British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

G-BASE
Geochemical Baseline Survey of the Environment

# G-BASE FIELD PROCEDURES MANUAL

version 1.1

June 2003

Economic Minerals and Geochemical Baseline Programme

Internal Report IR/03/096N

BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/03/096N

# G-BASE FIELD PROCEDURES MANUAL version 1.1

June 2003

Compiled by C C Johnson , S E Brown and T R Lister

*Contributors*

E L Ander

N Breward

F M Fordyce

J M Harvey

K E O'Donnell

B G Rawlins

R Staines



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☎ 01491-838800 Fax 01491-692345

*Parent Body*

**Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU**

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www.nerc.ac.uk

# Foreword

The G-BASE project has spanned more than four decades and remains one of BGS's primary survey programmes in the United Kingdom. The key to the project's success lies in the reliability and high quality of data produced which has been consistent over a long period of time covering changes in personnel and strategies. This has been achieved by following the procedures detailed here, which, with regular recorded updates, also serves as a means of monitoring changes as the project evolves. Although written essentially as instructions for internal use within BGS this manual will also act as a guidebook for regional geochemical mapping worldwide.

Dr C C Johnson

G-BASE Project Manager

June 2003

# Acknowledgements

This manual has been compiled by the G-BASE project team and is based on procedures which have evolved since the geochemical mapping started at the end of the 1960's. We acknowledge the input of previous G-BASE team workers and those under its previous guises as the GSP (Geochemical Survey Programme) and the Regional Geochemical Reconnaissance Programme. Not least we acknowledge the hundreds of volunteer student workers who over many years have been the principal agents in carrying out the procedures described here.

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# Summary

The G-BASE project is a long-term systematic geochemical survey that has required a high degree of consistency in its sampling methodologies. This report gives in detail all the project procedures associated with the collection of geochemical samples from the planning phase in the office through to sample reception and reporting of the completed field campaign. The procedures described here should be diligently followed in order to maintain the high levels of quality control the project aspires to. Any changes to procedures are indicated in the latest version of this manual and documented in an updates list in Annex I.

In addition to describing all the fieldwork procedures, the recruitment and training of "voluntary" student workers is described along with discussions relating to health and safety issues likely to be encountered during sampling.

When describing the methods used by G-BASE in reports or publications, reference should be made to this manual.

# 1 Introduction

The Geochemical Baselines Survey of the Environment (G-BASE) project is a systematic high-resolution survey to establish a geochemical baseline across the United Kingdom. In 1968 the Institute of Geological Sciences (IGS) (now the British Geological Survey, BGS) began a regional geochemical sampling programme in the northern Highlands of Scotland. This work was aimed at producing maps to show the distribution of trace elements in stream sediments. Prior to this, earlier geochemical studies were mainly involved with uranium reconnaissance work, a programme supported by the UK Atomic Energy Authority (1967 –1972).

The establishment of a Geochemistry Division on 1st August 1967 was the step that initiated the regional geochemical mapping programme. Funded by the Department for Trade and Industry (DTI) the project in the early 1970's was known as the Regional Geochemical Reconnaissance Programme and was closely associated with the work of the DTI Mineral Reconnaissance Programme. The project was then based in the Radioactive and Metalliferous Minerals Unit. The earliest samples were collected from the Sutherland atlas area in the summer of 1968 as part of the uranium reconnaissance work. The first systematic sampling for the regional geochemistry started in Orkney and Shetland in the summer of 1970. The work has progressed southwards from northern Scotland ever since. The first geochemical data from the regional survey of northern Scotland was placed on open file in 1972 for the Caithness quarter inch Geological map sheet area.

A further reorganisation of the IGS saw the creation of a Special Surveys Division in 1977 and the Regional Geochemical Reconnaissance Programme became a major project within the Metalliferous Minerals and Applied Geochemistry Unit. Work on the Orkney and Shetland geochemical atlases commenced in 1974 and the Shetland atlas was the first to be published in 1978. Between 1975 and 1990 the work was funded by the UK Department for Trade and Industry (DTI). After 1990 funding for the work came from the Department of Education and Science and subsequently, the Office of Science and Technology. The project was renamed the Geochemical Survey Programme (GSP) in 1988 and again in 1994 to the Geochemical Baselines Survey of the Environment Project (G-BASE).

Under the reorganisation of BGS in 2000 the project was placed in the Lands and Resources Directorate and is currently managed within the Economic Minerals and Geochemical Baseline (EMGB) Programme.

This manual relates to the procedures employed in collecting the geochemical samples. It supersedes all previous manuals the last of which was an unpublished "G-BASE Field Procedures Manual 2000" produced by Bob Lister that had been derived from the draft G-BASE Field Procedures Manual written by Flight and Lister in June 1998 as an unclassified report in the Applied Geochemistry Report Series (Flight and Lister, 1998).

The manual is written in sections and any changes to procedures will be inserted as updates. An update history is found at the back of this report (Annex I) and the footer details the version number and date for each section.

# 2 G-BASE Sampling Strategy

The basic sampling methodology has developed from that described by Plant (1971) and the organisational aspects of the sampling programme from Plant and Rhind (1974). Drainage samples have been the primary material collected for producing geochemical maps as sediments from low order streams have demonstrably been a very effective "average" representation of large areas of drainage catchment. The regional geochemical mapping strategies employed by G-BASE in the UK have successfully been transferred to numerous geochemical surveys around the world (e.g. Sumatra, Indonesia (Machali et al, 1997); Hong Kong (Sewell, 1999); and Morocco, (Johnson, 2001)). G-BASE procedures have been incorporated into international initiatives and some of the G-BASE methodology has been modified to correspond to international standards of geochemical mapping (Darnley et al, 1995 and Salminen et al 1998).

The sampling strategy has evolved since the inception of the project to reflect:

- the shift from mineral exploration to environmental issues
- the improved methods of chemical analysis that allow the low levels of elements found in stream waters to be determined
- the collection of soil samples in areas where there is no surface drainage (e.g. limestone areas)
- the collection of soil samples from urban areas to reflect the demand for data for areas where most of the population is based
- the collection of soil samples from rural areas where the drainage system has been extensively modified by intensive agriculture.

A summary of samples collected by the G-BASE project is given in Table 2-1. The location of all G-BASE samples collected is given in the BGS GeoScience data index[1].

In-field quality assurance (QA) and quality control (QC) measures have always been afforded the highest priority (Plant, 1973 and Plant et al, 1975). Procedures described in this manual are part of the QA and are to be strictly followed. Procedures are enforced by strict supervision by team leaders, regular monitoring by managers and discussion at biannual project meetings. The process is to be further enhanced with the introduction of a post-field campaign report (described in Section 18).

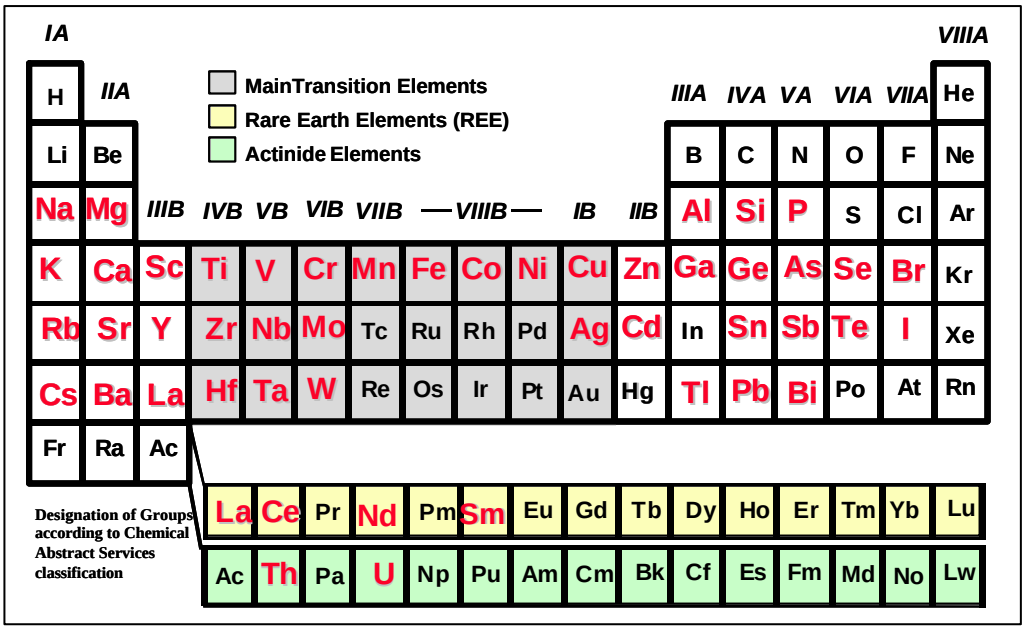
A central part of the strategy is the employment of students (of Earth or Environmental Sciences) referred to as voluntary workers (VW) to make up field sampling teams of normally four sampling pairs. They are not paid a wage but are provided with accommodation and a per diem which in 2003 has been increased to £25. These form four sampling pairs on a daily basis and are supervised by one experienced BGS field geochemist (team leader) and one or two support staff (assistant team leaders). This provides a cost effective way of collecting samples and provides university graduates with valuable geochemical sampling experience. The number of support staff depends on the experience of the BGS personnel. The optimum is a BGS staff member as assistant team leader and an experienced VW who will fill the role of a SVW ("super voluntary worker").

[1] http://www.bgs.ac.uk/geoindex/home.html

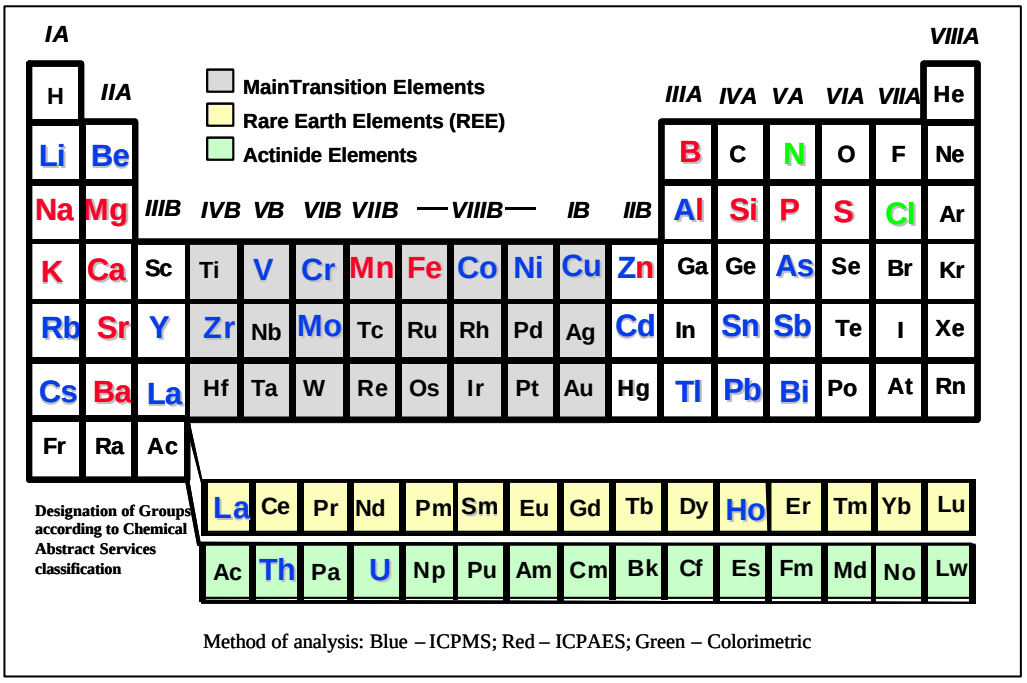
| *Sample Type* | *Sample Code* | *Density of sampling (1 sample/km$^2$)* | *Description* |
|---|---|---|---|
| Stream Sediment | C | 1.5 - 2.0 | Fine stream sediment wet sieved at site to <150µm collected from low order (i.e. smallest) streams. Routinely analysed by XRF (see Figure 2-1 for elements determined) |
| Panned Concentrate | P | 1.5 - 2.0 | <2mm sediment from drainage site panned in wooden dulang-style pan. 3-5 kg of sediment (a full pan) is panned until 20-40g of heavy minerals remain. Inspected at site with a hand lens. Not routinely analysed. |
| Stream water | W | 1.5 - 2.0 | Collected from site of C and P samples. Five samples are collected at each site for: (i) pH; (ii) alkalinity and conductivity; (iii) filtered/unacidified for nitrate, chloride and NPOC (labelled F/UA); (iv) filtered/acidified for ICP-AES (labelled F/A) and (v) filtered/acidified for ICP-MS (labelled W) (see Figure 2-1 for elements determined). |
| Surface soil | A | 2.0 | Collected from depth of 10-20 cm using a hand held Edelmen soil auger with a 15cm flight width and a composite of 5 samples collected at points on a 20 x 20 m square. Dried, disaggregated and sieved in the laboratory to < 2mm. Routinely analysed by XRF (see Figure 2-1 for elements determined) |
| Deep soil | S | 2.0 | Collected from depth of 40-50 cm using hand held Edelmen soil auger with a 5cm flight width and a composite of 5 samples collected at points on a 20 x 20 m square (using same auger holes as A sample). Dried, disaggregated and sieved in the laboratory to <2mm. Stored for future reference. Not routinely analysed. |

**Table 2-1: Summary of sample types collected by G-BASE.** Note that, generally, in urban areas only soils are collected at a density of 4 samples per km$^2$.

The sampling campaign normally takes place during the summer months to correspond to the student summer vacation. The duration of a field campaign and the number of sampling teams deployed depends on the available annual budget. With the present level of staff experience and equipment, two teams sampling for 10 weeks is the optimum sampling strategy.




(a) *Elements determined (by XRF) in surface soils and stream sediments (highlighted in red). Loss-on-ignition and pH are also routinely measured on soils.*




*(b) Elements determined in surface waters (highlighted in red, blue and green). Conductivity, pH, bicarbonate and non particulate organic carbon (NPOC) are also routinely measured.*

**Figure 2-1: Periodic tables summarising elements determined on (a) stream sediments and surface soils and (b) surface waters**

# 3 Health and Safety

Health and Safety (H&S) is an integral part of all G-BASE procedures and any activity considered to be of medium to high risk to health and safety is investigated by a risk assessment. H&S is of sufficient importance to merit its own procedures file and so these are not duplicated in this manual. The G-BASE H&S file is available in the project office at Keyworth and it is a requirement that all staff should sign to acknowledge they are aware of the existence of the file and their duty to read it. A copy of the G-BASE H&S file will be available for the field team to read on location at the field campaign base. The student workers will be informed of H&S issues during their training day (see Section 5).

A summary of the medium/high risk activities in the field and measures to reduce the risks is given in Table 3-1. The overriding principle of Health and Safety measures is that we have a duty to safeguard our own health and safety, those with whom we work and those on whom our work impacts. One of the main measures to reduce risks is training and all BGS staff working in the field should receive training in:

- first aid at work
- driving 4x4 vehicles (on and off road including trailer towing)
- manual handling
- Minibus driving (unless category D1 stated on driving license)

Field team leaders must be made aware (in confidence) of any health issues affecting members of their team (food allergies, health problems etc.) and such information should be requested by team leaders prior to commencement of fieldwork. Leaders must also have readily available a list of emergency contact numbers both for personnel, the local area (e.g. Police) and work (e.g. contact for senior managers).

In addition to the project Health & Safety file all BGS fieldworkers should have read the BGS Transport Manual[2] (latest version May 2003) and the BGS Guidance Note "A safe system of fieldwork" issued to all BGS fieldworkers.

**Photograph 1: Samplers are transported by a minibus that has a place to secure samples and equipment whilst travelling**

[2] available in Keyworth from http://intranet/docs/facilities/Transport_Manual.doc

| High/Medium risk activity | Summary of measures to reduce risk |
|---|---|
| Driving in field area | • receive appropriate vehicle driving training<br>• use vehicle appropriate for type of fieldwork |
| Transporting heavy loads and equipment | • do not overload vehicles<br>• secure equipment and samples<br>• transport acid in special anti-spill containers |
| Lifting heavy loads/ loading and unloading samples | • receive manual handling training<br>• use appropriate storage crates for sample transportation<br>• don't overload storage crates<br>• do not load/unload heavy items alone<br>• rucksacks must be fit for the job in hand and can be adjusted to suit the wearer |
| Sampling soils and drainage samples | • attend G-BASE sampling training day<br>• dress appropriately with good footwear and always take waterproof clothing<br>• stick to recognised paths. Do not take risks crossing barbed wire fences/stone walls or rivers/streams for the sake of making a shortcut |
| Walking on country roads | • always use Hi-vis jackets and rucksacks<br>• seek alternative footpaths if available<br>• walk into oncoming traffic except when approaching the brow of a hill |
| Remote working | • always sample in pairs<br>• inform team leaders of proposed route<br>• carry emergency telephone numbers |
| Adverse weather | • pay attention to weather forecasts<br>• do not sample areas in times of flood<br>• take appropriate measures against exposure to the sun<br>• during thunderstorms follow standard procedures to avoid lightening strikes and in particular don't carry a metal soil auger. |
| Attack by animals | • avoid potentially dangerous animals (e.g. bulls and guard dogs) where possible by choosing an alternative route |
| Military, shooting area and other hazardous land use | • always have permission to enter such areas first<br>• team leaders to advise samplers of such potential areas on their map<br>• team leaders plan daily sampling areas so hazards such as large rivers or railways do not have to be crossed<br>• always wear Hi-vis jackets |
| Exposure to infection, agrochemicals and pesticides | • samplers to be advised of dangers on training day<br>• avoid contaminated sites or fields being sprayed<br>• observe DEFRA exclusion notices when encountered in the field |

**Table 3-1: Summary of the high/medium risks in fieldwork and measures to reduce the risks**

# 4 Pre-field campaign planning

## 4.1 SITE PLANNING

1. Detailed planning is carried out well in advance of the commencement of fieldwork. This is essential in order that field accommodation and sampling boundaries can be identified. The total number of samples to be collected from the area must be calculated accurately in order to determine the duration of the field season and to sub-divide the area efficiently.

2. It is important to consult the stable base maps from adjacent areas in order to establish the sampling boundary for the new campaign. This is especially important in the case of soils.

3. Site planning is carried out on flat, coloured copies of the relevant 1:50 000 Ordnance Survey (OS) sheets (see Figure 4-1). Black and white maps are not suitable for this purpose, as different topographic features are distinguished by colour.

4. Sediment sites should be planned at an average of 1 per 1.5 sq. km where surface drainage is well defined. Sites should be located mainly on first and second order streams and situated upstream of obvious sources of contamination such as road intersections and farm buildings. Care must also be taken to locate sites upstream of confluences to minimise effects caused by sediment mixing and upstream dispersion.

5. G-BASE soil sites should be planned at the pre-determined density, generally one per 2 sq. km, on a regular grid. Sites should be located away from obvious sources of contamination, but a much greater degree of flexibility, with respect to the precise site location, is available to the sampler when collecting soils in the regional survey. Urban soils should be planned at one per 500 m x 500 m quadrant within each km grid square. The sample site should be located as near to the centre of the quadrant as possible.

6. If there is to be more than one sampling team and operating from a different field base, then once all planning has been undertaken, and boundaries established, a sets of duplicate maps must be prepared to ensure that different field teams understand the sub-division of sampling areas.

