

Forsmark site investigation

Hydrochemical monitoring of near surface groundwaters

Results from sampling of shallow soil monitoring wells, BAT pipes and private wells, summer 2006–spring 2007

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November 2007

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

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Abstract

The present report documents the second year of the hydrochemical monitoring programme for near surface groundwaters in Forsmark comprising the sampling period July 2006 to April 2007. Sampling and analyses of water from a total of five shallow soil monitoring wells, three private wells, and one pipe supplied with a BAT-type filter tip is performed four times a year. The objectives are to characterise near surface groundwaters down to the bedrock in order to understand natural variations and identify eventual changes in the water composition due to other activities in the area. The sampling objects are mainly located within the prioritised target area at the Forsmark site.

Besides the regular sampling objects, the report includes sampling and results from four newly installed soil monitoring wells (two sampling occasions) as well as sampling and analyses conducted within the GBIZ programme (Geosphere Biosphere Interface Zone) a special programme designed to investigate the properties of this potentially important zone. A total of five soil monitoring wells and seven pipes with BAT-type filter tips were included in the latter programme. However, due to tightening clay, it has not been possible to collect water from more than two of these BAT-pipes. Hence, in total 25 sampling objects were included in the activity, 14 shallow soil monitoring wells, three private wells and eight pipes supplied with BAT-type filter tips.

The activity included field measurements of redox potential (ORP), pH, dissolved oxygen, electrical conductivity and water temperature, as well as chemical analyses of major constituents, nutrient salts, trace metals and isotopes.

Sammanfattning

Rapporten dokumenterar andra året av det hydrokemiska övervakningsprogrammet för ytnära grundvatten i Forsmark och omfattar provtagningsperioden juli 2006 till april 2007. Provtagning och analys av vatten från totalt sex jordborrhål varav ett av dem utrustat med BAT filterspets och tre privata brunnar utförs vid fyra tillfällen per år. Syftet är karakterisera ytnära grundvatten ner till berggrunden för att kunna förstå naturliga variationer och identifiera eventuella förändringar i vattensammansättningen på grund av övriga aktiviteter i området. Provpunkterna är huvudsakligen lokaliserade inom prioriterat område för ett eventuellt djupförvar.

Förutom de ordinarie provpunkterna, inkluderar rapporten även prov vid två provtillfällen från fyra nyligen installerade jordborrhål liksom provtagningar genomförda inom det så kallade GBIZ-programmet (Geosphere Biosphere Interface Zone) ett speciellt program utformat för att undersöka denna potentiellt viktiga zon. Totalt fem jordborrhål och sju BAT filterspetsar ingick i det senare programmet men på grund av täta leror och begränsad tillrinning har det inte varit möjligt att samla in vatten från mer än två av BAT-rören. Sammantaget har alltså provtagning skett i 25 provtagningspunkter, 14 jordborrhål, tre privata brunnar och åtta BAT-rör.

Aktiviteten omfattade fältmätningar av redox potential (ORP), pH, löst syre, elektrisk konduktivitet och vattentemperatur, liksom kemiska analyser av huvudkomponenter, närsalter, spårmetaller och isotoper.

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1 Introduction

This document reports performance and results from the second year of the hydrochemical monitoring programme for near surface groundwaters, which is one of the activities performed within the site investigation in Forsmark /1/. Besides the regular objects the activity included sampling in four newly installed soil monitoring wells as well objects belonging to the GBIZ programme (Geosphere Biosphere Interface Zone). The sampling objects constituted three types; shallow soil monitoring wells, pipes equipped with BAT-type filter tips (a special sampling system described in Section 4.3) and private wells.

The controlling documents for the activity are listed in Table 1-1. The activity plans, the method description and the measurement system descriptions constitute SKB's internal controlling documents. Original data from the reported activity are stored in the primary database Sicada. Data are traceable by the respective activity plan numbers (AP PF 400-06-063 and AP PF 400-06-106) and only data in the databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the database may be revised if needed. However, such revision of the database will not necessarily result in a revision of this report, although major revisions are the normal procedure for a P-report. Minor revisions are normally presented as supplements, available at www.skb.se.

The different sampling objects (soil monitoring wells and private wells) are presented in Chapter 2 and a map showing their location is displayed in Figure 2-1.

Table 1-1. Controlling documents for performance of the activity.

Activity plans	Number	Version
Hydrokemiskt övervakningsprogram för ytnära grundvatten, juni 2006 till juni 2007	AP PF 400-06-063	1.0
Provtagning och vattenanalyser i kompletterande jordrör och BAT-rör (ytnära grundvatten)	AP PF 400-06-106	1.0
Method descriptions	Number	Version
Metodbeskrivning för ytvattenprovtagningar vid platsundersökningar	SKB MB 900.004	2.0
Mätsystembeskrivning för YSI	SKB MD 910.003	1.0
Multiparametersystem för vattenmätningar		
Provtagning och provhantering	SKB MD 452.001	3.0

2 Sampling objects

The monitoring programme for near surface groundwater includes six selected monitoring wells/stand pipes and three private wells. Besides these regular objects, 16 additional objects were sampled during the reported sampling period, most of them belonging to the GEBIZ programme. The wells/pipes are of the following types:

1. Single stand pipes made of HDPE (High Density PolyEthene) located close to drill sites for core drilled boreholes, see Appendix 1 for design, Figure A1-1.
2. Double and single stand pipes made of HDPE, see Appendix 1 for design, Figure A1-2. Double pipes meaning, that one of the pipes is equipped with a permanently installed sensor for logging the groundwater pressure and the other pipe is intended for hydro-chemical sampling.
3. Stand pipes installed in the sediment below the water layer in Lake Bolundsfjärden. These pipes are made of ordinary, non-stainless iron; see Appendix 1 Figure A1-3 for design. Stand pipes located in till below wetlands are of the same type.
4. Pipes equipped with BAT-type filter tip as described in Section 4.3.

For pipe types 1) to 3), the positions of the filter/screen part, and for type 4) the position of the BAT-filter tip, correspond to the upper and lower section limits (Secup and Seclow) in the Sicada database. The section limits refer to the top of the stand pipe (Top Of Casing or TOC). The sampled monitoring wells and their stand pipe types are listed in Table 2-1. The locations of the different sampling objects, including the three regularly sampled private wells, are displayed in Figure 2-1. Total depths and filter/screen depths, as well as coordinates for the different stand pipes, are given in Appendix 1 together with outlines of the different pipe types.

Table 2-1. List of sampling objects, type of sampling and type of object.

Idcode	Type of sampled object	Programme	Code*
SFM0001	Stand pipe connected to drill site	Monitoring	A
SFM0023	Stand pipe in sediment below water surface (steel pipe)	Monitoring	C
SFM0032	Double-pipe for chemistry	Monitoring	B
SFM0037	Double-pipe for chemistry	Monitoring	B
SFM0049	Double-pipe for chemistry	Monitoring	B
SFM0051	BAT-system, drill site 1	Monitoring	D
SFM0077	Stand pipe for chemistry	New	B
SFM0078	Stand pipe for chemistry	New	B
SFM0079	Stand pipe for chemistry	New	B
SFM0080	Stand pipe connected to drill site	New	A
SFM0081	Stand pipe in sediment below water surface (steel pipe)	GEBIZ	C
SFM0083	BAT-system	GEBIZ	D
SFM0084	Stand pipe in till below fen (steel pipe)	GEBIZ	C
SFM0086	BAT-system	GEBIZ	D
SFM0087	Stand pipe in sand below fen	GEBIZ	C
SFM0089	BAT-system	GEBIZ	D
SFM0091	Stand pipe in till below fen (steel pipe)	GEBIZ	C
SFM0093	BAT-system	GEBIZ	D

Idcode	Type of sampled object	Programme	Code*
SFM0095	Stand pipe for chemistry	GEBIZ	B
SFM0097	BAT-system	GEBIZ	D
SFM0100	BAT-system	GEBIZ	D
SFM0102	BAT-system	GEBIZ	D
PFM000001	Private well	Monitoring	E
PFM000009	Private well	Monitoring	E
PFM006382	Private well	Monitoring	E

* Code used to distinguish between different types of sampling objects included in the monitoring programme, see Table 5-1 and Appendix 1.

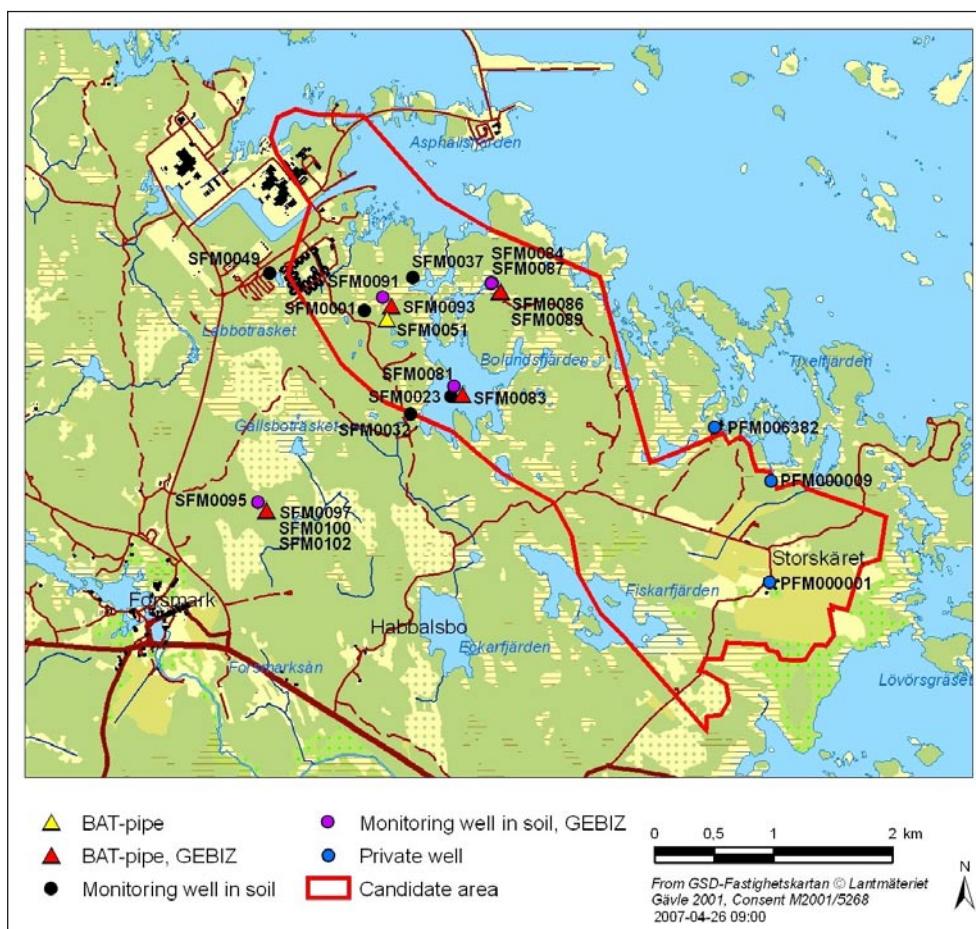


Figure 2-1. Location of sampling objects in the monitoring programme for near surface groundwaters, including different types of soil monitoring wells and private wells.

3 Objectives and scope

Near surface groundwaters were investigated in order to increase the understanding of processes that occur at the interface between the geosphere and the near surface ecosystem. Furthermore, sampling and analyses of groundwaters from shallow monitoring wells may be used to identify discharge areas. Wells located close to drill sites for deep core drilled boreholes were also monitored in order to identify possible changes in the water composition due to drilling activities.

The completed two years long extensive sampling campaign in order to characterise near surface groundwaters in different types of environments within the candidate area /2/ was followed by a reduced monitoring programme which started in July 2005. This programme includes sampling four times per year in five soil monitoring wells (stand pipes) and one pipe equipped with a BAT-type filter tip, all in the prioritised north-western part of the candidate area. Furthermore, three private wells are included to check the drinking water quality (sampled once per year).

The sampling of private wells is mainly performed in order to obtain initial information on the drinking water quality and to monitor possible changes in the water composition during the site investigation period. The private well data are of limited use for the chemical modelling as they are more or less affected by human activities. However, some additive information on the salinity distribution in the candidate area may be gained.

Besides the five stand-pipes and the BAT-type filter tip included in the long term monitoring programme, four newly installed wells and five additional stand-pipes as well as seven BAT-type filter tips, belonging to the GBIZ programme /2/, were included in the programme. However, only two of the BAT-type filter tips could be sampled, see Section 5-5.

The activity implied water sampling for chemical analysis as well as direct measurements in the field of parameters such as ORP (redox potential), pH, dissolved oxygen, electrical conductivity and water temperature. The analytical protocol included major constituents, nutrient salts, silica, carbon species as well as isotopes and trace metals, see Tables 5-1 and 5-2.

4 Equipment

4.1 Sampling equipment

Groundwater samples from the shallow soil monitoring wells/stand pipes and natural wells were collected using four online pumping setups, each one consisting of a submersible electrical pump (12 V, Awimex) connected to a 10–20 m long polyamide-tube (Tecalan) of 8 mm diameter. The inner metal part of the pumps was coated with Teflon. Manually operated electrical regulators (powered by 12 V, 7 Ah cells) were used to adjust the water flow to a maximum of 1 litre/minute. Disposable filters (Millipore, 0.45 μm , $\text{Ø} = 22$ mm) were fitted directly to the tube from the pump when collecting the sample portions for trace metals and ferrous iron. A separate sampling set-up was used for the stand pipe in the lake Bolundsfjärden, as this pipe was made out of ordinary iron, in order to minimise the risk to contaminate other samples.

4.2 Multi-parameter sondes

Field measurements were performed with two multi-parameter sondes (YSI 6600 EDS and YSI 600 QS). A terminal (YSI 650 MDS) is connected to each sonde through a cable for logging data, Figure 4-1. Calibration of the sondes was conducted according to the measurement system description SKB MD 910.003, see Table 1-1. The measured parameters in near surface groundwaters included pH, water temperature, oxygen, ORP (redox potential) as well as electrical conductivity and were determined in a simple flow-through cell constructed from a plastic bottle. The upper part of the bottle fitted tightly to the sonde and had a narrow outlet for the circulating water.

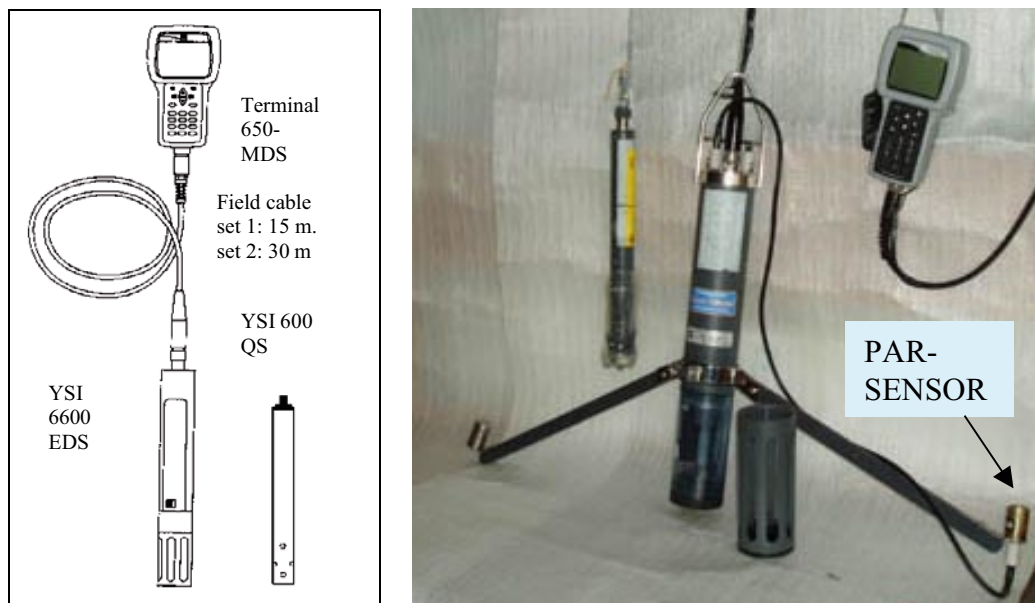


Figure 4-1. Details of the measurement sonde.

4.3 BAT-equipment

Water sampling in the stand pipe equipped with a BAT-type filter tip was performed by a Geon BAT-type groundwater sampler. The sampler carries an evacuated and hermetically closed glass sample container (500 mL) and a vial. The vial is fitted with a cap with a rubber disc, similar to the disc in the filter tip. The needle of the sampler, which is “double-ended”, penetrates through the two rubber discs, thus connecting the filter tip to the vial cap, see Figure 4-2. Due to the vacuum in the vial, water will be sucked from the aquifer, through the filter and the needle, into the vial.

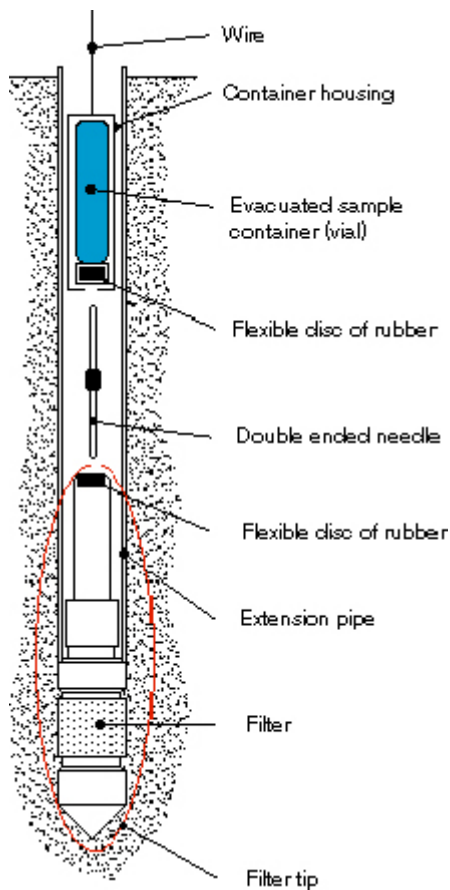


Figure 4-2. Outline of BAT-sampler system and the BAT-type filter tip.

