Maximising access to ground investigation data in New Zealand

R J Hutchison
BE, MSc, DIC, MICE, MIPENZ, CEng(UK)
Director, Keith Gillespie and Associates Ltd, New Zealand
(Formerly Chairman AGS Working Party on Electronic Transfer of Data)

G B Farquhar
BE, BD, MSc, DIC, MICE, FIPENZ, CEng(UK), CPEng(NZ)
Geotechnical Engineering Manager, Maunsell Ltd, New Zealand

Summary: Traditionally, ground investigation data is provided in paper form; borehole logs and tabulated or graphical test data. The data is often held in bespoke spreadsheet or database form by the originator, which cannot be reliably read electronically by subsequent users. In general, it has to be retyped from the paper copy, with attendant transcription errors and time delays for entry into third party graphical and analytical packages.

The Association of Geotechnical and Geoenvironmental Specialists (AGS) in the UK has overcome this problem by creating a file format protocol for presenting the data in electronic form such that it can be universally read by third parties. This paper describes the AGS data file format and demonstrates its ease of use and benefits accruing. Use of the AGS Format in New Zealand, particularly in procurement contracts, is recommended. An organisation such as the New Zealand Geotechnical Society should control the adaptation of the AGS Format to meet New Zealand requirements.

INTRODUCTION

Within the construction industry, uncertainties in the ground conditions provide the greatest risk to project costs and timescales. It is widely recognised that, once out of the ground, any project becomes much more straightforward. In New Zealand, for all but the largest projects, there is a chronic shortage of geotechnical data. As practising engineers, we should be concerned at the design decisions made using such limited data.

Historically the Ministry of Works or other Government agencies, undertook most of the infrastructure projects, which ensured continuity of staff, resources and data. Since the 1980's the situation has changed dramatically, with the private sector now providing the design function. This has had the effect of fragmenting the knowledge base and also the libraries of data that previously existed. Furthermore, individual organisations, being driven commercially, are protective of what they see as in-house advantage from their data archives. Consequently, there is limited sharing.

Loss of data may be compounded by the design process, where the initial investigations and feasibility studies may be undertaken by one organisation, detailed design by another and construction (perhaps to a Contractor's alternative) by yet another. When also taking into account the tight timescales under which final design and construction are often required, the potential for fragmentation and loss of invaluable base data is easily seen.

If the data can be presented in a reliable electronic form, it can be shared and passed along the design process, and added to as appropriate, maximising access and avoiding degradation or loss.

THE PROBLEM

It is accepted that we generally have insufficient information on the ground conditions. In addition, the data that we do have is often difficult to access by all but the originator, either due to time constraints or the inability to read the data into an easily assimilated form.

All too often, geotechnical data for a project will come from multiple sources, possibly obtained over a wide period of time. Boreholes will be in different presentation formats, making them difficult to compare, laboratory test data will come in a mix of hard copy, computer spreadsheet and even computer text files, which renders collation impossible, except by manual transcription. In today's project timescales, there is not time to do this and, even if there were, the risk of transcription errors is ever present. This confusion of data presentation format is illustrated in Figure 1.

THE SOLUTION

It was established in the early 1990's that, with the advent of powerful PCs and easily accessible software, major benefits would accrue if geotechnical data were to be available in electronic form. A pilot project was run and it quickly became evident that, for a successful outcome, a common form of presentation was required. If the data could be generated in a form that could be reliably and accurately read by receiving software, quick and universal access to the data was achievable (Hutchison and Chandler, 1999).

The challenge to develop such a format was taken up by the AGS in the UK in 1991. In 1992 the first version of the AGS format was published and rapidly became the accepted standard for the presentation of geotechnical data in electronic form. Since then, the AGS has published a second edition (1994) and a third edition (1999). In each case, the AGS Format has been developed and extended to meet the ongoing requirements of users and applications.

The immediate effect of the AGS Format has been to eliminate the chaotic structure inherent in Figure 1 and replace it with an ordered structure typified by Figure 2.

