

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

**GUIDELINES FOR THE USE OF ELECTRONIC
SURVEY FIELD NOTES & CAD COMPUTATION
FILES AS LEGAL RECORDS**

A dissertation submitted by

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Abstract

This project seeks to produce a set of guidelines for the use of Electronic Field Notes so that notes in this form may be acceptable as evidence in legal proceedings and disciplinary hearings.

The surveyor's field notes are the only permanent record of work performed in the field other than the actual monument or occupation located or marks placed.

It has been traditional that surveyors record their measurements of angle and distance into small paper paged books. These measurements were then collated to produce a plan or map of the boundary or boundaries.

Since the invention and advance of the microcomputer and electronic calculator, surveyors have embraced these technologies and used them to collect and store large amounts of measurements, analyse, and determine the position of new and existing boundaries.

The guidelines developed from this project will help improve the integrity of the cadastral surveyor's field notes and alert those using or intending to use electronic field notes of the standards required to enable them to be acceptable as evidence.

University of Southern Queensland

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<p>ENG4111 Research Project Part 1 & ENG4112 Research Project Part 2</p>

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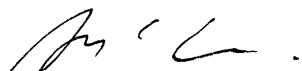
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Chapter 1

Introduction

“No part of the operations of surveying is of greater importance than the field notes. The competency of the surveyor is reflected with great fidelity by the character of the notes recorded in the field.”

Anderson & Mikhail (1998)

The profession of surveying has been defined as the science and art of determining relative positions of points above, on, or beneath the earth’s surface, or establishing such points. It can be regarded as that discipline which encompasses all methods for gathering and processing information about the physical earth and environment (Elfick et al 1994).

Anderson & Mikhail (1998) explain surveying as the art of measuring slope, horizontal and vertical distances between objects, of measuring angles between lines, of determining the directions of lines, and of establishing point locations by predetermined angular and linear measurements.

Looking at the last 200 years, and considering that part of surveying relating to property boundaries, it has been traditional that surveyors record their measurements of angle and distance into small paper paged books. Since these books contain notes taken whilst in the ‘field’, they have been given the name ‘field book’. The information within them is then referred to as the ‘field notes’. These measurements are manipulated to produce a plan, or map of the boundary or boundaries.

1.1 THE PROBLEM

1.1.1 INFORMATION TRANSITION

In the process of defining a property boundary onto a plan, there are three main transitions of information:

Actual Physical Position

Measured and/or Marked Position noted in Field Book

Dimensioned and Drafted Position (taken from Field Book) onto Survey Plan

During the middle transition, there is a degree of adjustment, calculation and decision made by the surveyor, based on evidence collected, as to the position of the boundary. This middle transition can be divided into:

Information collected

Boundary Position Determined

Boundary Position Marked

Proof of Boundary Position Marked

During each transition, there is the potential for error, misinterpretation, corruption and loss of information. Traditionally, a high proportion of the calculations were performed in the field book. The marking of the boundary position was then noted, along with appropriate check measurements, into the field book.

Since the invention and advance of the microcomputer and electronic calculator, surveyors have embraced these technologies and used them to collect and store large amounts of measurements and to also perform calculations using these measurements to determine the position of a boundary.

The 'position' of the property boundary (actual, measured, reinstated, depicted on plan), moves to-and-fro through the transitions mentioned above, via computer software packages (computational and CAD) and the data recorder. Tracing and therefore maintaining the integrity of this 'position' is difficult, as it is not visible in such a way as pen notes are in a book. The fewer transitions required, and the more reliable and robust they are, the less chance of error.

1.1.2 EVIDENCE

The mark placed by a surveyor may be disturbed or moved, either maliciously or by accident. A property owner (adjoining or subject) may perform an action on the land such as building construction or agriculture assuming the mark is correct. In a cadastral situation – especially of a rural nature, it may be several years before the circumstance is identified.

The surveyor may be required to prove that they did indeed place the boundary mark at its intended position at that time. Once the boundary position has been marked and the surveyor has left the sight, the only record of how and where that mark was placed – other than the mark itself is in the field notes.

Electronic data in its most basic form is nothing much more than a series of 0's and 1's, stored magnetically or optically on some sort of material. A concern is that it may be considered as nothing more than hearsay evidence, and could be deemed as not acceptable proof of a matter asserted.

The field notes are worth far more than merely the paper or computer material they are stored upon when we consider the time and thus money required to reproduce this data should the originals be lost, destroyed or noted inaccurately or in error.

Expensive litigation possibilities may arise - the magnitude of which depends only on the scale of operations that may have occurred, using information either collected or marked, that was recorded inaccurately or in error. Surveyors must recognise the importance of the records they have taken during the course of a survey. They need to recognise the vulnerabilities of both methods and put procedures in place to minimise these risks. Advances in technology changes the methods we use to accomplish tasks,

and if more efficient, should be embraced - so long as they do not jeopardise reliability elsewhere.

1.2 PROJECT AIM

This project seeks to produce a set of guidelines for the use of electronic field notes as evidence in legal proceedings.

1.3 OBJECTIVES

The project will investigate the purpose of field notes and their role in the definition of property boundaries. Traditional methods of survey field note recording and modern electronic field note recording will be compared.

The project will define key principles for acceptable legal records and documents.

A set of standards will be developed to address the key principles for acceptable legal records and documents.

Once these standards have been determined, and the purpose for field notes is understood, then a set of guidelines for the use of electronic field notes will be constructed, so that the notes in this format may be acceptable as evidence in legal proceedings and disciplinary hearings.

Chapter 2

Literature Review

2.1 INTRODUCTION

To produce standards and guidelines, a proper understanding of the complete purpose and requirements of field notes in general was required. To ensure this, it was essential to investigate existing standards and guidelines for field notes of both traditional and electronic format, and literature outlining specific expectations and requirements for field notes. The following is a summary of some of the literature reviewed to gain this understanding.

2.2 PURPOSE OF TRADITIONAL FIELD NOTES

The object of making field notes are to note the particulars obtained in the field from which a report or plan can be prepared and also to be a record of those particulars which can be filed away and used for reference in the future (Foxall, H. G. 1957).

They are an accepted proof of measurement & placement of boundary points as shown on the survey plan and a record of check measurements taken to marks placed.

The field notes are an integral part of the survey as a whole (Anderson & Mikhail, 1998) and were once required to be lodged with the survey plan. They could then be

used by subsequent surveyors to determine dimensions and positions of boundaries, especially if difficult to determine from the original plan. They may therefore be considered as a back-up system for the survey plan should the original plan be destroyed.

2.3 EXISTING GUIDELINES FOR TRADITIONAL FIELD NOTES

There are many texts written specifically for the purpose of educating those undergoing tertiary study in surveying. Many have comprehensive sections covering methods to use for the science and art of producing high quality field notes. The texts have very similar themes. The following is a collation of guidelines suggested by Anderson & Mikhail (1998), Cole (1970), Elfick et al (1994), Foxall (1957), Sneddon (1996):

Accuracy

- Cover page containing survey details such as client, job number, location, date, field party, instruments and equipment.
- Notes made with a sharp hard pencil. Some texts suggest a permanent, waterproof black ink pen to improve the notes' integrity.
- Lettering needs to be large and clear, with no possible confusion between them.
- Record actual measured data, not just the reduced bearings and horizontal distances.
- Make notations of atmospheric and other factors required to apply corrections to raw measurements.

Integrity

- No erasures should be made – alterations should be made by neat strikeout such that it may be still legible and correction noted beside. Erasures look suspicious – i.e. fudging. This also allows the original value to be used should it be later deemed to be correct.
- Notes must be signed and dated by the surveyor.
- Note arithmetic checks in field book prior to leaving sight.
- Note and examine check measurements to marks placed and misclosure ratios in field book prior to leaving sight.
- Computations made in the field should be arranged and noted for easy checking in the office.

Arrangement

- Multiple pages used must be clearly numbered, with enough information repeated on subsequent pages for obvious continuity.
- Use an orderly, standard notation method appropriate for the particular survey to ensure accuracy, integrity and legibility.
- All lines should be ruled; words & figures neatly printed and conventional signs and abbreviations should be used to indicate the unit of measurement.
- Show north point on sketches.

Clarity

- Notes must be clear, complete and unambiguous.
- Notes must not be cramped. Paper is cheap. Costly drafting and computational mistakes are possible from unambiguous notes.
- Include explanatory statements to clarify the location of the survey station and traverse in relation to whole survey i.e. Lot numbers, adjoining information, road names.
- Use sketches and tables as appropriate.

2.4 TRADITIONAL METHODS OF RECORDING FIELD NOTES

Diagram method – usually used for smaller sight areas and urban cadastral surveys. A simple diagram is drawn, with traversed lines and offset measurements numbered. These lines and the measurements of them are then tabulated on the next page (Foxall, 1957). An example of the diagram method can be found as Appendix C.

Column method – usually used for large extent surveys. The page has a central column representing the line traversed. The occupied station is at the base of the page and the foresight station is at the top. Notes are recorded of the backsight station and the direction set to it, the angle between backsight-foresight and thus bearing to foresight. Measurements to objects are noted as a chainage along and offset to this traverse line or as radiations from the occupied station. This method originated from early surveys that ran the actual boundary line as the traverse (Sneddon, 1996).

2.5 EXISTING GUIDELINES FOR ELECTRONIC FIELD NOTES

While there are many guidelines and specific standards for correct field notes in the traditional manner of pen and paper, there appears to be little evidence of guidelines for the use of electronic field notes.

Anderson & Mikhail (1998) comment that the rules with respect to the liability and legality of field notes in the standard field notebook are well established in the courts. They go on to say, however, that such is not the case concerning liability and legality of digital records, which are in a state of evolution. There may be speculation among surveyors, especially in the cadastral sector, that the use of electronic field notes would not be sufficient evidence to prove correct measurement and placement of property boundaries.

Although admitting to not trying electronic recording of field notes on cadastral work, Sneddon (1996) suggests several methods for written field notes should be applied to electronic field notes:

- All field observations are to be recorded in a field book in a clear and precise manner which is readily understandable by fellow surveyors
- All information collected in the field should be shown clearly in the field notes
- Check measurements need to be recorded so that sufficient information is available in the field notes to prove all measurements are correct
- Description of survey, date, surveyor, equipment used and reference number should be clearly shown
- Field notes can be used as evidence in court proceedings
- A sketch may be necessary to enable the electronic field notes to be interpreted

Anderson & Mikhail (1998) suggests that surveyors who use data recorded electronically should use the following recommendations to provide *authentication* of the data and prevent potential *tampering* of the record:

- Always archive the actual observations in condensed binary form. This suggestion is agreed by Hintz & Onsrud (1991), who state their reasoning being it is highly unlikely that surveyors could alter condensed binary files to produce a desirably modified ASCII file.
- This binary file also should contain all measurement and keyboard blunders

- Any mistake in the binary data should be ‘crossed out’, which means the software must be designed to permit flagging bad measurements
- The binary file, when converted to ASCII, should indicate whether the entry was automatic or via the keyboard

It has been common practice for surveyors to convert their electronic notes to paper printouts. Hardcopy outputs should be obtained at the end of each day or job and examined and signed by the party leader (Elfick et al 1994). The surveyor will want to be able to convince the jury that the printouts are authentic and not manufactured (Hintz & Onsrud 1991).

