, risks and management. Prepared for South Australian Murray-Darling Basin Natural Resources Management Board. *CSIRO Land and Water Science Report 42/08*. CSIRO, Adelaide, 131. pp. http://www.clw.csiro.au/publications/science/2008/sr42-08.pdf

Grigg NJ, Webster IT, Ford PW (1999) Pore-Water Convection Induced by Peeper Emplacement in Saline Sediment. *Limnology and Oceanography* **44**, 425–430.

Harriman R, Wells DEW (1985) Causes and effects of surface water acidification in Scotland. *Water Pollution Control* **84**, 215–224.

Hutson JL (2003) LEACHM - A process-based model of water and solute movement, transformations, plant uptake and chemical reactions in the unsaturated zone, version 4. Department of Crop and Soil Sciences, Research Series No. R03-1, Cornell University, Ithaca, New York, March, 2003.

Isbell RF (1996) *The Australian soil classification system*. CSIRO, Publishing, Melbourne.

Jeffrey SJ, Carter JO, Moodie KB, Beswick AR (2001) Using spatial interpolation to construct a comprehensive archive of Australian climate data. *Environmental Modelling and Software* **16**, 309–330.

Krom MD and Berner RA (1980) The diffusion coefficients of sulfate, ammonium and phosphate in anoxic marine sediments. *Limnology and Oceanography* **25**, 327–337.

Manheim RT (1970) The diffusion of ions in unconsolidated sediments. *Earth and Planetary Science Letters* **9**, 307-309.

Mortimer RJG, Krom MD, Boyle DR, Nishri A (1999) Use of a high-resolution pore-water gel profiler to measure groundwater fluxes at an underwater saline seepage site in Lake Kinneret, Israel. *Limnology and Oceanography* **44**, 1802–1809.

Parkhurst, D.L. and Appelo, C.A.J., 1999, User's guide to PHREEQC (Version 2)—A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations: U.S. Geological Survey Water-Resources Investigations Report 99-4259, 310 p.

Pons, L.J., 1973. Outline of the genesis, characteristics, classification and improvement of acid sulphate soils, 'Acid Sulphate Soils'. Proceedings of the International Symposium on Acid Sulphate Soils Wageningen, The Netherlands, pp. 3-27.

Sullivan, L.A. et al., 2009. Modifications to the classification of acid sulfate soil materials, Southern Cross GeoScience Technical Report No. 309

Simpson, S.L., Apte, S.C. and Batley, G.E., 1998. Acid, Metal and Nutrient Mobilisation Following Rewetting of Acid Sulfate Soils in the Lower Murray, CSRIO Report Number CLW27/08.

Soil Survey Staff, 2003. Keys to soil taxonomy; ninth edition, 2003, United States Department of Agriculture.

Sparks DL and Jardine PM (1984) Comparison of kinetic equations to describe K-Ca exchange in pure and in mixed systems. *Soil Science* **138**,115-122.

Stumm W and Morgan JJ (1996) 'Aquatic Chemistry.' 3rd edn (Wiley, New York) p905.

Sullivan LA, Fitzpatrick RW, Bush RT, Burton ED, Shand P, Ward NJ, (2009) Modifications to the classification of acid sulfate soil materials. Southern Cross GeoScience Technical Report No. 309.

van Breemen N (1975) Acidification and deacidification of coastal plain soils as a result of periodic flooding. *Soil Science Society of America Proceedings* **39**, 1153–1157.

Vorenhout M, van der Geest HG, van Marum D, Wattel K, Eijsackers HJP (2004) Automated and Continuous Redox Potential Measurements in Soil. *Journal of Environmental Quality* **33**, 1562–1567.

8 Appendix 1 Site information

Table 14 Boggy Ck. GPS locations of tanks (WGS84, zone 54 south)

Tank ID	Easting	Northing
BCFW1	0311149	6065860
BCFW2	0311145	6065858
BCSW1	0311170	6065870
BCSW2	0311173	6065872
External	0311158	6065862

Table 15 Boggy Ck. piezometer elevations (m AHD)

Piezometer ID	Top of pipe	Ground surface
BCFWP1	0.94	-0.07
BCFWP2	0.89	-0.12
BCFWP3	0.86	-0.15
BCFWP6	0.84	-0.19
BCFWP7	0.83	-0.20
BCFWP8	0.66	-0.36
BCSWP1	0.95	-0.05
BCSWP2	0.85	-0.18
BCSWP3	0.79	-0.23
BCSWP6	0.77	-0.26
BCSWP7	0.76	-0.27
BCSWP8	0.61	-0.43

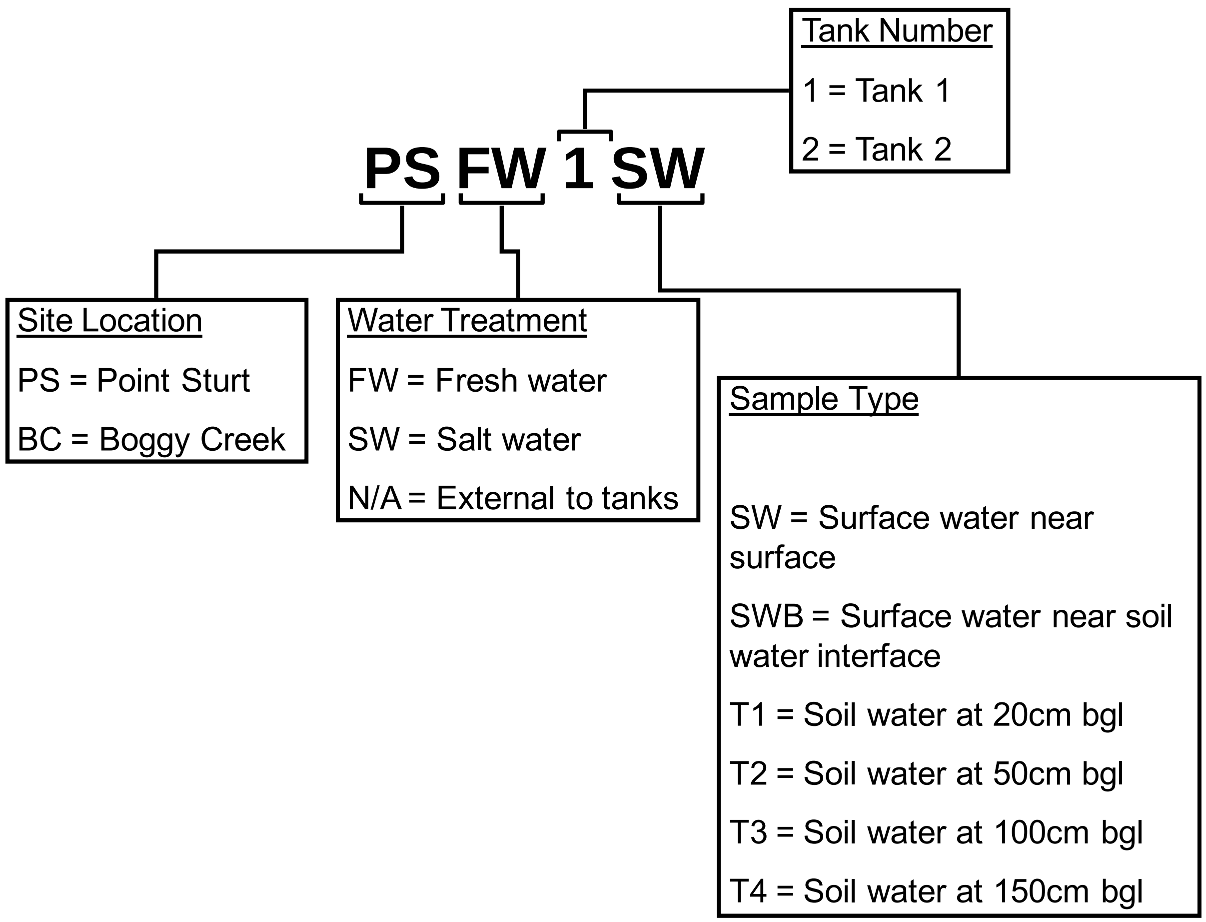
Table 16 Point Sturt GPS locations of tanks (WGS84, zone 54 south)

Tank ID	Easting	Northing
PSFW1	0314782	6069684
PSFW2	0314786	6069680
PSSW1	0314764	6069694
PSSW2	0314769	6069693
External	0314776	6069691

Table 17 Pt. Sturt piezometer elevations (m AHD)

Piezometer ID	Top of pipe	Ground surface
PSSWP1	1.03	-0.33
PSSWP2	0.93	-0.40
PSSWP3	0.93	-0.40
PSSWP6	0.92	-0.39
PSSWP7	0.94	-0.41
PSSWP8	0.94	-0.39
PSFWP1	0.99	-0.35
PSFWP2	1.01	-0.36
PSFWP3	0.96	-0.37
PSFWP6	1.02	-0.36
PSFWP7	1.06	-0.37
PSFWP8	0.91	-0.36

9 Appendix 2 Water sample coding



10 Appendix 3 Water analyses

Table 18 Data used to calculate acidity flux rates for soil - surface water interactions.

Sample ID	Date	Day since filling	Seepage (mm)	Evaporation (mm)	Rainfall (mm)	pH	Alkalinity (mol HCO_3^-/m^3)	Acidity (mol HCO_3^-/m^3)	ΔAlkalinity (mol HCO_3^-/m^3)	Acidity flux (mol H^+/m^2/day)
Freshwater (R Murray at Wellington)							1.47			
Seawater (Mundoo Is Barrage)							2.28			
BCFW1SW	20/7/2009	0.24				7.7	1.41	0.00	–0.06	0.159
BCFW1SW	24/7/2009	4	0.8	2.3	2.5	7.7	1.41	0.00	–0.06	0.003
BCFW1SW	27/7/2009	7	0.8	1.6	0.7	7.8	1.40	0.00	–0.07	0.004
BCFW1SW	3/8/2009	14	0.8	1.5	1.1	8.0	1.35	0.00	–0.12	0.006
BCFW1SW	14/8/2009	25	0.8	2.1	0.5	7.6	1.20	0.00	–0.27	0.009
BCFW1SW	19/8/2009	30	0.8	3.5	1.8	7.4	1.22	0.00	–0.25	0.000
BCFW1SW	10/9/2009	52	0.8	2.7	1.3	7.1	1.06	0.00	–0.41	0.006
BCFW1SW	21/9/2009	63	0.8	3.5	0.7	7.0	0.80	0.00	–0.67	0.015
BCFW1SW	15/10/2009	87	0.8	3.4	3.0	6.2	0.32	0.00	–1.15	0.013
BCFW1SW	30/10/2009	102	0.8	4.6	1.5	5.6	0.12	n.r.	–1.35	0.009
BCFW2SW	20/7/2009	0.24				8.0	1.41	0.00	–0.06	0.164
BCFW2SW	24/7/2009	4	0.8	2.3	2.5	7.7	1.42	0.00	–0.05	0.007
BCFW2SW	27/7/2009	7	0.8	1.6	0.7	7.8	1.37	0.00	–0.10	0.004
BCFW2SW	3/8/2009	14	0.8	1.5	1.1	7.7	1.32	0.00	–0.15	0.006
BCFW2SW	14/8/2009	25	0.8	2.1	0.5	7.7	1.17	0.00	–0.30	0.009
BCFW2SW	19/8/2009	30	0.8	3.5	1.8	7.1	1.05	0.00	–0.42	0.015
BCFW2SW	10/9/2009	52	0.8	2.7	1.3	7.1	0.87	0.00	–0.60	0.007
BCFW2SW	21/9/2009	63	0.8	3.5	0.7	6.9	0.58	0.00	–0.89	0.016
BCFW2SW	15/10/2009	87	0.8	3.4	3.0	6.3	0.25	0.00	–1.22	0.010
BCFW2SW	30/10/2009	102	0.8	4.6	1.5	5.6	0.11	n.r.	–1.36	0.008
BCSW1SW	20/7/2009	0.20				7.6	2.08	0.00	–0.20	0.486
BCSW1SW	24/7/2009	4	0.8	2.3	2.5	7.2	1.61	0.00	–0.67	0.067
BCSW1SW	27/7/2009	7	0.8	1.6	0.7	7.3	1.36	0.00	–0.92	0.045
BCSW1SW	3/8/2009	14	0.8	1.5	1.1	7.1	1.04	0.00	–1.24	0.027
BCSW1SW	14/8/2009	25	0.8	2.1	0.5	7.2	0.67	0.00	–1.61	0.021
BCSW1SW	19/8/2009	30	0.8	3.5	1.8	7.4	0.60	0.00	–1.68	0.012
BCSW1SW	10/9/2009	52	0.8	2.7	1.3	6.4	0.31	0.00	–1.97	0.011
BCSW1SW	21/9/2009	63	0.8	3.5	0.7	6.1	0.25	0.00	–2.03	0.008
BCSW1SW	30/10/2009	102	0.8	3.8	2.4	6.1	0.25	0.00	–2.03	0.005

§ n.r. = no result

Table 18 (continued)

Sample ID	Date	Day since filling	Seepage (mm)	Evaporation (mm)	Rainfall (mm)	pH	Alkalinity (mol HCO_3^-/m^3)	Acidity (mol HCO_3^-/m^3)	ΔAlkalinity (mol HCO_3^-/m^3)	Acidity flux (mol H^+/m^2/day)
BCSW2SW	20/7/2009	0.21				7.5	2.05	0.00	–0.23	0.579
BCSW2SW	23/7/2009	3				7.2	1.40	0.00	–0.88	0.119
BCSW2SW	24/7/2009	4	0.8	2.3	2.5	7.1	1.36	0.00	–0.92	0.020
BCSW2SW	27/7/2009	7	0.8	1.6	0.7	7.2	0.93	0.38	–1.35	0.076
BCSW2SW	3/8/2009	14	0.8	1.5	1.1	6.8	0.42	0.35	–1.86	0.039
BCSW2SW	14/8/2009	25	0.8	2.1	0.5	5.3	0.07	0.53	–2.21	0.021
BCSW2SW	19/8/2009	30	0.8	3.5	1.8	5.0	0.05	0.70	–2.23	0.007
BCSW2SW	10/9/2009	52	0.8	2.7	1.3	4.6	0.00	0.55	–2.28	0.016
BCSW2SW	21/9/2009	63	0.8	3.5	0.7	3.9	0.00	1.61	–2.28	0.057
BCSW2SW	30/10/2009	102	0.8	3.8	2.4	3.6	0.00	3.43	–2.28	0.029
BCSW1SWB	20/7/2009	0.17				7.6	2.12	0.00	–0.16	0.498
BCSW1SWB	3/8/2009	14	0.8	1.8	1.5	7.3	1.03	0.00	–1.25	0.043
BCSW1SWB	14/8/2009	25	0.8	2.1	0.5	7.2	0.63	0.00	–1.65	0.023
BCSW1SWB	19/8/2009	30	0.8	3.5	1.8	7.1	0.55	0.00	–1.73	0.013
BCSW1SWB	10/9/2009	52	0.8	2.7	1.3	6.5	0.34	0.00	–1.95	0.009
PSFW1SW	22/7/2009	0.17				7.9	1.43	0.00	–0.04	0.129
PSFW1SW	27/7/2009	5	15	2	2	7.9	1.39	0.00	–0.08	0.023
PSFW1SW	3/8/2009	12	15	2	1	8.5	1.41	0.00	–0.06	0.012
PSFW1SW	14/8/2009	23	15	3	1	8.4	1.46	0.00	–0.01	0.012
PSFW1SW	10/9/2009	50	15	3	2	8.2	1.28	0.00	–0.19	0.018
PSFW1SW	21/9/2009	61	15	3	1	7.8	1.70	0.00	0.23	–0.006
PSFW1SW	15/10/2009	85	15	3	4	8.4	1.99	0.00	0.52	0.005
PSFW1SW	30/10/2009	100	15	5	1	8.5	2.35	0.00	0.88	–0.004
PSFW2SW	22/7/2009	0.17				7.8	1.42	0.00	–0.05	0.147
PSFW2SW	23/7/2009	1				7.3	1.49	0.00	0.02	–0.029
PSFW2SW	27/7/2009	5	15	2	2	7.9	1.42	0.00	–0.05	0.023
PSFW2SW	3/8/2009	12	15	2	1	7.9	1.48	0.00	0.01	0.010
PSFW2SW	14/8/2009	23	15	3	1	8.4	1.46	0.00	–0.01	0.014
PSFW2SW	10/9/2009	50	15	3	2	7.7	1.56	0.00	0.09	0.012
PSFW2SW	21/9/2009	61	15	3	1	7.8	1.71	0.00	0.24	0.005
PSFW2SW	15/10/2009	85	15	3	4	7.3	2.22	0.00	0.75	–0.001
PSFW2SW	30/10/2009	100	15	5	1	8.5	2.35	0.00	0.88	0.003

§ n.r. = no result

Table 18 (continued)

Sample ID	Date	Day since filling	Seepage (mm)	Evaporation (mm)	Rainfall (mm)	pH	Alkalinity (mol HCO_3^-/m^3)	Acidity (mol HCO_3^-/m^3)	ΔAlkalinity (mol HCO_3^-/m^3)	Acidity flux (mol H^+/m^2/day)
PSSW1SW	22/7/2009	0.15				7.9	2.22	0.00	–0.06	0.138
PSSW1SW	23/7/2009	1				7.7	2.12	0.00	–0.16	0.077
PSSW1SW	24/7/2009	2				7.5	2.08	0.00	–0.20	0.034
PSSW1SW	27/7/2009	5	8	2	2	7.6	1.97	0.00	–0.31	0.034
PSSW1SW	3/8/2009	12	8	2	1	7.7	1.97	0.00	–0.31	0.015
PSSW1SW	14/8/2009	23	8	2	1	8.1	2.07	0.00	–0.21	0.010
PSSW1SW	19/8/2009	28	8	4	2	8.1	2.18	0.00	–0.10	0.003
PSSW1SW	10/9/2009	50	8	3	2	7.7	2.23	0.00	–0.05	0.013
PSSW1SW	21/9/2009	61	8	3	1	8.0	2.44	0.00	0.16	0.004
PSSW1SW	15/10/2009	85	8	3	4	7.9	3.00	0.00	0.72	0.000
PSSW1SW	30/10/2009	100	8	5	1	8.2	3.33	0.00	1.05	–0.001
PSSW2SW	22/7/2009	0.16				7.9	2.20	0.00	–0.08	0.247
PSSW2SW	23/7/2009	1				7.7	2.19	0.00	–0.09	0.025
PSSW2SW	24/7/2009	2				7.7	2.08	0.00	–0.20	0.066
PSSW2SW	27/7/2009	5	8	2	2	7.6	1.99	0.00	–0.29	0.030
PSSW2SW	3/8/2009	12	8	2	1	7.8	2.07	0.00	–0.21	0.009
PSSW2SW	14/8/2009	23	8	3	1	8.0	2.07	0.00	–0.21	0.014
PSSW2SW	10/9/2009	50	8	3	2	7.8	2.18	0.00	–0.11	0.013
PSSW2SW	21/9/2009	61	8	3	1	8.0	2.41	0.00	0.13	0.003
PSSW2SW	15/10/2009	85	8	3	4	7.9	3.00	0.00	0.72	0.000
PSSW2SW	30/10/2009	100	8	5	1	8.1	3.49	0.00	1.21	–0.007

§ n.r. = no result

Table 19 Guideline trigger values (mg/L) used in the water quality assessment. The colour coding has been applied in the following table (Table 20) to indicate which trigger value was used. Fresh water values for toxicants have been adjusted for very hard water.

			EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness $(CaCO_3)$	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
Physical & chemical stressors for South central Australia	Ecosystem																						
	Low land rivers			6.5–9				0.1	0.1	0.04											0.1		
	Lakes			6.5–9				0.025	0.1	0.01											0.025		
Toxicants	Freshw ater	Trigger value 80% protection	Low reliability value					6.56											1.3	0.3			
	Marine	Trigger value 80% protection						1.7											5.1				

Table 20 Major elements in surface and pore water. Concentrations are mg/L unless otherwise indicated. Water quality guideline exceedances are colour coded in accordance with the legend at the top of the table.

Sample ID	depth (m)	Date	EC	pH	Alkalinity	Acidity	Hardness	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
			(mS/cm)		meq/L	meq/L	($CaCO_3$)																
BCFWS (FW SUPPLY)		21/07/09	1.8	7.9	1.5	0.0	220	0.14	0.21	0.048	0.10	470	0.68	27	8.9	38	270	25	0.14		0.050	0.71	0.42
BCFWS (FW SUPPLY)		14/08/09	1.7	7.9	1.5	0.0	170				0.29	460	1.5	22	7.7	28	220	21	0.16		0.050	0.65	0.37
BCFW1SW	0.50	20/07/09	2.1	8.0	1.4	0.0	310							39	11	51	330	65	0.18		0.050	0.70	0.56
BCFW1SW	0.50	20/07/09	2.0	7.8	1.4	0.0	330	0.67	0.58	0.034	0.10	540	0.57	42	12	55	350	71	0.18		0.050	0.73	0.60
BCFW1SW	0.50	20/07/09	2.3	7.9	1.4	0.0	330							41	12	54	350	70	0.19		0.050	0.72	0.60
BCFW1SW	0.50	20/07/09	1.2	7.8	1.4	0.0	330	0.70	0.40	0.036	0.10	550	0.65	43	12	55	350	73	0.19		0.050	0.73	0.61
BCFW1SW	0.50	20/07/09	2.3	7.7	1.4	0.0	340							43	12	56	360	73	0.19		0.050	0.74	0.62
BCFW1SW	0.50	24/07/09	1.2	7.8	1.4	0.0	320	0.86	0.20	0.0082	0.26	570	1.5	42	12	53	310	78	0.19		0.050	0.68	0.58
BCFW1SW	0.50	27/07/09	1.2	7.8	1.4	0.0	380	0.73	0.16	0.012	0.24	590	1.6	51	14	62	350	95	0.23		0.050	0.78	0.68
BCFW1SW	0.50	03/08/09	1.4	8.0	1.4	0.0	410	0.65	0.14	0.0065	0.26	650	1.7	58	14	65	360	110	0.25		0.012	0.64	0.70
BCFW1SW	0.50	14/08/09	3.3	7.6	1.2	0.0	610	1.0	0.16	0.013	0.25	720	2.5	95	19	91	460	190	0.42		0.050	0.60	1.1
BCFW1SW	0.50	19/08/09	3.5	7.4	1.2	0.0	660	1.0	0.17	0.018	0.38	800	2.4	110	20	93	440	210	0.44		0.050	0.68	1.2
BCFW1SW	0.50	10/09/09	4.1	7.1	1.1	0.0	810	0.52	0.28	0.034	0.33	740	2.3	160	21	100	460	260	0.25	0.25	0.25	1.4	1.5
BCFW1SW	0.50	21/09/09	4.2	7.0	0.80	0.0																	
BCFW1SW	0.50	24/07/09	0.80	7.7	1.4	0.0	110	0.046	0.077	0.011	0.21	400	1.0	14	4.3	17	130	13	0.11		0.050	0.56	0.34
BCFW1SWB	0.05	20/07/09	1.3	7.8	1.4	0.0	340	0.73	0.40	0.034	0.10	550	0.68	44	12	56	360	77	0.19		0.050	0.74	0.62
BCFW1SWB	0.05	20/07/09	1.4	7.7	1.7	0.0	390	1.0	1.2	0.033	0.10	590	0.73	52	13	63	380	97	0.21		0.050	0.80	0.70
BCFW1SWB	0.05	03/08/09	2.0	7.4	1.0	0.0	810	1.7	0.12	0.010	0.27	780	2.0	130	20	120	460	280	0.49		0.018	0.89	1.3
BCFW1SWB	0.05	14/08/09	3.5	7.5	1.2	0.0	660	<0.005	0.16	0.017	0.25	740	2.4	110	20	95	460	220	0.47		0.050	0.81	1.2
BCFW1SWB	0.05	19/08/09	3.5	7.4	1.3	0.0	660	1.1	0.16	0.020	0.38	800	2.4	110	19	93	440	210	0.45		0.050	0.68	1.2
BCFW1SWB	0.05	10/09/09	3.8	7.1	1.1	1.0	800	0.46	0.29	0.033	0.34	740	2.3	150	21	100	450	250	0.25	0.25	0.25	1.4	1.5
BCFW2SW	0.50	20/07/09	1.8	7.8	1.4	0.0	290							37	11	49	320	56	0.17		0.050	0.70	0.55
BCFW2SW	0.50	20/07/09	1.2	7.8	1.4	0.0	290							38	11	49	320	58	0.17		0.050	0.70	0.56
BCFW2SW	0.50	20/07/09	2.1	7.8	1.4	0.0	300							38	11	49	330	58	0.17		0.050	0.71	0.57
BCFW2SW	0.50	20/07/09	2.1	7.8	1.4	0.0	300							39	11	49	320	59	0.17		0.050	0.72	0.57
BCFW2SW	0.50	20/07/09	2.1	8.0	1.4	0.0	290							37	12	47	310	61	1.3		1.3	0.63	0.63
BCFW2SW	0.50	24/07/09	1.1	7.7	1.4	0.0																	
BCFW2SW	0.50	27/07/09	1.2	7.8	1.4	0.0																	
BCFW2SW	0.50	03/08/09	1.3	7.7	1.3	0.0																	
BCFW2SW	0.50	14/08/09	2.9	7.7	1.2	0.0																	
BCFW2SW	0.50	19/08/09	3.0	7.1	1.0	0.0																	
BCFW2SW	0.50	10/09/09	3.2	7.1	0.87	0.0																	
BCFW2SW	0.50	21/09/09	3.5	6.9	0.58	0.0																	
BCFW2SW	0.50	24/07/09	0.79	7.7	1.4	0.0					0.21	450	1.2										
BCFW2SWB	0.05	20/07/09	1.2	7.7	1.4	0.0	300							39	11	49	320	60	0.17		0.050	0.69	0.56
BCFW2SWB	0.05	20/07/09	2.2	8.0	1.4	0.0	320							42	12	52	340	67	0.18		0.050	0.74	0.61

Table 20 (continued)

Sample ID	depth (m)	Date	EC	pH	Alkalinity	Acidity	Hardness	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
			(mS/cm)		meq/L	meq/L	($CaCO_3$)																
BCFW1T1	-0.20	21/07/09	13	3.0	0.0	12	3700	20	0.19	0.34	0.50	2700	2.9	540	80	570	1800	1500	0.49	11	0.25	51	5.8
BCFW1T1	-0.20	22/07/09	13	2.9	0.0	12	3900	20	0.17	0.34	0.50	2900	3.2	580	84	600	2000	1600	0.52	12	0.054	53	6.2
BCFW1T1	-0.20	23/07/09	2.6	7.7	1.4	0.0	350	0.85	0.17	0.0097	0.25	620	1.7	44	13	58	350	81	0.20	0.050	0.050	0.73	0.62
BCFW1T1	-0.20	24/07/09	12	3.0	0.0	12	3300	22	0.062	0.033	1.8	2700	6.7	480	74	520	1600	1400	0.25	13	0.25	49	5.3
BCFW1T1	-0.20	25/07/09	6.5	3.1	0.0	13	3200	17	0.039	0.057	1.3	2900	7.5	460	68	500	1600	1300	0.25	15	0.25	47	4.9
BCFW1T1	-0.20	04/08/09	8.2	3.1	0.0	12	3400	16	0.059	0.14	1.5	2800	7.2	500	73	530	1700	1400	0.75	37	0.25	50	5.3
BCFW1T1	-0.20	21/08/09	13	3.1	0.0		3500	18	0.0	1.2	2.0	3200	9.0	480	78	550	1800	1600	0.87	150	0.25	51	5.6
BCFW1T1	-0.20	03/09/09	13	3.2	0.0	15	3300				i.s.	i.s.	i.s.	470	73	510	1800	1500	0.76	160	0.36	49	5.1
BCFW1T1	-0.20	24/09/09	13	3.2	0.0	18																	
BCFW1T2	-0.50	21/07/09	3.7	7.8	11	0.0	770				0.10	550	0.88	130	42	110	550	190	0.90		0.68	23	1.2
BCFW1T2	-0.50	22/07/09	3.2	7.7	11	0.0	850				0.10	570	0.76	150	44	110	590	220	0.96		0.83	24	1.4
BCFW1T2	-0.50	23/07/09	1.2	7.6	1.4	0.0	300				0.26	520	1.5	39	11	49	300	64	0.18		0.050	0.73	0.57
BCFW1T2	-0.50	24/07/09	2.0	7.5	10	0.0	780				0.25	590	1.7	130	39	110	490	210	0.85		0.72	22	1.3
BCFW1T2	-0.50	25/07/09	3.8	7.8	10	0.0	740				0.25	610	1.8	130	37	110	480	200	0.78		0.64	20	1.2
BCFW1T2	-0.50	04/08/09	2.1	7.9	10	0.0	960				0.25	670	2.0	160	46	140	560	270	0.93	0.33	0.66	24	1.5
BCFW1T2	-0.50	21/08/09	4.6	7.7	9.8	0.0	1100				0.25	820	2.5	180	53	160	610	320	0.93	0.31	0.69	24	1.8
BCFW1T2	-0.50	03/09/09	4.9	8.2	9.0	0.0	1200				0.25	800	2.8	190	52	180	660	340	0.86	0.75	0.68	21	2.0
BCFW1T2	-0.50	24/09/09	5.6	7.6	8.7	0.0																	
BCFW1T3	-1.00	21/07/09	2.7	8.1	12	0.0	370				0.10	410	0.68	50	34	58	480	54	1.2		2.2	23	0.54
BCFW1T3	-1.00	22/07/09	2.5	7.9	12	0.0	330				0.10	410	0.70	43	34	54	510	30	1.3		2.4	24	0.47
BCFW1T3	-1.00	24/07/09	1.3	8.0	12	0.0	270				0.52	430	1.5	33	29	45	390	23	1.1		2.1	21	0.37
BCFW1T3	-1.00	25/07/09	2.5	8.0	12	0.0	240				0.52	410	0.99	28	27	42	400	21	1.0		1.9	21	0.32
BCFW1T3	-1.00	04/08/09	1.3	8.3	12	0.0	270				0.47	410	1.2	30	30	47	430	17	1.2		2.1	22	0.35
BCFW1T3	-1.00	21/08/09	2.5	8.1	12	0.0	280				0.62	460	1.5	30	32	50	460	23	1.2		2.3	24	0.38
BCFW1T3	-1.00	03/09/09	2.7	8.3	15	0.0	300				0.53	420	1.4	33	33	53	470	39	1.2	0.050	2.2	23	0.41
BCFW1T3	-1.00	24/09/09	3.1	7.8	12	0.0																	
BCFW1T4	-1.50	21/07/09	2.8	8.0	10	0.0	410				0.10	600	1.0	49	40	71	470	38	0.97		1.5	24	0.63
BCFW1T4	-1.50	22/07/09	2.7	8.1	10	0.0	410				0.10	600	1.0	48	40	71	480	31	1.0		1.7	24	0.63
BCFW1T4	-1.50	24/07/09	1.5	7.6	10	0.0	380				0.47	550	1.9	43	36	66	410	23	0.90		1.5	22	0.58
BCFW1T4	-1.50	25/07/09	1.4	8.0	10	0.0	350				0.25	570	1.7	40	33	61	390	48	0.82		1.3	21	0.51
BCFW1T4	-1.50	04/08/09	2.3	8.3	11	0.0	640				0.25	590	1.8	82	43	110	500	140	1.1		1.6	23	0.98
BCFW1T4	-1.50	21/08/09	3.7	7.8	10	0.0	720				0.46	720	2.3	95	44	120	520	160	0.98		1.4	24	1.2
BCFW1T4	-1.50	03/09/09	4.7	8.2	9.8	0.0	1100				0.33	750	2.3	170	50	170	640	300	0.94	0.25	1.5	21	1.9
BCFW1T4	-1.50	24/09/09	3.1	7.7	9.9	0.0																	

Table 20 (continued)

