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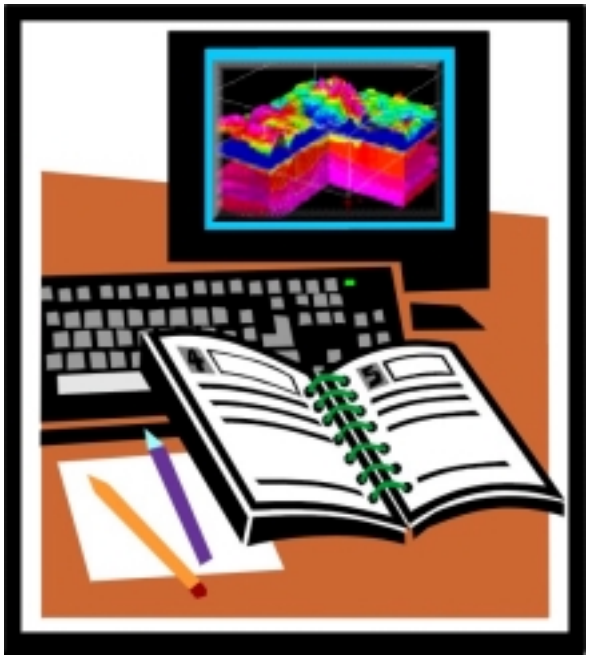
Digital Geoscience Spatial Model (DGSM) - Best Practice Guidelines

DGSM Programme

Internal Report IR/02/0156



BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/02/0156

Digital Geoscience Spatial Model (DGSM) - Best Practice Guidelines

AA McKenzie

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DGSM, Best Practice, Quality, Inference Metadata.

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Foreword

This report was produced as part of the Best Practice sub-project of the DGSM Framework project.

The objective of the DGSM Framework project is to define corporate strategies, structures and procedures within which geospatial models can be developed, archived and linked to associated data and knowledge.

Eleven sub-projects have been defined that together are planned to fulfill this objective:

- Data Architecture
- Metadata
- Data Warehouse (Object store)
- Application development
- Software standards
- Data linkages
- DGSM Policies
- Authoring
- Best Practice
- Training
- Maintenance

These projects will be tested by studies carried out under the parallel DGSM-UK (the population of the DGSM).

The Best Practice sub-project was tasked with developing a system for recording and disseminating best practice for the DGSM to contribute to maintaining DGSM quality standards.

Acknowledgements

Many staff assisted in the development of the concepts of Best Practice outlined in this report through discussions and through participation in DGSM workshops. The work of Shaun Reeder in developing concepts of Quality Management for the DGSM, and of Richard Shaw and Ian Smith for constructive comments and suggested approaches has been particularly helpful.

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Summary

As part of the DGSM component ‘Best Practice and Modelling Systems’ this report discusses how a system for preparing, managing and disseminating best practice can be implemented.

Best Practice, within the context of the DGSM, is defined as ‘sets of procedures that have been found, by experience, to be reliable and cost effective at providing solutions to the technical aspects of geoscience modelling’. This is designed to allow a wide adoption within BGS of those geological modelling practices which have worked well, and have produced successful results, contributing to staff training, the development of scientific consensus and quality.

Best practice forms just one component of a quality system for the DGSM, underpinning project specific, BGS wide, quality assurance procedures that address the administrative elements of a project. It will also be a support for project data management plans, and underpin the recording of inference metadata.

Best practice documentation will be classified hierarchically, with generic ‘Operating Procedures’ based on a structured DGSM workflow and ‘Task Specific Procedures’ that may be specific to a particular geological environment, a particular software package or to a specific dataset.

For best practice to be useful clearly it must be documented, but it must also be accessible to users. Three types of documents are proposed, which will be prepared by experts but subject to open review by interested staff.

- Best practice checklists
- Best practice guidelines
- Supporting reference material

Sets of standard templates for recording and disseminating best practice have been prepared. These will be supported by an Oracle database of best practice, allowing direct access to documents via the Intranet.

1 Introduction

This report has been prepared as part of the DGSM component ‘Best Practice and Modelling Systems’. This component of the DGSM project seeks to develop an understanding of issues surrounding the errors and uncertaintities in the computation of spatial models and the consequent confidence that might be placed upon them, to provide guidance on and to co-ordinate Best Practice standards to be used in the DGSM, and to implement procedures and documentation for carrying out the work.