Modern field methods using a traverse not often being on the exact boundary line (due to occupation) with most measurements taken by radiations may be better suited to using the diagram method (Sneddon 1996).

2.6 ELECTRONIC RECORDS FOR OTHER PROFESSIONS

The greatest issue with machine generated information is the information’s reliability (Ligertwood 1998). The issue with electronic evidence is how to ensure that the information in computer systems is a *record* - that it is evidence of a *transaction*. (Bearman 1994)

The revolution of computers is changing the way we do business, and that traditionally, communication in writing required the information content to be fixed onto a medium, in the form in which it was received. However, this can no longer be taken for granted and therefore, businesses and organizations must be accountable to create information systems so they create *records* rather than simply data (Bearman 1994).

An example used to illustrate how the lack of appropriate policy effectively undermined the accountability for electronic records is that of court rulings involving the electronic mail systems in the White House. The court ruled that to secure evidence it was essential to retain what Bearman has called “context and structure data” as well as the “content” data. The courts’ decision was that paper printouts lacking transmission information were not adequate records.

Although this example primarily involved ‘transmission data’ in the form of e-mails, it could be easily broadened to any contextual and structural electronic data used as information and considerable as evidence. The legality of an electronic record must be safeguarded to ensure it keeps its ‘unequivocal connection to the action of which it is evidence’ (Bearman 1994). An electronic record achieves this connection by containing content, context and structure (Bearman 1994). The best way to preserve the content, context and structure of a record is to manage it within a recordkeeping system (National Archives Australia 2004).

Content – That which conveys information – e.g. text, data, symbols, numerals, images, sound and vision. Surveyors recorded measurements of bearings and distances in an ASCII text file.

Context – The background information that enhances understanding of technical environments to which the records relate – e.g., metadata, application software, logical business models. In surveying, context is what the content data of bearings and distances relate to. The geographic software used to spatially display the data.

Structure – The appearance and arrangement of a record’s content. It is the relationship between the fields, entities, language, style, fonts, symbology, coding etc. Structure is the layout and relationship of the content and context data within the file itself, and within the record keeping system and then the relationship of the file itself with the record keeping system.

2.7 CONCLUSION

For an electronic record to be used as evidence, it must become a record, rather than just data. To achieve this, it must contain content, context and structural data and be shown to maintain a connection to the action of which it is evidence.

Most of the literature reviewed talks in essence about what *should* happen but does not talk in depth about *how* to achieve it – especially from the perspective of the cadastral surveying profession. Even the few texts found directly relating to surveying procedures fail to delve into how to achieve most of their recommendations.

For these guidelines to be effective, it is essential that they combine what is required and possible from a surveying perspective and what is required for electronic material to be admissible as evidence.

Chapter 3

Project Procedure

3.1 METHODOLOGY & PROCEDURES

3.1.1 BACKGROUND

The methodology concept used for this project is based on the model whereby a specific action or procedure is broken into three distinct parts – principles, standards & guidelines. An example of this model can be found in the structure of the Survey & Mapping Infrastructure Act 2003.

Principles define *what is intended* to be achieved by utilising a specific procedure.

Standards define *certain outcomes, levels of quality*, which must be met in order for the prescribed principles of a specific procedure to be confidently achieved.

Guidelines define possible *methods* to implement during a specific procedure, so that the prescribed standards are met. The purpose of guidelines is such that if a person follows them, that person can be confident the required standards will be met.

Principles and standards are relatively long-term. They can be written into acts and regulations of legislation and may stand for many years without alteration. Should they

be legislation, a breach of them may carry penalties. The aim of principles and standards is generally to protect the public interest.

Guidelines are more flexible. They are created with the technology, practicality and knowledge currently available.

Sometimes, technology advances quickly. People may find themselves trying to utilise a set of guidelines designed for obsolete procedures and equipment. There can be a ‘...that’s how it’s always been done...’ mind-set. This can be inefficient, and may leave a ‘gap’ in the system, whereby certain standards are no longer met when using modern technology and methods.

This project aims to investigate whether surveyors using electronic field notes as opposed to traditional pen & paper field notes, are meeting standards that are expected of them. It aims to search for any ‘gap’ in current methods of their use, and define guidelines that may be followed to fulfil any lack of standard.

3.2 PROJECT PROCEDURE

1 - Research the general rules of evidence through recent law and documentary evidence texts and current legislation regarding evidence.

2 - Investigate systems used by other professions to store data, records, & communications.

3 - Investigate any existing guidelines for field notes from surveying bodies and surveying texts.

4 - Use the discovered material to define the key principles of field notes.

5 - Investigate the capabilities of three systems of electronic field note software currently available in the context of the key principles of field notes.

The three systems investigated are listed here:

Topcon GTS 700 - On-board

Nikon NPL-352 – On-board

Trimble TSCe – On-board

The principle survey computations software used was the Liscad Survey & Engineering Environment. Most survey computations software communicates with most of their competitors' field software and data recorders. Some computer software specific to a field software system may be required to extract data in its most raw format.

6 – With knowledge of current market availability and standards required for electronic field notes, produce a set of guidelines for their implementation in order to achieve standards required

3.3 ELECTRONIC EVIDENCE

3.3.1 EVIDENCE AND THE HEARSAY RULE

The courts in common law have historically taken their main source of evidence as being the oral testimony of witnesses. Most of the rules of evidence have been based on the idea that a witness will speak of what they know or have seen. It was then considered that, after being tested by cross-examination, this is the most reliable material for use by the jury to determine the truth.

Hearsay may be defined as an oral or written assertion other than one made by the declarant while testifying at a trial or hearing which is offered in evidence to prove the truth of the matter asserted (Australian Law Reform <<http://www.austlii.edu.au>>).

Hearsay is the statement by a witness of what he or she heard someone else say and such evidence is inadmissible as to the truth of what the other person said. It exists because it is not the best evidence. For example, Mr X should give his own account of a matter to the court, under oath. Hearsay is second-hand evidence, meaning that it may have changed in the re-telling of the facts. If the originator of an account is not present, there is no opportunity to cross-examine that person who made the comment or observation to test his or her competence or credibility. Hearsay evidence is very easy to artificially produce, and is very difficult to disprove.

The common law considered a document to be less reliable, and was often excluded from evidence, insisting that they were merely ‘hearsay’ (Brown 1996).

The hearsay rule states that hearsay evidence is inadmissible unless the evidence can be considered as an *exception* to the hearsay rule.

3.3.2 DOCUMENTS FOR EXCEPTIONS TO THE HEARSAY RULE

A document can be admitted to court as an exception to the hearsay rule. A specific statutory exception is a banker’s book and book of accounts. These can be admissible if two principle requirements are met. The first is that there must be proof that the entry was made in the ordinary course of business, and there must be proof of verification in the case of a copy. This means, that the copy has been checked against the original (McNicol & Mortimer 2001).

In general, if a document is to be used for the purpose of proving that statements which it *contains* are true, then matters which may need to be proved about that document are the proof of execution of a document. This means a party needs to show that the document has been signed by the person who the party alleges has signed it. If the person admits signing the document, this will dispense any need for further proof (Heydon 2004).

It is usually required to produce the original document however there have been situations where courts have been prepared to accept ‘secondary evidence’ (such as a copy), to prove the contents of a copy. Generally a copy will be accepted where the original cannot be produced because it is lost or destroyed (Brown 1996).

3.3.3 ELECTRONIC DATA AS DOCUMENTS

The concept of a document involves:

- Some physical thing or *medium*;
- On or in which *data* are;
- More or less permanently *recorded*; and

- In such a manner that the data can subsequently be *retrieved* (with proper equipment).

This is a broad definition, and could be considered to extend to computer data, films and audio recordings (Brown 1996). Therefore, machine generated information is not necessarily caught by the hearsay prohibition. This broad definition of a 'document' to include *any record of information* brings computers under the umbrella of the documentary hearsay legislation. If this information is not derived from the out-of-court statement of a human being, the only issue is the information's reliability (Ligertwood 1998).

3.3.4 STATUTORY EXCEPTIONS TO THE RULE AGAINST HEARSAY

An examination of the Evidence Act 1977 (Qld) s95, it can be deduced that in any legal proceeding, where direct oral evidence of a fact would be admissible, then any statement contained in a document produced by a computer and tending to establish that fact is admissible, subject to four main conditions:

- *Document must be produced by the computer during a period over which the computer was regularly used to store or process information for the purposes of any activity regularly carried out during that period, for profit or not, by any person.*
- *Over that period, there must have been regularly supplied to the computer, in the ordinary course of those activities, information of the kind contained in the statement.*
- *The computer must have been operating properly at the time of document production.*
- *Information contained in the statement must reproduce or be derived from information supplied to the computer in the ordinary course of those activities.*

The Evidence Act 1977 (Qld) s95, subsection (7) describes a computer as any device for storing and processing information, and any reference to information being derived from other information is a reference to its being derived therefrom by calculation, comparison or any other process.

The common data collector certainly falls into this broad definition of a computer.

Quickly looking at the dot-points mentioned above, it might seem difficult to assure them however, following is an example of a situation where the judge accepted records stored by computer.

The respondent is charged with criminal offences in relation to accessing private information about individuals stored in a computer owned by his employer, the Department of Social Security. The disputed pieces of evidence were printouts of a 'trace', which had been placed on the respondent's log-on identification number for the full intention of charting information accessed.

Wright J, in the Supreme Court of Tasmania, held that this evidence was admissible at common law on the grounds the computer in its 'tracing' mode was a scientific instrument capable of mechanically producing reliable and accurate information. The accuracy, reliability and use of the program creating the trace could, his Honour held, be adequately tested through the oral evidence of the programmer responsible for creating the programme (McNicol & Mortimer 2001).

With regards to statutory exceptions for the rule against hearsay, types of primary evidence of the contents of a document may take the form of different types of *copies*. Copies proved by testimony to have been checked against the original are known as "examined copies" and those bearing a certificate of their accuracy to be known as "certified copies" (Heydon 2004).

