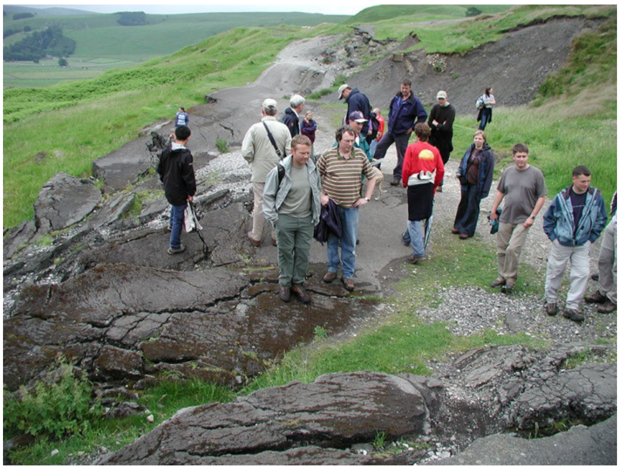
The Geological Society

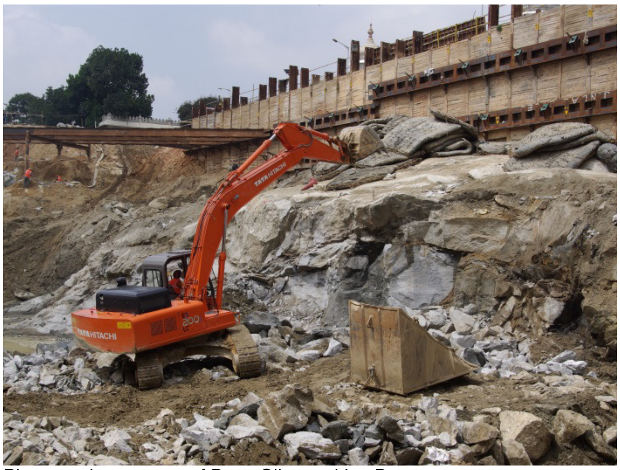
Continuing Professional Development

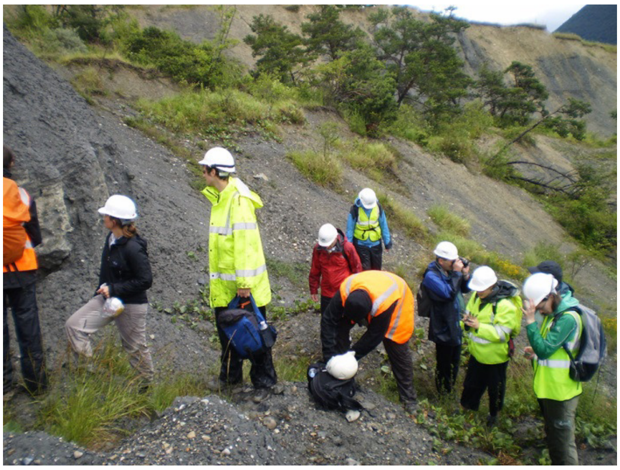
TRAINING GUIDE FOR ENGINEERING GEOLOGISTS

Third Edition

June 2016







Photographs courtesy of Dave Giles and Ian Duncan

REVISION	DATE	AUTHORS / CONTRIBUTORS
1	October 1994	Working Group under the auspices of the Education and Training Committee of the Engineering Group of the Geological Society
2	March 2008	• Simon Wheeler, Knapp Hicks and Partners Ltd • Sarah Chilton, Mott MacDonald • Ivan Hodgson, Scott Wilson Ltd • David Giles, University of Portsmouth • Mike Whitworth, DML • Dr John Perry, Mott MacDonald • Prof Jim Griffiths, University of Plymouth
3	June 2016	Committee members from the Engineering Group of the Geological Society and other contributors including: - • Charlie Knox, Arcadis • Matthew Baldwin, Soil Engineering • Steve Parry, Parry Engineering Geological Services • David Giles, University of Portsmouth • Ian Duncan, Mott MacDonald • Richard Mitchener, Atkins

The Geological Society

Continuing Professional Development

TRAINING GUIDE FOR ENGINEERING GEOLOGISTS

Third Edition

Contents

The Geological Society

Continuing Professional Development

TRAINING GUIDE FOR ENGINEERING GEOLOGISTS

Third Edition

EXECUTIVE SUMMARY

The Geological Society is responsible for awarding the title of Chartered Geologist to those of its Fellows it considers have sufficient competence (skills, training, knowledge, attitude and experience) to meet the requirements laid down by the Society. A primary aim of this Training Guide is to provide guidance to graduate earth scientists working in Engineering Geology in obtaining the necessary experience and knowledge to attain chartered status. To this end the tables provided in the Guide are designed to provide a comprehensive list of achieved skills that, in their project context, may serve as the basis of a submission for chartered status. It is further intended that the Training Guide will continue to be used by Chartered Geologists for whole career training and a record of Continual Professional Development

There are many specialisations within the geological profession and therefore one Training Guide cannot apply to them all. This Training Guide has been produced primarily with Engineering Geologists working in the construction industry in mind. It also contains some specific guidance particularly relevant to the following sectors:

- Geotechnics;
- Geoenvironmental engineering;
- Quarrying and open pit mining; and
- Hydrogeology.

Clearly the above sectors are, rightly, specialisms in their own right and a key skill for the Engineering Geologist is to recognise when to seek specialist assistance in these areas if they are relevant. However, individuals working within these specialist fields may also meet the requirements needed to be a Chartered Geologist so background information is also provided for the purposes of these candidates.

A working knowledge of geology to graduate level is required of all Trainees starting their training to be Chartered Geologist and most will have a first degree in the earth sciences. Those without an education majoring in geology should contact the Geological Society for advice on what further education may be needed to meet the requirements for Chartered status.

This Training Guide sets out a number of objectives which are worded in general terms so that a wide range of different experience can meet these objectives. A company may wish (and is encouraged) to write its own more specific Training Guide which must include the core objectives. Much of the Training Guide is appropriate for Engineering Geologists working outside the fields of civil engineering and construction, however, modifications may be necessary to suit some specific areas of activity.

The guide covers 14No. broad sections including a section of Core Skills, which are expected to be obtained to the required level of attainment before applying for Chartership. It is likely though that during the Trainee's career, objectives in other sections are likely to be fulfilled. Completion of every objective is not required. A detailed description of the use of the Guide is in Part 1 with detailed objectives being placed in Part 2. Instructions to Employers who wish to make use of the Training Scheme (with or without adaptation for their own use) are in the Appendix.

PART I – THE TRAINING GUIDE

1 INTRODUCTION

The Geological Society is the Chartered body recognised by the Department of Trade and Industry as the designated authority for Geology in the United Kingdom (UK) under the terms of the European Community Directive on the Recognition of Professional Qualifications. As such it is responsible for scrutinising the qualifications of candidates for Fellowship (FGS) and for validating as Chartered Geologists (CGeol) and Chartered Scientists (CSci) those Fellows it considers meet its standards of qualifications and experience. In common with other such bodies, the Geological Society is responsible for facilitating the practising of geology in the UK to the highest possible technical and professional standards. In this professional role, the Society has an obligation to guide the development of young geologists in their careers and, in particular, to ensure that those who wish to qualify for Chartered status receive the best possible training.

This Training Guide is provided for the use of geologists and other related earth scientists who would be classed as Engineering Geologists due to the nature of work they undertake, and / or the nature of the organisation they are employed by. It provides guidance on the level and range of experience that they should attain to support their applications to the Geological Society for Fellowship with Validation (CGeol) status and is further designed to serve as a whole career record of achievement of skills through continued professional development (CPD).

Geologists use their skills in such fields as site walkovers, data analysis, mapping of geological ground conditions and features, and development of ground models to name a few. Engineering Geologists may also be involved in the related disciplines of ground investigation, geotechnics, geoenvironmental assessment of contaminated land, quarrying / open pit mining and / or hydrogeology. Whatever their speciality, all Engineering Geologists require good training if they are to become competent professionals; it is with this aim in mind that the Geological Society has produced this Training Guide for Engineering Geologists.