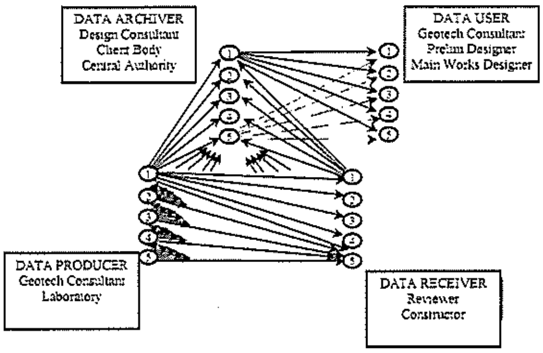

Figure 1. Before AGS

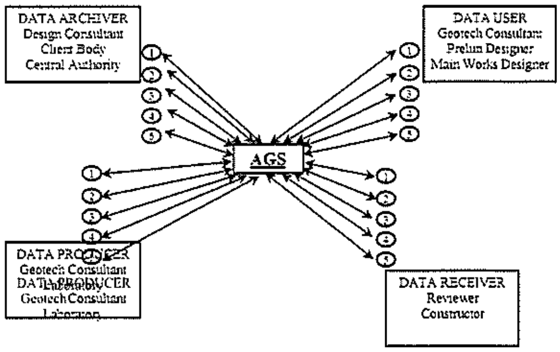

Figure 2. After AGS

In setting up the format, the AGS established a series of basic criteria to be met. These were that the format must:-

* be independent of any software package, proprietary or otherwise.

- be able to be incorporated into existing or future software either as an import filter or an export routine.

- be a file format protocol. It is NOT a database.

- be a simple ASCII text file.

- contain fundamental data only. Interpolated or derived data is excluded in order to avoid cluttering of data files.

By adhering to the above base criteria, universal access to the data by all is maintained.

ADVANTAGES TO DATA ACCESS

The overriding advantage of the use of the AGS format is that data can be transferred efficiently and accurately between users with no transcription errors. Furthermore, this transfer can be two way, with software able to both import and export data in electronic form. Acceptance of this will ensure that data can be read and shared by the entire project team, therefore maximising its use. There is an old adage that one should enter computer data once and once only and that it must be done as early in the process as possible, preferably by somebody else!

Access to data in electronic form using appropriate software provides immediate access to the information. Data does not have to be manually collated, plotted or drawn. Data can also be drawn from multiple sources and combined into a single data set.

To demonstrate how this can apply in practice, a typical progression on a large construction project may comprise:-

i) Feasibility Study

Geotechnical information for such a study may be sourced from an archive, in-house or external. A preliminary ground investigation may be carried out and the data merged with the archive information to provide a preliminary geotechnical data set.

ii) Main Design

At this point, additional sources of data become available, including survey and scheme plan drawings. Other archive information may be provided and further ground investigations may have been or will be carried out. It is paramount that these data sets can be merged into a consolidated data set that allows full access to the information. From this, the information can be manipulated into any one of a number of forms, including 2D and 3D models, data plots and statistical analysis.

iii) Construction

Invariably, the constructor is working to very tight timescales, particularly at the time of tender. Immediate access to quality data is fundamental at this point. Use of the AGS Format to import the data enables ground models to be set up at the commencement of the tender process. From these, the constructor/tenderer is able to evaluate the geotechnical risk, identify options and, if necessary, prepare alternative designs.

WHAT IS THE AGS FORMAT?

The AGS file format protocol defines a text file containing all of the geotechnical data available from a ground investigation. Tables of data, based on a data dictionary concept (Greenwood, 1988). cover the various aspects of investigation. Each table is defined by a "Group" name, with the contained data in a series of Fields, identified by a heading line. This is followed by the units applicable and then the corresponding data. An example of typical tables is appended. The use of the data dictionary concept allows each Group and item of data (Field) to be uniquely defined in a "dictionary". The "dictionary" in this case is maintained by the AGS. In this way, there is no confusion as to what each item of data comprises. It also allows additional Groups and Fields to be created to meet specific requirements, such as international variations in techniques, testing and terminology. However, care must be taken when creating these to ensure that their existence is known and understood by the receiving software.

For full details of the Format and standard groups defined, reference should be made to the AGS3 specification available from the AGS (www.ags.org.uk).

FLEXIBILITY

The key to the widespread adoption of the Format has been its inherent simplicity and flexibility based on the use of the data dictionary concept. Within the international context, local requirements can be accommodated by the addition of new fields to existing groups and also the addition of new groups where required. However, such additions require careful monitoring to maintain the order within the Format. It is suggested that, in the New Zealand context, this is controlled by a central organisation such as the New Zealand Geotechnical Society.

ADOPTION

The AGS Format was originally developed to address a major problem with access to ground investigation data in the UK. Since then, similar problems have become apparent elsewhere in the world and the Format has been found to be sufficiently robust to address these with a minimum of amendment.