What do we mean by best practice? Best practice is not designed to provide the definitive answer or methodology in a particular case, but rather it should represent a consensual guideline to the solution of a particular problem, or the implementation of a particular methodology. As such it is just one component in a quality management system for the DGSM.

This report outlines a framework for best practice, reviewing the relationship between best practice and other aspects of DGSM quality, such as quality assurance, data management and metadata. It outlines the suggested scope of best practice, and gives guidelines for preparation, review and dissemination of best practice documentation, sets out a structure for the preparation, management and dissemination of best practice for the DGSM. The IT systems required to support best practice are reviewed, and the appendixes contain templates for best practice documentation and examples.

2 Framework for Best Practice

Best Practice, within the context of the DGSM, is defined as ‘sets of procedures that have been found, by experience, to be reliable and cost effective at providing solutions to the technical aspects of geoscience modelling’

The purpose of defining best practice for the DGSM is to allow a wide adoption within BGS of those geological modelling practices which have worked well, and have produced successful results, recognising that the extensive use of the DGSM will lead to a large community of DGSM practitioners within BGS, and a real danger of lessons learnt within one project not being passed on to other projects.

Definition of best practice will contribute to training, consensus and quality:

1. Providing an overview of the fundamental steps needed to carry out a task – this will be important for training staff in DGSM modelling techniques. It will also assist non-modelling staff in understanding how models have been developed.
2. Ensuring the consistent application of methods across a range of projects, and the exchange of experience and technical expertise between modellers who may be working in isolation. This is designed to develop a consensual approach to modelling, and avoid the ‘reinvention of the wheel’.
3. Ensuring appropriate standards of quality, as required to ensure that a project meets client expectations, that data and models can be reused with confidence in future projects, and that models are documented and have a comprehensive audit trail. Best practice will also contribute to the maintenance of DGSM metadata, especially inference metadata, by allowing interpreters to reference standard methodologies, where appropriate, by quoting the relevant best practice.

DGSM best practice is expected to cover issues such as data compilation, surface interpolation, structural interpretation, visualisation and reporting. These topics are expanded on below in Section 4 of this report.

While ‘best’ implies that there should be one approach to each case, the heterogeneous nature of BGS work, varied scales, and differing geologies imply that best practices may need to be tailored to particular environments. To handle this there will be a hierarchy of best practice, with a top level of generic procedures that should be applicable in any environment, supported at a lower level by procedures specific either to a region, geological setting, or a particular hardware/software platform.

Best practice, to be useful, requires documentation that is disseminated to all users, and that can be easily acted upon. This documentation needs to be evaluated to ensure that it benefits users through the provision of one or more of cost effectiveness, time saving, proven performance or ease of implementation. To maintain its value, and to maintain consensus, mechanisms are required for peer review, for comments and for updating best practice in the light of experience and technical developments.

Recognizing the evolving nature of best practice, to allow best practice to contribute to inference metadata, version control of best practice documentation will be important.

3 Relationships with other DGSM Guidance

3.1 BEST PRACTICE AND QUALITY ASSURANCE

Best practice, and best practice documentation is one component of a quality assurance system for the DGSM, however guidelines for best practice are not synonymous with quality assurance procedures.

Best practice is designed to share knowledge and experience within an organisation. Best practice, especially in novel and rapidly developing fields, such as the DGSM, is likely to be evolving, and care needs to be taken to ensure that adherence to best practice does not stifle innovation. Nevertheless best practice can be used to set a basic standard that will be adhered to within a particular project, and this may be specified within the project specific quality assurance procedures.

The overall framework for quality management within the DGSM has been reviewed in two internal reports, the first setting out general quality issues associated with the DGSM and the second addressing Quality Assurance requirements. (Reeder 2000 and Reeder 2002).

It is anticipated that there will be a hierarchical structure for quality assurance. At the top level quality procedures relating to project management are defined within the standard framework for quality assurance of all BGS projects. It is likely that all projects associated with the DGSM will conform to these procedures. At lower levels quality assurance will make use of operating procedures; second level guidelines covering generic DGSM methodologies, and third level best practice guidelines that may be specific to a particular geological environment or hardware/software platform. Each project will require a project plan that will specify the extent to which best operating procedures practice guidelines will need to be followed, taking account the project purpose, and hence the degree of quality assurance required (and affordable).