The Training Guide was prepared jointly by the Geological Society's Professional Committee and the Engineering Group of the Society (EGGS). The First Edition was prepared by a working group chaired by Mr. A.J Bowden (October 1994). The Second Edition of the Guide was prepared in March 2008 by a working group chaired by Mr Simon Wheeler, whose brief was to update the Guide in light of:

- changes in technical requirements and professional practice of Engineering Geologists;
- revisions to the Geological Society's requirements and procedures for the granting of CGeol status;
- introduction of the Geological Society's CPD scheme, which is available as an on-line record through the Geological Society website; and
- the introduction of a Registration for Ground Engineering Professionals (RoGEP).

This Third Edition, which supersedes the 2008 Guide, has been prepared by volunteers from relevant industry sectors, who have realigned the document with the disciplines essential to the Engineering Geology profession. This has involved the removal of some of the very detailed sections on contaminated land, hydrogeology and the extractive mineral industry.

2 AN OVERVIEW OF THE TRAINING OBJECTIVES

The objective of the Training Guide is to encourage Engineering Geologists to expand their experience throughout their professional career and also to structure their early training so as to gain sufficient and relevant experience to meet the requirements for Chartered Status as applied to the discipline of Engineering Geology. It is anticipated that the Guide will form the basis for a formal structured training scheme within an organisation or, where that is not offered for any reason, a framework within which ‘on the job’ and other training can be planned and monitored by the Trainee.

The Geological Society Regulation R/FP/2 requires that Fellows seeking validation as a CGeol **demonstrate**[1] seven components of relevant experience (November, 2013). At the time of writing they are:

(i). *Understanding the complexities of geology and of geological processes in space and time in relation to the applicant’s speciality.*

(ii). *Critical evaluation of geoscience information to generate predictive models.*

(iii). *Effective communication in writing and orally.*

(iv). *Competency in the management of Health and Safety and environmental issues and other statutory obligations applicable to the discipline or areas of work.*

(v). *Clear understanding of the meaning and needs of professionalism, including a clear understanding of the Code of Conduct and commitment to it implementation.*

(vi). *Commitment to CPD throughout the applicant’s professional career.*

(vii). *Competence in his/her area of expertise.*

Trainees should check that they are using the current version of the Regulations. The requirements above are for all Fellows applying for validation as a Chartered Geologist. There are slightly different criteria for those applying for Chartered Scientist statues, which are outline in document R/FP/11 as described above.

The Training Guide is written with the intention that those complying with the Training Guide should meet these criteria.

The Training Guide is not intended as a substitute for postgraduate education, and the Engineering Geologist is encouraged to undertake an MSc in Engineering Geology, Geotechnical Engineering, Foundation Engineering, Hydrogeology, Soil Mechanics, Rock Mechanics or other related subject during his/her early career. It should be stressed however, that classroom teaching is not a substitute for practical on the job training and experience which are essential for achieving Chartered status. Due to the advanced and focused technical content of an MSc, the period of study may be included in the experience for Chartered status. Further information regarding MSc courses and GSL accredited degrees can be obtained at:

https://www.geolsoc.org.uk/accreditation

[1] The Trainee should be able to give examples of scenarios where they have used their awareness, training, knowledge, skills and/or attitude to successfully perform specific tasks, which can be assess against provided evidence and defined competency levels.

3 ADMISSION TO THE SCHEME

The Training Scheme is administered by the Geological Society and is open to all Fellows (Members) who are practising geology and who have a realistic prospect of satisfying the requirements for Chartered status as set out in the guidelines referenced above. Those without a formal qualification in geology will be accepted providing they are employed (or are otherwise active) in Engineering Geology. The Training Guide assumes a sound knowledge of geology and of geological processes; anyone joining the scheme without this knowledge should seek advice from the Society on what further geological education will be required.

The requirements for joining the Society and for the granting of Fellow and Chartered Status are set out in regulation documents: R/FP/1, R/FP/2 and R/FP/1. The Code of Conduct document R/FP/7 should also be read and understood. Additionally, the Council agreed on 15 June 2015 that the Society should sign the AGI's professional ethical guidelines. Therefore, the Trainee should read and implement the guidelines during their career as an Engineering Geologist.

4 THE STRUCTURE OF THE TRAINING GUIDE

This Training Guide lists the topics that are likely to be included in the work experience of an Engineering Geologist. The sphere of employment of Engineering Geologists is however very wide and it is not intended that all of the topics should be covered by an individual Trainee. The Core Skills are considered to be essential parts of the training of all Engineering Geologists, while achievement in the topics covered in the subsequent sections will depend on the work experience of the individual Trainee; normally, the range of topics appropriate for a particular Trainee would be identified and agreed (and periodically reviewed) as part of the quarterly meetings with the Training Supervisor / Mentor.

The key skills in each section are indicated, and the Trainee working in these areas should ensure the target level agreed with their Training Supervisor / Mentor is achieved in these areas. The details may be varied to suit individual Trainees or Organisations, and Training Supervisor / Mentors should consider producing their own training schemes using this document as a template. Where an employer's sphere of activity is particularly specialised, or lacking in the area of some key skills, consideration should be given to obtaining an appropriate secondment for the Trainee to obtain the necessary experience.

It should be noted that many of topics contained in this guide (Sections H, J, K, L, M & N; see list below) may be considered specialisms in their own right and detailed training guidance within these areas is not included in this Training Guide. The content included in these Sections reflects what the practicing Engineering Geologist may be expected to undertake on a routine basis if working in these areas. An Engineering Geologist may specialise in, for instance, Hydrogeology or Geoenvironmental Science, and if this is the case the Trainee should seek additional sources of guidance or routes to professional recognition as this is beyond the scope of this Training Guide for Engineering Geologists.

The training objectives are sub-divided into sections:

A	Core Skills
B	Desk Study
C	Engineering Geological Mapping (including Site Reconnaissance)
D	Designing the Investigation
E	Field based Investigation – Sampling and Logging
F	Field based Investigation – Testing
G	Laboratory Testing
H	Geoenvironmental Site Investigation and Management
I	Interpretation and Analysis of Data
J	Geotechnical Design

K Hydrogeological Design

L Construction Experience

M Contract Management

N Risk Assessment and Management

Each section starts with guidance on the applicability of the subjects, followed by a description of the relevant activities.

The relevant table for the section is included in Appendix A, on which the experience gained can be recorded. The experience gained should be endorsed by the Training Supervisor / Mentor who will date and initial the relevant column as each standard is achieved.

Trainees should score their current experience and competencies against each objective and use this (with their Training Supervisor / Mentor) to monitor their progress and professional development.

The following levels of attainment have been used:

A Appreciation; a general understanding of a subject or an appreciation as to how to undertake an activity

K Knowledge; observation and recall of information or knowing how to undertake an activity

E Experience; a depth of knowledge of a subject or activity actually undertaken by a Fellow (generally under supervision)

C Competence; a sound knowledge of a subject or activity actually undertaken by a Fellow without supervision; the Fellow can successfully direct others in the activity

An example is given below of the completion of the record of attaining training targets:-

Training Objectives		**Date of Assessment and Level of Attainment**				**Comment**
		A	**K**	**E**	**C**	
E2	Describe and log rock/soil material and rock/soil masses to appropriate / current Standards	5.7.13 MJB	5.11.13 MJB	5.6.14 MJB	5.7.15 MJB	MJB 5.7.15 Supervising a team of 3 geologists

When assessing their attainment level Trainees should consider what evidence they need to submit in support of their application for Chartership, noting that an item of evidence could cover more than one objective. In addition, objectives and abilities recorded under other schemes such as the industry-wide Construction Skills Certification Scheme (CSCS) and individual company schemes for Investors in People (IIP) may be used.

In using this Training Guide and preparing a Chartership submission, Trainees should also bear in mind the categories under which CPD is recorded (see the GSL web-site):

1. Acquiring knowledge and skills by deployment (that is during one's day-today work):
    - Professional practice
2. Enhancing and maintaining skills and knowledge:
    - Formal learning (tested)
    - Formal learning (untested)
    - Informal learning/training
    - Self-directed study

3. Participating in the geoscience community:
    - Non-work activities
    - Contributing to knowledge

5 TRAINING SUPERVISORS AND MENTORS

It is recommended that all Engineering Geologists participating in this training scheme have a Training Supervisor or Mentor, for the purpose of attaining Chartership. Such a person must be a Chartered Geologist, usually with significant experience, or an employee with at least fifteen years relevant experience. Wherever practicable, the Training Supervisor or Mentor will be a practising Engineering Geologist who is in the same organisation as the Trainee and who is fully committed to the aims of the Training Guide.