7. The sampling rate also has to be established so that the final total number of samples and the area of samples taken can be calculated. This has to take into account, training weeks and weeks when Saturday mornings are not worked due to an accommodation move (see Table 4-1).

| | Wk1 (training) | Wk 2 | Wk 3 (move) | Wk 4 | Wk 5 (training) | Wk 6 (move) | Wk 7 | Wk 8 | Wk 9 |
|---|---|---|---|---|---|---|---|---|---|
| Mon | 7x4 = 28 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 7x4 = 28 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 |
| Tue | 9x4 = 36 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 9x4 = 36 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 |
| Wed | 10x4 = 40 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 10x4 = 40 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 |
| Thu | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 |
| Fri | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 | 11x4 = 44 |
| Sat(1/2 day) | 6x4 = 24 | 6x4 = 24 | N/A | 6x4 = 24 | 6x4 = 24 | N/A | 6x4 = 24 | 6x4 = 24 | 6x4 = 24 |
| Total | 216 | 244 | 220 | 244 | 216 | 220 | 244 | 244 | 244 |
| Overall Total | | | | | | | | | **2092** |

**Table 4-1: Example of sampling rate calculation for a 9 week field campaign with four sampling pairs**

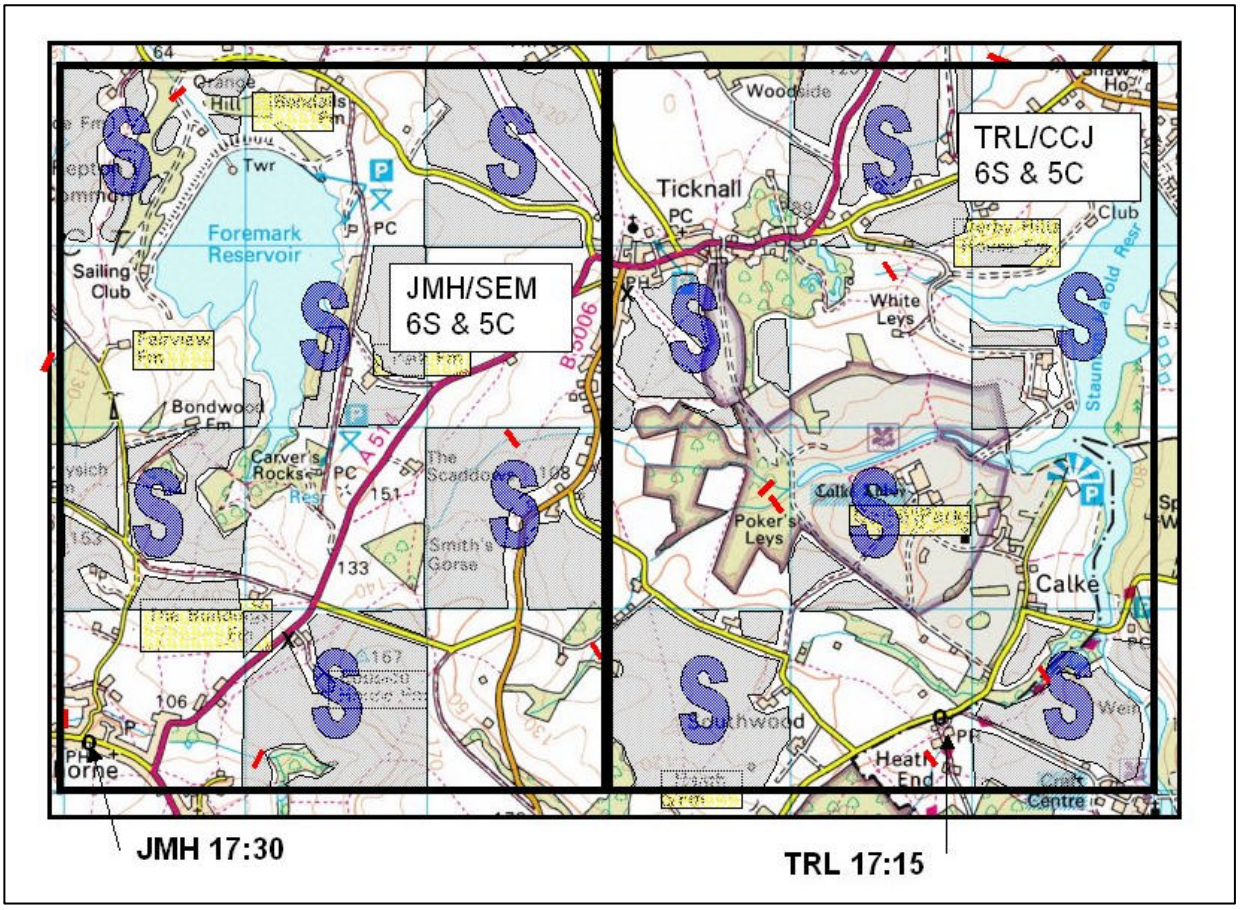



**Figure 4-1: Diagram of sample site planning on 1:50,000 OS topographic maps**

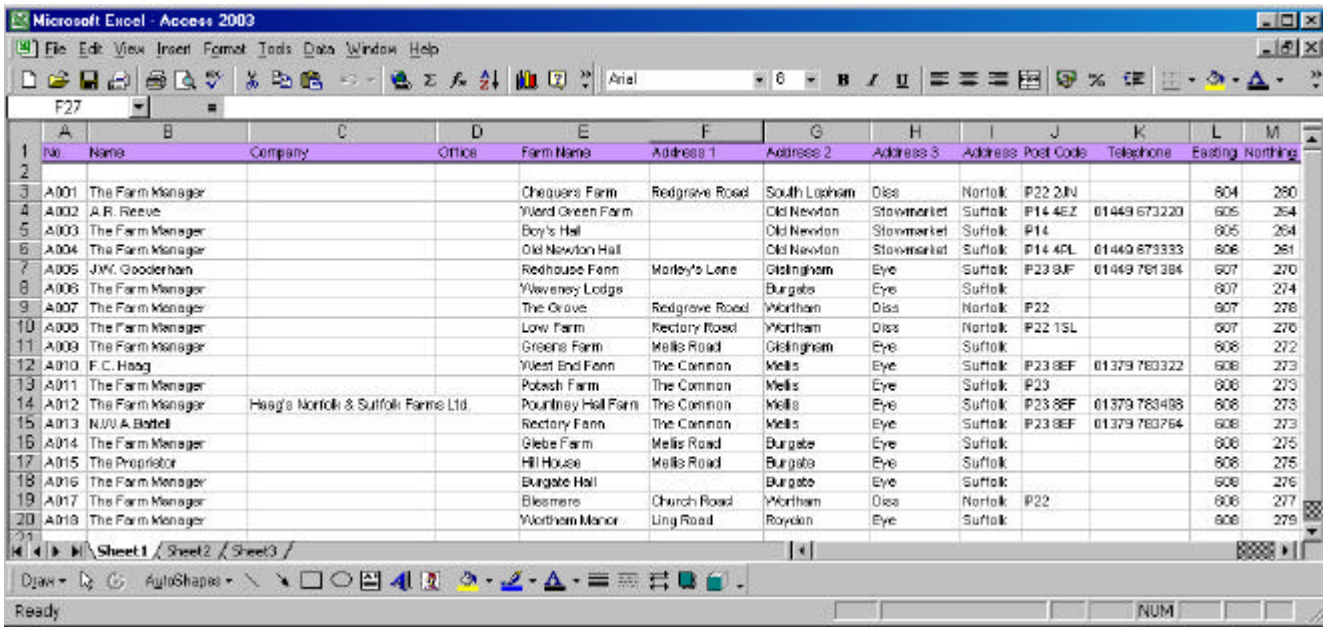
*This is an idealised figure combining the planning map and the field map. Drainage sample locations (red line), soil sample areas ("S" in kilometre square, sample within shaded area) and farms (highlighted in yellow) are marked on the planning map. The day before sampling the team leader will mark out field maps allocating suitably sized areas to a sampling pair indicating the number of soils and sediments to be collected. The sampling pair will indicate on the map where they wish to be dropped off in the morning and picked up (with a time) in the evening.*

## 4.2 SITE ACCESS

1. In order to gain access for the field season, written notice is sent to estates and farmers whose land falls on or near the planned sediment or soil sample sites.

2. The estates and farms are identified on the 1:50 000 planning map, and the addresses are located using www.yell.co.uk, www.streetmap.co.uk and www.royalmail.com.

3. The names and addresses of these farms are then entered into an Excel spreadsheet (see Figure 4-2 for an example). The finished spreadsheet is then used as a mail merge for a standard access letter and permission slip (see Annex A).




| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | No | Name | Company | Office | Farm Name | Address 1 | Address 2 | Address 3 | Address | Post Code | Telephone | Easting | Northing |
| 2 | | | | | | | | | | | | | |
| 3 | A001 | The Farm Manager | | | Chequers Farm | Redgrave Road | South Lopham | Diss | Norfolk | IP22 2JN | | 604 | 280 |
| 4 | A002 | A.R. Reeve | | | Ward Green Farm | | Old Newton | Stowmarket | Suffolk | IP14 4EZ | 01449 673220 | 605 | 264 |
| 5 | A003 | The Farm Manager | | | Boy's Hall | | Old Newton | Stowmarket | Suffolk | IP14 | | 605 | 264 |
| 6 | A004 | The Farm Manager | | | Old Newton Hall | | Old Newton | Stowmarket | Suffolk | IP14 4PL | 01449 673333 | 606 | 261 |
| 7 | A005 | J.W. Gooderham | | | Redhouse Fenn | Morley's Lane | Gislingham | Eye | Suffolk | IP23 8JF | 01449 761384 | 607 | 270 |
| 8 | A006 | The Farm Manager | | | Waveney Lodge | | Burgate | Eye | Suffolk | | | 607 | 274 |
| 9 | A007 | The Farm Manager | | | The Grove | Redgrave Road | Wortham | Diss | Norfolk | IP22 | | 607 | 276 |
| 10 | A008 | The Farm Manager | | | Low Farm | Rectory Road | Wortham | Diss | Norfolk | IP22 1SL | | 607 | 276 |
| 11 | A009 | The Farm Manager | | | Greens Farm | Mells Road | Gislingham | Eye | Suffolk | | | 608 | 272 |
| 12 | A010 | F.C. Haag | | | West End Fenn | The Common | Mells | Eye | Suffolk | IP23 8EF | 01379 783322 | 608 | 273 |
| 13 | A011 | The Farm Manager | | | Potash Farm | The Common | Mells | Eye | Suffolk | IP23 | | 608 | 273 |
| 14 | A012 | The Farm Manager | Haag's Norfolk & Suffolk Farms Ltd | | Pountney Hall Farm | The Common | Mells | Eye | Suffolk | IP23 8EF | 01379 783488 | 608 | 273 |
| 15 | A013 | N.J.V.A. Bottell | | | Rectory Fenn | The Common | Mells | Eye | Suffolk | IP23 8EF | 01379 783764 | 608 | 273 |
| 16 | A014 | The Farm Manager | | | Glebe Farm | Mells Road | Burgate | Eye | Suffolk | | | 608 | 275 |
| 17 | A015 | The Proprietor | | | Hill House | Mells Road | Burgate | Eye | Suffolk | | | 608 | 275 |
| 18 | A016 | The Farm Manager | | | Burgate Hall | | Burgate | Eye | Suffolk | | | 608 | 276 |
| 19 | A017 | The Farm Manager | | | Blesmere | Church Road | Wortham | Diss | Norfolk | IP22 | | 608 | 277 |
| 20 | A018 | The Farm Manager | | | Wortham Manor | Ling Road | Roydon | Eye | Suffolk | | | 608 | 279 |

**Figure 4-2: Example of the Farm Access Excel Spreadsheet**

4. The letters are sent out in the middle of May. The replies are then filed in order (all permission slips have a unique number) and marked on the map with a highlighter pen. Green = OK, Yellow = telephone call, blue = visit and red = no permission granted.

5. These slips are taken into the field and used as necessary. The used permission slips are filed away separately and marked as used.

## 4.3 ACCOMMODATION

Accommodation is usually booked by the beginning of the year. This is imperative in areas that are holiday destinations. The criteria for choosing G-BASE accommodation is as follows:

- Adequate room for 8 voluntary workers, 1 super voluntary worker and 2 members of staff.
- Centrally located in field area (no more than one hours drive away from furthest sample site).
- The owners must be aware of what the accommodation is being used for and agree to our using it for work purposes.
- If possible, space for sample storage.
- Preferably some indoor space where samples can be dried and checked off (garage or barn).

## 4.4 EQUIPMENT

Equipment is kept in the G-BASE field equipment store in Keyworth. Daily equipment used by each sampling team is listed in Section 10 and sufficient numbers of each of these items should be taken to the field to supply the number of sampling pairs used with some spares. In addition, the field base requires the following equipment:

1. pH electrode (x 3)
2. pH meter
3. pH buffers (4, 7 and 9)
4. Conductivity meter
5. Conductivity standard (1415µs @ 25°C)
6. Alkalinity titrator
7. Bromocresol indicator
8. $H_2SO_4$ cartridges (1.6N and 0.16N) plus spare dispenser tips
9. Water chemistry book (for recording analysis data)
10. Thermometer
11. 100 ml measuring cylinder and plastic conical flask
12. Binocular microscope and lamp for mineral inspection
13. Deionised water
14. Paper tissues and laboratory paper rolls
15. Laboratory coat, safety goggles and gloves
16. Acetone
17. Short pipettes
18. Concentrated $HNO_3$ in 100 ml bottles (1 bottle for each week of the field season)
19. Acetate stable base maps (1:50 000, covering field area)
20. 10 x 1:50 000 folded Ordnance Survey maps for each map covering field area
21. Laptop loaded with G-BASE farms access database and the MS ACCESS field database.
22. Numbered field cards (allowing enough for field season).
23. Random number lists
24. Mobile phones (1 for each team leader and one spare)
25. Stationary (including map pens)
26. Field access permission slips
27. Geological maps of the area
28. AA batteries for the GPS

**Photograph 2: A trailer is useful for transporting equipment to the field and provides valuable storage space**

## 4.5 FIELD BUDGET

Field budget comes from the "Other Recurrent" (OR) part of the general G-BASE budget. This is generally allocated in January of each year and it is the responsibility of the G-BASE Project Manager to monitor expenditure and determine the allocations. Day to day expenditure in the field is the responsibility of the Field Operations Manager.

**Photograph 3: Monk Soham field base, Suffolk, August 2003.**

# 5 Voluntary Workers

## 5.1 RECRUITMENT

Voluntary workers are recruited through an advertisement placed on the BGS web site or through posters sent to UK university earth or environmental science departments (see Annex B). The current application and medical declaration forms are given in Annex C. All applications are sent to BGS Personnel Section who then pass on the applications to the G-BASE field operations manager for selection.

The following criteria form the basis for selection:

- previous experience
- availability
- fitness to carry out sampling in difficult terrain and conditions
- geoscience background (preference should be given to those with a geochemical interest)
- team players / sociable
- legible handwriting

The number of voluntary workers (VW) required depends on the length of field season and number of field teams operating during the season. The average number employed per team is sixteen (eight working the first half of the season and eight the second half) with one super voluntary worker (SVW) for the entire period. At least six reserves, all with varying dates of availability are chosen in case any VWs drop out.

Offers of employment need to be sent out at least 4 weeks before the commencement of the field season. Applicants are contacted by phone in the first instance, if the post is accepted the following information is sent by mail:

- contact telephone number for field operations managers
- the timetable for their work including accommodation addresses, and pick up point for commencement of work
- what clothes and footwear to bring

Personnel Section must provide team leaders with information regarding any health issues and emergency contact numbers (next-of-kin) for the employed VWs.

Payment of the VWs will be made weekly into a bank account so students need to provide an account number for payment. It can take several weeks before the first payments are received so (commencing in 2003) VWs will receive an advance of two weeks once they have commenced employment. The team leader should notify BGS Personnel shortly after work has commenced as to who should receive advances. This will ensure that any students who fail after the initial training day are not paid an advance.

Team and assistant leaders usually look after food and drink purchases for the student workers. This often means VWs owe large sums to the team leaders. It is strongly recommended that the students are encouraged to bring cheque books so debts can be rapidly repaid.

## 5.2 TRAINING

Voluntary Workers (VWs) must be given adequate training in all aspects of geochemical sample collection before being asked to collect routine samples. Training is formally undertaken on the day after the field group has assembled, so no other activities should be scheduled for that day. It is advisable to identify suitable training and have the landowner's permission in advance of the training exercise. Sampling videos are available on CD-ROM and these can be made available to VWs throughout the duration of the sampling.

1. Stream Sediment and Water Sampling: The entire site procedure for collection of a stream sediment sample, a heavy mineral concentrate, and all types of water samples should be demonstrated by members of staff and/or experienced VWs. This should include completion of a field card including all site observations. VWs should then split into pairs and repeat the collection process, with staff supervision. In general, 3 - 4 hours should be allocated for this stage of training.

2. Soil Sampling: Soil sampling methodology can normally be demonstrated at the field base. Sampling should be demonstrated by staff and/or experienced VWs, before allowing VWs to practice for themselves with staff supervision. All relevant field card information should be discussed with particular attention to textural observations.

3. Field Cards - familiarisation and data recording: VWs must be familiar with the layout and understand the protocol involved in completing a field card. Staff should ensure that each member of the field team receives as much training as is necessary to make them fully competent with respect to field cards. (Very few VWs are able to complete faultless field cards during the first few days of a field season). VWs must be made familiar with grid reference conventions and in the use of a compass.

VWs should be carefully supervised in the field by members of staff and experienced VWs during the first few days of the sampling programme. Guidance on dealing with access negotiations must be given to VWs. It is important that everyone understands why they are actually collecting the samples and the general G-BASE rationale. VWs should be issued with a number of information cards (see Annex D). They must always be prepared to approach farmers/landowners whilst carrying out their work. Where possible, staff should make every attempt to explain land access arrangements to VWs on a day-to-day basis. This should include marking relevant information on field maps.

Samplers must be polite and courteous when dealing with members of the public. A general knowledge of field 'etiquette' is required and the country code must be adhered to at all times. It is important that the BGS maintains a good public image and is not misrepresented by poorly informed VWs.

Staff have a responsibility to ensure the reasonable safety of VWs at all times. The risk assessment and field register for all field procedures must have been completed by the project manager prior to commencement of fieldwork (see Section 3).

Safety booklets should be forwarded to all VWs when they have formally accepted their posts, along with advice on tetanus vaccination. Leaflets regarding Lyme Disease, Weil's Disease and other Occupational Zoonoses must be made available to all VWs. These should be signed for.

Contents of the first aid and safety kits must be explained to the VWs. These kits must remain in the field rucksacks at all times. If the first aid kit has been used VWs should inform team leaders so the kit can be restocked. Conventional International Distress Signals must be explained.

Sampling pairs should carry a whistle, torch and survival bag in the field rucksacks and these should be checked each day before sampling commences.

Sampling must always be undertaken in pairs. It is important to stress the necessity for sampling pairs to remain together at all times during the day. At all times VWs must wear "Hi-Vis" reflective waistcoats and be advised when offered the job of the requirement for strong boots and waterproofs. The use of trainers or tekking sandals for fieldwork is unacceptable.

All VWs should carry their official BGS identification pass at all times in case of difficulties with landowners or the public. The mobile phone contact numbers must also be carried by samplers so that emergency contact can be made when necessary.

# 6 Daily Field Campaign Procedures

Preparation for fieldwork is described in Section 4 where site planning and access is discussed. As part of the daily routine in the field the team leader and assistant should carry out the following procedures:

1. The number of samples to be collected per day depends on the types of sample being collected and on the terrain. Formerly only drainage samples were routinely collected with a maximum of nine sites per pair per day is recommended. Now both drainage and soil samples are required, six drainage sites and six soil sites per pair make an average day. Where soils only are required, fourteen samples should be within most sampling pairs capabilities.

2. It is good practice to have all sampling days for any particular field-base planned in detail in advance. This is done by sorting the sites into convenient and sensible groups: relief, roads, major rivers and suitable bridging points should be taken into account. This stage must be done meticulously in order to facilitate smooth day-to-day operation of the field programme.

3. Field maps should be prepared one day in advance of the sampling in order to allow VWs to familiarise themselves with the area and to transfer relevant geological data. Any access information should also be clearly marked on the field maps. All field maps are 1:50 000 OS Landranger series sheets for regional sampling and 1:25 000 for urban sampling. No other scale maps should be used as site maps.

4. The VW field maps are prepared by transcribing planned sample sites off the main G-BASE planning map onto a separate 1:50 000 OS map. This has to be done in a logical order to ensure that the VWs have a reasonable route (e.g bridges to cross rivers, no main roads to cross etc…). When a day has been planned onto the map, any access details have to be plotted onto the map and any permission slips from farms placed into the VWs kit for the next day. The maps are then placed into an A4 self seal bag, this is then placed into a large self seal bag, along with the following equipment:

    - Compass
    - GPS
    - Knox Protractor
    - Pentel black marker pen
    - Red Biro
    - Filofax with relevant number of field cards and codes for use on field cards
    - hand lens

The map kits are then assigned to a pair of VWs. Different pairs are chosen each day, this is to make sure that sampling bias is not introduced by a particular pair of samplers getting into bad habits.