Figure 1 – Hierarchal structure for DGSM Quality Assurance

3.2 BEST PRACTICE AND DATA MANAGEMENT

The British Computer Society has defined Data Management as:

> *"The corporate service that assists the provision and operation of information systems by controlling and/or co-ordinating the definitions (format and characteristics) and usage of reliable and relevant data."*

For BGS the key role of data management planning is to ensure that investments in data collection, processing and data storage made by individual projects and programmes are captured for the benefit of both BGS and the earth science community at large. Data management policies cover staff responsibilities, data collection policies, data standards, resourcing of data management, data quality, quality assurance and IPR considerations, and policy on access to data, data dissemination and data marketing.

Within the DGSM data management policy will be applied at several levels – at the macro level an overarching DGSM data policy will document how DGSM related datasets will be managed within a corporate framework. At the micro scale data plans should be adopted by individual DGSM modelling projects; in the first instance by the DGSM pilot projects.

Data Management Plans for DGSM projects are likely to reference best practice guidelines, especially where these cover areas such as metadata and use of DGSM framework facilities such as the Geoscience Large Object Store. Further details on Data Management can be found in Lowe & McKenzie, 1998 and Lowe et al 1999.

3.3 BEST PRACTICE AND DGSM INFERENCE METADATA

The requirements for DGSM Metadata have been set out in Laxton et al, 2001. The DGSM will make extensive use of discovery metadata systems to document both data and models, but will also use 'Inference' metadata. This metadata goes beyond discovery metadata and connects a particular model to a particular data subset and describes the interpretation placed on the data subset, the assumptions made, the interpolation methodology, and the quality of the data subset for the particular model being created

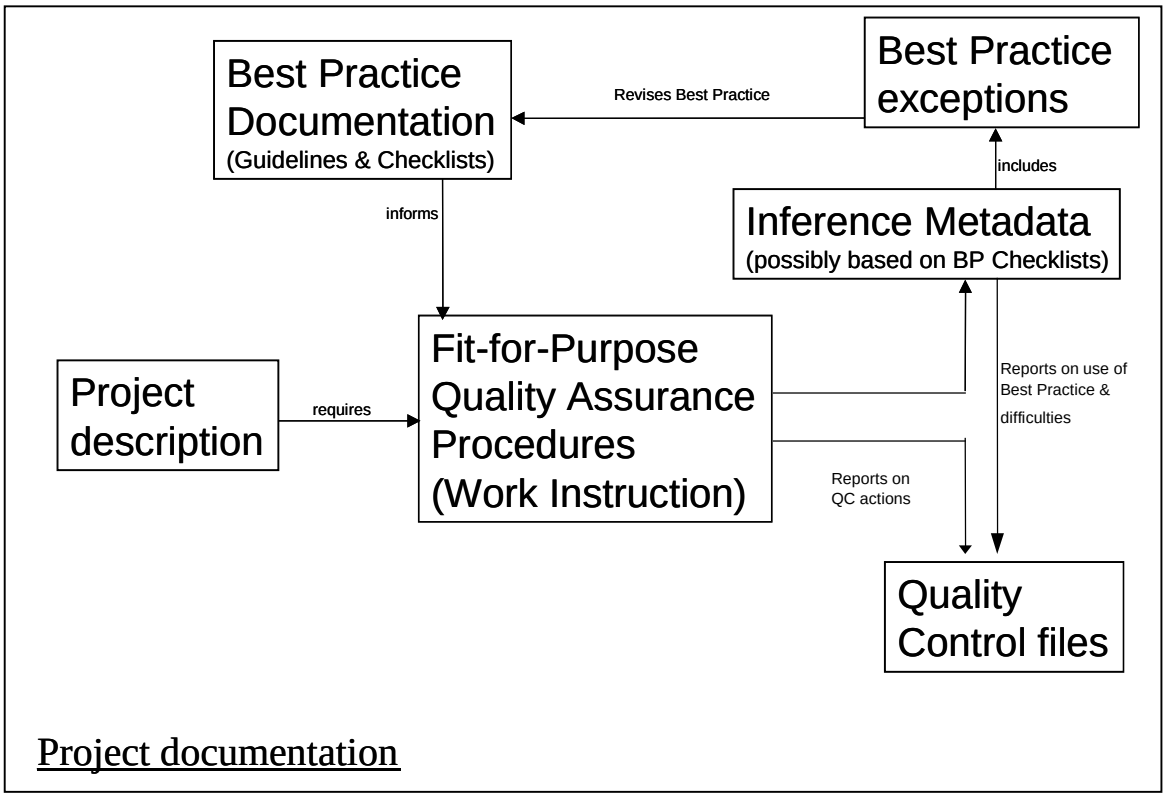
Detailed recording of inference metadata is likely to be extremely time consuming, but in a majority of cases, where standard methodologies are followed, and where these methodologies have been documented as best practice guidelines, it will be possible to reference the guideline directly, and hence limit inference metadata to the documentation of exceptions to standard practice.