Sample ID	depth (m)	Date	EC	pH	Alkalinity	Acidity	Hardness	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
			(mS/cm)		meq/L	meq/L	($CaCO_3$)																
BCSWS (SUPPLY)		21/07/09	49	7.4	2.3	0.0	6700	1.8	0.057	0.18	2.5	22000	32	450	360	1400	12000	1000	4.5		1.3	0.63	7.9
BCSWS (SUPPLY)		14/08/09	55	7.8	2.2	0.0	6200							410	360	1300	11000	900	4.5		1.3	0.60	7.9
BCSW1SW	0.50	20/07/09	51	7.8	2.2	0.0	6700							460	360	1400	12000	990	4.4		1.3	0.63	8.1
BCSW1SW	0.50	20/07/09	52	7.7	2.2	0.0	6800	1.6	0.29	<0.01	2.5	21000	31	470	360	1400	12000	1000	4.4		1.3	0.63	8.2
BCSW1SW	0.50	20/07/09	53	7.5	2.0	0.0	6900							490	370	1400	12000	1000	4.5		1.3	0.63	8.5
BCSW1SW	0.50	20/07/09	49	7.6	2.1	0.0	6900							490	370	1400	12000	1100	4.5		1.3	0.63	8.5
BCSW1SW	0.50	20/07/09	51	7.6	2.1	0.0	6700							470	350	1300	12000	1000	4.3		1.3	0.63	8.2
BCSW1SW	0.50	24/07/09	55	7.2	1.6	0.0	5700	2.8	0.075	<0.002	1.0	21000	60	440	310	1100	9500	960	3.9		0.50	1.3	7.3
BCSW1SW	0.50	27/07/09	55	7.3	1.4	0.0	6600	4.2	0.049	<0.002	1.0	22000	62	560	330	1300	9300	1100	4.1		0.50	1.8	8.3
BCSW1SW	0.50	03/08/09	57	7.1	1.0	0.0		4.2	0.030	<0.002	1.0	21000	57										
BCSW1SW	0.50	14/08/09	56	7.2	0.67	0.30	7200	5.4	0.013	0.043	2.5	22000	72	660	350	1400	11000	1200	4.3		1.3	0.60	9.9
BCSW1SW	0.50	19/08/09	56	7.4	0.60	0.33	7100	3.1	0.011	0.040	2.5	24000	81	660	330	1300	11000	1200	4.0		1.3	0.60	9.9
BCSW1SW	0.50	10/09/09	54	6.4	0.31	0.0	7300	3.3	<0.005	0.052	2.5	22000	75	690	330	1400	11000	1300	2.5	2.5	2.5	1.3	9.7
BCSW1SW	0.50	21/09/09	57	6.1	0.25	0.0																	
BCSW1SWB	0.05	20/07/09	53	7.7	2.2	0.0	6800	1.7	0.25	<0.01	2.5	22000	30	470	370	1400	12000	1000	4.5		1.3	0.63	8.3
BCSW1SWB	0.05	20/07/09	53	7.6	2.1	0.0	6900							490	360	1400	12000	1000	4.6		1.3	0.63	8.5
BCSW1SWB	0.05	03/08/09	55	7.3	1.0	0.0	6600	4.3	0.029	<0.002	1.0	23000	63	580	320	1300	9700	1100	4.0		0.50	1.7	8.6
BCSW1SWB	0.05	14/08/09	56	7.2	0.63	0.29	6900	4.9	0.012	0.044	2.5	22000	74	630	330	1300	10000	1200	4.0		1.3	0.60	9.5
BCSW1SWB	0.05	19/08/09	56	7.1	0.55	0.25	7100	3.1	0.013	0.040	2.5	23000	76	670	340	1300	11000	1200	4.1		1.3	0.60	9.9
BCSW1SWB	0.05	10/09/09	54	6.5	0.34	0.0	7300	3.3	<0.005	0.049	2.5	21000	73	690	330	1400	11000	1300	2.5	2.5	2.5	1.3	9.7
BCSW2SW	0.50	20/07/09	46	7.8	2.2	0.0	6800							470	370	1400	12000	1000	4.5		1.3	0.63	8.3
BCSW2SW	0.50	20/07/09	53	7.7	2.1	0.0	6700							460	370	1400	12000	1000	4.5		1.3	0.63	8.2
BCSW2SW	0.50	20/07/09	52	7.7	2.1	0.0	6900							480	370	1400	12000	1000	4.5		1.3	0.63	8.3
BCSW2SW	0.50	20/07/09	53	7.6	2.1	0.0	6800	3.2	0.19	0.052	2.5	21000	29	480	360	1400	12000	1000	4.5		1.3	0.63	8.4
BCSW2SW	0.50	20/07/09	51	7.5	2.0	0.0	6800							480	360	1400	12000	1100	4.5		1.3	0.63	8.4
BCSW2SW	0.50	23/07/09	54	7.2	1.4	0.0	5900	3.3	0.033	<0.002	1.0	21000	59	450	320	1200	9800	980	4.0		0.50	1.6	7.4
BCSW2SW	0.50	24/07/09	53	7.1	1.4	0.0					1.0	22000	58										
BCSW2SW	0.50	27/07/09	52	7.2	0.93	0.38																	
BCSW2SW	0.50	03/08/09	53	6.8	0.42	0.35																	
BCSW2SW	0.50	14/08/09	55	5.3	0.067	0.53																	
BCSW2SW	0.50	19/08/09	55	5.0	0.051	0.70																	
BCSW2SW	0.50	10/09/09	52	4.6	0.0	0.55																	
BCSW2SW	0.50	21/09/09	56	3.9	0.0	1.6																	
BCSW2SWB	0.05	20/07/09	53	7.6	2.1	0.0	6800							470	370	1400	12000	1000	4.5		1.3	0.63	8.3
BCSW2SWB	0.05	20/07/09	52	7.7	2.1	0.0	6700	1.5	0.36	<0.01	2.5	21000	31	470	350	1300	12000	1000	4.4		1.3	0.63	8.2

Table 20 (continued)

Sample ID	depth (m)	Date	EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness ($CaCO_3$)	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
BCSW1T1	-0.20	21/07/09	12	3.4	0.0	5.0	3900	11	0.15	0.29	0.59	2600	2.9	630	100	580	1900	1600	0.81	2.3	0.25	42	7.0
BCSW1T1	-0.20	22/07/09	12	3.4	0.0	6.1	4000	12	0.14	0.29	0.50	2700	2.7	630	100	590	1900	1600	0.79	3.3	0.25	44	6.9
BCSW1T1	-0.20	24/07/09	10	7.5	5.5	0.0	2200	6.1	0.15	0.0089	0.29	2300	6.4	320	74	350	1600	790	1.3	0.55	0.25	27	3.6
BCSW1T1	-0.20	25/07/09	15	3.3	0.0	7.7	4300	11	0.047	0.038	0.97	3900	10	650	110	650	2100	1500	0.91	6.7	0.25	45	7.3
BCSW1T1	-0.20	21/08/09	29	3.2	0.0	14	5600	14	<0.005	0.97	1.7	9700	31	770	140	890	4700	1500	1.2	80	0.50	38	9.5
BCSW1T1	-0.20	03/09/09	33	3.1	0.0	15	5800	13	0.012	0.11	5.3	11000	33	790	150	920	5500	1400	1.2	120	0.50	37	9.6
BCSW1T1	-0.20	24/09/09	37	3.2	0.0	18																	
BCSW1T2	-0.50	21/07/09	6.8	7.9	8.9	0.0	1800				0.25	1400	1.7	280	72	260	1100	550	1.0		0.92	18	2.9
BCSW1T2	-0.50	22/07/09	7.0	7.6	8.6	0.0	1800				0.25	1500	2.2	290	71	260	1100	580	1.0		0.81	18	3.0
BCSW1T2	-0.50	24/07/09	3.8	7.5	8.4	0.0	1700				0.25	1500	4.4	270	80	240	1000	550	0.90		0.70	17	2.6
BCSW1T2	-0.50	25/07/09	3.8	7.6	8.3	0.0	1800				0.25	1500	4.7	290	81	250	1000	570	1.0		0.74	19	3.1
BCSW1T2	-0.50	04/08/09	4.2	7.8	8.1	0.0	1900				0.25	1800	5.2	320	83	280	1000	610	0.96		0.56	18	3.4
BCSW1T2	-0.50	21/08/09	10	7.2	7.6	0.0	2500				0.50	2100	7.5	410	85	360	1300	730	1.0		0.25	17	4.6
BCSW1T2	-0.50	03/09/09	12	7.8	7.3	0.0	3000				0.60	2900	9.7	500	96	430	1700	810	0.96	0.25	0.25	17	5.5
BCSW1T2	-0.50	24/09/09	15	7.1	7.0	0.0																	
BCSW1T2	-0.50	24/09/09	15	7.1	7.0	0.0																	
BCSW1T3	-1.00	21/07/09	4.8	8.1	14	0.0	510				0.25	1200	2.8	53	39	91	970	69	1.5		3.6	21	0.68
BCSW1T3	-1.00	22/07/09	4.5	8.1	15	0.0	490				0.25	1100	1.7	52	39	88	930	110	1.6		4.0	21	0.67
BCSW1T3	-1.00	24/07/09	2.5	8.1	15	0.0	460				0.25	1100	3.5	51	40	80	920	81	1.4		3.3	20	0.60
BCSW1T3	-1.00	25/07/09	2.4	8.0	14	0.0	440				0.25	1100	3.5	48	39	78	890	120	1.5		3.5	21	0.63
BCSW1T3	-1.00	04/08/09	2.6	8.1	14	0.0	460				0.25	1200	3.6	47	40	83	880	87	1.5		3.2	21	0.67
BCSW1T3	-1.00	21/08/09	5.6	7.9	14	0.0	550				0.25	1200	4.1	53	43	100	950	120	1.5		3.4	19	0.81
BCSW1T3	-1.00	03/09/09	4.7	8.2	13	0.0	540				0.46	950	3.0	53	41	100	820	110	1.3	0.25	2.9	20	0.75
BCSW1T3	-1.00	24/09/09	7.9	7.6	13	0.0																	
BCSW1T4	-1.50	21/07/09	6.3	8.1	15	0.0	510				0.25	1600	2.1	42	46	99	1100	77	1.9		4.6	20	0.73
BCSW1T4	-1.50	22/07/09	6.0	7.8	15	0.0	540				0.25	1700	2.6	44	46	110	1200	230	1.9		4.6	20	0.70
BCSW1T4	-1.50	24/07/09	8.5	7.5	7.6	0.0	1800				0.25	2200	6.2	250	66	290	1500	610	1.3		0.25	24	2.7
BCSW1T4	-1.50	25/07/09	3.0	7.7	14	0.0	470				0.25	1600	5.1	39	46	89	1100	120	1.8		4.3	21	0.64
BCSW1T4	-1.50	04/08/09	3.0	8.0	14	0.0	440				0.25	1600	4.9	37	45	85	1000	310	1.8		4.1	20	0.62
BCSW1T4	-1.50	21/08/09	6.0	7.9	15	0.0	440				0.25	1500	5.4	37	45	85	1100	170	1.8		4.4	19	0.63
BCSW1T4	-1.50	03/09/09	6.2	8.3	15	0.0	470				0.25	1500	5.0	38	45	90	1100	130	1.7	0.25	4.3	18	0.65

Table 20 (continued)

Sample ID	depth (m)	Date	EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness ($CaCO_3$)	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
BCT1	-0.20	21/07/09	12	3.8	0.0	5.9	3600	22	0.31	0.31	0.50	2500	2.3	550	78	550	1600	1400	0.80	3.1	0.25	45	6.0
BCT1	-0.20	22/07/09	12	3.5	0.0	8.7	3700	21	0.15	0.35	0.50	2500	3.8	560	83	560	1800	1500	0.73	8.4	0.25	52	6.1
BCT1	-0.20	24/07/09	12	3.4	0.0	9.3	3300	18	0.081	0.11	1.3	2600	6.9	480	76	520	1500	1400	0.68	11	0.25	50	5.6
BCT1	-0.20	25/07/09	11	3.4	0.0	9.5	3100	18	0.040	0.22	1.5	2400	6.2	450	69	480	1500	1200	0.55	14	0.25	48	5.0
BCT1	-0.20	04/08/09	8.8	3.3	0.0	11	4300	14	0.028	0.14	1.3	5800	15	630	100	670	2600	1400	0.92	27	0.25	47	7.3
BCT1	-0.20	21/08/09	12	3.3	0.0	11	3100	18	0.0072	1.2	2.0	2200	5.5	450	80	470	1500	1300	0.75	41	0.25	56	5.5
BCT1	-0.20	03/09/09	11	3.2	0.0	15	3200	17	0.0077	0.16	2.1	2300	7.2	480	80	480	1500	1300	0.77	68	0.27	59	5.5
BCT1	-0.20	24/09/09	12	3.1	0.0	11																	
BCT2	-0.50	21/07/09	7.0	7.9	9.9	0.0	1400				0.25	1600	2.1	180	56	230	1100	310	1.0		2.1	21	1.9
BCT2	-0.50	22/07/09	6.5	7.8	9.6	0.0	1400				0.25	1700	2.6	180	57	230	1100	300	1.1		2.4	23	1.9
BCT2	-0.50	24/07/09	3.5	7.6	9.6	0.0	1100				0.25	1600	4.9	150	59	180	980	270	0.99	0.11	1.8	23	1.8
BCT2	-0.50	25/07/09	3.4	7.7	9.8	0.0	1000				0.25	1600	4.9	130	56	160	920	230	0.93		1.9	22	1.5
BCT2	-0.50	04/08/09	6.1	8.0	10	0.0	1100				0.25	1600	5.0	150	54	180	1000	230	1.1		2.4	23	1.7
BCT2	-0.50	21/08/09	6.5	7.7	11	0.0	990				0.25	1500	4.7	130	54	160	960	200	1.1		2.4	22	1.6
BCT2	-0.50	03/09/09	6.7	8.3	11	0.0	980				0.40	1600	5.2	130	54	160	990	210	1.0	0.25	2.2	21	1.6
BCT2	-0.50	24/09/09	6.6	7.9	11	0.0																	
BCT3	-1.00	21/07/09	4.9	7.9	14	0.0	510				0.25	1100	1.6	62	37	86	900	95	1.5		4.2	20	0.72
BCT3	-1.00	22/07/09	4.3	8.1	15	0.0	500				0.25	1100	2.7	57	37	85	920	67	1.5		4.4	21	0.69
BCT3	-1.00	24/07/09	2.5	8.1	15	0.0	380				0.25	1100	3.5	44	33	66	800	62	1.3		3.7	19	0.56
BCT3	-1.00	25/07/09	2.5	8.1	15	0.0	460				0.25	1100	3.4	52	38	79	930	90	1.5		4.1	23	0.65
BCT3	-1.00	04/08/09	2.5	8.1	15	0.0	410				0.25	1200	3.6	42	37	73	870	110	1.5		3.9	21	0.58
BCT3	-1.00	21/08/09	4.8	7.8	15	0.0	370				0.25	1000	2.9	37	35	67	850	210	1.4		4.0	21	0.55
BCT3	-1.00	03/09/09	4.9	8.3	15	0.0	400				0.10	1100	3.9	39	37	73	870	150	1.4	0.25	4.2	19	0.56
BCT3	-1.00	24/09/09	4.9	7.8	15	0.0																	
BCT4	-1.50	21/07/09	6.4	8.1	15	0.0	530				0.25	1700	2.5	42	45	100	1200	87	1.8		4.7	19	0.74
BCT4	-1.50	22/07/09	5.8	8.0	15	0.0	530				0.25	1700	2.3	41	44	100	1200	81	1.9		4.8	19	0.75
BCT4	-1.50	24/07/09	3.3	8.2	15	0.0	440				0.25	1700	5.3	36	42	86	1100	130	1.7		4.2	18	0.63
BCT4	-1.50	25/07/09	3.3	8.1	15	0.0	500				0.25	1700	5.3	41	46	98	1100	150	1.8		4.5	21	0.70
BCT4	-1.50	04/08/09	3.3	8.1	15	0.0	480				0.25	1800	5.4	39	45	93	1100	190	1.8		4.4	20	0.68
BCT4	-1.50	21/08/09	6.5	7.9	15	0.0	460				0.25	1600	5.4	37	44	90	1100	220	1.8		4.7	18	0.66
BCT4	-1.50	03/09/09	6.4	8.3	15	0.0	490				0.25	1600	5.1	38	45	96	1200	140	1.8	0.25	4.9	19	0.68
BCT4	-1.50	24/09/09	6.2	7.9	15	0.0																	

Table 20 (continued)

Sample ID	depth (m)	Date	EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness (CaCO$_3$)	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
PSFWS (FW SUPPLY)		22/07/09	1.5	7.9	1.4	0.0	190	0.052	0.42	0.047	0.10	390	0.49	25	7.6	32	230	22	0.12		0.050	0.66	0.39
PSFW1SW	0.50	22/07/09	1.5	7.8	1.4	0.0	190							25	7.5	32	230	22	0.12		0.050	0.69	0.39
PSFW1SW	0.50	22/07/09	1.8	7.8	1.4	0.0	240	0.077	0.21	0.046	0.10	530	0.64	28	9.6	42	300	28	0.15		0.050	0.65	0.44
PSFW1SW	0.50	22/07/09	1.5	7.8	1.4	0.0	200							26	7.7	33	230	23	0.12		0.050	0.66	0.40
PSFW1SW	0.50	22/07/09	1.5	7.8	1.4	0.0	200	0.20	0.21	0.048	0.10	390	0.51	26	7.6	33	230	22	0.12		0.050	0.64	0.40
PSFW1SW	0.50	22/07/09	1.5	7.9	1.4	0.0	200							26	7.6	33	230	22	0.12		0.050	0.65	0.40
PSFW1SW	0.50	23/07/09	0.80	7.9	1.4	0.0	180	0.11	0.089	0.025	0.22	440	1.1	24	7.7	29	210	22	0.12		0.050	0.65	0.37
PSFW1SW	0.50	27/07/09	0.79	7.9	1.4	0.0	190	0.014	0.055	0.014	0.22	440	1.2	26	8.0	30	230	24	0.13		0.050	0.54	0.38
PSFW1SW	0.50	03/08/09	0.77	8.5	1.4	0.0	180	0.019	<0.005	0.0096	0.22	440	1.2	24	7.4	28	220	22	0.14		0.050	0.28	0.37
PSFW1SW	0.50	14/08/09	1.6	8.4	1.5	0.0	160	0.52	0.00088	0.0050	0.29	430	1.4	22	7.2	27	210	19	0.13		0.050	0.13	0.36
PSFW1SW	0.50	10/09/09	1.7	8.2	1.3	0.0	180	0.047	<0.005	0.0058	0.28	410	1.3	24	8.4	30	230	22	0.16	0.050	0.050	0.11	0.40
PSFW1SW	0.50	21/09/09	1.8	7.8	1.7	0.0																	
PSFW1SW	0.50	23/07/09	55	7.3	1.6	0.0	6300	2.8	0.057	<0.002	1.0	22000	61	480	320	1200	9800	1000	4.0		1.0	1.2	7.9
PSFW1SWB	0.05	22/07/09	1.5	7.8	1.4	0.0	200	0.074	0.20	0.058	0.10	390	0.46	26	7.6	32	230	22	0.12		0.050	0.84	0.39
PSFW1SWB	0.05	22/07/09	1.5	7.8	1.4	0.0	200	0.067	0.19	0.048	0.10	400	0.44	26	7.7	33	230	22	0.12		0.050	0.66	0.39
PSFW1SWB	0.05	03/08/09	1.7	7.9	1.5	1.0	180	0.022	<0.005	0.0070	0.23	390	1.3	25	8.2	30	230	23	0.15		0.050	0.27	0.41
PSFW1SWB	0.05	14/08/09	1.7	8.4	1.4	0.0	170	0.015	<0.005	0.0041	0.29	430	1.4	22	7.2	27	210	20	0.14		0.050	0.12	0.37
PSFW1SWB	0.05	10/09/09	1.7	7.5	1.5	0.0	180	0.031	<0.005	0.0044	0.28	410	1.4	24	8.5	30	230	22	0.16	0.050	0.050	0.11	0.40
PSFW2SW	0.50	22/07/09	1.5	7.9	1.4	0.0	190							25	7.4	32	220	22	0.12		0.050	0.65	0.38
PSFW2SW	0.50	22/07/09	1.8	7.8	1.4	0.0	220							26	8.7	38	270	26	0.14		0.050	0.64	0.41
PSFW2SW	0.50	22/07/09	1.5	7.9	1.4	0.0	200							26	7.6	33	230	22	0.12		0.050	0.66	0.40
PSFW2SW	0.50	22/07/09	1.5	7.9	1.4	0.0	200							26	7.7	33	230	22	0.12		0.050	0.67	0.40
PSFW2SW	0.50	22/07/09	1.5	7.8	1.4	0.0	200							26	7.6	33	240	23	0.12		0.050	0.67	0.41
PSFW2SW	0.50	23/07/09	1.6	7.3	1.5	0.0																	
PSFW2SW	0.50	27/07/09	0.82	7.9	1.4	0.0																	
PSFW2SW	0.50	03/08/09	1.7	7.9	1.5	0.0																	
PSFW2SW	0.50	14/08/09	1.6	8.4	1.5	0.0																	
PSFW2SW	0.50	10/09/09	1.7	7.7	1.6	0.0																	
PSFW2SW	0.50	21/09/09	1.8	7.8	1.7	0.0																	
PSFW1T1	-0.20	23/07/09	7.1	2.6	0.0	25	2600	3.6	0.15	0.34	0.25	3300	9.2	260	51	470	1800	1200	0.25	70	0.25	76	3.8
PSFW1T1	-0.20	24/07/09	6.7	2.7	0.0	20	2400	3.6	0.25	0.10	1.1	2600	7.0	220	45	440	1500	1100	0.25	45	0.25	66	3.0
PSFW1T1	-0.20	27/07/09	12	2.6	0.0	22	2400	3.3	0.15	0.28	1.3	2700	7.3	250	50	430	1600	1100	0.50	62	0.50	70	3.5
PSFW1T1	-0.20	04/08/09	2.4	3.0	0.0	2.3	180	0.91	0.042	0.011	0.10	460	1.2	21	13	32	250	76	0.17	1.6	0.050	15	0.30
PSFW1T1	-0.20	19/08/09	2.0	3.4	0.0	1.2	110	0.34	0.0024	0.094	0.15	520	1.6	13	7.9	18	270	31	0.31	0.32	0.050	5.7	0.18
PSFW1T1	-0.20	03/09/09	1.9	3.3	0.0	1.2	87	0.40	0.0053	0.085	0.10	400	1.4	11	6.3	14	240	27	0.14	0.20	0.050	4.8	0.14
PSFW1T1	-0.20	24/09/09	1.7	3.4	0.0	0.93																	
PSFW1T2	-0.50	23/07/09	6.7	6.3	1.0	0.0	2100				0.25	4700	12	190	74	410	2000	550	1.4	20	0.25	35	3.1
PSFW1T2	-0.50	24/07/09	5.4	7.0	2.5	0.0	1600				0.25	3800	10	130	53	320	1800	350	1.1	0.25	0.25	23	2.0
PSFW1T2	-0.50	27/07/09	6.7	4.9	0.0	3.2	2600				0.60	3800	12	240	87	480	2100	760	1.5	61	0.25	51	3.8
PSFW1T2	-0.50	04/08/09	13	4.4	0.0	8.3	2700				0.50	3600	10	270	90	500	1900	940	1.4	110	0.25	69	4.2
PSFW1T2	-0.50	19/08/09	7.5	4.3	0.0	5.6	1600				1.2	1800	6.2	160	74	290	1100	690	0.91	68	0.25	73	2.5
PSFW1T2	-0.50	03/09/09	2.6	3.9	0.0	1.0	340				0.26	520	1.7	33	32	62	340	140	0.47	10	0.050	50	0.54
PSFW1T2	-0.50	24/09/09	1.7	4.2	0.0	0.75																	

Table 20 (continued)

Sample ID	depth (m)	Date	EC	pH	Alkalinity	Acidity	Hardness	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
			(mS/cm)		meq/L	meq/L	($CaCO_3$)																
PSFW1T3	-1.00	23/07/09	11	7.4	7.4	0.0	1800				0.50	5200	15	140	66	360	2600	240	1.2		1.4	19	2.6
PSFW1T3	-1.00	24/07/09	7.1	7.4	5.9	0.0	1700				0.60	4700	16	130	62	350	2500	230	1.1		1.2	17	2.1
PSFW1T3	-1.00	27/07/09	7.5	7.5	6.6	0.0	1900				0.60	5000	16	150	67	370	2600	250	1.2		1.2	20	2.6
PSFW1T3	-1.00	04/08/09	6.9	7.7	6.1	0.0	1700				0.60	4600	14	130	60	340	2400	250	1.2		1.2	21	2.4
PSFW1T3	-1.00	19/08/09	13	7.3	3.5	0.0	1700				0.60	4000	12	130	60	330	2000	470	1.3		0.83	21	2.4
PSFW1T3	-1.00	03/09/09	9.0	7.4	1.6	0.0	1300				0.37	2200	7.0	100	51	260	1500	530	1.5	0.25	0.86	23	1.9
PSFW1T3	-1.00	24/09/09	3.5	7.1	1.1	0.0																	
PSFW1T4	-1.50	23/07/09	10	7.8	8.2	0.0	2400				0.50	7500	20	180	85	470	3500	350	1.4		1.6	17	3.4
PSFW1T4	-1.50	24/07/09	13	7.6	5.9	0.0	2100				0.50	6000	17	160	75	410	3000	320	1.3		1.0	18	2.6
PSFW1T4	-1.50	27/07/09	10	7.9	8.1	0.0	2500				0.50	8000	23	190	86	480	3500	340	1.5		1.6	18	3.5
PSFW1T4	-1.50	04/08/09	9.7	8.4	0.55	0.0	1800				0.50	5400	15	140	63	350	2600	280	1.1		1.3	16	2.6
PSFW1T4	-1.50	03/09/09	16	7.7	1.3	0.0	1900							150	73	380	3000	360	1.4	0.25	1.9	17	2.8
PSSW1SW	0.50	22/07/09	47	7.9	2.2	0.0	6500							440	350	1300	11000	990	4.4		1.3	0.63	7.7
PSSW1SW	0.50	22/07/09	50	7.9	2.2	0.0	6500	0.79	0.11	0.058	2.5	22000	29	440	350	1300	11000	950	4.4		1.3	0.63	7.7
PSSW1SW	0.50	22/07/09	50	7.9	2.2	0.0	6600							450	360	1300	12000	990	4.6		1.3	0.63	7.9
PSSW1SW	0.50	22/07/09	50	7.9	2.2	0.0	6400	0.53	0.087	0.058	2.5	22000	29	430	350	1300	11000	950	4.3		1.3	0.63	7.6
PSSW1SW	0.50	22/07/09	50	7.9	2.2	0.0	6500	0.47	0.061	0.054				430	350	1300	11000	950	4.4		1.3	0.63	7.5
PSSW1SW	0.50	23/07/09	55	7.7	2.1	0.0	5400	0.42	0.012	<0.002	1.0	22000	62	360	320	1100	9600	800	3.9		0.50	0.25	6.5
PSSW1SW	0.50	24/07/09	55	7.5	2.1	0.0	5900	0.64	0.0025	<0.002	1.0	22000	62	390	350	1200	9500	870	4.2		0.50	0.32	7.0
PSSW1SW	0.50	27/07/09	56	7.6	2.0	0.0	5800	0.42	0.0096	<0.002	1.0	23000	63	390	340	1200	9500	890	4.2		0.50	0.42	6.8
PSSW1SW	0.50	03/08/09	58	7.7	2.0	0.0	5500	0.48	<0.005	0.023	1.0	22000	72	360	320	1100	9500	790	3.8		1.3	0.60	6.9
PSSW1SW	0.50	14/08/09	57	8.1	2.1	0.0	5800	0.85	<0.005	0.012	2.5	23000	79	380	330	1200	10000	850	4.2		1.3	0.60	7.3
PSSW1SW	0.50	19/08/09	58	8.1	2.2	0.0	6700	0.82	<0.005	0.012	2.5	24000	81	440	390	1400	12000	980	4.8		1.3	0.60	8.6
PSSW1SW	0.50	10/09/09	56	7.7	2.2	0.0	6700	0.24	<0.005	0.023	2.5	23000	79	440	390	1400	12000	950	2.5	2.5	2.5	1.3	8.1
PSSW1SW	0.50	21/09/09	59	8.0	2.4	0.0																	
PSSW1SWB	0.05	22/07/09	50	7.9	2.2	0.0	6400	0.62	0.11	0.057	2.5	21000	32	430	340	1300	11000	940	4.3		1.3	0.63	7.5
PSSW1SWB	0.05	22/07/09	50	7.8	2.2	0.0	6400	0.49	0.70	0.055	2.5	22000	29	430	340	1300	11000	930	4.3		1.3	0.63	7.5
PSSW1SWB	0.05	03/08/09	57	8.0	2.1	0.0	6000	0.48	<0.005	0.021	1.0	22000	71	390	350	1200	10000	870	4.2		1.3	0.60	7.6
PSSW1SWB	0.05	14/08/09	57	8.1	2.1	0.0	6700	0.84	<0.005	0.012	2.5	23000	81	440	380	1400	12000	960	4.7		1.3	0.60	8.5
PSSW1SWB	0.05	19/08/09	58	8.1	2.2	0.0	6700	0.83	<0.005	0.010	2.5	24000	84	440	390	1400	12000	980	4.8		1.3	0.60	8.5
PSSW1SWB	0.05	10/09/09	56	7.8	2.2	0.0	6700	0.24	<0.005	0.019	2.5	23000	84	440	380	1400	12000	950	2.5	2.5	2.5	1.3	8.1
PSSW2SW	0.50	22/07/09	50	7.8	2.2	0.0	6400							430	340	1300	11000	930	4.3		1.3	0.63	7.5
PSSW2SW	0.50	22/07/09	49	7.9	2.2	0.0	6500							440	350	1300	12000	950	4.4		1.3	0.63	7.6
PSSW2SW	0.50	22/07/09	50	7.9	2.2	0.0	6300							420	340	1300	11000	910	4.2		1.3	0.63	7.4
PSSW2SW	0.50	22/07/09	50	7.9	2.2	0.0	6300							420	340	1300	11000	910	4.2		1.3	0.63	7.4
PSSW2SW	0.50	23/07/09	51	7.7	2.2	0.0																	
PSSW2SW	0.50	24/07/09	56	7.7	2.1	0.0																	
PSSW2SW	0.50	27/07/09	56	7.6	2.0	0.0																	
PSSW2SW	0.50	03/08/09	58	7.8	2.1	0.0	6200	0.29	<0.005	0.022	1.0	22000	77	410	360	1300	11000	900	4.4		1.3	0.60	7.9
PSSW2SW	0.50	14/08/09	57	8.0	2.1	0.0																	
PSSW2SW	0.50	10/09/09	56	7.8	2.2	0.0																	
PSSW2SW	0.50	21/09/09	60	8.0	2.4	0.0																	
PSSW2SW	0.50	23/07/09	55	7.7	2.1	0.0																	

Table 20 (continued)