5. The VWs are expected to pack their rucksacks the night before. For every stream sediment site a "site bag" is needed, this contains a sediment bag, panned mineral concentrate bag, plastic sediment outers, five bottles for the various water samples, two syringes and enough water filters for one per site and a couple spare. It is also necessary to take two or three spare 250ml polythene Nalgene™ bottles in the event that the water at site is too dirty to be filtered, these are then filled with the water and filtered back at the field base on the VWs return. For soil samples, two soil sample bags are needed per site and an A4 size self seal bag to put the filled soil bags into.
6. Each sampling pair should check that they are carrying a spare wrapped red biro and black marker pen.
7. Spare self-seal bags are required in case dry sediments have to be collected (Section 11.5).
8. Permission slips from farmers are filed into numerical order and stored in a box file. On each 1:50 000 OS map, contacted farms are marked onto the map along with details of whether they have given permission for sampling. The relevant permission slips are retrieved from the box file and put into the field site bags. If the farmers have requested the VWs visit the farmhouse before taking a sample then this is also stated. Used permission slips are then filed in a new box file to avoid duplication.

Special procedures to ensure the high level of quality control for the water samples is described in Section 11.2.6.

# 7 Site Numbering

Sample site numbers are pre-allocated and based on a random numbering system as described by Plant (1973). The first two digits of the site number are a numeric area code. G-BASE area codes are summarised in Table 7-1. Note that when the project started area codes were alphanumeric and have since been substituted in the geochemistry database with all numeric values.

| Area/Map Sheet | Letter Code | Number Code |
|---|---|---|
| Shetland | AS | 01 |
| | | |
| Orkney | AR | 03 |
| | | |
| Caithness | AR | 02 |
| | AQ | 03 |
| | AP | 04 |
| | FN | 05 |
| | SN | 06 |
| | | |
| Sutherland | AP | 03 |
| | | 04 |
| | FN | 05 |
| | SN | 06 |
| | | |
| Lewis | DP | 07 |
| | | |
| Little Minch | CP | 20 |
| | DP | 07 |
| | | |
| Great Glen | AP | 04 |
| | SN | 06 |
| | FN | 05 |
| | DP | 07 |
| | BP | 10 |
| | TZ | 12 |
| | TB | 13 |
| | TD | 14 |
| | TA | 15 |
| | SR | 16 |
| | TX | 17 |
| | CP | 20 |
| | | |
| Moray-Buchan | BP | 10 |
| | | 18 |
| | | |
| Argyll-Tiree | CP | 20 |
| | | 21 |
| | CZ | 22 |
| | | |
| Tay-Forth | CZ | 22 |
| | CW | 23 |
| | CX | 23 |
| | | 24 |
| | | |
| Clyde-Malin | | 27 |
| | | 28 |

| Area/Map Sheet | Letter Code | Number Code |
|---|---|---|
| Borders-Farne | | 29 |
| | | 34 |
| | | 39 |
| | | |
| Isle of Man | | 31 |
| | | |
| Lake District | | 32 |
| | HB | 33 |
| | | |
| Tyne Tees | | 30 |
| | | |
| Abingdon | RZ | 99 |
| | | |
| Liverpool Bay - | | 35 |
| Anglesey | | |
| | | |
| Mid Wales - | | 36 |
| Cardigan Bay | | 37 |
| | | 38 |
| | | |
| Humber Trent | | 40 |
| | | 41 |
| | | |
| Northern Ireland | | 55 |
| | | |
| Shetland Re-Survey | | 83 |
| | | |
| East Midlands | | 42 |
| | | 43 |
| | | |
| East Anglia | | 44 |
| | | |
| Stoke-on-Trent | | 38 |
| | | |
| Wolverhampton | | 99 |
| | | |
| Manchester | | 63 |
| | | |
| All Other Urban | | 60 |
| | | 61 |
| | | |
| Glasgow Peri-Urban | | 62 |
| | | |
| SW England | | 50 |
| | | |
| | | |
| | | |

**Table 7-1: Summary of G-BASE Geochemical Atlas regional and area codes**

The rest of the sample number is allocated according to the following procedure.

1. Field cards are allocated according to one of four random number lists (RNLs) currently used by G-BASE (see Annex E). These lists are identified as RNL1, RNL2, RNL3, and RNL4. Each RNL covers a batch of 100 samples. In the event of two field teams being deployed, one field team will use RNLs 1 & 3, the other RNLs 2 & 4. The two RNLs allocated to each field team should be used alternately for consecutive batches of 100 samples. If one field team is working all four RNLs should be used consecutively.
2. There are different RNLs for drainage and soil samples.
3. Field cards are pre-numbered and sorted into random order corresponding to the associated RNL. The RNLs double up as field sample check lists and are therefore very important documents. Under no circumstances should cards be issued without reference to the RNL.
4. The reverse side of the RNL lists the numbers in random order. Field cards should be issued from the first available (unused) number in this list. The first card issued should correspond to the first available number on the list. Count off the number of sites allocated to each sampling pair for the day, and allocate the cards in sequence. On the RNL, indicate which sampling pair has been allocated each set of cards and on which date. It is essential that cards can be attributed to the samplers. This may be the only way in which field numbering errors or other mistakes may be resolved and allows clear tracking of samples.
5. Any cards which are returned unused at the end of a days' sampling should be retrieved and re-allocated. When this occurs, the initials of the new sampling pair should be marked next to the number on the RNL, along with the new date of issue. This procedure ensures that all field cards in each 100 are linked to a sample.
6. In each 100 cards there is a field duplicate pair. These cards should be allocated together for THE SAME site. Allocation of the duplicate site should take account of the day's schedule, as it will undoubtedly add 30-40 minutes to the sampling pairs' day.
7. Ensure that the cards allocated to standards (STDs), sub-samples (SSs) and blank waters (BWs) are not issued by mistake for field use .

Any labelling or numbering errors which can be identified from the RNL should be rectified immediately. RNLs are submitted to the laboratory along with the samples, so corrections must be made before the samples are dispatched to the laboratory.

# 8 Field Cards

## 8.1 RECORDING SITE AND SAMPLE INFORMATION

The primary method of data collection in the field is a hardcopy record referred to as a field card. Examples of the latest field card are shown in Figure 8-1. Codes used to complete the field cards are given in Figure 8-2 and Figure 8-3. VWs are trained to complete field cards during their training day (Section 5.2), and through the diligent validation of field cards and maps, team leaders ensure a high level of consistency and accuracy is achieved.

1. Field cards are numbered prior to fieldwork commencing
2. At the start of each day sampling teams are issued with a set of field cards corresponding to the number of sites to be sampled. The sampling team allocate the site number on arrival at site based on the next numbered blank field card to be used. This number is transcribed on to all sample bags and bottles and the field map at the site.
3. The field cards are completed at site using a red biro and all sections should be completed on location.
4. The sampling pair responsible for collecting the sample is identified by their initials on the field card. The individual responsible for completing the field card lists their initials first.

**Photograph 4: Site location is recorded using a GPS**

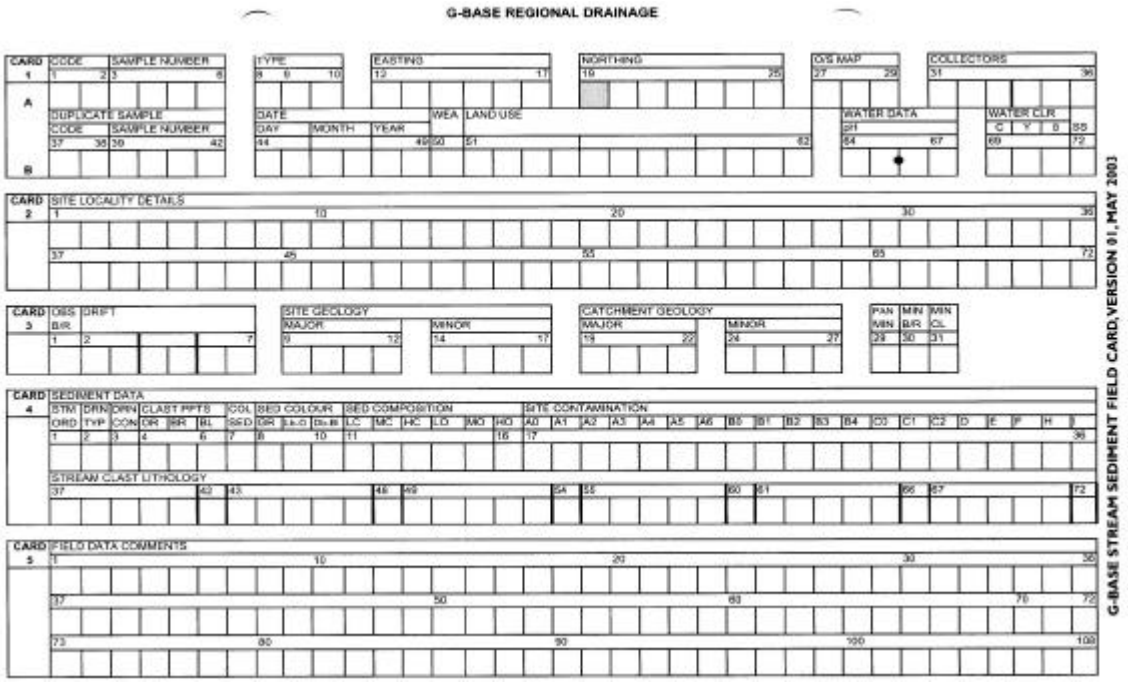
**Photograph 5: Completing a field card at site**

The most common problem facing VWs when completing field cards is unfamiliarity with the codes to be used. This can be overcome by providing a plastic laminated 'crib-sheet' in each filo-fax booklet. This contains information on all the relevant data entry fields to be completed. Only acceptable codes and abbreviations are listed, which reduces the amount of free-text information written on each field card.

Common errors are due to transcription mistakes, especially when copying the National Grid Reference of the site from the GPS onto the field cards. All data stored in the GPS are checked by team leaders at the field base, against the information on the field cards to eliminate location data errors.

Occasionally the wrong sample number may be written onto all the sample containers. This can happen if it is particularly breezy. A gust of wind may flip a field card over in the filo-fax, inadvertently displaying the sample number of the next field card. This will be obvious, and can be rectified when samples are checked in at the field base.

(a)




(b)

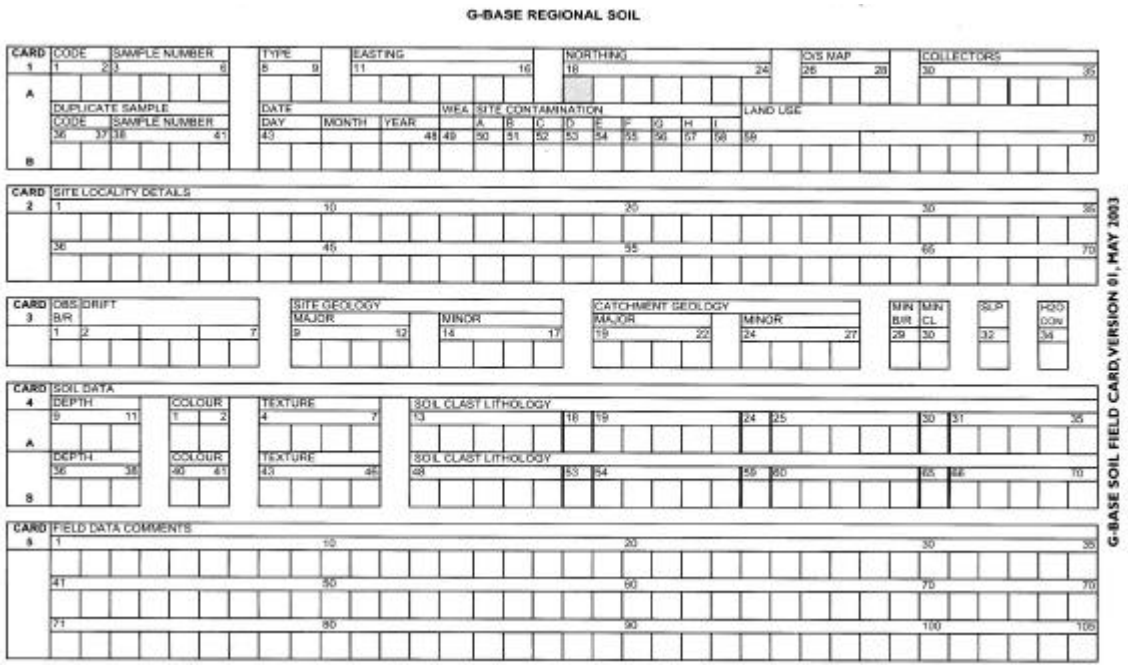



**Figure 8-1: Example of G-BASE field cards: (a) drainage and (b) regional soil**

**SAMPLE TYPE**
C Stream Sediment
P Panned Concentrate
W Water
S Soil

**EASTING/NORTHING**
As taken from GPS reading

**O/S MAP** O/S Field Map Number

**COLLECTORS** Collectors initials person filling in card first.

**WEATHER (RAINFALL)**
1 Rain heavy within 12 hours
4 Rain heavy within 24 hours
6 Rain heavy within 48 hours
7 Rain heavy 2-7 days
8 No rain within a week

**LAND USE**
AEBB Mature Coniferous Forest
AEBA Recent Coniferous Forest
AEAB Mature Deciduous Forest
AEAA Recent Deciduous Forest
AC00 Rough Grazing
ABB0 Heather Moor
BD00 Arable
BAB0 Pasture
DD00 Recreational
DAC0 Urban Open Space
E000 Industrial

**WATER COLOUR**
C Clear
Y Yellow
B Brown

**OSERVED BEDROCK** (within 100m of site)
1 No outcrop
2 Moderate outcrop
3 Abundant outcrop

**DRIFT**
A1 Blown Sands
A4 Raised Beach
A5 Estuarine

B2 Alluvium
B3 Coarse Gravel

C1 Soil
C2 Marsh
C3 Peat Bog

D1 Clay with Flints
D2 Scree

E1 Till
E2 Moraine
E3 Fluvioglacial

**DRAINAGE TYPE**
1 Seepage or Spring
2 Ditch
3 Drains – land drains etc.
4 Small Stream<3m wide
5 Stream 3-10m wide
6 Small River 30-33m wide
7 Large River >33m wide
8 Estuary

**DRAINAGE CONDITION**
1 Dry – no visible surface drainage
2 Ponded with dry sections
3 Low Flow – river bed not covered by running water
4 Moderate Flow – stream boulders visible only
5 Strong Flow – large boulders visible only
6 Channel filled from bank to bank
7 Overflow – stream banks burst
8 Spate

**CLAST PRECIPITATES**
COLOUR
OR Orange
BR Brown
BL Black

**ABUNDANCE**
1 Light
2 Moderate
3 Heavy

**SEDIMENT COLOUR**
GR Grey
LB-O Light Brown/Orange
Db-Bl Dark Brown/Black

**SEDIMENT COMPOSITION**
LC Low Clay
MC Medium Clay
HC High Clay
LO Low Organics
MO Moderate Organics
HO High Organics

**COLLOIDS IN SEDIMENT**
1 Light
2 Moderate
3 Heavy

**CONTAMINATION**

| | | | |
|---|---|---|---|
| A0 | METAL | E0 | RUBBER |
| A1 | Iron/Steel Wire | | |
| A2 | Galvanised Iron | F0 | PAINT |
| A3 | Copper | | |
| A4 | Lead | G0 | EFFLUENT |
| A5 | Zinc | G1 | Farm Effluent |
| A6 | Brass | G2 | Domestic Effluent |
| B0 | CERAMICS | H0 | BULK INDUSTRIAL WASTE |
| B1 | Pottery | H1 | Metal Mine Tailings |
| B2 | Tiles | H2 | Coal Tailing |
| B3 | Bricks | H3 | China Clay Tailings |
| B4 | Glazed China | H4 | Slag (furnace waste) |

**ROCK NAME**

| | | | |
|---|---|---|---|
| AGATE | Agate | BA | Basalt |
| CHLK | Chalk | CHRT | Chert |
| COAL | Coal | CLAY | Clay |
| COLSHL | Coal Shale | DOLR | Dolerite |
| DL | Dolomite | OILS | Oil Shale |
| DI | Diorite | FELS | Felsite |
| FLNT | Flint | FEST | Ironstone |
| GNSS | Gneiss | GB | Gabbro |
| LMST | Limestone | GN | Granite |
| SMARL | Marl | MARBLE | Marble |
| QZITE | Quartzite | MDST | Mudstone |
| SDST | Sandstone | PEL | Pelite |
| SCH | Schist | SLTE | Slate |
| SLST | Siltstone | TUF | Tuff |
| AGG | Agglomerate | CONG | Conglomerate |
| SI | Silicate | CRBAC | Carbonaceous Material |
| IGRU | Igneous Rock | METR | Metamorphic Rock |
| SR | Sedimentary Rock | | |

**MINERALS GENERAL**

| | |
|---|---|
| Arsenopyrite | AsFes |
| Baryte | Ba |
| Bornite | Born |
| Calcite | Cal |
| Cassiterite | Cass |
| Chalcopyrite | CuFeS |
| Chromite | Cr |
| Cinnabar | HgS |
| Epidote | Epi |
| Fluorite | Fluor |
| Galena | PbS |
| Garnet | Gt |
| Gold | Au |
| Haematite | He |
| Ilmenite | FeTiox |
| Magnetite | Mag |
| Molybdenite | MoS |
| Monazite | Mon |
| Pyrite | FeS |
| Pyrrhotite | Pyrr |
| Quartz | Qtz |
| Realgar | AsS |
| Rutile | Tiox |
| Scheelite | Schee |
| Sphalerite | Zns |
| Stibnite | SbS |
| Tourmaline | Tour |
| Wolframite | Wolf |
| Zircon | Zr |

**Figure 8-2: Codes used on G-BASE stream sediment field cards**

**SAMPLE TYPE** A Horizon
S Horizon

**EASTING/NORTHING**
As taken from GPS reading

**O/S MAP** O/S Field Map Number

**COLLECTORS** Collectors initials person filling in card first.

**WEATHER (RAINFALL)**
1 Rain heavy within 12 hours
4 Rain heavy within 24 hours
6 Rain heavy within 48 hours
7 Rain heavy 2-7 days
8 No rain within a week

**SOIL COLOUR**
BL Black
DB Dark Brown
LB Light Brown
RE Red
OR Orange
YE Yellow
GR Green
GY Grey

**SOIL TEXTURE**
SAND – Sand
SILT – Silt
CLAY – Clay
SACL – Sandy Clay
SICL – Silty Clay
SASI – Sandy Silt (loam)

**CONTAMINATION**

| | |
|---|---|
| A0 METAL | E0 RUBBER |
| A1 Iron/Steel Wire | |
| A2 Galvanised Iron | F0 PAINT |
| A3 Copper | |
| A4 Lead | G0 EFFLUENT |
| A5 Zinc | G1 Farm Effluent |
| A6 Brass | G2 Domestic Effluent |
| B0 CERAMICS | H0 BULK INDUSTRIAL WASTE |
| B1 Pottery | H1 Metal Mine Tailings |
| B2 Tiles | H2 Coal Tailing |
| B3 Bricks | H3 China Clay Tailings |
| B4 Glazed China | H4 Slag (furnace waste) |
| C0 GLASS | I0 AGRO-CHEMICALS |
| C1 Clear Glass | I1 Solid Fertilisers (pellets) |
| C2 Coloured Glass | I2 Liquid Fertilisers (sprays |
| D0 PLASTICS | |

**DRIFT**
A1 Blown Sands
A4 Raised Beach
A5 Estuarine
B2 Alluvium
B3 Coarse Gravel
C1 Soil
C2 Marsh
C3 Peat Bog
D1 Clay with Flints
D2 Scree
E1 Till
E2 Moraine
E3 Fluvioglacial

**OBSERVED BEDROCK**
1 No Outcrop
2 Minor Moderate Outcrop
3 Abundant Outcrop

**LAND USE**
AEBB Mature Coniferous Forest
AEBA Recent Coniferous Forest
AEAB Mature Deciduous Forest
AEAA Recent Deciduous Forest
AC00 Rough Grazing
ABB0 Heather Moor
BD00 Arable
BAB0 Pasture
DD00 Recreational
DAC0 Urban Open Space
E000 Industrial

**SLOPE**
1 None
2 Moderate
3 Steep

**$H_2O$ CONTENT**
1 Dry
2 Moderate
3 Waterlogged

**ROCK NAME**

| | | | |
|---|---|---|---|
| AGATE | Agate | BA | Basalt |
| CHLK | Chalk | | |
| CHRT | Chert | CLAY | Clay |
| COAL | Coal | DOLR | Dolerite |
| DL | Dolomite | FELS | Felsite |
| FEST | Ironstone | FLNT | Flint |
| GNSS | Gneiss | GN | Granite |
| LMST | Limestone | MARBLE | Marble |
| SMARL | Marl | MDST | Mudstone |
| SCH | Schist | SDST | Sandstone |
| SLTE | Slate | SLST | Siltstone |
| TUF | Tuff | | |
| AGG | Agglomerate | CONG | Conglomerate |
| SI | Silicate | CRBAC | Carbonaceous Material |
| METR | Metamorphic Rock | IGRU | Igneous Rock |
| SR | Sedimentary Rock | | |

**Texture:**

Most particles > 200 mm = Boulders
Most particles < 200 mm >60 mm = Cobbles
Most particles < 60 mm > 2 mm = Gravel
Most particles < 2 mm > 0.06 mm= sand
Most particles < 0.06 mm > 0.006 mm = silt
Most particles < 0.006 mm > 0.002 mm = clay/silt
Most particles < 0.002 mm = clay
Soil is dark, black and of low density = organic
Soil laid down by man = Made ground

Soil (omitting boulders and cobbles) containing > 35% of fine material should be described as silt or clay.