Once the Training Supervisor / Mentor has been identified, the Training Supervisor and the Trainee are jointly responsible for the implementation of the scheme. If it becomes necessary for the Training Supervisor / Mentor to be changed during the training period, the Trainee's employer must make appropriate arrangements to replace the Training Supervisor / Mentor with another of comparable qualifications / experience.

The training period leading to Chartership shall be a minimum of 5 years (which may include postgraduate study) and, during the period(s) of employment, the Training Supervisor / Mentor should have formal, face to face contact with the trainee on at least a quarterly basis to:

- discuss the training and experience that the Trainee is receiving;
- inspect the training record (Appendix A) and authenticate the grades achieved by dating and initialling the record. The tables in the Training Guide are designed to serve as the training record;
- review the non-core topic areas covered to date and the training levels attained;
- identify any knowledge/experience gaps and agree short and medium term training objectives; and
- assist in arranging any secondments for the Trainee and monitor their progress.

As part of the requirements for attaining Chartership, it is recommended that the Trainee should record these quarterly meetings and any objectives set for the purposes of producing an annual report of 1500 – 2000 words. It is recommended that any lectures or training courses attended during the period are to be reported separately as a brief summary with an emphasis on the content and value to the trainee of the lecture/course attended and recorded on the online CPD record. Attendance at the course is to be authenticated by the employer, supervisor or course organiser.

6 THE TRAINING AND CPD RECORD

Maintenance of a training and CPD record is an essential part of the training of any professional geologist. It is a requirement for attaining Chartered Status and it is recommended that the record should be maintained throughout the Engineering Geologist's professional career and is mandatory for those also validated as Chartered Scientists and/or European Geologists. The training and CPD record should record the type of work carried out, illustrating the experience gained and responsibilities held. It should therefore be sufficiently detailed to allow correlation with the experience recorded in the Training Guide, but should not contain confidential information, nor need it include details regarding the Client, administrative information or site locations that might be of a sensitive nature. The training and CPD record should contain details of all formal and informal training received.

As mentioned in earlier sections the Geological Society have produced an online CPD record, which it is recommended is utilised at the earliest opportunity. This can be found on the website at:

http://www.geolsoc.org.uk/Membership/CPD-and-Training

PART II – TRAINING OBJECTIVES

7 SECTION A - CORE SKILLS

7.1 Introduction

The training objectives identified as Core Skills are considered fundamental requirements for anyone employed as a professional Engineering Geologist. Attainment of these skills at the 'Competence' level should be considered a mandatory requirement for becoming a Chartered Geologist within the Engineering Geology discipline.

Many of the core skills will have been learnt (at 'A' or 'K' level) as part of an undergraduate and / or post graduate degree programme prior to the Trainee embarking on a professional career and it is important that they should be maintained and levels of attainment extended to 'C' as part of their work supplemented, for example, by attending workshops and fieldtrips that are arranged by the Geological Society through its various regional and specialist groups (including the Engineering Group) and by a number of other organisations.

The Core Skills listed in this Training Guide are considered fundamental building blocks to the professional life of any Engineering Geologist and consideration must be given by the Trainee's employing organisation as to how the Trainee may be given suitable opportunity to learn these skills.

8 SECTION B – DESK STUDY

8.1 Introduction

Collection and collation of existing data is the essential first stage in any ground investigation. It is necessary for the establishment of the conceptual ground model which can then be used to scope and plan appropriate field investigations to develop the model through to design stage. These activities are often called the 'desk study' even though site reconnaissance ('walkover survey') and possibly some more detailed mapping may be, and ideally should be, included in this stage of an investigation (See Section C). The Trainee should develop the necessary skills for this work which often requires the evaluation of data from different sources and the assessment of confidence levels where there is an absence of information or conflicting evidence.

Training in this area should ensure that a methodical approach is taken to data collection, that it is collated appropriately and used in a logical manner to develop a fully supported conceptual ground model, which can be used to plan the subsequent stages of the investigation and developed as further information becomes available.

8.2 Retrieval of Information

Existing data that is likely to be relevant to creation of a conceptual ground model for a site arises from a variety of sources. In the UK, this will include, but not be limited to, the Ordnance Survey, the British Geological Survey, public libraries and the libraries of learned and professional bodies, university and copyright libraries, the Environment Agency, Local Planning Authorities and records held by the client. Comparable sources are likely to be available in other countries, and should be sought at this stage of a project.

8.3 Collation, Synthesis, Interpretation and Presentation of Results

The best way to present data summaries will depend on the details of the site and the project. In many cases it will be best to present the desk study results as a report including a series of plans and cross sections. The Trainee should gain experience in producing outputs of this type and should learn to select the best method or technique for of presenting information.

8.4 Conceptual Ground Model

Once the data has been gathered, a conceptual ground model and assessment of the associated risks can be produced. This should identify all of the potential ground hazards and risks associated with the site so that a planned investigation can address potential issues. It is essential that Trainees learn the importance of planning, carrying out, and presenting data based on a clear understanding of the use to which the data will be put. In the event that the scope and objectives of the project are outside of your own field of expertise, the input of specialists should be sought at this stage where required so that the conceptual ground model is as accurate as possible.

9 SECTION C - ENGINEERING GEOLOGICAL MAPPING (INCLUDING SITE RECONNAISSANCE)

9.1 Introduction

Site reconnaissance and mapping can form part of the desk study or may be carried out as a separate phase of the investigation. The purpose of site reconnaissance is to confirm information obtained from the desk study and to note any relevant features that may not be evident from the documentary records. Mapping may be used to obtain a basis for the conceptual ground model, or it may be of a more specialist nature aimed at a particular feature of the site, such as the extent of soft or waterlogged ground, a suspected contamination source such as a spoil tip or former landfill, the morphology of an old or active landslide, or other geohazard.

Specialist mapping may be carried out at any stage of a project and might consist of one of the following:

- Geomorphological mapping for geotechnical/asset management purposes;
- Resource maps for extractive industries and hydrogeological purposes;
- Contamination delimitation for geo-environmental purposes; and
- Structural geological mapping for rock slope design.

9.2 Field Work

Field experience is one of the most important aspects of an Engineering Geologist's training and it is the specialist skills in this area that often distinguish the Engineering Geologist from other ground specialists. Accurate and detailed field observations and the recognition of the geological and ‘man-made’ processes which affect the site are often crucial to the effectiveness and the safety of the final design.

9.3 Mapping and its Interpretation

It is essential that an Engineering Geologist demonstrates ability to record and present data in the form of plans, sections and three-dimensional models derived from systematic engineering geological mapping. The mapping may be factual or interpretative, with the difference clearly indicated, and should always include a key to symbols, north point, grid and scale. Experience should be gained at working at a variety of scales depending on the size of the site and the degree of detail required. An ability to think in three dimensions and to recognise the effects of natural and man-made processes are essential elements of the technical skills of the Engineering Geologist.

10 SECTION D – DESIGNING THE INVESTIGATION

10.1 Introduction

An Engineering Geologist must regard a ground investigation as an iterative process and not attempt to follow a predetermined plan. The results must therefore be continually re-evaluated as work progresses and used to plan subsequent, more detailed, or infill investigations, particularly if subsurface conditions are complex, or not as anticipated in the initial desk study.

All Engineering Geologists must have a detailed knowledge of the more commonly used site investigation methods and be able to supervise and control the works and carry out a progressive interpretation of the data.

The Trainee will also need to be aware of requirements that are being developed by other professionals with different project responsibilities. The Trainee should acquire skills in liaison and cross disciplinary working to avoid duplication of effort, to resolve any inconsistencies in interpretation, to identify where investigations can usefully be combined, and to identify information collected by others which could usefully be included in the conceptual ground model being created by Engineering Geologists.

10.2 Requirements of the Investigation

A ground investigation is required to develop the conceptual ground model and form an observational ground model on which future design work will be based and to provide the parameters required for the design. The Trainee will require knowledge of the project as well as an understanding of the conceptual ground model derived from the earlier studies in order to plan a successful and cost effective investigation.