Sample ID	depth (m)	Date	EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness $(CaCO_3)$	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
PSSW1T1	-0.20	23/07/09	13	2.7	0.0	18	2300	3.3	0.21	1.1	1.8	2700	9.4	210	51	430	1600	1000	0.52	47	0.25	69	3.5
PSSW1T1	-0.20	24/07/09	6.7	2.7	0.0	25	2500	3.5	0.15	0.31	1.0	3200	8.8	260	50	460	1800	1200	0.25	67	0.25	76	3.7
PSSW1T1	-0.20	04/08/09	13	2.7	0.0	21	3200	4.6	0.15	0.054	1.2	9800	27	270	86	620	4200	810	0.55	38	0.25	46	4.5
PSSW1T1	-0.20	19/08/09	44	2.8	0.0	15	4700	4.7	<0.005	0.72	2.5	17000	60	340	210	940	7700	830	1.3	39	1.3	30	6.3
PSSW1T1	-0.20	03/09/09	47	2.9	0.0	8.2	5800	2.0	<0.005	0.61	1.3	19000	62	390	290	1200	9800	930	2.5	37	2.5	23	7.2
PSSW1T1	-0.20	24/09/09	56	3.4	0.0	3.2																	
PSSW1T2	-0.50	23/07/09	12	7.0	2.9	0.0	1500				0.50	3200	11	120	54	300	1800	320	1.2		0.25	22	2.2
PSSW1T2	-0.50	24/07/09	6.7	6.1	0.34	2.0	2400				0.60	3800	10	220	82	450	2200	670	1.5	44	0.25	45	3.5
PSSW1T2	-0.50	04/08/09	5.6	7.0	1.2	0.0	2000				0.60	3200	10	170	62	390	1800	550	1.5	6.8	0.25	32	2.9
PSSW1T2	-0.50	19/08/09	15	6.8	1.0	0.0	2800				0.60	4800	18	230	84	550	2300	730	1.8	16	0.25	38	4.3
PSSW1T2	-0.50	03/09/09	24	4.0	0.0	1.8	4000				0.60	8100	25	330	110	760	3900	770	1.7	25	0.50	39	5.9
PSSW1T2	-0.50	24/09/09	39	4.7	0.0	4.8																	
PSSW1T3	-1.00	24/07/09	7.7	7.5	6.7	0.0	1900				0.60	5100	16	140	67	380	2800	230	1.2	0.25	1.4	20	2.6
PSSW1T3	-1.00	04/08/09	6.5	7.4	5.1	0.0	1700				0.60	4200	14	130	62	340	2300	290	1.3	0.25	1.2	21	2.4
PSSW1T3	-1.00	19/08/09	15	7.1	3.3	0.0	2200				0.60	5000	16	160	68	420	2400	440	1.4	0.25	0.70	24	3.1
PSSW1T3	-1.00	03/09/09	6.6	8.1	13	0.0	730				0.25	1400	4.7	69	47	140	1100	170	1.4	0.25	3.3	19	1.0
PSSW1T3	-1.00	24/09/09	40	6.1	0.56	0.0																	
PSSW1T4	-1.00	23/07/09	18	7.8	6.6	0.0	1900				0.50	5500	17	140	74	380	2700	290	1.3	0.25	1.2	17	2.7
PSSW1T4	-1.50	24/07/09	9.9	7.6	7.5	0.0	2300				0.50	7900	22	180	81	460	3400	300	1.4		1.5	17	3.3
PSSW1T4	-1.50	04/08/09	8.5	7.9	6.1	0.0	2200				0.60	5700	17	170	79	440	2900	380	1.5		1.4	22	3.1
PSSW1T4	-1.50	19/08/09	19	7.4	4.7	0.0	2500				0.60	7000	21	200	85	500	3200	440	1.6	0.25	1.2	22	3.7
PSSW1T4	-1.50	03/09/09	23	7.7	4.8	0.0	3200				0.60	8000	25	240	94	630	4100	510	1.6	0.50	0.50	22	4.5
PSSW1T4	-1.50	24/09/09	29	7.3	4.5	0.0																	
PST1	-0.20	23/07/09	5.8	2.9	0.0	15	2300	2.8	0.077	0.038	1.2	3000	8.4	230	68	430	1600	950	0.52	51	0.25	76	3.4
PST1	-0.20	24/07/09	5.9	2.9	0.0	15	2400	2.7	0.070	0.055	1.1	2900	8.2	230	68	440	1600	970	0.25	53	0.25	71	3.1
PST1	-0.20	27/07/09	5.7	2.9	0.0	14	2400	2.6	0.054	0.051	1.1	2900	8.2	240	69	440	1600	940	0.56	60	0.25	76	3.4
PST1	-0.20	27/07/09	5.6	2.7	0.0	19	2200	4.7	0.25	0.11	1.1	2600	7.1	210	42	410	1400	990	0.25	45	0.25	68	3.1
PST1	-0.20	04/08/09	5.8	2.9	0.0	14	2400	2.6	0.048	0.084	1.1	2900	8.3	240	68	440	1600	940	0.60	68	0.25	76	3.6
PST1	-0.20	19/08/09	12	2.9	0.0	12	2300	2.5	0.024	1.1	1.4	3100	11	220	72	430	1700	920	0.70	38	0.25	74	3.5
PST1	-0.20	03/09/09	12	2.8	0.0	11	2200	2.7	0.029	0.074	1.7	2700	8.3	210	66	410	1600	840	0.55	37	0.25	69	3.3
PST1	-0.20	24/09/09	11	2.8	0.0	10																	
PST2	-0.50	23/07/09	5.6	6.8	2.1	0.0	1800				0.25	3900	11	160	67	340	1800	420	1.2	1.2	0.25	30	2.5
PST2	-0.50	24/07/09	5.7	7.0	1.7	0.0	1800				0.60	3300	11	160	65	340	1800	430	1.1	2.9	0.25	29	2.3
PST2	-0.50	27/07/09	5.6	7.0	1.6	0.0	1800				0.60	3400	11	170	66	350	1700	460	1.2	2.3	0.25	32	2.5
PST2	-0.50	27/07/09	5.7	7.4	2.1	0.0	1700				0.60	3300	10	140	56	330	1700	430	1.3	0.83	0.25	27	2.3
PST2	-0.50	04/08/09	5.9	6.9	1.3	0.0	1900				0.50	3300	8.9	170	68	360	1800	480	1.3	4.9	0.25	34	2.8
PST2	-0.50	19/08/09	12	7.3	1.6	0.0	1800				0.60	3700	13	160	70	350	1800	460	1.3		0.25	30	2.8
PST2	-0.50	03/09/09	11	6.9	1.5	0.0	1800				0.25	3400	11	160	70	350	1800	470	1.2	0.25	0.25	30	2.7
PST2	-0.50	24/09/09	12	6.7	1.4	0.0																	

Table 20 (continued)

Sample ID	depth (m)	Date	EC (mS/cm)	pH	Alkalinity meq/L	Acidity meq/L	Hardness $(CaCO_3)$	NH_4-N	NO_x-N	PO_4-P	F^-	Cl^-	Br^-	Ca	K	Mg	Na	S	B	Fe	P	Si	Sr
PST3	-1.00	23/07/09	7.5	7.3	6.9	0.0	1700				0.50	5000	14	130	63	350	2400	230	1.1		1.2	18	2.3
PST3	-1.00	24/07/09	7.5	7.4	6.2	0.0	1700				0.60	4900	16	130	59	340	2500	220	1.1		1.1	17	2.2
PST3	-1.00	27/07/09	7.5	7.7	6.5	0.0	1800				0.60	5000	15	140	64	350	2400	240	1.1		1.2	19	2.4
PST3	-1.00	27/07/09	7.1	7.7	6.5	0.0	1700				0.60	4700	15	130	61	340	2300	240	1.2		1.3	18	2.2
PST3	-1.00	04/08/09	7.5	7.5	6.4	0.0	1800				0.50	5000	14	140	64	360	2600	230	1.2		1.2	19	2.5
PST3	-1.00	19/08/09	15	7.4	7.0	0.0	1800				0.60	5600	17	130	65	350	2500	230	1.2		1.2	18	2.5
PST3	-1.00	03/09/09	15	7.5	7.0	0.0	1800				0.60	4900	18	130	67	360	2600	240	1.1	0.50	1.3	17	2.5
PST3	-1.00	24/09/09	15	7.2	6.5	0.0																	
PST4	-1.50	23/07/09	10	7.5	8.1	0.0	2400				0.50	7700	21	180	85	470	3400	320	1.4		1.6	17	3.3
PST4	-1.50	24/07/09	9.8	7.5	7.2	0.0	2300				0.50	7500	20	180	81	460	3300	300	1.4		1.5	17	3.2
PST4	-1.50	27/07/09	9.7	7.6	7.4	0.0	2400				0.50	7500	21	190	85	480	3400	330	1.5		1.6	18	3.3
PST4	-1.50	27/07/09	8.5	7.7	6.5	0.0	2100				0.60	5800	19	160	75	410	2700	340	1.4		1.4	19	2.8
PST4	-1.50	04/08/09	9.7	7.5	7.2	0.0	2400				0.50	6800	18	180	84	470	3400	320	1.4		1.5	18	3.4
PST4	-1.50	19/08/09	20	7.6	7.9	0.0	2300				0.60	7800	25	170	85	460	3400	310	1.5	0.25	1.6	17	3.5
PST4	-1.50	03/09/09	19	7.7	7.6	0.0	2300				0.60	6600	22	170	85	460	3500	320	1.4	0.50	1.5	16	3.3
PST4	-1.50	24/09/09	19	7.2	7.3	0.0																	

Table 21 Guideline trigger values (µg/L) used in the water quality assessment of toxicants. The colour coding has been applied in the following table (Table 22) to indicate which trigger value was used. Fresh water values have been adjusted for very hard water.

Be	Al pH >6.5, <6.5	V	Cr (III), (VI)	Mn	Co	Ni	Cu	Zn	As (III), (V)
ID 0.13		ID, 6	ID 16, 1	1900	ID, 1.4	57	7		
ID	150, ID	ID	ID, 40	3600	ID	88	13	161	360, 140
ID	ID, 0.5	100	27.4,4.4	ID, 80	1	70	1.3	15	ID, 2.3, 4.5
ID	ID	280	90.6, 85	ID	150	560	8	43	ID

Se Total, (IV)	Mo	Ag	Cd	Sn (IV)	Sb	La	Tl	Pb	U
						ID	ID	12	ID
	ID, 23	0.05	1.1	ID, 3	ID 9	ID, 0.04	ID, 0.03	40	ID, 0.5
	ID	0.10	2.3	ID	ID	ID	ID	66	ID
34, ID	ID	0.20	4.56	ID	ID	ID	ID	111	ID
						ID	ID	2	ID
ID, 3(T)	ID, 23	1.4	5.5	ID, 10	ID, 270	ID	ID	4	ID
						ID	ID	7	ID
ID	ID	2.6	36	ID	ID	ID	ID	12	ID

80% freshwater	low reliability value only available	ID = Insufficient data to derive a reliable trigger value.

80% marine water	low reliability value only available	ID = Insufficient data to derive a reliable trigger value.

Table 22 Concentrations (µg/L) of minor elements in surface and pore water samples. Where values that exceed water quality guidelines are colour coded to indicate the trigger value applied.

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
BCFWS	FW		21/7/09	<40	<0.04	<10	0.30	0.40	0.40	0.16	2.0	0.070	0.90	1.0	12	0.80	0.30	<20	0.070
BCFWS (FW SUPPLY)	FW		14/8/09	<20	<0.6	<20	0.24	0.40	0.30	0.050	6.8	0.080	1.0	2.2	80	0.40	0.18	<20	0.050
BCFW1SW	FW	0.5	20/7/09	<40	0.40	40	0.40	0.80	1.8	0.60	380	3.6	6.5	2.5	39	1.2	0.90	<20	0.69
BCFW1SW	FW	0.50	20/7/09	<40	0.20	50	0.50	0.40	1.4	0.20	420	3.2	5.9	2.3	15	1.2	0.50	<20	0.47
BCFW1SW	FW	0.50	20/7/09	<40	0.080	50	0.30	0.20	1.4	0.20	410	3.2	6.2	2.2	33	0.80	0.30	<20	0.30
BCFW1SW	FW	0.50	20/7/09	<40	0.080	50	0.30	0.20	1.4	0.20	420	3.0	5.9	2.4	21	0.80	0.20	<20	0.43
BCFW1SW	FW	0.50	20/7/09	<40	<0.04	60	0.60	<0.2	1.4	0.16	430	2.9	5.4	2.5	26	0.80	0.30	<20	0.43
BCFW1SW	FW	0.50	24/7/09	<20	<0.2	<20	<4	<1	1.6	<0.1	430	2.8	5.2	3.4	34	0.80	0.10	<20	0.28
BCFW1SW	FW	0.50	24/7/09	<20	<0.2	<20	<4	<1	0.40	<0.1	2.6	0.050	0.80	1.0	15	0.40	<0.1	<20	<0.01
BCFW1SW	FW	0.50	27/7/09	<20	<0.2	80	<4	<1	1.6	<0.1	570	2.9	4.8	2.2	16	0.80	<0.1	<20	0.38
BCFW1SW	FW	0.50	3/8/09	<20	<0.2	80	<4	<1	2.4	<0.1	610	3.1	6.0	3.0	41	1.2	0.10	<20	0.61
BCFW1SW	FW	0.50	14/8/09	<20	<0.6	140	0.32	<0.2	2.1	0.16	1300	5.5	10	3.7	41	1.0	0.24	<20	0.59
BCFW1SW	FW	0.50	19/8/09	<20	<0.1	<20	<0.4	<0.6	0.40	0.080	1600	5.5	8.6	3.0	36	0.80	<0.2	<20	0.12
BCFW1SW	FW	0.50	10/9/09	<10	0.12	<20	1.0	200	5.9	0.26	2600	11	19	4.4	72	3.2	0.36	<10	0.16
BCFW2SW	FW	0.50	20/7/09	<40	0.28	70	0.40	0.40	1.2	0.36	320	3.7	6.3	2.2	19	1.2	0.40	<20	0.64
BCFW2SW	FW	0.50	20/7/09	<40	0.12	50	0.30	0.40	1.0	0.16	330	3.5	6.2	1.8	19	0.80	0.40	<20	0.47
BCFW2SW	FW	0.50	20/7/09	<40	0.040	50	0.30	<0.2	0.80	0.12	340	3.3	5.8	1.7	18	0.80	0.20	<20	0.38
BCFW2SW	FW	0.50	20/7/09	<40	0.12	50	0.30	0.20	1.2	0.16	340	4.0	7.0	2.0	23	0.80	0.40	<20	0.52
BCFW2SW	FW	0.50	20/7/09	<40	0.12	50	0.50	<0.2	0.80	0.16	270	3.0	6.7	3.6	34	0.80	0.20	<20	0.38
BCFW1SWB	FW	0.05	20/7/09	<40	0.12	40	0.30	0.40	1.4	0.16	470	2.9	5.3	2.1	18	0.80	0.30	<20	0.42
BCFW1SWB	FW	0.05	20/7/09	<40	0.080	20	0.30	0.20	1.6	0.080	650	4.6	8.5	1.9	23	0.80	0.30	<20	0.65
BCFW1SWB	FW	0.05	3/8/09	<20	<0.2	<20	<4	<1	0.60	<0.1	2700	22	34	3.6	95	1.2	0.20	<20	4.1
BCFW1SWB	FW	0.05	14/8/09	<20	<0.6	100	0.32	<0.2	1.2	0.15	1600	9.7	16	4.0	68	1.0	0.24	<20	0.86
BCFW1SWB	FW	0.05	19/8/09	<20	<0.1	<20	<0.4	<0.6	0.40	0.080	1600	5.8	9.6	3.2	37	0.80	0.40	<20	0.13
BCFW1SWB	FW	0.05	10/9/09	<10	0.18	<20	1.0	200	5.5	0.52	2500	9.6	17	4.1	100	2.9	0.30	<10	0.24
BCFW2SWB	FW	0.05	20/7/09	<40	0.080	20	0.30	0.20	1.4	0.16	380	3.9	6.9	1.9	20	0.80	0.30	<20	0.50
BCFW2SWB	FW	0.05	20/7/09	<40	0.12	30	0.40	<0.2	1.2	0.16	420	4.8	8.7	2.6	25	0.80	0.40	<20	0.53
BCFW1T1	FW	-0.20	21/7/09	200	36	69000	6.5	2.8	20	51	19	270	650	48	290	22	5.8	<40	610
BCFW1T1	FW	-0.20	22/7/09	200	33	79000	11	2.4	17	44	20000	230	680	40	270	19	5.0	<40	530
BCFW1T1	FW	-0.20	23/7/09	<20	<0.2	40	<4	<1	1.6	<0.1	480	2.7	4.6	1.6	18	0.80	0.30	<20	0.29
BCFW1T1	FW	-0.20	24/7/09	200	31	64000	<20	<4	21	43	18000	230	450	39	290	20	2.0	<100	520
BCFW1T1	FW	-0.20	25/7/09	250	32	62000	10	<2	31	46	16000	240	460	39	260	19	2.4	<50	540
BCFW1T1	FW	-0.20	4/8/09	200	30	62000	10	<2	79	51	18000	260	500	50	990	21	2.4	<50	580
BCFW1T1	FW	-0.20	21/8/09	100	21	59000	4.0	<3	110	36	20000	230	420	40	870	18	<1	<100	400
BCFW1T1	FW	-0.20	3/9/09	120	22	53000	6.0	440	140	49	19000	270	500	29	1100	38	3.2	60	450

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
BCFWS	FW		21/7/09	0.30	0.20	<0.2	<0.01	<0.02	0.030	0.080	<1	0.80	<0.1	96	0.070	0.22	0.020	0.060	0.020	0.010	0.020	<0.01	0.030	<0.01	0.010	<0.01
BCFWS (FW SUPPLY)	FW		14/8/09	0.64	<0.02	<0.2	<0.01	<0.02	0.26	0.18	0.64	<0.06	<0.02	260	0.040	0.080	<0.01	0.010	<0.02	0.010	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01
BCFW1SW	FW	0.5	20/7/09	0.90	1.4	<0.2	0.49	0.42	0.42	0.76	3.0	1.6	0.40	190	0.78	0.90	0.46	0.58	0.44	0.44	0.45	0.43	0.47	0.44	0.44	0.43
BCFW1SW	FW	0.50	20/7/09	0.50	0.80	<0.2	0.19	0.20	0.18	0.48	2.0	1.0	0.10	76	0.59	0.76	0.23	0.38	0.22	0.18	0.20	0.18	0.21	0.18	0.19	0.18
BCFW1SW	FW	0.50	20/7/09	0.30	0.40	<0.2	0.030	0.10	0.040	0.32	1.0	0.80	<0.1	150	0.38	0.52	0.070	0.20	0.060	0.040	0.050	0.040	0.060	0.040	0.040	0.030
BCFW1SW	FW	0.50	20/7/09	0.30	0.40	<0.2	0.010	0.080	0.060	0.36	1.0	0.80	<0.1	100	0.58	0.82	0.090	0.30	0.060	0.030	0.070	0.020	0.070	0.020	0.040	0.020
BCFW1SW	FW	0.50	20/7/09	0.40	0.30	<0.2	0.020	0.040	0.060	0.32	1.0	0.90	<0.1	99	0.54	0.78	0.10	0.30	0.080	0.040	0.080	0.040	0.080	0.040	0.050	0.030
BCFW1SW	FW	0.50	24/7/09	0.29	<0.1	<1	<0.01	<0.01	<0.01	0.26	0.60	0.40	<0.1	160	0.32	0.42	0.040	0.10	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1SW	FW	0.50	24/7/09	0.21	<0.1	<1	<0.01	<0.01	<0.01	<0.02	0.60	0.20	<0.1	120	<0.02	<0.01	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1SW	FW	0.50	27/7/09	0.25	<0.1	<1	<0.01	<0.01	<0.01	0.26	0.50	0.40	<0.1	110	0.36	0.50	0.040	0.20	<0.2	<0.02	0.040	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1SW	FW	0.50	3/8/09	0.52	1.0	<1	0.040	0.040	0.080	0.36	1.1	0.60	<0.1	170	0.34	0.48	0.10	0.20	<0.2	0.060	0.10	0.070	0.10	0.070	0.080	0.060
BCFW1SW	FW	0.50	14/8/09	1.2	0.040	<0.2	<0.01	0.060	0.080	0.30	1.2	0.36	<0.02	140	0.41	0.71	0.070	0.25	0.040	0.020	0.070	0.010	0.060	0.020	0.040	<0.01
BCFW1SW	FW	0.50	19/8/09	1.4	<0.04	<0.4	<0.02	<0.06	<0.01	0.080	0.79	0.20	<0.04	100	0.070	0.14	<0.01	<0.06	<0.04	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01
BCFW1SW	FW	0.50	10/9/09	0.16	<0.1	<0.1	<0.04	1.8	0.040	0.20	0.50	0.49	<0.01	150	0.090	0.11	<0.01	0.080	<0.02	0.40	0.020	<0.01	<0.01	<0.01	<0.01	<0.01
BCFW2SW	FW	0.50	20/7/09	0.60	1.1	<0.2	0.31	0.30	0.29	0.64	3.0	1.3	0.20	110	0.86	1.1	0.34	0.52	0.34	0.29	0.32	0.28	0.31	0.28	0.30	0.28
BCFW2SW	FW	0.50	20/7/09	0.40	0.60	<0.2	0.070	0.14	0.10	0.36	2.0	0.90	<0.1	110	0.67	0.88	0.14	0.32	0.12	0.090	0.12	0.080	0.12	0.080	0.10	0.080
BCFW2SW	FW	0.50	20/7/09	0.30	0.40	<0.2	0.010	0.080	0.050	0.28	1.0	0.80	<0.1	96	0.55	0.74	0.090	0.28	0.060	0.030	0.060	0.030	0.060	0.030	0.040	0.020
BCFW2SW	FW	0.50	20/7/09	0.60	0.60	<0.2	0.050	0.10	0.080	0.36	2.0	1.1	<0.1	110	0.71	0.98	0.13	0.38	0.12	0.070	0.12	0.060	0.10	0.060	0.080	0.050
BCFW2SW	FW	0.50	20/7/09	0.30	0.20	<0.2	0.020	0.040	0.050	0.28	<1	0.70	<0.1	120	0.52	0.68	0.080	0.24	0.060	0.040	0.070	0.030	0.070	0.030	0.050	0.020
BCFW1SWB	FW	0.05	20/7/09	0.40	0.50	<0.2	0.080	0.12	0.090	0.36	2.0	0.80	<0.1	96	0.56	0.76	0.14	0.32	0.12	0.090	0.12	0.080	0.13	0.080	0.10	0.080
BCFW1SWB	FW	0.05	20/7/09	0.30	0.30	<0.2	<0.01	0.040	0.030	0.28	<1	0.70	<0.1	95	0.96	1.4	0.13	0.52	0.080	0.030	0.12	0.020	0.080	0.020	0.050	0.010
BCFW1SWB	FW	0.05	3/8/09	0.42	0.50	<1	<0.01	0.030	<0.01	0.42	1.0	0.60	<0.1	150	6.1	8.3	0.72	2.6	0.40	0.080	0.54	0.080	0.40	0.090	0.24	0.030
BCFW1SWB	FW	0.05	14/8/09	0.86	<0.02	<0.2	<0.01	0.060	0.19	0.30	1.2	0.48	<0.02	170	0.72	1.3	0.12	0.47	0.080	0.030	0.13	0.020	0.12	0.030	0.070	0.010
BCFW1SWB	FW	0.05	19/8/09	0.90	<0.04	<0.4	<0.02	<0.06	<0.01	0.12	0.68	0.10	<0.04	100	0.060	0.12	<0.01	<0.06	<0.04	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01
BCFW1SWB	FW	0.05	10/9/09	0.14	<0.1	0.20	<0.04	1.5	0.040	0.17	0.50	0.49	<0.01	130	0.080	0.080	<0.01	0.030	<0.02	0.34	0.010	<0.01	<0.01	<0.01	<0.01	<0.01
BCFW2SWB	FW	0.05	20/7/09	0.30	0.50	<0.2	0.040	0.10	0.060	0.32	2.0	0.80	<0.1	110	0.68	0.94	0.12	0.36	0.10	0.050	0.10	0.050	0.10	0.050	0.080	0.040
BCFW2SWB	FW	0.05	20/7/09	0.50	0.50	<0.2	0.030	0.060	0.080	0.32	2.0	1.0	<0.1	110	0.75	1.1	0.12	0.40	0.080	0.040	0.090	0.040	0.090	0.040	0.060	0.030
BCFW1T1	FW	-0.20	21/7/09	2.2	0.80	<0.4	0.020	0.96	0.14	3.5	<2	1.0	0.20	62	590	1300	150	610	130	33	150	21	130	24	61	7.8
BCFW1T1	FW	-0.20	22/7/09	1.8	0.80	<0.4	<0.02	0.68	0.12	2.9	<2	1.0	0.10	80	500	1100	130	540	120	28	120	18	110	20	51	6.5
BCFW1T1	FW	-0.20	23/7/09	0.41	0.50	<1	<0.01	0.060	<0.01	0.28	1.4	0.80	<0.1	110	0.34	0.45	0.040	0.10	<0.2	<0.02	0.020	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T1	FW	-0.20	24/7/09	1.8	<0.5	<8	<0.01	0.10	<0.04	2.8	1.5	<1	<0.3	90	510	1100	130	540	110	28	130	18	100	20	52	6.6
BCFW1T1	FW	-0.20	25/7/09	1.5	0.90	<4	<0.01	0.28	0.040	2.8	1.2	0.50	<0.2	88	540	1200	140	570	120	29	130	19	110	20	54	6.9
BCFW1T1	FW	-0.20	4/8/09	1.7	0.30	<4	<0.01	0.32	0.060	3.1	1.4	<0.5	0.20	190	560	1300	150	600	120	30	130	20	110	21	55	6.9
BCFW1T1	FW	-0.20	21/8/09	2.0	<0.2	<2	<0.08	0.60	<0.06	2.8	1.5	<0.7	<0.2	90	390	860	100	400	82	20	89	13	73	14	37	4.6
BCFW1T1	FW	-0.20	3/9/09	2.8	<0.2	<0.2	<0.08	11	0.040	3.0	1.0	0.80	0.30	140	450	990	110	460	93	23	110	17	84	16	46	5.2

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
BCFWS	FW		21/7/09	0.010	<0.01	<0.5	0.050	<0.01	<0.1	<1	<0.2
BCFWS (FW SUPPLY)	FW		14/8/09	<0.01	<0.01	0.78	0.23	<0.01	0.050	0.33	<0.06
BCFW1SW	FW	0.5	20/7/09	0.40	0.41	1.0	0.92	0.47	0.40	<1	0.80
BCFW1SW	FW	0.50	20/7/09	0.18	0.16	<0.5	0.42	0.20	0.20	<1	0.40
BCFW1SW	FW	0.50	20/7/09	0.040	0.030	<0.5	0.20	0.050	<0.1	<1	0.20
BCFW1SW	FW	0.50	20/7/09	0.030	0.010	<0.5	0.15	0.040	<0.1	<1	0.20
BCFW1SW	FW	0.50	20/7/09	0.050	0.030	<0.5	0.13	0.050	<0.1	<1	0.20
BCFW1SW	FW	0.50	24/7/09	<0.02	<0.02	0.24	0.080	<0.02	<0.06	0.24	<0.4
BCFW1SW	FW	0.50	24/7/09	<0.02	<0.02	0.16	0.020	<0.02	<0.06	0.20	<0.4
BCFW1SW	FW	0.50	27/7/09	<0.02	<0.02	0.20	0.040	<0.02	<0.06	0.24	<0.4
BCFW1SW	FW	0.50	3/8/09	0.060	0.060	0.48	0.30	0.10	<0.06	0.56	<0.4
BCFW1SW	FW	0.50	14/8/09	0.020	<0.01	1.8	0.27	0.030	0.22	0.95	0.24
BCFW1SW	FW	0.50	19/8/09	<0.01	<0.01	2.3	0.17	0.17	0.25	0.90	<0.08
BCFW1SW	FW	0.50	10/9/09	<0.01	<0.01	0.12	0.060	0.060	0.060	<1	<0.05
BCFW2SW	FW	0.50	20/7/09	0.27	0.26	0.50	0.59	0.30	0.30	<1	0.60
BCFW2SW	FW	0.50	20/7/09	0.080	0.070	<0.5	0.26	0.10	<0.1	<1	0.40
BCFW2SW	FW	0.50	20/7/09	0.030	0.020	<0.5	0.16	0.040	<0.1	<1	0.20
BCFW2SW	FW	0.50	20/7/09	0.070	0.050	0.50	0.25	0.090	<0.1	<1	0.40
BCFW2SW	FW	0.50	20/7/09	0.030	0.020	<0.5	0.11	0.040	<0.1	<1	<0.2
BCFW1SWB	FW	0.05	20/7/09	0.090	0.070	<0.5	0.28	0.11	<0.1	<1	0.20
BCFW1SWB	FW	0.05	20/7/09	0.030	<0.01	<0.5	0.11	0.040	<0.1	<1	0.20
BCFW1SWB	FW	0.05	3/8/09	0.12	<0.02	0.40	0.14	0.12	<0.06	0.64	<0.4
BCFW1SWB	FW	0.05	14/8/09	0.050	<0.01	1.4	0.24	0.050	0.17	0.63	0.24
BCFW1SWB	FW	0.05	19/8/09	<0.01	<0.01	1.6	0.12	0.15	0.090	0.63	<0.08
BCFW1SWB	FW	0.05	10/9/09	<0.01	<0.01	0.090	0.060	0.050	0.030	<1	<0.05
BCFW2SWB	FW	0.05	20/7/09	0.060	0.040	<0.5	0.22	0.070	<0.1	<1	0.20
BCFW2SWB	FW	0.05	20/7/09	0.050	0.030	0.50	0.17	0.070	<0.1	<1	0.20
BCFW1T1	FW	-0.20	21/7/09	43	6.0	<1	0.46	3.0	2.4	16	21
BCFW1T1	FW	-0.20	22/7/09	37	5.1	<1	0.38	2.7	2.0	16	18
BCFW1T1	FW	-0.20	23/7/09	<0.02	<0.02	0.40	0.64	0.040	<0.06	0.48	<0.4
BCFW1T1	FW	-0.20	24/7/09	35	4.6	0.80	0.40	2.4	2.7	6.0	14
BCFW1T1	FW	-0.20	25/7/09	37	4.9	0.50	0.35	2.7	1.4	7.8	16
BCFW1T1	FW	-0.20	4/8/09	38	5.3	0.50	0.20	3.0	3.0	4.8	14
BCFW1T1	FW	-0.20	21/8/09	28	3.7	1.2	0.45	7.9	8.4	9.5	6.4
BCFW1T1	FW	-0.20	3/9/09	33	4.8	2.0	1.0	2.8	2.2	4.0	7.7

Table 22 (continued)