Soil with < 35% fine material should be described as sand or gravel

**Sand/Silt/Clay Texture:**

Sand - Visible to naked eye; no cohesion when dry.

Silt - Only coarse silt visible with hand lens; exhibits little plasticity and marked dilatancy; slightly granular or silky to the touch; disintegrates in water; lumps dry quickly; possesses cohesion but can be powdered easily between fingers

Clay/silt - Intermediate in behaviour between clay and silt. Slightly dilatant.

Clay - Dry lumps can be broken but not powdered between the fingers; they also disintegrate under water but more slowly than silt; smooth to the touch; exhibits plasticity but no dilatancy, sticks to the fingers and dries slowly; shrinks appreciably on drying usually showing cracks.

**Made Ground:**

Does soil comprise natural or man made materials?

If natural, describe as natural soils

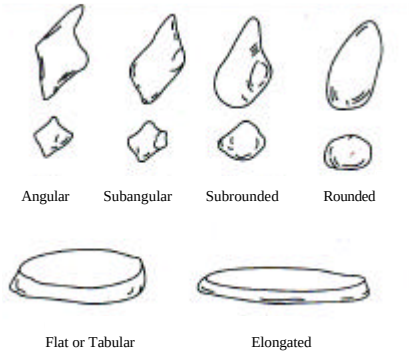



**Figure 8-3: Codes used on G-BASE soil field cards**

## 8.2 FIELD CARD VALIDATION

1. VWs must be encouraged to check their field cards rigorously before handing them in at the end of each day. National Grid References (NGR) and field data comments are particularly prone to error. Geological information should also be completed in the evening with the aid of geological maps.
2. Staff should designate a location for VWs to deposit the field cards, along with 'Filofax' books, field maps, pens and any access slips that they have used that day. This minimises the potential for loss or misplacement of these primary field documents.
3. The validation procedure is carried out on the day following sampling. Firstly, ensure that the number of field cards returned corresponds to the number of cards issued. Remove any unused cards and ascertain the reasons for this. VWs should indicate on the field map why samples were not collected. Check each card in turn against the field map to establish the correct location. Ensure that the National Grid Reference and field site locality description are consistent. Check that all other entries on the field card are correct, especially codes and abbreviations. Field card errors should be logged against the VWs responsible. It is important to iron out problems as early as possible. Once habits are formed, they are difficult to break.
4. Once all cards have been checked, sites should be plotted onto the transparent copies of the 1:50 000 OS sheets (stable base maps). Locations must be accurately transferred using the Knox protractor. Pilot permanent marker pens should be used, and by convention, drainage sites are marked in red, soil sites in blue, and duplicate B in green next to the duplicate A number. Error can be reduced if this step is carried out by two persons, one reading the NGR whilst the other plots the sites on the map.
5. When the sites have been plotted on the stable base maps, the field cards should be arranged into numerical order before field card data is entered into the database. Keep the database up to date and do not allow a backlog of un-entered cards to build up. This will avoid confusion during staff changes and will help to establish a daily routine of working practice. Water chemistry data from the previous days' samples may only be entered **after** the data from the field card has been entered.
6. When all card data has been entered, the field cards should be recombined in numerical order in the field card storage trays.

# 9 Working with Landowners, Farmers and the Public

The G-BASE fieldwork depends on good cooperation with landowners, farmers and the public. Sampling teams need to be aware of important issues that may lead to potential problems in the field and at all times must remain polite, courteous and respectful. Team leaders need to monitor carefully the behaviour of sampling pairs in the field and any incidents that breach a respectful code of conduct or cause upset to local landowners or farmers must be dealt with firmly and swiftly.

Strategies for reducing such incidents should include the following:

1. Pre-fieldwork planning. Site access planning is described in Section 4.2 and it is important to establish who is responsible for ownership or custodianship of areas to be sampled. This may involve some pre-fieldwork reconnaissance to the area and meeting with different individuals/organisations involved. Individual farms are covered in the farms access database that gives team leaders an indication of farms that should be avoided. The pre-fieldwork planning should identify:
    - military areas
    - Forestry Commission
    - National Trust or sites of special scientific interest
    - large country estates
    - natural and man made hazards

    Permission to work in these areas should be obtained before fieldwork commences.

2. Informing the local community. Effort should be made to inform local communities of our activities. This can be done through an article in the local newspaper or contacting the local branch of the National Farmers Union.

3. High visibility and low profile. High visibility jackets are worn by all samplers as a health and safety measure. Since these were introduced, it has been noted that samplers are shown a much greater respect. The Hi-vis jackets reinforce the fact that we are on official business and reassures landowners that samplers are not suspicious characters clandestinely moving around the countryside. At the same time as maintaining a high visibility a low profile is also advised. Public roads and footpaths should be used wherever possible and vehicles should be parked in public rather than private areas.

4. Training. BGS staff and students need to be coached in how to deal with farmers and the general public. This is covered during the training of VWs (Section 5.2). Team leaders should have available at the field base examples of G-BASE work which can be shown to interested parties.

5. Awareness of Agricultural Issues. Sampling teams must be aware of current agricultural issues including arable and pastoral diseases and the precautions to be used whilst working in such areas. Information on these issues is given in Annex F and include:
    - Foot and Mouth
    - Swine Fever and pig rearing
    - sugar beet rhizomania

# 10 Field Equipment carried by sampling team

Staff should ensure that VWs are fully equipped for each day in the field. Each sampling pair should have:

1. ID passes
2. Compass
3. Whistle
4. Hand lens
5. First aid kit containing : plasters, triangular bandages, antiseptic wipes, eye pads, two standard bandages and eye wash solution
6. Polythene survival bag
7. Sieve set (two sieves with 2 mm and 150 µm nylon mesh), 2 pans, funnel and rubber gloves
8. Trenching tool (shovel)
9. Auger
10. Field map with sites marked stored in 14 x 16 in ("over-size") self-seal polythene bag
11. Filofax with field cards and mobile phone number
12. Relevant access information
13. Filter kit: Enough clean filters for each site plus 2 spares, 2 clean syringes, bag for used filters. All stored in clean self-sealing bag
14. Kraft™ sediment bags (4 x 8 in) soil bags (5 x 10 in), heavy mineral concentrate bags (3 x 5 in) plus spares of each
15. 6 x 17 in polythene bags ("sedi-outers") for safe-keeping of sediment samples, plus spares
16. Alkalinity/conductivity sample bottles (250 ml Nalgene™) plus spares
17. Greiner™ tubes for F/A (filtered/acidified sample) plus spares
18. 30 ml Nalgene™ bottles for F/UA and W samples plus spares
19. 30 ml polythene bottles with black lids for pH samples plus spares
20. Enough money for emergency phone-calls
21. 10 x 14 in. (approx A4) self-seal polythene bags for water samples from each site
22. Spare 10 x 14 in (approx A4) self-seal for dry sediment samples
23. Red and black biro and black Pentel marker plus spares sealed in plastic bag

24. Sieve rucksack and sample transport rucksack
25. 2 ½ lb geological hammer and safety glasses or goggles
26. Torch and batteries
27. “Hi-Vis” jacket
28. GPS
29. Knox Protractor

**Photograph 6: Regular checking of sieve sets is important to ensure only fine sediment passes through the sieve**

**Photograph 7: The sieve set is the geochemist's basic equipment**

Samplers should check certain equipment on a weekly basis, a job usually done Saturday afternoon or Sunday. Tasks include:

- checking, cleaning and reassembling sieve sets
- checking that the Kraft™ sample bags are glued correctly
- checking state of first aid kit, torch, whistle and survival bag

# 11 Collecting Stream Drainage Samples

## 11.1 SITE SELECTION

The sample site should be located as closely as surface conditions allow to that indicated on the field map. Obvious contamination should be avoided, e.g. locate sites upstream of stream or road intersections. Every attempt must be made to collect active sediment from the middle of the stream channel. One sampler should walk 50-100 m upstream (along the bank) of the intended site to check for any localised contamination.

## 11.2 STREAM WATER COLLECTION

**Hands must be clean, rinsed in stream water and free from jewellery, plasters, sun screen or any hand creams or lotions.** At sites where water samples are required, all water samples must be collected before disturbance of the stream bed. A total of five samples are normally collected - pH; total alkalinity/conductivity; trace elements by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES); trace element by Inductively Coupled Plasma Mass Spectrometry (ICP-MS); and major anions/NPOC (sulphate, chloride, fluoride/non particulate organic carbon). Three of these require filtration at site (ICP-AES, ICP-MS, major anions/NPOC).

### 11.2.1 Sampling Equipment

- 2 x 25 ml plastic syringes
- 10 x Millex™ sealed filters pre-loaded with 0.45 µm millipore cellulose filters
- Four different sample container types are supplied;

i) 30 ml polyethylene bottles with black watertight caps (pH).

ii) 250 ml polyethylene bottles 'Nalgene'™ with watertight caps (total alkalinity/conductivity).

iii) 30 ml plastic 'Greiner'™ universal tubes with white watertight caps (ICP-AES).

iv) 30 ml high-density polyethylene 'Nalgene'™ bottles with watertight polyethylene caps (ICP-MS, major anions/NPOC).

### 11.2.2 Sample labelling

Write the sample number (taken from the field card) on the sample containers, using the black 'Pentel' marker. The following sample–type codes must also be written on each container:

| | | | | |
|---|---|---|---|---|
| i) | Major anions/NPOC | - | F/UA | (30 ml Nalgene™ bottle) |
| ii) | ICP-MS | - | W | (30 ml Nalgene™ bottle) |
| iii) | ICP-AES | - | F/A | (30 ml Greiner™ universal tube) |
| iv) | pH | - | pH | (30 ml polyethylene bottle) |
| v) | Total Alkalinity/Conductivity | | | (250 ml polyethylene bottle) |

### 11.2.3 ICP-AES, ICP-MS, Major anions/TOC sample collection

These samples must be collected first, from the mid-stream flow, on the upstream side of the sediment sample location. The sampler should stand facing upstream and sediment must not be disturbed. Flush the syringe three times with stream water before connecting a clean Millex™ filter. Flush the filter with 5-10 ml of stream water. Carefully rinse the Greiner™ tubes, Nalgene™ bottle, and caps with filtered stream water (minimum 10 ml). Special care must be taken to ensure that the sample containers and lids remain uncontaminated; the inside of lids and containers should not be handled and must not be allowed to come into contact with soil or vegetation, or unfiltered water. If they need to be put down while open they must be placed on a clean polythene bag. Fill each container with filtered stream water to the neck of the bottle except the F/UA bottle which is completely filled. Apply caps tightly, ensuring that no leakage occurs. Place the filtered samples into a clean 6 x 17 in polythene bag tied with a knot then transported inside a self-seal polythene bag.

In situations where filtration is difficult, the F/A and W samples should be collected first. An additional 250 ml Nalgene™ bottle may be filled with unfiltered water, marked with the sample number and the relevant sample type(s), and taken to the field base for filtration (see Section 11.2.6). It is important to try and filter the samples for trace element analysis at site, as an unquantifiable rate of cation adsorption onto container walls may occur from the larger bottle before filtration.

### 11.2.4 pH, total alkalinity/Conductivity sample collection

These samples should be collected, after the filtered water samples. Like the filtered samples, they should be collected from the mid-stream flow, on the upstream side of the sampler.

Thoroughly rinse the sample containers and caps with stream water thrice. Submerge the containers in the stream to fill; then seal underwater, ensuring that all air has been expelled. Place the unfiltered samples into a clean, self-seal polythene bag along with the bag containing the filtered water samples.

### 11.2.5 Water colour and suspended solids

The water colour and suspended solids need to be determined and entered on the field card, a job undertaken during the sediment collection. This is assessed by filling a polythene bags (6 x 17 in) with water and holding it up against the sky as a background.

### 11.2.6 General quality control procedures for filtered water samples

Filtered water samples, especially those for trace element analysis undergo the most low-level and sensitive analyses and are the most susceptible to contamination of all the samples collected by G-BASE. Special attention must be paid during their collection, collation and storage.

1. Unused sample containers must be stored in a covered, dust-free environment. This should be checked daily and any contaminated bottles disposed of.
2. Field samplers must use clean plastic bags for storage and transportation of unused sample containers and collected samples. They should not use recycled dirty bags for either of these purposes.
3. Filtered water samples should be placed inside a clean 6 x 17 in polythene bag tied with a knot, then transported in a self-seal polythene bag to avoid contamination.
4. Filters should be used for one sample site only and changed for duplicate sites.

5. If samples cannot be filtered at site due to a high proportion of suspended material, a second 250 ml container of unfiltered water should be collected. Samples (especially W, F/A) should be filtered as soon as possible on return to the field base using pre-filters as necessary. Adsorption of cations to walls of the container presents an unquantifiable error that must be minimised. If only one or two samples can be filtered at site then the order of priority should be W, F/A, F/UA. Particularly difficult samples may be allowed to stand overnight prior to filtering but this should be avoided where possible and recorded on the card and in the database.

The syringes are collected each evening and cleaned the following day. At the field base samples with a high proportion of suspended material are also filtered the next day. The filtering process includes the use of a coarser 25 µm pre-filter mounted in a Swinnex ™ filter holder.

i) Pre-filter holders should be taken apart.
ii) The papers removed.
iii) Soaked in a bowl of tap water (**no detergent of any kind should be used).**
iv) Scrubbed with a clean plastic brush (reserved for this sole purpose) as necessary.
v) Rinsed with de-ionised water.
vi) Reloaded with a new paper using plastic tweezers (without handling the paper or inside of the filter holder)
vii) Blown through to check for seal.

Swinex ™ filter holder is loaded with the 25 µm Millipore filter paper and the sample is passed first through the coarse pre-filter then the 0.45 µm Millex™ disposable filter.

**Photograph 8: Filtered water is collected with a syringe and passed through a filter into a Nalgene™ bottle**

## 11.3 STREAM SEDIMENT AND PANNED CONCENTRATE SAMPLE COLLECTION

Before proceeding with the collection of a stream sediment sample hands must be clean, rinsed in stream water and free from jewellery, plasters or any hand creams or lotions

1. *Sampler 1.*

Following collection of any water samples (section 11.2) wash the trenching tool, sieve nest, both pans, the plastic funnel and both sets of thick black rubber gloves with stream water. The sieve nest comprises two circular wooden frames (approximately 45 x 15 cm), housing 2000 µm and 150 µm aperture nylon sieve cloth in the upper and lower sieves respectively. The sieve nest should be assembled on top of the glass-fibre pan, in a stable position, as close to the sediment collection point as possible. The collection pan and sieves must be clean and free from any particulate matter prior to commencement of sampling.

The sediment collection position should be an active area of the stream bed, and should ideally be centrally placed in the stream, to minimise contamination from any bank slip material. Firstly, remove the uppermost (10–20 cm) heavily oxidised sediment using the trenching tool. Secondly, load the top sieve with coarsely sorted sediment from beneath the oxidised layer, taking care to drain off excess water and remove any large clasts before placing the material into the top sieve. If the sediment lies on a base of peat or clayey till, take care to ensure that the sediment is sampled without digging into the underlying fixed material. It will normally be necessary to dig 15 - 25 kg (wet weight ) of material to provide a sufficient final sample weight.

2. *Sampler 2.*

As loading proceeds, the other member of the team rubs the stream sediment through the top sieve, providing sufficient <2000 µm material in the lower sieve to produce adequate <150 µm material (normally 2-3 kg). During this process look out for any contaminant material in the sediment, which should be removed from the sieve and the details noted on the field data card. Before the upper sieve becomes too full and heavy it should be removed and shaken to allow more <2000 µm material to fall through into the bottom sieve. The upper sieve material can then be discarded and this material is often worth observing for stream clast lithologies, which are noted on the field data card. Several cycles of filling, rubbing, shaking and discarding of the top sieve material may be required to provide enough material in the lower sieve. This is dependant on the physical nature of the stream sediment material. Once there is sufficient material in the lower sieve it should be mixed around and rubbed, to allow < 150 µm material to pass through into the grey glass-fibre pan. If the lower sieve material is very dry and sandy it is often necessary to sprinkle a small amount of water into the lower sieve while mixing and rubbing the material. When the lower sieve material has been well mixed and rubbed through, rinse the rubber gloves and then use the funnel to rinse any particulate material off of the top rim and outer sides of the lower sieve, ensuring that the volume of water which goes into the sieve is kept to a minimum. The lower sieve should then be picked up carefully, without disturbing the glass-fibre collecting pan, and gently shaken to allow additional <150 µm material to fall through into the collecting pan. If there appears to be insufficient material in the collecting pan, the lower sieve may be replaced and the material re-mixed and rubbed while sprinkling with a small volume of water (<100 ml). The gloves and sieve top and outer sides should then be re-rinsed and the sieve carefully lifted and shaken as before. Take particular care at this stage to avoid biasing the sediment sample by incorporating oversize material. Once there is enough sediment in the collecting pan, remove the lower sieve and retain the <2000 µm material which it contains. Leave the pan containing the <150 µm sample undisturbed for 20 to 25 minutes to allow the settling out of suspended material. During the settling out period, collect the heavy-mineral concentrate (see 3, below).

3. *Sampler 2.*

To obtain the panned heavy-mineral concentrate, transfer the <2000 µm material retained from the sediment collection process into the wooden Malaysian “dulang” style pan, using water from the funnel to wash all the material from the sieve. In addition, collect further wet <2000 µm sediment

from as deep as possible within the stream bed, using the top sieve placed directly on the wooden pan. Copious amounts of water may be used to aid sieving at this stage. Once the wooden pan is almost full of <2000 µm material the panned heavy mineral concentrate is then collected using the following three stages;

1) Removal of clay and organic material which binds grains together by repeated washing and stirring of the material in the pan. The pan should not be submerged during this procedure but clean water should be continually added and dirty water poured out. Once the grains feel well separated and the water being poured out looks relatively clean, proceed to stage 2.

2) Formation of heavy-mineral bed by vigorous shaking of pan with ample water for a minimum duration of two minutes. This allows density separation in the pan material and is extremely important before proceeding to stage 3.

3) Selective removal of the less dense fraction by circulating the pan on the surface of the water in an elliptical fashion to yield 20–40 g of heavy mineral (density greater than 2.9 $g/cm^3$) concentrate. This process is best demonstrated by an experienced sampler and it is important during stage 3 to regularly stop circulating and re-shake the material to maintain density separation.

Inspect the final concentrate with a hand lens and note the presence and relative abundance of heavy minerals on the field data card. Finally, use the funnel to transfer the concentrate material to a numbered (see below), 3 x 5 in Kraft™ envelope using sufficient water to ensure complete recovery of all grains.

4. *Sampler 1.*

After digging the material for the stream-sediment and heavy-mineral concentrate samples, copy the sample number from the pre-numbered field card to all the sample containers required for the site, using the black marker pen. Below the sample number, write the sample type code (C for sediments, P for pan concentrates) and below that, the initials of the sampling pair with those of the person completing the data card first. Using co-ordinates from a GPS and a Knox Protractor, mark the exact site location, in red biro, on the field map by means of a small line perpendicular to the stream flow. Beside this line write the final four digits of the sample site number as shown on the field data card. At this stage also note other details on the field card in red biro. These include stream clast composition and relative abundance and also the presence and colour of any clast precipitates. Also note the type of stream channel, level of flow, bedrock type, drift composition, surrounding land use and the details of any contamination. Site locality details should also be noted on the field card as a back up to the field map and GPS co-ordinates.