5 Performance

5.1 Sampling programme

5.1.1 Sampling scheme

The sampling scheme for the sampling programme is given in Table 5-1. Number of bottles filled and analysis performed according to the different SKB chemical classes (class 3 and class 5, respectively) are summarised in Table 5-2. Omitted sampling objects and the reasons for deviation from the sampling scheme are given in Table 5-3.

5.1.2 Presampling preparations

Prior to the sampling campaign, sample bottles were cleaned, labelled and packed in insulated boxes/bags according to established routines (SKB MD 452.001, see Table 1-1). Acid additions were made in advance in the bottles intended for trace metal analyses. The different pumping setups were washed and rinsed with deionised water before use and all parts of equipment were kept well protected in plastic bags or in tight containers. The disposable filters (Millipore, 0.45 µm, Ø = 22 mm) were rinsed with deionised water and placed in plastic bags to prevent contamination. Calibration of the sonde was performed according to the measurement system description SKB MD 910.003.

Table 5-1. Sampling scheme July 2006–April 2007.

Year	Month	Week	Sampling object*	Sampling and analysis class and options
2006	July	29	Shallow monitoring wells, A, B Shallow monitoring wells, C	SKB class 5 SKB class 3 and isotopes
		30	BAT-pipe, D	SKB class 5
2006	October	41, 46	Shallow monitoring wells, A, B Shallow monitoring wells, C Private wells, E	SKB class 5 SKB class 3 and isotopes Drinking water
		46	BAT-pipe, D	SKB class 5
2007	January	3, 4	Shallow monitoring wells, A, B	SKB class 5
			Shallow monitoring wells, C	SKB class 3 and isotopes
			BAT-pipe, D	SKB class 5
2007	March	13	Shallow monitoring wells, A, B	SKB class 5
			Shallow monitoring wells, C	SKB class 3 and isotopes
2007	April	14	BAT-pipe, D	SKB class 5

* The sampling object types A, B, C and D are defined in Table 2-1.

Table 5-2. Sample portions/bottles and preparation procedures for class 3 and class 5 /1/.

Class 3 and 5:

Class 5:

Bottle volume (mL)	Number of bottles	SKB-label	Components	Preparation	Filling instructions
125	1	Red	ICP; cations and S, Si	Acid addition (1 mL conc. HNO ₃) Filtering with syringe/0.45 µm	Fill up
100	1	Green	Br, I	–	Fill up
250	2	Green	Alkalinity, pH, Electric conductivity Anions (Br, SO ₄ , Cl, F)	–	Fill up
25	4	Green	Ammonia, NOx, Silicate	Filtering with syringe/0.45 µm filter	
100	1	Green	Tot-N, Tot-P	–	Fill 80% of the volume.
50	1	Green	TOC	–	Fill 80% of the volume.
50	2	Green	DIC/DOC	Filtering with syringe/0.45 µm filter	Fill 80% of the volume.
500	1	Green	Tritium	–	Flow over x 3
100	1	Green	Deuterium, O-18	–	Fill up from bottom
Winkler bottles	2	Green	HS	1 ml 1 M ZnAc + 1 ml 1 M NaOH and mix	Flow over x 3
100 ¹	1	Red	ICP; cations and S, Si, Br, I, trace metals, 10B/11B	Acid addition (1 mL conc. HNO ₃) Filtering with 0.45 µm filter	Fill up
250	1	Red	Fe(II)/Fetot	Acid addition (2.5 mL conc. HCl) Filtering with 0.45 µm filter	Fill up

¹ Same bottle as the first SKB class 3 one. Analyses of trace metals Al, As, Ba, B, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn, Sc, Rb, Y, Zr, Sb, Cs, La, Hf, Ti, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U, Th.

Table 5-3. List of collected samples (excluding BAT-type filter tips) during the period July 2006 to April 2007 and reasons for sampling failures.

Id code	Name or location	Week/year					Sum (x)
		29/06	41/06	46/06	03/07	13/07	
Sondes							
YSI 600 QS		X	X	X	X	X	
Soil wells							
SFM 0001	Drill site 1	X	X		X	X	4
SFM 0023	Bolundsfjärden	X	X		X	X	4
SFM 0032	SV-Bolundsfjärden	X	X		X	X	4
SFM 0037	N-Bolundsfjärden	X	X		X	X	4
SFM 0049	Bostadsområdet	X	X		X	X	4
SFM 0077	–		X		X		2
SFM 0078	–		X		X		2
SFM 0079	–		X		X		2
SFM 0080	–		X		X		2
SFM 0081	Bolundsfjärden			A	X	X	2
SFM 0084	Puttan			X	X	X	3
SFM 0087	Puttan			X	X	X	3
SFM 0091	–			X	X	X	3
SFM 0095	–			X	X	X	3
Private wells							
PFM 000001	F3:3		X				1
PFM 000009	F3:34		X				1
PFM 006382	F3:38.Tixelfjärden		X				1
Sum (X)		5	12	4	14	10	45

Explanations:

X: collected sample

A: no sample, due to no access, weak ice

5.1.3 Sampling and measurements

The groundwater sampling procedure as described below was generally applied in groundwater pipes and wells, except for the BAT-pipes (see sampling procedure in Section 4.3. and the drilled private wells where the water was collected directly from the tap.

First, the groundwater level in the pipe was established by manual groundwater levelling and the water volume of the pipe was calculated. The pump with its tubing was lowered carefully in order to prevent dirt from entering the pipe. The water inlet of the submersible pump (Awimex) was lowered to the filter/screen section of the pipe or just above. Pumping was then performed at a maximum flow rate of one litre per minute. The pumped water was disposed of at least 10 m away from the sampling object where it infiltrated back into the ground. The pumping phases were as follows:

- *Exchange of water volume in pipe and tubes:* The water volume was exchanged three to five times (depending on the exchange/recovery time) prior to the actual sampling.
- *Sampling:* All sample bottles, except the ones with added acid, were rinsed three times with pumped water. Disposable filters were used for filtration of water portions for trace metals, Fe(+II) and DOC/DIC. The filters were fitted directly on the outlet tube from the pump. Each filter was rinsed with sample water (approx. 30 mL) before the sample portion/filtrate was collected. The bottles containing acid were the last ones to be filled in order to prevent acid contamination in the other sample portions. Disposable plastic gloves were used during the sampling. The samples were transported back from the field in insulated bags.
- *Field measurement:* A flow-through cell was connected to the pumping setup and measurements were performed with the sonde (YSI 600 QS). The results were recorded when the electrodes and sensors in the flow-through cell showed stable values (minimum 10 minutes). A judgement of the plausibility of the values was made in the field and accepted values were noted in the field protocol.

5.1.4 Sampling performance using BAT-system

Sampling of the BAT-type filter tip pipe followed the sampling scheme for the regular shallow soil wells with a few days delay. The approximate time to fill one 500 mL container in SFM0051 was 15 minutes, in SFM0083 5 minutes, and in SFM0102 it was approximately 3–4 h.

A total of four sample containers were filled from a BAT-pipe in order to obtain enough water for the analyses. The use of the sample volumes and the analyses performed are listed in Table 5-4 (SFM0051) and Table 5-5 (SFM0083 and SFM0102).

Table 5-4. Sample containers and analyses, SFM0051.

Sample container no.	Analyses and determinations			Total volume
1	Chloride, bromide, fluoride and sulphate by IC (200 mL)	Alkalinity titr, pH and EC (150 mL)	$\delta^2\text{H}$, $\delta^{18}\text{O}$ (100 mL)	450 mL
2	Tritium (500 mL)			Approx. 500 mL
3	Fe (+II), (Fe(tot) (50 mL)	Major constituents, trace elements, $^{10}\text{B}/^{11}\text{B}$ by ICP AES/MS (125 mL)	5 mL of HCl was added to the container prior to sampling.	175 mL

Table 5-5. Sample containers and analyses, SFM0083 and SFM0102.

Sample container no.	Analyses and determinations			Total volume
1	Major constituents, trace elements, ¹⁰ B/ ¹¹ B by ICP AES/MS (125 mL)	Chloride, bromide, fluoride and sulphate by IC (200 mL)	Alkalinity titr, pH and EC (150 mL) Iodine (50 mL)	475 mL
2	Tritium (500 mL)			Approx. 500 mL
3	N/P-tot, NO _x , NH ₄ -N, Silicat, PO ₄ -P TOC, DOC (300 mL)	δ ² H, δ ¹⁸ O (100 mL)	Br/I (100 mL)	Approx. 500 mL

5.2 Sample handling and analyses

Measurements/analyses of pH_(lab), electrical conductivity_(lab) and alkalinity as well as spectrophotometric analyses of total iron and ferrous iron (Fe+II) were conducted immediately at the site in the mobile field laboratory. An overview of sample treatment and analytical routines for major constituents, minor anions, trace metals and isotopes is given in Appendix 3. The routines are applicable independent of sampling method or type of sampling object.

5.3 Data handling

The following routines for quality control and data management are generally applied for hydrogeochemical analysis data, independent of sampling method or sampling object.

Several components are determined by more than one method and/or laboratory. Moreover, control analyses by an independent laboratory are performed as a standard procedure on each fifth or tenth collected sample.

All analytical results were stored in the Sicada database. The applied hierarchy path “Hydrochemistry/Hydrochemical investigation/Analyses/Water in the database” contains two types of tables, raw data tables and primary data tables (final data tables).

Data on basic water analyses are inserted into raw data tables for further evaluation. The evaluation results in a final reduced data set for each sample. These data sets are compiled in a primary data table named “water_composition”. The evaluation is based on:

- Comparison of the results from different laboratories and/or methods. The analyses are repeated if a large disparity is noted (generally more than 10%).
- Calculation of charge balance errors. Relative errors within ± 5% are considered acceptable (in surface waters ± 10%).

$$rel.error(\%) = 100 \times \frac{\sum cation(equivalents) - \sum anions(equivalents)}{\sum cation(equivalents) + \sum anion(equivalents)}$$

- General expert judgement of plausibility based on earlier results and experiences.

All results from “**biochemical**” components and **special analyses of trace metals and isotopes** are inserted directly into primary data tables. In those cases where the analyses are repeated or performed by more than one laboratory, a “best choice” notation will indicate those results which are considered most reliable.

An overview of the data management is given in Figure 5-1.

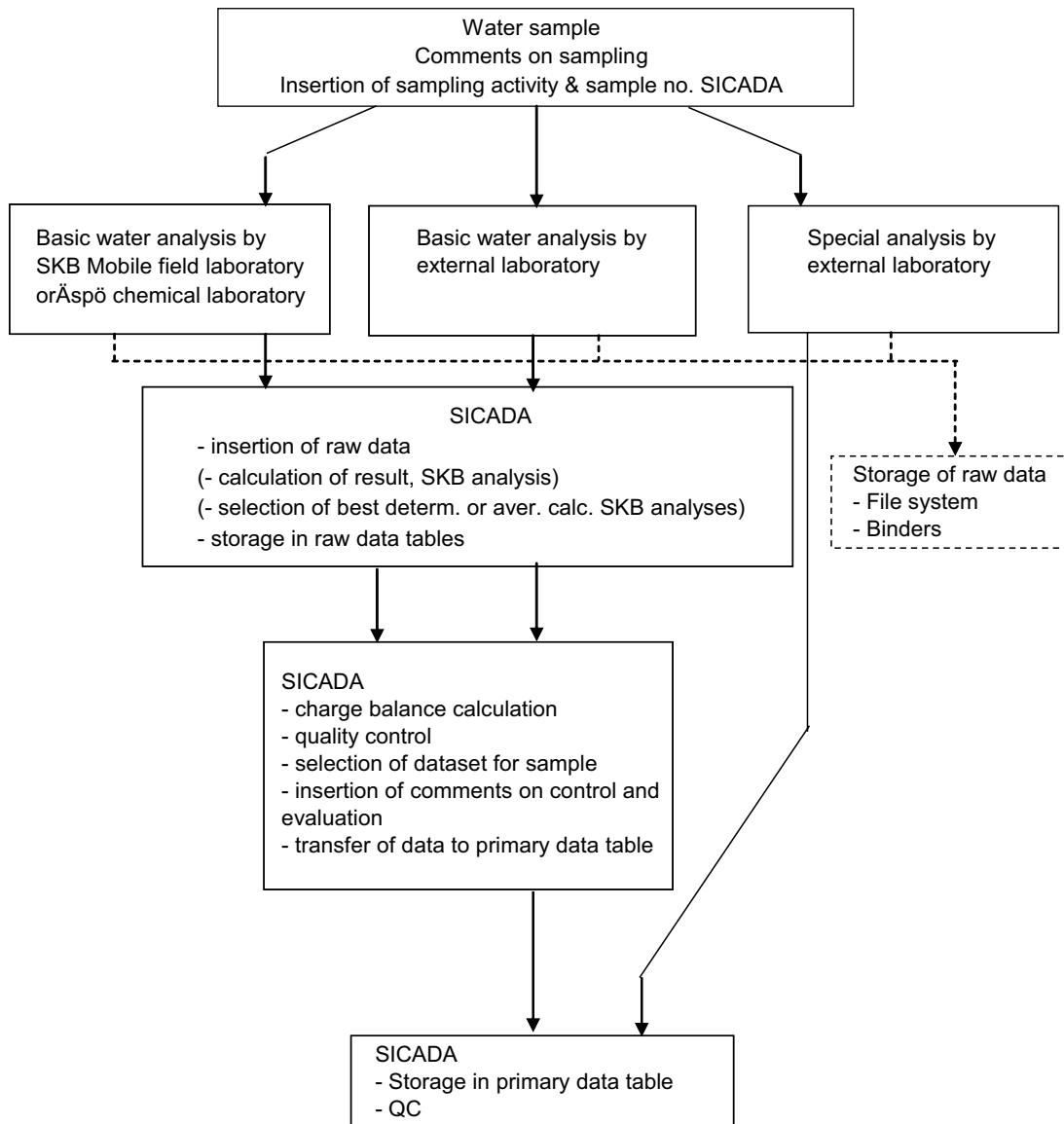


Figure 5-1. Overview of data management for hydrochemical data.

5.4 Nonconformities

No nonconformities occurred regarding the regular monitoring programme for near surface waters during the time period concerned. The same goes for the four extra soil monitoring wells included in AP PF 400-06-063.

However, water sampling has not been successful from some of the objects in the GBIZ programme. The following deviations from AP PF 400-06-106 can be noted:

- Only two (SFM0102 and SFM0083) out of seven BAT-pipes yielded sufficient water to allow sampling.
- SFM0102 was sampled twice and SFM0083 only at one occasion, instead of four times according to plans. This was due to lack of time and weak ice .
- SFM0081 was sampled at three and not four occasions due to weak ice at the time of the first sampling.

6 Results

6.1 Field measurements

The results from the field measurements on pH, electrical conductivity, dissolved oxygen, water temperature and redox potential (ORP) are presented in Appendix 3.

6.1.1 pH-measurement

Field measurements of pH are plotted against the corresponding laboratory values in Figure 6-1. Some deviation is reasonable considering the change of water temperature, and the time delay prior to the laboratory measurement. However, in a few cases, the disagreement seems to be greater than expected.

6.1.2 Electrical conductivity

Electrical conductivity field values are plotted versus corresponding laboratory values in Figure 6-2 and show good agreement.

6.1.3 Dissolved oxygen

The measurements of dissolved oxygen were checked in April 2005 (in a previous measurement campaign) by comparison to results from laboratory analyses /3/. This control showed that, generally, the field measurement values were somewhat higher, especially at oxygen concentrations below 4 mg/L. Field measurements of dissolved oxygen are presented in Appendix 3.

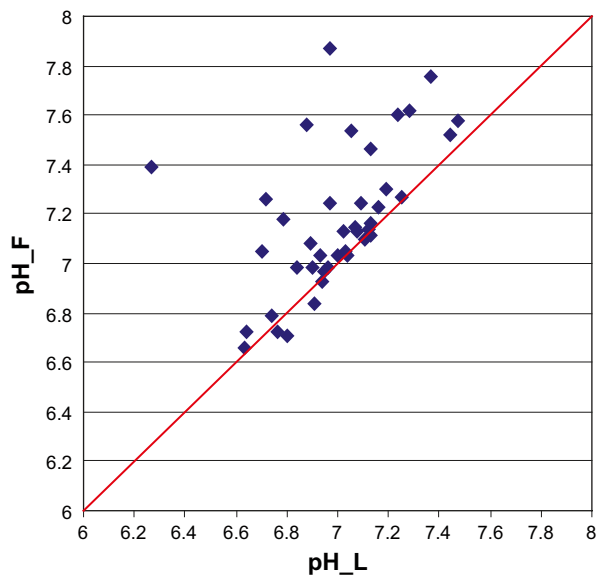


Figure 6-1. Field-pH (pH_F) values versus laboratory-pH (pH_L) values. Field-pH and laboratory-pH values are measured at prevailing water temperature and at 25°C respectively.