The Format is now the accepted standard in the UK and has also been officially adopted in Hong Kong, Singapore and Ireland. It is also reported as being successfully used in South Africa, China, Turkey, Australia and India (Chandler et al, 2002).

EXAMPLES OF USE

The availability of geotechnical data in electronic form has enabled organisations to attain efficient data management and data access. Once in electronic form, the data can be manipulated and used in many ways. This may be as simple as collating exploratory holes and adding them to a GIS, from which plans or drawings can be prepared showing their type, number and spatial distribution. Such a plan is shown in Figure 3. It can also be used to provide graphical representation of more complex testing such as soil contaminants, where conventional tabulated data may be confusing or difficult to assimilate. An example of such a pictorial presentation is shown in Figure 4.

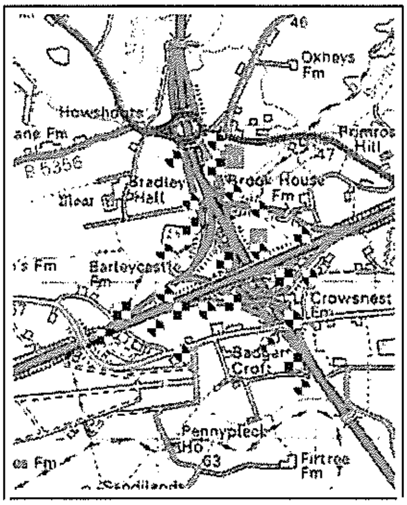

Figure 3. Distribution of exploratory holes

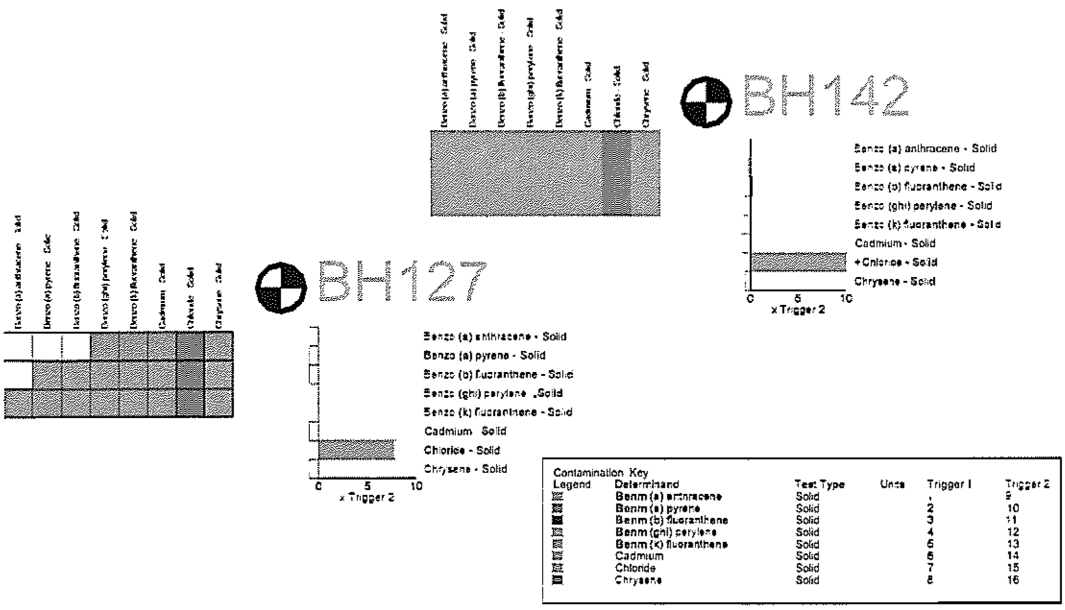

Figure 4. Pictorial presentation of soil contaminant data

A more common use of the data is to provide data plots to assist in the development of the ground model or to determine appropriate design parameters. Such plots take many forms and a plot of in situ test data presented alongside the borehole stratigraphy is shown in Figure 5.