Sample ID	Treatment	depth(m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
BCFW1T2	FW	-0.50	21/7/09	<100	0.30	<100	1.5	<0.4	0.80	0.40	290	1.6	3.8	1.8	21	3.0	0.40	<40	1.5
BCFW1T2	FW	-0.50	22/7/09	<40	0.12	<10	0.90	0.40	0.60	0.44	390	1.7	2.3	0.70	19	1.6	0.40	<20	1.4
BCFW1T2	FW	-0.50	23/7/09	<20	<0.2	40	<4	<1	1.0	1.9	420	3.8	6.2	1.6	20	0.80	0.20	<20	0.34
BCFW1T2	FW	-0.50	24/7/09	<20	<0.2	140	<4	<1	0.80	0.20	460	3.0	4.8	0.40	17	0.80	0.10	<20	1.4
BCFW1T2	FW	-0.50	25/7/09	<20	<0.2	120	<4	<1	0.60	0.20	380	2.1	3.4	0.40	16	0.80	<0.1	<20	1.2
BCFW1T2	FW	-0.50	4/8/09	<20	<0.2	250	<4	<1	1.4	0.30	450	2.2	4.0	1.2	50	2.0	0.20	<20	2.1
BCFW1T2	FW	-0.50	21/8/09	<20	<0.1	80	<0.4	<0.6	0.80	0.22	410	1.1	1.2	0.80	140	1.0	<0.2	<20	0.62
BCFW1T2	FW	-0.50	3/9/09	<20	0.30	200	2.0	120	3.9	0.28	510	3.3	5.8	0.70	52	1.2	0.24	<20	2.0
BCFW1T3	FW	-1.00	21/7/09	<100	<0.1	<100	1.5	0.80	0.80	1.4	160	0.88	5.2	0.80	18	4.0	<0.2	<40	0.52
BCFW1T3	FW	-1.00	22/7/09	<40	<0.04	<10	0.80	0.40	0.80	0.72	110	0.69	1.5	0.30	16	1.6	0.10	<20	0.57
BCFW1T3	FW	-1.00	24/7/09	<20	<0.2	<20	<4	<1	1.0	0.60	79	0.66	1.2	<0.2	17	0.80	<0.1	<20	0.13
BCFW1T3	FW	-1.00	25/7/09	<20	<0.2	<20	<4	<1	0.80	0.40	50	0.59	1.0	0.20	13	0.80	<0.1	<20	0.16
BCFW1T3	FW	-1.00	4/8/09	<20	<0.2	<20	<4	<1	1.0	0.30	29	0.58	0.60	1.0	50	0.80	<0.1	<20	0.19
BCFW1T3	FW	-1.00	21/8/09	<20	<0.1	<20	<0.4	1.2	1.0	0.46	26	0.64	<0.2	0.20	380	<0.2	<0.2	<20	0.13
BCFW1T3	FW	-1.00	3/9/09	<20	<0.1	<40	2.0	<40	2.8	0.60	56	0.95	1.3	0.50	98	<0.2	<0.04	<20	0.67
BCFW1T4	FW	-1.50	21/7/09	<100	0.20	<100	1.5	<0.4	<0.4	0.70	120	2.2	4.2	0.60	14	1.0	<0.2	<40	1.3
BCFW1T4	FW	-1.50	22/7/09	<40	<0.04	<10	0.60	0.60	0.40	0.84	21	0.56	0.50	0.20	16	0.80	0.30	<20	0.20
BCFW1T4	FW	-1.50	24/7/09	<20	<0.2	<20	<4	<1	0.20	0.20	24	0.62	0.40	0.20	15	<0.4	<0.1	<20	0.040
BCFW1T4	FW	-1.50	25/7/09	<20	<0.2	<20	<4	<1	0.20	0.30	15	0.52	0.20	0.20	15	<0.4	<0.1	<20	0.040
BCFW1T4	FW	-1.50	4/8/09	<20	<0.2	<20	<4	<1	0.40	0.20	29	0.53	0.40	1.2	68	0.40	<0.1	<20	0.080
BCFW1T4	FW	-1.50	21/8/09	<20	<0.1	<20	<0.4	<0.6	<0.2	0.18	53	0.46	<0.2	0.40	50	<0.2	<0.2	<20	0.080
BCFW1T4	FW	-1.50	3/9/09	<20	0.60	<40	2.0	80	2.3	0.28	330	0.74	2.0	0.60	56	0.80	0.20	<20	0.42
BCSWS	SW		21/7/09	<500	<0.5	<1000	15	<3	<3	1.0	170	1.9	5.0	4.0	30	<5	11	<300	3.4
BCSWS (SUPPLY)	SW		14/8/09	<250	<8	<250	2.0	<3	<2	<0.2	16	0.20	<0.5	2.4	80	<3	<0.8	<250	<0.1
BCSW1SW	SW	0.5	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	500	5.0	10	2.0	12	<5	<1	<300	1.5
BCSW1SW	SW	0.50	20/7/09	<500	1.0	<300	4.0	<3	<3	<0.5	660	6.6	12	2.0	16	<5	<1	<300	1.4
BCSW1SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	660	6.7	12	1.0	14	<5	<1	<300	1.3
BCSW1SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	800	8.5	15	1.0	12	<5	<1	<300	1.2
BCSW1SW	SW	0.50	20/7/09	<200	<2	<200	<40	<8	<2	<0.6	920	31	48	4.0	56	4.0	<1	<200	4.6
BCSW1SW	SW	0.50	24/7/09	<200	<2	<200	<40	<8	<2	<0.6	2500	41	64	6.0	64	<4	<1	<200	8.9
BCSW1SW	SW	0.50	27/7/09	<200	<2	<200	<40	<8	<2	<0.6	3900	61	88	10	110	<4	<1	<200	4.4
BCSW1SW	SW	0.50	14/8/09	<250	<8	<250	3.0	<3	<2	<0.2	5900	49	64	7.2	88	<3	<0.8	<250	0.90
BCSW1SW	SW	0.50	19/8/09	<250	<2	<250	<5	<8	<2	<0.3	5900	53	58	<3	90	<3	<3	<250	0.40
BCSW1SW	SW	0.50	10/9/09	<200	2.4	<400	<20	<400	50	0.40	6600	63	71	3.0	80	6.0	0.40	<200	3.9
BCSW2SW	SW	0.50	20/7/09	<500	0.50	<300	4.0	<3	<3	<0.5	630	6.5	11	2.0	16	<5	<1	<300	1.2
BCSW2SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	840	8.6	15	2.0	16	<5	<1	<300	1.3
BCSW2SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	830	9.2	15	1.0	14	<5	<1	<300	1.1
BCSW2SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	790	9.3	16	1.0	12	<5	<1	<300	1.0
BCSW2SW	SW	0.50	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	1000	14	23	2.0	18	<5	<1	<300	1.5
BCSW2SW	SW	0.50	23/7/09	<200	<2	<200	<40	<8	<2	<0.6	3100	45	76	4.0	64	<4	<1	<200	9.4

Table 22 (continued)

Sample ID	Treatment	depth(m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
BCFW1T2	FW	-0.50	21/7/09	1.0	0.40	<0.4	<0.02	0.080	0.020	<0.1	<2	0.90	<0.1	34	1.5	3.1	0.36	1.4	0.28	0.10	0.36	0.060	0.34	0.060	0.16	0.030
BCFW1T2	FW	-0.50	22/7/09	1.0	0.40	<0.2	0.010	0.080	0.040	<0.04	<1	0.80	<0.1	45	1.4	3.0	0.35	1.5	0.38	0.090	0.36	0.050	0.29	0.060	0.15	0.030
BCFW1T2	FW	-0.50	23/7/09	0.36	0.20	<1	0.010	0.040	0.030	0.24	1.2	0.80	<0.1	120	0.44	0.52	0.060	0.10	<0.2	<0.02	0.040	0.020	<0.02	0.030	<0.04	0.020
BCFW1T2	FW	-0.50	24/7/09	0.58	<0.1	<1	<0.01	<0.01	<0.01	<0.02	0.60	<0.2	<0.1	40	0.74	1.5	0.18	0.70	<0.2	<0.02	0.16	0.020	0.16	0.030	0.12	0.010
BCFW1T2	FW	-0.50	25/7/09	0.60	0.20	<1	<0.01	<0.01	<0.01	<0.02	0.80	0.20	<0.1	47	0.84	1.8	0.20	0.80	<0.2	0.040	0.18	0.020	0.16	0.030	0.12	<0.01
BCFW1T2	FW	-0.50	4/8/09	0.67	<0.1	<1	<0.01	<0.01	<0.01	<0.02	0.80	0.20	<0.1	110	1.8	3.9	0.44	1.8	0.40	0.080	0.42	0.060	0.34	0.070	0.20	0.020
BCFW1T2	FW	-0.50	21/8/09	0.80	<0.04	<0.4	<0.02	<0.06	<0.01	<0.04	0.67	<0.1	<0.04	89	0.49	1.1	0.11	0.42	0.080	0.020	0.080	0.010	0.080	0.010	0.040	<0.01
BCFW1T2	FW	-0.50	3/9/09	0.40	<0.2	<0.2	<0.08	<0.1	<0.04	0.020	<1	0.60	<0.02	71	1.6	3.4	0.38	1.6	0.20	0.13	0.43	0.050	0.30	0.060	0.17	0.020
BCFW1T3	FW	-1.00	21/7/09	1.0	0.40	<0.4	<0.02	0.080	0.040	<0.1	<2	0.80	<0.1	62	0.46	1.0	0.12	0.48	0.12	0.040	0.12	0.020	0.10	0.030	0.060	0.010
BCFW1T3	FW	-1.00	22/7/09	0.70	0.20	<0.2	<0.01	0.16	0.020	<0.04	<1	0.40	<0.1	62	0.53	1.3	0.14	0.56	0.12	0.030	0.13	0.020	0.12	0.030	0.060	0.010
BCFW1T3	FW	-1.00	24/7/09	0.70	<0.1	<1	<0.01	0.050	<0.01	<0.02	0.60	<0.2	<0.1	62	0.060	0.13	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T3	FW	-1.00	25/7/09	0.63	<0.1	<1	<0.01	0.040	<0.01	<0.02	0.60	<0.2	<0.1	50	0.10	0.25	0.020	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T3	FW	-1.00	4/8/09	0.68	<0.1	<1	<0.01	0.030	<0.01	<0.02	0.60	<0.2	<0.1	130	0.080	0.23	0.020	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T3	FW	-1.00	21/8/09	0.90	<0.04	<0.4	<0.02	0.18	<0.01	<0.04	0.54	<0.1	<0.04	94	0.060	0.18	<0.01	<0.06	<0.04	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01
BCFW1T3	FW	-1.00	3/9/09	0.48	<0.2	<0.2	<0.08	<0.1	<0.04	0.060	<1	0.40	<0.02	200	0.63	1.4	0.17	0.60	0.080	0.21	0.14	0.020	0.10	0.020	0.060	<0.01
BCFW1T4	FW	-1.50	21/7/09	0.60	0.40	<0.4	<0.02	0.12	0.040	<0.1	<2	0.80	<0.1	46	0.90	1.9	0.24	0.96	0.20	0.080	0.24	0.040	0.24	0.050	0.14	0.020
BCFW1T4	FW	-1.50	22/7/09	0.50	0.20	<0.2	<0.01	0.16	0.030	<0.04	<1	0.40	<0.1	52	0.20	0.54	0.050	0.20	0.060	0.020	0.050	<0.01	0.050	0.010	0.030	<0.01
BCFW1T4	FW	-1.50	24/7/09	0.35	<0.1	<1	<0.01	<0.01	<0.01	<0.02	0.50	<0.2	<0.1	56	<0.02	0.030	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T4	FW	-1.50	25/7/09	0.41	<0.1	<1	<0.01	0.040	<0.01	<0.02	0.40	<0.2	<0.1	58	<0.02	0.23	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T4	FW	-1.50	4/8/09	0.70	1.1	<1	<0.01	0.49	0.050	<0.02	1.2	0.40	<0.1	200	0.040	0.12	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCFW1T4	FW	-1.50	21/8/09	0.40	<0.04	<0.4	<0.02	<0.06	<0.01	<0.04	0.51	<0.1	<0.04	110	0.050	0.16	<0.01	<0.06	<0.04	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01
BCFW1T4	FW	-1.50	3/9/09	0.26	<0.2	<0.2	<0.08	<0.1	<0.04	<0.02	<1	0.40	<0.02	120	0.43	1.0	0.10	0.43	0.040	0.17	0.090	0.010	0.060	<0.01	0.040	<0.01
BCSWS	SW		21/7/09	3.0	1.0	<2	0.10	0.60	<0.1	<0.5	<10	4.0	<1	40	3.0	6.0	0.80	3.0	1.2	0.30	0.80	0.18	0.80	0.15	0.30	0.090
BCSWS (SUPPLY)	SW		14/8/09	1.5	<0.2	<2	<0.2	<0.3	2.0	<0.2	2.0	<0.8	<0.3	160	<0.08	<0.1	<0.05	<0.1	<0.3	<0.08	<0.1	<0.03	<0.2	0.030	<0.1	0.030
BCSW1SW	SW	0.5	20/7/09	2.0	2.0	<2	0.20	0.30	0.20	<0.5	<10	4.0	<1	<20	1.8	1.8	0.30	0.90	0.30	0.30	0.40	0.24	0.40	0.21	0.30	0.24
BCSW1SW	SW	0.50	20/7/09	2.0	1.0	<2	0.20	0.60	0.30	0.50	<10	4.0	<1	<20	1.8	1.8	0.40	0.60	0.60	0.30	0.40	0.24	0.20	0.24	0.30	0.27
BCSW1SW	SW	0.50	20/7/09	2.0	3.0	<2	0.50	0.30	0.50	0.50	<10	5.0	<1	<20	1.8	1.8	0.60	0.90	0.60	0.50	0.60	0.46	0.60	0.48	0.60	0.45
BCSW1SW	SW	0.50	20/7/09	2.0	2.0	<2	<0.1	<0.3	0.10	<0.5	<10	4.0	<1	<20	1.8	1.8	0.20	0.60	<0.3	0.10	0.20	0.14	0.20	0.15	0.20	0.12
BCSW1SW	SW	0.50	20/7/09	2.2	<1	<10	<0.02	<0.1	<0.08	1.0	1.8	2.0	<0.6	60	11	12	0.80	3.0	<2	<0.2	0.40	0.060	<0.2	0.080	<0.4	0.080
BCSW1SW	SW	0.50	24/7/09	1.9	<1	<10	<0.02	<0.1	<0.08	0.80	1.2	<2	<0.6	72	17	21	1.6	5.0	<2	<0.2	0.80	0.060	0.40	0.080	<0.4	<0.04
BCSW1SW	SW	0.50	27/7/09	2.3	<1	<10	<0.02	<0.1	0.32	1.4	3.0	2.0	<0.6	200	13	12	1.0	2.0	<2	<0.2	0.20	0.18	<0.2	0.16	<0.4	0.16
BCSW1SW	SW	0.50	14/8/09	1.8	<0.2	<2	<0.2	<0.3	5.0	1.6	2.0	<0.8	<0.3	130	3.0	2.0	0.20	0.40	<0.3	0.080	0.20	0.12	<0.2	0.11	0.10	0.10
BCSW1SW	SW	0.50	19/8/09	<1	<0.5	<5	<0.2	<0.8	<0.2	1.5	3.6	<2	<0.5	150	1.7	0.90	<0.08	<0.8	<0.5	<0.03	<0.3	<0.1	<0.3	<0.03	<0.2	<0.05
BCSW1SW	SW	0.50	10/9/09	0.40	<2	<2	<0.8	<1	<0.4	1.6	<10	4.0	<0.2	170	5.6	5.0	0.24	1.6	<0.4	0.30	0.30	<0.06	0.18	<0.06	<0.1	<0.04
BCSW2SW	SW	0.50	20/7/09	2.0	2.0	<2	0.20	0.60	0.30	0.50	<10	4.0	<1	<20	1.8	1.5	0.30	0.60	0.30	0.20	0.40	0.22	0.40	0.21	0.20	0.21
BCSW2SW	SW	0.50	20/7/09	2.0	2.0	<2	0.10	0.30	0.10	0.50	<10	4.0	<1	<20	2.0	1.8	0.20	0.90	0.30	0.20	0.20	0.14	0.40	0.15	0.20	0.15
BCSW2SW	SW	0.50	20/7/09	2.0	2.0	<2	0.20	0.30	0.20	<0.5	<10	4.0	<1	<20	2.0	1.8	0.30	0.90	0.30	0.20	0.40	0.20	0.40	0.18	0.20	0.18
BCSW2SW	SW	0.50	20/7/09	2.0	1.0	<2	<0.1	<0.3	<0.1	<0.5	<10	3.0	<1	<20	1.8	1.5	0.20	0.60	<0.3	0.10	<0.2	0.060	<0.2	0.090	0.10	0.090
BCSW2SW	SW	0.50	20/7/09	2.0	1.0	<2	0.20	<0.3	0.20	<0.5	<10	4.0	<1	<20	2.6	2.4	0.40	0.90	0.30	0.30	0.40	0.20	0.40	0.21	0.30	0.24
BCSW2SW	SW	0.50	23/7/09	3.0	1.0	<10	0.54	0.40	0.48	1.4	3.6	4.0	<0.6	72	19	23	2.2	6.0	<2	0.40	1.2	0.42	0.80	0.48	0.80	0.40

Table 22 (continued)

Sample ID	Treatment	depth(m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
BCFW1T2	FW	-0.50	21/7/09	0.14	0.030	<1	0.22	0.040	<0.2	<2	<0.4
BCFW1T2	FW	-0.50	22/7/09	0.14	0.020	1.0	0.12	0.020	<0.1	<1	0.60
BCFW1T2	FW	-0.50	23/7/09	<0.02	<0.02	0.36	0.44	0.040	<0.06	0.40	<0.4
BCFW1T2	FW	-0.50	24/7/09	0.060	<0.02	0.36	0.080	<0.02	<0.06	0.48	0.80
BCFW1T2	FW	-0.50	25/7/09	0.060	<0.02	0.40	0.080	<0.02	<0.06	0.52	0.80
BCFW1T2	FW	-0.50	4/8/09	0.12	<0.02	0.32	0.040	<0.02	<0.06	0.36	<0.4
BCFW1T2	FW	-0.50	21/8/09	0.030	<0.01	1.2	0.060	0.010	0.30	0.74	<0.08
BCFW1T2	FW	-0.50	3/9/09	0.11	0.010	0.060	0.16	0.030	<0.01	<2	<0.1
BCFW1T3	FW	-1.00	21/7/09	0.060	0.020	<1	0.30	<0.02	<0.2	<2	<0.4
BCFW1T3	FW	-1.00	22/7/09	0.060	0.010	<0.5	0.12	0.010	<0.1	<1	<0.2
BCFW1T3	FW	-1.00	24/7/09	<0.02	<0.02	0.28	0.080	<0.02	<0.06	0.24	<0.4
BCFW1T3	FW	-1.00	25/7/09	<0.02	<0.02	0.28	0.060	<0.02	<0.06	0.24	<0.4
BCFW1T3	FW	-1.00	4/8/09	<0.02	<0.02	0.24	0.040	<0.02	<0.06	0.24	<0.4
BCFW1T3	FW	-1.00	21/8/09	<0.01	<0.01	0.96	0.080	<0.01	0.39	0.26	<0.08
BCFW1T3	FW	-1.00	3/9/09	0.060	<0.01	<0.06	0.12	<0.01	<0.01	<2	<0.1
BCFW1T4	FW	-1.50	21/7/09	0.12	0.30	<1	0.16	0.040	<0.2	<2	<0.4
BCFW1T4	FW	-1.50	22/7/09	0.030	<0.01	<0.5	0.090	<0.01	<0.1	<1	<0.2
BCFW1T4	FW	-1.50	24/7/09	<0.02	<0.02	0.20	0.060	<0.02	<0.06	0.24	<0.4
BCFW1T4	FW	-1.50	25/7/09	<0.02	<0.02	0.20	0.060	<0.02	<0.06	0.20	<0.4
BCFW1T4	FW	-1.50	4/8/09	<0.02	<0.02	0.52	0.24	<0.02	<0.06	0.68	<0.4
BCFW1T4	FW	-1.50	21/8/09	<0.01	<0.01	0.64	0.030	<0.01	0.080	0.34	<0.08
BCFW1T4	FW	-1.50	3/9/09	0.050	<0.01	<0.06	0.080	<0.01	<0.01	<2	<0.1
BCSWS	SW		21/7/09	0.50	0.20	<2	0.60	0.10	<1	<5	<3
BCSWS (SUPPLY)	SW		14/8/09	<0.03	<0.03	1.0	1.2	<0.1	<0.08	1.0	<0.8
BCSW1SW	SW	0.5	20/7/09	0.40	0.30	<2	1.4	0.30	<1	<5	<3
BCSW1SW	SW	0.50	20/7/09	0.30	0.30	<2	1.2	0.30	<1	<5	<3
BCSW1SW	SW	0.50	20/7/09	0.60	0.40	<2	2.2	0.70	<1	<5	<3
BCSW1SW	SW	0.50	20/7/09	0.20	0.10	<2	1.2	0.30	<1	<5	<3
BCSW1SW	SW	0.50	20/7/09	<0.2	<0.2	1.6	0.80	0.40	-0.54	2.0	<4
BCSW1SW	SW	0.50	24/7/09	<0.2	<0.2	1.2	0.20	0.40	-0.23	2.0	<4
BCSW1SW	SW	0.50	27/7/09	<0.2	<0.2	1.6	1.0	0.80	-0.58	2.4	<4
BCSW1SW	SW	0.50	14/8/09	0.090	0.090	1.2	1.2	0.40	<0.08	1.0	<0.8
BCSW1SW	SW	0.50	19/8/09	<0.1	<0.1	2.0	7.4	1.4	<0.1	2.3	<1
BCSW1SW	SW	0.50	10/9/09	<0.1	<0.04	<0.6	<0.4	0.70	<0.1	<20	<1
BCSW2SW	SW	0.50	20/7/09	0.30	0.20	<2	1.2	0.30	<1	<5	<3
BCSW2SW	SW	0.50	20/7/09	0.30	0.20	<2	1.0	0.30	<1	<5	<3
BCSW2SW	SW	0.50	20/7/09	0.30	0.20	<2	1.6	0.40	<1	<5	<3
BCSW2SW	SW	0.50	20/7/09	0.20	<0.1	<2	0.80	0.20	<1	<5	<3
BCSW2SW	SW	0.50	20/7/09	0.30	0.20	<2	0.80	0.30	<1	<5	<3
BCSW2SW	SW	0.50	23/7/09	0.60	0.40	2.0	3.4	1.0	0.29	2.4	<4

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
BCSW1SWB	SW	0.05	20/7/09	<500	<0.5	<300	6.0	<3	<3	3.0	700	6.9	12	2.0	16	<5	<1	<300	1.3
BCSW1SWB	SW	0.05	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	900	9.9	17	2.0	14	<5	<1	<300	1.4
BCSW1SWB	SW	0.05	3/8/09	<200	<2	<200	<40	<8	<2	<0.6	4800	55	78	8.0	110	<4	<1	<200	3.7
BCSW1SWB	SW	0.05	14/8/09	<250	<8	<250	3.0	<3	<2	<0.2	5700	49	63	8.0	98	<3	2.4	<250	0.90
BCSW1SWB	SW	0.05	19/8/09	<250	2.0	<250	<5	<8	<2	2.1	6100	56	62	9.0	130	<3	<3	<250	3.2
BCSW1SWB	SW	0.05	10/9/09	<200	<0.6	<400	<20	<400	50	0.40	6600	66	87	4.0	80	4.0	1.6	<200	5.3
BCSW2SWB	SW	0.05	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	1000	8.7	15	2.0	18	<5	<1	<300	0.90
BCSW2SWB	SW	0.05	20/7/09	<500	<0.5	<300	4.0	<3	<3	<0.5	930	12	21	2.0	12	<5	<1	<300	1.4
BCSW1T1	SW	-0.20	21/7/09	200	23	32000	3.0	2.4	3.2	23	16000	220	460	31	250	12	3.0	<40	370
BCSW1T1	SW	-0.20	22/7/09	100	22	39000	4.0	1.6	3.2	21	16000	190	360	26	220	12	2.4	<40	360
BCSW1T1	SW	-0.20	24/7/09	100	0.80	250	<10	<2	<0.5	0.40	7500	40	130	0.50	14	<1	<0.3	<50	7.2
BCSW1T1	SW	-0.20	25/7/09	200	20	48000	10	<2	8.0	22	17000	170	330	22	220	12	2.1	<50	350
BCSW1T1	SW	-0.20	21/8/09	<250	22	62000	5.0	<8	82	31	19000	220	410	45	550	21	<3	<250	530
BCSW1T1	SW	-0.20	3/9/09	120	28	69000	12	720	140	36	19000	240	460	62	780	45	4.2	60	520
BCSW1T2	SW	-0.50	21/7/09	<100	<0.1	<100	2.0	<0.4	1.6	0.40	680	1.4	10	1.4	20	4.0	0.60	<40	1.1
BCSW1T2	SW	-0.50	22/7/09	<100	0.20	<100	1.5	<0.4	0.40	0.40	1000	2.5	5.6	0.80	21	2.0	0.40	<40	2.3
BCSW1T2	SW	-0.50	24/7/09	40	<0.2	<20	<4	<1	0.40	0.20	700	0.97	2.2	<0.2	17	1.6	0.20	<20	0.27
BCSW1T2	SW	-0.50	25/7/09	20	<0.2	60	<4	<1	0.20	<0.1	740	1.3	2.2	0.40	42	1.2	<0.1	<20	0.85
BCSW1T2	SW	-0.50	4/8/09	20	<0.2	<20	<4	<1	0.60	0.10	560	0.42	1.2	1.2	44	1.6	0.20	<20	0.060
BCSW1T2	SW	-0.50	21/8/09	<100	<0.7	200	<2	<3	<0.9	<0.1	2000	2.1	0.80	<1	70	<1	<1	<100	2.4
BCSW1T2	SW	-0.50	3/9/09	40	<0.1	280	2.0	560	6.2	0.32	2700	2.8	11	1.1	62	2.2	0.24	<20	3.3
BCSW1T3	SW	-1.00	21/7/09	<100	<0.1	<100	1.5	0.80	2.0	2.3	76	1.1	6.8	0.60	18	5.0	<0.2	<40	0.74
BCSW1T3	SW	-1.00	22/7/09	<100	0.10	<100	1.5	0.80	1.2	1.1	110	1.3	2.6	0.60	12	2.0	1.0	<40	1.3
BCSW1T3	SW	-1.00	24/7/09	<20	<0.2	<20	<4	<1	1.4	0.70	72	0.83	1.0	0.20	51	1.6	<0.1	<20	0.23
BCSW1T3	SW	-1.00	25/7/09	<20	<0.2	<20	<4	<1	1.0	0.50	47	0.65	0.60	0.40	23	1.2	<0.1	<20	0.16
BCSW1T3	SW	-1.00	4/8/09	<20	<0.2	<20	<4	1.0	1.4	0.60	37	0.84	0.60	1.4	53	1.6	<0.1	<20	0.18
BCSW1T3	SW	-1.00	21/8/09	<50	<0.4	<50	<1	<2	<0.5	0.40	24	0.64	<0.4	<0.5	64	<0.5	<0.5	<50	0.12
BCSW1T3	SW	-1.00	3/9/09	<20	<0.1	<40	<2	<40	2.8	0.56	74	0.91	1.1	0.20	48	0.60	0.12	<20	0.51
BCSW1T4	SW	-1.50	21/7/09	<100	<0.1	<100	1.5	0.80	0.80	0.90	21	0.68	1.6	0.40	9.6	2.0	5.0	<40	0.40
BCSW1T4	SW	-1.50	22/7/09	<100	<0.1	<100	1.5	1.2	0.80	0.90	42	0.98	1.6	0.40	14	2.0	19	<40	0.68
BCSW1T4	SW	-1.50	24/7/09	50	<0.4	100	<10	<2	<0.5	0.20	5600	37	110	1.5	21	1.0	<0.3	<50	2.1
BCSW1T4	SW	-1.50	25/7/09	<20	<0.2	<20	<4	<1	1.0	0.50	9.9	0.54	0.40	0.40	20	0.80	<0.1	<20	0.090
BCSW1T4	SW	-1.50	4/8/09	<20	<0.2	<20	<4	<1	1.0	0.50	9.0	0.56	0.40	1.0	40	0.80	0.10	<20	0.060
BCSW1T4	SW	-1.50	21/8/09	<50	<0.4	<50	<1	<2	<0.5	0.40	9.0	0.60	<0.4	<0.5	25	<0.5	<0.5	<50	<0.03
BCSW1T4	SW	-1.50	3/9/09	<20	<0.1	<40	2.0	<40	4.6	0.64	14	0.69	0.84	0.20	30	1.2	0.16	<20	0.070

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
BCSW1SWB	SW	0.05	20/7/09	2.0	1.0	<2	0.30	0.60	0.30	0.50	<10	4.0	<1	<20	1.8	1.5	0.30	0.60	<0.3	0.30	0.40	0.20	0.20	0.21	0.30	0.21
BCSW1SWB	SW	0.05	20/7/09	2.0	2.0	<2	0.20	0.30	0.10	<0.5	<10	4.0	<1	<20	2.2	2.1	0.30	0.90	<0.3	0.20	0.20	0.12	0.20	0.12	0.20	0.12
BCSW1SWB	SW	0.05	3/8/09	2.2	<1	<10	<0.02	<0.1	<0.08	1.4	1.8	<2	<0.6	140	12	11	0.60	2.0	<2	<0.2	<0.2	<0.06	<0.2	<0.04	<0.4	<0.04
BCSW1SWB	SW	0.05	14/8/09	2.4	<0.2	<2	<0.2	0.30	7.7	1.8	3.5	<0.8	<0.3	120	3.0	2.1	0.25	0.60	<0.3	0.16	0.10	0.090	<0.2	0.10	0.10	0.11
BCSW1SWB	SW	0.05	19/8/09	4.0	2.5	<5	2.8	2.4	3.6	4.5	5.2	<2	2.0	180	5.3	4.5	3.1	2.4	2.5	2.8	2.7	2.9	2.7	2.9	3.0	2.9
BCSW1SWB	SW	0.05	10/9/09	0.20	<2	<2	<0.8	<1	0.40	1.2	<10	4.0	0.40	180	8.9	8.0	1.0	1.7	<0.4	0.90	1.2	0.66	0.96	0.72	1.0	0.60
BCSW2SWB	SW	0.05	20/7/09	2.0	1.0	<2	<0.1	<0.3	<0.1	<0.5	<10	3.0	<1	<20	1.6	1.2	0.20	0.30	<0.3	0.10	<0.2	0.080	0.20	0.090	0.20	0.060
BCSW2SWB	SW	0.05	20/7/09	2.0	1.0	<2	0.30	0.60	0.30	<0.5	<10	4.0	<1	<20	2.4	2.1	0.50	0.90	0.60	0.40	0.40	0.30	0.40	0.33	0.40	0.33
BCSW1T1	SW	-0.20	21/7/09	1.4	1.6	<0.4	0.20	0.60	0.18	3.0	<2	1.4	0.30	66	350	4.0	86	4.0	72	17	80	11	67	13	33	4.3
BCSW1T1	SW	-0.20	22/7/09	1.0	0.60	<0.4	0.060	0.60	0.060	2.4	<2	1.0	0.20	54	4.0	4.0	81	4.0	69	17	76	11	64	12	32	4.0
BCSW1T1	SW	-0.20	24/7/09	0.60	<0.3	<4	<0.01	0.040	<0.02	<0.05	0.60	<0.5	<0.2	52	7.6	7.4	0.64	2.1	<0.5	0.040	0.50	0.060	0.45	0.11	0.40	0.040
BCSW1T1	SW	-0.20	25/7/09	1.0	1.2	<4	<0.01	0.28	0.040	2.0	1.4	0.50	<0.2	100	330	710	82	330	69	17	77	11	65	12	33	4.2
BCSW1T1	SW	-0.20	21/8/09	1.0	<0.5	<5	<0.2	0.80	<0.2	2.5	3.5	<2	<0.5	140	510	1100	130	510	100	25	110	16	92	18	49	6.0
BCSW1T1	SW	-0.20	3/9/09	0.84	<0.6	<0.6	<0.2	24	0.70	2.0	<3	1.2	0.30	240	500	1100	120	480	99	26	130	21	91	18	55	6.5
BCSW1T2	SW	-0.50	21/7/09	1.0	0.80	<0.4	0.080	0.16	0.060	<0.1	<2	0.90	<0.1	70	0.90	1.9	0.26	0.96	0.32	0.10	0.30	0.080	0.26	0.080	0.16	0.060
BCSW1T2	SW	-0.50	22/7/09	0.80	0.60	<0.4	0.040	0.12	0.040	<0.1	<2	0.90	<0.1	60	2.0	4.0	0.50	1.9	0.52	0.14	0.45	0.090	0.46	0.10	0.24	0.050
BCSW1T2	SW	-0.50	24/7/09	0.48	0.20	<1	<0.01	<0.01	<0.01	<0.02	0.60	0.20	<0.1	81	0.20	0.27	0.040	<0.1	<0.2	<0.02	0.040	<0.01	0.020	<0.01	<0.04	<0.01
BCSW1T2	SW	-0.50	25/7/09	0.52	0.30	<1	<0.01	0.070	0.010	<0.02	0.60	0.20	<0.1	120	0.72	1.4	0.16	0.60	<0.2	0.020	0.14	0.020	0.12	0.030	0.080	0.010
BCSW1T2	SW	-0.50	4/8/09	0.57	0.60	<1	<0.01	0.080	0.010	<0.02	1.1	0.20	<0.1	150	0.040	0.090	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T2	SW	-0.50	21/8/09	0.50	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.94	<0.7	<0.2	160	2.2	4.4	0.45	1.8	<0.2	<0.01	0.30	<0.04	0.20	0.030	0.16	<0.02
BCSW1T2	SW	-0.50	3/9/09	0.24	<0.2	<0.2	<0.08	2.1	0.040	<0.02	1.0	0.50	<0.02	150	3.4	6.6	0.67	3.2	0.52	0.30	0.76	0.080	0.43	0.14	0.31	0.040
BCSW1T3	SW	-1.00	21/7/09	1.2	0.60	<0.4	0.040	0.52	0.060	<0.1	<2	0.80	<0.1	72	0.64	1.3	0.18	0.68	0.24	0.080	0.15	0.050	0.18	0.050	0.14	0.040
BCSW1T3	SW	-1.00	22/7/09	1.0	0.60	<0.4	0.040	0.20	0.060	<0.1	<2	0.70	<0.1	54	1.1	2.4	0.30	1.2	0.28	0.080	0.30	0.060	0.26	0.070	0.14	0.040
BCSW1T3	SW	-1.00	24/7/09	0.76	<0.1	<1	<0.01	0.030	<0.01	<0.02	0.60	<0.2	<0.1	120	0.10	0.20	0.020	<0.1	<0.2	<0.02	0.020	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T3	SW	-1.00	25/7/09	0.72	0.30	<1	<0.01	0.25	0.030	<0.02	0.70	0.20	<0.1	110	0.060	0.15	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T3	SW	-1.00	4/8/09	0.86	0.60	<1	<0.01	0.17	0.030	<0.02	1.4	0.20	<0.1	150	0.060	0.17	0.020	<0.1	<0.2	<0.02	0.020	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T3	SW	-1.00	21/8/09	1.5	<0.1	<1	<0.04	<0.2	<0.03	<0.1	0.76	<0.4	<0.1	170	0.060	0.20	<0.02	<0.2	<0.1	<0.01	<0.05	<0.02	<0.05	<0.01	<0.04	<0.01
BCSW1T3	SW	-1.00	3/9/09	0.44	<0.2	<0.2	<0.08	<0.1	<0.04	<0.02	1.0	0.50	<0.02	120	0.39	0.87	0.12	0.28	<0.04	0.12	0.070	0.010	0.080	0.010	0.060	<0.01
BCSW1T4	SW	-1.50	21/7/09	0.80	0.20	<0.4	<0.02	0.12	0.040	<0.1	<2	0.90	<0.1	50	0.32	0.68	0.080	0.32	0.080	0.020	0.090	0.020	0.10	0.020	0.060	0.010
BCSW1T4	SW	-1.50	22/7/09	1.0	0.40	<0.4	0.020	0.12	0.060	<0.1	<2	1.1	<0.1	58	0.60	1.2	0.16	0.64	0.20	0.060	0.18	0.040	0.16	0.040	0.10	0.030
BCSW1T4	SW	-1.50	24/7/09	0.63	<0.3	<4	<0.01	<0.04	<0.02	<0.05	0.60	<0.5	<0.2	170	1.1	1.3	0.12	0.30	<0.5	<0.04	0.10	<0.02	0.050	0.020	<0.1	<0.01
BCSW1T4	SW	-1.50	25/7/09	0.57	0.10	<1	<0.01	0.11	0.030	<0.02	0.60	<0.2	<0.1	110	0.020	0.060	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T4	SW	-1.50	4/8/09	0.58	0.20	<1	<0.01	0.080	0.020	<0.02	0.80	<0.2	<0.1	170	0.020	0.090	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCSW1T4	SW	-1.50	21/8/09	0.90	<0.1	<1	<0.04	<0.2	<0.03	<0.1	0.62	<0.4	<0.1	160	<0.03	<0.05	<0.02	<0.2	<0.1	<0.01	<0.05	<0.02	<0.05	<0.01	<0.04	<0.01
BCSW1T4	SW	-1.50	3/9/09	0.28	<0.2	<0.2	<0.08	<0.1	<0.04	0.060	1.0	0.40	<0.02	130	0.010	0.11	<0.01	0.050	0.040	0.090	<0.01	<0.01	0.010	<0.01	0.010	<0.01