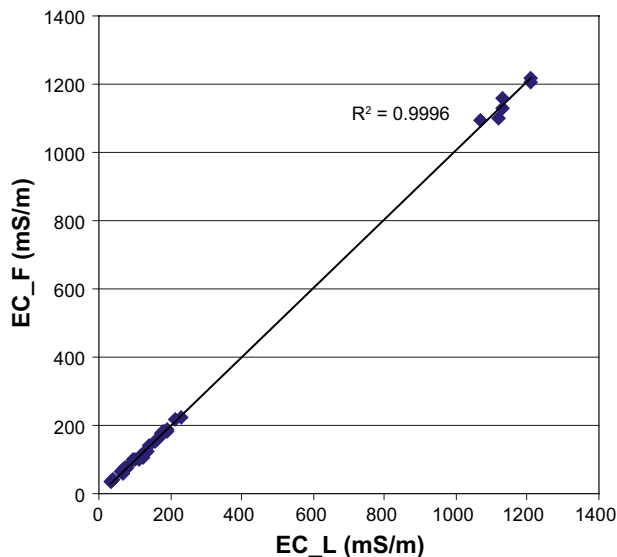


Figure 6-2. Electrical conductivity (25°C). Field measurements (EC_F) versus laboratory values (EC_L).

6.1.4 ORP-measurements and redox conditions

ORP-measurements (Oxidising-Reducing Potential) have been conducted using the multi-purpose measurement sonde. The recorded ORP-values (potential against Ag/AgCl reference electrode) should be used with great caution and merely considered as an indication of the redox conditions in the waters. Measured ORP-values are presented in Appendix 3.

6.2 Water analyses

6.2.1 Basic components

The basic water analyses include the major constituents Na, K, Ca, Mg, Sr, S, SO_4^{2-} , Cl^- , Si and HCO_3^- as well as the minor constituents Fe, Li, Mn, Br, F, I and HS^- . Furthermore, batch measurements of pH and electrical conductivity are included. The basic water analysis data are compiled in Appendix 4, Table A4-1. The charge balance errors give an indication of the quality and uncertainty of the analyses of major constituents. The errors exceed the acceptance limit $\pm 5\%$ in a few cases. Furthermore, duplicate analyses by a second laboratory or another method are conducted regularly for some of the analysed constituents. Comparison between results from different laboratories and/or methods shows that the agreement is acceptable in most cases (within $\pm 10\%$).

The chloride concentrations are plotted against the corresponding electrical conductivity values in Figure 6-3 as a rough check and the data agree well with a trend line.

The bromide analyses are often uncertain. For example the detection limit of bromide by ion chromatography ($< 0.2 \text{ mg/L}$) is often too high for fresh waters. Therefore, duplicate analyses by ICP (bromine) have been performed for most samples. Selected bromide/bromine values for each sample are plotted against the corresponding chloride concentrations in Figure 6-4 as a consistency check.

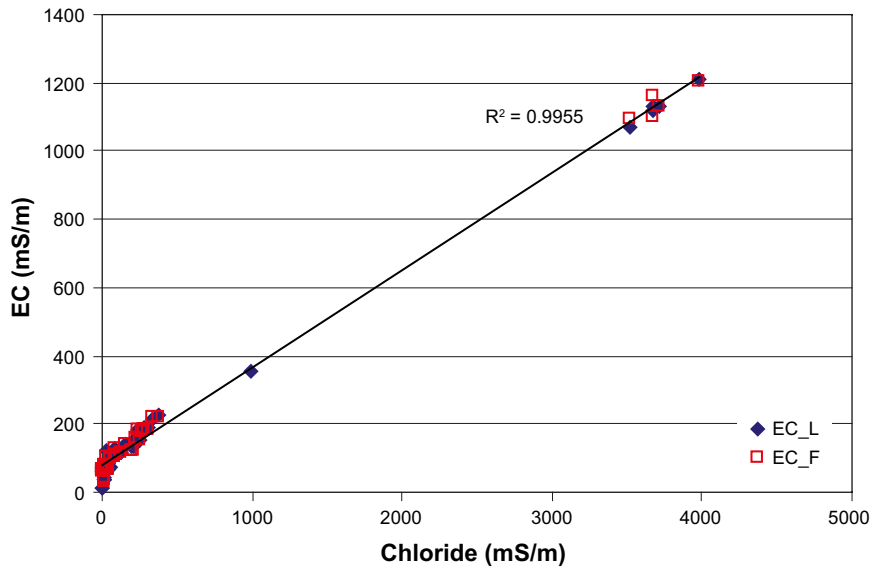


Figure 6-3. Electrical conductivity (EC) values versus chloride concentrations. EC_L = Laboratory value, EC_F = Field value.

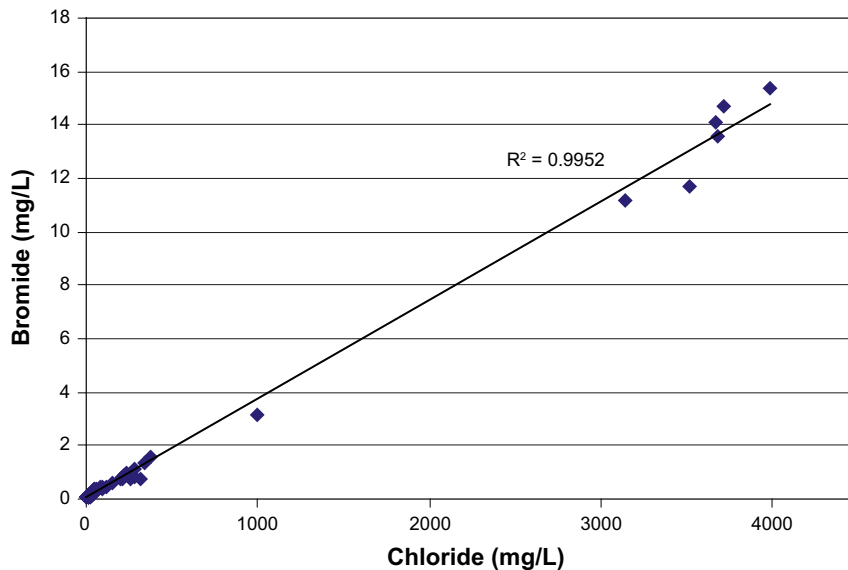


Figure 6-4. Bromide concentrations versus chloride concentrations.

Sulphate by ion chromatography and sulphate calculated from total sulphur by ICP are compared in Figure 6-5 and most samples show a satisfactory agreement. However, several samples with high sulphide concentrations diverge. The total sulphur by ICP increases disproportionately due to hydrogen sulphide gas entering the plasma. In the most obvious cases (sample nos. 12522, 12576, 12732, 12523, 12577 and 12731) the ICP results are rejected in Sicada.

Total silicon concentrations by ICP, and SiO₄ as silicon concentrations (SiO₄-Si) by spectrophotometry, are compared in Figure 6-6. Here the values diverge, but somewhat higher total silicon concentrations may be expected/explained.

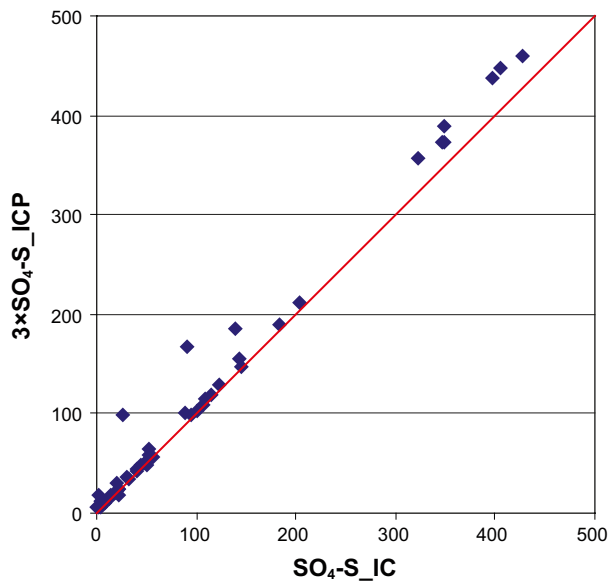


Figure 6-5. Sulphate (SO_4 by IC) versus sulphate calculated from total sulphur ($3 \times SO_4-S$) by ICP.

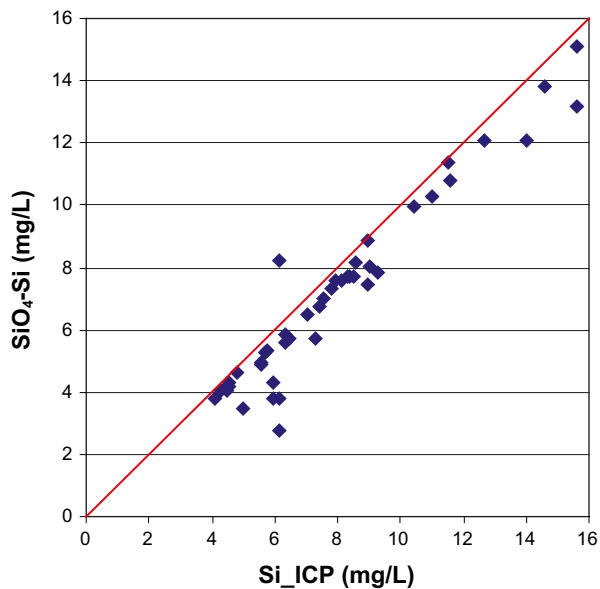


Figure 6-6. SiO_4-Si determined by spectrophotometry versus total Si analysed by ICP.

The iron concentrations determined by ICP-AES (total Fe) and by spectrophotometry (Fe(+II) and Fe-tot) are compared in Figure 6-7. In most cases, the total iron concentrations determined by ICP agree well with the results obtained by spectrophotometry.

6.7.2 Surface water supplements

Shallow groundwater analysis includes the surface water supplements/options NH_4-N , NO_2-N , NO_3-N+NO_2-N , NO_3-N , tot-N, tot-P, PO_4-P , TOC, DOC and DIC. The analytical data are compiled in Appendix 4, Table A4-2. The DIC values should be used with care and bicarbonate values (by alkalinity titration) are considered more reliable.

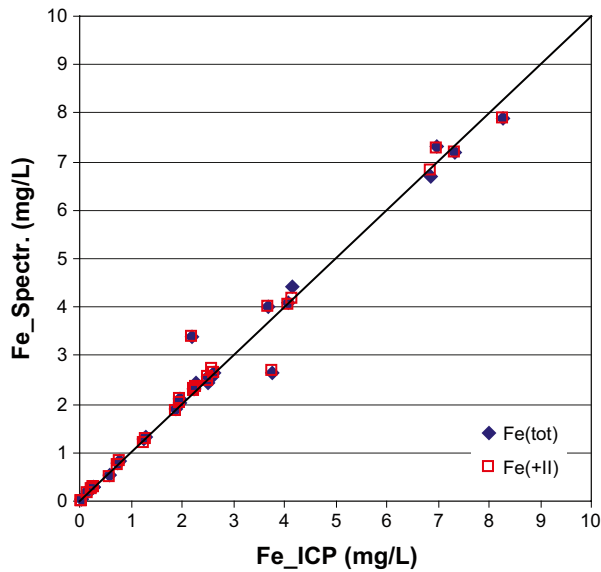


Figure 6-7. Comparison of iron concentrations obtained by ICP and by spectrophotometry (Fe_{tot} and Fe_{II}).

The concentrations of the different nitrogen, phosphorous and carbon compounds are expected to show seasonal variation depending on decomposition processes and varying redox conditions. However, this variation is more pronounced in surface waters than in the present shallow groundwaters. Figures 6-8 a to 6-8 e show the variations of total nitrogen, ammonium and phosphate in the sampled groundwaters from the five soil-pipes included in the long term monitoring programme.

6.7.4 Drinking water quality (private wells)

Data on drinking water quality parameters/components for the investigated private wells are presented in Appendix 4, Table A4-3.

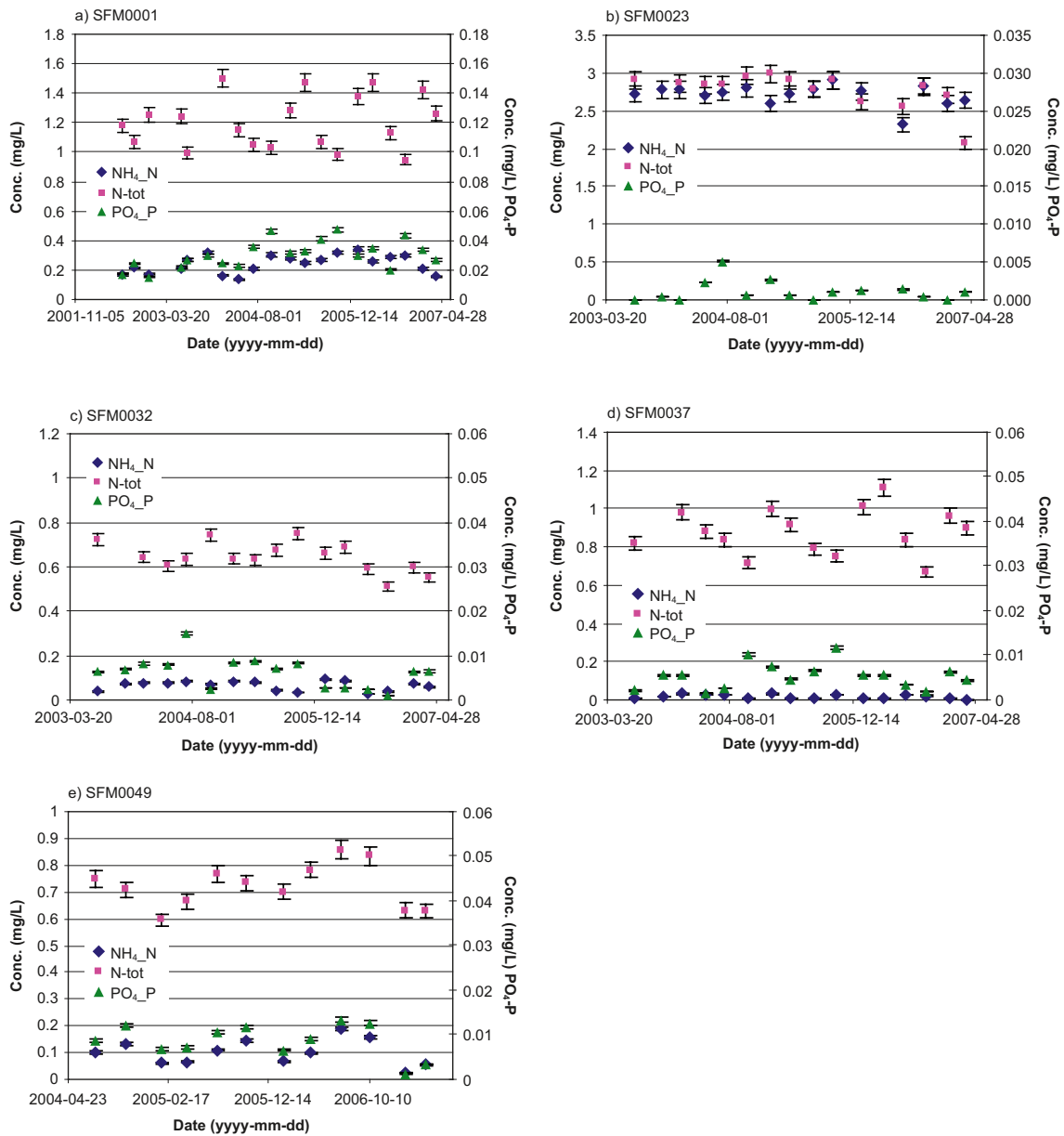
6.7.5 Trace metals

The analyses of trace and rare earth elements include Al, As, Sc, Cd, Cr, Cu, Co, Hg, Ni, Zn, Pb, V, U, Th, Rb, Y, Zr, Mo, In, Sb, Cs, Ba, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu. The trace element data are compiled in Appendix 4, Tables A4-5 and A4-6.

These elements are generally present at low concentrations in the groundwater and the risk for contamination is high. Especially data on common metals such as Al, Cr, Cu, Co, Ni and Zn must be used with caution. Generally, the borehole data conform well but outliers exist.

6.7.6 Isotopes

Isotope determinations include the stable isotopes δD , $\delta^{18}O$ and $^{10}B/^{11}B$ as well as the radioactive isotope 3H (TU). The isotope data are compiled in Appendix 4, Table A4-4.



Figures 6-8a–e. Ammonium, total nitrogen and phosphate concentrations versus sampling date in the stand pipes included in the long-term monitoring programme. Note that phosphate concentrations refer to the secondary Y-axis.

7 Summary and discussion

The chemical investigation routines for near surface waters are well established after more than four years of field work /3, 4/, reporting and data administration and the second year of the long-term monitoring programme has passed without any major nonconformities or surprises.

The statements/findings regarding the character of the near surface waters within the monitoring programme remain unchanged. However, two out of 49 samples showed relative charge balance errors exceeding $\pm 5\%$ (sample nos. 12733 and 12583) and one exceeded $\pm 10\%$ (sample no. 12581). Furthermore, some low sulphate concentrations are uncertain as the ICP-results seem to be affected by high contents of sulphide and can not be used to verify the IC analyses.