3.4 METHOD OF SURVEY USING ELECTRONIC DATA RECORDERS

The following is a general overview of the procedures implemented during a typical, small scale survey using a total station and data recorder:

- Traverse Control Network (& collect information at same time)
- Close and adjust control (& any information collected during traverse)
- Collect information
- Process information (reinstatement)
- Output (mark) required positions of boundaries
- Obtain proof that position of boundary marked is correct

Steps in data reduction

- EDM measures slope distance to target
- Data recorder measures the horizontal and vertical circles of the theodolite, and stores these with the slope distance in a very raw format
- This data is usually viewable in the data recorder (but not very user-friendly) and transferable to computer as a raw text file
- The raw text file is either reduced directly by the surveyor's computations software or third-party software (usually supplied by the data collector manufacturer) into a user-friendly text 'field' file
- This file can be edited, correcting small field blunders such as incorrect codes and descriptions
- The field file is reduced by the computer into co-ordinate form
- The computer is used for further rigorous calculations of boundary positions if required
- The final boundary positions are transferred back to the data recorder for set-out
- After the boundaries are marked, check data is collected and downloaded back to computer for storage in the file system

Depending on the size and complexity of the survey, many calculations of the boundary position can be performed in the data recorder or with pen/paper notes and calculator, eliminating the necessity to download & upload to the computer prior to the boundary set-out.

3.5 PRINCIPLES OF FIELD NOTES

From the research, field notes could be considered as a *document being a record* of:

- 1- Detailed information about the survey performed answering Who, What, When & Where
- 2- Measurements taken to monuments, occupation and reference marks, from which boundary positions and dimensions are determined through the process of reinstatement.

- 3- Measurements or records of sufficient checks on the marks placed and measurements taken.
- 4- Calculations during the reinstatement process.
- 5- Measurements placing monuments at the reinstated position of the new or existing property boundary and to marks referenced to it.
- 6- Determined boundary dimensions from which the survey plan is drafted. This plan defines the individual parcel in relation to surrounding parcels and defines its area.

With this understanding of the full purpose and principles of field notes, there is a direction for the standards to aim to achieve.

3.6 EXISTING ELECTRONIC FIELD NOTE SYSTEMS

3.6.1 INTRODUCTION

This task attempted to gain knowledge of how current electronic field note software collect, store and display measurements and calculations performed in the field. It investigated the capabilities of three systems of electronic field note software currently available in the context of the key principles of field notes and examined in particular:

- Raw data file
- Field data file
- Protection of data from corruption & modification
- Connectivity between data and the purpose of its collection:
- Traverse information of control network
- Collected information and its connection to the traverse
- Processing of collected information & determination of boundary point
- Record of placement of boundary marker

A basic scenario was constructed consisting of a three-sided traverse (9001 to 1000 to 1001 to 9001). The traverse connects two iron pins that are reference marks to corners requiring reinstatement.

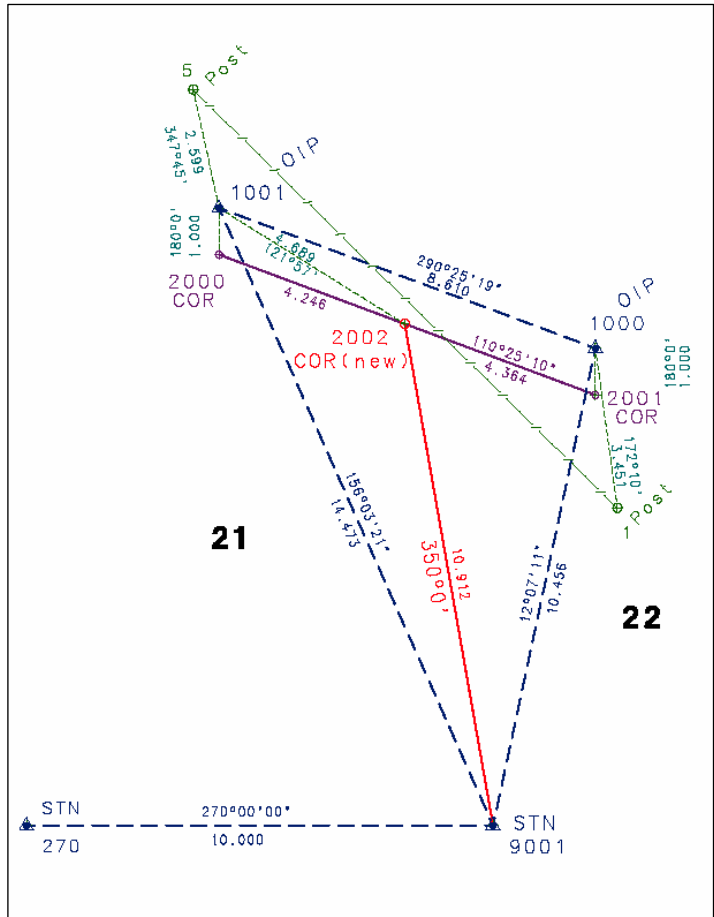


Figure 1. Sketch Plan of Boundary Reinstatement Simulation

A new boundary position was to be determined along this reinstated boundary line by intersecting it with a new boundary being a bearing of 350°0' from the first traverse station.

This new boundary position was then set-out and marked. Any recording of this marked position was noted.

During the traverse, other marks are located as radiations or 'side shots' to simulate locating occupation or new reference marks.

Measurements were taken to 'close' the traverse and the way the software recorded these was examined.

The intention of this analysis was not to compare the different systems as a 'road-test', but to gather ideas to determine how the software should record measurements and checks to effectively produce an electronic record of the transaction being the reinstatement and marking of a new boundary.

3.6.2 EQUIPMENT

The three instruments used were:



Trimble S6

Software: Trimble S6 – Trimble DC File Editor Version 2.03

Files:

DM2.dc - Trimble DC File Editor file

DM2.fld - Field file produced by Liscad SEE from the Trimble file downloaded in a Sokkia SDR33 format (text)

Figure 2. Trimble S6



Topcon GTS700

Software: Topcon GTS700 – Standard Survey Version 3.09A

Files:

project-topcon.raw - Topcon FC-5 raw file

project-topcon.fld - Field file produced by Liscad SEE from the FC-5 file (text)

project-topcon-raw-setout.raw - Report created by the instrument (as GTS-6 text file) of set-out information

Figure 3. Topcon GTS700



Nikon NPL-352.

Software: Nikon NPL352 – Standard Onboard Software

Files:

project-nikon-raw.trn - Transit Version 2.36

Update 12

project-nikon-raw.raw - Nikon raw file (text)

project-nikon-raw.fld - Field file produced by
Liscad SEE from the Nikon raw file

Figure 4. Nikon NPL352

The computational software used was the Liscad Surveying & Engineering Environment (Liscad SEE) version 6.1.

The Trimble DC File Editor and the Nikon Transit software are spreadsheet type programs with editable and non-editable dropdown cells. The files can only be read by their respective software. The data can be printed and appears as formatted text.

Any text editor such as notepad can read the Topcon and Nikon raw files and the Field files created by Liscad SEE.

3.6.3 RESULTS

A simple checklist was created (see Appendix B) to use in the analysis of the three systems.

Protection During Downloads

The data downloaded from the Trimble was through the Microsoft Active Sync Program. A confirmation file could be produced stating that the files transferred did so correctly. Interestingly, this confirmation file was simply an editable text file. It could have been created at any time, by any one. It is only good for the surveyor's peace of mind at that time. The Topcon and Nikon downloaded into Liscad had no such checks.

Control

Some data collection systems utilise a control network system, whereby a control traverse can be adjusted to spread any misclose using least squares or Bowditch adjustments. The side shot data is adjusted accordingly to produce adjusted co-ordinates of all data.

This function was not investigated in depth by this project. It is common field practice for surveyors to show their dimensions 'as measured' distances after the angular misclose is adjusted. This is most likely a hang-over from when the theodolite read angles far less accurately than modern theodolites. Sneddon (1996) suggests that so long as the traverse closes angularly within 20" depending on the instrument and number of angles and is linearly within 1:20 000, or meets the Surveyors Regulation, the misclose should be adjusted. This is so calculations from a different approach will agree.

The field method adopted will effect how electronic field notes are used.

Traverse Close Check

The simulation closed a traverse and the check method used was simply to examine an inverse between the start point and the end point.

For this reason, the notes should record an examined inverse if requested. The Trimble and Nikon stores this, the Topcon cannot.

Creation of New Points

All systems allowed for the creation of new points with Co-ordinate Geometry (COGO) tools. A code could be given to this point. The Trimble and Topcon only stored the new point, code and co-ordinates but not where the point was created from or how. The Nikon stored the origins and the information regarding the bearing/bearing intersection function. It is assumed similar functions such as bearing/distance and distance/distance would also be stored. Oddly though, a simple radiation only recorded the point and co-ordinates. The Nikon identified whether points were measured (side shots) or calculated.

Set-out Points

The Topcon used two separate systems – the collection operations and set-out operations. The collection data was downloaded in an FC-5 format and contained no information of the set-out operations. The set-out needed to be downloaded as GTS-6 format and this data had no correlation with the collection system other than the set-out point identifier.

The set-out data only stored point number design co-ordinates and a residual. A new point with as-collected co-ordinates was not stored, or downloadable. The station number from which points were set-out was not stored.

The Trimble and Nikon use a system that records actions as they occur, whether collecting or set-out. The Trimble only stored a residual co-ordinate of the point set out. The Nikon stored the measured bearing, and distance to the point set out, and the as-collected co-ordinates and stored this point by adding a specified increment to the point number. These check shots could be downloadable as a co-ordinate dump of the file and after manipulation, be imported into the computer's software.

Examinations / Calculations

The Topcon and Nikon did not store any examinations performed through the COGO function where the Trimble did. This meant examining between reinstated boundaries and checks on traverse closes could be stored.

Backsights

The Nikon stored the backsight at the beginning of the setup and could store a backsight check when requested and with a time stamp.

The Topcon did not store the set backsight. The only way to do so was to measure and record a shot to the backsight point. A check to the backsight at the end of measurements from that station could only be gathered the same way.

The Trimble stores the backsight bearing and station number. This project did not manage to make the system store backsight checks but it is most likely able to do so.

Timestamps

The Nikon stored a timestamp after almost every measurement, station setup and backsight check.

The Topcon did not store any timestamps in the data collection file or the setout residuals file.

The Trimble timestamped at the beginning of the job and then at inconsistent time periods of approximately 30 minutes.