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
BCSW1SWB	SW	0.05	20/7/09	0.30	0.20	<2	1.0	0.30	<1	<5	<3
BCSW1SWB	SW	0.05	20/7/09	0.30	0.10	<2	1.0	0.30	<1	<5	<3
BCSW1SWB	SW	0.05	3/8/09	<0.2	<0.2	1.6	0.40	0.60	-0.86	2.0	<4
BCSW1SWB	SW	0.05	14/8/09	0.21	0.12	2.0	4.9	0.60	<0.08	2.0	-4.8
BCSW1SWB	SW	0.05	19/8/09	3.0	2.7	4.5	7.5	3.2	0.70	4.1	<1
BCSW1SWB	SW	0.05	10/9/09	0.40	0.40	<0.6	0.80	1.4	<0.1	<20	<1
BCSW2SWB	SW	0.05	20/7/09	0.20	<0.1	<2	0.80	0.20	<1	<5	<3
BCSW2SWB	SW	0.05	20/7/09	0.40	0.40	<2	1.0	0.40	<1	<5	<3
BCSW1T1	SW	-0.20	21/7/09	24	3.4	<1	0.60	2.6	2.0	8.0	8.4
BCSW1T1	SW	-0.20	22/7/09	23	3.2	<1	0.26	2.2	1.4	4.0	8.4
BCSW1T1	SW	-0.20	24/7/09	0.10	<0.05	0.40	0.15	0.10	<0.2	0.60	2.0
BCSW1T1	SW	-0.20	25/7/09	23	3.1	0.50	0.50	1.9	1.0	6.8	7.0
BCSW1T1	SW	-0.20	21/8/09	36	4.8	1.5	1.5	3.4	5.4	16	3.0
BCSW1T1	SW	-0.20	3/9/09	44	6.8	3.6	1.4	4.0	2.5	<6	5.1
BCSW1T2	SW	-0.50	21/7/09	0.16	0.080	<1	0.28	0.080	<0.2	<2	0.45
BCSW1T2	SW	-0.50	22/7/09	0.20	0.060	<1	0.14	0.080	<0.2	<2	<0.4
BCSW1T2	SW	-0.50	24/7/09	<0.02	<0.02	0.24	0.060	<0.02	<0.06	0.44	<0.4
BCSW1T2	SW	-0.50	25/7/09	0.040	<0.02	0.40	0.10	<0.02	<0.06	0.72	<0.4
BCSW1T2	SW	-0.50	4/8/09	<0.02	<0.02	0.40	0.12	<0.02	<0.06	1.0	<0.4
BCSW1T2	SW	-0.50	21/8/09	<0.06	<0.04	1.2	0.35	<0.02	<0.05	1.8	<0.4
BCSW1T2	SW	-0.50	3/9/09	0.24	0.040	0.060	0.080	0.050	0.050	<2	<0.1
BCSW1T3	SW	-1.00	21/7/09	0.14	0.050	<1	0.42	0.040	<0.2	<2	<0.4
BCSW1T3	SW	-1.00	22/7/09	0.14	0.040	<1	0.20	0.040	<0.2	<2	<0.4
BCSW1T3	SW	-1.00	24/7/09	<0.02	<0.02	0.24	0.12	<0.02	<0.06	0.28	<0.4
BCSW1T3	SW	-1.00	25/7/09	<0.02	<0.02	0.36	0.12	<0.02	<0.06	0.32	<0.4
BCSW1T3	SW	-1.00	4/8/09	<0.02	<0.02	0.36	0.14	<0.02	<0.06	0.44	<0.4
BCSW1T3	SW	-1.00	21/8/09	<0.03	<0.02	1.8	0.12	<0.01	<0.03	0.87	<0.2
BCSW1T3	SW	-1.00	3/9/09	0.050	<0.01	<0.06	0.12	<0.01	<0.01	<2	<0.1
BCSW1T4	SW	-1.50	21/7/09	0.060	0.020	<1	0.22	<0.02	<0.2	<2	<0.4
BCSW1T4	SW	-1.50	22/7/09	0.12	0.040	<1	0.22	0.040	<0.2	<2	<0.4
BCSW1T4	SW	-1.50	24/7/09	<0.05	<0.05	0.40	0.15	0.15	<0.2	0.50	1.0
BCSW1T4	SW	-1.50	25/7/09	<0.02	<0.02	0.24	0.14	<0.02	<0.06	0.24	<0.4
BCSW1T4	SW	-1.50	4/8/09	<0.02	<0.02	0.20	0.14	<0.02	<0.06	0.28	<0.4
BCSW1T4	SW	-1.50	21/8/09	<0.03	<0.02	1.2	0.15	<0.01	<0.03	0.54	<0.2
BCSW1T4	SW	-1.50	3/9/09	<0.01	<0.01	<0.06	0.12	<0.01	<0.01	<2	<0.1

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
BCT1	C	-0.20	21/7/09	200	22	40000	2.6	1.2	9.2	25	20000	190	340	16	190	9.0	3.0	<40	270
BCT1	C	-0.20	22/7/09	200	36	60000	4.0	1.6	30	47	21000	300	570	27	350	18	3.8	40	550
BCT1	C	-0.20	24/7/09	250	27	57000	<10	<2	25	33	19000	210	390	20	260	14	1.5	<50	400
BCT1	C	-0.20	25/7/09	100	24	51000	<20	<4	25	29	17000	190	360	16	220	12	1.0	<100	360
BCT1	C	-0.20	4/8/09	200	25	56000	10	<2	38	32	18000	230	430	32	360	18	2.1	<50	470
BCT1	C	-0.20	21/8/09	100	24	64000	2.0	<3	38	29	17000	190	380	15	390	18	<1	<100	370
BCT1	C	-0.20	3/9/09	80	20	43000	4.0	360	59	30	17000	210	410	22	530	31	2.0	60	430
BCT2	C	-0.50	21/7/09	<100	0.20	200	1.5	0.80	1.6	0.90	800	2.9	7.2	0.80	16	4.0	0.20	<40	2.4
BCT2	C	-0.50	22/7/09	<100	<0.1	<100	2.0	0.80	1.2	0.80	760	1.8	3.0	0.60	18	2.0	0.40	<40	1.9
BCT2	C	-0.50	24/7/09	20	<0.2	100	<4	<1	1.2	0.50	1000	2.8	4.4	0.80	16	1.6	0.20	<20	0.96
BCT2	C	-0.50	25/7/09	<20	<0.2	<20	<4	<1	1.0	0.40	680	0.97	0.80	0.40	20	1.6	<0.1	<20	0.31
BCT2	C	-0.50	4/8/09	<50	<0.4	50	<10	<2	0.50	<0.2	540	1.5	1.6	2.0	54	2.0	<0.3	<50	0.93
BCT2	C	-0.50	21/8/09	<50	<0.4	<50	<1	<2	<0.5	0.35	310	1.1	<0.4	<0.5	57	<0.5	<0.5	<50	0.39
BCT2	C	-0.50	3/9/09	<20	<0.1	440	<2	<40	3.2	0.64	520	4.6	8.3	1.5	38	1.6	0.16	<20	4.9
BCT3	C	-1.00	21/7/09	<100	<0.1	<100	1.5	1.6	2.4	2.1	130	1.3	3.2	0.60	16	4.0	0.20	<40	0.74
BCT3	C	-1.00	22/7/09	<100	<0.1	<100	1.5	0.80	1.2	1.0	200	1.2	2.0	0.40	9.6	2.0	0.40	<40	0.94
BCT3	C	-1.00	24/7/09	<20	<0.2	<20	<4	<1	1.6	0.70	170	0.94	0.80	<0.2	8.4	1.6	0.20	<20	0.25
BCT3	C	-1.00	25/7/09	<20	<0.2	<20	<4	<1	1.6	0.70	140	0.85	0.60	0.40	7.6	1.2	<0.1	<20	0.24
BCT3	C	-1.00	4/8/09	<20	<0.2	<20	<4	<1	1.4	0.50	46	0.83	0.80	1.2	28	1.2	<0.1	<20	0.22
BCT3	C	-1.00	21/8/09	<100	<0.7	<100	<2	<3	<0.9	0.30	31	0.96	<0.8	<1	34	<1	<1	<100	0.10
BCT3	C	-1.00	3/9/09	<20	<0.1	<40	<2	<40	3.6	2.2	32	0.91	1.3	1.1	26	0.80	0.16	<20	0.34
BCT4	C	-1.50	21/7/09	<100	<0.1	<100	1.0	1.6	1.2	1.2	30	0.90	1.6	0.40	12	2.0	7.0	<40	0.44
BCT4	C	-1.50	22/7/09	<100	<0.1	<40	1.0	0.80	0.80	0.70	51	0.90	1.2	0.40	12	1.0	9.0	<40	0.66
BCT4	C	-1.50	24/7/09	<20	<0.2	<20	<4	<1	1.2	0.60	27	0.75	0.60	<0.2	12	1.2	0.20	<20	0.22
BCT4	C	-1.50	25/7/09	<20	<0.2	<20	<4	<1	0.80	0.40	23	0.53	0.40	<0.2	7.2	0.80	<0.1	<20	0.16
BCT4	C	-1.50	4/8/09	<20	<0.2	<20	<4	<1	1.0	0.40	14	0.59	0.60	1.0	26	0.80	<0.1	<20	0.21
BCT4	C	-1.50	21/8/09	<50	<0.4	<50	<1	<2	<0.5	0.50	11	0.72	<0.4	<0.5	21	<0.5	<0.5	<50	0.12
BCT4	C	-1.50	3/9/09	<20	<0.1	<40	<2	<40	3.3	0.52	14	0.71	1.0	0.70	28	0.60	0.080	<20	0.25

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
BCT1	C	-0.20	21/7/09	1.2	0.40	<0.4	<0.02	0.56	0.040	2.6	<2	1.0	0.10	68	230	460	62	240	51	13	59	8.8	53	10	26	3.2
BCT1	C	-0.20	22/7/09	1.4	0.60	<0.4	0.020	0.80	0.040	3.6	<2	1.2	0.20	110	510	1000	120	470	97	24	110	16	98	19	48	5.9
BCT1	C	-0.20	24/7/09	1.1	<0.3	<4	<0.01	0.12	<0.02	2.3	0.80	<0.5	<0.2	110	380	820	92	370	74	19	89	13	77	15	39	4.8
BCT1	C	-0.20	25/7/09	1.4	<0.5	<8	<0.01	0.20	<0.04	1.9	0.90	<1	<0.3	57	340	750	83	330	67	17	80	12	68	13	35	4.3
BCT1	C	-0.20	4/8/09	1.4	0.60	<4	<0.01	0.36	0.060	2.8	1.6	<0.5	<0.2	170	450	990	110	460	92	23	100	15	88	17	45	5.7
BCT1	C	-0.20	21/8/09	1.0	<0.2	<2	<0.08	0.30	<0.06	1.8	0.84	<0.7	<0.2	130	340	750	83	330	67	17	75	11	63	12	32	3.8
BCT1	C	-0.20	3/9/09	1.4	<0.2	<0.2	<0.08	5.2	0.040	2.0	<1	0.60	0.28	110	410	910	100	390	76	19	86	14	75	14	39	4.5
BCT2	C	-0.50	21/7/09	1.4	0.40	<0.4	<0.02	0.24	0.020	<0.1	<2	1.1	<0.1	58	1.9	3.9	0.52	2.0	0.44	0.12	0.51	0.080	0.48	0.10	0.22	0.040
BCT2	C	-0.50	22/7/09	1.0	0.40	<0.4	<0.02	0.080	0.020	<0.1	<2	0.70	<0.1	60	1.7	3.6	0.42	1.6	0.36	0.10	0.39	0.070	0.38	0.080	0.20	0.040
BCT2	C	-0.50	24/7/09	0.91	0.90	<1	<0.01	0.11	0.010	0.020	1.0	0.60	<0.1	61	0.60	1.1	0.14	0.50	<0.2	0.020	0.14	0.020	0.10	0.030	0.080	0.010
BCT2	C	-0.50	25/7/09	0.68	0.10	<1	<0.01	<0.01	<0.01	<0.02	0.60	0.20	<0.1	76	0.22	0.51	0.040	0.20	<0.2	<0.02	0.040	<0.01	0.040	<0.01	0.040	<0.01
BCT2	C	-0.50	4/8/09	0.99	<0.1	<4	<0.01	0.080	0.020	<0.05	1.0	<0.5	<0.2	150	0.70	1.5	0.16	0.60	<0.5	<0.04	0.15	0.020	0.10	0.020	<0.1	<0.01
BCT2	C	-0.50	21/8/09	0.60	<0.1	<1	<0.04	<0.2	<0.03	<0.1	0.46	<0.4	<0.1	120	0.27	0.60	0.060	<0.2	<0.1	<0.01	<0.05	<0.02	<0.05	<0.01	<0.04	<0.01
BCT2	C	-0.50	3/9/09	0.54	<0.2	<0.2	<0.08	<0.1	<0.04	0.060	<1	0.40	<0.02	180	4.7	10	1.1	4.5	0.80	0.26	0.86	0.17	0.80	0.19	0.39	0.070
BCT3	C	-1.00	21/7/09	2.2	1.0	<0.4	0.20	1.2	0.22	0.20	<2	1.4	0.10	52	0.58	0.96	0.28	0.64	0.28	0.22	0.30	0.20	0.30	0.21	0.26	0.20
BCT3	C	-1.00	22/7/09	1.0	0.60	<0.4	<0.02	0.12	0.040	<0.1	<2	0.80	<0.1	50	0.76	1.8	0.20	0.76	0.20	0.060	0.24	0.040	0.18	0.040	0.10	0.030
BCT3	C	-1.00	24/7/09	0.95	0.40	<1	<0.01	0.20	0.020	<0.02	0.70	0.40	<0.1	56	0.080	0.20	0.020	<0.1	<0.2	<0.02	0.020	<0.01	0.040	<0.01	<0.04	<0.01
BCT3	C	-1.00	25/7/09	0.81	<0.1	<1	<0.01	0.040	<0.01	<0.02	0.60	<0.2	<0.1	68	0.080	0.32	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCT3	C	-1.00	4/8/09	0.74	<0.1	<1	<0.01	0.040	0.020	<0.02	0.70	<0.2	<0.1	120	0.080	0.24	0.020	<0.1	<0.2	<0.02	0.020	<0.01	0.020	<0.01	<0.04	<0.01
BCT3	C	-1.00	21/8/09	1.0	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.38	<0.7	<0.2	120	<0.05	<0.1	<0.03	<0.3	<0.2	<0.01	<0.1	<0.04	<0.1	<0.01	<0.08	<0.02
BCT3	C	-1.00	3/9/09	0.78	<0.2	<0.2	<0.08	<0.1	0.040	0.040	1.0	0.70	<0.02	100	0.24	0.59	0.060	0.31	0.12	0.050	0.050	0.020	0.050	<0.01	0.060	<0.01
BCT4	C	-1.50	21/7/09	1.2	0.80	<0.4	0.12	0.44	0.16	0.10	<2	1.2	<0.1	56	0.24	0.40	0.14	0.28	0.16	0.12	0.15	0.12	0.20	0.12	0.18	0.12
BCT4	C	-1.50	22/7/09	0.80	0.20	<0.4	<0.02	0.080	0.040	<0.1	<2	0.70	<0.1	54	0.46	0.96	0.12	0.48	0.16	0.040	0.15	0.030	0.14	0.030	0.10	0.020
BCT4	C	-1.50	24/7/09	0.58	0.30	<1	<0.01	0.10	0.010	<0.02	0.70	0.20	<0.1	62	0.020	0.050	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	0.020	<0.01	<0.04	<0.01
BCT4	C	-1.50	25/7/09	0.42	<0.1	<1	<0.01	<0.01	<0.01	<0.02	0.30	<0.2	<0.1	52	<0.02	0.13	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCT4	C	-1.50	4/8/09	0.54	<0.1	<1	<0.01	0.020	0.010	<0.02	0.60	<0.2	<0.1	130	0.020	0.16	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
BCT4	C	-1.50	21/8/09	1.8	<0.1	<1	<0.04	0.80	<0.03	<0.1	0.93	<0.4	<0.1	130	<0.03	<0.05	<0.02	<0.2	<0.1	<0.01	<0.05	<0.02	<0.05	<0.01	<0.04	<0.01
BCT4	C	-1.50	3/9/09	0.44	<0.2	<0.2	<0.08	<0.1	<0.04	<0.02	<1	0.50	<0.02	130	0.070	0.12	0.020	0.090	<0.04	0.11	0.020	<0.01	0.030	<0.01	0.030	<0.01

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
BCT1	C	-0.20	21/7/09	16	2.3	<1	0.18	1.5	1.8	4.0	3.2
BCT1	C	-0.20	22/7/09	31	4.3	<1	0.22	2.1	3.8	6.0	7.2
BCT1	C	-0.20	24/7/09	24	3.3	0.40	0.10	1.4	3.0	2.3	5.0
BCT1	C	-0.20	25/7/09	22	2.9	0.60	<0.1	1.2	2.4	2.6	2.0
BCT1	C	-0.20	4/8/09	30	4.1	0.50	0.10	2.5	2.6	5.8	8.0
BCT1	C	-0.20	21/8/09	23	3.0	0.80	0.050	2.1	6.5	2.9	2.0
BCT1	C	-0.20	3/9/09	25	3.4	0.78	0.40	1.5	3.4	<2	4.4
BCT2	C	-0.50	21/7/09	0.18	0.040	1.0	0.24	0.040	<0.2	<2	<0.4
BCT2	C	-0.50	22/7/09	0.16	0.040	<1	0.14	0.040	<0.2	<2	<0.4
BCT2	C	-0.50	24/7/09	0.060	<0.02	0.64	0.28	0.020	<0.06	0.84	<0.4
BCT2	C	-0.50	25/7/09	<0.02	<0.02	0.28	0.060	<0.02	<0.06	0.40	<0.4
BCT2	C	-0.50	4/8/09	<0.05	<0.05	0.40	0.10	<0.05	<0.2	0.60	<1
BCT2	C	-0.50	21/8/09	<0.03	<0.02	0.70	<0.03	<0.01	<0.03	0.39	<0.2
BCT2	C	-0.50	3/9/09	0.26	0.050	0.060	0.12	0.060	0.020	<2	<0.1
BCT3	C	-1.00	21/7/09	0.26	0.20	2.0	0.72	0.20	<0.2	<2	<0.4
BCT3	C	-1.00	22/7/09	0.12	0.030	<1	0.16	0.020	<0.2	<2	<0.4
BCT3	C	-1.00	24/7/09	<0.02	<0.02	0.36	0.22	<0.02	<0.06	0.40	<0.4
BCT3	C	-1.00	25/7/09	<0.02	<0.02	0.20	0.10	<0.02	<0.06	0.24	<0.4
BCT3	C	-1.00	4/8/09	<0.02	<0.02	0.20	0.080	<0.02	<0.06	0.28	<0.4
BCT3	C	-1.00	21/8/09	<0.06	<0.04	0.80	<0.05	<0.02	<0.05	0.50	<0.4
BCT3	C	-1.00	3/9/09	0.050	<0.01	0.36	0.44	0.030	<0.01	<2	<0.1
BCT4	C	-1.50	21/7/09	0.18	0.12	<1	0.48	0.12	<0.2	<2	<0.4
BCT4	C	-1.50	22/7/09	0.10	0.030	<1	0.18	<0.02	<0.2	<2	<0.4
BCT4	C	-1.50	24/7/09	0.040	<0.02	0.24	0.20	<0.02	<0.06	0.28	<0.4
BCT4	C	-1.50	25/7/09	<0.02	<0.02	0.16	0.080	<0.02	<0.06	0.20	<0.4
BCT4	C	-1.50	4/8/09	<0.02	<0.02	0.20	0.12	<0.02	<0.06	0.20	<0.4
BCT4	C	-1.50	21/8/09	<0.03	<0.02	2.1	0.78	<0.01	<0.03	0.84	<0.2
BCT4	C	-1.50	3/9/09	<0.01	<0.01	0.12	0.28	<0.01	0.020	<2	<0.1

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
PSFWS	FW		22/7/09	<40	<0.04	<10	0.30	1.0	0.40	0.12	1.6	0.060	0.90	1.2	17	0.80	0.30	<20	0.060
PSFW1SW	FW	0.5	22/7/09	<40	<0.04	<10	0.30	1.0	0.40	0.12	1.6	0.070	1.3	1.0	16	0.80	0.20	<20	0.060
PSFW1SW	FW	0.50	22/7/09	<40	<0.04	<10	0.40	0.80	0.40	0.12	1.6	0.090	1.0	1.1	17	0.80	0.20	<20	0.060
PSFW1SW	FW	0.50	22/7/09	<40	<0.04	<10	0.30	0.80	0.80	0.16	2.4	0.12	1.5	1.7	21	1.2	0.40	<20	0.070
PSFW1SW	FW	0.50	22/7/09	<40	<0.04	<10	0.50	<0.2	0.40	0.16	1.6	0.080	0.80	1.1	22	0.40	0.20	<20	0.040
PSFW1SW	FW	0.50	22/7/09	<40	<0.04	<10	0.40	0.40	0.40	0.12	2.0	0.090	1.0	1.3	17	0.80	0.10	<20	0.050
PSFW1SW	FW	0.50	23/7/09	<250	<2	<250	<50	<10	<3	2.0	2600	38	60	6.0	70	5.0	1.0	<250	6.0
PSFW1SW	FW	0.50	23/7/09	<20	<0.2	<20	<4	<1	0.40	<0.1	2.7	0.080	1.2	2.8	18	0.80	0.20	<20	0.020
PSFW1SW	FW	0.50	27/7/09	<20	<0.2	<20	<4	<1	0.40	<0.1	2.8	0.090	1.0	1.4	14	0.80	<0.1	<20	0.040
PSFW1SW	FW	0.50	3/8/09	<20	<0.2	<20	<4	<1	0.60	<0.1	4.1	0.42	1.0	2.0	28	1.2	0.10	<20	0.030
PSFW1SW	FW	0.50	14/8/09	<20	<0.6	<20	0.24	0.20	0.90	0.14	2.5	0.13	1.4	2.9	38	1.2	0.18	<20	0.090
PSFW1SW	FW	0.50	10/9/09	<10	0.18	<20	<1	<20	5.3	0.42	<0.3	0.080	1.5	2.0	47	1.0	0.24	<10	0.060
PSFW2SW	FW	0.50	22/7/09	<40	0.12	<10	0.30	0.60	0.60	0.20	1.6	0.15	1.0	1.2	15	0.80	0.40	<20	0.14
PSFW2SW	FW	0.50	22/7/09	<40	<0.04	<10	0.30	0.60	0.40	0.080	1.2	0.060	0.80	1.0	12	0.40	0.20	<20	0.040
PSFW2SW	FW	0.50	22/7/09	<40	<0.04	<10	0.40	0.60	0.40	0.12	1.2	0.060	1.0	1.1	14	0.40	0.20	<20	0.040
PSFW2SW	FW	0.50	22/7/09	<40	<0.04	<10	0.40	0.60	0.40	0.16	2.8	0.080	1.1	1.4	17	0.80	0.20	<20	0.070
PSFW2SW	FW	0.50	22/7/09	<40	<0.04	<10	0.40	0.60	0.40	0.12	2.4	0.10	1.0	1.2	16	0.80	0.10	<20	0.040
PSFW1SWB	FW	0.05	22/7/09	<40	0.040	70	0.40	2.8	0.40	0.16	1.6	0.090	0.90	1.0	13	0.80	0.30	<20	0.090
PSFW1SWB	FW	0.05	22/7/09	<40	<0.04	<10	0.40	0.40	0.40	0.12	1.6	0.080	0.90	1.1	15	0.80	0.20	<20	0.040
PSFW1SWB	FW	0.05	3/8/09	<20	<0.1	<20	<0.4	<0.6	<0.2	<0.02	<0.2	0.060	<0.2	<0.2	7.0	<0.2	<0.2	<20	0.020
PSFW1SWB	FW	0.05	14/8/09	<20	<0.6	<20	0.24	<0.2	0.60	0.14	1.0	0.090	0.96	2.1	33	0.80	0.060	<20	0.060
PSFW1SWB	FW	0.05	10/9/09	<10	<0.03	<20	<1	<20	6.5	2.7	0.30	0.10	1.5	2.2	55	1.6	0.14	<10	0.070
PSFW1T1	FW	-0.20	23/7/09	300	62	110000	40	2.0	76	160	13000	590	880	120	420	46	3.3	<50	980
PSFW1T1	FW	-0.2	24/7/09	250	56	88000	20	<2	90	120	12000	510	760	71	320	34	3.0	<50	800
PSFW1T1	FW	-0.2	27/7/09	100	52	110000	40	<4	70	120	12000	460	720	91	280	32	2.5	<100	730
PSFW1T1	FW	-0.2	4/8/09	<20	6.2	2700	<4	<1	7.6	4.4	910	42	73	9.6	120	2.0	<0.1	<20	19
PSFW1T1	FW	-0.2	19/8/09	<20	1.3	560	<0.4	<0.6	1.6	0.74	300	12	22	4.2	280	0.20	<0.2	<20	3.4
PSFW1T1	FW	-0.2	3/9/09	<10	0.90	320	<1	<20	2.3	0.74	230	9.5	18	3.5	110	1.1	0.12	<10	3.1
PSFW1T2	FW	-0.5	23/7/09	<50	0.40	100	<10	<2	<0.5	<0.2	2900	18	34	<0.5	37	<1	0.30	<50	15
PSFW1T2	FW	-0.5	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	1000	2.6	4.8	<0.5	20	3.0	<0.3	<50	0.090
PSFW1T2	FW	-0.5	27/7/09	50	3.2	1700	<10	<2	<0.5	0.60	5600	51	90	<0.5	120	3.0	0.90	<50	77
PSFW1T2	FW	-0.5	4/8/09	<100	11	22000	<20	<4	<1	11	9100	150	270	2.0	330	10	0.50	<100	240
PSFW1T2	FW	-0.5	19/8/09	150	11	16000	<1	<2	<0.5	4.4	6600	110	220	2.0	380	3.0	<0.5	<50	150
PSFW1T2	FW	-0.5	3/9/09	20	2.8	1300	2.0	<20	0.90	1.2	1500	18	47	1.3	170	0.90	0.14	<10	10