8 References

- /1/ **SKB, 2001.** Generellt genomförande program för platsundersökningar. SKB R 01-10 (in Swedish), Svensk Kärnbränslehantering AB.
- /2/ **Werner K, Lundholm L, Johansson P-O, 2006.** Forsmark site investigation. Supplementary drilling and soil sampling, and installation of groundwater monitoring wells, pumping wells and BAT filter tips. SKB P-06-89, Svensk Kärnbränslehantering AB.
- /3/ **Nilsson A-C, Borgiel M, 2005.** Forsmark site investigation. Sampling and analyses of near surface groundwaters. Results from sampling of shallow soil monitoring wells, BAT pipes, a natural spring and private wells, May 2003–April 2005. SKB P-05-071, Svensk Kärnbränslehantering AB.
- /4/ **Berg C, Nilsson A-C, Borgiel M, 2007.** Forsmark site investigation. Sampling and analyses of near surface groundwaters. Results from sampling of five shallow soil monitoring wells, one BAT pipe and three private wells, July 2005–April 2006. SKB P-06-304, Svensk Kärnbränslehantering AB.

Sampling objects; coordinates and installation designs

Table A-1. Sampling object coordinates, depth to the upper (Secup) and lower (Seclow) limits of the filter sections and total depths.

Sampling object* Id code	Coordinates (RT90-RHB70)**			Depths		
	Northing (m)	Easting (m)	Elevation (m.a.s.l.)	Secup*** (m)	Seclow*** (m)	Depth**** (m)
SFM0001	6699713	1631335	1.10	3.95	4.95	4.95
SFM0023	6698983	1632064	1.10	4.42	5.42	5.42
SFM0032	6698838	1631726	1.60	3,00	4,00	5,00
SFM0037	6699992	1631744	1.50	2,00	3,00	4,00
SFM0049	6700028	1630533	4.03	4,00	5,00	6,00
SFM0051	6699600	1631488	2.20	5.02	5.18	5.27
SFM0077	6699921	1630389	5.02	6,00	7,00	8,00
SFM0078	6699704	1630765	5.24	3.50	4.50	5.60
SFM0079	6699691	1630568	4.20	4.70	5.70	6.70
SFM0080	6698659	1631719	4.36	8.62	9.62	9.62
SFM0081	6698999	1632093	1.31	4.85	5.25	5.25
SFM0083	6699000	1632093	1.36	2.54	2.70	2.75
SFM0084	6699868	1632406	1.23	3.70	4.10	4.10
SFM0086	6699869	1632406	1.69	3.09	3.25	3.30
SFM0087	6699868	1632406	1.31	2,00	2.20	2.35
SFM0089	6699868	1632406	1.06	2.09	2.25	2.30
SFM0091	6699746	1631491	1.41	1.90	2.30	2.30
SFM0093	6699745	1631490	1.31	1.55	1.71	1.76
SFM0095	6698015	1630437	12.1	5,00	6,00	7.10
SFM0097	6698018	1630438	11.49	3.09	3.25	3.30
SFM0100	6698015	1630437	11.48	2.09	2.25	2.30
SFM0102	6698015	1630438	12.03	2.09	2.25	2.30
PFM000001	6697373	1634709	-	-	-	45
PFM000009	6698227	1634724	-	-	-	70
PFM006382	6698691	1634249	-	-	-	-

* The designs of the different types (A, B and C) of monitoring wells/stand pipes are presented in Figures A1-1 to A1-3. Typ D= BAT filter tip installation is described in section 4.3.

** Northing, easting and elevation for the reference point TOC (Top Of Casing).

*** Secup = Length from TOC to filter/screen part of the pipe (upper section limit).

*** Seclow = Length from TOC to end of filter/screen part of the pipe (lower section limit).

**** Length/depth of casing/pipe from TOC.

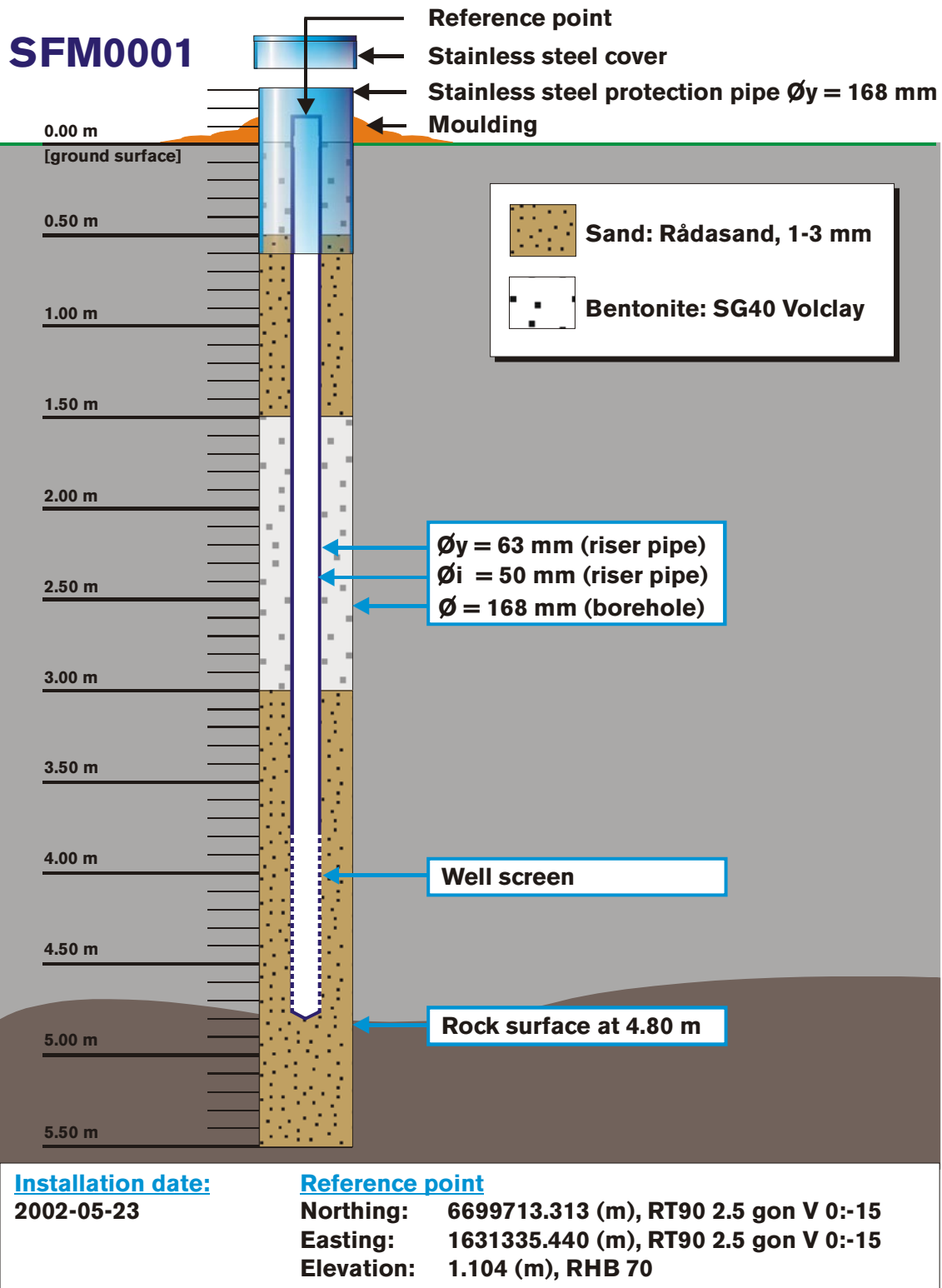


Figure A1-1. Design of an A-type, drill site connected shallow soil monitoring well (e.g. SFM0001). The filter/screen section is placed at the bottom of the pipe. Note that all length information given in the database Sicada refers to the reference point as zero point.

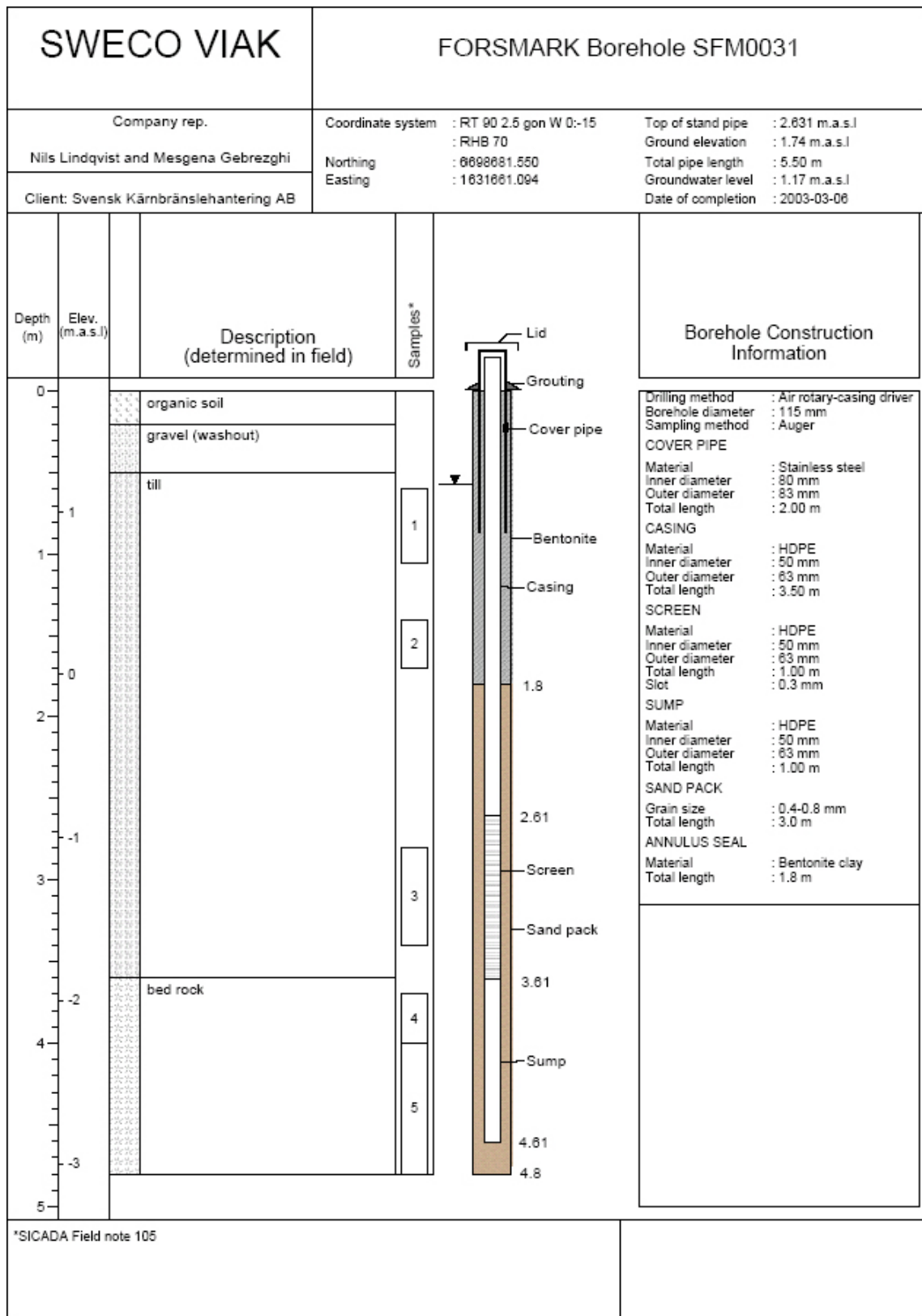


Figure A1-2. Design of a B-type, double stand pipe for sampling of water. The filter section is placed one metre up from the bottom of the pipe. Note that all length information given in the database Sicada refers to Top Of Casing as zero point.

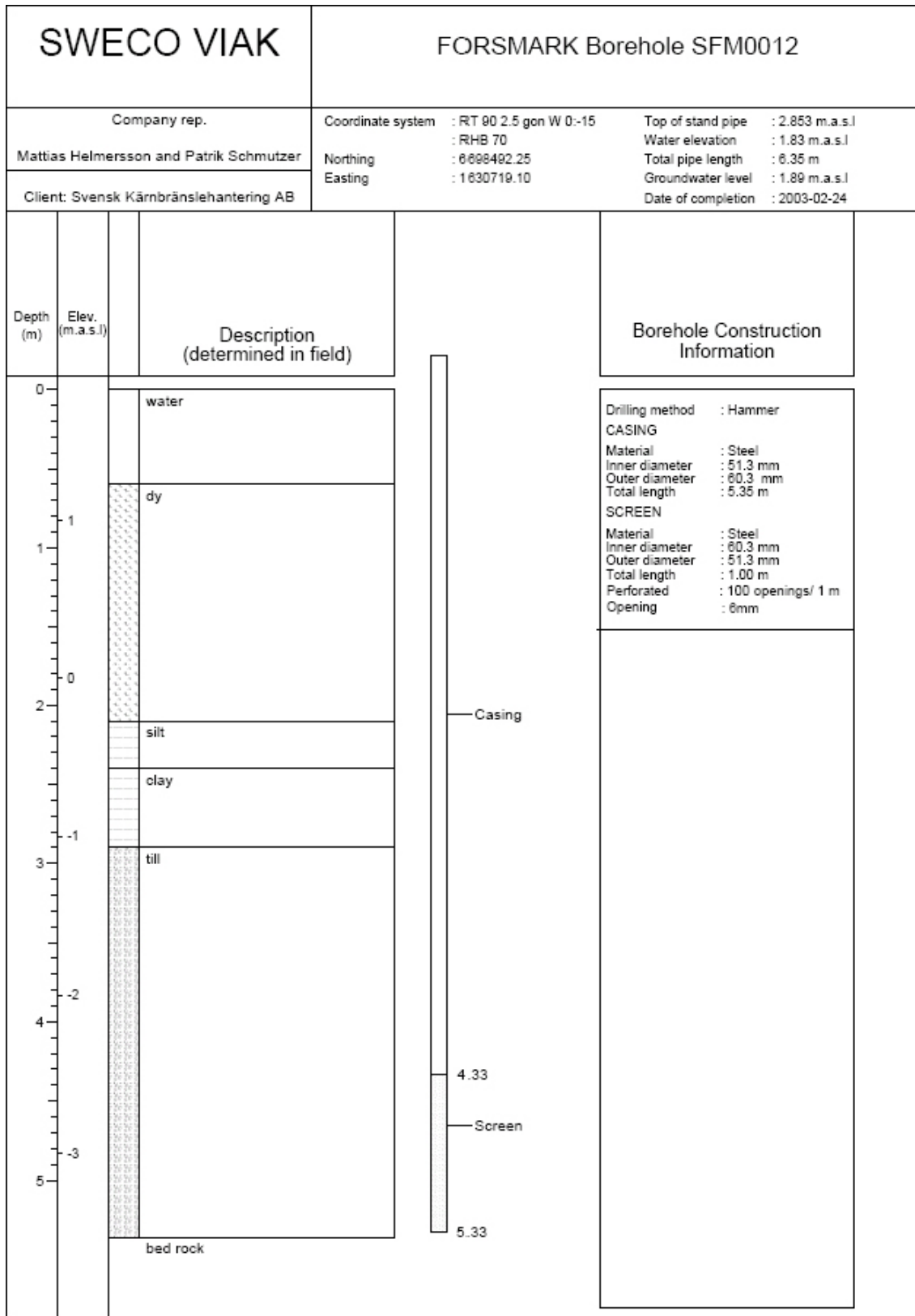


Figure A1-3. Design of a C-type, stand pipe in sediment layer below open water. Note that all length information given in the database Sicada refers to Top Of Casing as zero point.

Sampling and analytical methods

Table A2-1. Sample handling routines and analytical methods.