Field Note File

The raw data files from the Topcon are exported as Topcon FC-5 text files or Topcon GTS-6 text files. The FC-5 file is difficult to read since many ASCII characters. Liscad takes this file and converts it to a readable field file also in a text format.

Nikon raw data is downloaded as a text file and is easy to read & follow. Simple and understandable operation codes at the beginning of each line makes following the sequence of measurements easy. The data can also be downloaded in Sokkia SDR-33 format. This was almost an industry standard format for electronic data recorders to export their data in the late 1980's and early 1990's. It is not quite as user-friendly as the raw Nikon file. The Transit software supplied by Nikon is a spreadsheet arrangement with editable drop-down cells. The raw text file is converted to a .trn file that can only be opened by the Transit software. The raw file remains in its original format. Transit can also talk directly to the instrument and bypass the raw text transition. The Transit printout is very easy to follow with good comments and structure. It is not an editable file.

The DC File Editor program supplied with the Trimble is similar in format and function to the Transit program. The printout from the DC File Editor is not very easy to read. It contains a great deal of extra metadata most likely designed for GPS observations and interaction between the total station and the GPS. The Trimble data can also be saved from DC File Editor in Sokkia SDR-33 format text file.

Summary

The raw files of all systems are easily editable before the computations software reduces them. The onus is wholly on the user to save the original raw file as a read-only file prior to editing and reduction.

The Nikon system was the most user-friendly, complete and meaningful as either a raw text file or printed from the Transit software.

It must be noted that only a limited amount of time was available to learn the Trimble system and that there are possibly many settings and options not properly explored or implemented. The screen system made for easier understanding of calculations and conveying the procedures spatially during field operations.

The Topcon system offered poor connectivity between the traverse, collection, calculation and set-out procedures. It would not be adequate for use without extensive reliance of pen and paper notes.

3.7 ELECTRONIC RECORDS

3.7.1 INTRODUCTION

Electronic records must be properly managed to support business needs and meet accountability obligations. They are subject to the same legislative requirements as records on paper or any other format (National Archives Australia 2004).

Organisations create and maintain records as evidence of business activities and transactions. A systematic approach to records management within an organization is required to protect and preserve the information contained in that organization's records as required (Australian Standard 4390.1, 1996).

If an organisation does not take a systematic approach to records management and inadequate records are taken, this could contribute to accountability failures through:

- Failure of employees or systems to make records in the first place.
- Making records that are inadequate to meet accountability and other organisational requirements (records that are not full and accurate).
- Failure to capture records into recordkeeping systems so that they cannot be found when required.
- Failure to maintain records during the time necessary to meet specific accountability requirements.
- Failure to assign responsibility for different aspects of recordkeeping at appropriate levels in the organization – so that no one takes responsibility.

(Australian Standard 4390.1, 1996)

3.7.2 ELECTRONIC RECORDS STORAGE

Digital records both active and inactive must be stored in appropriate conditions to ensure their ongoing accessibility. Digital records can be stored *online*, *offline* or *nearline*, depending on how often they are required to be re-accessed.

Online digital records are stored on mainframe storage, network attached storage and personal computer hard drives that have immediate access for retrieval. These are used for active digital records that are accessed regularly for business activities.

Offline digital records are stored on devices that are not directly accessible through a network system. They are usually stored on removable digital storage devices such as CD and DVD's. They are usually inactive records, not often required for normal business operations. Offline digital records may often be stored offsite, as part of a counter-disaster strategy. It is important to ensure that these records are protected from environmental degradation of the storage device and technology obsolescence of software required to access the data stored on them. Since they are not accessed regularly, these breakdowns can occur slowly without detection, eventually rendering the data useless.

Nearline digital records are stored on removable storage devices that are still relatively accessible, usually through a network system. The records are technically considered as offline records. The systems used are CD jukeboxes and magnetic tape silos.

In most circumstances digital records are initially created and stored online and over time, move to either nearline or offline, as the records are accessed less regularly.

It is suggested by the National Archives of Australia that records of high significance and those required to be held for a long period of time and of archival value, be stored on an online system. Records stored online usually on magnetic hard drives connected through a network system can be easily maintained and controlled as part of a firm's recordkeeping system. The large storage capacities of hard drives allow significant quantities of inter-related files to be stored on a single device. The records can have regular integrity checks performed when stored on a single device. Some specific recordkeeping software can make these automatically. Online records are easily recognised and noted, should a firm undergo a migration process, physically, or by software upgrades. Online systems can aid in quick and easy back-up and disaster management techniques by periodically creating copies onto offline systems that can be stored off sight.

The National Archives of Australia do not recommend using CD and DVD's to store long-term digital records. These should only be used for storing low-value records. Individual disks need to be indexed accurately to find records as required, are less likely to be checked for integrity and may be overlooked during a migration process. The longevity of the CD and DVD is not proven.

3.7.3 XML

The use of the Extensible Markup Language (XML) computer software is common for the use of capturing digital information for archiving purposes. Computer files created by commercial programs can be converted and stored in a long-term XML form. This allows records to be read in the future regardless of their original format. The National Archives of Australia are developing software that converts digital records to standardised XML form. While the XML Electronic Normalising of Archives (XENA) program is primarily for use by Archives for use internally, its development will be open-source for external parties to use to preserve their own digital records (National Archives of Australia, 2006).

A variant of XML (LandXML), is intended to be used to capture and store the Queensland cadastral survey plans if they move to a system of electronic lodgement of survey plans (pers comm., Cummerford, N, April 2006 Department of Natural Resources and Water).

3.7.4 AUTHENTICITY

Digital records can be easily modified and while security is an important issue, care must be taken to ensure that authentication methods used do not cause records to become inaccessible in the long term future.

Locking files and sub-directories of the field data and computations files as read-only and ready for archiving at a certain period - possibly after the final survey plan is lodged, will require saving and renaming them as a 'copy', before being modifiable. This will ensure the original is kept as an original.

A statement made by Hintz & Onsrud (1991) on this topic is that creating read-only files will keep the honest people honest. Most standard read-only functions can be easily side-stepped. No security measure is absolute, but any is better than none, and if these measures are seen to be part of the normal business practice it will enhance the likelihood of the records being admissible as evidence.

For recordkeeping systems to ensure the authenticity of their records, they should be able to show whether the digital records have been altered, the reliability of the software applications that created the records, the time and date of creation of the records, identify the author or creator of the record and the security of the record. Being able to track when the record was created, and when it was last altered will greatly improve a record's evidential value.

Authenticity may be shown by limiting access to records to authorised personnel only, by having security mechanisms in place preventing access by unauthorised personnel. An automatic system of audit trails would be able to track access to files, the time and date, and by whom.

3.7.5 CRYPTOGRAPHY

Cryptography can be used to ensure that a file transmitted elsewhere has not been tampered with and also to confirm that a file is an exact copy of an original. This is relatively easy with the use of simple 'hash function' (van der Lubbe, J.C.A., 1998, p163) software such as *MD5* (Message Digest Algorithm) and *SHA-1* (Secure Hash Algorithm) programs.

MD5 was designed by Ronald Rivest in 1991. The MD5 Message Digest Algorithm inputs a file and produces a 128-bit (or 16 byte) output that is represented as a string of 32 hexadecimal values. This output can be considered as a 'fingerprint' or 'message digest' for that file. An MD5 value can be transmitted along with the particular file. By comparing the supplied MD5 value to the actual value computed by the MD5 value created by the receiver, it can be verified that it is the same file (van der Lubbe, J.C.A., 1998).

It was originally considered computationally infeasible to produce two messages having the same message digest, or to produce any message having a given pre-specified target message digest (Berkes, J, 2005). Some flaws have been found since its' design, and cryptographers began recommending more secure hashes such as SHA-1. This algorithm is used in the Digital Signature Standard and is the copy prevention system for Microsoft's Xbox game consoles (Wikipedia.com). The MD5 algorithm is still considered as a very effective way to easily check basic file authenticity.

Checksum Test

A simple checksum program titled *MD5sums*, created and copyrighted by Berkes (2000-2005) was downloaded from <<http://www.pc-tools.net/files/win32/freeware>> to examine the viability for use by surveyors.

The raw data file from the Nikon NPL-352 was run through the program and the following signature was obtained:

b80c05cbe277bffec759e00789aa7f53

The file was then modified slightly by changing a single ASCII character and run through the program. A completely different signature was obtained – as expected.

The file was then modified back to its original state and run through the program. The exact signature above was returned. The same signature was also returned when the file *name* was altered. This indicates that this checksum program only reads the data in the file, and not the name. Nor does it read the information created by Microsoft Explorer such as 'date last accessed' or 'date last modified'. This information is viewable through Microsoft Explorer by examining file and folder 'properties'.

3.8 FURTHER REQUIREMENTS FOR FIELD NOTES

3.8.1 LODGEMENT OF FIELD NOTES

It was once a requirement for a surveyor's field notes to be lodged with the survey plan at the government department at that time. They were considered to be as important as the plan itself, in recording the position and dimensions of boundaries. It could be

considered that the field notes were a more reliable record of the boundary position, because there is one less ‘transition’ of the information pertaining to the boundary.

In certain situations it may be required to obtain copies of these notes to help determine a range of aspects about a boundary.

The original field notes may be considered to be a more reliable record of the dimensions of a boundary than the plan, because they are one less level of removal from the physical marking. There is one less chance of error possible through transcription or misinterpretation.

The most recent requirements for the lodgement of survey notes have been to show sun observations which were used to place surveys onto the Australian Map Grid Datum and when the survey reinstated an ambulatory boundary.

An ambulatory boundary is usually a boundary defined by a natural feature such as cliff faces, ridges, tidal watermarks and most commonly creek or riverbanks. These boundaries are not dimensioned on the face of the plan, as this would attempt to definitely define them, removing their ambulatory nature. The lodgement of the field notes was an attempt to have a record of the boundary’s position – at that point in time – and to provide for the calculation of land area.

Now, the requirement in Queensland is for a Survey Report relating to the ambulatory boundary to be lodged. It is not a requirement to show the *actual* field traverse and measurements to the boundary feature, as in the original fashion of chainage and offset. Instead, a report on the reasoning behind the determination of its position is lodged. The position is then depicted by scaled plot and a tabulation of calculated dimensions. The surveyor now keeps the proof of the measured location of the boundary (DNR & M, 2005).

3.8.2 RECORDS AS A STANDARD UNDER SMI ACT

While the lodgment of field notes is no longer a requirement, a cadastral surveyor may lodge them as *Survey Records* to provide further information about a survey or surveyed boundary that cannot be conveniently shown on the plan or is to show additional support of the survey. The survey records include information such as reinstatement

reports, creek traverses, encroachment advices etc or information which is not publicly searchable in the Department of Natural Resources & Mines.