The proposed inference metadata specification in Laxton et al, 2001, will need slight modification to allow for explicit reference to version controlled best practice guidelines as an adjunct to the *Interpolation/ modelling process* field.

3.4 DGSM PROJECT DOCUMENTATION

The relationships between Best Practice Guidelines and other DGSM guidance can be summarised by setting best practice within the context of a model documentation cycle for a DGSM project, as set out in Figure 2 below. The project description (plan) defines the Quality Assurance procedures that need to be followed. These Quality Assurance procedures draw on best practice guidelines. As modelling progresses Inference Metadata are generated, and this metadata forms a significant component of Quality Control files for the project. At the same time exceptions to Best Practice, documented as part of the Inference Metadata, will inform the process of revision to Best Practice.

Figure 2 – Relationships between DGSM Project Documentation and Best Practice

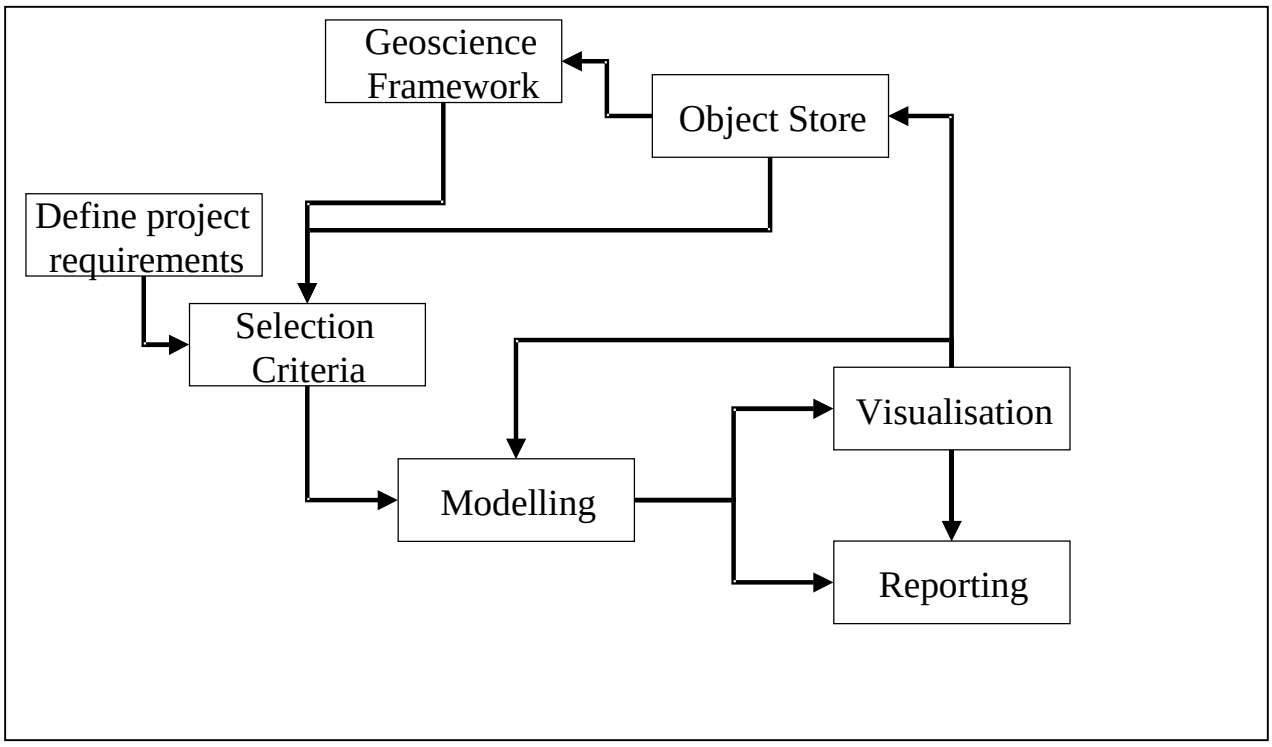


4 Scope of DGSM Best Practice

Best practice documentation will be classified hierarchically

The top-level of best practice will be known as ‘Operating Procedures’. They form the second level of the Quality Assurance hierarchy for the DGSM. At this level procedures will be generic, and will be based on a structured DGSM workflow (Figure 3). Procedures will be prepared for each element of the workflow.

Figure 3 – Structured DGSM Workflow



At the next (third) level best practice guidelines will known as ‘Task Specific Procedures’. These may be specific to a particular geological environment (for instance interpretation of DTMs will require different techniques in the Chalk than in a fluvio-glacial environment) or guidelines may be specific to a particular software package or to a specific dataset. A suggested range of topics for DGSM Best Practice is listed below in Table 1. It is not intended as a definitive list but to indicate the style and range that might be appropriate. Only experience will allow us to judge the extent to which best practice guidelines prepared by different project teams in different geological/software environments can be integrated into pan-BGS best practice, but that will be the ultimate aim.

Table 1 –Indicative Range of Topics to be covered by DGSM Best Practice

Workflow Element	Best Practice
Definition of project data requirements, and selection criteria	Sourcing relevant data for modelling Borehole data selection for Quaternary models Attribution of DiGMap lines with elevation Digitisation of analogue data