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/ Conservation*	Analysis method	Analysis within – or delivery time to lab
Anions 1	HCO ₃ pH(lab) cond (lab)	Plastic	250	No	No	Titration Pot. meas, Cond. meas	The same day – maximum 24 hours
Anions 2	Cl, SO ₄ , Br ⁻ , F ⁻ , I ⁻	Plastic	100	Yes (not in the field)	No	Titration (Cl ⁻) IC (Cl ⁻ , SO ₄ , Br ⁻ , F ⁻) ISE (F ⁻)	Not critical (month)
	Br, I	Plastic	100	Yes (not in the field)	No	ICP MS	Not critical (month)
Cations, Si and S according to SKB class 3	Na, K, Ca, Mg, S(tot), Si(tot), Li, Sr	Plastic (at low conc. acid washed bottles)	100	Yes (not in the field)	Yes (not in the field, 1 mL HNO ₃)	ICP-AES ICP-MS	Not critical (month)
Cations, Si and S according to SKB class 4 and 5	Na, K, Ca, Mg, S(tot), Si(tot), Fe, Mn, Li, Sr	Plastic (Acid washed)	100	Yes (immediately in the field)	Yes (1mL HNO ₃)	ICP-AES ICP-MS	Not critical (month)
Fe(II), Fe(tot)	Fe(II), Fe(tot)	Plastic (Acid washed)	500	Yes	Yes (5 mL HCl))	Spectrophotometry Ferrozine method	As soon as possible the same day
Hydrogen sulphide	HS-	Glass (Winkler)	About 120×2	Yes	Ev 1 mL 1 M NaOH+ 1 mL 1M ZnAc	Spectrophotometry	Immediately or if conserved, a few days
Environmental metals	Al, As, Ba, B, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn	Plastic (Acid washed)	100	Yes	Yes (1 mL HNO ₃)	ICP-AES ICP-MS	Not critical (month)
Lantanoids, U, Th and so on	Sc, Rb, Y, Zr, I, Sb, Cs, La, Hf, Tl, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, U, Th	Plastic (Acid washed)	100	Yes	Yes (1 mL HNO ₃)	ICP-AES ICP-MS	Not critical (month)
Dissolved organic Carbon, dissolved inorganic Carbon	DOC, DIC	Plastic	250 25	Yes	Frozen, transported in isolated bag	UV oxidation, IR Carbon analysator Shimadzu TOC5000	Short transportation time

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/ Conservation*	Analysis method	Analysis within – or delivery time to lab
Total organic Carbon	TOC	Plastic	250 25	No	Frozen, transported in isolated bag	UV oxidation, IR Carbon analysator Shimadzu TOC5000	Short transportation time
Environmental isotopes	$\delta^2\text{H}$, $\delta^{18}\text{O}$	Plastic	100	No	–	MS	Not critical (month)
Tritium	^3H (enhanced.)	Plastic (dry bottle)	500	No	–	LSC	
Chlorine-37	^{37}Cl	Plastic	100	No	–	(A)MS	Not critical (month)
Carbon isotopes	^{13}C , pmC	Plastic (HDPE)	100×2	No	–	(A)MS	A few days
Sulphur isotopes	^{34}S	Plastic	500–1,000	No	–	Combustion, MS	No limit
Strontium-isotopes	$^{87}\text{Sr}/^{86}\text{Sr}$	Plastic	100	No	–	TIMS	Days or Week
Uranium and Thorium isotopes	^{234}U , ^{235}U , ^{238}U , ^{232}Th , ^{230}Th ,	Plastic	50 1,000	No	–	Chemical separat. Alfa/gamma spectrometry	No limit
Boron isotopes	$^{10}\text{B}/^{11}\text{B}$	Plastic	100	Yes	Yes (1 mL HNO_3)	ICP – MS	No limit
Radon and Radium isotopes	^{222}Rn , ^{226}Ra	Plastic	500–1,000	No	No	LSS	Immediate transport
Dissolved gas (content and composition)	Ar, N_2 , CO_2 , O_2 , CH_4 , H_2 , CO , C_2H_2 , C_2H_4 , C_2H_6 , C_3H_8	Cylinder of stainless steel	200	No	No	GC	Immediate transport
Colloids	Filter series	Polycarbonate filter	0.4, 0.2 and 0.05 μm	–	Ar atmosphere	ICP-AES ICP-MS	Immediate transport
Fractionation; Humic and fulvic acids, inorganic constituents	<1,000 D >1,000 D but <5,000 D >5,000 D	Fractions are collected in plastic bottles	250	–	N_2 atmosphere	UV oxidation, IR (DOC)	Immediate transport
Archive samples with acid	–	Plast (washed in acid)	100×2**	Yes	Yes (1 mL HNO_3)	–	Storage in freeze container
Archive samples without acid	–	Plastic	250×2**	Yes	No	–	Storage in freeze container
Carbon isotopes in humic and fulvic acids	^{13}C , ^{14}C (pmc)	DEAE cellulose (anion exchanger)	–	–	–	(A)MS	A few days
Nutrient salt + silicate	NO_2 , NO_3 , NO_2+NO_3 , NH_4 , PO_4 , SiO_4	Sample tubes, plastic	25×2 250	No	No, frozen immediately***	Spectrophotometry	Short transportation time
Total concentrations of Nitrogen and Phosphorous	N-tot, P-tot	Plastic	100	No	No, frozen immediately***	Spectrophotometry	Short transportation time

Component group	Component/element	Sample container (material)	Volume (mL)	Filtering	Preparation/Conservation*	Analysis method	Analysis within – or delivery time to lab
Particulate Carbon, Nitrogen and Phosphorous	POC, PON, POP	Plastic	1,000	Yes (within 4 h)	Filtering, the filters are frozen immediately prepared filters. Blank filters 2 filters/sample	Elementar-analysator (N, C) own method 990121 (P)	Short transportation time
Chlorophyll	Chlorophyll a, c and pheopigment	Plastic	1,000–2,000	Yes (within 4 h)	Filtering, the filters are frozen immediately	Spectrophotometry Fluorometry	Short transportation time
Oxygen	Dissolved O ₂	Winkler, glass	2×ca 120	No	Mn (II) reagent Iodide reagent	Spectrophotometry SIS SS-EN 25813	Within 3 days
Archive samples for supplementary radio nuclides		Plastic	5,000	No	50 mL HNO ₃	–	Storage in freeze container

* Suprapur acid is used for conservation of samples.

** Minimum number. The number of archive samples can vary depending on the number of similar samples collected at the same occasion.

*** The sample is transported in frozen condition to the laboratory. It is possible that the silicate concentration can change due to polymerisation for this reason.

Abbreviations and definitions:

IC	Ion chromatograph
ISE	Ion selective electrode
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry (ICP SFMS, ICP AFS)
INAA	Instrumental Neutron Activation Analysis
MS	Mass Spectrometry
TIMS	Thermal Ionization Mass Spectrometer
LSC	Liquid Scintillation Counting
LSS	Liquid Scintillation Spectrometry
(A)MS	(Accelerator) Mass Spectrometry
GC	Gas Chromatography

Table A2-2. Methods, reporting limits and measurement uncertainties (updated 2008).

Component	Method	Reporting limits (RL), detection limits (DL) or range ¹	Unit	Measurement uncertainty ²
pH	Potentiometric	3–10	pH unit	± 0.1
EC	Electrical conductivity meas.	1–150 150–10,000	mS/m	5% 3%
HCO ₃	Alkalinity titration	1	mg/L	4%
Cl ⁻	Mohr- titration	≥ 70	mg/L	5%
Cl ⁻	IC	0.5 – 70		8%
SO ₄	IC	0.5	mg/L	12%
Br ⁻	IC	DL 0.2, RL 0.5	mg/L	15%
Br	ICP SFMS	0.001, 0.004, 0.010 ³	mg/L	25% ⁴
F ⁻	IC	DL 0.2, RL 0.5	mg/L	13%
F ⁻	Potentiometric	DL 0.1, RL 0.2		12%
I ⁻	ICP SFMS	0.001, 0.004, 0.010 ³	mg/L	25% ⁴
Na	ICP AES	0.1	mg/L	13%
K	ICP AES	0.4	mg/L	12%
Ca	ICP AES	0.1	mg/L	12%
Mg	ICP AES	0.09	mg/L	12%
S(tot)	ICP AES	0.16	mg/L	12%
Si(tot)	ICP AES	0.03	mg/L	14%
Sr	ICP AES	0.002	mg/L	12%
Li	ICP AES	0.004	mg/L	12.2%
Fe	ICP AES	0.02	mg/L	13.3% ⁵
Fe	ICP SFMS	0.0004, 0.002, 0.004 ³	mg/L	20% ⁵
Mn	ICP AES	0.003	mg/L	12.1% ⁴
Mn	ICP SFMS	0.00003, 0.00004, 0.0001 ³	mg/L	53% ⁵
Fe(II), Fe(tot)	Spectrophotometry	DL 0.006, RL 0.02	mg/L	9% (0.05–1 mg/L)
HS ⁻	Spectrophotometry, SKB	SKB DL 0.006, RL 0.02	mg/L	25%
HS ⁻	Spectrophotometry, external laboratory	0.01	mg/L	0.02 (0.01–0.2 mg/L) 12% (> 0.2 mg/L)
NO ₂ as N	Spectrophotometry	0.1	µg/L	2%
NO ₃ as N	Spectrophotometry	0.2	µg/L	5%
NO ₂ +NO ₃ as N	Spectrophotometry	0.2	µg/L	0.2 (0.2–20 µg/L) 2% (> 20 µg/L)
NH ₄ as N	Spectrophotometry, SKB	11	µg/L	30% (11–20 µg/L) 25% (20–50 µg/L) 12% (50–1,200 µg/L)
NH ₄ as N	Spectrophotometry external laboratory	0.8	µg/L	0.8 (0.8–20 µg/L) 5% (> 20 µg/L)
PO ₄ as P	Spectrophotometry	0.7	µg/L	0.7 (0.7–20 µg/L) 3% (> 20 µg/L)
SiO ₄	Spectrophotometry	1	µg/L	3% (>200 µg/L)
O ₂	Iodometric titration	0.2 – 20	mg/L	5%
Chlorophyll a, c pheopigment ⁶	/1/	0.5	µg/L	5%
PON ⁶	/1/	0.5	µg/L	5%
POP ⁶	/1/	0.1	µg/L	5%
POC ⁶	/1/	1	µg/L	4%
Tot-N ⁶	/1/	10	µg/L	4%
Tot-P ⁶	/1/	0.5	µg/L	6%
Al,	ICP SFMS	0.2, 0.3, 0.7 ³	µg/L	17.6% ⁵

Component	Method	Reporting limits (RL), detection limits (DL) or range ¹	Unit	Measurement uncertainty ²
Zn	ICP SFMS	0.2, 0.8, 2 ³	µg/L	15.5, 17.7, 25.5% ⁵
Ba, Cr, Mo,	ICP SFMS	0.01, 0.04, 0.1 ³	µg/L	Ba 15% ⁴ , Cr 22% ⁵ Mo 39% ⁵
Pb	ICP SFMS	0.01, 0.1, 0.3 ³	µg/L	15% ⁵
Cd	ICP SFMS	0.002, 0.02, 0.5 ³	µg/L	15.5% ⁵
Hg	ICP AFS	0.002	µg/L	10.7% ⁵
Co	ICP SFMS	0.005, 0.02, 0.05 ³	µg/L	25.9% ⁵
V	ICP SFMS	0.005, 0.03, 0.05 ³	µg/L	18.1% ⁵
Cu	ICP SFMS	0.1, 0.2, 0.5 ³	µg/L	14.4% ⁵
Ni	ICP SFMS	0.05, 0.2, 0.5 ³	µg/L	15.8% ⁵
P	ICP SFMS	1, 5, 40 ³	µg/L	16.3% ⁵
As	ICP SFMS	0.01 (520 mS/m)	µg/L	59.2% ⁵
La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu	ICP SFMS	0.005, 0.02, 0.05 ³	µg/L	20%, 20%, 25% ⁵
Sc, In, Th	ICP SFMS	0.05, 0.2, 0.5 ³	µg/L	25% ⁵
Rb, Zr, Sb, Cs	ICP SFMS	0.025, 0.1, 0.25 ³	µg/L	15%, 20%, 20% ⁴ 25% ⁵
Tl	ICP SFMS	0.025, 0.1, 0.25 ³	µg/L	14.3% ^{4 and 5}
Y, Hf	ICP SFMS	0.005, 0.02, 0.05 ³	µg/L	15%, 20%, 20% ⁴ 25% ⁵
U	ICP SFMS	0.001, 0.005, 0.01 ³	µg/L	13.5%, 14.3%, 15.9% ⁴ 19.1%, 17.9%, 20.9% ⁵
DOC	UV oxidation, IR Carbon analysator	0.5	mg/L	8%
TOC	UV oxidation, IR Carbon analysator	0.5	mg/L	10%
δ ² H	MS	2	‰ SMOW ⁷	1 (one std)
δ ¹⁸ O	MS	0.1	‰ SMOW ⁷	0.2
³ H	LSC	0.8	TU ⁸	0.8
³⁷ Cl	A (MS)	0.2	‰ SMOC ⁹	0.2 ¹⁶
δ ¹³ C	A (MS)	–	‰ PDB ¹⁰	0.3 ¹⁶
¹⁴ C pmc	A (MS)	–	PMC ¹¹	0.4 ¹⁶
δ ³⁴ S	MS	0.2	‰ CDT ¹²	0.4 (one std)
⁸⁷ Sr/ ⁸⁶ Sr	TIMS	–	No unit (ratio) ¹³	0.00002
¹⁰ B/ ¹¹ B	ICP SFMS	–	No unit (ratio) ¹³	–
²³⁴ U, ²³⁵ U, ²³⁸ U, ²³² Th, ²³⁰ Th	Alfa spectr. ICP SFMS	0.0005	Bq/L ¹⁴	≤ 5%
²²² Rn, ²²⁶ Ra	LSS or Alfa spectr.	0.01, resp. 0.005	Bq/L	≤ 5%

1. Reporting limits (RL), generally 10×standard deviation, are presented if nothing else is stated.
2. Measurement uncertainty reported by the laboratory, generally 95% confidence interval.
3. Reporting limits at electrical cond. 520 mS/m, 1,440 mS/m and 3,810 mS/m respectively.
4. Measurement uncertainty at concentrations 100×RL.
5. Measurement uncertainty at concentrations 10×RL.
6. Determined only in surface waters and near surface groundwater.
7. Per mille deviation¹⁵ from SMOW (Standard Mean Oceanic Water).
8. TU=Tritium Units, where one TU corresponds to a tritium/hydrogen ratio of 10⁻¹⁸ (1 Bq/L Tritium = 8.45 TU).
9. Per mille deviation¹⁵ from SMOC (Standard Mean Oceanic Chloride).

10. Per mille deviation¹⁵ from PDB (the standard PeeDee Belemnite).
11. The following relation is valid between pmC (percent modern carbon) and Carbon-14 age:

$$\text{pmC} = 100 \times e^{((1950-y)-1.03t)/8274}$$
 where y = the year of the C-14 measurement and t = C-14 age.
12. Per mille deviation¹⁵ from CDT (the standard Canyon Diablo Troilite).
13. Isotope ratio without unit.
14. The following expressions are applicable to convert activity to concentration, for uranium-238 and thorium-232: 1 ppm U = 12.4 Bq/kg²³⁸U, 1 ppm Th = 3.93 Bq/kg²³²Th.
15. Isotopes are often reported as per mill deviation from a standard. The deviation is calculated as: $\delta y \text{‰} = 1,000 \times (K_{\text{sample}} - K_{\text{standard}}) / K_{\text{standard}}$, where K = the isotope ratio and y = ²H, ¹⁸O, ³⁷Cl, ¹³C or ³⁴S etc.
16. SKB estimation from doublet analyses by the contracted laboratory.

Field measurements

Id code	Start_date	Stop_date	Water temp. (°C)	pH	EC (mS/m)	Salinity (%)	ORP (mV)	O₂ diss. (mg/L)	Oxygen (%)
PFM000001	2006-10-12	2006-10-12	10.4	7.01	127	0.64	3.3	1.01	9.1
PFM000009	2006-10-12	2006-10-12	6.9	7.61	1412	8.14	-76.4	2.33	20.2
PFM006382	2006-10-12	2006-10-12	10.2	7.03	516	2.79	-44.6	2.71	24.6
SFM0001	2006-07-18	2006-07-18	6.8	7.46	217	-	-123	0.49	4.1
SFM0001	2006-10-10	2006-10-10	8.7	7.27	221	1.14	-155	0.61	5.2
SFM0001	2007-01-18	2007-01-18	6.3	7.11	158	0.80	-63.0	1.24	10.1
SFM0001	2007-03-27	2007-03-27	5.6	7.13	154	0.77	-90.0	3.18	25.4
SFM0023	2006-07-21	2006-07-21	14.2	7.39	1160	6.65	-160	1.44	14.6
SFM0023	2006-10-12	2006-10-12	12.9	7.26	1129	6.45	-136	0.99	9.8
SFM0023	2007-01-17	2007-01-17	7.4	7.18	1098	6.22	-127	2.64	22.9
SFM0023	2007-03-29	2007-03-29	7.9	7.56	1095	6.21	-207	0.46	4.0
SFM0032	2006-07-18	2006-07-18	11.6	7.54	69.0	-	-153	0.52	4.8
SFM0032	2006-10-10	2006-10-10	10.9	6.97	107	0.53	-153	0.40	3.7
SFM0032	2007-01-22	2007-01-22	4.9	7.24	75.1	0.37	-126	0.14	1.1
SFM0032	2007-03-28	2007-03-28	4.1	7.14	71.8	0.35	-62.0	0.23	1.7
SFM0037	2006-07-19	2006-07-19	11.0	7.24	140	0.71	-107	0.88	8.0
SFM0037	2006-10-10	2006-10-10	10.6	6.93	126	0.63	-132	0.54	4.9
SFM0037	2007-01-17	2007-01-17	4.5	6.98	99.2	0.49	-135	0.22	1.7
SFM0037	2007-03-28	2007-03-28	3.9	6.98	115	0.57	-87.0	0.32	2.4
SFM0049	2006-07-18	2006-07-18	13.2	7.05	42.4	-	-140	0.60	5.7
SFM0049	2006-10-10	2006-10-10	12.0	6.71	39.8	0.19	-206	0.91	8.5
SFM0049	2007-01-23	2007-01-23	2.4	7.08	34.6	0.16	-35.0	0.87	6.4
SFM0049	2007-03-27	2007-03-27	2.0	6.84	33.1	0.16	-52.0	0.26	1.9
SFM0077	2006-10-12	2006-10-12	10.5	6.79	68.8	0.34	151	0.52	4.7
SFM0077	2007-01-23	2007-01-23	7.7	6.98	61.7	0.30	121	0.23	2.0
SFM0078	2006-10-12	2006-10-12	9.3	7.05	68.7	0.34	36.6	1.63	14.2
SFM0078	2007-01-23	2007-01-23	6.5	7.15	69.0	0.34	14.0	0.29	2.4
SFM0079	2006-10-12	2006-10-12	8.9	7.52	124	0.62	-71.2	0.80	6.9
SFM0079	2007-01-23	2007-01-23	7.4	7.58	125	0.63	-74.0	1.08	9.0
SFM0080	2006-10-11	2006-10-11	9.2	7.03	79.0	0.39	1.9	0.69	6.0
SFM0080	2007-01-24	2007-01-24	8.1	7.13	78.9	0.39	76.0	0.74	6.3
SFM0081	2007-01-17	2007-01-17	7.2	7.87	1207	6.88	-208	2.65	22.9
SFM0081	2007-03-29	2007-03-29	7.0	8.09	1216	6.94	-255	0.48	4.2
SFM0084	2006-11-15	2006-11-15	7.7	7.76	103	0.51	-129	0.30	2.6
SFM0084	2007-01-23	2007-01-24	6.8	7.60	107	0.53	-150	0.25	2.1
SFM0084	2007-03-29	2007-03-29	7.1	7.62	98.4	0.49	-194	0.48	4.0
SFM0087	2006-11-14	2006-11-14	7.7	6.66	185	0.94	-173	0.36	3.0
SFM0087	2007-01-18	2007-01-18	5.8	6.72	183	0.93	-92.0	0.56	4.5
SFM0087	2007-03-27	2007-03-27	5.7	6.72	178	0.90	-129	3.29	26.4
SFM0091	2006-11-14	2006-11-14	7.2	7.03	186	0.95	-231	0.40	3.3
SFM0091	2007-01-18	2007-01-18	3.4	7.30	183	0.92	-127	0.46	3.5
SFM0091	2007-03-26	2007-03-26	4.0	7.10	176	0.89	-231	0.28	2.2
SFM0095	2006-11-15	2006-11-15	6.5	7.03	69.1	0.34	-98.7	0.20	1.6
SFM0095	2007-01-19	2007-01-19	6.1	7.23	66.3	0.32	-107	0.68	5.5
SFM0095	2007-03-28	2007-03-28	6.7	7.16	64.1	0.31	-113	0.58	4.8