The Department of Natural Resources & Mines creates a Standard, to satisfy the Survey Mapping Infrastructure Act 2003 in their Cadastral Survey Requirements. It stipulates that survey records for lodgment must be clearly identified *as survey records* and must include a completed Form 12 certificate in accordance with s.22(1) of the *Survey and Mapping Infrastructure Regulation 2004*.

Sufficient survey records must be deposited with the plan of survey to ensure that a complete record of the survey is available to the Department of Natural Resources and Mines. The survey records need not be in the traditional field note form but should be no larger than A4. Survey records must have a cover or cover sheet containing information such as:

- A description of the survey (in most cases the Lots numbers being created)
- A description of the lots being cancelled
- The Parish and County Names
- The surveyors name
- The plan number to which they refer

If a report is to accompany survey records, the report and survey records must be the same size and be securely bound together. When additional data is lodged in support of the survey e.g. creek traverse offsets, this information shall be indicated in the appropriate box on the face of the Form 21 Survey Plan (DNR & M, 2005).

3.8.3 REQUIREMENT TO CAPTURE AND STORE DIGITAL RECORDS

Surveyors need to recognise that they are required to keep field notes as a record of the survey performed and also because it is a requirement under legislation.

The Survey and Mapping Infrastructure Regulation 2004, states in Section 10, that the importance of cadastral surveys for a cadastral boundary system contributes to the maintenance and improvement of cadastral boundaries throughout the State and the information held in a State dataset or the land register kept under a registration Act. It

continues by stating that this may be achieved by, for example, ensuring each of the following in Subsections:

(e) the survey records for the survey contain a clear description of the survey marks placed;

(g) the survey records for the survey are kept in –

- (i) a State dataset; or*
- (ii) in the land registry kept under a registration Act;*

(h) the cadastral surveyor for the survey –

- (i) accepts responsibility for the survey quality; and*
- (ii) keeps survey records for the survey in a form suitable as a record of the survey*

In Section 22 of the Regulation, it states in Subsection:

(2) The cadastral surveyor must, unless the surveyor has a reasonable excuse, keep for 6 years any survey records not mentioned in subsection (1), whether or not all the information from the survey records is shown on the plan of survey.

To clarify what is meant by a survey record, The Survey and Mapping Infrastructure Regulation dictionary declares that:

***survey records**, for a survey, means the documents necessary to adequately record every aspect of the survey including the following –*

(a) a measurement or an analysis made for, or in relation to, the survey;

(b) information about –

- (i) survey marks placed in carrying out the survey; or*
- (ii) survey marks used as reference points in carrying out the survey:*

(c) the plan of survey;

*(d) any electronically produced measurement, analysis or
plan of survey.*

3.8.4 SUMMARY

A cadastral surveyor remains responsible for the cadastral surveys they perform forever. For this reason, it is important that they maintain adequate records of these activities. There is some conjecture that holding business records for any period longer than required may become a liability. Many professions purposefully and periodically destroy their business records for this reason. It has been suggested by colleagues in the profession that surveyors keep their records indefinitely. This project failed to find guidelines for the period required to hold records other than the previous statements in the Survey and Mapping Infrastructure Regulation.

Chapter 4

Results

4.1 STANDARDS for GENERAL APPLICATION of ELECTRONIC RECORDS

From the review of several sources of literature focused on records of an electronic nature, a summary of key standards required for their use as evidence has been established.

- Compliant. Records must comply with the record keeping requirements arising from the regulatory and accountability environment in which the organization operates. Employees must understand how their activities and record capture are affected.

- Adequate. Records should be adequate for the purposes for which they are kept. A corporation should not expend more on the record keeping process than what it may be worth (Bearman 1994). Records should be made for all those business activities for which there is a requirement for evidence. It is necessary to consider legislative and regulatory requirements when determining standards for electronic records.

- Complete. A record must contain not only the content, but also the structural and contextual information necessary to document the activity. The STRUCTURE of a record is its physical format, and the relationships between the data elements comprising the record should remain intact. The CONTEXT in which the record was created and used during the business operation should be recognisable in the record. This includes the process of which the transaction is part of, and the key components of the transaction.

- Meaningful. The contextual links of records requires enough information to correctly understand the transaction that created and used them. It should be possible to identify a record within the context of the broader business activity. The links between records, which document a sequence of activities, should be maintained. The date and time of a transaction should be part of the record.
- Accurate. Records must accurately reflect the transactions that they document. Business practices should require employees to make records that accurately reflect the transactions that they intend to document. The processes should be designed to make it easy, if not automatic, to make an accurate record of the transaction.
- Authentic. The creator of a record must be able to prove that documents actually are what they say they are a record of, and that they actually are the producer of it. It should be possible to show that the record keeping system was operating normally during the period the transactions occurred and made the record of it.
- Robust. Records must be securely maintained to prevent unauthorised access, alteration, or removal. No information in a record should be deleted, altered or lost once the transaction that it documents has occurred. Information added to existing hard copy records (i.e. annotations - which should be considered as part of a new transaction), should be initialled and dated. The integrity of electronic records should be maintained by identifying any change or annotation by audit trails. Information should never be added to a record so that it appears to be part of the original.
- Migration. Records migrated from one system to another due to technological upgrades or operational changes need to maintain the authenticity and accuracy of evidence. They must have the appropriate information brought forward.
- Responsibilities. Business policy needs to assign certain responsibilities of record keeping to particular staff members. These need to be incorporated into job descriptions and expectations. Each staff member should be trained to recognise and be capable of capturing the required records. Specific requirements (e.g. backup procedures) must be recognised and it be clear who is responsible for them.

- Accessibility. Records need to be retrievable by appropriate personnel so that it may be used as evidence of a transaction. Access to records must not modify or destroy the original record.

4.2 GUIDELINES

4.2.1 CONNECTION BETWEEN FIELD NOTES AND EVIDENCE

The Recordkeeping System

An electronic document becomes an electronic record when it takes part in a business transaction, and is kept to provide evidence of that transaction (Australian Standard 4390.1, 1996). Electronic field notes, as text or binary files, remain simply as a document until it is submitted into a record keeping system, containing relevant structural and contextual information as well as content.

Record keeping systems are systems that contain information linked to transactions that they document. The job folder could be considered a crude record keeping system. It should contain the raw electronic field notes downloaded from the data collector - the computations file that creates a spatial representation of the notes and facilitates and displays calculations – and the drafted CAD plan prepared for registration.

Job Folder/Directory

The job folder documents the transaction of creating or identifying cadastral boundaries. A simple link is that of the common job descriptor as a prefix to file names. The file name should represent its purpose, with a suffix indicating a version, upgrade or amendment.

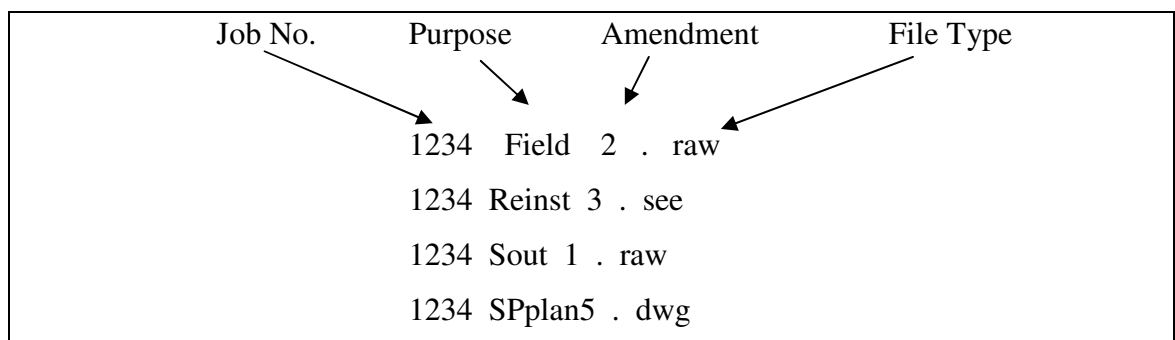


Figure 5. Job Folder File Naming Protocol

File naming structures should be as common as possible throughout an organization to help strengthen the argument that the record keeping system operates as part of the normal business function (see requirements for electronic records as evidence). This will also strengthen the *meaningfulness* of the records.

The computations file and raw files should be in the same sub-directory relating to field work, to keep the content data and context data together.

A simple text file (like a readme.txt) can easily be stored in the folder containing a small explanation of each file and the variations to new versions and stating the process of construction of the computations file.

1234Field1.see	-	Day 1 traverse	01/06/06
1234Field2.see	-	Day 1, 2, 3 traverse	05/06/06
1234Field3.see	-	Rotated by $-0^{\circ}04'40''$ about stn(26) For RP140116 DATUM (OIP@(6) and OIP@(8)	06/06/06
1234Reinst1.see	-	Bdy Reinstated Calcs	07/06/06

Figure 6. Explanatory File

Some software may have this built in as an amendment log. These are intended to keep a trace of major amendments such as rotations, co-ordinate shifts and adjustments.

There needs to be enough information to be able to reverse construction of the file to show where and how the dimensions of boundaries depicted on the survey plan originated.

4.2.2 FIELD NOTE FILE

Identifiers

Point numbers to objects in the field notes should match those same objects in the computations file. This is to produce a continual connectivity between the object located or marked in the field, and that same object as stored in the computer. This will be difficult with computational software that is heavily based on a CAD engine that does not use a system of unique identifiers.

Datum

Ideally, the datum (bearing rotation and to a lesser extent the co-ordinates) of the field notes and the computational file should be the same to enhance the connectivity between the two. In the traditional field notes lodged with the old plans, bearings and distances in the notes matched those on the final survey plan. This may be difficult on larger jobs that may merge small field operations into one large database. It may also be difficult because it is likely that the two marks first found and used as an initial datum may be used to calculate and find further marks, better suited for datum purposes.

Identification

It is important to have sufficient codes to depict the different forms of reference marks and corners. This can be divided into original marks by previous surveys, new marks placed by the current survey, original boundary positions, calculated positions for searching original marks, reinstated boundary positions, check shots on marks placed, traverse and control stations and traverse checks.

4.2.3 INTEGRITY – FIELD OBSERVATIONS

For this project, let it be assumed that there is the utmost confidence in the accuracy of the measurements of angles and distances by the modern total station. The integrity examined here, is that of the collection and importantly the *arrangement* of these, to produce a record of the survey.