Planning the investigation should address three fundamental questions:

- What is already known about the site?
- What is the proposed development (nature, size and effect on the ground)?
- What further information is required at this stage of the design (feasibility, preliminary, detailed design)?

Ideally the investigation should be carried out in stages, with the results of each stage being used to plan the subsequent work. Each stage of the investigation must be planned so as to be as flexible as possible to allow for any reasonable changes arising from unexpected ground conditions or changes in scheme proposals.

Investigations should be planned with the above objectives in mind and the Trainee should have a clear understanding of the reason, whether specific or general, for the location of each exploratory hole, and of the ways in which the necessary information will be obtained from each hole.

10.3 Geotechnical Parameters Required

In order to plan an effective investigation, the Trainee will be required to have an understanding of the type of geotechnical parameters that are to be used in design, how the parameters are related to the predicted ground conditions and how they can be obtained from in situ testing and sampling for laboratory testing. Implicit in this is an appreciation of any shortcomings of the chosen methods, of the quality of samples that can be obtained by various methods and the likely effects of sample disturbance on the testing.

10.4 Geoenvironmental Parameters Required

As for the geotechnical parameters the Trainee is required to have knowledge of the previous industrial land uses of the site so that an appropriate and targeted investigation can be carried out to characterise the geoenvironmental aspects of the site. It is important that the Trainee understands the importance of receiving specialist input into the design of the investigation to ensure that it meets current technical and legislative requirements for the assessment of contaminated sites. Further details are presented in Section 13.3 and 14.0.

10.5 Mineral Exploration Parameters Required

Geotechnical and geoenvironmental information relevant to quarrying and surface mining projects may be collected at the same time as a general ground investigation.

This Training Guide does not provide guidance on the additional levels of training and knowledge required for geologists working in the extractive minerals industry.

10.6 Groundwater Observations

The Trainee must learn to appreciate the role of groundwater in the conceptual and observational ground models and its effect on the project requirements. He/she must also understand the ways in which groundwater information can be obtained during an investigation and the benefit of long term monitoring and sampling to obtain information that is representative of the equilibrium conditions at the site. The aim of the groundwater investigation should be an understanding of the groundwater table(s), hydraulic gradients, nature of flow and permeability of the ground.

10.7 Ground Gas Observations

Ground gas, as with water, can be an issue particularly on sites close to landfills, contaminated site, marshes, Coal Measures and carbonate rocks and will need to be incorporated into the conceptual ground model. Therefore the Trainee should be aware of these potential issues and be able to design an appropriate monitoring and, if required, sampling regime so that the risks associated with ground gas can be managed.

11 SECTION E - FIELD BASED INVESTIGATION – SAMPLING AND LOGGING

11.1 Introduction

Once it has been decided where investigation is required and what parameters are needed (if necessary in consultation with those engaged in other aspects of the project), decisions can be taken on the most appropriate techniques for obtaining the data. These will all have limitations, for example depending on the ground conditions, quality of samples required, depth of investigation, working area and cost. The Trainee will require knowledge of these in order to determine which techniques to use.

11.2 Sampling

Specifying an appropriate sampling regime for a project requires the designer to have a thorough understanding of what parameters they need for design and the interaction and relationship of sampler types to sample quality classes (see British Standard BS 5930:2015 *Code of practice for ground investigations* and BS EN ISO 1997–2 *Eurocode 7 Geotechnical design. Ground investigation and testing*).

There are a range of samplers available for use in the UK, and many have specific uses and limitations. The designer must be able to demonstrate that they have a good understanding of the relationship between material types (soil and rock), and the various samplers that are available.

11.3 Description and Classification

An Engineering Geologist must be able to use standard descriptive terminology for soils and rocks to present detailed and consistent trial pit and borehole logs to recognised standards. There is a clear distinction between geological logs and geotechnical (engineering) logs and all Trainees must become competent at the descriptive process so that they can both prepare and understand logs and records that have been prepared by others.

The Trainee should develop an understanding of the various systems that are available for classifying engineering characteristics of particular rock types and become familiar with the use of some of those used in his/her area of work.

Reference to available standards, such as British Standard BS 5930:2015 *Code of practice for ground investigations* and BS EN ISO 1997–2 *Eurocode 7 Geotechnical design. Ground investigation and testing*, would be expected.

12 SECTION F - FIELD BASED INVESTIGATION – TESTING

12.1 General

In addition to being able to specify appropriate samplers and sampling regimes, the Engineering Geologist should acquire the knowledge to be able to specify in situ testing techniques. For many ground investigations it will necessary as well as desirable to specify in situ testing as a means of deriving ground parameters.

There are a large number of in situ test types for soil and rock, some of which are simple, whilst others are complex. For this reason the Engineering Geologist will be able to interpret test data for some tests and not for others. The more complex tests such as pressuremeter testing and geophysical testing are often undertaken by specialist contractors who will provide an analysis of the data and who will derive material parameters.

Normally, Engineering Geologists will become familiar with the simpler test types first and will understand what they are, how and when they should be applied and what parameters can be derived from them. Whilst it is not necessary to have undertaken the tests personally, there is an advantage in having seen the tests performed and also working with the data.

12.2 Groundwater Testing

There are fewer field based tests relating to ground water than for soil and rock. Nonetheless the Engineering Geologist will be expected to be able to specify and schedule various tests to help determine and understand the ground water regime at a site.

As for soil and rock tests the Engineering Geologist should be able to understand how the tests are performed, what applicability they have and also what types of parameters they can derive. Trainees should also be able to show an understanding of which tests can be used in different types of exploratory holes.

13 SECTION G – LABORATORY TESTING

13.1 Introduction

An Engineering Geologist will frequently be asked to schedule the laboratory testing for a ground investigation. In order to do this effectively he/she should have knowledge of the soil and/or rock properties that are required, how they can be obtained and the way in which they will be used in characterising the soil and/or rock and in design. In acquiring these skills the Trainee should appreciate the effects of sample disturbance, how representative the sample is likely to be, and the probable rate of deterioration of the sample.

The above comments apply equally to environmental testing and in this case relate not just to soil and rock, but also to groundwater and ground gas.

An understanding of laboratory test scheduling can be gained by attending specialist courses or by studying previous reports, but work place training leading to experience of scheduling tests and the subsequent application of the test data often constitutes the best training. It is particularly beneficial if the Trainee can also obtain 'hands on' experience of testing in a laboratory.

Where testing is required to meet specific objectives that fall outside of your own area, then it will be necessary to engage the advice or services of a specialist to ensure that the correct testing is completed to obtain relevant data for the project.

13.2 Soil and Rock Testing

In scheduling soil and rock testing, BS EN ISO 1997–2 *Eurocode 7 Geotechnical design. Ground investigation and testing*, requires the designer to start by considering the structure and parameters required for design. This process will inform the type or quality of sample required for test. As noted previously it is important for Trainees to understand this process and be able to demonstrate that they understand the relationship of soil and rock parameters in relation to individual test types (see also analysis and interpretation).

Testing will normally be undertaken in accordance with the British Standards, but Trainees should be aware of other standards that are sometimes used in the UK for specific projects and these include ASTM and ISO standards. For rock testing reference should be made to standards published by the International Society for Rock Mechanics (ISRM).

For geotechnical testing an understanding is also required of the stress changes that will occur during construction and any relevant details regarding the method of construction and/or proposed use of the site.

Testing for large earthworks schemes also requires a good knowledge of the appropriate earthworks tests, not least the large quantities of material that are required.

For rock quality testing (in relation to extraction of geo-materials), an understanding of standard aggregate or other tests and the acceptance criteria relevant to the end-use of those products or the market is important.

Guidance on laboratory testing is provided in the AGS guide 'An Introduction to Geotechnical Laboratory Testing for Routine Construction Projects' (2016).

13.3 Environmental (contamination and other chemical) Testing

For contamination testing an understanding of the type of contaminants likely to be encountered based on the previous industrial uses, construction methods likely to be used, the requirement to remove waste material and the proposed end use need to be taken into account.

In view of the onerous risks associated with contamination aspects of site development, it is recommended that Engineering Geologists should seek assistance form appropriately qualified environmental scientists / chemists when geoenvironmental test scheduling is required.