Compilation of water analysis data

Table A4-1. Water composition. Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	RCB %	Na mg/L	K mg/L	Ca mg/L	Mg mg/L	HCO ₃ mg/L	Cl mg/L	SO ₄ mg/L	SO ₄ -S mg/L	Br mg/l	F ⁻ mg/L
SFM0001	3.95	4.95	2006-07-18	12346	-0.3	295	20.5	101	46.5	544	339	183	63	1.32	0.72
SFM0001	3.95	4.95	2006-10-10	12388	-0.27	344	22.8	88.3	44.9	544	371	203	70.8	1.55	0.83
SFM0001	3.95	4.95	2007-01-18	12578	2.23	205	18.6	107	38.9	463	226	143	52	0.925	0.58
SFM0001	3.95	4.95	2007-03-27	12733	-9.36	159	14.9	111	31.8	372	253	114	39.9	0.785	0.52
SFM0023	4.42	5.42	2006-07-21	12229	-3.03	1520	67.9	510	162	104	3680	347	124	13.6	0.76
SFM0023	4.42	5.42	2006-10-12	12380	-2.13	1570	73.8	525	171	146	3710	348	130	14.7	0.93
SFM0023	4.42	5.42	2007-01-17	12574	-2.81	1510	66.6	525	172	156	3670	348	124	14.1	0.91
SFM0023	4.42	5.42	2007-03-29	12739	-2	1470	62.5	503	160	77.7	3520	323	119	11.7	0.68
SFM0032	3	4	2006-07-18	12344	2.13	29.4	6.2	115	9.2	363	28.2	40	14.6	0.155	0.82
SFM0032	3	4	2006-10-10	12389	0.57	36.2	8.53	232	16.1	254	31.5	427	153	0.18	0.71
SFM0032	3	4	2007-01-22	12582	1.47	34.3	6.25	121	10.1	355	40.4	52.5	21.7	0.214	0.67
SFM0032	3	4	2007-03-28	12737	3.26	29	5.69	119	9.8	348	34.4	51.3	16.1	0.162	0.61
SFM0037	2	3	2006-07-19	12347	1.15	133	12.4	128	30.4	498	158	89.4	33.5	0.633	0.79
SFM0037	2	3	2006-10-10	12387	-0.2	109	13.3	135	31.5	549	88.7	145	49	0.394	0.83
SFM0037	2	3	2007-01-17	12573	2.4	55.4	8.95	137	23.3	407	55.7	123	42.8	0.364	0.61
SFM0037	2	3	2007-03-28	12736	1.42	75.4	8.42	140	22.8	383	121	109	38.1	0.463	0.64
SFM0049	4	5	2006-07-18	12345	3.8	13.7	2.88	73.6	5.2	234	17.4	0.82	1.99	0.069	0.34
SFM0049	4	5	2006-10-10	12386	1.49	13.4	2.19	69.2	4.5	195	18.9	19.4	9.93	0.044	0.36
SFM0049	4	5	2007-01-23	12584	4.03	11.3	4.1	57.9	5	173	19	8.5	3.47	0.064	0.24
SFM0049	4	5	2007-03-27	12734	3.36	10.1	3.9	54.7	4.4	176	14.4	3.56	1.94	0.05	0.28
SFM0051	4.32	4.48	2006-07-25	12352	5.09	16.4	5.22	127	8.1	350	39.6	20.8	7.48	0.2	0.62
SFM0051	4.32	4.48	2006-10-26	12515	2.47	16.7	5.4	122	7.8	355	41.6	21	7.4	0.369	0.6
SFM0051	4.32	4.48	2007-01-17	12587	5.21	18.4	5.53	133	8.5	348	51.4	22.4	8.33	0.213	0.55
SFM0051	4.32	4.48	2007-04-03	12742	2.66	18.3	5.15	127	8.2	361	47.2	21.6	7.93	0.196	0.54
SFM0077	6	7	2006-10-12	12391	4.5	8.4	4.73	139	7.5	365	9.5	48.8	17.1	0.062	0.58
SFM0077	6	7	2007-01-23	12580	2.2	8.4	4.56	121	8.3	328	11	55.9	19	0.061	0.48
SFM0078	3.5	4.5	2006-10-12	12393	-0.52	15.8	6.43	129	6.9	384	42.6	14.6	6.21	0.404	0.92
SFM0078	3.5	4.5	2007-01-23	12581	-10.75	15	5.87	127	7	490	39.9	17.9	6.45	0.329	0.81
SFM0079	4.7	5.7	2006-10-12	12392	-0.31	183	14.3	71.2	18.9	410	199	51.8	18.2	0.763	0.9
SFM0079	4.7	5.7	2007-01-23	12585	1.3	188	15.4	77.2	21.6	399	216	52.5	19.3	0.857	0.83
SFM0080	8.65	9.62	2006-10-11	12390	0.92	13	8.86	145	16.4	402	10.9	107	36.5	0.066	0.65
SFM0080	8.62	9.62	2007-01-24	12586	1.71	15.2	6.82	153	10.5	401	13.3	94.8	32.8	0.071	0.64
SFM0081	4.85	5.25	2007-01-17	12575	-1.71	1820	81.8	348	261	154	3980	405	149	15.4	1.32
SFM0081	4.85	5.25	2007-03-29	12738	-2.84	1770	72.2	310	264	148	3941	398	146	11.2	1.18
SFM0083	2.54	2.7	2007-04-03	12529	-1.76	538	20.6	94.8	67.2	211	994	140	62.1	3.12	0.34
SFM0084	3.7	4.1	2006-11-15	12524	0.94	97.6	23.3	69.7	55.7	598	87.3	22.6	6.07	0.48	0.47
SFM0084	3.7	4.1	2007-01-24	12583	-8.64	70.8	18.9	75.1	46.8	611	91.6	31.7	11.2	0.414	0.39
SFM0084	3.7	4.1	2007-03-29	12740	-0.06	51.2	16.9	91.1	37.9	480	52.6	45.1	16	0.237	0.38
SFM0087	2	2.2	2006-11-14	12522		198	21.1	111	60.7	777	276	3.83		0.852	0.45
SFM0087	2	2.2	2007-01-18	12576		192	20.3	109	62.1	817	237	1.87		1.01	0.33
SFM0087	2	2.2	2007-03-27	12732		187	20.2	109	61.2	826	213	1.54		0.774	0.4
SFM0091	1.9	2.3	2006-11-14	12523		223	17.1	94.5	52.1	572	311	90.1		0.772	0.52
SFM0091	1.9	2.3	2007-01-18	12577	1.34	234	18.3	91.2	56.8	641	281	40.7	14.4	1.11	0.4
SFM0091	1.9	2.3	2007-03-26	12731		217	17	80.7	51.9	650	262	25.4		0.822	0.46
SFM0095	5	6	2006-11-15	12521	1.9	17.7	6.69	116	18.1	351	5	100	34.5	0.084	0.45
SFM0095	5	6	2007-01-19	12579	0.06	29.6	7.85	86.6	22.7	421	5.1	30.4	12.3	0.07	0.47
SFM0095	5	6	2007-03-28	12735	-0.29	32.2	8.06	72.7	22.6	419	4.3	12.9	4.51	0.054	0.52
SFM0102	2.09	2.25	2006-11-15	12527		12.7	1.09	19.7	3.9	-	5.9	<0.2	3.05	0.067	<0.2
SFM0102	2.09	2.25	2007-04-02	12528		2.7	1.07	14.2	2.7	-	6.1	<0.2	1.6	0.058	<0.2

Table A4-1. Water composition (cont.). Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	Si mg/L	Fe mg/L	Fe(tot) mg/L	Fe(+II) mg/L	Mn mg/L	Li mg/L	Sr mg/L	pH (lab)	EC (lab) mS/m	HS- mg/L	I- mg/L
SFM0001	3.95	4.95	2006-07-18	12346	8.12	2.63	2.66	2.66	0.244	0.018	0.397	7.13	215	0.085	0.016
SFM0001	3.95	4.95	2006-10-10	12388	8.36	1.97	2.11	2.11	0.2	0.019	0.409	7.25	229	0.075	0.011
SFM0001	3.95	4.95	2007-01-18	12578	8.94	2.51	2.45	2.49	0.223	0.019	0.397	7.13	162	0.086	0.011
SFM0001	3.95	4.95	2007-03-27	12733	7.54	2.24	2.31	2.31	0.203	0.014	0.342	7.08	155	0.033	0.007
SFM0023	4.42	5.42	2006-07-21	12229	5.96	-	-	-	-	0.06	3.71	6.27	1130	-	0.071
SFM0023	4.42	5.42	2006-10-12	12380	5.92	-	-	-	-	0.061	3.83	6.72	1130	-	0.062
SFM0023	4.42	5.42	2007-01-17	12574	6.17	-	-	-	-	0.059	3.71	6.79	1120	-	0.054
SFM0023	4.42	5.42	2007-03-29	12739	4.99	-	-	-	-	0.055	3.48	6.88	1070	-	0.045
SFM0032	3	4	2006-07-18	12344	7.92	2.51	2.55	2.56	0.247	0.007	0.192	7.05	70.6	0.108	0.009
SFM0032	3	4	2006-10-10	12389	9.05	3.77	2.64	2.67	0.398	0.016	0.393	6.95	121	0.092	<0.005
SFM0032	3	4	2007-01-22	12582	7.03	1.9	1.91	1.84	0.258	0.01	0.227	7.09	75.5	0.038	0.006
SFM0032	3	4	2007-03-28	12737	6.32	1.95	2.03	2.02	0.196	0.007	0.205	7.12	73	<0.006	0.005
SFM0037	2	3	2006-07-19	12347	7.79	2.58	2.57	2.71	0.273	0.013	0.36	6.97	142	0.109	0.01
SFM0037	2	3	2006-10-10	12387	8.29	2.21	3.4	3.39	0.274	0.016	0.427	6.94	131	0.072	0.006
SFM0037	2	3	2007-01-17	12573	6.35	2.23	2.3	2.29	0.235	0.011	0.334	6.9	101	0.072	0.008
SFM0037	2	3	2007-03-28	12736	5.68	2.27	2.44	2.37	0.244	0.01	0.318	6.96	116	0.121	0.006
SFM0049	4	5	2006-07-18	12345	4.31	1.28	1.31	1.29	0.145	0.003	0.092	6.7	38.9	0.353	0.008
SFM0049	4	5	2006-10-10	12386	4.46	0.8	0.83	0.824	0.118	<0.004	0.087	6.8	41.8	0.421	<0.005
SFM0049	4	5	2007-01-23	12584	5.54	0.17	0.192	0.149	0.05	<0.004	0.078	6.89	35.2	0.038	0.003
SFM0049	4	5	2007-03-27	12734	4.8	0.76	0.769	0.763	0.114	<0.004	0.071	6.91	33.9	0.158	0.005
SFM0051	4.32	4.48	2006-07-25	12352	9.44	8.28	7.9	7.89	0.269	0.006	0.171	7.49	69	-	-
SFM0051	4.32	4.48	2006-10-26	12515	7.8	6.97	7.3	7.29	0.254	0.006	0.18	7.16	69.8	-	0.008
SFM0051	4.32	4.48	2007-01-17	12587	8.4	7.32	7.21	7.2	0.272	0.007	0.197	7.38	72	-	0.007
SFM0051	4.32	4.48	2007-04-03	12742	7.88	6.85	6.69	6.8	0.262	0.007	0.183	7.26	72	-	0.007
SFM0077	6	7	2006-10-12	12391	4.53	-	-	-	-	<0.004	0.155	6.74	69.8	-	-
SFM0077	6	7	2007-01-23	12580	4.11	0.04	0.043	0.01	0.105	<0.004	0.137	6.84	65.3	0.006	0.003
SFM0078	3.5	4.5	2006-10-12	12393	5.76	-	-	-	-	<0.004	0.119	7.03	70.8	-	-
SFM0078	3.5	4.5	2007-01-23	12581	5.54	0.6	0.527	0.503	0.23	0.005	0.12	7.07	70.3	<0.006	0.008
SFM0079	4.7	5.7	2006-10-12	12392	8.48	-	-	-	-	0.012	0.375	7.44	134	-	-
SFM0079	4.7	5.7	2007-01-23	12585	9.29	1.27	1.27	1.2	0.156	0.015	0.432	7.47	137	0.015	0.013
SFM0080	8.65	9.62	2006-10-11	12390	7.44	-	-	-	-	0.004	0.284	7.04	81.4	-	-
SFM0080	8.62	9.62	2007-01-24	12586	6.44	0.04	0.041	0.006	0.197	0.007	0.209	7.02	81.1	<0.006	0.003
SFM0081	4.85	5.25	2007-01-17	12575	6.15	-	-	-	-	0.054	3.07	6.97	1210	-	0.057
SFM0081	4.85	5.25	2007-03-29	12738	1.83	-	-	-	-	0.05	2.78	7.24	1210	-	0.044
SFM0083	2.54	2.7	2007-04-03	12529	10.4	0.06	-	-	0.174	0.012	0.494	6.94	357	-	0.016
SFM0084	3.7	4.1	2006-11-15	12524	8.57	-	-	-	-	0.016	0.593	7.37	113	-	0.015
SFM0084	3.7	4.1	2007-01-24	12583	6.14	-	-	-	-	0.014	0.468	7.24	113	-	0.012
SFM0084	3.7	4.1	2007-03-29	12740	7.3	-	-	-	-	0.014	0.481	7.28	95	-	0.008
SFM0087	2	2.2	2006-11-14	12522	14.0	0.24	0.242	0.24	0.553	0.022	0.61	6.63	189	1.64	0.031
SFM0087	2	2.2	2007-01-18	12576	12.7	0.29	0.3	0.287	0.601	0.021	0.606	6.64	185	1.22	0.026
SFM0087	2	2.2	2007-03-27	12732	11.6	0.29	0.305	0.301	0.61	0.021	0.59	6.76	179	0.748	0.022
SFM0091	1.9	2.3	2006-11-14	12523	15.6	-	-	-	-	0.02	0.517	7	190	-	0.015
SFM0091	1.9	2.3	2007-01-18	12577	15.6	-	-	-	-	0.021	0.537	7.19	180	-	0.012
SFM0091	1.9	2.3	2007-03-26	12731	14.6	-	-	-	-	0.02	0.482	7.11	175	-	0.011
SFM0095	5	6	2006-11-15	12521	8.94	4.09	4.08	4.06	0.423	0.007	0.31	6.93	71.9	0.098	0.013
SFM0095	5	6	2007-01-19	12579	11.0	4.15	4.41	4.18	0.379	0.01	0.312	7.16	68.4	0.169	0.011
SFM0095	5	6	2007-03-28	12735	11.5	3.67	4.01	4.02	0.326	0.009	0.286	7.13	64.1	0.137	0.009
SFM0102	2.09	2.25	2006-11-15	12527	4.52	0.43	-	-	0.062	<0.004	0.087	4.46	9.5	-	0.016
SFM0102	2.09	2.25	2007-04-02	12528	4.49	0.35	-	-	0.038	<0.004	0.035	4.34	9.5	-	0.014