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
PSFWS	FW		22/7/09	0.30	0.20	<0.2	<0.01	<0.02	0.030	<0.04	<1	0.80	<0.1	110	0.050	0.14	0.010	0.060	0.040	0.010	0.020	<0.01	0.020	<0.01	0.010	<0.01
PSFW1SW	FW	0.5	22/7/09	0.20	0.20	<0.2	<0.01	<0.02	0.010	<0.04	<1	0.60	<0.1	110	0.060	0.14	0.020	0.080	0.020	0.010	0.020	<0.01	0.010	<0.01	<0.01	<0.01
PSFW1SW	FW	0.50	22/7/09	0.40	0.40	<0.2	0.020	<0.02	0.050	0.040	<1	0.70	<0.1	96	0.060	0.14	0.030	0.060	0.040	0.020	0.030	0.020	0.030	0.020	0.020	0.020
PSFW1SW	FW	0.50	22/7/09	0.40	0.30	<0.2	<0.01	<0.02	0.030	0.080	<1	0.80	<0.1	150	0.070	0.14	0.020	0.080	0.040	0.020	0.020	<0.01	0.030	<0.01	0.010	<0.01
PSFW1SW	FW	0.50	22/7/09	0.20	0.10	<0.2	<0.01	<0.02	0.010	0.040	<1	0.60	<0.1	130	0.030	0.080	<0.01	0.040	0.020	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01
PSFW1SW	FW	0.50	22/7/09	0.20	0.10	<0.2	<0.01	<0.02	0.020	0.040	<1	0.60	<0.1	100	0.050	0.10	0.010	0.080	<0.02	<0.01	0.010	<0.01	0.020	<0.01	<0.01	<0.01
PSFW1SW	FW	0.50	23/7/09	5.6	4.0	<20	2.9	2.0	2.4	3.0	5.6	6.0	2.4	72	14	13	2.8	4.0	2.0	2.0	2.4	2.1	2.4	2.0	2.5	2.2
PSFW1SW	FW	0.50	23/7/09	0.33	0.20	<1	0.010	0.010	<0.01	0.080	0.90	0.60	<0.1	130	0.020	0.040	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
PSFW1SW	FW	0.50	27/7/09	0.20	<0.1	<1	<0.01	<0.01	<0.01	0.060	0.50	0.20	<0.1	110	0.040	0.090	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
PSFW1SW	FW	0.50	3/8/09	0.28	0.30	<1	<0.01	<0.01	<0.01	0.040	0.80	0.40	<0.1	160	0.020	0.050	<0.02	<0.1	<0.2	<0.02	<0.02	<0.01	<0.02	<0.01	<0.04	<0.01
PSFW1SW	FW	0.50	14/8/09	0.92	<0.02	<0.2	<0.01	0.040	0.42	0.060	0.96	0.30	<0.02	230	0.040	0.12	0.010	0.040	<0.02	0.020	0.010	<0.01	<0.02	<0.01	0.010	<0.01
PSFW1SW	FW	0.50	10/9/09	0.35	<0.1	<0.1	<0.04	<0.07	0.060	0.050	1.5	0.49	<0.01	200	0.050	0.070	<0.01	0.050	<0.02	0.28	0.010	<0.01	0.020	<0.01	<0.01	<0.01
PSFW2SW	FW	0.50	22/7/09	0.50	0.60	<0.2	0.090	0.020	0.11	0.12	<1	0.80	<0.1	100	0.11	0.16	0.090	0.14	0.10	0.080	0.080	0.070	0.11	0.090	0.080	0.070
PSFW2SW	FW	0.50	22/7/09	0.30	0.20	<0.2	<0.01	<0.02	0.020	<0.04	<1	0.60	<0.1	87	0.030	0.080	<0.01	0.040	<0.02	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PSFW2SW	FW	0.50	22/7/09	0.30	0.10	<0.2	<0.01	<0.02	0.010	<0.04	<1	0.60	<0.1	110	0.040	0.10	<0.01	0.040	<0.02	<0.01	<0.01	<0.01	0.010	<0.01	<0.01	<0.01
PSFW2SW	FW	0.50	22/7/09	0.30	0.20	<0.2	0.010	<0.02	0.040	0.080	<1	0.70	<0.1	110	0.050	0.12	0.020	0.080	0.040	0.020	0.020	0.010	0.030	0.010	0.020	<0.01
PSFW2SW	FW	0.50	22/7/09	0.40	0.40	<0.2	<0.01	0.020	<0.01	<0.04	<1	0.60	<0.1	110	0.030	0.060	0.010	0.040	0.040	0.020	0.010	<0.01	0.010	<0.01	0.010	<0.01
PSFW1SWB	FW	0.05	22/7/09	0.50	0.30	<0.2	0.020	<0.02	0.040	0.040	<1	0.70	<0.1	90	0.090	0.20	0.030	0.10	0.040	0.020	0.030	0.010	0.030	0.020	0.020	0.010
PSFW1SWB	FW	0.05	22/7/09	0.30	0.10	<0.2	<0.01	<0.02	0.020	0.040	<1	0.60	<0.1	100	0.050	0.10	0.010	0.060	<0.02	<0.01	0.020	<0.01	0.010	<0.01	<0.01	<0.01
PSFW1SWB	FW	0.05	3/8/09	<0.1	<0.04	<0.4	0.020	<0.06	0.030	0.080	0.14	<0.1	<0.04	32	0.040	0.020	0.040	<0.06	<0.04	0.040	0.020	0.050	<0.02	0.050	0.040	0.040
PSFW1SWB	FW	0.05	14/8/09	0.56	<0.02	<0.2	<0.01	0.020	0.42	0.080	0.76	0.12	<0.02	170	0.030	0.11	0.010	0.020	<0.02	0.010	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01
PSFW1SWB	FW	0.05	10/9/09	0.18	<0.1	<0.1	<0.04	<0.07	0.040	0.050	1.0	0.49	<0.01	210	0.040	0.080	0.010	0.050	<0.02	0.40	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PSFW1T1	FW	-0.20	23/7/09	1.1	0.60	<4	<0.01	0.36	0.14	7.1	3.0	1.0	<0.2	100	1100	2700	300	1200	260	64	270	39	210	39	100	13
PSFW1T1	FW	-0.2	24/7/09	0.75	<0.3	<4	<0.01	0.32	<0.02	5.4	1.4	<0.5	<0.2	40	880	2200	250	1000	220	53	230	33	180	33	88	11
PSFW1T1	FW	-0.2	27/7/09	1.2	<0.5	<8	<0.01	0.40	<0.04	5.9	1.8	<1	<0.3	42	790	2000	220	910	200	48	200	30	170	30	80	10
PSFW1T1	FW	-0.2	4/8/09	0.27	0.40	<1	<0.01	<0.01	<0.01	0.76	0.90	<0.2	<0.1	160	20	52	5.7	24	5.0	1.2	5.2	0.77	4.2	0.78	2.0	0.25
PSFW1T1	FW	-0.2	19/8/09	<0.1	<0.04	<0.4	<0.02	<0.06	<0.01	0.32	0.78	<0.1	<0.04	230	3.5	8.7	0.98	3.8	0.84	0.21	0.84	0.12	0.70	0.12	0.34	0.030
PSFW1T1	FW	-0.2	3/9/09	0.080	0.10	<0.1	<0.04	<0.07	0.060	0.22	0.70	0.42	0.040	130	3.4	8.7	0.99	3.9	0.90	0.26	0.83	0.14	0.72	0.14	0.36	0.060
PSFW1T2	FW	-0.5	23/7/09	0.57	<0.3	<4	<0.01	0.040	<0.02	<0.05	1.2	<0.5	<0.2	120	19	31	2.6	9.9	1.5	0.36	2.1	0.26	1.6	0.31	0.80	0.090
PSFW1T2	FW	-0.5	24/7/09	0.75	2.1	<4	0.040	0.16	0.040	<0.05	1.4	1.0	<0.2	96	<0.05	0.060	<0.04	<0.3	<0.5	0.040	0.050	<0.02	<0.05	0.020	<0.1	0.020
PSFW1T2	FW	-0.5	27/7/09	0.54	<0.1	<4	<0.01	<0.04	0.040	0.10	0.80	<0.5	<0.2	150	78	160	16	64	13	3.2	15	2.3	13	2.5	6.4	0.78
PSFW1T2	FW	-0.5	4/8/09	1.1	<0.5	<8	<0.01	<0.1	<0.04	<0.1	1.5	<1	<0.3	180	240	490	48	190	37	9.3	48	6.8	39	7.5	20	2.3
PSFW1T2	FW	-0.5	19/8/09	<0.3	<0.1	<1	<0.04	<0.2	<0.03	0.10	1.1	<0.4	<0.1	110	130	260	24	92	18	4.6	24	3.5	21	4.2	10	1.2
PSFW1T2	FW	-0.5	3/9/09	0.090	<0.1	<0.1	<0.04	<0.07	0.020	0.060	0.60	0.35	0.010	210	9.0	18	1.7	7.0	1.3	0.48	1.9	0.29	1.6	0.30	0.86	0.10

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
PSFWS	FW		22/7/09	0.010	<0.01	<0.5	0.050	<0.01	<0.1	<1	<0.2
PSFW1SW	FW	0.5	22/7/09	0.010	<0.01	<0.5	0.040	<0.01	<0.1	<1	<0.2
PSFW1SW	FW	0.50	22/7/09	0.030	0.020	<0.5	0.10	0.030	<0.1	<1	<0.2
PSFW1SW	FW	0.50	22/7/09	0.020	0.010	<0.5	0.070	0.020	<0.1	<1	0.40
PSFW1SW	FW	0.50	22/7/09	0.010	<0.01	<0.5	0.040	<0.01	<0.1	<1	<0.2
PSFW1SW	FW	0.50	22/7/09	0.010	<0.01	<0.5	0.030	<0.01	<0.1	<1	<0.2
PSFW1SW	FW	0.50	23/7/09	2.1	2.1	4.5	6.6	3.0	3.2	4.0	<5
PSFW1SW	FW	0.50	23/7/09	<0.02	<0.02	0.24	0.26	0.020	<0.06	0.28	<0.4
PSFW1SW	FW	0.50	27/7/09	<0.02	<0.02	0.16	0.020	<0.02	<0.06	0.20	<0.4
PSFW1SW	FW	0.50	3/8/09	<0.02	<0.02	0.24	0.040	<0.02	<0.06	0.28	<0.4
PSFW1SW	FW	0.50	14/8/09	<0.01	<0.01	1.3	0.28	<0.01	0.12	0.53	0.42
PSFW1SW	FW	0.50	10/9/09	<0.01	<0.01	0.30	0.22	0.030	0.020	<1	0.45
PSFW2SW	FW	0.50	22/7/09	0.10	0.090	<0.5	0.22	0.11	<0.1	<1	0.20
PSFW2SW	FW	0.50	22/7/09	0.010	<0.01	<0.5	0.050	<0.01	<0.1	<1	<0.2
PSFW2SW	FW	0.50	22/7/09	<0.01	<0.01	<0.5	0.040	<0.01	<0.1	<1	<0.2
PSFW2SW	FW	0.50	22/7/09	0.020	0.010	<0.5	0.040	0.020	<0.1	<1	<0.2
PSFW2SW	FW	0.50	22/7/09	0.020	<0.01	<0.5	0.16	0.020	<0.1	<1	<0.2
PSFW1SWB	FW	0.05	22/7/09	0.030	0.020	<0.5	0.080	0.020	<0.1	<1	<0.2
PSFW1SWB	FW	0.05	22/7/09	0.010	<0.01	<0.5	0.030	<0.01	<0.1	<1	<0.2
PSFW1SWB	FW	0.05	3/8/09	0.030	0.040	0.16	0.12	<0.01	0.030	0.15	<0.08
PSFW1SWB	FW	0.05	14/8/09	<0.01	<0.01	0.83	0.16	<0.01	0.10	0.38	0.18
PSFW1SWB	FW	0.05	10/9/09	<0.01	<0.01	0.12	0.10	0.020	0.040	<1	0.40
PSFW1T1	FW	-0.20	23/7/09	72	9.6	0.70	0.80	2.5	1.4	75	240
PSFW1T1	FW	-0.2	24/7/09	56	7.4	0.50	0.15	1.5	0.20	44	170
PSFW1T1	FW	-0.2	27/7/09	54	7.4	0.80	0.20	2.0	<0.3	55	200
PSFW1T1	FW	-0.2	4/8/09	1.5	0.18	0.16	0.060	0.62	0.42	0.60	12
PSFW1T1	FW	-0.2	19/8/09	0.24	0.020	0.12	0.29	0.41	0.90	0.25	2.4
PSFW1T1	FW	-0.2	3/9/09	0.28	0.060	0.090	0.30	0.34	0.29	<1	2.3
PSFW1T2	FW	-0.5	23/7/09	0.40	<0.05	0.40	0.30	<0.05	<0.2	1.4	<1
PSFW1T2	FW	-0.5	24/7/09	0.050	<0.05	0.50	0.60	0.050	<0.2	1.0	<1
PSFW1T2	FW	-0.5	27/7/09	3.9	0.55	0.40	0.050	<0.05	<0.2	0.90	<1
PSFW1T2	FW	-0.5	4/8/09	12	1.4	0.60	0.20	<0.1	<0.3	1.4	<2
PSFW1T2	FW	-0.5	19/8/09	6.1	0.78	0.40	0.51	0.090	0.51	3.0	<0.2
PSFW1T2	FW	-0.5	3/9/09	0.58	0.080	0.12	0.16	0.020	0.18	1.0	<0.05

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
PSFW1T3	FW	-1	23/7/09	<100	<1	<100	<20	<4	<1	<0.3	240	0.52	<1	<1	6.0	<2	<0.5	<100	0.50
PSFW1T3	FW	-1	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	230	0.66	1.2	<0.5	7.0	3.0	<0.3	<50	0.30
PSFW1T3	FW	-1	27/7/09	<50	<0.4	150	<10	<2	<0.5	<0.2	260	2.9	5.2	<0.5	20	2.0	<0.3	<50	1.4
PSFW1T3	FW	-1	4/8/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	490	0.50	0.40	1.0	15	2.0	<0.3	<50	0.36
PSFW1T3	FW	-1	19/8/09	<100	<0.7	100	<2	<3	<0.9	<0.1	500	1.5	<0.8	<1	60	<1	<1	<100	1.9
PSFW1T3	FW	-1	3/9/09	<20	0.30	<40	<2	<40	1.9	0.080	250	0.18	0.96	0.80	54	0.40	0.080	<20	0.10
PSFW1T4	FW	-1.5	23/7/09	<100	<1	<100	<20	<4	<1	<0.3	240	0.16	<1	<1	12	<2	<0.5	<100	<0.1
PSFW1T4	FW	-1.5	24/7/09	<100	<1	400	<20	<4	<1	0.90	590	5.2	8.0	2.0	26	8.0	<0.5	<100	2.8
PSFW1T4	FW	-1.5	27/7/09	<100	<1	<100	<20	<4	<1	<0.3	260	0.20	1.0	<1	10	4.0	<0.5	<100	0.10
PSFW1T4	FW	-1.5	4/8/09	<50	<0.4	<50	<10	<2	<0.5	0.20	240	0.70	8.0	2.0	30	2.0	<0.3	<50	0.57
PSFW1T4	FW	-1.5	3/9/09	<30	<0.1	<60	<3	<60	2.8	0.36	170	0.24	1.6	3.2	390	0.90	<0.06	<30	0.10
PSSW1SW	SW	0.5	22/7/09	<500	<0.5	<1000	10	<3	<3	2.0	90	1.1	3.0	3.0	22	5.0	48	<300	2.1
PSSW1SW	SW	0.50	22/7/09	<500	0.50	<500	6.0	<3	<3	1.5	40	0.60	2.0	2.0	20	5.0	5.0	<300	1.1
PSSW1SW	SW	0.50	22/7/09	<500	1.5	<1000	10	<3	<3	5.0	10	0.90	2.0	3.0	16	<5	<1	<300	1.1
PSSW1SW	SW	0.50	22/7/09	<500	<0.5	<1000	10	<3	<3	<0.5	10	0.40	1.0	2.0	14	<5	<1	<300	0.70
PSSW1SW	SW	0.50	22/7/09	<500	0.50	<1000	10	<3	<3	<0.5	10	0.50	2.0	2.0	22	5.0	2.0	<300	0.80
PSSW1SW	SW	0.50	23/7/09	<200	<2	<200	<40	<8	<2	<0.6	38	1.4	<2	2.0	24	<4	<1	<200	1.9
PSSW1SW	SW	0.5	24/7/09	<200	<2	<200	<40	<8	<2	<0.6	74	2.9	4.0	2.0	48	<4	<1	<200	2.9
PSSW1SW	SW	0.5	27/7/09	<200	<2	<200	<40	<8	<2	<0.6	90	3.3	4.0	2.0	12	<4	<1	<200	3.5
PSSW1SW	SW	0.5	3/8/09	<250	<2	<250	<5	<8	<2	<0.3	74	2.6	<2	<3	63	<3	<3	<250	2.6
PSSW1SW	SW	0.5	14/8/09	<250	<8	<250	3.0	<3	<2	<0.2	58	2.4	3.0	14	76	<3	<0.8	<250	2.2
PSSW1SW	SW	0.5	19/8/09	<250	<8	<250	3.0	<3	<2	<0.2	44	1.5	2.5	13	50	<3	<0.8	<250	2.0
PSSW1SW	SW	0.5	10/9/09	<200	<0.6	<400	<20	<400	41	0.80	36	1.9	8.4	4.0	60	4.0	<0.4	<200	2.6
PSSW2SW	SW	0.5	22/7/09	<500	<0.5	<1000	10	<3	<3	1.0	10	0.50	1.0	2.0	30	<5	<1	<300	0.60
PSSW2SW	SW	0.50	22/7/09	<500	<0.5	<1000	10	<3	<3	<0.5	10	0.40	<1	1.0	26	<5	<1	<300	0.60
PSSW2SW	SW	0.50	22/7/09	<500	<0.5	<1000	10	<3	<3	1.5	15	0.50	2.0	2.0	22	<5	<1	<300	0.80
PSSW2SW	SW	0.50	22/7/09	<500	1.5	<1000	10	<3	<3	2.0	15	0.60	2.0	3.0	26	5.0	<1	<300	0.90
PSSW2SW	SW	0.50	3/8/09	<250	<2	<250	<5	<8	<2	<0.3	84	3.4	<2	<3	66	<3	<3	<250	2.6
PSSW1SWB	SW	0.05	22/7/09	<500	<0.5	<1000	10	<3	<3	<0.5	15	0.30	2.0	2.0	26	5.0	2.0	<300	0.60
PSSW1SWB	SW	0.05	22/7/09	<500	<0.5	<1000	10	<3	<3	1.5	5.0	0.30	<1	2.0	16	<5	3.0	<300	0.50
PSSW1SWB	SW	0.05	3/8/09	<250	<2	<250	<5	<8	<2	<0.3	66	2.4	<2	<3	63	<3	<3	<250	2.2
PSSW1SWB	SW	0.05	14/8/09	<250	<8	<250	3.0	<3	<2	1.4	53	2.0	3.5	7.2	66	<3	1.6	<250	2.2
PSSW1SWB	SW	0.05	19/8/09	<250	<8	<250	3.0	<3	<2	<0.2	52	1.7	2.5	1.6	64	<3	<0.8	<250	2.1
PSSW1SWB	SW	0.05	10/9/09	<200	<0.6	<400	<20	<400	37	0.40	36	1.8	9.6	4.0	40	<2	<0.4	<200	1.9

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
PSFW1T3	FW	-1	23/7/09	1.2	<0.5	<8	<0.01	1.0	<0.04	<0.1	1.5	<1	<0.3	84	0.50	1.3	0.16	<0.5	<1	<0.08	<0.1	<0.03	<0.1	<0.02	<0.2	<0.02
PSFW1T3	FW	-1	24/7/09	0.84	1.5	<4	0.050	0.24	0.040	0.10	1.6	1.0	<0.2	82	0.20	0.42	0.080	<0.3	<0.5	0.040	0.10	0.020	0.050	0.030	<0.1	0.030
PSFW1T3	FW	-1	27/7/09	0.66	<0.1	<4	<0.01	<0.04	<0.02	<0.05	0.80	<0.5	<0.2	78	1.2	2.6	0.28	1.2	<0.5	<0.04	0.20	0.020	0.20	0.040	0.10	0.010
PSFW1T3	FW	-1	4/8/09	0.69	<0.1	<4	<0.01	<0.04	<0.02	<0.05	1.0	<0.5	<0.2	160	0.30	0.69	0.040	<0.3	<0.5	<0.04	0.050	<0.02	<0.05	<0.01	<0.1	<0.01
PSFW1T3	FW	-1	19/8/09	<0.5	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.72	<0.7	<0.2	68	1.7	3.4	0.30	0.90	<0.2	<0.01	0.20	<0.04	0.20	0.030	0.080	<0.02
PSFW1T3	FW	-1	3/9/09	0.18	<0.2	<0.2	<0.08	<0.1	<0.04	0.040	<1	0.60	<0.02	92	0.080	0.16	<0.01	0.040	<0.04	0.070	0.010	<0.01	0.020	<0.01	<0.01	<0.01
PSFW1T4	FW	-1.5	23/7/09	1.1	<0.5	<8	<0.01	0.30	<0.04	<0.1	0.90	<1	<0.3	93	<0.1	0.24	<0.08	<0.5	<1	<0.08	<0.1	<0.03	<0.1	<0.02	<0.2	<0.02
PSFW1T4	FW	-1.5	24/7/09	1.6	3.0	<8	0.15	0.40	0.12	0.20	2.1	2.0	<0.3	96	2.8	6.1	0.80	3.0	<1	0.24	0.80	0.15	0.80	0.16	0.40	0.12
PSFW1T4	FW	-1.5	27/7/09	1.4	3.0	<8	<0.01	2.3	0.16	<0.1	2.1	2.0	<0.3	110	0.10	0.24	<0.08	<0.5	<1	<0.08	<0.1	<0.03	<0.1	<0.02	<0.2	<0.02
PSFW1T4	FW	-1.5	4/8/09	0.87	0.60	<4	<0.01	0.12	<0.02	<0.05	2.0	<0.5	<0.2	68	0.50	1.1	0.12	0.30	<0.5	<0.04	0.10	<0.02	0.050	<0.01	<0.1	<0.01
PSFW1T4	FW	-1.5	3/9/09	0.30	<0.3	<0.3	<0.1	<0.2	<0.06	0.21	<2	0.80	<0.03	560	0.040	0.14	<0.01	0.040	<0.06	0.26	<0.02	<0.01	<0.01	<0.01	<0.02	<0.01
PSSW1SW	SW	0.5	22/7/09	3.0	2.0	<2	0.20	0.30	0.20	<0.5	<10	6.0	<1	40	1.8	3.3	0.50	1.8	0.90	0.30	0.80	0.16	0.60	0.15	0.50	0.12
PSSW1SW	SW	0.50	22/7/09	3.0	2.0	<2	0.20	0.30	0.10	<0.5	<10	5.0	<1	20	0.80	1.5	0.30	1.2	0.90	0.20	0.60	0.12	0.40	0.12	0.30	0.12
PSSW1SW	SW	0.50	22/7/09	3.0	4.0	<2	0.60	0.30	0.80	1.0	<10	5.0	<1	40	1.0	1.2	0.80	1.2	0.90	0.70	0.80	0.70	0.80	0.69	0.80	0.66
PSSW1SW	SW	0.50	22/7/09	2.0	2.0	<2	0.20	<0.3	0.30	<0.5	<10	4.0	<1	40	0.60	0.90	0.30	0.60	0.60	0.30	0.40	0.24	0.40	0.21	0.30	0.24
PSSW1SW	SW	0.50	22/7/09	3.0	3.0	<2	0.30	0.60	0.20	<0.5	<10	5.0	<1	60	0.80	1.2	0.30	0.90	0.60	0.20	0.40	0.14	0.40	0.15	0.30	0.12
PSSW1SW	SW	0.50	23/7/09	2.1	<1	<10	<0.02	<0.1	0.080	<0.2	1.8	<2	<0.6	36	2.6	4.1	0.60	2.0	<2	<0.2	0.20	0.12	<0.2	0.080	<0.4	0.080
PSSW1SW	SW	0.5	24/7/09	2.0	<1	<10	<0.02	<0.1	<0.08	<0.2	1.8	<2	<0.6	110	4.8	6.6	1.0	3.0	<2	<0.2	0.40	<0.06	<0.2	0.040	<0.4	<0.04
PSSW1SW	SW	0.5	27/7/09	1.9	<1	<10	<0.02	<0.1	<0.08	<0.2	1.8	<2	<0.6	<6	6.4	8.3	0.80	3.0	<2	<0.2	0.20	<0.06	<0.2	<0.04	<0.4	<0.04
PSSW1SW	SW	0.5	3/8/09	<1	<0.5	<5	<0.2	<0.8	<0.2	<0.5	0.55	<2	<0.5	96	3.8	1.8	0.57	2.4	<0.5	<0.03	<0.3	<0.1	<0.3	<0.03	<0.2	<0.05
PSSW1SW	SW	0.5	14/8/09	2.1	<0.2	<2	<0.2	<0.3	5.3	0.60	3.0	<0.8	<0.3	140	2.6	1.1	0.50	1.8	0.30	0.16	0.40	0.12	0.40	0.15	0.20	0.11
PSSW1SW	SW	0.5	19/8/09	1.8	<0.2	<2	<0.2	<0.3	5.8	0.40	2.0	<0.8	<0.3	40	1.9	0.90	0.45	1.3	<0.3	0.24	0.40	0.15	0.40	0.16	0.20	0.13
PSSW1SW	SW	0.5	10/9/09	<0.2	<2	<2	<0.8	<1	<0.4	<0.2	<10	5.0	<0.2	84	1.3	0.16	0.40	1.3	<0.4	0.30	0.50	<0.06	0.12	<0.06	<0.1	<0.04
PSSW2SW	SW	0.5	22/7/09	2.0	2.0	<2	<0.1	<0.3	0.10	<0.5	<10	4.0	<1	80	0.80	1.2	0.20	0.90	0.60	0.20	<0.2	0.10	0.20	0.060	0.20	0.060
PSSW2SW	SW	0.50	22/7/09	2.0	2.0	<2	<0.1	<0.3	<0.1	<0.5	<10	4.0	<1	60	0.60	0.90	0.10	0.60	0.30	0.10	0.20	0.060	0.20	0.060	0.20	0.060
PSSW2SW	SW	0.50	22/7/09	3.0	2.0	<2	<0.1	<0.3	0.10	<0.5	<10	4.0	<1	40	0.80	1.2	0.20	0.90	0.30	0.20	0.40	0.080	0.40	0.090	0.20	0.060
PSSW2SW	SW	0.50	22/7/09	3.0	2.0	<2	0.10	0.30	0.20	<0.5	<10	5.0	<1	40	1.0	1.2	0.20	1.2	0.90	0.20	0.40	0.10	0.40	0.090	0.20	0.090
PSSW2SW	SW	0.50	3/8/09	<1	<0.5	<5	<0.2	<0.8	<0.2	<0.5	2.1	<2	<0.5	78	4.1	2.7	0.75	2.4	<0.5	0.12	0.30	0.10	<0.3	0.18	0.20	0.10
PSSW1SWB	SW	0.05	22/7/09	3.0	2.0	<2	0.20	0.30	<0.1	<0.5	<10	4.0	<1	80	0.40	0.60	0.20	0.90	0.60	0.20	0.40	0.10	0.40	0.12	0.30	0.090
PSSW1SWB	SW	0.05	22/7/09	2.0	2.0	<2	<0.1	<0.3	0.10	<0.5	<10	3.0	<1	20	0.60	0.60	0.20	0.60	0.30	0.10	<0.2	0.10	<0.2	0.090	0.20	0.090
PSSW1SWB	SW	0.05	3/8/09	<1	<0.5	<5	<0.2	<0.8	<0.2	<0.5	0.25	<2	<0.5	54	3.1	1.5	0.42	1.6	<0.5	<0.03	<0.3	<0.1	<0.3	<0.03	<0.2	<0.05
PSSW1SWB	SW	0.05	14/8/09	1.8	<0.2	<2	<0.2	<0.3	3.5	0.40	2.0	<0.8	<0.3	96	2.4	0.90	0.45	1.5	0.30	0.16	0.40	0.090	0.20	0.11	0.20	0.070
PSSW1SWB	SW	0.05	19/8/09	1.8	<0.2	<2	<0.2	<0.3	0.030	0.40	2.0	<0.8	<0.3	80	2.2	0.90	0.40	1.7	<0.3	0.16	0.30	0.030	0.20	0.070	0.20	0.050
PSSW1SWB	SW	0.05	10/9/09	0.20	<2	<2	<0.8	<1	<0.4	0.20	<10	4.0	<0.2	72	1.3	<0.08	<0.08	0.68	<0.4	0.20	0.20	<0.06	<0.06	<0.06	<0.1	<0.04

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
PSFW1T3	FW	-1	23/7/09	<0.1	<0.1	0.80	0.70	<0.1	<0.3	1.2	<2
PSFW1T3	FW	-1	24/7/09	0.10	0.050	0.60	0.40	<0.05	<0.2	0.80	<1
PSFW1T3	FW	-1	27/7/09	0.050	<0.05	0.30	0.10	<0.05	<0.2	0.60	<1
PSFW1T3	FW	-1	4/8/09	<0.05	<0.05	0.40	0.10	<0.05	<0.2	0.60	<1
PSFW1T3	FW	-1	19/8/09	<0.06	<0.04	0.60	0.70	0.040	<0.05	0.95	<0.4
PSFW1T3	FW	-1	3/9/09	<0.01	<0.01	0.18	0.24	<0.01	0.11	<2	<0.1
PSFW1T4	FW	-1.5	23/7/09	<0.1	<0.1	0.60	0.50	<0.1	<0.3	1.0	<2
PSFW1T4	FW	-1.5	24/7/09	0.40	0.20	1.0	0.60	0.10	<0.3	1.4	<2
PSFW1T4	FW	-1.5	27/7/09	<0.1	<0.1	0.80	1.3	<0.1	<0.3	1.2	<2
PSFW1T4	FW	-1.5	4/8/09	<0.05	<0.05	0.50	0.20	<0.05	<0.2	0.70	<1
PSFW1T4	FW	-1.5	3/9/09	<0.02	<0.04	0.20	0.30	<0.02	<0.02	<3	<0.2
PSSW1SW	SW	0.5	22/7/09	0.60	0.20	<2	0.80	0.20	<1	<5	<3
PSSW1SW	SW	0.50	22/7/09	0.50	0.20	<2	0.40	0.20	<1	<5	<3
PSSW1SW	SW	0.50	22/7/09	0.90	0.80	<2	2.4	0.90	<1	<5	<3
PSSW1SW	SW	0.50	22/7/09	0.40	0.20	<2	1.2	0.30	<1	<5	<3
PSSW1SW	SW	0.50	22/7/09	0.40	0.20	<2	1.0	0.20	<1	<5	<3
PSSW1SW	SW	0.50	23/7/09	<0.2	<0.2	1.6	1.0	<0.2	-0.33	2.0	<4
PSSW1SW	SW	0.5	24/7/09	<0.2	<0.2	1.2	0.20	<0.2	-0.73	2.0	<4
PSSW1SW	SW	0.5	27/7/09	<0.2	<0.2	1.2	<0.2	<0.2	-0.50	2.0	<4
PSSW1SW	SW	0.5	3/8/09	<0.2	<0.1	1.0	<0.1	<0.05	<0.1	1.4	<1
PSSW1SW	SW	0.5	14/8/09	0.27	0.12	1.7	1.7	<0.1	<0.08	2.0	<0.8
PSSW1SW	SW	0.5	19/8/09	0.24	0.18	1.2	1.0	<0.1	<0.08	2.0	<0.8
PSSW1SW	SW	0.5	10/9/09	<0.1	<0.04	<0.6	0.80	0.20	<0.1	<20	<1
PSSW2SW	SW	0.5	22/7/09	0.30	0.10	<2	0.60	0.20	<1	<5	<3
PSSW2SW	SW	0.50	22/7/09	0.30	<0.1	<2	0.40	0.10	<1	<5	<3
PSSW2SW	SW	0.50	22/7/09	0.30	0.10	<2	0.60	0.10	<1	<5	<3
PSSW2SW	SW	0.50	22/7/09	0.40	0.20	<2	0.60	0.20	<1	<5	<3
PSSW2SW	SW	0.50	3/8/09	<0.2	<0.1	1.5	2.2	0.050	<0.1	2.1	<1
PSSW1SWB	SW	0.05	22/7/09	0.40	0.20	<2	0.40	0.10	<1	<5	<3
PSSW1SWB	SW	0.05	22/7/09	0.20	0.10	<2	0.60	0.10	<1	<5	<3
PSSW1SWB	SW	0.05	3/8/09	<0.2	<0.1	1.0	<0.1	<0.05	<0.1	1.3	<1
PSSW1SWB	SW	0.05	14/8/09	0.18	0.090	1.3	1.3	<0.1	<0.08	2.0	<0.8
PSSW1SWB	SW	0.05	19/8/09	0.15	0.060	1.2	0.96	<0.1	<0.08	2.0	<0.8
PSSW1SWB	SW	0.05	10/9/09	<0.1	<0.04	<0.6	0.80	0.20	<0.1	<20	<1