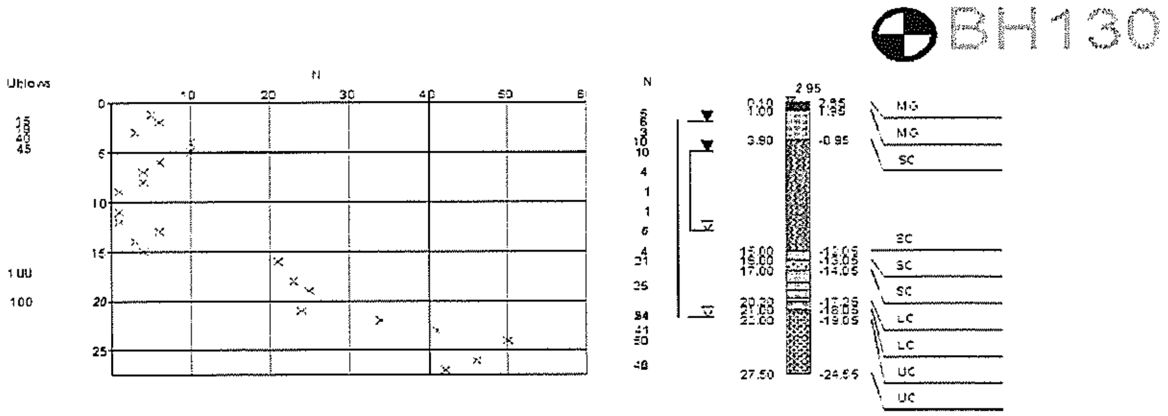

Figure 5. Collated borehole log and borehole test data.

One of the first tasks construction tenderers attempt is to prepare geotechnical cross sections in order to identify the ground conditions relating to the project. Unless appropriate sections have been prepared as part of the main design and are made available within the tender documents, these must be prepared from scratch. This can be time consuming, which may restrict the number and locations of sections plotted. With the data in a reliable electronic form, there is the ability to not only prepare sections quickly, but also to prepare multiple sections to establish potential variability of ground conditions. A basic geotechnical cross section is shown in Figure 6.

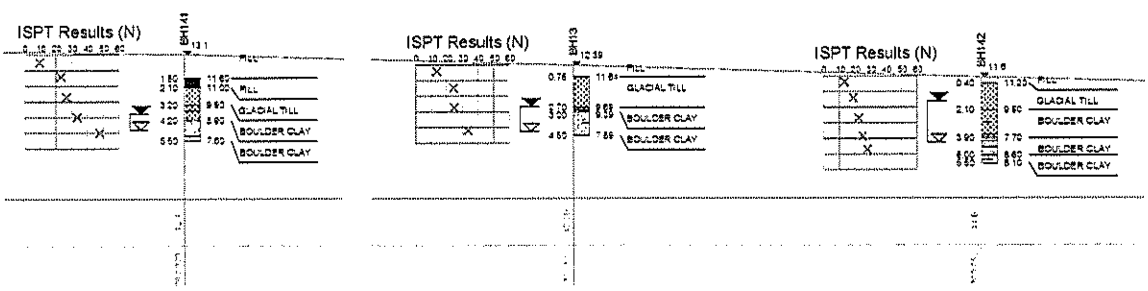

Figure *6*. Typical geotechnical cross section

DEVELOPMENT OF THE FORMAT

The success of the AGS Format in streamlining access to ground investigation data has generated other uses for the concept. One of these is the development of the AGS-M Format for the collection, transmission and collection of field monitoring data. The AGS-M Format is a logical extension of the main AGS Format and is described by Richards et al, 2003. It is available for download from the AGS (www.ags.org.uk).

Other developments have been in the area of data management systems, managing geotechnical hazards and risks on highway networks. These data management systems hold geotechnical data as well as inspection and maintenance records, identification of geotechnical hazards and allow the generation of maps to provide proactive and strategic asset management.

APPLICATION IN NEW ZEALAND

In order to maximise the use of limited geotechnical data on projects within New Zealand, it is important that the available data is shared between all parties involved on a project. Once the concept of sharing a common data set is established, there must be a means of accurately and reliably accessing it. Provided that this is simple and effective, substantial benefits are available.

The AGS Format is well established internationally and provides a consistent, robust and reliable means of presenting data. It is no longer necessary to re-enter or regenerate data at each stage of the design process; data need only be entered once, at source. Powerful software is commercially available to sort and present the data giving users the ability to fully exploit the data in the design process. Direct access to data will lead to immediate savings in time and cost through improved efficiency. Consequent reductions in construction risk (time and cost overruns) will also accrue.

Within the New Zealand context, it must be ensured that the software used to generate ground investigation data is AGS Format compatible. This does not preclude the use of simple spreadsheet outputs, as conversion and Format integrity checking software is readily available. The provision of data in AGS Format should be specified in procurement contracts. Availability of geotechnical data in AGS Format will then become the norm, allowing improvement in the design process and its reliability.