Each set-up station needs to be considered as a confident *block* of data, *fixed* by:

Occupied Station Position fixed in a closed traverse

Backsight Station Fixes orientation of observations to the traverse

Foresight Station Can be a check on orientation to the traverse

Data Collected/Marked Stored as Bearings and Distances (not just coordinates) that relate to the traverse

Backsight Bearing Checked Confirms this block of data is correctly rotated to the traverse, and remained so during that period of data collection

The occupied station must be part of a closed traverse, or a traverse with some check in place to remove any chance of undetectable error within it.

Calculated points (determined by bearing/bearing intersection, distance/distance intersection, traverse/radiation, distance/offset, co-ordinate input etc) should show how they were created – what their origin is and thus their intention for creation. For example, if creating a corner say, 180°0' for 1.006 from an Original Iron Pin, the field notes should store this. They should not create just the coordinates. This is to enhance the connectivity between the intentions on the ground and the data in the field notes. An example may appear as follows:

```
pnt (116), Rad from (20), 180°00'00" 1.006
116 4116.112 10801.116 100.000 BDY
```

Set-Out Point Check Data

This needs to show the station from which they are set-out and needs to be included in a *fixed block* of confident data as mentioned earlier. The bearing and distance to the set-out point (as marked, not as calculated) should be stored. From these, the marked point's Easting & Northing is calculated, and the delta Easting & Northing can be calculated and stored.

It should be possible for this point to be stored as a downloadable check point (coded as such), to be stored into the computations software. This gives the check a spatial entity - not just residual numbers - to help link it to the desired boundary point. Nikon adds a specified addition (say 10000) to the set-out point number that can be coded as a check. This is ideal for maintaining the link between points using their identifier.

Check Back sight regularly. When occupying a station for lengthy periods of time, check the Back Sight regularly, reset if necessary, but this should be recorded and time stamped.

4.2.4 AUTHENTICITY

The investigation of the Message Digest (MD5) checksum test revealed the program can only be used to verify a file has not been altered. For MD5 to be used to ensure authenticity, a third party would be required to hold a control copy of the checksum signature that incorporates a timestamp of the file. There are private companies that specialise in this activity.

Although simple text files are easily modifiable, they are also the most likely form still readable by software in the future. Converting electronic field notes into an XML format may be an option in the near future. The XML platform is an attempt to standardise digital record archiving. Files captured in this format will be readable in the future, as software will be developed for that exact purpose.

4.2.5 RECOGNITION OF RESPONSIBILITY

Ensure that staff at all levels of management are aware of their responsibilities with respect to recordkeeping. They need to understand and be able to perform the procedures in place so that the correct information is collected and stored appropriately. There is no point having policies in place if no one knows of them or how to implement them.

Junior Survey Party Leader

This position involves performing minor data collection, minimal reinstatement calculations, and most likely demarcation of boundaries under the supervision of senior party leaders. They need to be aware of the importance of good quality field notes and the standard required. They not only need to know *how*, but *why* they are expected to produce field notes of such a standard.

Middle Management – Senior Survey Party Leader

This level of management will possibly take most of the responsibility for the use and storage of field notes. Since they are usually the project manager for a particular job, the senior party leader will be in control of the job's physical folder and data directory, the set up of its content and storage. Constant supervision of the notes taken by junior staff will need to be performed.

Higher Management – Directors

Directors need to be confident that the information collected is accurate and reliable and is handled in such a way to ensure it is an accurate and reliable record of the transaction. Adequate time must be allocated to job timeframes to allow for the proper procedures of data collection, manipulation and storage to be performed.

4.2.6 STORAGE & RECOVERY

The storage of both electronic and paper based field notes must be part of the firm's business recordkeeping system. A firm may elect to have two job databases to separate records of the field and office operations that relate directly to the procedures of a survey and the records that relate to the administration procedures of that job. This will depend on the size of the firm, and the size and nature of the individual job.

Having the administration records separate would allow for easier purposeful destruction of them after a determined period, leaving the survey records in their permanent storage system.

Digital Records Storage

A surveyor's electronic field notes are not likely to be re-accessed very often (if at all) once the survey has been completed and the final survey plan is lodged. In staged developments it is highly likely that the co-ordinated survey control traverses and reference marks stored in the computations files will be sourced for future work, but unlikely that their notes will be required. A new set of notes will be created for those surveys. The only likely time that notes may need to be re-accessed is in the event that they are called upon for evidence of mark placement or collection. The notes may be considered as important archival evidence, but will only be accessed very rarely.

In order to maintain the unequivocal connection between the digital record and that to which it is evidence of, it is suggested that the raw electronic field notes should be stored in the same recordkeeping system as that of the computations file and CAD plan. These files would be best stored in an online system and later a nearline system, with adequate information to link the relationship between files together. Offline back-up storage should be used for disaster management. Portable plug-in hard drives currently available have very large amounts of storage space for offline backup systems for a reasonable price. The longevity of these is also unknown so purchasing a new drive and transferring data periodically will reduce the chance of failure.

4.2.7 PAPER FIELD NOTES

From the study of existing electronic field books, it was discovered that the amount of information that could be stored was limited. Not information about the measurements themselves, but information about the objects measured to, and their surroundings.

Cadastral surveys require the analysis of the type and age of monuments, occupation, reference marks and also the general situation. Some evidence pertaining to the reinstatement of a boundary may have more weight than others due to the original intentions of previous surveys. Most data collection systems allow for the input of additional explanatory text, but the amount is limited. While good quality coding of objects can help, the old saying that ‘a picture says a thousand words’ cannot be ignored. Also, it is much quicker to sketch and write information than it is to enter via a keyboard – especially where three letters are assigned to a single key.

Paper field notes need to be taken to close any gaps of integrity that may exist in the particular electronic system utilised. If certain operations or decisions cannot be portrayed in the electronic system, then these need to be noted by pen and paper. They can be used to enhance that important connectivity between the electronic records system and the field operations to which it is evidence by spatially portraying point identifiers of objects and property corners as calculated and marked.

4.2.8 PAPER PRINTOUTS

Although electronic field notes could be kept as evidence of a fact in their digital form, it may be better practice to convert them to a paper copy that can be analysed and annotated by the surveyor. This should of course be stored with any relevant pen/paper field notes and accurately cross referenced.

By placing a signature and date onto these printouts, the surveyor is effectively creating a ‘certified’ copy of the electronic notes. The certification could be enhanced by attaching a certifying statement such as:

I, *surveyor* , hereby certify that these printouts are a true and accurate copy of the electronic field notes which are true and accurate records of the survey performed by *surveyor* on *date*

_____	_/ _/ _
Surveyor	Date

The advantages of converting electronic notes to paper include:

- capturing them into an almost permanent, robust state
- can be stored and compiled with other paper based records as a complete system
- alleviates problems associated with software migration and obsolescence
- can be certified as shown above

4.3 SUMMARY

These guidelines attempt to address the standards required of electronic records to be admissible as evidence by methods practically available to a small to medium surveying firm.

Chapter 5

Conclusion

Until such time that an electronic field book system can capture sketch and annotative information as quickly and accurately as pen/paper can, surveyors will and should continue to use this traditional method – although not exclusively. The electronic field note system can be very effective and efficient in collecting measurements and performing complex calculations. They can be used to eliminate transitions of information that require human transcriptions and therefore greatly reduce human errors in the boundary definition process.

Unfortunately the project failed to produce a booklet of guidelines for distribution to surveyors. It was felt that there were still many issues that required further research – especially in the area of authenticity of electronic records and a robust format in which to capture and store. These are difficult issues that, in hindsight, could not be fully understood and addressed by the scope of this project and may be researched by one with a software engineering background.

The use of the Extensible Mark-up Language (XML) was not researched in depth, but with the electronic lodgement of survey plans, perhaps electronic field note systems could become efficient and standardised enough for use and interaction with digital lodgement and the Digital Cadastral Data Base.

If the surveying industry moved heavily towards a paperless profession, perhaps the business sector of the Spatial Science Institute could warrant facilitating a holding bank

for cryptographic keys and digital signatures of electronic field notes to ensure their authenticity.

Although this project did not manage to fulfil all of its objectives, it is hoped that readers may use the guidelines stated in Chapter Four to recognise existing pitfalls and to ensure that the important link between the field notes, being evidence, and the determined and marked position of a property boundary, being what the notes are evidence of, is preserved to help ensure their admissibility as evidence in legal proceedings and disciplinary hearings.

It is hoped that by using the guidelines stated in this project will help improve the integrity of the modern surveyor's field notes.

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LEGISLATION

Evidence Act 1977 (Qld)

Surveyors Act 2003 (Qld)

Survey & Mapping Infrastructure Act 2003 (Qld)

Survey & Mapping Infrastructure Regulation 2003 (Qld)

Surveyors Regulation 2004 (Qld)

APPENDICES

APPENDIX B1

RESULTS – TRIMBLE S6

ATTRIBUTE	Y/N	COMMENTS
PROTECTION OF DATA FROM CORRUPTION DURING DOWNLOAD	Y	<i>Can request a data transfer check</i>
CONTROL NETWORK	?	<i>Not investigated in detail</i>
COLLECTED INFORMATION & THE CONNECTION TO TRAVERSE	Y	<i>Yes, but not obvious</i>
TRAVERSE CLOSE CHECK - Computed Inverses	Y	<i>Can compute inverse – does store this as comment – Brg & Dist – good</i>
CREATION OF NEW POINTS - Show Origin - Show How - Show Co-Ordinates - Give Code	N N Y Y	
SET-OUT OF NEW POINT - Show Setup Station - Show Bearing & Distance - Show Residuals - Store Co-ordinates of Set-out Point - Code Set-out Point - Set-out Data & Traverse in Same File	Y N Y N N Y	<i>Only at start of Stn Set-up</i> <i>Delta Co-Ords</i> <i>May also store elsewhere – not investigated</i>
EXAMINATIONS/CALCULATIONS - Store All - Store on Demand - Store None	N N N	
BACKSIGHT - Store Setting - Store Checks - Store Resets	Y ? ?	<i>Stores backsight bearing & Stn</i> <i>Not determined</i> <i>Not determined</i>
TIME STAMPS - How often - After Each Shot - After Each Stn Setup - After Each Calculation - After each Backsight Check - On Demand	N N N N ?	<i>Not consistent – approx 32 mins ?</i> <i>Not determined</i>
FIELD NOTE FILE - Format (.txt, specific etc) - Easy to Follow - Concise	N N	<i>Printed from DC file Editor</i> <i>Lots of unnecessary info</i> <i>Simple Job – 3 pages long</i>