Next, put on a pair of rubber gloves, clean them in the stream water, then return to the grey sediment collection pan and slowly decant excess water from the surface. Homogenise the remaining sample by firmly, but carefully, shaking the pan to mix the dense, particulate material with the fine colloidal fraction. This is important as if there is an excess of material, any portion discarded must be the same as the portion which is retained (final sample volume = 200–250 ml). At this stage, the sediment details (colour, clay, organic and colloidal content) should be noted. Next, thoroughly rinse clean the polypropylene funnel with stream water then transfer the sample, via the funnel, to the appropriate, numbered Kraft™ paper bag (4 x 8 in). Seal the Kraft™ envelope by folding the tab over three times and bending the wire fixings over the ends of the envelope. Place the sealed Kraft™ envelope in a 6 x 17 in polythene bag and tie a loose knot in the polythene bag to prevent loss or contamination during transport. Place this sealed sample into a plastic box, and then into a rucksack, taking care to ensure that the Kraft™ bag is upright.

Before leaving the site, as was performed on arrival, thoroughly rinse all equipment to remove traces of particulate material to avoid between site contamination. Also, check the field data card to ensure that all observations have been noted. If any field observations are not applicable at a site, e.g. there is no contamination, score through the relevant box so it is clear that the observation was investigated. Finally, on departure, check that all of the samples and field equipment have been packed in the rucksacks to be taken to the next site.

## 11.4 COLLECTION OF STREAM SEDIMENT SAMPLES FROM DRY SITES

1. If a site is dry (or too little water is present to allow the normal stream-sediment sampling procedure to be carried out), but not grassed over, a 'dry sample' should be collected.
2. Select the site in the usual way and set up the coarse sieve and wooden pan. After removal of the surface sediment layer, sieve enough of the dry sediment to fill two large plastic seal-again bags. Number the bags with the appropriate sample number.
3. Mark the sample number on the map and fill in the field card as normal, except for the sediment details which can be completed after the sample has been wet-sieved through the 150µm sieve. The sample should be recorded as a 'dry sample' in the field data comment box and annotated on the field map as such.
4. Clean the sieve and pan as well as possible at site and then wash before use at the next stream site.
5. Wet sieve the dry material at the next wet site, any other suitable stream en route (if time permits) or on return to the field base, remembering to add the sediment details to the field card. A panned heavy-mineral concentrate should be collected if possible and it should be noted on the card if this was from a smaller than normal volume of starting material.

## 11.5 SAMPLING A DRY DRAINAGE SITE

1. If a site is dry (or too little water is present to allow the normal stream-sediment sampling procedure to be carried out), but not grassed over, a 'dry sample' should be collected.
2. Select the site in the usual manner and set up the coarse sieve and wooden pan. After removal of the surface sediment layer, sieve enough of the dry sediment to fill two large plastic self-seal bags. Number the bags with the appropriate sample number and collectors initials.
3. Mark the sample number on the map and fill in the field card as normal, except for the sediment details that can be completed after the sample has been wet-sieved through the 150 µm sieve at another site or at the field base. The sample should be recorded as a 'dry sample' in the field data comment box and annotated on the field map as such.
4. Clean the sieves as well as possible at site and then wash before use at the next stream site.
5. Wet sieve the dry material at the next wet site (if time permits) or on return to the field base, remembering to add the sediment details to the field card. A panned heavy-mineral concentrate should be collected if possible and it should be noted on the card if this was from a smaller than normal volume of starting material.

**Photograph 9: Sediment is shovelled from the stream bed**

**Photograph 10: The sediment (with large stones removed) is initially rubbed through a 2 mm screen**

**Photograph 11: The fine sediment is wet sieved through a 150 µm screen and collected in a fibre-glass pan**

**Photograph 12: The -2mm +150 µm is panned using a wooden "dulang" style pan**

## 11.6 WATER MONITOR SITE

1. Each team should maintain a stream-water monitoring site from each field base. This should be sampled every day that field teams are working.
2. The site should be selected using the normal guidelines and should preferably be on a 1st or 2nd order stream. Monitor-sample location and NGR should be noted in the water chemistry book and on the planning map. It is also useful to note ownership details if the site is to be used in future years.

3. A full suite of water samples, as routinely collected, plus a filtered sample for determination of reduced iron (in pre-dosed tube) should be collected every day, preferably at about the same time of day.
4. Samples should be acidified in the normal way, and pH, conductivity and alkalinity measurements made.
5. Samples should be labelled as follows:

   Team A : MA 1, date, sample type code

   Team B : MB 1, date, sample-type code
6. Large variations in flow conditions should be noted in the water chemistry book as appropriate.

On moving to new monitor sites the numbers would be MA 2, MB 2 etc. Monitor samples of each type from each site should be stored together in clearly labelled seal-again bags and kept separate from routine field samples. It is helpful to the smooth running of the field office if the stream selected lies a short drive from the field office and has easy access by Landrover.

**Photograph 13: Soil sampling is done using a one metre soil auger**

# 12 Collecting Soil Samples

## 12.1 NON-URBAN

Soil samples are routinely collected as part of the G-BASE sampling strategy. For non-urban areas the following procedure is used:

1. One sample site per alternate 1 km grid square on the OS 1:50 000 topographic maps - preferred site locations to be indicated on field maps. Sites to be located at least 100m from roads, buildings, railways, electricity pylons etc. on open unforested, undisturbed ground whenever possible.
2. Two samples (**A** and **S**) to be collected from each site, with the same sample number. The sample bags should be labelled with the sample number, with **A** or **S** as appropriate and with the samplers' initials. The initials of the person marking the map and field card should be written first.
3. Each sample is to be made of a composite of material from auger flights taken from 5 holes distributed within an area (where possible) of approximately 20 m x 20 m. Auger holes should be located at the corners and centre of a square. Large 5 x 10" (12.5 x 27cm) Kraft™ bags should be used. The auger should be used as close as possible to the vertical.
4. Sample **A**: Sample collected from a depth of 10–20cm, after removal of surface vegetation (the actual depths are recorded on the field card).
5. Sample **S:** Sample collected from a depth of 40–50 cm or below the ploughing depth as appropriate (the actual depths are recorded on the field card).
6. Over terrains where only thin soils (<40 cm) have developed e.g. the Chalk hills of east Yorkshire then a surface A sample should be collected from the normal surface depth, i.e. 5–20 cm and the S sample from as deep as possible down to bedrock. In such instances there may be little difference in the sampling depths between the A and S samples.
7. At duplicate sites, a second series of A and S samples (with different sample number) should be collected from an adjacent 20 m x 20 m square.
8. Each sampling pair should use only one soil auger. Using two augers will speed up sampling, but will also introduce non-standard sampling practice.

## 12.2 URBAN

In urban surveys the following procedures should be followed:

1. Four sample sites are located within each National Grid one km square on 1:25 000 topographic OS map. Sample sites are notionally located at the centre of each the four 500m x 500m sub-cells within the kilometer square. Sampling is carried out on the least disturbed area of unbuilt ground close to the centre of each cell. This may be domestic gardens, allotments, parks, recreational ground, or, in the worst instance, road verge or made ground.
2. Two samples (**A** and **S**) should be collected from each site, with the same sample number. The Kraft bag should be labelled with the sample number, with **A** or **S** as appropriate and with the samplers' initials. The initials of the person marking the map and field card should be written first.
3. Each sample should be made of a composite of material from auger flights taken from 5 holes distributed within an area (where possible) of approximately 20 m x 20 m. Auger holes should be located at the corners and centre of a square. Large size Kraft bags should be used (10 x 5" 27 x 12.5 cm).
4. Sample **A**: Sample collected from a depth of 10–20 cm, after removal of surface vegetation.
5. Sample **S:** Each auger flight to be recovered from a depth of 40–50 cm.
6. Where sampling at depth is difficult, S should be collected from as deep as possible and the details marked on the field data card.
7. At duplicate sites a second series of A and S samples (with different sample number) should be collected from an adjacent 20 m x 20 m square.
8. Each sampling pair should use only one soil auger. Using two augers will speed up sampling, but will also introduce non-standard sampling practice.

**Photograph 14: Soil from the auger head is transferred to a Kraft™ paper bag**

# 13 Collecting Samples for Quality Control and Quality Assurance monitoring

Some samples are collected for error monitoring procedures to establish the validity of variation between samples collected. The different control samples collected are described below.

## 13.1 DUPLICATE SAMPLES

1. One site in every batch of 100 is designated for collection of a duplicate field sample. Specific pairs of sample numbers, and field cards, are allocated to the primary sample and the duplicate.
2. At soil sites the duplicate should be collected from an adjacent 20 x 20 m square to the original sample. Both A and S samples should be duplicated. The bags should be labelled normally with the appropriate sample number, sample-type code and samplers' initials.
3. At drainage sites, the duplicate suite should be collected from within 25 m of the original. All samples except the pan concentrate should be duplicated. All are labelled normally, with the appropriate allocated number. They should not be marked as a duplicate as these control samples should be seen by the laboratories as a normal routine sample.

## 13.2 REPLICATE SAMPLES

Replicate samples are prepared in the laboratory by taking a sub-sample from the duplicate sample. Replicate A is a sub-sample of Duplicate A and Replicate B is a sub-sample of Duplicate B. ANOVA analysis of results helps to determine the within site, between site and laboratory variability.

Replicate analysis is done by analysing some samples twice. The procedures for water sample controls are currently under review.

## 13.3 WATER BLANKS

Two sample numbers in every batch of 100 numbers are set aside for the insertion of blank waters. These numbers are identified on the sample check lists (see Section 14). The blank waters **must** be prepared in the field during or on completion of every batch of 100 numbers prior to double checking and dispatch of samples to the Keyworth laboratories. Five blank waters are prepared for each sample number, for insertion into Major anions/TOC, ICP-AES and ICP-MS sample sets.

At present no water standards are routinely inserted .

## 13.4 STANDARD REFERENCE SAMPLES

For every batch of 100 samples collected in the field there are two sample numbers are reserved for standard samples (see Annex E). These standards are inserted into batches during sample preparation at the BGS laboratories in Keyworth. These standards are more correctly referred to as "secondary reference material" and they are used for G-BASE error control. Primary reference materials (international standards) are routinely analysed by the laboratories for their own error control and are independent of the G-BASE QA/QC procedure.

The standard reference materials have been prepared by the G-BASE project to be representative of materials collected from the on-going field areas. These are included in laboratory batches "blind" to the analysts to ensure strict monitoring of laboratory and analytical error. Reference material used by G-BASE are summarised in Table 13-1.

| Sample ID | Media Type | Origin of sample | Collected by | Date |
|---|---|---|---|---|
| S3B | Stream Sediment | Grudie Granite, Sutherland | R T Smith T R Lister | Sept 1987 |
| S13B | Stream Sediment | Mineralised Carboniferus Limestone | D M A Flight T R Lister | Sept 1997 |
| S15B | Stream Sediment | Triassic Sandstone/Shale | D M A Flight T R Lister | Sept 1997 |
| S23B | Stream Sediment | Shap Granite | D M A Flight T R Lister | Sept 1997 |
| S55 | Soil (Sub-surface) | Mercia Mudstone | D M A Flight J Freeeman | Sept 1997 |
| S56 | Soil (Sub-surface) | Sherwood Sandstone | D M A Flight J Freeeman | Sept 1997 |
| S57 | Soil (Surface) | Sherwood Sandstone | D M A Flight J Freeeman | Sept 1997 |

**Table 13-1: Summary of secondary reference materials used by the G-BASE project**

Results for the repeated determinations of these standards are collated by the G-BASE data manager.

# 14 Field sample checking, collation and storage

## 14.1 CHECKING-IN SAMPLES

Samples collected in the field by VWs must be checked off on a daily basis and then double-checked before dispatch to the field laboratory.

### 14.1.1 Daily checking

1. On return from the field, each sampling pair should lay their samples out in ascending numerical order (left to right), with samples from each individual site arranged horizontally. The order of each sample type should be consistent: e.g. samples from each drainage site should always be laid out top to bottom in the order C, P, alkalinity/conductivity, pH, W, F/UA, F/A. Samples should not be laid out on dusty or gravely ground where water sample containers may become contaminated - lay them out on a clean plastic bag.
2. Checking off should be carried out by staff or SVW and, when possible, by two persons; one person to check the numbers marked on samples and to call them out, and the second to mark off the checklist (printed with the corresponding RNL as a double-sided document).
3. Before marking off on the check list, the number and sample-type code on each sample should be checked for legibility and any obvious inconsistency with other samples from that site. Corrections should be made clearly in black marker pen.
4. Two types of checklist are used, one for samples that are dispatched to the sample preparation facility at BGS headquarters in Keyworth and a second for filtered water samples which are dispatched to the Keyworth laboratories (see Annex G). Both have four variations (corresponding to RNL 1, 2, 3 or 4) and it is essential that for each batch of 100 the two different check lists are from the same RNL. Numbers and sample types should be called out and marked off on the sample checklist with a diagonal line through the check box.
5. If a sample has previously been checked off, the problem should be resolved immediately. Firstly, by reference to the reverse of the checklist establish whether that sample number was issued to the sampler in question. If so, then the problem lies with an earlier mis-numbered sample suite that should be found and re-numbered. Conversely, if the sampler was not issued with the sample number then it has probably been wrongly transcribed from the field card by the sampler and this should be checked. Occasionally two field cards may have erroneously been numbered alike; in this event one set of samples and the map and field card must be re-numbered.
6. When checking off has been completed, samples should immediately be put away in appropriate storage containers (except those requiring further treatment, i.e. W, F/A).
7. Any panned or sediment samples requiring re-bagging should be dealt with immediately. A water sprayer (using clean tap water) helps in the task of washing sediment into the bag.
8. Water samples that could not be filtered in the field should also be attended to as a matter of priority, and identified as 'TBF' (to be filtered) on the water checklist.

**Photograph 15: Samples are checked in after each day of sampling**

**Photograph 16: Samples are hung out to dry**

**Photograph 17: Batches of 100 samples are stored in crates after being checked ready for transportation to the BGS laboratories**

### 14.1.2 Double checking:

1. On completion of each batch of a hundred samples, every sample number should be double checked before dispatch to the Keyworth laboratories. This is most efficiently carried out by two persons at least one of whom should be staff or SVW.
2. For each sample type every individual sample should be identified and checked off on the sample-number list (using a diagonal stroke perpendicular to the original).
3. Any unclear labelling should be dealt with.
4. Lids should be tightened on water bottles.
5. Any inconsistencies should be dealt with by reference to check lists, field cards, field maps and initials on sample bags. In the worst instance, if two samples are numbered alike and the problem cannot be resolved then both should be disposed of and another recollected from the appropriate site or sites.
6. Decomposing soil bags should be replaced by new ones.

## 14.2 COLLATION OF WATER SAMPLES AT FIELD BASE

1. pH sample: All numbered 30 ml bottles labelled 'pH' are placed in an appropriate receptacle, e.g. plastic bucket. Samples are placed in the designated water chemistry room, along with pH buffer solutions and pH meter for a minimum of two hours to allow temperature equilibration to take place. Analyses should be conducted the same evening, in the water chemistry room.
2. Total alkalinity/conductivity sample: All numbered 250 ml bottles are placed in an appropriate receptacle, e.g. plastic tub. Titrations are conducted the following morning, by addition of Sulphuric acid to 100 ml of sample, using a Hach digital titrator. The conductivities are carried out using a HANNAH HI9033 portable conductivity meter.
3. Major anions/TOC samples: All numbered 30 ml Nalgene™ bottles labelled 'F/UA' are placed in an appropriate receptacle, e.g. plastic bucket. Ensure that numbers are written legibly and bottle caps are tightly secured. Rinse any dirt from the caps or containers using de-ionised water. Samples are then placed into large self-seal plastic bags, pre-numbered with the corresponding "hundred" sample number range. Samples should be stored in a fridge. The samples are transported to BGS Keyworth in cool boxes.
4. ICP-AES sample: All numbered 30 ml 'Greiner'™ tubes labelled 'F/A' are placed in an appropriate receptacle, e.g. plastic bucket. Samples are treated with concentrated nitric acid the same evening. Sample numbers should be written on caps, using black, permanent marker, after acidification process. Samples are then placed into large self-seal plastic bags, pre-numbered with the corresponding sample-number range. These can be placed in a black sack and stored in a secure and cool place. Note that the sacks can easily be mistaken as refuse and should be kept well away from refuse disposal areas.
5. ICP-MS sample: All numbered 30 ml 'Nalgene'™ bottles labeled 'W' are placed in an appropriate receptacle, e.g. plastic bucket. Ensure that numbers are written legibly. Samples are treated with concentrated nitric acid the same evening. After acidification, samples are placed into large self-seal plastic bags, pre-numbered with the corresponding sample-number range. These can be placed in a black sack and stored in a secure and cool place.

## 14.3 ACIDIFICATION OF WATER SAMPLES

1. This is a high risk procedure and Health and Safety information provided must be consulted before commencing the acidification. Goggles, plastic gloves and a laboratory coat must be used. Any skin exposure to the nitric acid should be treated immediately with copious water.
2. F/A and W samples should be acidified each evening as soon after collection as possible.
3. Acidification is carried out in a clean, well-ventilated, dust-free area, and clear of cigarette smoke. Hands must be clean and plastic gloves worn. Be aware of possible contamination: e.g. putting hands in pocket and handling coins.
4. Aristar-grade nitric acid should be provided in multiples of 100 ml bottles. One bottle should be used per week of sampling (Mon-Sun). Each bottle should be marked with the code for the field team, the year and the appropriate dates e.g. A97 14/6-20/6. This information may prove invaluable should contamination occur.
5. Samples to be lined up in clean, dry, dust-free area. Lids should be removed for the least possible time. Lids should be placed rim down on a clean polythene bag and any lids containing any visible particulate matter should be rinsed with a small volume of the sample itself.
6. A new plastic pipette should be used each day when samples are acidified. Used pipettes should be disposed of safely (rinsed 3x with tap water) after acidifications are completed. If the pipette is accidentally put down on a table or wooden block during acidification then it should be disposed of and a new one used. The pipettes must be kept in a clean sealed polythene bag.
7. The lid of the acid bottle should be removed only when the pipette is being filled. The lid should be replaced on the acid bottle whilst samples are being acidified.
8. The samples are acidified to 1% v/v i.e. 0.3 ml per 30 ml. The pipettes vary in dimensions and are marked for volume along the side. The appropriate number of drops to be added must be checked and standardised at the start of each field season. For samples less than the full volume then the acid should be added in proportion. One fill of the pipette contains enough acid to treat several samples.
9. Lids must be replaced and tightened on samples.
10. Samples must be kept in cool, dark place at all times.
11. Acid must be kept in a safe place in a robust container which can hold >100% of the bottle volume and is clearly labelled.

## 14.4 STORAGE OF SAMPLES

1. Stream sediments: After checking off, stream sediment samples, in Kraft™ bags, should be removed from the plastic outer bag (re-bagged if the Kraft™ bag is damaged) and hung to dry on a line. When they become plastic (like plasticine in consistency) they should be removed from the line and stored upright in crates in batches of 100. Before dispatch to the field laboratory any sloppy samples should be placed in a plastic outer bag.
2. Panned concentrates: Samples in Kraft™ bags should be stored in batches of 50 or 100 in a clearly labelled seal-again plastic bag. The labelling should indicate the sample type and number range, e.g. 420001- 420050 P.

3. Soil samples: Soil samples, in Kraft bags, should be stored carefully (i.e. stacked) in sturdy bread crates in batches of 25 – 30 samples. Crates should not be overloaded to reduce risk of a strain when loading into the vehicle. 'A' and 'S' soils should be stored separately. When possible, soils should be laid out in an open sunlit area, on plastic sheeting, to dry.

4. F/UA Samples should be stored in batches of 50 or 100 in clearly labelled sel-seal plastic bags and kept inside a black plastic sack in as cool and dark a location as possible.

5. F/A, W: Samples should be stored in batches of 50 or 100 in clearly labelled self-seal plastic bags and kept inside as cool and dark a location as possible.

All water samples should be stored in a clean environment with minimal contamination potential. Care must be taken to ensure that samples are stored in a location that is not readily open to vandalism, burglary, or sabotage and away from livestock that will cause damage to the samples. Particular care should be taken with hanging the sediment samples to dry - experience has shown that these are the most vulnerable.

**Photograph 18: Samples in damaged bags are rebagged during the sample check-in**

# 15 Field Database

Field data is stored in a Microsoft Access 2000 Meta-Database (MDB). All relevant data from the field cards are entered via user-friendly input screens. Field cards should be separated into cards containing sediment data, and cards containing soil data. Each set of cards should then be arranged in numerical order; from lowest to highest sample number.