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
PSSW1T1	SW	-0.20	23/7/09	<100	39	93000	18	<3	77	110	12000	440	660	60	390	32	<1	<100	720
PSSW1T1	SW	-0.2	24/7/09	250	60	110000	30	<2	77	150	12000	540	820	110	380	37	4.5	<50	880
PSSW1T1	SW	-0.2	4/8/09	<100	49	110000	40	<4	93	160	8200	450	710	92	380	46	5.0	<100	1100
PSSW1T1	SW	-0.2	19/8/09	<250	8.0	74000	8.0	<3	90	85	4800	210	320	68	300	27	3.2	<250	610
PSSW1T1	SW	-0.2	3/9/09	<100	8.1	36000	<10	<200	95	50	3000	110	170	63	330	30	2.2	<100	390
PSSW1T2	SW	-0.5	23/7/09	<100	<0.7	400	<2	<3	<0.9	0.20	880	3.5	3.2	<1	87	<1	<1	<100	3.6
PSSW1T2	SW	-0.5	24/7/09	50	2.4	350	<10	<2	<0.5	0.40	4200	39	71	0.50	110	3.0	0.30	<50	54
PSSW1T2	SW	-0.5	4/8/09	<50	<0.4	250	<10	<2	<0.5	<0.2	2000	5.7	10	1.0	54	<1	<0.3	<50	3.0
PSSW1T2	SW	-0.5	19/8/09	<100	<3	<100	1.2	<1	<0.7	<0.07	4200	6.8	15	0.30	68	<1	0.30	<100	2.6
PSSW1T2	SW	-0.5	3/9/09	40	0.60	320	<4	80	2.4	0.080	8100	7.6	21	1.8	72	1.2	0.16	<40	33
PSSW1T3	SW	-1	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	210	0.54	0.80	1.0	19	2.0	<0.3	<50	0.57
PSSW1T3	SW	-1	4/8/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	250	0.34	<0.4	0.50	11	<1	<0.3	<50	0.33
PSSW1T3	SW	-1	19/8/09	<100	<3	<100	1.6	<1	<0.7	0.28	1400	0.40	0.80	3.3	59	<1	0.30	<100	0.40
PSSW1T3	SW	-1	3/9/09	<20	<0.1	<40	<2	<40	2.2	0.48	70	0.77	0.96	0.90	86	0.60	0.040	<20	0.41
PSSW1T4	SW	-1.5	23/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	230	0.14	<0.4	<0.5	18	2.0	<0.3	<50	0.12
PSSW1T4	SW	-1.5	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	610	0.16	<0.4	0.50	50	1.0	<0.3	<50	0.18
PSSW1T4	SW	-1.5	4/8/09	<100	<0.7	<100	<2	<3	<0.9	<0.1	1200	<0.08	<0.8	2.0	66	<1	<1	<100	<0.05
PSSW1T4	SW	-1.5	19/8/09	<100	<0.7	200	<2	<3	<0.9	0.30	350	2.7	1.6	<1	52	<1	<1	<100	1.5
PSSW1T4	SW	-1.5	3/9/09	<50	<0.2	<100	<5	<100	2.8	<0.1	2200	0.080	0.40	1.2	45	0.50	<0.1	<50	0.060

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
PSSW1T1	SW	-0.20	23/7/09	<0.5	<0.2	<2	<0.08	1.2	<0.06	4.6	1.3	<0.7	<0.2	89	780	2000	210	860	190	44	190	27	150	27	71	8.6
PSSW1T1	SW	-0.2	24/7/09	0.93	<0.3	<4	<0.01	0.36	0.12	6.8	1.0	<0.5	<0.2	100	970	2400	270	1100	250	60	250	37	210	38	100	13
PSSW1T1	SW	-0.2	4/8/09	1.3	1.5	<8	<0.01	0.50	0.60	5.1	2.7	1.0	<0.3	160	1100	2900	320	1300	270	63	270	39	220	41	110	14
PSSW1T1	SW	-0.2	19/8/09	1.5	<0.2	<2	<0.2	0.60	0.72	2.2	4.0	<0.8	<0.3	72	670	1700	190	780	160	37	160	22	130	24	63	8.3
PSSW1T1	SW	-0.2	3/9/09	0.20	<1	<1	<0.4	3.5	1.4	0.90	<5	2.0	0.30	190	420	1100	120	510	100	24	100	16	78	15	41	5.2
PSSW1T2	SW	-0.5	23/7/09	<0.5	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.76	<0.7	<0.2	140	3.9	10	1.0	3.9	0.60	0.17	0.90	0.080	0.60	0.10	0.32	<0.02
PSSW1T2	SW	-0.5	24/7/09	0.54	<0.3	<4	<0.01	<0.04	<0.02	<0.05	0.80	<0.5	<0.2	200	61	120	12	45	8.0	2.0	11	1.5	8.6	1.7	4.3	0.47
PSSW1T2	SW	-0.5	4/8/09	0.57	<0.1	<4	<0.01	<0.04	<0.02	<0.05	1.2	<0.5	<0.2	150	3.4	7.5	0.76	3.0	<0.5	0.12	0.60	0.080	0.45	0.090	0.20	0.020
PSSW1T2	SW	-0.5	19/8/09	0.70	<0.08	<0.8	<0.06	<0.1	0.080	<0.08	1.4	<0.3	<0.1	150	4.4	3.8	0.26	0.84	<0.1	0.030	0.20	0.020	0.080	0.030	0.040	<0.01
PSSW1T2	SW	-0.5	3/9/09	0.16	<0.4	<0.4	<0.2	<0.3	<0.08	<0.04	<2	0.90	<0.04	210	33	53	4.4	16	2.5	0.68	4.1	0.57	3.2	0.68	1.8	0.18
PSSW1T3	SW	-1	24/7/09	0.84	1.8	<4	<0.01	0.72	0.10	0.10	1.6	1.0	<0.2	160	0.45	0.99	0.20	0.60	<0.5	0.080	0.15	0.080	0.10	0.060	0.10	0.070
PSSW1T3	SW	-1	4/8/09	0.60	<0.1	<4	<0.01	0.28	<0.02	<0.05	0.80	<0.5	<0.2	140	0.35	0.90	0.080	0.30	<0.5	<0.04	0.050	<0.02	<0.05	<0.01	<0.1	<0.01
PSSW1T3	SW	-1	19/8/09	1.2	0.32	<0.8	0.24	0.30	1.7	0.32	2.0	<0.3	<0.1	93	0.42	0.72	0.28	0.40	0.20	0.24	0.24	0.22	0.24	0.23	0.24	0.23
PSSW1T3	SW	-1	3/9/09	0.46	<0.2	<0.2	<0.08	<0.1	<0.04	0.040	<1	0.50	<0.02	180	0.32	0.65	0.060	0.29	0.040	0.090	0.050	<0.01	0.040	<0.01	0.030	<0.01
PSSW1T4	SW	-1.5	23/7/09	0.75	1.2	<4	0.010	0.24	0.020	<0.05	1.4	0.50	<0.2	160	0.10	0.18	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PSSW1T4	SW	-1.5	24/7/09	0.63	<0.1	<4	<0.01	0.16	<0.02	<0.05	0.80	<0.5	<0.2	180	0.15	0.36	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PSSW1T4	SW	-1.5	4/8/09	1.0	<0.2	<2	<0.08	1.8	<0.06	<0.2	1.9	<0.7	<0.2	110	<0.05	<0.1	<0.03	<0.3	<0.2	<0.01	<0.1	<0.04	<0.1	<0.01	<0.08	<0.02
PSSW1T4	SW	-1.5	19/8/09	<0.5	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.56	<0.7	<0.2	150	1.3	3.1	0.30	0.90	<0.2	<0.01	0.20	<0.04	0.10	<0.01	<0.08	<0.02
PSSW1T4	SW	-1.5	3/9/09	0.10	<0.5	<0.5	<0.2	<0.4	<0.1	<0.05	<3	0.80	<0.05	190	<0.04	0.020	<0.02	0.020	<0.1	0.12	<0.03	<0.02	<0.02	<0.02	<0.03	<0.01

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
PSSW1T1	SW	-0.20	23/7/09	53	7.2	1.2	0.15	1.4	1.5	39	130
PSSW1T1	SW	-0.2	24/7/09	65	8.9	0.50	0.15	2.4	1.2	66	230
PSSW1T1	SW	-0.2	4/8/09	80	11	0.80	0.30	4.2	1.8	32	150
PSSW1T1	SW	-0.2	19/8/09	51	7.0	1.1	1.0	4.3	3.0	10	59
PSSW1T1	SW	-0.2	3/9/09	33	4.7	0.60	0.80	3.5	5.2	<10	29
PSSW1T2	SW	-0.5	23/7/09	0.18	<0.04	0.80	<0.05	<0.02	<0.05	1.2	<0.4
PSSW1T2	SW	-0.5	24/7/09	2.2	0.25	0.40	<0.05	<0.05	<0.2	1.1	<1
PSSW1T2	SW	-0.5	4/8/09	0.10	<0.05	0.40	<0.05	<0.05	<0.2	1.3	<1
PSSW1T2	SW	-0.5	19/8/09	0.030	0.020	0.45	0.24	<0.04	<0.03	1.5	<0.3
PSSW1T2	SW	-0.5	3/9/09	1.0	0.16	<0.1	0.16	0.020	0.20	<4	<0.2
PSSW1T3	SW	-1	24/7/09	0.10	0.050	0.60	0.70	0.10	<0.2	0.80	<1
PSSW1T3	SW	-1	4/8/09	<0.05	<0.05	0.40	0.050	<0.05	<0.2	0.60	<1
PSSW1T3	SW	-1	19/8/09	0.28	0.23	1.0	2.1	<0.04	<0.03	1.0	<0.3
PSSW1T3	SW	-1	3/9/09	0.020	<0.01	0.12	0.12	<0.01	0.070	<2	<0.1
PSSW1T4	SW	-1.5	23/7/09	<0.05	<0.05	0.50	0.35	<0.05	<0.2	0.70	<1
PSSW1T4	SW	-1.5	24/7/09	<0.05	<0.05	0.40	0.10	<0.05	<0.2	0.60	<1
PSSW1T4	SW	-1.5	4/8/09	<0.06	<0.04	1.4	1.7	0.64	<0.05	3.5	<0.4
PSSW1T4	SW	-1.5	19/8/09	<0.06	<0.04	0.80	<0.05	<0.02	<0.05	0.75	<0.4
PSSW1T4	SW	-1.5	3/9/09	<0.03	<0.01	<0.2	0.10	<0.03	<0.03	<5	<0.3

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Li	Be	Al	Sc	Ti	V	Cr	Mn	Co	Ni	Cu	Zn	As	Se	Rb	Y
PST1	C	-0.2	23/7/09	300	37	72000	20	<2	120	86	11000	380	590	69	440	28	2.7	<50	640
PST1	C	-0.2	24/7/09	250	34	67000	20	<2	140	86	11000	380	590	64	420	24	1.8	<50	650
PST1	C	-0.2	27/7/09	150	29	69000	20	<2	130	72	11000	320	500	54	360	22	2.1	<50	550
PST1	C	-0.2	27/7/09	200	50	92000	20	<2	78	110	12000	470	720	68	350	32	3.0	<50	730
PST1	C	-0.2	4/8/09	200	33	65000	10	<2	180	77	12000	360	570	71	550	24	2.4	<50	600
PST1	C	-0.2	19/8/09	100	27	56000	8.0	<3	37	54	11000	270	430	63	550	16	<1	<100	450
PST1	C	-0.2	3/9/09	60	22	37000	8.0	80	58	56	9600	270	430	55	390	32	3.0	40	470
PST2	C	-0.5	23/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	1700	12	24	<0.5	28	<1	<0.3	<50	0.57
PST2	C	-0.5	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	1900	12	24	<0.5	21	2.0	<0.3	<50	1.9
PST2	C	-0.5	27/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	2100	13	25	<0.5	21	<1	<0.3	<50	2.3
PST2	C	-0.5	27/7/09	<50	<0.4	300	<10	<2	<0.5	<0.2	1300	7.1	12	1.0	68	<1	<0.3	<50	3.5
PST2	C	-0.5	4/8/09	<50	0.40	100	<10	<2	<0.5	<0.2	2500	12	23	1.0	54	<1	<0.3	<50	4.4
PST2	C	-0.5	19/8/09	<100	<0.7	<100	<2	<3	<0.9	<0.1	2300	2.2	4.0	3.0	130	<1	<1	<100	0.50
PST2	C	-0.5	3/9/09	20	<0.1	<40	<2	80	1.6	0.080	2600	6.3	15	1.6	56	<0.2	<0.04	<20	1.1
PST3	C	-1	23/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	210	0.20	<0.4	<0.5	5.0	2.0	<0.3	<50	0.090
PST3	C	-1	24/7/09	<50	<0.4	100	<10	<2	<0.5	<0.2	270	1.3	1.6	0.50	19	3.0	<0.3	<50	0.93
PST3	C	-1	27/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	220	0.70	0.80	0.50	19	<1	<0.3	<50	0.57
PST3	C	-1	27/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	200	0.28	<0.4	0.50	60	<1	<0.3	<50	0.15
PST3	C	-1	4/8/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	210	0.46	0.80	1.0	14	<1	<0.3	<50	0.51
PST3	C	-1	19/8/09	<100	<0.7	<100	<2	<3	<0.9	<0.1	170	0.16	<0.8	3.0	12	<1	<1	<100	<0.05
PST3	C	-1	3/9/09	<30	<0.1	<60	<3	<60	1.6	0.18	180	0.22	0.30	3.0	48	0.60	<0.06	<30	0.12
PST4	C	-1.5	23/7/09	<50	<0.4	<50	<10	<2	<0.5	0.20	240	0.10	<0.4	<0.5	5.0	3.0	<0.3	<50	0.12
PST4	C	-1.5	24/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	250	0.18	<0.4	<0.5	7.0	2.0	<0.3	<50	0.30
PST4	C	-1.5	27/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	230	0.16	<0.4	0.50	16	<1	<0.3	<50	0.18
PST4	C	-1.5	27/7/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	470	0.54	0.80	1.0	65	<1	<0.3	<50	0.57
PST4	C	-1.5	4/8/09	<50	<0.4	<50	<10	<2	<0.5	<0.2	240	0.14	<0.4	1.0	12	2.0	<0.3	<50	0.18
PST4	C	-1.5	19/8/09	<200	<1	<200	<4	<6	<2	<0.2	170	<0.2	<2	<2	16	<2	<2	<200	<0.1
PST4	C	-1.5	3/9/09	<40	<0.1	<80	<4	<80	3.0	0.16	230	0.39	0.80	4.2	44	0.40	<0.08	<40	0.12

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Zr	Nb	Mo	Ru	Pd	Ag	Cd	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
PST1	C	-0.2	23/7/09	0.63	<0.3	<4	<0.01	0.24	0.020	3.1	1.6	<0.5	<0.2	48	710	1700	180	760	150	38	170	24	130	25	66	8.1
PST1	C	-0.2	24/7/09	0.75	0.90	<4	<0.01	0.24	0.060	3.0	1.6	0.50	<0.2	30	710	1700	180	730	150	37	160	23	130	24	63	7.8
PST1	C	-0.2	27/7/09	0.75	1.8	<4	<0.01	0.32	0.040	2.4	2.2	0.50	<0.2	4.0	580	1400	150	590	120	29	130	18	100	19	49	6.1
PST1	C	-0.2	27/7/09	0.69	<0.1	<4	<0.01	0.32	<0.02	5.2	1.0	<0.5	<0.2	68	800	2000	220	890	190	46	200	28	160	29	75	9.4
PST1	C	-0.2	4/8/09	0.60	<0.1	<4	<0.01	0.32	<0.02	2.4	1.0	<0.5	<0.2	190	640	1500	160	650	130	32	140	21	120	22	56	6.9
PST1	C	-0.2	19/8/09	<0.5	<0.2	<2	<0.08	0.30	<0.06	1.8	2.8	<0.7	<0.2	78	470	1200	120	480	98	24	110	15	84	16	41	5.0
PST1	C	-0.2	3/9/09	0.16	<0.2	<0.2	<0.08	3.6	0.12	2.1	<1	0.60	0.24	94	510	1300	130	520	100	25	110	17	90	17	45	5.3
PST2	C	-0.5	23/7/09	0.69	1.2	<4	<0.01	0.080	0.040	<0.05	1.6	1.0	<0.2	90	0.50	0.36	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	0.010	<0.1	0.010
PST2	C	-0.5	24/7/09	0.63	0.60	<4	<0.01	<0.04	<0.02	<0.05	1.0	<0.5	<0.2	110	2.4	1.9	0.16	0.60	<0.5	<0.04	0.15	<0.02	0.050	0.020	<0.1	<0.01
PST2	C	-0.5	27/7/09	0.54	0.60	<4	<0.01	<0.04	<0.02	<0.05	0.80	<0.5	<0.2	110	3.0	2.6	0.20	0.60	<0.5	<0.04	0.15	<0.02	0.050	0.010	<0.1	<0.01
PST2	C	-0.5	27/7/09	0.51	<0.1	<4	<0.01	<0.04	<0.02	<0.05	0.80	<0.5	<0.2	150	4.0	9.1	0.96	3.9	0.50	0.16	0.85	0.12	0.60	0.11	0.30	0.030
PST2	C	-0.5	4/8/09	0.60	1.8	<4	<0.01	0.16	0.040	<0.05	1.6	0.50	<0.2	170	5.6	8.0	0.76	2.7	<0.5	0.080	0.60	0.10	0.40	0.11	0.30	0.060
PST2	C	-0.5	19/8/09	<0.5	<0.2	<2	<0.08	<0.3	<0.06	<0.2	1.2	<0.7	<0.2	120	0.45	0.90	0.060	<0.3	<0.2	<0.01	<0.1	<0.04	<0.1	<0.01	<0.08	<0.02
PST2	C	-0.5	3/9/09	0.10	<0.2	<0.2	<0.08	<0.1	<0.04	0.040	<1	0.40	<0.02	180	1.3	1.5	0.13	0.52	0.12	0.070	0.13	0.020	0.090	0.010	0.050	<0.01
PST3	C	-1	23/7/09	0.69	0.60	<4	<0.01	0.040	<0.02	<0.05	1.0	0.50	<0.2	68	0.050	0.15	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PST3	C	-1	24/7/09	0.72	0.30	<4	<0.01	0.36	0.020	<0.05	1.0	0.50	<0.2	88	0.80	1.7	0.20	0.60	<0.5	<0.04	0.20	<0.02	0.15	0.030	<0.1	<0.01
PST3	C	-1	27/7/09	0.63	<0.1	<4	<0.01	<0.04	<0.02	<0.05	0.80	<0.5	<0.2	86	0.60	1.3	0.12	0.60	<0.5	<0.04	0.10	<0.02	<0.05	0.010	<0.1	<0.01
PST3	C	-1	27/7/09	0.63	<0.1	<4	<0.01	0.24	<0.02	<0.05	0.80	<0.5	<0.2	170	0.15	0.45	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PST3	C	-1	4/8/09	0.66	0.60	<4	<0.01	0.64	0.040	<0.05	1.4	<0.5	<0.2	120	0.50	1.0	0.12	0.30	<0.5	<0.04	<0.05	0.020	<0.05	0.020	<0.1	0.020
PST3	C	-1	19/8/09	<0.5	<0.2	<2	<0.08	<0.3	<0.06	<0.2	0.90	<0.7	<0.2	110	<0.05	<0.1	<0.03	<0.3	<0.2	<0.01	<0.1	<0.04	<0.1	<0.01	<0.08	<0.02
PST3	C	-1	3/9/09	0.15	<0.3	<0.3	<0.1	<0.2	<0.06	<0.03	<2	0.80	<0.03	110	0.080	0.23	0.010	0.080	<0.06	0.020	<0.02	<0.01	0.010	<0.01	<0.02	<0.01
PST4	C	-1.5	23/7/09	0.72	0.30	<4	<0.01	0.20	<0.02	<0.05	1.0	0.50	<0.2	100	<0.05	0.030	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PST4	C	-1.5	24/7/09	0.72	<0.3	<4	<0.01	0.12	0.040	0.050	0.80	<0.5	<0.2	110	0.25	0.66	0.12	0.30	<0.5	<0.04	0.050	0.040	0.050	0.030	<0.1	0.020
PST4	C	-1.5	27/7/09	0.63	<0.1	<4	<0.01	<0.04	<0.02	<0.05	0.60	<0.5	<0.2	94	0.10	0.18	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PST4	C	-1.5	27/7/09	0.63	<0.1	<4	<0.01	0.12	<0.02	<0.05	1.0	<0.5	<0.2	180	0.60	1.5	0.16	0.60	<0.5	<0.04	0.10	0.020	<0.05	0.030	<0.1	0.010
PST4	C	-1.5	4/8/09	0.75	0.90	<4	<0.01	0.36	0.040	<0.05	1.0	<0.5	<0.2	180	<0.05	0.15	<0.04	<0.3	<0.5	<0.04	<0.05	<0.02	<0.05	<0.01	<0.1	<0.01
PST4	C	-1.5	19/8/09	<1	<0.4	<4	<0.2	<0.6	<0.1	<0.4	1.1	<1	<0.4	78	<0.1	<0.2	<0.06	<0.6	<0.4	<0.02	<0.2	<0.08	<0.2	<0.02	<0.2	<0.04
PST4	C	-1.5	3/9/09	0.12	<0.4	<0.4	<0.2	<0.3	<0.08	0.040	<2	0.90	<0.04	160	0.030	0.14	<0.02	0.030	<0.08	0.060	<0.02	<0.01	<0.01	<0.01	<0.02	<0.01

Table 22 (continued)

Sample ID	Treatment	depth (m)	Date	Yb	Lu	Hf	W	Tl	Pb	Th	U
PST1	C	-0.2	23/7/09	42	5.6	0.50	0.30	1.7	0.80	20	64
PST1	C	-0.2	24/7/09	42	5.6	0.60	0.30	1.7	0.60	19	61
PST1	C	-0.2	27/7/09	36	4.6	0.50	0.40	1.5	0.40	19	48
PST1	C	-0.2	27/7/09	51	6.9	0.50	0.10	1.4	0.40	38	160
PST1	C	-0.2	4/8/09	38	5.0	0.50	0.050	1.3	0.60	16	49
PST1	C	-0.2	19/8/09	29	3.8	0.80	0.90	2.8	1.7	20	39
PST1	C	-0.2	3/9/09	30	4.0	0.78	0.36	1.2	0.64	14	47
PST2	C	-0.5	23/7/09	<0.05	<0.05	0.50	0.70	<0.05	<0.2	1.3	<1
PST2	C	-0.5	24/7/09	<0.05	<0.05	0.40	0.15	<0.05	<0.2	0.80	<1
PST2	C	-0.5	27/7/09	<0.05	<0.05	0.40	0.15	<0.05	<0.2	0.90	<1
PST2	C	-0.5	27/7/09	0.15	<0.05	0.40	<0.05	<0.05	<0.2	0.90	<1
PST2	C	-0.5	4/8/09	0.10	<0.05	0.40	0.55	<0.05	<0.2	2.2	<1
PST2	C	-0.5	19/8/09	<0.06	<0.04	0.60	0.45	0.080	<0.05	0.80	<0.4
PST2	C	-0.5	3/9/09	0.020	<0.01	0.12	0.12	<0.01	<0.01	<2	<0.1
PST3	C	-1	23/7/09	<0.05	<0.05	0.50	0.40	<0.05	<0.2	0.70	<1
PST3	C	-1	24/7/09	0.050	<0.05	0.50	0.15	<0.05	<0.2	0.60	<1
PST3	C	-1	27/7/09	<0.05	<0.05	0.40	0.15	<0.05	<0.2	0.60	<1
PST3	C	-1	27/7/09	<0.05	<0.05	0.40	0.050	<0.05	<0.2	0.50	<1
PST3	C	-1	4/8/09	<0.05	<0.05	0.50	0.25	<0.05	<0.2	0.80	<1
PST3	C	-1	19/8/09	<0.06	<0.04	0.60	0.25	<0.02	<0.05	0.60	<0.4
PST3	C	-1	3/9/09	<0.02	<0.01	<0.2	0.18	<0.02	<0.02	<3	<0.2
PST4	C	-1.5	23/7/09	<0.05	<0.05	0.40	0.35	<0.05	<0.2	0.60	<1
PST4	C	-1.5	24/7/09	<0.05	<0.05	0.40	0.15	<0.05	<0.2	0.60	<1
PST4	C	-1.5	27/7/09	<0.05	<0.05	0.40	0.10	<0.05	<0.2	0.60	<1
PST4	C	-1.5	27/7/09	<0.05	<0.05	0.40	0.10	<0.05	<0.2	0.60	<1
PST4	C	-1.5	4/8/09	<0.05	<0.05	0.40	0.25	<0.05	<0.2	0.60	<1
PST4	C	-1.5	19/8/09	<0.1	<0.08	1.2	1.4	<0.04	<0.1	1.4	<0.8
PST4	C	-1.5	3/9/09	<0.02	<0.01	<0.1	0.16	<0.02	<0.02	<4	<0.2

11 Appendix 4 Soil analyses

Table 23 Results of baseline soil physicochemical analyses

									ASS Lab method codes (Ahern *et al.* 2004)										
									23A	23F	23V	23S	23C	20J	a-20J	23X	23U	22B	a- 22B
									If 1:5 H_2O pH ≤ 5.5					Retained				Reduced Inorganic Sulfur	
							Carbonate			1:40 KCl ext.				(A_{HCl}–A_{KCl})					
Sample I.D.	Upper layer depth cm	Lower layer depth cm	Bulk density	$EC_{1:5}$ dS/m	$pH_{1:1}$	pH_{POX}	% $CaCO_3$	mol H^+/t	pH (1: 40 1M KCl)	TAA mol H^+/t	Ca mg/kg	Mg mg/kg	S %	S_{NAS} %	S_{NAS} mol H^+/t	Ca_{NAS} mg/kg	Mg_{NAS} mg/kg	Scr %	Scr mole H^+/t
BCM 1.1	0	3	0.88	6.9	4.4	1.5	0	0	4.3	82	0.591	0.172	0.707	0.147	69	2126	1020	0.504	314
BCM 1.2	3	15	1.22	2.9	3.3	2.0	0	0	4.3	29	0.012	0.035	0.056	0.061	28	132	300	<0.005	0
BCM 1.3	15	20	1.35	4.1	3.0	1.9	0	0	4.0	44	0.022	0.050	0.113	0.030	14	114	198	<0.005	0
BCM 1.4	20	30	1.29	3.1	3.1	1.8	0	0	4.1	46	0.018	0.045	0.092	0.082	38	148	310	0.045	28
BCM 1.5	30	38	1.24	3.3	3.2	1.6	0	0	3.9	79	0.024	0.053	0.090	0.044	20	160	420	0.239	149
BCM 1.6	38	50	1.24	1.7	7.2	6.2	1.5	304	7.8	0	–	–	–	–	–	–	–	0.186	116
BCM 1.7	50	60	1.28	1.0	8.5	6.6	5.6	1127	8.3	0	–	–	–	–	–	–	–	0.255	159
BCM 1.8	60	80	1.28	1.1	8.6	6.6	3.4	673	5.7	0	–	–	–	–	–	–	–	0.182	114
BCM 1.9	80	100	1.28	1.2	8.5	6.6	5.6	1117	8.6	0	–	–	–	–	–	–	–	0.474	296
BCM 1.10	100	180	1.28	0.86	8.8	6.6	20	4004	9.1	0	–	–	–	–	–	–	–	0.196	122
BCM 1E.1	0	0.5	–	1.9	3.6	2.4	0	0	4.0	69	1.887	0.080	1.819	0.651	305	6990	640	0.026	16
BCM 1E.2	0.5	5	–	6.8	3.3	1.7	0	0	4.7	16	–	–	–	–	–	–	–	<0.005	0
PSM 1.1	0	0.5	–	0.86	3.8	3.0	0	0	5.6	6	–	–	–	–	–	–	–	<0.005	0
PSM 1.2	0	1	1.53	3.0	3.1	2.4	0	0	5.0	13	–	–	–	–	–	–	–	<0.005	0
PSM 1.3	1	10	1.53	1.2	3.1	2.6	0	0	5.1	6	–	–	–	–	–	–	–	<0.005	0
PSM 1.4	10	20	1.53	3.1	2.9	2.0	0	0	4.7	12	–	–	–	–	–	–	–	0.019	12
PSM 1.5	20	30	1.53	3.8	3.0	1.8	0	0	5.0	7	–	–	–	–	–	–	–	<0.005	0
PSM 1.6	30	40	1.53	2.8	3.2	2.0	0	0	5.1	8	–	–	–	–	–	–	–	0.022	14
PSM 1.7	40	50	1.58	3.8	3.7	1.7	0	0	5.5	4	–	–	–	–	–	–	–	0.010	6
PSM 1.8	50	60	1.48	3.6	6.5	1.8	0.08	16	7.6	0	–	–	–	–	–	–	–	0.045	28
PSM 1.9	60	160	1.53	4.2	8.1	1.7													

Table 24 Acid base accounting for soil samples

				Acid–Base calculations requires depth interval and bulk density to give /ha						
				Total Potential Acidity	Net Acid Gen. Pot.	Net Acidity	Lime requirement incl 1.5 safety factor to neutralise			
Sample I.D.	Upper layer depth cm	Lower layer depth cm	Bulk density	=TAA+Scr mole H^+/t	=(TAA+Scr) –Carbonate mole H^+/t	RA+NAGP mole H^+/t	NA kg/t	NAGP kg/t	TAA kg/t	RIS kg/t
BCM 1.1	0	3	0.88	396	396	465	35	30	6.2	472
BCM 1.2	3	15	1.22	29	29	57	4.3	2.2	2.2	0.0
BCM 1.3	15	20	1.35	44	44	58	4.3	3.3	3.3	0.0
BCM 1.4	20	30	1.29	74	74	112	8.4	5.6	3.5	42
BCM 1.5	30	38	1.24	228	228	248	19	17	5.9	224
BCM 1.6	38	50	1.24	116	-188	-188	-6.5	-6.5	0.0	174
BCM 1.7	50	60	1.28	159	-968	-968	-44	-44	0.0	239
BCM 1.8	60	80	1.28	114	-560	-560	-25	-25	0.0	170
BCM 1.9	80	100	1.28	296	-821	-821	-34	-34	0.0	443
BCM 1.10	100	180	1.28	122	-3882	-3882	-191	-191	0.0	183
BCM 1E.1	0	0.5		85	85	390	29	6.4	5.2	24
BCM 1E.2	0.5	5		16	16	16	1.2	1.2	1.2	0.0
PSM 1.1	0	0.5		6.0	6	6	0.5	0.5	0.5	0.0
PSM 1.2	0	1	1.53	13	13	13	1.0	1.0	1.0	0.0
PSM 1.3	1	10	1.53	6.0	6	6	0.5	0.5	0.5	0.0
PSM 1.4	10	20	1.53	24	24	24	1.8	1.8	0.9	18
PSM 1.5	20	30	1.53	7.0	7	7	0.5	0.5	0.5	0.0
PSM 1.6	30	40	1.53	22	22	22	1.6	1.6	0.6	21
PSM 1.7	40	50	1.58	10	10	10	0.8	0.8	0.3	9.4
PSM 1.8	50	60	1.48	28	12	12	1.3	1.3	0.0	42
PSM 1.9	60	160	1.53							

Table 25 Major elements by XRF

	Sample ID	Depth Upper (m)	Depth Lower (m)	Si	Ti	Al	Fe	Mn	Mg	Ca	Na	K	P	Cl
				Major elements (%)										
Boggy Creek	BCM 1.1	0.00	0.03	31.9	0.25	4.88	2.43	0.03	0.44	0.78	0.52	1.35	0.04	1012
	BCM 1.2	0.03	0.15	33.8	0.11	2.17	0.58	0.00	0.13	0.15	0.47	1.07	0.01	699
	BCM 1.3	0.15	0.20	34.0	0.15	3.04	0.98	0.01	0.19	0.16	0.45	1.20	0.01	420
	BCM 1.4	0.20	0.30	37.1	0.14	2.92	0.90	0.01	0.17	0.17	0.49	1.27	0.01	422
	BCM 1.5	0.30	0.38	33.2	0.18	3.57	1.44	0.01	0.24	0.18	0.47	1.27	0.02	525
	BCM 1.6	0.38	0.50	34.1	0.13	2.51	0.74	0.01	0.17	0.75	0.46	1.22	0.01	201
	BCM 1.7	0.50	0.60	38.3	0.14	2.66	0.88	0.01	0.24	2.24	0.44	1.17	0.02	211
	BCM 1.8	0.60	0.80	36.2	0.13	2.51	0.74	0.01	0.21	1.84	0.48	1.22	0.01	303
	BCM 1.9	0.80	1.00	36.0	0.20	3.69	1.64	0.02	0.41	2.37	0.41	1.29	0.02	174
	BCM 1.10	1.00	1.80	29.5	0.13	2.10	0.83	0.02	0.47	10.06	0.32	0.89	0.03	71
	BCM 1E.1†	0.00	0.005	35.3	0.15	2.68	1.23	0.01	0.24	2.03	0.58	1.21	0.03	2052
	BCM 1E.2†	0.00	0.005	40.1	0.11	1.96	0.42	0.00	0.07	0.16	0.39	1.09	0.01	106
Point Sturt	PSM 1.1†	0.00	0.005	42.6	0.06	0.88	0.23	0.01	0.03	0.06	0.20	0.58	0.01	243
	PSM 1.2	0.00	0.01	43.2	0.10	0.91	0.30	0.01	0.06	0.06	0.17	0.47	0.01	486
	PSM 1.3	0.01	0.10	44.2	0.06	0.77	0.25	0.01	0.04	0.06	0.11	0.43	0.00	31
	PSM 1.4	0.10	0.20	41.1	0.08	1.30	0.32	0.01	0.07	0.08	0.26	0.71	0.01	353
	PSM 1.5	0.20	0.30	43.6	0.04	1.23	0.20	0.00	0.05	0.08	0.31	0.79	0.01	592
	PSM 1.6	0.30	0.40	43.7	0.05	1.15	0.25	0.01	0.06	0.09	0.31	0.69	0.00	690
	PSM 1.7	0.40	0.50	43.2	0.06	0.97	0.20	0.01	0.04	0.07	0.25	0.62	0.00	576
	PSM 1.8	0.50	0.60	41.7	0.08	1.37	0.34	0.01	0.08	0.10	0.30	0.75	0.01	429
	PSM 1.9	0.60	1.60	40.2	0.10	1.79	0.67	0.01	0.14	0.09	0.28	0.73	0.01	457