CONCLUSIONS

The use of the AGS Format to aid the sharing of geotechnical data is well established internationally and provides a consistent, robust and reliable means of presenting data. Direct access to data leads to immediate savings in time and cost through improved efficiency.

Within the New Zealand context, it must be ensured that the software used to generate ground investigation data is AGS Format compatible, and the provision of data in AGS Format should be specified in procurement contracts. An organisation such as the New Zealand Geotechnical Society should control the adaptation of the AGS Format to meet New Zealand requirements.

ACKNOWLEDGEMENTS

The support of Dr Roger Chandler of Key Systems Geotechnical (www.keygeotech.co.uk) in supplying the examples of the ways in which the data can be utilised when in electronic format is gratefully acknowledged. The examples were produced using HoleBASE.

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APPENDIX – Typical Data Tables

Project Table

Group Name	"**PROJ"
	"*PROJ_ID","*PROJ_NAME","*PROJ_LOC","*PROJ_CLNT","*PROJ_ENG","*PRO
Units	"<UNITS>","","","","","","dd/mm/yyyy","",""
Data	"7845","A Treatment Plant","Somewhere","Somewhere District Council","ConsEng"

Hole Table

Group Name	"**HOLE"
Data Fields	"*HOLE_ID","*HOLE_TYPE","*HOLE_NATE","*HOLE_NATN","*HOLE_GL","*HOL
Units	"<UNITS>","","m","m","m","m","dd/mm/yyyy","",""
Data	"TP501","TP","523196","178231","61.86","3.25","21/07/1999","ANO","FS002"
	"BH502","IP+CP","523142","178183","58.72","15.45","22/07/1999","ANO","FS003"

Geology Table

Group Name	"**GEOL"
Data Fields	"*HOLE_ID","*GEOL_TOP","*GEOL_BASE","*GEOL_DESC","*GEOL_LEG","*GE
Units	"<UNITS>","m","m","","","","",""
Data	"TP501","0.00","0.25","Friable brown sandy CLAY with numerous rootlets (Topsoil)
	"BH502","0.00","0.30","Friable brown sandy CLAY with numerous rootlets (Topsoil)
	"BH502","5.75","15.45","Dense becoming very dense yellow brown very sandy fine

Sample Table

Group Name	"**SAMP"
Data Fields	"*HOLE_ID","*SAMP_TOP","*SAMP_REF","*SAMP_TYPE","*SAMP_BASE","*SA
Units	"<UNITS>","m","","","m","dd/mm/yyyy","hhmmss","",""
Data	"TP501","1.00","1","D","1.00","","","B",""
	"TP501","2.50","3","B","2.75","","","C",""
	"BH502","3.00","11","W","3.00","22/07/1999","120000","",""

Classification Test Table

Group Name	"**CLSS"
Data Fields	"*HOLE_ID","*SAMP_TOP","*SAMP_REF","*SAMP_TYPE","*SPEC_REF","*SPE
Units	"<UNITS>","m","","","","m","%","%","%"
Data	"BH502","1.00","1","U","A","1.10","28","56","22"
	"BH502","1.00","1","U","B","1.25","31","62","24"

Contaminant Test Table

Group Name	"**CNMT"
Data Fields	"*HOLE_ID","*SAMP_TOP","*SAMP_REF","*SAMP_TYPE","*SPEC_REF","*SPE
Units	"<UNITS>","m","","","","m","","",""
Data	"BH502","3.00","11","W","","","PHBSW","7.2",""
	"BH502","3.00","11","W","","","SOBSW","0.037","g/l"
	"BH502","3.00","11","W","","","CHLRW","51","mg/l"

SPT Test Table

Group Name	"** ISPT"
Data Fields	"*HOLE_ID","*ISPT_TOP","*ISPT_NVAL","*ISPT_REP","*?ISPT_CORN","*?ISPT_
Units	"<UNITS>","m","","","","",""
Data	"BH502","6.00","37","8,9/9,10,10,8 N=37","","","S"
	"BH502","9.00","45","5,7/8,10,12,15 N=45","30","","S"

Detail Description Table

Group Name	"**DETL"
Data Fields	"*HOLE_ID","*DETL_TOP","*DETL_BASE","*DETL_DESC"
Units	"<UNITS>","m","m",""
Data	"BH502","3.20","3.45","3.20-3.45m Boulder of yellow brown sandstone, weak"
	"BH502","5.00","5.00","5.00m Becoming very stiff"