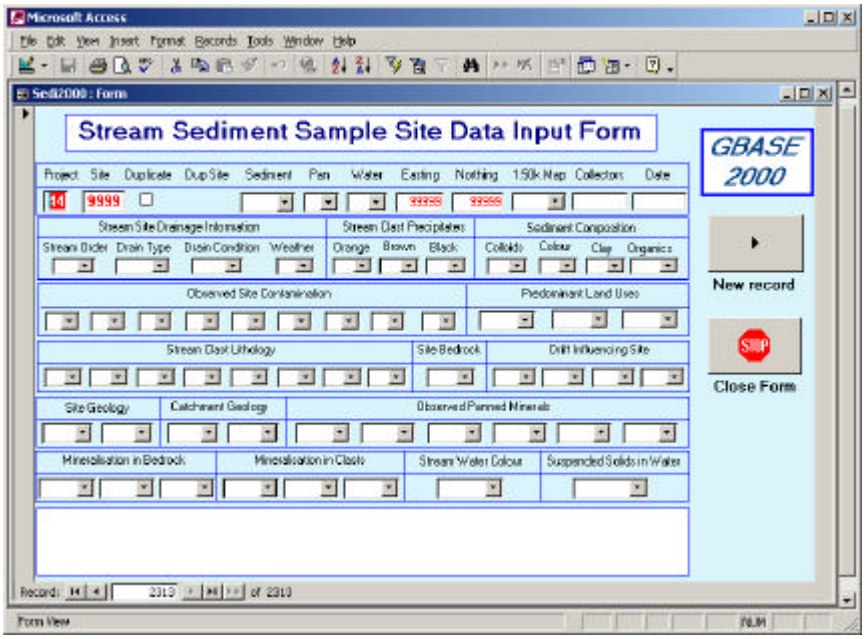



Figure 15-1: Example of field database stream sediment data entry screen

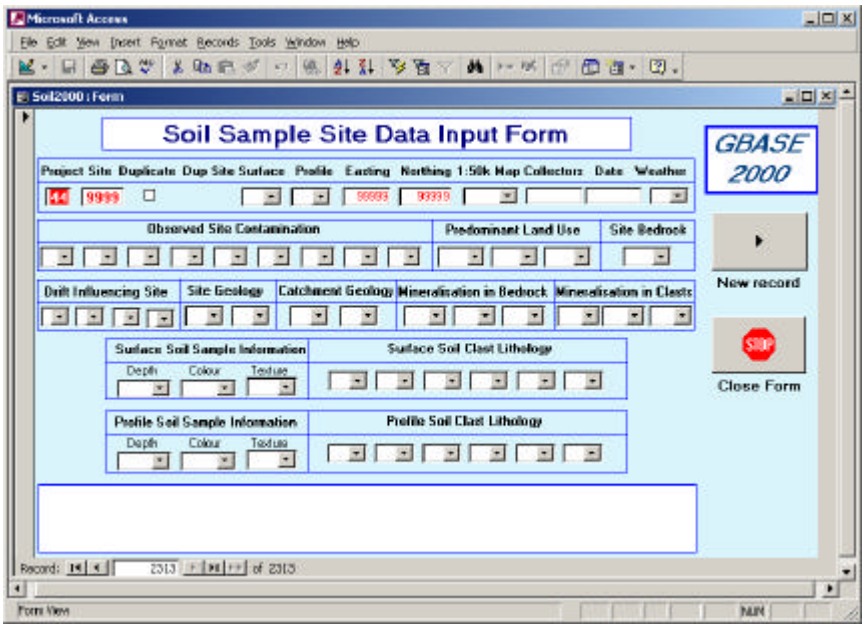



Figure 15-2: Example of field database soil data entry screen

Input screens are designed to facilitate easy data entry, and resemble the field card layout as much as possible (Figure 15-1 and Figure 15-2). Separate input screens are used for sediments and soils. Most data fields are completed using drop-down menus in the input screens. These drop-down menus access data from linked look-up tables, ensuring that only acceptable data may be entered into each field. Key fields such as sample number and grid reference have built-in rules, which prevent, for instance, duplication of sample number, and locations out-with the sampling area being entered. On completion of each record, a blank input screen will appear for entry of the next field card.

## 15.1 FIELD DATABASE MAINTENANCE

1. The field database is designed to be consistent with field databases used in other areas of work (e.g. Urban geochemistry) and to ensure greater ease of data transfer to the BGS Geochemistry Database.
2. The whole process is menu driven by initialising the file 'MENU.MPX'. A customised pull-down menu bar appears with all the available data operations. The command window also appears by default, and this can be closed by clicking on the white box in the top left corner of the window.
3. Choosing the 'Add Data' option gives three further choices - Sediment, Soil, or STD's. Select as appropriate according to sample type. It is easier if the sediment and soil cards are separated and arranged in ascending numerical order for each sample type before commencing data processing. The data input screens are much revised, having scrollable option windows for many of the entry fields. Previous records may be accessed and amended by using the navigation buttons to move through the database.
4. The 'Browse' option from the 'Database' main menu will allow you to view, but NOT make changes to, the database. 'Edit Data' will allow you to edit records one at a time. The edit mode does not use the data input screen format.
5. 'Add Water Data' will select all the records following your initial entry number which have a 'W' sample-type code. The sample numbers should be the same as those entered in the water chemistry book. Once all water data has been entered, close the data input screen by clicking on the white box in the top left corner of the window.
6. 'Print Report' will print a summary report of the next 100 records following your initial entry number. There is as yet no 'Escape' function available to exit once you have selected this option, so make sure you choose this option intentionally, and that you enter the initial sample number with care.
7. The 'Quit' option automatically creates a back-up (Stream03.bak) of the database (Stream03.dbf). You will be asked each time whether you wish to overwrite the existing version of Stream03.bak. The response is '**YES**'.
8. The database should be backed up onto floppy disk on a daily basis, and the floppy disks stored and transported separately from the lap-top.

## 15.2 FIELD DATABASE VALIDATION

It is essential that the key fields entered to the database are checked and validated before return from the field campaign. Mistakes are much easier to trace and correct when those involved in collection and entry of the data are still present. All checking operations should be carried out in pairs and should address batches of 100 field cards.

1. For each batch of 100 field cards, the key fields entered on the database should be listed using the "print report" command. The list should be folded and stored with the cards.
2. The location of each sample plotted on the stable base map should be checked against the field card. *Person 1* should read out the 3 digits each for easting and northing which define the 100 kilometre square and the kilometre square part of the NGR (e.g. 350, 462). *Person 2* should locate the square on the stable base map. *Person 1* should read out the remaining two digits of easting and northing which define the sample location to the nearest 10 m. *Person 2* should locate this using a Knox protractor and confirm whether the sample is located correctly on the map. An error of plus/minus 30 m is acceptable. If there is a problem locating the sample then reference should be made to the written locality details on the field card and the original field map. VWs should refer to the field team leader for help as necessary. On occasion the map, database or field card may require modification. When a batch of 100 has been completed the checkers should note this on the list with any modifications made. They should note their initials and the date.
3. On completion of stable base checking, they should proceed onto checking of the printed list against the field card. The key fields checked will include sample number, sample type, easting, northing, date collected and samplers' initials. The checkers should work sequentially through the batch of 100, noting any necessary amendments on the printed sheet. They should note their initials and the date on completion.
4. pH, conductivity and alkalinity measurements should be printed from the database and checked against the hand-written recording book for each batch of 100 samples. Again, this should be carried out in pairs. One person reads from the book while the other checks the list and notes any amendments. On completion they should date and initial the list.
5. Amendments to the database should only be made by the field team leader using the "edit data" option. On completion of edits for a batch of 100 samples, the team leader should note and sign the appropriate listing.
6. The database must be backed up after edits have been made.

**Photograph 19: Some water measurements such as pH, conductivity and alkalinity are done at the filed base**

# 16 Field Water Sample Measurements

## 16.1 pH MEASUREMENT USING RADIOMETER PHM80 WITH COMBINATION ELECTRODE

pH measurements must be made on the same day as sampling, after allowing time for samples and buffers to equilibrate to similar temperature.

1. Electrode preparation: Remove the parafilm covering from KCl filling hole at top of combination glass electrode. Ensure that 0.5 - 1.0 cm of KCl crystals (see separate hazard sheet) are present in base of electrode (refill as necessary using crystals or saturated solution provided, referring to manufacturers instructions). Air bubbles in the electrode bulb or red reference stems should be removed by gentle shaking. Insert the electrode plug into the combination socket at the side of the meter.
2. Samples should be arranged in ascending numerical order and listed in the water chemistry book, along with weather, temperature (of samples), ID number of the electrode used and calibration details. The initials of the analyst should also be recorded.
3. Calibration: **Calibration must be undertaken before any pH measurements of samples are made.**
    a. Using the thermometer provided, measure and record the temperature of the first sample (all buffer solutions and samples should be left to equilibrate at room temperature for at least 2 hours before measurement). Immediately replace the lid of the sample bottle after temperature measurement. Press the 'Temp' button on the meter. Using the ***set temp*** control, adjust the displayed temperature until it is equal to the temperature of solutions to be measured.
    b. Press the 'pH' button on the meter. Rinse electrode with de-ionised water (DI) and dry gently with tissue. Immerse electrode in buffer 7 solution, gently agitate and allow the reading to stabilise. It should do so rapidly when measuring buffer solutions. Adjust the displayed value to 7.00 using the ***buffer*** control. Note that electrode is very delicate and must not be allowed to touch the base or walls of the sample container.
    c. Rinse electrode thoroughly with DI. Dry gently with clean tissue. Place in buffer 9 and measure as above. Adjust the displayed value to 9.00 using ***set temp*** control.
    d. Rinse electrode thoroughly with DI. Dry gently with clean tissue. Place in buffer 7 and allow reading to stabilise. If correctly calibrated the instrument reading should be 7.00. If this is not the case, recalibrate as from b above, otherwise proceed to e.
    e. Rinse electrode with DI and dry gently with clean tissue. Immerse in buffer 4 solution and record the reading (an acceptable pH range is 3.9 - 4.2). If overall pH range of samples is acidic then calibration should be carried out using buffers 7 and 4.
4. Sample pH measurement:
    a. After rinsing with DI, rinse the electrode again with a small volume of the sample to be measured. Immerse the electrode in the bottle containing the sample, gently agitate, and record the reading after it has stabilised. If pH reading drifts, leave for a maximum of 1.5 minutes before recording reading. As above, do not allow the electrode to rest on the bottle base
    b. This procedure is repeated for every sample. Caps should only be removed from individual sample bottles as they are measured. The first three samples in each daily batch are retained (with caps replaced) after measurement, and the pH re-measured at the end of the batch; values should be clearly recorded next to the original reading. Any "unusual" results (i.e.

notably different from neighbouring samples) should be re-measured and the second value noted.

5. Re–measurement of buffers:
    a. Buffers 7, 4 and 9 should be re-measured and the readings recorded.
    b. If the repeated measurements of samples are more than 0.4 pH units out and the buffers are more than 0.1 pH units out, the instrument should be recalibrated and the entire batch should be re-measured after recalibration of the pH meter. Remember to switch off the pH meter after use.

After use, the electrode should be stored in pH buffer 7; if it is to be left for more than 12 hours without use, the KCl filling hole should be covered with parafilm. At no stage should the electrode be allowed to dry out. The electrode should not be inverted as the KCl solution will leak from the filling hole. The electrode must be cleaned using Renew solutions at least every 2 weeks during the field campaign. After pH determinations have been completed sample bottles should be rinsed with tap water and labels removed with acetone so the bottles are ready for re-use.

## 16.2 CONDUCTIVITY MEASUREMENT USING HANNAH HI9033 PORTABLE CONDUCTIVITY METER

1. Measurement of stream water conductivity is undertaken the day after collection, in conjunction with alkalinity determination and so this procedure is done at the same time as that described in Section 16.3. Both sets of equipment for procedures 16.2 and 16.3 need to be set up simultaneously. The conductivity standard should be stored overnight alongside the samples to ensure temperature equilibration.
2. Check that the probe is properly connected to the meter. Rinse the probe thoroughly with deionised water (DIW). Using the mercury thermometer provided, measure and record the temperature of the conductivity standard. Immerse the probe in the conductivity standard and calibrate the meter using the precision screwdriver, to the correct value for that temperature. (A look-up table of temperatures and corresponding conductivity standard values is provided).
3. Samples should be arranged in ascending numerical order. The numbers should have been copied into the water chemistry book the previous evening when pH measurements were made. A common error here usually arises from poor handwriting on the sample bottles. Record the initials of the analyst.
4. Remove the probe cover, rinse the probe with DIW and replace cover. Sequentially immerse the probe in each solution to be measured. On each occasion the solution must be deep enough to cover the holes in the probe sheath. If there is insufficient solution use the sample in the plastic measuring cylinder that will be used for the alkalinity measurement. When the reading has stabilised it should be recorded in the book alongside the appropriate sample number. The sheath should be removed and the probe rinsed between each sample.
5. The first three samples from each batch should be retained and re-measured at the end. If these readings are not within 5 % of the original, the sample should be re-measured, as should any results that appear unusual for the area. If the meter needs recalibration the entire batch should be repeated.

## 16.3 ALKALINITY MEASUREMENT

Equipment required: 100 ml measuring cylinder, 250 ml conical flask, bromo-creosol green indicator and pipette, Hach digital titrator & delivery tubes, Sulphuric acid cartridges (1.6 N and 0.16 N). Spare titrator, delivery tubes and cartridges should also be available.

1. Team leaders will ensure that the person carrying out the procedure has adequate safety equipment (eye protection and lab coat), and is made aware of health and safety controls. Any person carrying out the procedure should have read and signed the COSHH regulations (Control of Substances Hazardous to Health) that are provided along with the equipment.

2. This procedure should be carried out in a well-lit area (but not direct sunlight) over a piece of white paper or a white surface. It follows the immersion of a clean dry conductivity probe into the sample (see procedure 16.3, item 4). When the conductivity measurement has stabilised, the probe is removed and the $HCO_3$ determination by the procedure described below is immediately carried out.

3. Alkalinity measurements should be made the day after sample collection. Samples should not be left for more than 24 hours before measurement, in order to minimise degassing of $CO_2$. They should have no gas volume visible in the bottle. If they have, then this should be recorded in the laboratory book.

4. The sulphuric acid cartridge should be loaded to the titrator and any air expelled by pointing the cartridge in the air (away from any persons) and, very carefully, depressing the plunger until all visible bubbles are removed, with a suitable receptacle being present for any inadvertently expelled acid.

5. The delivery tube should be inserted into the acid cartridge and air removed by rotating the release wheel on the titrator until a few drops are released from the end and no air bubbles remain. (Note that the delivery tubes must remain bagged with the normality acid that they have been used with.)

6. Samples should be pre-sorted by pH into those which require strong (1.6 N) acid and those that require the weaker acid (0.16 N). The cut off is generally around pH 6.8, with those of pH<6.8 requiring weak acid. If a sample requires <30 units of 1.6N acid then the measurement should be repeated using the 0.16N acid.

7. The measuring cylinder should be rinsed with a small volume of sample. 100 ml of sample should then be accurately measured and transferred to the clean flask. A few drops of bromo-cresol should be added (2 - 5 drops depending on the strength of the bromo-cresol solution). The solution should be a blue colour that is sufficient to clearly see a colour change. It must not be so dark blue that the solution becomes opaque and the titration inaccurate. (If the sample immediately turns to green or yellow on addition of the indicator then the alkalinity is recorded as <1 in the book and entered as 0.01 on the database).

8. The unused sample should be retained with the lid on in case a repeat measurement is required.

9. Before adding acid, **the counter on the titrator must be set to zero**. Acid should be added rapidly at first using the release wheel while the flask is gently and constantly swirled with the other hand. The end point value to be recorded is when the solution hasa turned green. If the operator is unsure that this point has been reached, the reading should be noted and the titration continued in small increments (noting each reading) until an endpoint has definitely been reached. Inexperienced operators should approach endpoints in this way. At the end point the reading on the titrator should be recorded in the book. **If the weak acid (0.16 N) is used, the reading should be divided by 10 before being recorded.** If the sample has changed to bright green or yellow then the end point has been passed and the titration should be repeated.

10. At this point the dial on the dispenser should be reset to zero. The most common error arises from operators forgetting to reset the dispenser. Careful attention should also be paid to the amount of acid left.
11. The sample in the flask is disposed of and the flask shaken empty. If the titration was stopped precisely at the end point there is no need for rinsing though the flask should be rinsed with a small volume of DIW.
12. Approximately 10% of measurements should be repeated to check the reproducibility of the method, and any new operators should always repeat their first few measurements until they have satisfactorily managed to produce results within 5% of the first reading. The days measurements should be reviewed and any unusual results should be repeated.
13. After completion of measurements, the excess samples can be disposed of, the containers rinsed clean with tap water as necessary and the numbers removed with acetone. Bottles can then be recycled for future use.
14. Water chemistry data should be added to the database each day after the field cards have been entered. Any additional notes should be recorded in the database such as coloured solutions or presence of air in the sample bottle.

**Photograph 20: Water alkalinity being determined at the field base**

# 17 Sample reception and registration for laboratories

1. G-BASE samples are sent to BGS Keyworth on a regular basis determined by the rate of sampling and the availability of someone to transport the samples. The project will try to combine journeys back to Keyworth with other activities, such as staff changeovers, so as to make efficient use of transport.
2. Staff in sample preparation should be given at least 24 hours notice of arrival of samples, preferably a three day warning. If a vehicle transporting the samples is parked on site over a weekend, instructions must be left as to where the vehicle keys can be found. Water samples **must not be left in vehicles** and need to be stored in a cool dark place
3. Samples will be transported to Keyworth in field batches of 100 samples. The field batch of 100 will include numbers reserved for standard reference samples and replicates to be added during sample preparation, so in reality a batch will have less than 100 field samples. Each batch will consist of a particular media type and different types must not be mixed in a single batch. Media types are, stream sediment (C), surface soil (A), profile soil (S), panned concentrate (P) and surface water (W).
4. Samples should be packed in the provided crates and H&S considerations regarding the loading of vehicles, the transport of equipment and samples, and manual lifting should be observed. It is recommended that no more than 25 - 30 soil samples should be packed in each crate.
5. Every field batch will be accompanied by a hardcopy sample checklist (see Annex G) and an Excel file listing the sample numbers (see Table 17-1). The Excel file will be named according to the sample type and the lowest sample number e.g. C4400500.xls or A4401500.xls
6. The sample checklists will be received by sample preparation staff who will unload the samples and commence the sample collation and preparation procedures. There will be a nominated G-BASE team member who will be a contact point for any enquiries from sample preparation staff.
7. After drying, a G-BASE team member will assemble the field batches into laboratory batches of 500 samples. At the completion of sampling the final laboratory batch will inevitably have less than 500 samples, the final number will be indicated on the sample registration form.
8. Every laboratory batch of samples will have a unique G-BASE ID assigned by the nominated G-BASE team member in Keyworth. The ID will be a four letter code (e.g. EA03) comprising of two letters to signify the area (e.g. EA for East Anglia) plus a two digit year code (e.g. 03 for 2003). The code is completed by a three digit sequential number starting with 001. An example of a full G-BASE ID would be EA03001, EA03002, EA03003 etc.
9. The sample lists delivered as Excel files on a diskette will be received by a member of the G-BASE team who will enter each laboratory batch into the G-BASE sample registration system (see Figure 17-1). The sample list will be checked to ensure all the information regarding control samples and samples to be selected for LOI and pH is included.
10. For each batch a registration report form is printed twice. Examples of forms are given in Annex H. One copy is sent to the head of Sample Preparation and one copy is retained for files.

11. The head of Sample Preparation will register the samples in the LIMS system assigning a Lab. No. to each batch. This will include samples which are not routinely analysed (panned concentrates and deep soils) but will require some sample preparation before storage.
12. The head of Sample Preparation will complete an IR form for each batch and any other forms as required by the laboratory management system. These forms which should include a Lab. No. for each batch submitted will be sent to the G-BASE project leader or deputy for signing.
13. On completion of analyses results will be sent to the G-BASE data manager or deputy who will maintain a table in the G-BASE sample registration system to indicate progress with receipt of results, quality control and loading results to the corporate geochemistry database.