† Efflorescences

Table 26 Trace elements by XRF

	Sample ID	Depth		Minor elements (mg/kg)																		
		Upper	Lower	Ag	As	Ba	Bi	Br	Cd	Ce	Co	Cr	Cs	Cu	Ga	Ge	Hf	Hg	I	La	Mn	Mo
		(m)	(m)	**1/3.7§**	**20/70§**				**1.5/10§**			**80/370§**		**65/270§**								
Boggy Creek	BCM 1.1	0.00	0.03	<3	8	232	<2	45	<3	63	25	40	<7	20	10	<1	<6	<11	19	28	288	<1
	BCM 1.2	0.03	0.15	<3	4	242	<2	9	<3	19	39	18	9	6	4	<1	<6	<11	<6	<12	73	<1
	BCM 1.3	0.15	0.20	<3	6	217	<2	9	<3	19	27	25	18	8	6	<1	<6	<11	<6	21	86	<1
	BCM 1.4	0.20	0.30	<3	5	241	<2	8	<3	21	12	25	<7	6	6	<1	<6	<11	<6	<12	84	<1
	BCM 1.5	0.30	0.38	<3	7	236	<2	10	<3	29	31	32	<7	10	8	<1	<6	<11	9	<12	146	<1
	BCM 1.6	0.38	0.50	<3	6	253	<2	5	<3	22	40	18	<7	6	5	<1	<6	<11	<6	13	129	<1
	BCM 1.7	0.50	0.60	<3	6	210	<2	6	<3	28	28	21	<7	6	7	<1	<6	<11	<6	<12	161	<1
	BCM 1.8	0.60	0.80	<3	5	224	<2	5	<3	23	39	18	11	5	6	<1	<6	<11	<6	<12	134	<1
	BCM 1.9	0.80	1.00	<3	8	207	<2	8	<3	38	27	29	11	9	8	<1	<6	<11	<6	19	222	<1
	BCM 1.10	1.00	1.80	<3	7	160	<2	5	<3	40	13	23	12	6	5	<1	<6	<11	9	22	183	<1
	BCM 1E.1†	0.00	0.005	<3	5	208	<2	37	<3	48	24	21	10	12	6	<1	<6	<11	<6	17	130	<1
	BCM 1E.2†	0.00	0.005	<3	4	253	<2	5	<3	<14	61	14	<7	4	3	1	<6	<11	<6	<12	38	<1
Point Sturt	PSM 1.1†	0.00	0.005	<3	4	184	<2	3	<3	<14	124	12	7	2	2	<1	<6	<11	<6	<12	44	<1
	PSM 1.2	0.00	0.01	<3	4	178	<2	6	<3	18	103	77	<7	4	2	<1	<6	<11	<6	<12	68	<1
	PSM 1.3	0.01	0.10	<3	3	165	<2	2	<3	<14	133	6	<7	2	1	<1	<6	<11	<6	<12	80	<1
	PSM 1.4	0.10	0.20	<3	3	204	<2	5	<3	<14	132	11	<7	3	2	<1	<6	<11	<6	<12	57	<1
	PSM 1.5	0.20	0.30	<3	3	209	<2	5	<3	<14	143	7	<7	2	<1	<1	<6	<11	<6	<12	23	<1
	PSM 1.6	0.30	0.40	<3	4	190	<2	7	<3	14	195	6	<7	2	2	<1	<6	<11	<6	<12	53	<1
	PSM 1.7	0.40	0.50	<3	3	170	<2	3	<3	<14	189	5	<7	2	2	<1	<6	<11	<6	<12	50	<1
	PSM 1.8	0.50	0.60	<3	3	238	<2	6	<3	<14	134	11	<7	4	3	<1	<6	<11	<6	<12	69	<1
	PSM 1.9	0.60	1.60	<3	5	159	<2	6	<3	<14	<4	16	<7	5	4	<1	<6	<11	<6	<12	104	<1

† Efflorescences

§ Interim sediment quality guideline low (trigger)/high value

Table 26 (continued)

	Sample ID	Depth		Minor elements (mg/kg)																				
		Upper	Lower	Nb	Nd	Ni	Pb	Rb	Sb	Sc	Se	Sm	Sn	Sr	Ta	Te	Th	Tl	U	V	Y	Yb	Zn	Zr
		(m)	(m)			21/52[§]	50/220[§]		2/25[§]														200/410[§]	
Boggy Creek	BCM 1.1	0.00	0.03	7	25	22	12	74	<7	9	<1	<9	<3	101	<5	<6	8	4	<2	76	28	<8	47	132
	BCM 1.2	0.03	0.15	4	<8	<1	5	54	<7	7	<1	<9	<3	57	<5	<6	<3	5	<2	26	6	<8	13	124
	BCM 1.3	0.15	0.20	5	8	<1	6	62	<7	9	<1	<9	<3	57	<5	<6	4	4	<2	43	7	<8	20	107
	BCM 1.4	0.20	0.30	5	14	<1	5	63	<7	8	<1	<9	<3	60	<5	<6	<3	3	<2	36	7	<8	16	104
	BCM 1.5	0.30	0.38	6	13	<1	7	71	<7	7	<1	<9	<3	59	<5	<6	4	<2	<2	51	10	<8	25	130
	BCM 1.6	0.38	0.50	4	11	<1	3	61	<7	5	<1	<9	<3	96	<5	<6	<3	3	<2	27	9	<8	10	135
	BCM 1.7	0.50	0.60	5	13	<1	4	58	<7	<3	<1	<9	<3	179	<5	<6	4	3	<2	35	9	<8	16	121
	BCM 1.8	0.60	0.80	4	<8	<1	5	59	<7	4	<1	<9	<3	160	<5	<6	<3	<2	<2	32	9	<8	12	117
	BCM 1.9	0.80	1.00	6	17	3	5	68	<7	4	<1	12	<3	169	<5	<6	4	<2	<2	50	12	8	25	146
	BCM 1.10	1.00	1.80	5	17	<1	<2	43	<7	<3	<1	<9	<3	595	<5	<6	8	3	3	24	12	<8	13	177
	BCM 1E.1[†]	0.00	0.005	4	21	<1	7	55	<7	5	<1	<9	<3	173	<5	<6	4	4	<2	40	17	<8	14	144
	BCM 1E.2[†]	0.00	0.005	4	<8	<1	3	48	<7	<3	<1	<9	<3	53	<5	<6	<3	4	<2	15	6	<8	5	155
Point Sturt	PSM 1.1[†]	0.00	0.005	3	<8	<1	<2	23	<7	<3	<1	<9	<3	28	<5	<6	<3	<2	<2	10	4	<8	2	158
	PSM 1.2	0.00	0.01	4	<8	<1	<2	21	<7	<3	<1	<9	<3	25	<5	<6	3	<2	<2	17	6	<8	5	247
	PSM 1.3	0.01	0.10	3	<8	<1	<2	22	<7	<3	<1	<9	<3	24	<5	<6	<3	4	<2	<5	5	<8	<2	171
	PSM 1.4	0.10	0.20	3	<8	<1	<2	31	<7	<3	<1	9	<3	34	<5	<6	<3	5	<2	15	5	<8	3	142
	PSM 1.5	0.20	0.30	1	<8	<1	<2	29	<7	<3	<1	<9	<3	34	<5	<6	<3	4	<2	6	3	11	3	42
	PSM 1.6	0.30	0.40	2	<8	<1	<2	28	<7	<3	<1	<9	<3	33	<5	<6	<3	6	<2	10	5	10	2	86
	PSM 1.7	0.40	0.50	3	<8	<1	<2	22	<7	<3	<1	<9	<3	27	<5	<6	<3	5	<2	8	4	13	2	127
	PSM 1.8	0.50	0.60	4	<8	<1	2	36	<7	<3	<1	13	<3	48	<5	<6	<3	<2	<2	12	6	9	5	164
	PSM 1.9	0.60	1.60	4	<8	<1	2	37	<7	6	<1	<9	<3	35	<5	<6	<3	3	<2	22	7	<8	8	194

† Efflorescences

§ Interim sediment quality guideline low (trigger)/high value

12 Appendix 5 Modelling

12.1 Adaptation of LEACHM for acid sulfate soils

12.1.1 Diffusion and seepage in ponded soils.

In these scenarios, a 1 m saturated soil profile is overlain by 500 mm water. In our demonstrations, constant downward seepage rates of 0 and 5 mm/day were used, along with a dispersivity of 10 mm and an aqueous diffusion coefficient of $0.43x10^6$ mm^2/d (1.16 cm^2/s). Evaporation was assumed to be negligible in these simulations, but water of defined composition can be added to replace that lost through seepage. Several chemical behaviour classes were simulated, which included chemicals of high and low solubility, non-sorbing and sorbing (both linear and Freundlich isotherms, and cation exchange) conservative and degrading and ion exchange. The simulations assumed daily mixing of the water column. If desired the mixing can include the upper layer of sediment to mimic resuspension effects.

Preliminary results (Figure 49) show the importance of seepage, which counteracts upward diffusion. Chemical properties that tend to maintain high concentration gradients near the soil:water interface leads to greater diffusion into the water column. High ionic strength water also leads to greater upward diffusion of displaced exchangeable cations.

12.1.2 Transient water and oxygen contents and pyrite oxidation in exposed soils.

LEACHM was modified to reflect the some of the processes that occur in exposed materials. The concentration of oxygen at the soil surface equals atmospheric concentrations. Downward diffusion of oxygen in both gas and aqueous phases depends upon concentration gradients, water and air contents, and aqueous and gas phase diffusion coefficients. Oxygen is consumed by oxidation of organic matter (defined by a temperature and water content-dependent rate constant) and pyrite oxidation. Oxidation of pyrite is a function of a first-order rate constant and oxygen concentration. These functions can be modified to reflect factors that influence FeS_2 oxidation, such as pyrite particle size and surface area. At this stage the oxidation products are SO_4^{2-}, H^+ and Fe^{3+}, generated according to the overall reaction

$$FeS_2 + 15/4O_2 \rightarrow Fe(OH)_3 + 2SO_4^{2-} + 4H^+$$

Further development of the model functionality will include neutralization reactions, the major Al and Fe equilibria and reduction processes when the soil is saturated. The profile water regime in the profile reflects rain, evaporation and transpiration, and either a fixed depth water table or a freely draining or slowly permeable lower boundary. Soil properties can reflect textural changes. An example of the output from this model is shown in Figure 50.

12.2 Capacitance Probes

Capacitance probes installed at Point Sturt and Boggy Creek measure changes in water content at 10 cm intervals to a depth of 50 cm. Results from their installation until 12/11/09 are shown in Figure 51. These show that saturated or near saturated conditions for the clayey soil at Boggy Creek are maintained to 0.4 m bgl so that conditions for oxygen entry and pyrite oxidation are only present in the top 0.3 m of the soil profile. These observations are in line with soil data.

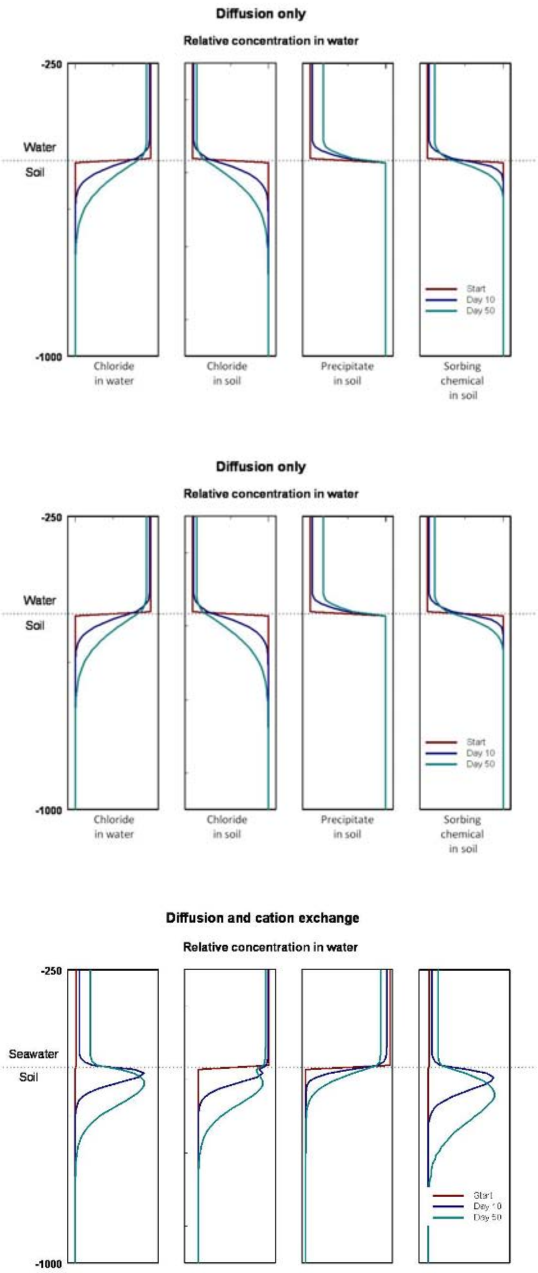


Figure 49 LEACHM Simulations of diffusion and seepage between ponded water and saturated soil

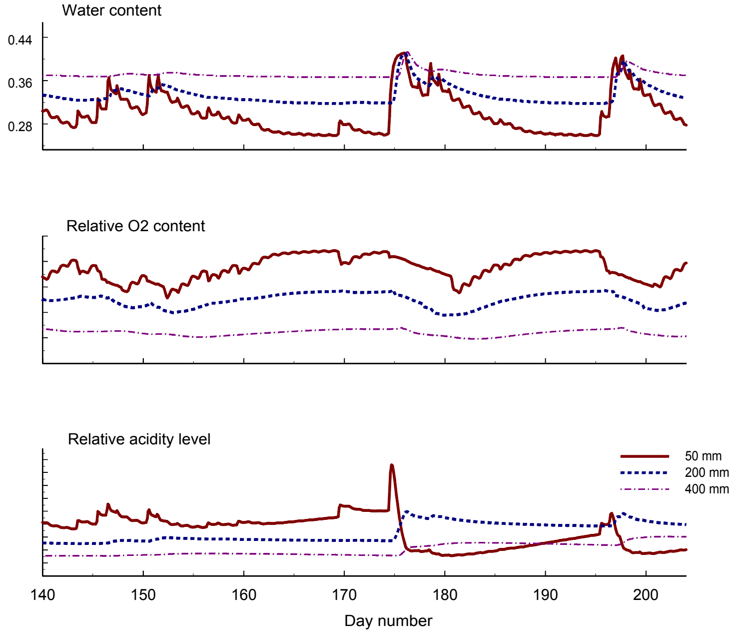


Figure 50 Water, oxygen and acidity fluctuations at three depths in an exposed soil (Goolwa weather data).

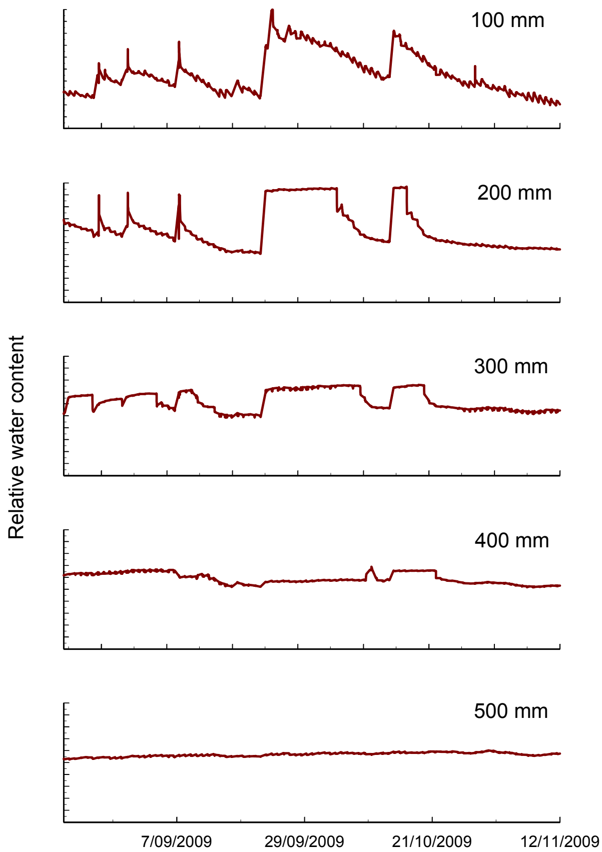


Figure 51 Relative water contents at five depths as measured by capacitance sensors. Periods of saturation at 200 and 300 mm are indicated by the periods of constant water content (the 'flat tops'). At 400 mm there are some small fluctuations which we are unable to interpret. The largely constant water contents at 400 and 500 mm indicate saturation.

13 Appendix 6 Definitions

13.1 Acid Sulfate Soils (ASS)

Acid Sulfate Soils (ASS) are all those soils in which Sulfuric acid may be produced, is being produced, or has been produced in amounts that have a lasting effect on main soil characteristics (Pons, 1973).

The definitions of acid sulfate soils are confusing and the Acid Sulfate Soil Working Group of the International Union of Soil Sciences has recently agreed in principle to adopt changes to the classification of acid sulfate soil materials and horizons (Sullivan et al., 2009). This report follows these recommendations. Acid sulfate soils are essentially soils containing detectable sulfide minerals, principally pyrite (FeS_2) or monosulfides ($Fe_{1-x}S$). The definitions used in this report are:

- **Sulfidic**: soils containing detectable sulfide.
  - **Hypersulfidic**: Sulfidic soil material that is capable of severe acidification (pH <4) as a result of oxidation of contained sulfides.
  - **Hyposulfidic**: Sulfidic soil material that is not capable of severe acidification (pH <4) as a result of oxidation of contained sulfides.
- **Sulfuric**: Soil material that has a pH less than 4 (1:1 by weight in water, or in a minimum of water to permit measurement) when measured in dry season conditions as a result of the oxidation of sulfidic materials.
- **Monosulfidic**: Soil material containing ≥ 0.01% acid volatile sulfide.

ASS form in coastal, estuarine, mangrove swamp, coastal back swamp/marsh environments and in inland saline wetlands (e.g. Fitzpatrick et al., 1996) because these waterlogged, typically highly reducing environments are ideal for the formation of sulfide minerals, predominantly iron pyrite (FeS_2). Iron sulfide minerals are one of the end products that form as part of the process of sulfate reduction (i.e. the use of SO_4^{2-} instead of O_2 during microbial respiration). Sulfate reduction is a natural process that occurs virtually in all subaqueous soils in oceans, estuaries, lakes, rivers and wetlands. However, the quantities of sulfidic material that will accumulate in a given environment are a function of many factors. The key requirements for high rates of sulfate reduction and sulfide accumulation are:

i. high concentrations of sulfate in surface or groundwater,
ii. saturation of soils and sediments for periods long enough to favour anaerobic conditions,
iii. availability of labile carbon to fuel microbial activity and
iv. availability of iron minerals (see Figure below).

To form sulfidic materials, the bicarbonate produced by the reduction reactions must be flushed from the sediment, for example by tides or seiches (standing waves) caused by wind in lakes and rivers.

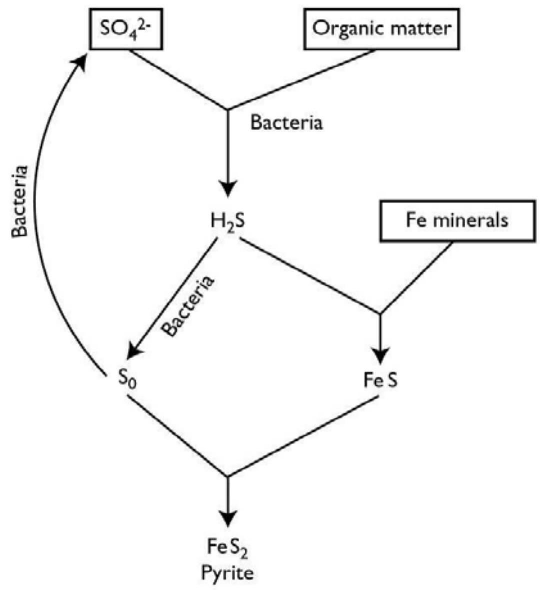


Figure 52 Schematic diagram for the formation of pyrite in anoxic sediments (after Berner, 1984)

Soil horizons that contain sulfides are called sulfidic materials (Isbell, 2002; Soil Survey Staff, 2003) and can be environmentally damaging if exposed to air by disturbance.

In summary, **sulfidic** materials contain oxidisable sulfur compounds. They may be mineral or organic soil materials, have a natural **pH >4**, and when incubated as a layer 1 cm thick under moist conditions, while maintaining contact with the air at room temperature, they show a **drop in pH of 0.5 units or more to a value of 4.0 or less within 8 weeks** (Soil Survey Staff, 2003).

Exposure of sulfidic material results in the oxidation of pyrite, with each mole of pyrite yielding 4 moles of protons (i.e. 2 moles of sulfuric acid). This process transforms sulfidic material to **sulfuric** material when, on oxidation, the material develops a **pH <4** or less (Isbell, 2002); note that a sulfuric horizon has a pH of 3.5 or less according to Soil Survey Staff (2003). If disturbed, the time required for the transition from sulfidic materials to sulfuric material ranges from weeks to years.

Monosulfidic black ooze (MBO) material is a subaqueous or waterlogged mineral or organic material that contains mainly oxidisable monosulfides that have a field pH of 4 or more but which will not become extremely acid (pH <4) when drained.

The recognition of the occurrence and importance of monosulfides in soil materials led in 2005 to the inclusion of monosulfidic materials as a distinguishing property within mapping units of the Australian National Atlas of Acid Sulfate Soils (Fitzpatrick et al., 1996). High nutrient environments together with the activity of algae and micro-organisms generate redoximorphic conditions, which result in the formation of black, smelly, iron monosulfides. When subaqueous materials rich in monosulfides are resuspended, for example during the flushing of drains by high runoff events, they rapidly oxidise, potentially removing most of the oxygen from the water column (Sullivan et al., 2002). This can lead to fish kills, especially in enclosed areas such as aquaculture ponds or estuaries. Hence, MBO is reactive if exposed to oxygen but is harmless if left undisturbed.

Monosulfidic soil materials have the ability to favourably affect surrounding environments by immobilizing potential metal pollutants (e.g. Simpson et al., 1998). However, when a drain is cleaned, iron and alumino-sulfo-salts (e.g. jarosite and alunite), iron oxyhydroxy-sulfate salts (e.g. schwertmannite) precipitate on the soil surface along the drain edges. These soluble salts dissolve during rain events and contribute to MBO formation, acidity and metal content in drainage waters.

14 Appendix 7 Methodologies used to assess acid generating potential

14.1 Soil pH in Hydrogen Peroxide (pH_{POX})

All soil samples, except for efflorescences, were selected for the following laboratory analyses: soil pH in (i) water and (ii) 30% hydrogen peroxide with pH adjusted to ca. pH 5. Since the soil samples were mostly wet or moist, soil to solution ratios will have varied, but approximated 1:1 to 1:2 soil material to liquid. For the peroxide pH determinations, about 5 to 7.5 ml of peroxide was carefully added until frothing and fuming ceased (Figure A2.1; example of effect) and the sample cooled. These variations in soil to solution ratios (and therefore ionic strength of the suspensions) introduces errors compared to usual laboratory pH measurements (see Rayment and Higginson, 1992) with controlled soil to solution ratios, but these are not thought to be significant in the context of this study. All pH measurements were made at 20°C using a calibrated laboratory pH meter. Peroxide addition oxidises sulfide minerals and organic matter, the former oxidising to sulfuric acid:

Sulfidic material + hydrogen peroxidę sulfuric acid + iron sulfate minerals + heat

Figure 53 Photographs of the peroxide test in the field used to assess the presence of ASS (sulfidic material). Note the change in colour of the pH test strips indicating the drop in pH. Frothing and fuming is caused by the reaction of peroxide with organic matter and peroxide decomposition catalysed by metal ions. Colour changes to orange and yellow are more indicative of acid formation.

Comparing the water pH to the peroxide pH indicates, where the peroxide pH drops to below about 4, that the materials have the potential to acidify significantly and produce an acid sulfate soil with sulfuric material. If the peroxide pH does not acidify significantly, the material is likely to contain enough acid neutralising capacity to avoid sulfuric conditions. The laboratory reactions are relatively quick and may not attain a true equilibrium, thereby indicating more acidic conditions than may actually be reached by natural oxidation. However, poorly buffered sands are likely to reach the indicated pH and we have observed field pH values as low as 2.5 in clayey soils of Murray River wetlands.

The final pH and reaction vigour can then be interpreted to qualitatively assess soil or sediment materials (Figure 53and Table 27)

Table 27 Soil rating scale for the pHPOX test. If the field pH in hydrogen peroxide (pHFOX) is at least one unit below field pH, it may indicate potential ASS. The greater the difference between the two measurements, the more indicative the value is of sulfidic material. The lower the final pHOX value is, the better the indication of a positive result.

pH_{OX}	Indication of ASS
<3	High probability
3–4	Probable; confirm with laboratory tests
4–5	Sulfides may be present in small quantities or may be unreactive, or neutralising material is present. Confirm with laboratory tests
>5	Combined with little drop from field pH, little net acid generation potential is indicated. Confirm with laboratory tests

14.2 Acid-base accounting

14.2.1 Sulfur and acid-base accounting

14.2.1.1 Sulfur chemistry

In sediments, total sulfur is an inexpensive, convenient measure to screen samples for acid sulfate soil potential. However, this analysis estimates the maximum potential environmental risk, so that when a trigger value is exceeded, more detailed analysis is required. Interpretation is complicated by the presence of sulfate salts (containing oxidised S) such as gypsum which do not produce acidity. Directly measuring the amount of reduced sulfur in a sample using the chromium reduction method has become the accepted standard for further investigation. Chromium reducible sulfur (commonly written as either SCR or CRS) can be equated with the acid generating potential (AGP) of a soil or sediment, and is one component of the net acidity, the other being the existing or actual acidity. The difference between reduced sulfur and total sulfur is the quantity of sulfate plus organic sulfur in the sample. Further analysis is required to separate the individual contributions of these components. For coastal and inland acid sulfate soils in Australia, the action criteria or trigger values for the preparation of an ASS management plan are shown in Table 28.

Table 28 Criteria indicating the need for an ASS management plan based on texture range and chromium reducible sulfur concentration and amount of soil material disturbed (Dear et al., 2002).

Texture range		S_{CR} (%S)	
		<1000 t disturbed soil	>1000 t disturbed soil
Coarse:	Sands to loamy sands	0.03	0.03
Medium:	Sandy loams to light clays	0.06	0.03
Fine:	Medium to heavy clays	0.10	0.03

Chromium reducible sulfur: Methods for analysing soil samples to assess acid generation potential (AGP) are given in Ahern et al. (2004), which includes the chromium reducible sulfur (Reduced Inorganic Sulfur (RIS) or SCR: Method Code 22B) and its conversion to AGP.

14.2.1.2 Acid-Base Accounting

Acid-base accounting is used to assess both the potential of a soil to produce acidity and also its ability to neutralise acid formed. These concepts are discussed by Ahern et al. 2004.

14.2.1.3 Total Actual Acidity

Actual acidity is a measure of the existing acidity in acid sulfate soil materials that have already oxidised. The method measures acidity stored in a number of forms in the soil such as iron and aluminium oxyhydroxides and oxyhydroxysulfate precipitates (e.g. jarosite, schwertmannite and alunite), which dissolve to produce acidity. However, it can be applied to the acid–base budget, which uses the total of actual and potential acidity to assess the acid generation potential of a soil.

The methods for determining total actual acidity and oxidised sulfur are given by Ahern et al. (2004) Method Codes 23F and 23C respectively.

14.2.1.4 Retained Acidity (RA)

When pHKCl is less than 4.5, this indicates that secondary less soluble acid-producing minerals such as jarosite are present. This is measured as retained acidity.

14.2.1.5 Acid Neutralising Capacity (ANC)

Soils with pH values > 6.5 may potentially have ANC in the form of (usually) carbonate minerals, principally of calcium, magnesium and sodium. The carbonate minerals present are estimated by titration and alkalinity present expressed in CaCO3 equivalents. By definition any soil with a pH <6.5 has a zero ANC. Fine grinding of soil materials may lead to an over-estimate of ANC when carbonates are present in the form of hard nodules or shells. In the soil environment they may provide little effective ANC when exposure to acid may result in the formation of surface crusts (iron oxides or gypsum), preventing or slowing further neutralisation reactions.

14.2.1.6 Acid Generation Potential (AGP)

This parameter is calculated from the concentration of reduced sulfur in the sample. Methods for analysing soil samples to assess AGP are given in Ahern et al. (2004), which includes the chromium reducible sulfur (SCR or RIS) (Method Code 22B) and its conversion to AGP.

14.2.1.7 Net Acid Generation Potential (NAGP)

NAGP is calculated by subtracting the ANC from the AGP and is a measure of the overall acidification risk of a soil. A positive value indicates an excess of acid and the likelihood of sulfuric materials (or an actual acid sulfate soil material) forming in the soil when it is disturbed and oxidised:

NAGP = AGP – ANC

14.2.1.8 Net Acidity

The net acidity of a soil is where there is existing acidity and includes both NAGP and the existing or titratable actual acidity (TAA) plus retained acidity, so that:

Net Acidity = TAA + RA + AGP – ANC

or

Net Acidity = TAA + RA + NAGP

Net acid generating potential (NAGP): Net acid generating potential (NAGP) was calculated by subtracting the acid neutralising capacity (ANC) from the AGP. The NAGP is conventionally expressed as the calcium carbonate equivalent to neutralise the potential acid generated (Ahern *et al.* 2004). A positive value for NAGP indicates acid generating potential and the potential for formation of an ASS, while a negative value indicates an excess of neutralising capacity over acidity, with little likelihood of ASS formation. When converted to a lime requirement a safety factor of 1.5 is employed to account for lime purity and reactivity (fineness or particle size).

On selected soil profile samples, chromium reducible S, acid neutralising capacity (ANC, usually carbonate content) and Net Acidity was determined by the Environmental Analysis Laboratory of Southern Cross University, Lismore. Chemical analysis generally followed procedures from Ahern *et al.* 1998.

14.3 Incubation of Soil Material

The formal Australian Soil Classification (Isbell 1996) test for identification of sulfidic material is to:

- Incubate mineral or organic soil materials, which have a natural pH value >4, for 8 weeks (as a layer 1 cm thick under moist conditions, while maintaining contact with the air at room temperature).
- Measure the pH and observe whether there is a drop in pH of 0.5 units or more to a value of 4.0 or less within 8 weeks.
- Observe formation of jarosite mottles, which implies that the pH has dropped below 4.

Collection and storage of moist samples in chip trays produces similar conditions and can similarly be used as a diagnostic test for the presence of sulfidic material. Incubation tests have the advantage of not requiring 30% hydrogen peroxide, which should only be handled by a trained operator. Soil samples collected during this study were placed in compartments of chip trays as a 1 cm thick layer and moistened. In the laboratory, the 1 cm thick layers of soil in each compartment were kept moist, which allows slow oxygen diffusion into the soil sample and potential formation of sulfuric acid in the presence sulfidic materials, mimicking field conditions of drying soils. In the chip trays, the soil sample was moistened and allowed to stand at room temperature (20 to 25 °C) for at least 8 weeks with occasional checking and re-moistening with distilled water.