Modelling	Surface interpolation from borehole log data Use of regional DTMs for structural interpretation Modelling with geophysical data Integrating onshore and offshore datasets Quantifying error in DGSM models
Visualisation	Incorporating vector and bit-map overlays into model visualisations Preparing VRML Models for data distribution Preparing MPEG fly-throughs for presentations Visualisation of DGSM model confidence/error
Reporting	Authoring for XML
	Preparing information for browsing & digital dissemination
Object Store	Preparation of Discovery & Technical metadata Documenting inferences Populating the GLOS
Geoscience Framework	Populating the GSF Integrating data at varied scales

NB This list is indicative of the style and range of topics to be covered. It is not intended as a definitive list.

5 Documenting Best Practice

Documentation will be the principal mechanism for disseminating best practice, and also plays a pivotal role in managing quality.

5.1 A STRUCTURE FOR DOCUMENTING BEST PRACTICE

For best practice to be useful clearly it must be documented, but it must also be accessible to users. That accessibility is not just a matter of dissemination, but also of style and of striking an appropriate balance between detail and readability.

This is probably best achieved through the use of a structured set of best practice documentation. Three types of documents are proposed:

- Best practice checklists- Short (1 page A4 max) checklists, designed for ready reference, and mainly as aide-memoirs to ensure that best practice has been followed for the experienced practitioner. Written to a standard template (see Appendix 1).
- Best practice guidelines- Medium length (but no more than 4 pages A4) will be the main medium for disseminating best practice. Written to a standard template (see Appendix 2).
- Supporting reference material – Referenced by the guidelines, standard internal reports and referenced external publications.

5.2 WRITING UP AND MAINTAINING BEST PRACTICE

It is expected that best practice will be defined and prepared by staff expert and experienced in their field. The definition of 'best practice' adopted for the DGSM includes the concept that it should be consensual; there is little point defining best practice if it is not accepted as best practice by users. Several, albeit anecdotal, instances have been recorded where different approaches to the same problem have been identified by different teams within BGS operating in ignorance of their colleague's efforts. To avoid this there has to be a consensual, participatory, element to the drafting of best practice guidelines. This would appear to be an ideal role for the Intranet.