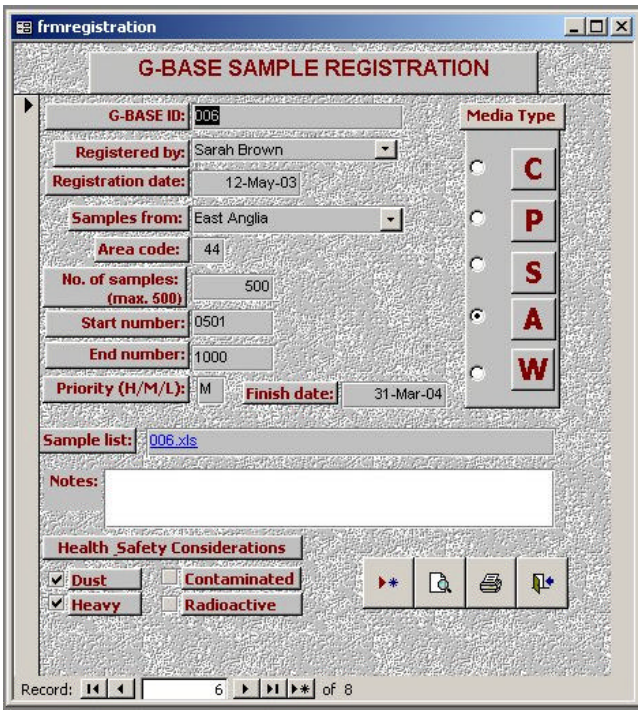



**Figure 17-1: G-BASE sample registration program written in MS ACCESS**

| Project_Code | Site_Number | Sample_ID | Samp_A | Easting | Northing | Dup_sample | Samp_STD | LOI | pH |
|---|---|---|---|---|---|---|---|---|---|
| 44 | 2 | 440002 | A | 537110 | 326110 | | | X | X |
| 44 | 6 | 440006 | A | 538210 | 325160 | | | | |
| 44 | 9 | 440009 | A | 543710 | 330090 | | | | |
| 44 | 13 | 440013 | A | 540550 | 333490 | | | X | X |
| 44 | 20 | 440020 | A | 538580 | 327340 | | | | |
| 44 | 23 | 440023 | A | 539770 | 330310 | | STD1 | | |
| 44 | 30 | 440030 | A | 541720 | 326650 | | | X | X |
| 44 | 43 | 440043 | A | 535620 | 328500 | | | X | X |
| 44 | 47 | 440047 | A | 536820 | 333700 | | | | |
| 44 | 48 | 440048 | A | 542400 | 333250 | | | X | X |
| 44 | 204 | 440204 | A | 547600 | 320580 | 440296 | DUP A | | |
| 44 | 206 | 440206 | A | 545400 | 324650 | | | | |
| 44 | 209 | 440209 | A | 536550 | 313950 | | | | |

**Table 17-1: Example of digital sample list to accompany each field batch of samples**

# 18 Post-Field Campaign Report

At the completion of each year's field campaign the Field Operation Manager will be responsible for writing a report on the field sampling to be completed within one month of the completion of sampling. This report will act as the definitive record of the fieldwork activities and will provide a reference to the work completed.

The report should have the following sections:

1. Schedule of fieldwork detailing what was done where and when.
2. A simplified map showing the area sampled.
3. A reference to the version of the field procedures manual used.
4. Details of the field team including all the VWs. This should include a table of samplers' initials.
5. Details of accommodation - its suitability and any problems.
6. Logistical report of operating in the area (shops, petrol stations, road access, railway stations etc.)
7. Health and Safety report detailing any incidents, near misses or recommendations for improving safety. This should be taken from the field base H&S incident book.
8. Summary table of number of samples collected indicating number ranges and any missing samples.
9. Details of laboratory batch numbers and how they related to G-BASE sample numbers.
10. Annex of sample checklists.

# 19 References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# Annex A: Standard farm access letter

Dear Sir,

REGIONAL GEOCHEMICAL SURVEY 2003

I am writing on behalf of the British Geological Survey (BGS) to seek your agreement to the collection of geochemical samples over your land. BGS is responsible for the geological survey of Great Britain and for several years has been engaged in the preparation of maps showing the distribution of chemical elements in stream sediment, stream water and soil. This is a continuation of a nation-wide survey, which has already covered Scotland, Wales, northern and central England.

The geochemical survey results have applications to studies of a wide range of topics, including some with particular benefits to agriculture, human and animal health. Particular interest has been shown, for instance, in the possible identification of areas over which trace element imbalances may lead to disease in livestock or affect the growth of crops.

During this spring/summer we shall be extending the sampling over the area which includes your property. I am therefore seeking your co-operation in allowing access for one of our survey teams to collect small samples from streams which cross your land or a soil sample; about 1 kg of soil is collected by hand auger. The number of samples taken is only approximately one per square kilometre and the work is carried out between July and September by sampling teams of two persons on foot. The time spent at any locality seldom exceeds thirty minutes. All staff of the Survey are well acquainted with the Country Code and the need to avoid disturbance to agricultural and other activities.

Should you require further information I shall be happy to arrange for a member of BGS staff to telephone or visit you prior to the sampling. Please could you confirm that you are willing to allow our team to enter your land by forwarding the reply slip in the prepaid envelope provided.

Yours faithfully

Sarah Brown

G-BASE Field Operations Manager

British Geological Survey

# Annex B: Voluntary Worker Recruitment Advert

SUMMER VACATION WORK 2003

*Geochemical Baseline Survey of the Environment (G-BASE)*

The British Geological Survey (BGS) will be recruiting Earth Science students for the 2003 summer vacation to assist with geochemical sampling in support of the above programme. Field work, based in East Anglia, will involve the systematic collection of geochemical samples. There will also be a limited number of vacation posts in other departments within BGS.
Applicants need to be able to traverse difficult terrains and have a high degree of commitment to field work and be capable of integrating into a team. Sampling is usually undertaken by students working in pairs and will involve walking long distances in all weather conditions. Students work a six day week and will be expected to undertake evening work as necessary. It will not be possible for students to take time off during their period of employment, except in an emergency. The work will give successful applicants an opportunity to gain valuable experience in the more practical aspects of geology and geochemistry.
A standard subsistence allowance of £25 per night (£175 per week) will be paid. Accommodation (self-catering) will be paid by BGS but students will be required to pay for food. Posts will be available from July to September 2003 and preference will be given to those available for a minimum of 5 consecutive weeks. Application forms and further details are available from your departmental secretary or from the BGS web site, www.bgs.ac.uk/gbase. The closing date for applications is Friday 11th April 2003.
Download Application form and Health Declaration.

The above is an example of the advertisement on the BGS internet site. The next page is an example of the poster sent out to university Earth Science Departments.

British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

# Summer Vacation Work

## GEOCHEMICAL BASELINE SURVEY OF THE ENVIRONMENT (G-BASE)

The British Geological Survey (BGS) will be recruiting Earth Science students for the 2003 summer vacation to assist with geochemical sampling in support of the above programme. Field work, based in East Anglia, will involve the systematic collection of geochemical samples. There will also be a limited number of vacation posts in other departments within BGS.

Applicants need to be able to traverse difficult terrains and have a high degree of commitment to field work and be capable of integrating into a team. Sampling is usually undertaken by students working in pairs and will involve walking long distances in all weather conditions. Students work a six day week and will be expected to undertake evening work as necessary. It will not be possible for students to take time off during their period of employment, except in an emergency. The work will give successful applicants an opportunity to gain valuable experience in the more practical aspects of geology and geochemistry.

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# Annex C: Voluntary Worker Application Forms

Please return completed form by 11th April to:-

Mr. A.L. Crosby

Personnel Section
British Geological Survey
Keyworth
Nottingham
NG12 5GG


PLEASE ATTACH
1 PASSPORT SIZE
PHOTOGRAPH WITH A
PAPER CLIP
(PLEASE WRITE NAME
ON THE REVERSE)

Ref No:_____
(for office use)

**VOLUNTARY WORKER**

**APPLICATION 2003**

Please use HAND-WRITTEN BLOCK CAPITALS.

Dates available for employment:- From: Day_____/Month_____

To: Day_____/Month_____

Title:_____ Surname:_____ Forename(s):_____ Age:_____

Undergrad. year:_____

University or College:_____

Main subjects(s):_____

Subsidiary subjects(s):_____

Term address:_____

_____

_____

_____Post code:_____ Tel. no.:_____

email:_____

Date of leaving this address: Day_____/Month_____

Home address:_____

_____

_____

_____Post Code:_____ Tel. no.:_____

Have you held a driving licence for at least 1 year? yes / no
Do you have any endorsements? yes / no

Have you been employed by BGS before? Group:_____ Year:_____

Give a brief summary of your field experience, past employment, outside interests and state why you are applying for vacation employment with BGS (continue overleaf if necessary).

SIGNED:_____ DATE:

**Due to limited resources it is not possible for BGS to write to unsuccessful applicants**

**NERC**

**HEALTH DECLARATION: Voluntary Workers Scheme**

We want to be sure that we can reasonably expect you to be able to give an effective service, and we therefore ask you to provide us with some details about your health record. Each declaration we receive is considered individually and no decision to reject you on medical grounds will be made without further discussions with yourself.

The Natural Environment Research Council is an equal opportunities employer and will recruit on the basis of ability, not perceived disability.

| | | | |
|---|---|---|---|
| Full name | | | |
| Post applied for | | | |
| 1a. Do you have any disability which may affect your ability to undertake the tasks set out in the duties of this post? (If yes, please give details)<br><br>1b. If your answer to 1a. was yes, which facilities, adjustments or equipment (if any) would enable you to perform the duties of the post most effectively (use a separate sheet if necessary)? | | Yes ? | No ? |
| 2. Are you now or have you been in the past under any medical treatment or observation, taken any form of medication to control or stabilise a condition (eg insulin for diabetes or ventolin for asthma), undergone any operation or hospital treatment, or had any serious accident? (If yes, please give details including dates) | | Yes ? | No ? |
| 3. Have you now or in the past had any disease or complaint, other than normal childhood illnesses, colds and flus? (If yes, please give details including dates and treatment received) | | Yes ? | No ? |
| 4. Have you now or in the past had any drug or alcohol related problem? (If yes, please give details, including dates and medication (if any) prescribed.) | | Yes ? | No ? |
| 5. Have you now or in the past had any back, muscle or joint problems (eg slipped disc, rheumatism, arthritis etc) or any work-related upper limb disorder (eg from keyboard/VDU use)? (If yes, please give details, including dates and medication (if any) prescribed.) | | Yes ? | No ? |

| | | | |
|---|---|---|---|
| 6. | Have you now or in the past had depression or any stress related illness? (If yes, please give details, including dates and medication (if any) prescribed.) | Yes ? | No ? |
| 7. | Have you consulted a doctor at any time regarding an illness or condition in the past five years? (If yes, please give details.) | Yes ? | No ? |

8. What is the name and address of your GP? (medical emergency contact)

Name .....

Address .....

.....

.....

Telephone .....

**MEDICAL IN CONFIDENCE (WHEN COMPLETED)**

**I declare that the information given on this form is to the best of my knowledge correct and understand that if at any time in the future the information is found to be false, any contract of employment I have with the Natural Environment Research Council may be terminated by the Natural Environment Research Council without notice**.

Name
.....

Signed ..... Date
.....

**MEDICAL IN CONFIDENCE (WHEN COMPLETED)**

# Annex D: G-BASE Information card

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

For further information about our geochemical survey project (G-BASE):

**email :** enquiries@bgs.ac.uk

**telephone :** 01159 363143

**internet:** www.bgs.ac.uk/gbase

We are collecting soil, water and stream sediment samples as part of a national survey to make geochemical maps. This work started at the end of the 1960's in northern Scotland and we collect samples every summer using student workers. We have now progressed southwards to your area and have to date covered about 80% of the country sampling more than 125,000 sites. We collect samples at a high density, for example we collect one soil sample every 2 $km^2$. Samples are analysed for wide range of chemical elements including those important to the health and nutrition (e.g. Ca, Cu, Se etc.) and those that are potentially harmful elements such as As, Pb and Cd. We are interested in regional trends rather than site specific results and the final maps generally reflect the underlying geology. In areas where there are no rock outcrops this can help geologist to make better geological maps. Our work helps us to establish a natural geochemical baseline for our surface environment against which we can monitor past and future activities that cause changes to the soil and water. Hence the name of our project - Geochemical Baseline Survey of the Environment ( G-BASE).

# Annex E: Random Number Lists

**RANDOM NUMBER LIST 1**
**SEDIMENT**

AREA CODE……..

NUMBER RANGE…….

| | | | |
|---|---|---|---|
| 18 | 01 | 36 | 29 |
| 49 | 99 | 70 | 73 |
| 46 | 03 | 59 | 43 |
| 41 | 38 | 88 | 82 |
| 32 | 91 | 66 | 55 |
| 45 | 67 | 64 | 14 |
| 94 | 07 | 52 | 87 |
| 98 | 34 | 79 | 06 |
| 56 | 89 | 05 | 12 |
| 15 | 83 | 60 | 92 |
| 26 | 95 | 08 | 02 |
| 19 | 21 | 96 | 63 |
| 39 | 84 | 25 | 31 |
| 28 | 93 | 47 | 53 |
| 54 | 40 | 100 | 27 |
| 62 | 71 | 24 | 30 |
| 80 | 57 | 77 | 11 |
| 16 | 61 | 09 | 76 DUPLICATE A |
| 17 | 48 | 85 | 81 DUPLICATE B |
| 72 | 35 | 50 | 86 SUB SAMPLE A |
| 65 | 13 | 33 | 78 SUB SAMPLE B |
| 37 | 51 | 42 | 68 STANDARDS |
| 04 | 97 | 20 | 22 |
| 90 | 74 | 58 | 10 BLANK WATERS |
| 69 | 23 | 44 | 75 |

**RANDOM NUMBER LIST 2**
**SOIL**

AREA CODE……..

NUMBER RANGE……

| | | | |
|---|---|---|---|
| 11 | 05 | 32 | 89 | |
| 76 | 86 | 49 | 07 | |
| 01 | 15 | 50 | 74 | |
| 71 | 29 | 63 | 24 | |
| 68 | 100 | 79 | 66 | |
| 73 | 19 | 91 | 97 | |
| 38 | 06 | 95 | 92 | |
| 25 | 23 | 67 | 26 | |
| 85 | 78 | 10 | 53 | |
| 46 | 72 | 90 | 55 | |
| 21 | 17 | 60 | 20 | |
| 41 | 88 | 40 | 61 | |
| 64 | 93 | 99 | 84 | |
| 82 | 35 | 75 | 83 | |
| 70 | 59 | 16 | 33 | |
| 47 | 03 | 12 | 02 | |
| 22 | 44 | 18 | 43 | |
| 34 | 87 | 69 | 62 | |
| 39 | 65 | 42 | 14 | |
| 54 | 30 | 09 | 31 | DUPLICATE A |
| 48 | 81 | 45 | 37 | DUPLICATE B |
| 96 | 94 | 98 | 77 | SUB SAMPLE A |
| 27 | 51 | 13 | 58 | SUB SAMPLE B |
| 04 | 57 | 52 | 28 | STANDARDS |
| 36 | 08 | 56 | 80 | |

**RANDOM NUMBER LIST 3**
**SEDIMENT**

AREA CODE……..

NUMBER RANGE…….

| | | | |
|---|---|---|---|
| 86 | 19 | 21 | 99 | |
| 43 | 31 | 20 | 80 | |
| 23 | 32 | 73 | 98 | |
| 29 | 16 | 35 | 33 | |
| 69 | 25 | 36 | 01 | |
| 57 | 26 | 77 | 40 | |
| 94 | 45 | 92 | 37 | |
| 03 | 71 | 64 | 11 | |
| 88 | 34 | 42 | 14 | |
| 48 | 55 | 100 | 76 | |
| 50 | 79 | 30 | 60 | |
| 54 | 22 | 65 | 72 | |
| 39 | 67 | 09 | 52 | |
| 18 | 95 | 13 | 05 | |
| 63 | 46 | 58 | 68 | |
| 81 | 97 | 59 | 47 | |
| 66 | 49 | 02 | 91 | |
| 84 | 28 | 27 | 04 | DUPLICATE A |
| 38 | 78 | 61 | 96 | DUPLICATE B |
| 24 | 10 | 83 | 62 | SUB SAMPLE A |
| 74 | 15 | 06 | 53 | SUB SAMPLE B |
| 70 | 07 | 82 | 17 | STANDARDS |
| 85 | 90 | 12 | 87 | |
| 93 | 08 | 51 | 44 | BLANK WATERS |
| 41 | 56 | 89 | 75 | |

**RANDOM NUMBER LIST 4**
**SOIL**

AREA CODE……..

NUMBER RANGE…….

| | | | |
|---|---|---|---|
| 83 | 64 | 61 | 55 | |
| 05 | 52 | 74 | 78 | |
| 37 | 82 | 36 | 100 | |
| 99 | 23 | 65 | 49 | |
| 75 | 76 | 95 | 12 | |
| 22 | 16 | 29 | 91 | |
| 13 | 41 | 58 | 63 | |
| 62 | 43 | 59 | 68 | |
| 84 | 98 | 90 | 02 | |
| 89 | 97 | 88 | 53 | |
| 87 | 73 | 77 | 51 | |
| 27 | 17 | 50 | 19 | |
| 01 | 81 | 15 | 08 | |
| 33 | 42 | 45 | 28 | |
| 79 | 25 | 57 | 07 | |
| 11 | 06 | 67 | 54 | |
| 93 | 18 | 48 | 30 | |
| 14 | 56 | 46 | 03 | |
| 39 | 94 | 85 | 32 | |
| 24 | 92 | 26 | 71 | DUPLICATE A |
| 21 | 80 | 70 | 66 | DUPLICATE B |
| 44 | 04 | 09 | 60 | SUB SAMPLE A |
| 20 | 72 | 31 | 34 | SUB SAMPLE B |
| 10 | 35 | 69 | 96 | STANDARDS |
| 86 | 38 | 40 | 47 | |

# Annex F : Important Agricultural Issues

## Sugar Beet Rhizomania

**Referernce: Asher, M. 1999. Sugar-beet rhizomania: the spread of soilborne disease. Microbiology Today, 26, 120-122. August 1999.**
http://www.sgm.ac.uk/pubs/micro_today/pdf/039906.pdf

"Sugar-beet crops can be decimated by rhizomania, a disease caused by a virus, yet transmitted by a fungus in the soil. Although stringent control measures are in place in the UK to prevent its spread; severe economic losses are being experienced in other parts of the world."

"Rhizomania disease of sugar-beet – so-called because of its 'mad root' symptoms – is caused by a virus (beet necrotic yellow vein virus) transmitted by a soilborne parasitic fungus, *Polymyxa betae*. *Polymyxa* species are members of a small group of zoosporic fungi that do not produce hyphae; indeed the debate continues as to whether they are truly fungi or more closely related to the protozoans. They infect by means of swimming spores which attach themselves to the rootlets and inject their contents (which may contain the virus) into the superficial cells. Here the fungus develops and differentiates to produce a further generation of zoospores which are released to infect neighbouring roots. Several such cycles of multiplication occur during the growing season. At some stage, however, usually in more mature plants, the fungus switches to producing thick-walled resting spores, which are released into the soil when the rootlets decay and can survive almost indefinitely, protecting the virus particles they contain"

***"Current statutory measures to contain the disease***

Over the years the statutory containment measures have gradually been relaxed as more and more outbreaks have been confirmed. When an outbreak occurs now, the infected patch plus a *cordon sanitaire* of 25 metre radius from the edge of the patch is destroyed with glyphosate. Any remaining crop in the field can be harvested but it can only be processed at a factory with a tidal outlet. Cropping restrictions are imposed. No transplants such as seed potatoes or strawberry runners can be grown; ware potatoes can be produced in the infected field with the harvested tubers subject to soil level restrictions. Partially resistant varieties can be grown on outbreak farms but not in outbreak fields. Hygiene measures are required for machinery."

from Technical Briefing held at Central Science Laboratories (CSL), York, 28 November 2001

http://www.defra.gov.uk/planth/Rhizback.pdf

# Foot and Mouth

**Reference:** DEFRA Foot and Mouth Web pages (http://www.defra.gov.uk/footandmouth/)

## BGS policy towards the Foot and Mouth Outbreak in 2001

BGS is treating the outbreak of Foot & Mouth Disease with the utmost seriousness and will do everything it can to avoid the risk of spreading the disease. Field work was suspended on 22nd February. Procedures in force during the period of the outbreak are as follows:

**1.** BGS policy during the crisis will be co-ordinated by Dr Lee. He will work with Mr Holmes to monitor the situation on a regular basis as the outbreak develops and issue further guidance as necessary. In the case of Northern Ireland, Mr Arthurs will monitor the situation and issue instructions based on local advice.