There are other chemical tests relating to the design of concrete mixes that Engineering Geologists are required to become familiar with. The tests associated with concrete design are cover by BRE guidance document SD1.

14 SECTION H - GEOENVIRONMENTAL SITE INVESTIGATION AND MANAGEMENT

The geoenvironmental industry has grown in size and complexity over the past decade. In order to equip professionals to deal with these complexities, many higher degree courses are now offered by HEI's. Additionally, many companies now have specialist sections that deal with the environmental aspects of site development.

For these reasons, this Training Guide does not go into significant depth on geoenvironmental matters, and assumes that professionals working within the geoenvironmental profession, will pursue different training paths.

It is recognised however, that many ground investigations are undertaken in order to address both the geotechnical and geoenvironmental aspects of a project. For this reason, this Training Guide does provide certain key topics that Engineering Geologists might be expected to become familiar with. Training Supervisors / Mentors, should not however expect Trainees to achieve the 'competence' category for all of the items listed and indeed, there will be some items for which the achievement of the 'experience' category will be sufficient.

It is recommended that when embarking on this training scheme, both Training Supervisor / Mentor and the Trainee should agree which aspects of this section are key / critical to the Trainee's role.

15 SECTION I - INTERPRETATION AND ANALYSIS OF DATA

Data will arise from a variety of sources and at several stages of an investigation. This data needs to be recorded, manipulated as necessary, and analysed to extract the required information and parametric values. Data analysis may be used to reappraise and refine some aspect of the ground model for further analysis or be used directly in engineering design.

Training in this area should give an appreciation of the sufficiency and reliability of the data, an understanding of the most appropriate method of analysis and the meaning of the results as they relate to the project requirements and the site conditions. Data to be analysed can be presented in a variety of ways and come from a variety of sources such as these listed below:

- Information on geological surfaces such as 3D point data or contours;
- Laboratory or field test results in tabular or graphical form;
- Geophysical information in plan and section;
- Groundwater or pore water pressure monitoring information as time sequence graphs; and
- Remote sensing imagery as annotated maps.

Key skills required in data analysis are listed below and the Trainee should be able to demonstrate competence in a variety of techniques. Typically these processes provide the basis for detailed geotechnical design.

The Trainee should develop a critical consideration of the approach to be adopted for each specific project and data set, for example whether to analyse data in relation to ground level, reduced level or depth below a marker horizon, rather than working to a formula. The Trainee should develop an appreciation of the distribution of data and the extent of natural variation and hence be able to identify the effects of sample disturbance and the presence of rogue results and to differentiate real and meaningless statistical relationships.

When using analytical software, the Engineering Geologist must:

- have a clear appreciation of the assumptions implicit in a particular programme and an understanding of the way in which the program works;
- Use appropriate software with an understanding of the principles, assumptions and an appreciation of the sensitivity to the input variables;
- Critically appraise the model outputs to ensure the analyses are appropriate and the results are correct;
- develop skills in systematically or spot checking the input data, underlying assumptions and results as appropriate; and
- the Trainee should learn to undertake analyses ‘long hand’ to develop his/her skills in checking input to and output from computer programs.

16 SECTION J – GEOTECHNICAL DESIGN

It is vital that Trainees get some exposure to geotechnical design, the limitations of the conceptual / observational / analytical ground models and associated data (levels and ranges of uncertainty associated with given parameters in the model). Knowledge and/or practical application of geotechnical design for the following elements would be expected, but not limited to:

- Shallow foundations;
- Piled foundations;
- Deep excavations and bulk earthworks;
- Slope stability;
- Dewatering; and
- Retaining structures.

Where inter-disciplinary elements arise throughout the design process, advice from specialists should be sought. For example, dewatering of excavations is a necessary consideration during geotechnical design of basements, however, the process could benefit from engaging a hydrogeologist for their input to the design and ground model through the different development stages.

The Trainee and Training Supervisor / Mentor, should at the outset agree on the likely degree of involvement that the Trainee will have in design. If this turns out to be minimal, then every effort should be made by both supervisor / Mentor, to arrange some minimal training on these matters. This could be in house training via courses or simply guided learning by the Training Supervisor / Mentor for the Trainee.

17 SECTION K – HYDROGEOLOGICAL DESIGN

Hydrogeology is, rightly, a specialism in its own right and the key skill for the Engineering Geologist is to recognise when to seek specialist assistance. The proper consideration of groundwater in the process is essential to good design and the management of risk.

Hydrogeologists may use the term 'conceptual site model' in place of the conceptual ground model and observational model, but for consistency with common acceptance within the Engineering Geology profession, the term conceptual ground model and observational ground model is maintained in the Section.

Hydrogeological Design, as with all geological design works should start with a robust conceptual ground model, which is based initially on a desk study and then refined and strengthened with site specific-testing to develop an observational ground model. The initial conceptual ground model may need to be highly conservative in areas where there is no readily available data relating to, for example, water levels.

Key elements that a Trainee Engineering Geologist should understand are:

- Groundwater (in the sense of water that is able to flow in meaningful amounts) may be present in a number of layers in the subsurface;

- The groundwater in each of these layers may be hydraulically connected or may be isolated by the presence of low permeability layers (aquicludes or aquitards). Each of these layers may have a separate water table of piezometric surface associated within it and these need to be considered separately.

- Where such separation exists significant pore pressures may build up in confined systems.

- Water in separate layers may have very different quality and this requires consideration within any design.

- Groundwater is not static – it is almost always flowing in response to a hydraulic gradient in accordance with Darcy's Law. Engineering features that may impact upon this flow must be considered to ensure that there are not unintended consequences elsewhere (e.g. groundwater flooding)

- The water table (or peizometric surface in Confined aquifers) is not static in time. It will almost always move in response to the seasons, commonly showing a significant lag (i.e. the groundwater high may be several months after the wettest period). Close to the sea the aquifer may response to tidal variation. Close to rivers it may response to flood conditions. A conceptual ground model developed for engineering purposes must identify these potential effects and ensure that the data collected is suitable for use.

- Hydrogeological design therefore needs to identify the sources of water that impact upon the wider design process, recognise whether control will be required during construction or during use and then consider how to achieve this.

- Solutions to engineering challenges created by groundwater must be founded on a conceptual ground model that properly identified the hydrogeology of each geological unit and the interaction between them.

- Numerical modelling will only provide a good design tool when based on a robust, well founded observational ground model. In particular, boundary conditions to the model have a very significant effect on the model outcomes. Often defining these boundary conditions will require data over a significantly larger area that would be required for a similar geotechnical problem. It is highly recommended that specialist advice is sought.

Hydrogeological understanding is also required to address land contamination in accordance with the UK regulatory framework.

18 SECTION L – CONSTRUCTION EXPERIENCE

It is strongly recommended that the Engineering Geologist gains some experience of construction processes in order better to understand the practicalities of design options. Not all firms can provide site experience as part of a Trainee's normal employment and time may have to be specifically set aside for site observation, or an opportunity sought for secondment to a firm involved in a suitable construction project.

19 SECTION M – CONTRACT MANAGEMENT

The management of contracts within the civil engineering industry is a key element of any Engineering Geologist's training. It is acknowledged that in practice this is unlikely to comprise the management of major civil engineering schemes, but could include both the management of ground investigation contracts and minor build projects. It could also include the management of projects that comprise remedial design and construction.

Trainees working within the contracting and consulting parts of the industry can gain the necessary experience via progressively getting more involved in contracts. This would normally start with the management of an element of a project and progress to the management of an entire small project. With time, Trainees would be expected to have managerial control of larger and more complex contracts.

It follows from the above comments therefore, that the Trainee's employing company, must make every effort to ensure that the Trainee has the opportunity to manage contracts during their training period leading up to Chartership.

20 SECTION N – RISK ASSESSMENT AND RISK MANAGEMENT

In most industries today, risk assessment is a common tool to ensure that design risks associated with a projected are reviewed and managed appropriately. The conceptual ground model provides the Engineering Geologist with an appreciation of the risks associated with a particular project. The Trainee should be able to identify key risks associated with design, construction and maintenance phases of a project, including risks that might affect safety, cost and programme.

The risk assessment should be carried out at the earliest opportunity and is generally started as part of the desk study phase; this is then reviewed as each stage of the site investigation process is undertaken.