APPENDIX B2
RESULTS – TOPCON-GTS 700

ATTRIBUTE	Y/N	COMMENTS
PROTECTION OF DATA FROM CORRUPTION DURING DOWNLOAD	N	<i>Need to run own checksum software</i>
CONTROL NETWORK	N	<i>Part of main file</i>
COLLECTED INFORMATION & THE CONNECTION TO TRAVERSE	Y	<i>Yes but not obvious</i>
TRAVERSE CLOSE CHECK - Computed Inverses	N	<i>Cannot store inverses</i>
CREATION OF NEW POINTS - Show Origin - Show How - Show Co-Ordinates - Give Code	N N N Y	<i>Point stored as co-ord point only – can be downloaded as such</i>
SET-OUT OF NEW POINT - Show Setup Station - Show Bearing & Distance - Show Residuals - Store Co-ordinates of Set-out Point - Code Set-out Point - Set-out Data & Traverse in Same File	N N Y Y/N N N	<i>Displays Design, Collect, Delta Co-Ords Stores as above, Not as separate point Stored separate – can download Point & Residuals Only</i>
EXAMINATIONS/CALCULATIONS - Store All - Store on Demand - Store None	N N N	<i>Only stores point & co-ords of points calculated – no inverse or other examinations</i>
BACKSIGHT - Store Setting - Store Checks - Store Resets	Y/N N N	<i>Only by using computations field codes Only as ‘Side-shot’ (detail pickup) Only as New Stn Set-Up</i>
TIME STAMPS - How often - After Each Shot - After Each Stn Setup - After Each Calculation - After each Backsight Check - On Demand	N N N N N	<i>Only in Header File at start of Job Setup No timestamps during field work No timestamps in Set-out data or checks</i>
FIELD NOTE FILE - Format (.txt, specific etc) - Easy to Follow - Concise	Y/N Y	<i>Raw data(FC-5) and field file as text files Raw data very difficult – Field file Easy Small files – don’t store much</i>

APPENDIX B3
RESULTS – NIKON NPL-352

ATTRIBUTE	Y/N	COMMENTS
PROTECTION OF DATA FROM CORRUPTION DURING DOWNLOAD	N	<i>Need to run own checksum software</i>
CONTROL NETWORK	N	<i>Part of main file</i>
COLLECTED INFORMATION & THE CONNECTION TO TRAVERSE	Y	<i>Yes not obvious</i>
TRAVERSE CLOSE CHECK - Computed Inverses	Y	<i>Can compute inverse – does store in Transit File as comment – Brg & Dist - good</i>
CREATION OF NEW POINTS - Show Origin - Show How - Show Co-Ordinates - Give Code	Y/N Y/N Y Y	<i>Yes for Brg/Brg intstn, but not for Radiation As above States “manual’ or ‘sight shot’ for creation</i>
SET-OUT OF NEW POINT - Show Setup Station - Show Bearing & Distance - Show Residuals - Store Co-ordinates of Set-out Point - Code Set-out Point - Set-out Data & Traverse in Same File	Y Y Y Y Y Y	<i>Only at start of Stn setup To as-marked point As delta co-ords New point with incremented identifier by specified amount (say 10,000) Need to download ALL co-ord points to get set-out points</i>
EXAMINATIONS/CALCULATIONS - Store All - Store on Demand - Store None	N Y N	<i>Most examinations saved as comments</i>
BACKSIGHT - Store Setting - Store Checks - Store Resets	Y Y Y	<i>Bearing and Stn No Stores read bearing Stores check bearing and reset bearing</i>
TIME STAMPS - How often - After Each Shot - After Each Stn Setup - After Each Calculation - After each Backsight Check - On Demand	Y Y N Y N	<i>Not periodic In Raw file, not Transit</i>
FIELD NOTE FILE - Format (.txt, specific etc) - Easy to Follow - Concise	Y Y/N	<i>Raw file is .txt file – Transit is Print file Raw file and Transit Print file Yes for Raw file, lots of whitespace for Transit Print file</i>

APPENDIX C1 - TRIMBLE INVESTIGATION - Paper Field Notes

TRIMBLE SFC
28-6-06

At 9001 BS 9000 270°0'
to (1000) 12° 32' 35" 4-008

At (1000) BS (9001) 192° 32' 35"
to (1001) 292° 26' 10" 5-243 00200
to (1) RFP 9660
to (2) CLERIC 00500

At (1001) BS (1000) 112° 26' 10"
to (3) check BS 00500
to (4) 146° 04' 58" 7-125 close 00600
to (9001)

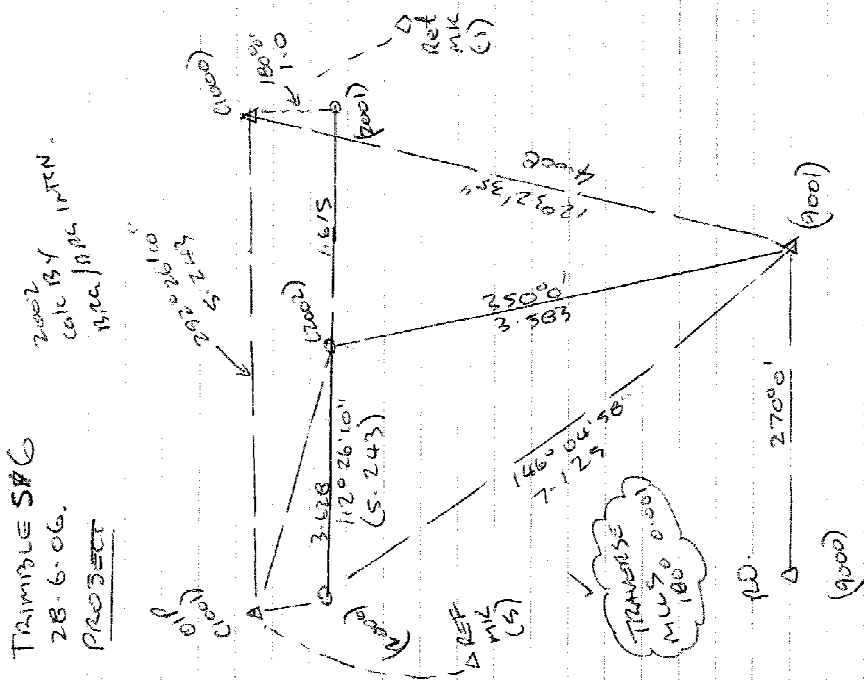
CLERIC CLOSE (4-9001) 240° 0' 000 ✓
to (5) RFP 906

CALLS:
NEW COTS (2000) (2001), (2002) (SEE SKETCH)

SETOUT (2002)
- stake out BS POINT AS CLERIC
to (2002) 125° 25' 04" 4-115 Ag Pld.

check BS. By stakeout Pt. (1000) ✓

(2)



APPENDIX C2 – TRIMBLE INVESTIGATION – Trimble as SDR33 Field File

DM2.fld (FIELD FILE PRODUCED FROM LISCAD)
 OF SDR33 FORMAT RAW FILE
 TRIMBLE SG

DM2

```

1 010 Sokkia SDR-33 DM2.RAW
2 011 Thursday, 10 August 2006
3 ; Version Number SDR33 V04-03
4 032 2146
5 ; 009 29-Jun-06 14:25
6 051 DD
7 053 M
8 021 YX
9 052 +
10 001 DM2
11 ; 1:Meters:
12 ; Time Date 06/28/2006 Time 19:11:26
13 022 1.00000000
14 033
15 034 000000
16 031 S Series
17 035 Z
18 ; 037 0.000
19 030 710.92500000000015.0000000000000
20 061 9001 2000.00000 1000.00000 600.00000 002
21 061 9001 2000.00000 1000.00000 600.00000 002
22 ;
23 102 9001 1.5000 1.1000 9000 270.00000
24 121 9000 270.00000 0.0000 -9999.9990 002
25 111 9000 270.00000 96.53391 5.4725 002
26 105 1.6000
27 033
28 034 000000
29 031 S Series
30 035 Z
31 ; 037 0.000
32 033
33 034 000000
34 031 S Series
35 035 Z
36 ; 037 0.000
37 033
38 034 000000
39 031 S Series
40 035 Z
41 ; 037 0.000
42 030 710.92500000000015.0000000000000
43 111 1000 12.54303 90.60885 4.0079 004
44 061 1000 2003.91206 1000.87036 599.85741 004
45 ;
46 102 1000 1.6000 1.5000 9001 192.54303
47 111 9001 192.54303 90.82953 4.0100 002
48 ; Time Date 06/28/2006 Time 19:42:02
49 105 1.3000
50 111 1001 292.43583 92.67948 5.2482 002
51 111 1 173.01645 109.51371 2.5686 906
52 105 1.6000
53 033
54 034 000000
55 031 S Series
56 035 Z
57 ; 037 0.000
58 030 710.92500000000015.0000000000000
59 111 2 192.54231 90.82467 4.0083 005
60 061 1001 2005.91285 996.02467 599.91206 005
61 ;
62 102 1001 1.3000 1.5000 1000 112.43583
63 111 1000 112.43583 89.55531 5.2426 004
    
```