**2.** The suspension currently applies to all onshore field activities in rural and semi-rural areas THROUGHOUT THE UK (i.e. it includes site visits, borehole logging, geophysical surveys, geochemical surveys and any other type of field-based activity).

**3.** Field activities in urban areas and along coasts may be approved on a case by case basis. A risk assessment must be carried out prior to any proposed survey or site visit. This should consider the likelihood of coming into contact with livestock during the field operation itself or during travel to/from the field site. The case for proceeding with an urban or coastal field activity (together with the risk assessment) should be submitted through Programme Managers to Dr Lee (or to Mr Arthurs in the case of GSNI). No work should be undertaken until permission has been granted.

**4.** Offshore field surveys may continue but staff should be aware of guidelines (below) related to travel. Similarly, staff travelling overseas should be aware of the need to observe procedures put in place by other countries to stop the spread of the disease.

**5.** BGS is dependent on the goodwill of the farming community to carry out its field surveys and staff should avoid any actions during the course of their normal business that might risk spreading the disease or even give the impression that we are not treating the outbreak seriously. For example, staff using official vehicles for any purpose (e.g. travelling to and from meetings) should avoid driving along country lanes and gated roads wherever possible.

**6.** Staff should be aware that information about the progress of the outbreak and the measures in place to contain it are posted on the MAFF web site (www.maff.gov.uk). This will be kept under constant review.

**7.** It is not possible to predict at the present time when the outbreak will end or when restrictions may be lifted. Even when restrictions are removed, farmers may still be unwilling to see BGS recommence survey operations on their land.

**8.** Project Leaders and Programme Managers should review their fieldwork operations for the coming year and make contingency plans. Where possible, work should be rescheduled for later in the year. 'Decision dates' should be defined for all field programmes as the last date at which the decision can be taken to proceed, postpone or cancel.

**9.** As the outbreak develops, the authorities may impose movement restrictions which might prevent staff from travelling to work. Staff affected by such restrictions should contact their HoD and relevant Programme Managers to discuss alternative working arrangements.

**10.** It is accepted that the Foot and Mouth outbreak is likely to affect project schedules and deliverables in some programmes. The Board will be kept informed of the impact through Programme Directors. In the case of commissioned research, Programme Managers should take on board the views of clients, discuss the impact of the restrictions on the project timetable and negotiate contract extensions where possible. Finance staff should be kept informed of any changes to budgets and timetables.

## Classical Swine Fever

http://www.ukagriculture.com/uk_farming/livestock/classical_swine_fever.htm

Classical swine fever is a highly contagious virus disease of swine. No other animals are affected. First recognised in Tennessee in 1810, it then rapidly spread around the world. It was first seen in Great Britain in 1864 and controls were instigated in 1878. The disease was eradicated from the country in 1966. Since then breakdowns have occurred in 1971 (215 pigs slaughtered), 1986 (7,800 pigs slaughtered) and most recently in 2000 in East Anglia when 75,000 diseased and in-contact pigs were slaughtered before the disease was beaten.

In the acute form of the disease, affected pigs develop a very high temperature followed by a variety of other clinical signs which may include coughing, diarrhoea, abortion, skin lesions and nervous signs. In young pigs the mortality rate may approach 100%. Apparently healthy pigs may be incubating the disease and recovered pigs can carry on excreting the virus and so be a source of infection for others. This means that movements of pigs from farms can easily spread the disease. The virus can also remain in the environment, for example on people, boots and lorries and this is another source of spread and infection.

The disease is controlled by various means. There are very strict controls on the import of meat and meat products into the UK - the outbreak in 2000 was suspected to have been caused by pigs (or a pig) consuming a contaminated imported pig product. Movement orders, in place since 1995, prevent the movement of pigs from a farm until 20 days after pigs have moved on. By law, all owners must inform DEFRA immediately if any sick pigs are showing any signs suggestive of swine fever. All affected and in-contact animals are slaughtered. In addition no feeding of swill to pigs is allowed.

Other EU countries have had large numbers of outbreaks, with Holland in 1997 taking over a year to bring an outbreak under control. Currently the all - slaughter policy is still in use, but cost-benefit analysis into the use of vaccines have shown that their use may decrease the cost of an outbreak. However at present there is not a vaccine available where vaccinated pigs on test can be differentiated from infected ones.

# Annex G: Sample Checklists

| Atlas Name | Area Code | Sample Number Range |
|---|---|---|
| *South West England* | 50 | Random Number List 1 (Sediment) |

| | C | P | | | | | C | P | | | | | C | P | | | | | C | P | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 26 | | | | | | 51 | | | | | | 76 | | | DUP | | A |
| 2 | | | | | | 27 | | | | | | 52 | | | | | | 77 | | | | | |
| 3 | | | | | | 28 | | | | | | 53 | | | | | | 78 | SUB-SAMP | | | | |
| 4 | | | | | | 29 | | | | | | 54 | | | | | | 79 | | | | | |
| 5 | | | | | | 30 | | | | | | 55 | | | | | | 80 | | | | | |
| 6 | | | | | | 31 | | | | | | 56 | | | | | | 81 | | | DUP | | B |
| 7 | | | | | | 32 | | | | | | 57 | | | | | | 82 | | | | | |
| 8 | | | | | | 33 | | | | | | 58 | | | | | | 83 | | | | | |
| 9 | | | | | | 34 | | | | | | 59 | | | | | | 84 | | | | | |
| 10 | B W | | | | | 35 | | | | | | 60 | | | | | | 85 | | | | | |
| 11 | | | | | | 36 | | | | | | 61 | | | | | | 86 | SUB-SAMP | | | | |
| 12 | | | | | | 37 | | | | | | 62 | | | | | | 87 | | | | | |
| 13 | | | | | | 38 | | | | | | 63 | | | | | | 88 | | | | | |
| 14 | | | | | | 39 | | | | | | 64 | | | | | | 89 | | | | | |
| 15 | | | | | | 40 | | | | | | 65 | | | | | | 90 | | | | | |
| 16 | | | | | | 41 | | | | | | 66 | | | | | | 91 | | | | | |
| 17 | | | | | | 42 | | | | | | 67 | | | | | | 92 | | | | | |
| 18 | | | | | | 43 | | | | | | 68 | STANDARD | | | | | 93 | | | | | |
| 19 | | | | | | 44 | | | | | | 69 | | | | | | 94 | | | | | |
| 20 | | | | | | 45 | | | | | | 70 | | | | | | 95 | | | | | |
| 21 | | | | | | 46 | | | | | | 71 | | | | | | 96 | | | | | |
| 22 | STANDARD | | | | | 47 | | | | | | 72 | | | | | | 97 | | | | | |
| 23 | | | | | | 48 | | | | | | 73 | | | | | | 98 | | | | | |
| 24 | | | | | | 49 | | | | | | 74 | | | | | | 99 | | | | | |
| 25 | | | | | | 50 | | | | | | 75 | B W | | | | | 100 | | | | | |

## Summary

| Dup Sample | Sub-Sample | | Standards | | Unused Numbers | Blank Water |
|---|---|---|---|---|---|---|
| 76 | 86 | | 68 | 22 | | 10 |
| 81 | 78 | | | | | 75 |

| Atlas Name | Area Code | Sample Number Range |
|---|---|---|
| *South West England* | 50 | Random Number List 2 (Soil) |

| | A | S | | | | | A | S | | | | | A | S | | | | | A | S | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 26 | | | | | | 51 | | | | | | 76 | | | | | |
| 2 | | | | | | 27 | | | | | | 52 | | | | | | 77 | SUB-SAMP | | | | |
| 3 | | | | | | 28 | STANDARD | | | | | 53 | | | | | | 78 | | | | | |
| 4 | | | | | | 29 | | | | | | 54 | | | | | | 79 | | | | | |
| 5 | | | | | | 30 | | | | | | 55 | | | | | | 80 | STANDARD | | | | |
| 6 | | | | | | 31 | | DUP | A | | | 56 | | | | | | 81 | | | | | |
| 7 | | | | | | 32 | | | | | | 57 | | | | | | 82 | | | | | |
| 8 | | | | | | 33 | | | | | | 58 | SUB-SAMP | | | | | 83 | | | | | |
| 9 | | | | | | 34 | | | | | | 59 | | | | | | 84 | | | | | |
| 10 | | | | | | 35 | | | | | | 60 | | | | | | 85 | | | | | |
| 11 | | | | | | 36 | | | | | | 61 | | | | | | 86 | | | | | |
| 12 | | | | | | 37 | | DUP | B | | | 62 | | | | | | 87 | | | | | |
| 13 | | | | | | 38 | | | | | | 63 | | | | | | 88 | | | | | |
| 14 | | | | | | 39 | | | | | | 64 | | | | | | 89 | | | | | |
| 15 | | | | | | 40 | | | | | | 65 | | | | | | 90 | | | | | |
| 16 | | | | | | 41 | | | | | | 66 | | | | | | 91 | | | | | |
| 17 | | | | | | 42 | | | | | | 67 | | | | | | 92 | | | | | |
| 18 | | | | | | 43 | | | | | | 68 | | | | | | 93 | | | | | |
| 19 | | | | | | 44 | | | | | | 69 | | | | | | 94 | | | | | |
| 20 | | | | | | 45 | | | | | | 70 | | | | | | 95 | | | | | |
| 21 | | | | | | 46 | | | | | | 71 | | | | | | 96 | | | | | |
| 22 | | | | | | 47 | | | | | | 72 | | | | | | 97 | | | | | |
| 23 | | | | | | 48 | | | | | | 73 | | | | | | 98 | | | | | |
| 24 | | | | | | 49 | | | | | | 74 | | | | | | 99 | | | | | |
| 25 | | | | | | 50 | | | | | | 75 | | | | | | 100 | | | | | |

## Summary

| Dup Sample | Sub-Sample | Standards | Unused Numbers |
|---|---|---|---|
| 31 | 77 | 28 80 | |
| 37 | 58 | | |

| Atlas Name | Area Code | Sample Number Range |
|---|---|---|
| *South West England* | 50 | Random Number List 3 (Sediment) |

| | C | P | | | | | C | P | | | | C | P | | | | C | P | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 26 | | | | | 51 | | | | | | 76 | | | | | |
| 2 | | | | | | 27 | | | | | 52 | | | | | | 77 | | | | | |
| 3 | | | | | | 28 | | | | | 53 | SUB-SAMP | | | | | 78 | | | | | |
| 4 | | DUP A | | | | 29 | | | | | 54 | | | | | | 79 | | | | | |
| 5 | | | | | | 30 | | | | | 55 | | | | | | 80 | | | | | |
| 6 | | | | | | 31 | | | | | 56 | | | | | | 81 | | | | | |
| 7 | | | | | | 32 | | | | | 57 | | | | | | 82 | | | | | |
| 8 | | | | | | 33 | | | | | 58 | | | | | | 83 | | | | | |
| 9 | | | | | | 34 | | | | | 59 | | | | | | 84 | | | | | |
| 10 | | | | | | 35 | | | | | 60 | | | | | | 85 | | | | | |
| 11 | | | | | | 36 | | | | | 61 | | | | | | 86 | | | | | |
| 12 | | | | | | 37 | | | | | 62 | SUB-SAMP | | | | | 87 | STANDARD | | | | |
| 13 | | | | | | 38 | | | | | 63 | | | | | | 88 | | | | | |
| 14 | | | | | | 39 | | | | | 64 | | | | | | 89 | | | | | |
| 15 | | | | | | 40 | | | | | 65 | | | | | | 90 | | | | | |
| 16 | | | | | | 41 | | | | | 66 | | | | | | 91 | | | | | |
| 17 | STANDARD | | | | | 42 | | | | | 67 | | | | | | 92 | | | | | |
| 18 | | | | | | 43 | | | | | 68 | | | | | | 93 | | | | | |
| 19 | | | | | | 44 | B W | | | | 69 | | | | | | 94 | | | | | |
| 20 | | | | | | 45 | | | | | 70 | | | | | | 95 | | | | | |
| 21 | | | | | | 46 | | | | | 71 | | | | | | 96 | | DUP B | | | |
| 22 | | | | | | 47 | | | | | 72 | | | | | | 97 | | | | | |
| 23 | | | | | | 48 | | | | | 73 | | | | | | 98 | | | | | |
| 24 | | | | | | 49 | | | | | 74 | | | | | | 99 | | | | | |
| 25 | | | | | | 50 | | | | | 75 | B W | | | | | 100 | | | | | |

## Summary

| Dup Sample | Sub-Sample | | Standards | | Unused Numbers | Blank Water |
|---|---|---|---|---|---|---|
| 04 | 62 | | 17 | 87 | | 44 |
| 96 | 53 | | | | | 75 |

| Atlas Name | Area Code | Sample Number Range |
|---|---|---|
| *South West England* | 50 | Random Number List 4 (Soil) |

| | A | S | | | | | A | S | | | | | A | S | | | | | A | S | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | 26 | | | | | | 51 | | | | | | 76 | | | | | |
| 2 | | | | | | 27 | | | | | | 52 | | | | | | 77 | | | | | |
| 3 | | | | | | 28 | | | | | | 53 | | | | | | 78 | | | | | |
| 4 | | | | | | 29 | | | | | | 54 | | | | | | 79 | | | | | |
| 5 | | | | | | 30 | | | | | | 55 | | | | | | 80 | | | | | |
| 6 | | | | | | 31 | | | | | | 56 | | | | | | 81 | | | | | |
| 7 | | | | | | 32 | | | | | | 57 | | | | | | 82 | | | | | |
| 8 | | | | | | 33 | | | | | | 58 | | | | | | 83 | | | | | |
| 9 | | | | | | 34 | SUB-SAMP | | | | | 59 | | | | | | 84 | | | | | |
| 10 | | | | | | 35 | | | | | | 60 | SUB-SAMP | | | | | 85 | | | | | |
| 11 | | | | | | 36 | | | | | | 61 | | | | | | 86 | | | | | |
| 12 | | | | | | 37 | | | | | | 62 | | | | | | 87 | | | | | |
| 13 | | | | | | 38 | | | | | | 63 | | | | | | 88 | | | | | |
| 14 | | | | | | 39 | | | | | | 64 | | | | | | 89 | | | | | |
| 15 | | | | | | 40 | | | | | | 65 | | | | | | 90 | | | | | |
| 16 | | | | | | 41 | | | | | | 66 | | DUP | B | | | 91 | | | | | |
| 17 | | | | | | 42 | | | | | | 67 | | | | | | 92 | | | | | |
| 18 | | | | | | 43 | | | | | | 68 | | | | | | 93 | | | | | |
| 19 | | | | | | 44 | | | | | | 69 | | | | | | 94 | | | | | |
| 20 | | | | | | 45 | | | | | | 70 | | | | | | 95 | | | | | |
| 21 | | | | | | 46 | | | | | | 71 | | DUP | A | | | 96 | STANDARD | | | | |
| 22 | | | | | | 47 | STANDARD | | | | | 72 | | | | | | 97 | | | | | |
| 23 | | | | | | 48 | | | | | | 73 | | | | | | 98 | | | | | |
| 24 | | | | | | 49 | | | | | | 74 | | | | | | 99 | | | | | |
| 25 | | | | | | 50 | | | | | | 75 | | | | | | 100 | | | | | |

## Summary

| Dup Sample | Sub-Sample | Standards | Unused Numbers |
|---|---|---|---|
| 71 | 60 | 47 96 | |
| 66 | 34 | | |

# Annex H: G-BASE Sample Registration Forms

## G-BASE SAMPLE REGISTRATION

**C**

G-BASE Ref: **EA03 006**

Lab No:

*Samples from :* East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

*From number:* 440501 *To number:* 441000 *Number of samples:* 500

*Sample list file:* 006.xls *Priority* **M** *Required by:* 31/03/2004

**Health and Safety considerations**

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

*SAMPLE PREPARATION*

*Air dry. Disaggregate.*
*Agate Milling.*
*Excess sample to be stored in core store.*
*Mill with binder for XRF pellet.*
*Pelletise for XRF analysis (xx mm pellets).*
*Add standards as indicated on sample list.*

*ANALYSIS*

*XRF: Standard G-BASE rural. Elements reported: Ag, Al2O3, As, Ba, Bi, Br, CaO, Cd, Ce, Co, Cr, Cs, Cu, Fe2O3, Ga, Ge, Hf, I, K2O, La, MgO, MnO, Mo, Na2O, Nb, Nd, Ni, P2O5, Pb, Rb, Sb, Sc, Se, SiO2, Sm, Sn, Sr, Ta, Te, Th, TiO2, Tl, U, V, W, Y, Zn and Zr. Ag, As, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Ga, K, La, Mg, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Se, Sn, Sr, Th, Ti, V, Y, Zn, Zr, U (33 elements required).*

******* PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk extn 3536) *********

*Notes from field team :*

*Submitted electronically/as hardcopy to lab : on:* .....

*Signed :* .....

Example sample registration form for stream sediment

# G-BASE SAMPLE REGISTRATION

**A**

G-BASE Ref: **EA03 006**

Lab No:

*Samples from :* East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

*From number:* 440501 *To number:* 441000 *Number of samples:* 500

*Sample list file:* 006.xls *Priority* **M** *Required by:* 31/03/2004

**Health and Safety considerations**

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

*SAMPLE PREPARATION*

*Air dry. Disaggregate.*
*Agate Milling.*
*Excess sample to be stored in core store.*
*Mill with binder for XRF pellet.*
*Pelletise for XRF analysis (xx mm pellets).*
*Add standards as indicated on sample list.*
*Select samples for pH and LOI as indicated on sample list*

*ANALYSIS*

*XRF: Standard G-BASE rural.*
*Elements reported: Ag, Al2O3, As, Ba, Bi, Br, CaO, Cd, Ce, Co, Cr, Cs, Cu, Fe2O3, Ga, Ge, Hf, I, K2O, La, MgO, MnO, Mo, Na2O, Nb, Nd, Ni, P2O5, Pb, Rb, Sb, Sc, Se, SiO2, Sm, Sn, Sr, Ta, Te, Th, TiO2, Tl, U, V, W, Y, Zn and Zr.*
*Elements required: Ag, As, Ba, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Ga, K, La, Mg, Mn, Mo, Nb, Ni, P, Pb, Rb, Sb, Se, Sn, Sr, Th, Ti, V, Y, Zn, Zr, U (33).*

*LOI @ 450°C*
*pH with CaCl2 slurry*

******* PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk ext 3536) *********

*Notes from field team :*

*Submitted electronically/as hard copy to lab : on:* .....

*Signed :* .....

Example sample registration form for surface soil

# G-BASE SAMPLE REGISTRATION

**W**

G-BASE Ref: **EA03 006**

Lab No:

*Samples from :* East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

*From number:* 440501 *To number:* 441000 *Number of samples:* 500

*Sample list file:* 006.xls *Priority* **M** *Required by:* 31/03/2004

**Health and Safety considerations**

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

*SAMPLE PREPARATION*

*None*

*ANALYSIS*

*ICP-MS (filtered, acidified with nitric in nalgene bottles) for*

*ICP-AES (filtered, acidified with nitric in sterelin tubes) for*

*Aqueous analytical for Cl, F and NPOC*

****** *PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk ext.3536)* ********

*Notes from field team :*

*Submitted electronically/as hardcopy to lab : on:* .....

*Signed :* .....

Example of sample registration form for surface water

# G-BASE SAMPLE REGISTRATION

**P**

G-BASE Ref: **EA03 006**

Lab No:

*Samples from :* East Anglia *Registered on:* 12-May-03 *by:* Sarah Brown

*From number:* 440501 *To number:* 441000 *Number of samples:* 500

*Sample list file:* 006.xls *Priority* **M** *Required by:* 31/03/2004

**Health and Safety considerations**

Dust ☑ Contamination ☐ Other:

Heavy ☑ Radioactivity ☐

*SAMPLE PREPARATION*

*Air dry.*
*Samples to be stored in core store.*

*ANALYSIS*

*None*

****** PLEASE REPORT RESULTS TO T R LISTER (trl@bgs.ac.uk extn 3536) *********

*Notes from field team :*

*Submitted electronically/as hardcopy to lab : on:* .....

*Signed :* .....

Example of sample registration form for panned concentrate

# Annex I: Manual Update History

| Date | Pages | Section | Description of update | Updated by: | Authorised by: |
|---|---|---|---|---|---|
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