Best practice guidelines will go through a three-stage process of preparation and review. This process will require approximately 8 weeks, to allow opportunity for interested staff to comment and or contribute as appropriate. There will be nothing to prevent projects using draft guidelines internally during the review and consultation periods if required to maintain progress towards deliverables.

Table 2 –Drafting process for DGSM Best Practice

Stage	Time (Weeks)	Action
1	Start of 1	Best Practice proposal mounted on Intranet
2	1–2	Period for interested parties to contact proposer.
3	2 –6	Drafting of best practice, in consultation with interested parties.
4	Start of 7	Draft best practice posted onto Intranet
5	7 – 8	Period for comments on draft
6	End of 8	Final best practice posted on Intranet

Each best practice guideline will need to have a named ‘owner’ (in the first instance probably the guideline author), and each best practice guideline should be subject to periodic review. It is expected that, at a minimum, each guideline document will be annually reviewed to ensure that it is still relevant. A central registry of best practice documentation will allow tracking of the review status, as well as managing changing ‘ownership’, in response

6 Guideline format

The adoption of a standardised format for guidelines and checklists is proposed. Each guideline or checklist will have a header for cataloguing the guideline, and a footer recording the guidelines revision history. Best Practice checklists will also allow the recording of project details and the datasets or models to which the checklist is applied, as part of project quality control documentation.

Standard elements of a Best Practice Guideline and Checklist will include:

Headers

Title - A short descriptive title (120 characters max) of the documentation.

Category - A category selected from a pull down list, with categories matching the principal DGSM workflow elements (see Section 4).

Version – The version number. The initial version will be 1.00. The minor reference number should be incremented on each and any revision, the major number when a guideline is significantly rewritten.

Reference Id - Will be assigned on processing by DGSM staff.

Scope - A short description of the scope and application of the document (254 characters max).

Geological limits? - If the document refers to a specific geological environment, this will be specified, otherwise it will be left as 'General'.

Software specific? - If the document refers to a specific software package, this will be specified, otherwise it will be left as 'General'.

Checklist Headers

Additional headers for Best Practice Checklists will include

Project Number – The project number or other identification for quality control

Checklist applied to – The datasets and/or models to which the checklist has been applied.

Checklist applied by – The modeller carrying out the actions on the checklist (with date).

Project manager review – The manager reviewing the actions on the checklist (with date).

Main body

The body of the best practice document or checklist will then follow. Guidelines are expected to be of less than 4 sides of A4 – longer documents should be split, and reference made to supporting documentation. For checklists space is provided to initial completed actions.

Footers

Version – The version number

Author - Author of revision.

Date - Date of last revision.

Note – For revisions, a note of the major changes in the revised version.

7 Supporting best practice

To allow best practice to be introduced and managed effectively, it is proposed to make extensive use of databases and the Intranet.

The core of this management system will be a database of best practice, held in Oracle. This database will support several applications for the management and dissemination of best practice:

- End user application for accessing best practices via Intranet.
- Application for managing best practices documentation, including drafting process and reviews.
- Application for integration of best practice checklists

These components are discussed in greater detail below.

7.1 BEST PRACTICE DATABASE

The core of the best practice database will be three tables; a list of best practice identifiers, a table holding the index and header details for a particular version of a best practice document, and the other holding the text data that forms the body of a guideline or checklist. The index database may also hold references to external documents or reports that act as support to the best practice guidelines and checklists. To allow a hierarchical system of best practice documentation, a separate table will hold parent child relationships and associations between guidelines and checklists. The principal fields within these tables are discussed in more detail below.

A further set of tables will be developed to allow best practice checklists to be completed and stored on-line, but the tables and fields required will be defined in a subsequent report.

7.1.1 Identifier table – Identifiers

The identifier will be a unique identifier, unique to each document, and will be the primary key.

7.1.2 Identifier table - Shelfmark

A 'readable' identifier in the form BP/CAT/NNNN

7.1.3 Identifier table – Title

The title of the best practice document will be recorded as a free text field.

7.1.4 Identifier table – Category

Field to define which pre-defined workflow element is referenced. Dictionary constrained.

7.1.5 Index table – Identifiers

The identifier will be a unique identifier, unique to each document. Foreign key to Identifiers table.