The Trainee should be able to carry out both qualitative and quantitative risk assessments to determine the extent to which mitigation measures will reduce the risk. Typical mitigation measures may include additional or specific desk studies or ground investigation, monitoring before, during and after construction and, defining contingency measures which can be prepared and ready for deployment when required. The Trainee should be able to manage the mitigation of risks for aspects of work for which he/she is responsible. The Trainee should gain experience in drafting and maintaining a risk register as a live document throughout the life of a project.

If a Trainee is working within a particular specialism, then they will need to identify when input should be sought from others with specific expertise in fields that may require assessment as part of the project objectives. For example, a geotechnical focussed Trainee may require input from a contaminated land specialist and / or hydrogeologist to adequately characterise and assess the associated risks at a site.

Trainees working in the quarrying and open pit mining sectors would be expected to carry out their risk assessments (and hazard appraisals) relating to the design and monitoring of quarry excavations, tips and related structures in accordance with the requirements of the Quarries Regulations (1999). Key hydrogeological risks arise from failure to properly develop a conceptual ground model and understand the spatial and temporal variability of groundwater.

REFERENCES

Geological Society (2013) Criteria and Procedure for Validation as a Chartered Geologist. R/FP/2. Issue 10. 27 November 2013.

Geological Society (2013) Criteria and Procedure for Validation as a Chartered Geologist. R/FP/11. Issue 6. 27 November 2013.

British Standard BS 5930:2015 Code of practice for ground investigations

BS EN ISO 1997–2 Eurocode 7 Geotechnical design. Ground investigation and testing

Association of Geotechnical and Geoenvironmental Specialists (AGS) guide 'An Introduction to Geotechnical Laboratory Testing for Routine Construction Projects' (2016).

BRE Guide. Concrete in aggressive ground (Special Digest 1) (2005 ed)

APPENDICES

APPENDIX A – OBJECTIVE TABLES A TO N

NOTES

The objectives are sub-divided into sections:

A	Core Skills
B	Desk Study
C	Engineering Geological Mapping
D	Designing the Investigation
E	Field based Investigation - Sampling and Logging
F	Field based Investigation - Testing
G	Laboratory Testing
H	Geoenvironmental Site Investigation and Management
I	Interpretation and Analysis of Data
J	Geotechnical Design
K	Hydrogeological Design
L	Construction Experience
M	Contract Management
N	Risk Assessment and Management

Health & Safety is covered in Geological Society Publication R/FP/02
CRITERIA AND PROCEDURE FOR VALIDATION AS A CHARTERED GEOLOGIST'

The following levels of attainment have been used:

A	Appreciation; a general understanding of a subject or an appreciation as to how to undertake an activity
K	Knowledge; observation and recall of information or knowing how to undertake an activity
E	Experience; a depth of knowledge of a subject or activity actually undertaken by a Fellow (generally under supervision)
C	Competence; a sound knowledge of a subject or activity actually undertaken by a Fellow without supervision; the Fellow can successfully direct others in the activity

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
A	**CORE SKILLS**					
A1	Explain the complexities of geology and of geological processes in space and time within a stratigraphic framework.				•	
A2	Classify sedimentary, igneous and metamorphic rocks, assemblages and terrains; their mode of formation, field occurrence and engineering significance.				•	
A3	Describe geological structures; their mode of formation, field occurrence and engineering significance.				•	
A4	Interpret the stratigraphic framework of the region in which the work is to be undertaken.				•	
A5	Categorise the Quaternary setting of a given project area and predict the associated sediments, landforms and geohazards present within that terrain.				•	
A6	Recognise and categorise geo-hazards such as; landslides and potentially unstable slopes, mineworkings, dissolution features & compressible soils.				•	
A7	Accurately record geoscience data in the field. For example via preparation of: exposure logs, scan lines, borehole and trial pit logs.				•	
A8	Utilise geoscience information to develop conceptual, observational and analytical ground models which include aspects of:- - *Stratigraphy* - *Lithology* - *Structural Geology* - *Geomorphology* - *Hydrogeology* - *Geo-environmental* - *Geotechnical properties* - *Uncertainty*				•	

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
A	**CORE SKILLS**					
A9	Undertake systematic, geological, engineering geological, geomorphological and other appropriate thematic mapping. Mapping undertaken must include aspects of : - *Geology / statigraphy and geological structure* - *Geomorphology and terrain evaluation* - *Rock mass properties* - *Hydrogeological and hydrological features* - *Geological hazards*				•	
A10	With consideration of the geo-hazards, and their potential impact, prepare and update project Geotechnical Risk Registers throughout the project lifecycle				•	