< "value" = Value below detection – or reporting limit

RCB % = Relative charge balance error %

EC = Electrical conductivity

SICADA: water_composition

Table A4-2. Surface water supplements. Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	NH ₄ -N mg/L	NO ₂ -N mg/L	NO ₃ -N+NO ₂ -N mg/L	NO ₃ -N mg/L	N-tot mg/L	P-tot mg/L	PO ₄ -P mg/L	SiO ₄ -Si mg/L	TOC mg/L	DOC mg/L	DIC mg/L
SFM0001	3.95	4.95	2006-07-18	12346	0.286	0.0003	0.0003	<0.0003	1.13	0.0471	0.0202	7.58	26.3	25.6	98.2
SFM0001	3.95	4.95	2006-10-10	12388	0.296	0.0002	0.0007	0.0005	0.948	0.0568	0.0433	7.7	20.6	20.9	104.8
SFM0001	3.95	4.95	2007-01-18	12578	0.211	<0.0002	<0.0003	<0.0003	1.42	0.0395	0.0338	7.48	36.3	36	90.6
SFM0001	3.95	4.95	2007-03-27	12733	0.155	0.0007	0.0007	<0.0003	1.26	0.0347	0.0267	6.98	31.9	30.4	61.2
SFM0023	4.42	5.42	2006-07-21	12229	2.32	0.0127	0.0187	0.006	2.56	0.0074	0.0014	4.32	4	x	15
SFM0023	4.42	5.42	2006-10-12	12380	2.82	0.0005	0.0004	<0.0003	2.83	0.0938	0.0005	3.76	3.2	3.4	18.2
SFM0023	4.42	5.42	2007-01-17	12574	2.59	0.0002	0.0003	<0.0003	2.7	0.868	<0.0005	2.78	4.1	4.6	11.5
SFM0023	4.42	5.42	2007-03-29	12739	2.64	0.0005	0.0007	<0.0003	2.07	0.0073	0.0011	3.47	3.5	3.6	15.5
SFM0032	3	4	2006-07-18	12344	0.0277	0.0002	<0.0003	<0.0003	0.591	0.0101	0.0024	7.56	19.1	18.8	67.7
SFM0032	3	4	2006-10-10	12389	0.0387	<0.0002	<0.0003	<0.0003	0.511	0.0116	0.001	8.06	13.9	14	48.3
SFM0032	3	4	2007-01-22	12582	0.0735	0.0002	0.0016	0.0014	0.597	0.0126	0.0064	6.47	17.6	17.4	67
SFM0032	3	4	2007-03-28	12737	0.059	0.0004	0.0005	<0.0003	0.553	0.0117	0.0065	5.86	16.8	16.8	55.9
SFM0037	2	3	2006-07-19	12347	0.0255	0.0002	<0.0003	<0.0003	0.836	0.0478	0.0034	7.33	24.5	23.8	96.6
SFM0037	2	3	2006-10-10	12387	0.0217	<0.0002	<0.0003	<0.0003	0.666	0.0518	0.002	7.74	17.4	18.2	103.2
SFM0037	2	3	2007-01-17	12573	0.0083	0.0003	0.0003	<0.0003	0.962	0.0202	0.0063	5.58	30.7	30.9	77.8
SFM0037	2	3	2007-03-28	12736	0.0009	0.0004	0.0005	<0.0003	0.899	0.0265	0.0044	5.24	29	28.7	65.9
SFM0049	4	5	2006-07-18	12345	0.189	0.0002	0.0003	<0.0003	0.858	0.02	0.0133	4.02	22.6	21.8	49.5
SFM0049	4	5	2006-10-10	12386	0.155	0.0002	<0.0003	<0.0003	0.835	0.018	0.0126	4.06	20.8	21.1	42.3
SFM0049	4	5	2007-01-23	12584	0.0235	0.0005	0.0068	0.0063	0.632	0.008	0.0013	4.9	18	17.6	36.5
SFM0049	4	5	2007-03-27	12734	0.0554	0.0004	0.0005	<0.0003	0.631	0.0141	0.0034	4.62	17.6	17.2	33.4
SFM0077	6	7	2006-10-12	12391	0.238	—	2.8	—	3.33	0.0384	0.0336	4.16	6.6	7	25
SFM0077	6	7	2007-01-23	12580	0.438	0.0047	3.78	3.78	4.39	0.136	0.129	3.77	9	9.2	67
SFM0078	3.5	4.5	2006-10-12	12393	0.0283	—	0.0044	—	0.42	0.0554	0.0006	5.31	9.9	10.1	21.1
SFM0078	3.5	4.5	2007-01-23	12581	0.0295	0.0004	0.0031	0.0027	0.413	0.207	0.0007	4.95	11.8	12.1	63.9
SFM0079	4.7	5.7	2006-10-12	12392	0.282	—	0.0011	—	0.563	0.0367	0.0033	7.71	11.8	12	23
SFM0079	4.7	5.7	2007-01-23	12585	0.283	0.0002	0.0007	0.0005	0.556	0.0394	0.0034	7.85	11.5	11.9	71.6
SFM0080	8.65	9.62	2006-10-11	12390	0.121	—	<0.0003	—	0.516	0.0148	0.003	6.77	13.3	13.7	22.9

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	NH ₄ -N mg/L	NO ₂ -N mg/L	NO ₃ -N+NO ₂ -N mg/L	NO ₃ -N mg/L	N-tot mg/L	P-tot mg/L	PO ₄ -P mg/L	SiO ₄ -Si mg/L	TOC mg/L	DOC mg/L	DIC mg/L
SFM0080	8.62	9.62	2007-01-24	12586	0.0434	0.139	1.77	1.63	1.93	0.0101	0.005	5.75	14.5	14.7	80.1
SFM0081	4.85	5.25	2007-01-17	12575	2.1	<0.0002	<0.0003	<0.0003	1.92	0.722	<0.0005	3.77	2.5	2.4	22
SFM0081	4.85	5.25	2007-03-29	12738	2.12	<0.0002	0.0003	0.0003	1.63	0.0074	<0.0005	2.23	2.1	5	13.6
SFM0083	2.54	2.7	2007-04-03	12529	2.38	0.0009	0.0014	0.0005	3.72	0.0657	0.0008	9.96	16.7	14.7	31.7
SFM0084	3.7	4.1	2006-11-15	12524	0.165	<0.0002	<0.0003	<0.0003	0.693	0.0803	0.0069	8.13	13	13.2	121
SFM0084	3.7	4.1	2007-01-24	12583	0.187	<0.0002	<0.0003	<0.0003	0.665	0.325	0.001	8.21	13.3	13.3	96.9
SFM0084	3.7	4.1	2007-03-29	12740	0.235	0.0003	0.001	0.0006	0.662	0.0255	0.0005	5.72	13.6	14.8	92.1
SFM0087	2	2.2	2006-11-14	12522	0.0074	0.0029	0.0004	<0.0003	0.781	0.0707	0.0546	12.1	20.9	20.2	164
SFM0087	2	2.2	2007-01-18	12576	0.0021	<0.0002	<0.0003	<0.0003	0.717	0.0634	0.0515	12.1	19	18.6	165
SFM0087	2	2.2	2007-03-27	12732	0.0002	<0.0002	<0.0003	<0.0003	0.679	0.0623	0.047	10.8	18.7	18.7	156
SFM0091	1.9	2.3	2006-11-14	12523	0.0794	0.0002	0.0002	<0.0003	0.643	0.12	0.0392	15.1	13.1	12.9	114
SFM0091	1.9	2.3	2007-01-18	12577	0.0681	<0.0002	<0.0003	<0.0003	0.571	0.124	0.021	13.2	12	12	114
SFM0091	1.9	2.3	2007-03-26	12731	0.0658	0.0004	0.0006	<0.0003	0.503	0.122	0.0383	13.8	11.1	11.2	114
SFM0095	5	6	2006-11-15	12521	0.876	0.0006	0.003	0.0024	2.18	0.0784	0.0558	8.88	35.7	37.6	72.3
SFM0095	5	6	2007-01-19	12579	1.16	0.0225	0.0238	0.0013	1.75	0.0849	0.0619	10.3	22.3	22.2	78.2
SFM0095	5	6	2007-03-28	12735	1.32	0.0003	0.0008	0.0005	1.47	0.118	0.0361	11.4	14.4	14.6	76
SFM0102	2.09	2.25	2006-11-15	12527	0.123	0.0013	0.0065	0.0052	3.57	0.149	0.0124	4.32	152	140	8.7
SFM0102	2.09	2.25	2007-04-02	12528	0.0712	0.0014	0.0019	0.0004	3.3	0.137	0.0179	4.2	144	136	9.4

< "value" = Below reporting limit

x = No result due to analytical problems

SICADA: biochemistry_supplements

Table A4-3. Drinking water quality. Compilation, June 2007.

Id code	Date	Kbact no/100mL	Microbesw no/100mL	Ecoli no/100mL	Temp. _Field (°C)	Smell _Lab	Colour (number)	pH_L	Temp_pH (°C)	Alk mg/L	EC_L mS/m	Ca mg/L	Cl mg/L	COD mg/L	Cu mg/L
PFM000001	2006-10-12	2	2600	<1	10.5	Weak	62	7.1	25	630	119	150	49	4.5	0.021
PFM000009	2006-10-12	<1	20	<1	6.9	No smell	160	7.2	25	64	1400	770	4900	12	<0.02
PFM006382	2006-10-12	1	2400	<1	10.2	No smell	68	7.1	25	250	500	200	1500	11	<0.02

Table A4-3. Drinking water quality (cont.). Compilation, June 2007.

Id code	Date	Cu mg/L	F mg/L	Fe mg/L	Hardness _German (dH)	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	NH₄_N mg/L	NH₄ mg/L	NO₃_N mg/L	NO₃ mg/L	NO₂_N mg/L	NO₂ mg/L	PO₄_P mg/L	PO₄ mg/L	SO₄ mg/L
PFM000001	2006-10-12	0.021	1.0	1.6	–	40	33	0.3	54	4.1	5.3	<0.1	<0.44	0.002	0.01	0.005	0.02	120
PFM000009	2006-10-12	<0.02	1.1	4.9	152	29	190	0.92	1900	1.5	1.9	<0.1	<0.44	<0.002	<0.01	<0.02	<0.01	340
PFM006382	2006-10-12	<0.02	0.5	11	43	25	65	0.58	680	0.16	0.21	<0.1	<0.44	<0.002	<0.01	<0.02	<0.01	220

Explanations:

- Kbact Number of coliform bacteria
- Ecoli Number of escherichia coli bacteria at 35°C
- Sediment Ocular inspection of sediment
- EC_L Electric conductivity
- < "value" = Value below reporting limit

Table A4-4. Isotopes. Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	¹⁰B/¹¹B	δ D (‰ SMOW)	Tritium (TU)	δ¹⁸O (‰ SMOW)
SFM0001	3.95	4.95	2006-07-18	12346	0.2383	-76.6	10.5	-10.8
SFM0001	3.95	4.95	2006-10-10	12388	0.2397	-77.1	10.8	-10.5
SFM0001	3.95	4.95	2007-01-18	12578	-	-82.0	9.5	-11.1
SFM0001	3.95	4.95	2007-03-27	12733	-	-85.5	7	-11.2
SFM0023	4.42	5.42	2006-07-21	12229	0.2448	-68.7	3.1	-8.8
SFM0023	4.42	5.42	2006-10-12	12380	0.2338	-69.0	2.3	-8.7
SFM0023	4.42	5.42	2007-01-17	12574	-	-70.2	2.6	-8.6
SFM0023	4.42	5.42	2007-03-29	12739	-	-70.1	3	-8.8
SFM0032	3	4	2006-07-18	12344	0.2409	-82.4	10.8	-11.8
SFM0032	3	4	2006-10-10	12389	0.2392	-78.7	11.6	-11.0
SFM0032	3	4	2007-01-22	12582	-	-87.5	9.6	-11.8
SFM0032	3	4	2007-03-28	12737	-	-87.0	7.9	-12.1
SFM0037	2	3	2006-07-19	12347	0.2432	-76.0	9.2	-10.5
SFM0037	2	3	2006-10-10	12387	0.2417	-72.6	11.5	-10.1
SFM0037	2	3	2007-01-17	12573	-	-83.4	8.5	-11.5
SFM0037	2	3	2007-03-28	12736	-	-82.0	9.1	-11.4
SFM0049	4	5	2006-07-18	12345	0.2409	-71.2	11.5	-9.4
SFM0049	4	5	2006-10-10	12386	0.2403	-69.5	13.4	-8.7
SFM0049	4	5	2007-01-23	12584	-	-82.4	10.0	-10.9
SFM0049	4	5	2007-03-27	12734	-	-82.8	8.3	-11.2
SFM0051	4.32	4.48	2006-07-25	12352	0.2452	-82.3	11.8	-12.0
SFM0051	4.32	4.48	2006-10-26	12515	-	-89.0	9.1	-11.9
SFM0051	4.32	4.48	2007-01-17	12587	0.2486	-86.9	9.1	-12.0
SFM0051	4.32	4.48	2007-04-03	12742	-	-87.4	8.9	-12.1
SFM0077	6	7	2006-10-12	12391	-	-77.9	12.2	-11.2
SFM0077	6	7	2007-01-23	12580	-	-87.3	9.8	-11.8
SFM0078	3.5	4.5	2006-10-12	12393	-	-88.6	10.8	-11.9
SFM0078	3.5	4.5	2007-01-23	12581	-	-86.4	7.8	-11.9
SFM0079	4.7	5.7	2006-10-12	12392	-	-86.3	10.4	-11.3
SFM0079	4.7	5.7	2007-01-23	12585	-	-84.1	6.6	-11.2
SFM0080	8.65	9.62	2006-10-11	12390	-	-82.5	12.1	-11.5
SFM0080	8.62	9.62	2007-01-24	12586	-	-90.0	8.5	-11.7
SFM0081	4.85	5.25	2007-01-17	12575	-	-64.9	2.0	-8.1
SFM0081	4.85	5.25	2007-03-29	12738	-	-65.9	1.4	-8.3
SFM0083	2.54	2.7	2007-04-03	12529	0.2402	-65.3	10.5	-7.9
SFM0084	3.7	4.1	2006-11-15	12524	-	-82.9	14.0	-11.5
SFM0084	3.7	4.1	2007-01-24	12583	-	-82.6	10.2	-11.2
SFM0084	3.7	4.1	2007-03-29	12740	-	-83.2	10.4	-11.5
SFM0087	2	2.2	2006-11-14	12522	-	-79.6	10.6	-11.2
SFM0087	2	2.2	2007-01-18	12576	-	-80.6	11.1	-10.9
SFM0087	2	2.2	2007-03-27	12732	-	-82.8	11	-11.0
SFM0091	1.9	2.3	2006-11-14	12523	-	-81.3	8.9	-11.4
SFM0091	1.9	2.3	2007-01-18	12577	-	-82.4	11.1	-11.2
SFM0091	1.9	2.3	2007-03-26	12731	-	-83.5	9.9	-11.3
SFM0095	5	6	2006-11-15	12521	-	-82.1	8.7	-11.6
SFM0095	5	6	2007-01-19	12579	-	-86.5	7.1	-11.7
SFM0095	5	6	2007-03-28	12735	-	-89.0	6.4	-12.1
SFM0102	2.09	2.25	2006-11-15	12527	-	-83.0	11	-11.9
SFM0102	2.09	2.25	2007-04-02	12528	0.2403	-83.7	10.4	-11.8

A = Results to be reported

SICADA: Isotopes_1

Table A4-5. Trace metals I. Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	Al µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Co µg/L	Hg µg/L	Ni µg/L	Zn µg/L	Pb µg/L	V µg/L	Mo µg/L	Ba µg/L	B µg/L
SFM0001	3.95	4.95	2006-07-18	12346	21.7	–	0.0115	0.359	0.426	0.188	<0.002	0.77	0.688	0.127	1.97	1.2	64.2	–
SFM0001	3.95	4.95	2006-10-10	12388	12.4	–	0.0024	0.217	0.215	0.17	<0.002	0.464	0.345	0.0634	1.96	1.58	63.9	429
SFM0001	3.95	4.95	2007-01-18	12578	54.8	1.63	0.0054	0.566	0.419	0.211	<0.002	1.27	1.56	0.115	2.01	1.35	54.1	265
SFM0001	3.95	4.95	2007-03-27	12733	35.9	1.15	<0.002	0.349	0.404	0.17	<0.002	1.21	0.875	0.0611	1.67	0.975	45.1	174
SFM0032	3	4	2006-07-18	12344	18.8	–	0.019	0.268	0.373	0.0969	<0.002	0.456	1.36	0.0394	2.15	3.4	57.7	–
SFM0032	3	4	2006-10-10	12389	19.4	–	0.0031	0.324	0.151	0.202	<0.002	0.913	<0.2	0.0236	1.26	2.52	103	111
SFM0032	3	4	2007-01-22	12582	16.6	0.994	0.0032	0.228	0.465	0.0763	<0.002	0.654	2.88	0.061	1.33	2.27	58.4	46.4
SFM0032	3	4	2007-03-28	12737	16	0.85	<0.002	0.177	0.243	0.085	<0.002	0.554	0.327	0.0236	1.42	1.91	54.1	38.8
SFM0037	2	3	2006-07-19	12347	21.1	–	0.0052	0.51	0.371	0.0843	<0.002	0.574	<0.2	0.0878	2.93	1.35	98.8	–
SFM0037	2	3	2006-10-10	12387	13.5	–	0.0062	0.371	0.368	0.135	<0.002	1.84	0.284	0.0548	2.18	3.09	110	186
SFM0037	2	3	2007-01-17	12573	36	0.697	<0.002	0.445	0.618	0.0993	<0.002	1.36	0.508	0.0441	2.29	1.83	82.2	82.6
SFM0037	2	3	2007-03-28	12736	59.9	0.675	<0.002	0.392	0.517	0.11	<0.002	1.19	0.347	0.0496	2.47	1.19	86	72.7
SFM0049	4	5	2006-07-18	12345	30.8	–	0.0083	0.209	0.277	0.0797	<0.002	0.264	0.421	0.0626	0.971	0.0553	31.9	–
SFM0049	4	5	2006-10-10	12386	25.5	–	<0.002	0.214	0.103	0.072	<0.002	0.316	<0.2	0.0919	0.978	<0.05	27.9	18.8
SFM0049	4	5	2007-01-23	12584	29.7	0.373	0.0273	0.173	1.63	0.523	<0.002	0.839	0.875	0.344	0.394	0.26	33.5	11.2
SFM0049	4	5	2007-03-27	12734	43.1	0.675	0.0064	0.168	0.66	0.289	0.003	0.446	0.78	0.566	0.78	0.118	28.8	10.1
SFM0051	4.32	4.48	2006-07-25	12352	205	–	0.0088	15.5	0.462	0.32	<0.002	8.27	2.79	0.482	2.5	1.17	90.6	–
SFM0051	4.32	4.48	2006-10-26	12515	116	1.53	0.004	1.64	0.393	0.11	0.005	1.21	1.63	0.683	2.35	1.13	92	24.9
SFM0051	4.32	4.48	2007-01-17	12587	89.3	1.31	<0.01	7.88	<0.5	0.0696	<0.002	1.7	3.59	1.29	2.21	1.33	98	26.2
SFM0051	4.32	4.48	2007-04-03	12742	113	1.3	0.0995	24.5	2.37	0.396	<0.002	15.4	6.22	1.4	2.39	1.11	90.9	22.6
SFM0077	6	7	2007-01-23	12580	23.8	0.438	0.067	0.219	6.3	0.332	<0.002	1.04	6.2	0.125	0.33	4.43	48.2	22.4
SFM0078	3.5	4.5	2007-01-23	12581	19.7	0.815	0.0235	0.228	3.41	0.782	<0.002	1.95	1.5	0.0655	0.855	2.32	88.3	21.2
SFM0079	4.7	5.7	2007-01-23	12585	3.47	4.74	<0.002	0.21	0.164	0.149	<0.002	0.611	1.33	0.037	0.749	6.46	75.4	217
SFM0080	8.62	9.62	2007-01-24	12586	22	0.739	0.0333	0.149	6.14	0.442	<0.002	1.74	0.9	0.139	0.712	4.64	114	17.8