7.1.6 Index table – Version

The version number will be held as a number. In conjunction with the Identifier it will form a composite primary key. Each version of a document will have its own entry and index information. This is necessary to maintain access to superseded best practice documentation referred to in quality control files or by inference metadata.

7.1.7 Index table – Type

Definition of document as best practice guideline, checklist or supporting documentation. Dictionary constrained.

7.1.8 Index table – Status

The status of a document will be defined, with a document passing through stages of ‘Proposal’, ’Draft’, ’Current’ and ‘Superseded’. Dictionary constrained.

7.1.9 Index table – Scope

A free text field outlining the scope and application of the document.

7.1.10 Index table – Geological limits

Dictionary constrained.

7.1.11 Index table - Software Limits

Dictionary constrained.

7.1.12 Index table – External document ID

Where an index entry refers to a document that has been prepared outside the DGSM Best Practice Guideline or Checklist format, a hypertext pointer to the external document. Normally used for supporting reports.

7.1.13 Index table – Author

A free text field with the author’s name.

7.1.14 Index table – Date

Date of drafting or document revision.

7.1.15 Index table – Notes

A free text field outlining the changes made at document revision..

7.1.16 Body table – Identifier

The unique identifier, unique to each document, a part of the foreign key to the index table.

7.1.17 Body table – Version number

The version number, also part of the foreign key to the index table.

7.1.18 Body table - Text

Long field for freeform text, holding the body of a guideline document, or individual checklist items. A guideline document will have a single entry in the Body table, Checklists may have multiple entries.

7.1.19 Body table – Item order

An integer identifying the order of output of text. In conjunction with the Identifier and Version Number, forms part of the table's primary key.

7.1.20 Link table – Parent Index Identifier

The identifier of a parent document. Links will be made only on the identifier, not on the version numbers of documents. This will allow links to persist even when documents are revised.

7.1.21 Link table – Child Index

The identifier of the child document.

7.2 BEST PRACTICE APPLICATIONS

Best practice applications will be developed using Cold Fusion, for deployment directly to the BGS Intranet. Demonstrations of functionality may be prototyped using Microsoft Access to allow work to start, especially in cataloguing existing best practice.

7.2.1 Accessing best practice via Intranet.

The primary application for end users will be a read only system allowing searches of existing best practice documentation. The interface will allow a user to review all best practice documents by drilling down the parent - child relationships by workflow element. The initial output will be of index level data, but the application will also allow the download and printing of selected best practice documentation.

7.2.2 Managing best practice documentation.

The system to manage best practice documentation will handle the tasks of drafting and reviewing best practice. It will be integrated with a new 'BGS Best Practice' discussion forum on the Intranet, so that when a new best practice document is proposed, it will be announced on the board, with links to the proposal, or to drafts for comment.

7.2.3 Integration of best practice checklists

Ultimately it will be possible to complete best practice checklists online, with resulting data stored for future reference as part of project quality control and inference metadata. However the introduction of this system will be phased in as quality assurance systems for the DGSM are further developed.

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Appendix 1 Best practice guideline template

Title	Title of best practice document	
Category	Best practice category	
Version	Version number	Ref ID (to be assigned)
Scope	A short description of the scope of the document & any limitations on application.	
Geological limits?	Specify any geological limits	
Software specific?	Specify any software limits	

Main body of best practice guideline

Version	***Author***	***Date***	***Notes***	
Version number	Name of author	Date of first draft	Comment	
	Name of author	Date of revision	Major items revised	

Appendix 2 Best practice checklist template

Title	Title of best practice document	
Category	Best practice category	
Version	Version number	Ref ID (to be assigned)
Scope	A short description of the scope of the document & any limitations on application.	
Geological limits?	Specify any geological limits	
Software specific?	Specify any software limits	

Project Details *(This section contains details for quality control)*			
Project Number	Project numbe*r*		
Checklist applied to	Identify dataset or model component		
Checklist applied by	Modellers name	***Date***	
Project manager review	Reviewers name	***Date***	

Item	***Description***	***Dated***	***Initials***
1	Checklist actions are listed here, with space for noting exceptions.	Date action completed	Signature of modeller
2			
3			
4			
5			
6			
7			
8			
9			
10			

Version	***Author***	***Date***	***Notes***	
Version number	Name of author	Date of first draft	Comment	
	Name of author	Date of revision	Major items revised	

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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