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	**K**	**E**	**C**	
B	**DESK STUDY**					
B1	Prepare a site specific engineering geological desk study. This may include usage of the following existing data sets:- *- Published and unpublished topographic maps and other plans at relevant scales (including previous editions and historical maps).* *- Published and unpublished geological and applied geological maps* *- Published hydrogeological maps* *- Published geological and geotechnical academic papers, reports, memoirs, guides, monographs and other relevant literature* *- Aerial photographs, satellite images and other remotely sensed imagery* *- Previous technical reports on the site or nearby sites* *- Records of previous borehole or trial pit investigations* *- Well or water monitoring borehole records* *- Mining or other mineral extraction records and plans* *- National geoscience databases* *Internet-based material* *Data in AGS Format*					
B2	Assess the reliability and relevance of such information					
B3	Utilise existing information to develop Conceptual and Observational Ground Models of the site					
B4	Develop a profile of the site history including potential contamination sources, historical structures etc.					
B5	Utilise the ground models to identify potential contaminant sources, pathways and receptors.					
B6	Utilse ground models to identify potential ground or groundwater hazards.					
B7	Utilise the ground models to identify potential geohazards					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
C	**ENGINEERING GEOLOGICAL MAPPING (INC SITE RECONNAISSANCE)**					
C1	Design a structured approach to the mapping.					
C2	Identify the key geological and geomorphological features of engineering significance from the mapping.					
C3	Identify potential contaminant sources, pathways and receptors from the mapping.					
C4	Identify potential ground and surface water issues from the site reconnaissance.					
C5	Undertake field-based mapping including the compilation of thematic maps such as: - *Slope and landslide hazards* - *Potential construction material sources* - *Ease of rock excavation* - *Rock mass properties* - *Engineering geological description* - *Utilise remotely sensed data to assist with site mapping*					
C6	Undertake rock mass characterisation including scanline surveys, discontinuity surveys and general rock mass assessments					
C7	Understand the advantages and disadvantages of using various remote sensing systems.					
C8	Analyse and interpret appropriate remotely sensed data formats					
C9	Utilise these data sets to generate a three dimensional interpretation of the ground to feed into the Ground Models.					
C10	Identify the presence of geological hazards from the mapping.					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
D	**DESIGNING THE INVESTIGATION**					
D1	Design an investigation to evaluate predicted ground conditions and to test and develop the Conceptual Ground Models. Design should address aspects of: - *Geomorphology* - *Sequence of strata anticipated* - *Thickness of strata and variations anticipated* - *Nature of strata boundaries* - *Strata variability* - *Groundwater levels and their variability* - *Contamination sources, their extent and concentration in ground and groundwater, potential contamination pathways* - *Structural geology* - *Proposed engineering to ensure suitable sampling and testing regime*					
D2	Define the methods of investigation including depth range, size and manoeuvrability of equipment, time required, relative costs, capabilities and limitations					
D3	Design ground investigations for a range of engineering projects using appropriate and cost effective methods; preparing cost estimates of investigations.					
D4	Recognise the phasing of investigations to optimise information gathering to suit the stages of a engineering scheme for example route optimisation, preliminary design, detailed design and construction.					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
E	**FIELD BASED INVESTIGATION - SAMPLING AND LOGGING**					
E1	Undertake ground investigation specifying / utilising a variety of sampling techniques, for example: - - *Trial pits and trenches,* - *Window sampling* - *Augering* - *Cable tool percussion* - *Piston sampling* - *Rotary open hole* - *Rotary core drilling*					
E2	Describe and log rock/soil material and rock/soil masses to appropriate / current Standards					
E3	Describe and classify rocks and soils utilising specialist descriptive schemes such as for Chalk, Granite, Mercia Mudstone, London Clay, Glacial Till					
E4	Draw appropriate pit, face and borehole logs to appropriate standards					
E5	Prescribe instrumentation for example: - - *Standpipes and Piezometers* - *Inclinometers and slip indicators* - *Extensometers* - *Pressure gauges and load cells* - *Settlement gauges and tiltmeters*					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
F	**FIELD BASED INVESTIGATION - TESTING**					
F1	Undertake ground investigation utilising a variety of in situ testing techniques, for example: - - *Cone penetration testing* - *Dynamic probing* - *High pressure dilatometer* - *Pressuremeter testing* - *Dynamic probing* - *Shear vane testing* - *In situ density tests* - *Standard penetration testing* - *Plate bearing tests*					
F2	Specify and schedule in situ permeability testing for example: - - *Permeability Testing in Piezometer* - *Permeability Testing in borehole e.g.using packers* - *Infitration Testing* - *Pump testing*					
F3	Undertake ground investigation utilising a variety of geophysical techniques, for example: - - *Seismic reflection* - *Seismic refraction* - *Electrical resistivity / conductivity* - *Magnetometer* - *Gravitymeter* - *Ground penetrating radar* - *Borehole sonde geophysics* - *Crosshole seismic tomography*					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
G	**LABORATORY TESTING**					
G1	Specify and schedule appropriate laboratory testing of soil samples including: - *Classification Testing* - *Chemical Testing* - *Performance Testing* - *Consolidation Testing* - *Shear / Triaxial Testing* - *Effective Stress Testing* - *Permeability Testing*					
G2	Specify and schedule specialist soil testing for example: - - *scanning electron microscopy* - *small strain triaxial testing* - *stress path analysis* - *X-ray diffraction and X-ray florescence analysis*					
G3	Specify and schedule appropriate laboratory testing of rock samples including: - *Classification Tests; e.g. Porosity and Density, Particle Density, Moisture Content* - *Strength Tests; e.g. Uniaxial Compressive Strength, Direct Shear Strength, Point Load Test, Tensile Strength.* - *Other; e.g. Thin section analysis*					
G4	Specify and schedule appropriate laboratory testing of groundwater samples					
G5	Recognise the effects of sample disturbance, the stress and moisture changes that occur in samples with time and how these affect the test results.					
G6	Recognise the effects of sample size and fabric on test results.					
G7	Specify and schedule tests to mirror the stress changes that will occur during construction.					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
G	**LABORATORY TESTING**					
G8	Specify and schedule tests used in assessing construction materials for example: - - *Los Angeles Abrasion test* - *Sulphate Soundness test* - *Aggregate Abrasion Value* - *10% fines* - *Alkali Silica Reactivity* - *Slake Durability Testing* - *Lime Stabilization Testing*					
G9	Specify and schedule tests used in assessing concrete materials for example: - - *Cube / Core Compressive Strength,* - *Carbonate / Oxide / Chloride / Cement Content Testing*					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
H	**GEOENVIRONMENTAL SITE INVESTIGATION AND MANAGEMENT**					
H1	Understand the determination of Contaminated Land under Part 2a of the Environmental Protection Act 1990 and the assessment of land affected by contamination under the National Planning Policy Framework					
H2	Understand the special nature of asbestos on geoenvironmental sites with respect to health and safety, site investigation, human health risk assessment and remediation					
H3	Formulate a tiered risk-based approach to geoenvironmental site assessment					
H4	Develop a geoenvironmental site desk study taking into consideration ground and groundwater conditions, historical mapping and aerial photography, past and present land uses and potential contaminants					
H5	Undertake a geoenvironmental site reconnaissance walkover survey					
H6	Understand the importance of the Conceptual Site Model and Construct a Conceptual Ground Model (ground and groundwater conditions) and a Conceptual Exposure Model (source-pathway-receptor pollutant linkages) for a geoenvironmental site					
H7	Design and plan an appropriate intrusive ground investigation of a geoenvironmental site with reference to solids, gases, vapours and liquids including suitable sampling strategies					
H8	Write a Risk Assessment Method Statement (RAMS) for a geoenvironmental site investigation					
H9	Undertake an intrusive ground investigation of a geoenvironmental site including suitable sampling protocols					
H10	Schedule a geoenvironmental laboratory test programme					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
H11	Undertake geoenvironmental generic risk assessments (GRA) for human health, plant life, Controlled Waters, ground gases including radon, building products, etc.					
H12	Undertake higher tiers of risk assessment (Detailed Quantitative Risk Assessment, DQRA) (as above)					
H13	Understand contaminated land remediation methods at the options appraisal level					
H14	Understand the possible interactions between geotechnical and geoenvironmental aspects of a site, which could affect the recommendations made					
H15	Understand the roles of the regulatory authorities, the relevant guidance and principles and liaise with the regulators on a site-specific basis					
H16	Understand the regulations with respect to waste arisings on a geoenvironmental site and the use of the CL:AIRE Code of Practice and Material Management Plans (MMP)					
H17	Write a geoenvironmental site investigation report					
H18	Undertake the design of remedial measures for a geoenvironmental site: engineering-based (excavation, containment, hydraulic) and process-based (thermal, physical, chemical, biological, stabilisation)					
H19	Undertake site work of remedial measures for a geoenvironmental site (as above)					
H20	Undertake remediation verification investigation work and write a verification report					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
I	**INTERPRETATION AND ANALYSIS OF DATA**					
I1	Define the most important engineering geological units and identify any relevant geological processes that could impact the project.					
I2	Analyse site observations and data, interpreting the distribution of the defined units in three dimesions					
I3	Test and if necessary amend the conceptual models based on the site specific data obtained					
I4	Develop observational ground models based on site specific data					
I5	Based on the ground models and the results of field and laboratory data, determine characterisitc material properties for use in assessment and design					
I6	Formulate the problem being evaluated and select a method of analysis that is appropriate.					
I7	Utilise appropriate techniques for data manipulation, analysis and presentation					
I8	Present an intepretation based on the ground models and field and laboratory observations and data in a Ground Investigation Report.					
I9	Estimate and communicate the possible uncertainteis in the models and their limitations. Investigate and understand the sensitivity of the analysis and design method to different assumptions or simplifications.					
I10	Investigate and understand the sensitivity of the analysis and design method to different assumptions or simplifications.					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
J	**GEOTECHNICAL DESIGN**					
J1	Understand and apply Geotechnical Standards, Codes of Practice to design situations.					
J2	Undertake an analysis for different modes of failure appropriate to the design situation and identify the dominant failure mechanism.					
J3	Undertake an analysis for different limit state conditions using appropriate geotechnical parameters					
J4	Undertake a Rock Design including aspects of rock slope stability, rock anchorages & tunnel support, accceptability/ suitability of rock materials					
J5	Undertake quantitative slope stability analysis and design including aspects of circular methods, Non-circular methods, Infinite slope models, Soil nail design, Reinforced soil design,					
J6	Undertake Foundation Design including aspects of shallow and deep foundations, bearing capacity assessment, settlement, short and long term behaviour					
J7	Undertake Retaining Wall Design including aspects of: internal and global stability, bearing capacity / overturning / sliding					
J8	Undertake Advanced Design Techniques for instance Finite element/difference methods					
J9	Preparation of the Geotechnical Design Report					
J10	Preparation of a Geotechnical Baseline Report					
J11	Preparation of a specification for geotechnical works including aspects of earthworks, piles, retaining walls					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
K	**HYDROGEOLOGICAL DESIGN**					
K1	Develop/revise Conceptual Site Model based on results of field investigations					
K2	Undertake and specify a Hydrogeological Design including aspects of well/dewatering design,estimating flow/modelling, geological controls and Screen/filter design					
K3	Specify and utilise appropriate modelling techniques for hydrogeological analysis and conceptual design.					
K4	Identify and specify sustainable materials that can be used in design					
K5	Assess a proposed scheme's impacts on groundwater resources and quality					
K6	Identify appropriate mitigation measures and communicate these effectively.					
K7	Identify and assess potential effects of changes to groundwater on other receptors e.g. Surface water and ecological receptors.					
K8	Understand the concept of effective stress and the role of groundwater therein.					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	**K**	**E**	**C**	
L	**CONSTRUCTION EXPERIENCE**					
L1	Implement / supervise construction activities, for example: - - *Earthworks* - *Foundations (shallow / deep)* - *Slope stabilisation (soil / rock)* - *Retaining structures* - *Deep / underground excavations* - *Reinforced soil* - *Ground Improvement* - *Drainage & Dewatering*					
L2	Specify compliance tests, for example : - - *Pile testing* - *Anchorage testing* - *Earthworks testing*					
L3	Define the circumstances that may lead to variation in contract cost or construction period and the need for procedures to maintain site records on which to evaluate these circumstances.					
L4	Appraise the problems involved in the practical application of design and theoretical studies to construction					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
M	CONTRACT MANAGEMENT					
M1	Describe the duties and responsibilities of the parties in a contract and the role of the participants in the work (the Engineer, Supervisor, etc)					
M2	Explain the components, purpose and practical application of tender documents, the tendering process and award of contract					
M3	Explain the use of technical specifications for geotechnical activities such as ground investigation, quarry workings, grouting of mine workings and earthworks					
M4	Take off quantities and prepare bills of quantities using appropriate methods of measurement					
M5	Explain the system for recording data issued to and received from the contractor					
M6	Describe the contractor's organisation and the main duties of the contractor's staff					
M7	Detail the procedures for measurement, valuation and certification of payments					
M8	Describe the circumstances that may lead to variation in contract cost or construction period and the need for procedures to maintain site records on which to evaluate these circumstances					
M9	Define the problems involved in the practical application of design and theoretical studies to construction					
M10	Supervise geotechnical operations (which may be investigation or construction) on site, including their organisation, control, monitoring and conformance with the specification					