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	Al µg/L	As µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Co µg/L	Hg µg/L	Ni µg/L	Zn µg/L	Pb µg/L	V µg/L	Mo µg/L	Ba µg/L	B µg/L
SFM0083	2.54	2.7	2007-04-03	12529	10.7	0.5	<0.002	0.262	<0.1	0.0869	0.0027	0.443	0.344	0.069	0.293	0.405	80.4	236
SFM0087	2	2.2	2006-11-14	12522	57.5	0.25	0.0049	0.609	<0.1	0.13	<0.002	0.254	0.246	0.0852	3.34	<0.05	131	426
SFM0087	2	2.2	2007-01-18	12576	11.1	0.2	0.0027	0.679	<0.1	0.117	<0.002	0.192	0.684	0.0354	3.61	0.0604	137	416
SFM0087	2	2.2	2007-03-27	12732	10.6	0.2	<0.002	0.539	<0.1	0.0906	<0.002	0.107	<0.2	0.0148	3.44	<0.05	133	419
SFM0095	5	6	2006-11-15	12521	73.1	0.59	<0.02	0.643	0.553	0.175	<0.002	0.555	<0.8	<0.1	3.61	1.42	95.6	77.4
SFM0095	5	6	2007-01-19	12579	29.6	0.665	0.0026	0.478	0.356	0.135	<0.002	0.577	1.56	0.028	2.21	1.15	89.5	109
SFM0095	5	6	2007-03-28	12735	4.18	0.495	<0.002	0.207	<0.1	0.0767	<0.002	0.144	0.326	0.0149	1.26	0.493	76.5	115
SFM0102	2.09	2.25	2006-11-15	12527	143	1.4	0.033	0.354	1.27	0.0675	0.0079	0.791	51.7	1.35	0.518	0.104	10.5	25.6
SFM0102	2.09	2.25	2007-04-02	12528	118	1.51	0.0233	0.308	2.08	0.099	0.0057	0.382	22.9	1.36	0.446	<0.05	8.94	18.9

< "value" = Below reporting limit

SICADA: trace_elements_1

Table A4-6. Trace metals II. Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	U µg/L	Th µg/L	Sc µg/L	Rb µg/L	Y µg/L	Zr µg/L	In µg/L	Sb µg/L	Cs µg/L	La µg/L	Hf µg/L	Tl µg/L	Ce µg/L
SFM0001	3.95	4.95	2006-07-18	12346	3.51	0.152	0.105	4.79	2.12	6.45	–	0.0585	0.132	1.77	0.101	<0.005	4.3
SFM0001	3.95	4.95	2006-10-10	12388	3.01	0.098	0.0678	4.1	1.5	5.95	<0.05	0.0557	0.122	1.5	0.0779	<0.005	3.69
SFM0001	3.95	4.95	2007-01-18	12578	4.28	0.213	0.114	3.37	3.08	5.11	<0.05	0.0875	<0.03	2.95	0.0942	<0.005	7.69
SFM0001	3.95	4.95	2007-03-27	12733	3.87	0.235	0.157	2.55	2.96	7.87	<0.05	0.0749	<0.03	2.64	0.251	<0.005	6.93
SFM0032	3	4	2006-07-18	12344	3.83	0.092	0.0649	1.89	2.08	4.46	–	0.0314	<0.03	1.77	0.0734	0.0072	1.92
SFM0032	3	4	2006-10-10	12389	3.91	0.09	0.0648	2.96	1.76	2.71	<0.05	0.0531	0.0472	1.53	0.0457	0.0061	1.59
SFM0032	3	4	2007-01-22	12582	6.98	0.0543	0.0669	2.01	1.87	3.83	<0.05	0.0438	<0.03	1.35	0.0554	<0.005	1.57
SFM0032	3	4	2007-03-28	12737	8.02	0.08	0.0836	1.7	1.7	7.02	<0.05	0.0362	<0.03	1.14	0.149	<0.005	1.45
SFM0037	2	3	2006-07-19	12347	6.28	0.158	0.105	3.95	2.56	6.19	–	0.064	0.0432	1.41	0.122	0.0056	2.69
SFM0037	2	3	2006-10-10	12387	19.9	0.0885	0.0644	4.5	1.63	3.98	<0.05	0.0879	0.0546	0.99	0.0734	<0.005	1.69
SFM0037	2	3	2007-01-17	12573	19.4	0.196	0.151	2.65	3.96	4.47	<0.05	0.107	<0.03	2.2	0.109	<0.005	3.78
SFM0037	2	3	2007-03-28	12736	15.2	0.249	0.206	2.54	4.15	8.08	<0.05	0.0923	<0.03	1.95	0.216	<0.005	3.49
SFM0049	4	5	2006-07-18	12345	0.175	0.117	0.0665	4.1	0.988	0.429	–	0.0293	<0.03	1.46	0.0146	<0.005	2.8
SFM0049	4	5	2006-10-10	12386	0.175	0.0873	0.0666	3.07	1.09	0.446	<0.05	0.0303	<0.03	1.27	0.0168	<0.005	2.36
SFM0049	4	5	2007-01-23	12584	1.02	0.0606	0.0519	4.56	0.803	0.31	<0.05	0.0895	<0.03	1.62	0.0087	0.0208	2.78
SFM0049	4	5	2007-03-27	12734	0.362	0.131	0.071	3.33	1.01	0.753	<0.05	0.0585	<0.03	1.65	0.0611	<0.005	3.32
SFM0051	4.32	4.48	2006-07-25	12352	1.09	0.0909	0.118	1.79	1.07	<10	–	0.0375	0.0487	0.796	0.0768	0.006	1.62
SFM0051	4.32	4.48	2006-10-26	12515	1.06	0.148	0.108	1.58	0.787	5.26	<0.05	0.0498	0.0325	0.519	0.0671	<0.005	0.966
SFM0051	4.32	4.48	2007-01-17	12587	1.02	<0.1	<0.3	1.45	0.764	4.65	<0.3	<0.05	<0.1	0.418	0.07	<0.03	0.882
SFM0051	4.32	4.48	2007-04-03	12742	0.964	0.177	0.12	1.28	0.874	10.4	<0.05	0.0299	<0.03	0.502	0.14	<0.005	1.09
SFM0077	6	7	2007-01-23	12580	45.7	0.0519	0.0826	4.54	1.19	1.19	<0.05	0.184	<0.03	0.602	0.0326	0.0539	0.608
SFM0078	3.5	4.5	2007-01-23	12581	36.9	0.0566	0.0969	1.95	2.78	4.52	<0.05	0.0766	<0.03	2.19	0.0629	0.0202	1.69
SFM0079	4.7	5.7	2007-01-23	12585	4.18	<0.02	<0.05	4.08	0.269	1.02	<0.05	0.0349	<0.03	0.0629	0.0142	<0.005	0.085
SFM0080	8.62	9.62	2007-01-24	12586	94.9	0.0565	0.111	6.61	2.47	2.15	<0.05	0.135	<0.03	3.39	0.0426	<0.3	1.96
SFM0083	2.54	2.7	2007-04-03	12529	0.37	<0.02	<0.05	8.03	0.289	0.417	<0.05	0.0387	<0.03	0.281	0.0147	<0.005	0.427
SFM0087	2	2.2	2006-11-14	12522	0.0425	<0.02	<0.05	4.73	0.505	1.56	<0.05	0.0229	<0.03	0.215	0.0318	<0.005	0.304
SFM0087	2	2.2	2007-01-18	12576	0.195	<0.02	<0.05	4.32	0.478	1.54	<0.05	0.0156	<0.03	0.194	0.0318	<0.005	0.281

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	U µg/L	Th µg/L	Sc µg/L	Rb µg/L	Y µg/L	Zr µg/L	In µg/L	Sb µg/L	Cs µg/L	La µg/L	Hf µg/L	Tl µg/L	Ce µg/L
SFM0087	2	2.2	2007-03-27	12732	0.0331	<0.02	<0.05	3.65	0.472	3.65	<0.05	0.0184	<0.03	0.178	0.241	<0.005	0.256
SFM0095	5	6	2006-11-15	12521	9.15	0.0717	<0.08	1.59	0.92	1.00	<0.2	<0.1	<0.1	0.362	0.0187	<0.03	0.656
SFM0095	5	6	2007-01-19	12579	8.73	0.129	0.0857	1.82	2.52	4.47	<0.05	0.107	<0.03	0.7	0.053	<0.005	1.15
SFM0095	5	6	2007-03-28	12735	3.05	0.062	<0.05	1.64	1.38	5.62	<0.05	0.0178	<0.03	0.254	0.117	<0.005	0.449
SFM0102	2.09	2.25	2006-11-15	12527	0.184	0.0307	<0.05	1.67	0.601	0.198	<0.05	0.11	0.0366	0.286	0.0054	<0.005	0.556
SFM0102	2.09	2.25	2007-04-02	12528	0.0174	<0.02	<0.05	1.29	0.0654	0.237	<0.05	0.0723	<0.03	0.045	0.0061	0.0051	0.127

Table A4-6. Trace metals II (cont.). Compilation, June 2007.

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	Pr µg/L	Nd µg/L	Sm µg/L	Eu µg/L	Gd µg/L	Tb µg/L	Dy µg/L	Ho µg/L	Er µg/L	Tm µg/L	Yb µg/L	Lu µg/L
SFM0001	3.95	4.95	2006-07-18	12346	0.4	1.53	0.284	0.0297	0.312	0.0465	0.286	0.0575	0.173	0.0276	0.16	0.0273
SFM0001	3.95	4.95	2006-10-10	12388	0.325	1.28	0.237	0.0237	0.238	0.034	0.212	0.0441	0.127	0.0185	0.125	0.0212
SFM0001	3.95	4.95	2007-01-18	12578	0.631	2.75	0.512	0.062	0.549	0.0736	0.473	0.0953	0.315	0.0395	0.266	0.0423
SFM0001	3.95	4.95	2007-03-27	12733	0.595	2.48	0.459	0.0526	0.484	0.0664	0.433	0.0851	0.275	0.0359	0.252	0.0369
SFM0032	3	4	2006-07-18	12344	0.367	1.46	0.259	0.0253	0.305	0.0369	0.245	0.0537	0.178	0.0264	0.173	0.0275
SFM0032	3	4	2006-10-10	12389	0.259	1.07	0.179	0.0108	0.209	0.0286	0.189	0.0426	0.137	0.0197	0.137	0.0229
SFM0032	3	4	2007-01-22	12582	0.257	1.12	0.197	0.0218	0.219	0.0304	0.196	0.0416	0.138	0.0181	0.13	0.0209
SFM0032	3	4	2007-03-28	12737	0.24	1.02	0.187	0.0207	0.204	0.0289	0.207	0.0427	0.152	0.0213	0.154	0.0257
SFM0037	2	3	2006-07-19	12347	0.338	1.4	0.28	0.0244	0.323	0.0501	0.341	0.0741	0.248	0.037	0.246	0.0376
SFM0037	2	3	2006-10-10	12387	0.225	0.951	0.19	0.015	0.212	0.0317	0.209	0.0467	0.151	0.0225	0.159	0.0238
SFM0037	2	3	2007-01-17	12573	0.526	2.17	0.471	0.0588	0.56	0.0835	0.588	0.121	0.426	0.0568	0.416	0.0639
SFM0037	2	3	2007-03-28	12736	0.464	2.02	0.436	0.0499	0.497	0.0762	0.533	0.114	0.398	0.0546	0.374	0.0588
SFM0049	4	5	2006-07-18	12345	0.328	1.22	0.232	0.0262	0.21	0.0301	0.172	0.0319	0.0988	0.0136	0.0896	0.0132
SFM0049	4	5	2006-10-10	12386	0.284	1.13	0.217	0.0251	0.202	0.0285	0.179	0.0351	0.106	0.0145	0.0948	0.015
SFM0049	4	5	2007-01-23	12584	0.328	1.3	0.231	0.0237	0.219	0.0261	0.142	0.0257	0.0735	0.0086	0.0577	0.0146
SFM0049	4	5	2007-03-27	12734	0.385	1.5	0.273	0.0295	0.235	0.0305	0.184	0.0334	0.0998	0.0128	0.0848	0.0119

Id code	Secup m	Seclow m	Date yyyy-mm-dd	Sample no.	Pr µg/L	Nd µg/L	Sm µg/L	Eu µg/L	Gd µg/L	Tb µg/L	Dy µg/L	Ho µg/L	Er µg/L	Tm µg/L	Yb µg/L	Lu µg/L
SFM0051	4.32	4.48	2006-07-25	12352	0.195	0.73	0.143	0.0155	0.116	0.0198	0.128	0.0287	0.09	0.0135	0.104	0.0185
SFM0051	4.32	4.48	2006-10-26	12515	0.127	0.539	0.105	<0.005	0.113	0.017	0.117	0.0282	0.0914	0.0145	0.112	0.0201
SFM0051	4.32	4.48	2007-01-17	12587	0.105	0.422	0.0791	<0.03	0.114	<0.03	0.111	<0.03	0.0806	<0.03	0.0868	<0.03
SFM0051	4.32	4.48	2007-04-03	12742	0.134	0.549	0.112	0.0093	0.115	0.0182	0.125	0.026	0.0927	0.0143	0.115	0.0207
SFM0077	6	7	2007-01-23	12580	0.145	0.612	0.139	0.0151	0.155	0.0232	0.16	0.0334	0.122	0.0162	0.122	0.0186
SFM0078	3.5	4.5	2007-01-23	12581	0.407	1.94	0.325	0.0332	0.349	0.0442	0.267	0.0558	0.187	0.0248	0.176	0.0299
SFM0079	4.7	5.7	2007-01-23	12585	0.0165	0.07	0.0181	<0.005	0.0249	<0.005	0.027	0.0067	0.0256	<0.005	0.0242	0.0057
SFM0080	8.62	9.62	2007-01-24	12586	0.535	2.37	0.358	0.0502	0.395	0.0464	0.302	0.0619	0.209	0.025	0.168	0.0261
SFM0083	2.54	2.7	2007-04-03	12529	0.065	0.277	0.0515	<0.005	0.0479	0.0064	0.0417	0.008	0.0276	<0.005	0.0279	<0.005
SFM0087	2	2.2	2006-11-14	12522	0.0507		0.053	0.0206	0.0623	0.0098	0.0624	0.0153	0.0482	0.0082	0.0506	0.0099
SFM0087	2	2.2	2007-01-18	12576	0.0434	0.21	0.0489	0.0056	0.0643	0.0087	0.0641	0.0141	0.0474	0.007	0.0485	0.008
SFM0087	2	2.2	2007-03-27	12732	0.0416	0.193	0.0421	<0.005	0.0539	0.0079	0.0574	0.0125	0.0456	0.0062	0.0461	0.0078
SFM0095	5	6	2006-11-15	12521	0.0931	0.403	0.0878	0.0131	0.103	0.0154	0.109	0.0271	0.0857	0.014	0.0951	0.0178
SFM0095	5	6	2007-01-19	12579	0.171	0.701	0.168	0.0179	0.211	0.0351	0.271	0.0616	0.237	0.0331	0.226	0.0416
SFM0095	5	6	2007-03-28	12735	0.0601	0.29	0.0688	0.005	0.0936	0.0149	0.122	0.0313	0.127	0.0184	0.148	0.0251
SFM0102	2.09	2.25	2006-11-15	12527	0.0809	12.5	0.0705	0.011	0.0787	<0.006	0.0785	0.0166	0.0474	0.0061	0.0357	0.0061
SFM0102	2.09	2.25	2007-04-02	12528	0.0167	0.0621	0.016	<0.005	0.0139	<0.005	0.0134	<0.005	0.0067	<0.005	0.0054	<0.005

< "value" = Below reporting limit

SICADA: trace_elements_2