Training Objectives		Date of Assessment and Level of Attainment				Comments
		A	K	E	C	
N	**RISK ASSESSMENT AND RISK MANAGEMENT**					
N1	Identify sources of geotechnical hazard / uncertainty such as: - *Geological variability* - *Site history / use* - *Hydrogeology and hydrology*					
N2	Quantify ground related hazards in terms of their associated impact on, for example: - - *Health and Safety* - *Cost & Programme* - *Quality & Environmental*					
N3	With consideration of the geo-hazards, and their potential impact, and mitigation measures, prepare and update project Geotechnical Risk Registers throughout the project lifecycle.					
N4	Effectively communicate Geotechnical Risk to the Client, Designer and Contractor.					
N5	Recognise the Client's role within the risk management framework including: - - *Setting the objectives* - *Defining risk tolerance* - *Seeking geotechnical advice* - *Establishing and managing the Geotechnical Risk Register*					
N6	Recognise the Designer's role within the risk management framework including: - - *Hazard and risk identification* - *Risk mitigation measures* - *Development and application of Risk Registers* - *Systematic risk management*					
N7	Recognise the Contractor's role within the risk management framework including: - - *Application of Risk Registers* - *Risk ownership* - *Means / methods to manage risk.* - *Review procedures*					

APPENDIX B GUIDE TO EMPLOYERS

OBJECTIVE OF THE GUIDE

The objective of the Training Guide for Engineering Geologists is set out in full in the Introduction to the Guide. In brief, it has been produced to outline the type of experience and training desirable for an Engineering Geologist in his/her formative years and to provide a whole career record of training and skills achievement.

The aim of the training is to assist the Trainee to develop the appropriate skills and adherence to good practice that will make him/her an Engineering Geologist who is a competent professional of wide experience and a credit to him/herself, his/her employer and the profession.

The implementation of the Training Guide need not entail significant cost or loss of income to an employer since it should be possible to provide most of the training within the framework of project work. Any costs that are incurred should be more than offset by the value to the company of an increasingly competent, well-motivated, Engineering Geologist.

The Employer's Role

The Training Guide sets out a framework of desirable experience. It is written in terms of general objectives so that it can apply to a wide variety of organisations and individuals with a range of relevant experience. The training and experience is to be provided by the employer and the appointed Training Supervisor based on the outline of objectives given in the Training Guide.

Ideally the Training Supervisor / Mentor will be in the same company as the Trainee, in which case the Training Supervisor / Mentor is expected to negotiate with line managers to ensure that the Trainee is given appropriate experience to facilitate his/her training, if not, the Trainee will need to negotiate assignment to appropriate projects directly with his/her manager. The manager will then ensure that the Trainee is given appropriate instruction and supervision. It is appreciated that the Trainee may be the only Engineering Geologist in the company, in which case the Training Supervisor / Mentor may have to discuss the training requirements with the employer in order to ensure that the employer has a full understanding of the objectives of the training programme as set out in this Guide.

The employer will need to be familiar with the basic requirements of the Guide. He will then need either to plan in advance how the various topics can be covered in, say, a 5 year period, or take the opportunities as they arise on individual projects to assign the Trainee to work on aspects not so far addressed.

The Training Guide is written in general terms to cover the very wide range of types of organisation in which Engineering Geologists are employed and the wide range of areas in they are active. An individual employer may wish (and is encouraged) to produce his own company specific Training Guide. The Geological Society is prepared to review any such document and give formal approval to signify that it meets the requirements set out in this guide. A company specific guide may be written in the format of this Training Guide but with more specific objectives replacing general ones.

A company’s Training Scheme should include

i. A description of the company's objectives and organisation

ii. The training policy of the company and the specific commitment to training.

iii. The Training Objectives, both general and company specific should be clearly defined and must include all the Core Skills as listed in this Training Guide. There is, however, wide scope for specifying exactly how these should be achieved within the operating environment of any one company. Other company specific objectives may replace non-core objectives in the Training Guide but in every case the objectives should be clearly stated together with a clear pathway as to how they are to be achieved. The company may either carry out its own assessment of the level of achievement or it may rely on the quarterly review by the Training Supervisor / Mentor.

iv. Procedures for the Trainee to obtain continuing education and training both taught and in the workplace.

v. Review procedures and the Trainee's probable internal movement within the company, including any secondments.

vi. The role and authority of the line managers and Training Supervisor / Mentor in terms of planning and managing the training programme.

The employer is expected to provide opportunities for the Trainee to attend conferences and courses and to pay any necessary fees or expenses. Many companies, universities and institutions run evening lectures, workshops of half day to 2 or 3 days or longer conferences.

The Trainee should take advantage of training courses such as those run by the Geological Society on various geological formations, on report writing and expert witness. The ICE covers subjects such as Contract Law, Health and Safety and Design Methods. The Trainee is also expected to engage in background reading in his/her own time.

The aim of this Guide is to give broad experience that will provide an appreciation of the many facets of the Engineering Geology and ensure a suitable standard in the Core Skills. In writing the Guide in general terms, it is hoped that an individual will not have undue difficulty meeting the requirements whilst remaining in one company. However, it may be that the work of a company is so specialised that whole sections of the Guide cannot be covered. In this case it will be necessary to arrange secondment to another company for the Trainee to gain the necessary experience.

Any questions concerning how to apply the Training Guide should be addressed initially to the Training Supervisor / Mentor.

APPENDIX C SUMMARY OF REQUIREMENTS FOR CHARTERED STATUS

The requirements for Chartered Status are set out in the Geological Society's regulations: R/FP/2 (CGeol) and R/FP/11 (CSci), but broadly the general requirements at the time of publishing this Training Guide are:

1) You must be a Fellow of the Society;
2) You must hold a recognised Honours (H) degree or equivalent qualification in geoscience. Fellows without a geoscience degree are eligible for validation but they must be able to demonstrate a minimum of 12 years' experience practising in geoscience for CGeol, or a recognised degree or equivalent qualification in science at M-level; or have post-graduation experience to demonstrate M-level attainment for CSci;
3) You must have relevant, post-graduation experience in the profession and practice of science and demonstrate the required competencies;
4) You must be supported by two sponsors who should normally be Chartered Geologists or Scientists as appropriate;
5) You must have submitted a complete application;
6) You must have satisfied the Society that you meet the above requirements for validation through a Professional / Validation Interview; and
7) You must have paid the required application fee.

In connection with Item 2, you need to have a certain number of years' relevant post-graduate experience in the profession and practice of geology (CGeol) or science (CSci). For the majority of Applicants, the requirement will be for at least five years relevant post-graduation experience. However, to find out how many years post-graduate experience you will need, please see the following website link:

https://www.geolsoc.org.uk/Membership/Chartership-and-Professional/Applicants/Chartership-Eligibility