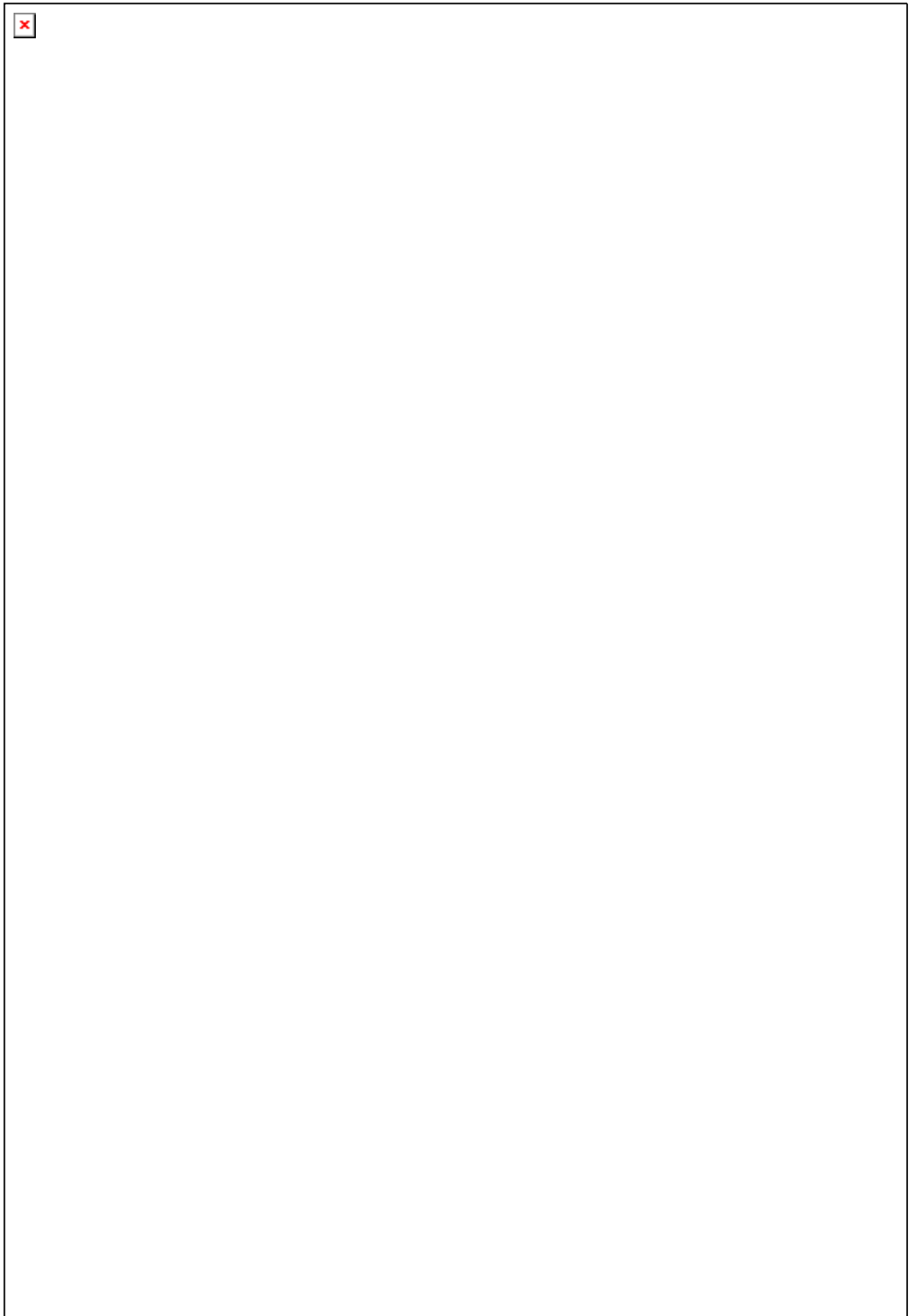
APPENDIX C2 – TRIMBLE INVESTIGATION – Trimble as SDR33 Field File

```

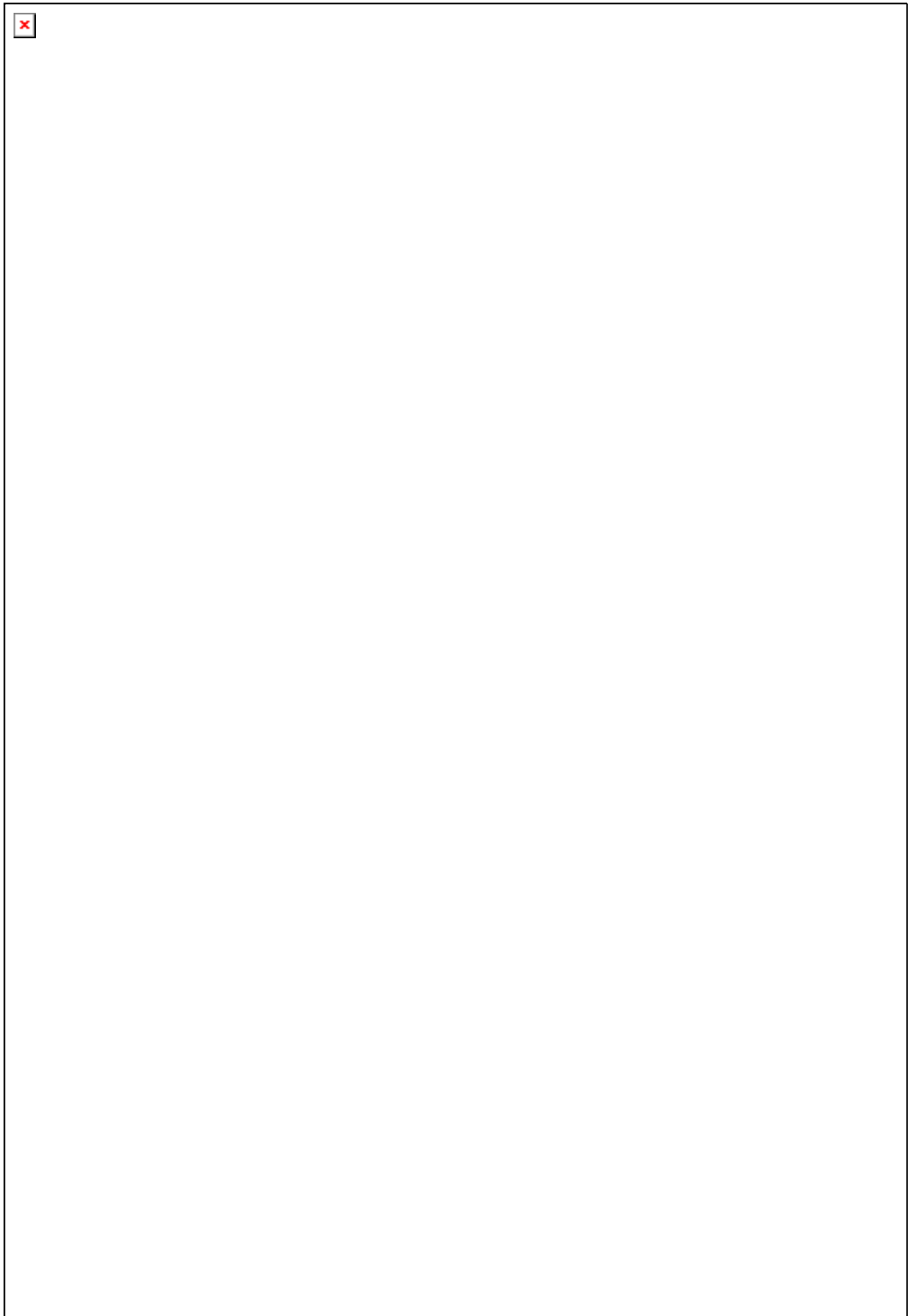
64      111      1000 292.43583 270.44469 5.2427 004
65      116      1000      2003.91203 1000.87042 599.75276 004
66      111      3 112.43565 89.55531 5.2430 005
67      105      1.6000
68      111      4 146.08287 89.32662 7.1254 004
69      ; Computed inverse, Start pt: 4, End pt: 9001,
70      ; Azimuth: 240.440°, H Dist: 0.000m, V Dist: 0.304m, } CLOSE CHECK
71      ; S Dist: 0.304m } RECORDED
72      105      1.1000
73      111      5 194.18805 103.77261 3.1503 906
74      ; Time Date 06/28/2006 Time 20:14:26
75      116      2000      2004.91285 996.02467 599.91206 901 } CORRS BY
76      116      2001      2002.91206 1000.87036 599.85741 901 } OLD'S
77      ; Computed inverse, Start pt: 2000, End pt: 2001, } NO RECORD
78      ; Azimuth: 112.436°, H Dist: 5.243m, V Dist: -0.055m, } OF HOW
79      ; S Dist: 5.243m } COR BY INTSN
80      117      2002      2003.52829 999.37787 901 } NO RECORD HOW
81      105      1.5000
82      111      6 112.42971 89.58078 5.2424 1000
83      111      7 125.41518 99.78705 4.1767 2002
84      111      8 112.43574 89.58483 5.2432 1000
85      ; Computed inverse, Start pt: 9001, End pt: 2002,
86      ; Azimuth: 350.000°, H Dist: 3.583m, V Dist: ?, S Dist: ?

```

APPENDIX C3 – TRIMBLE INVESTIGATION – Trimble as DC FILE EDITOR



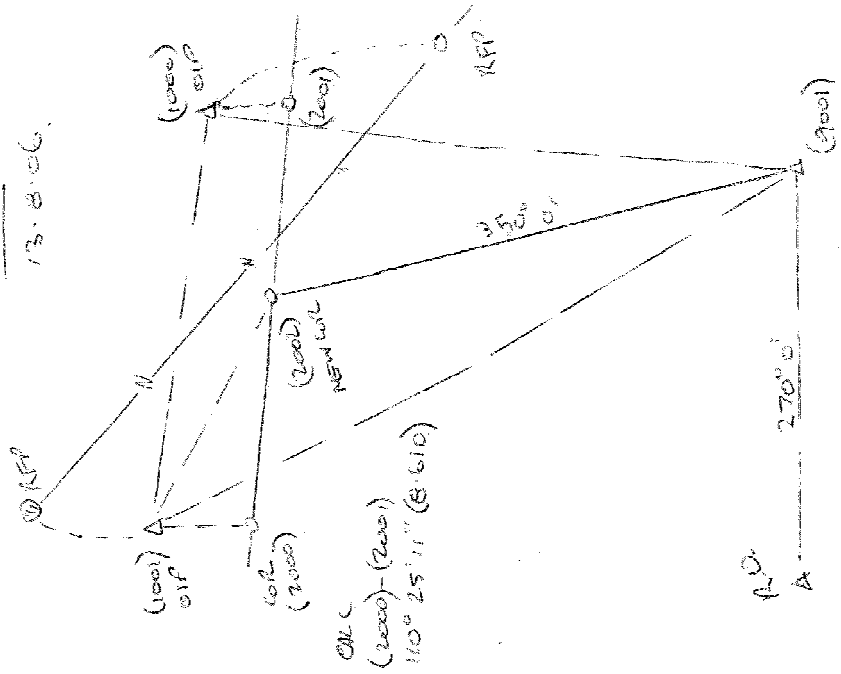
APPENDIX C3 – TRIMBLE INVESTIGATION – Trimble as DC FILE EDITOR



APPENDIX D1 - NIKON INVESTIGATION - Paper Field Notes

PROJECT

NIKON
13.8.06



NIKON NPL-35Z
13.8.06

AT (1000) BS (1000) 270°00' RL/MR
to (1000) RL 12°07'02" to BS 10-456
RL 192°07'31" 10-456

CHECK BS 270°00' 00"

AT (1000) BS (2000) 192°07'05" FL/MR
to (1000) RL 290°25'12" B 609

to (1) 90600 RFP
to (2) 00500 check to BS (2000)
check BS 192°07'09"

AT (1000) BS (2000) 110°25'10"
to (3) 00500 check to (1000)
to (4) 00300 check to (1000)
to (5) 90600 RFP

CHECK CLOSE (A) - (1000) 270°0'00" ✓

CHECKS

Calc (2000) + (2000) By Brg/Dist.
Calc (2000) By Brg/Brg when (2000) + (2000)

SETUP NEW GPR

CHECK BS ✓
to (2000) 121°56'40" 4.674. Brg/Dist.
check BS ✓

②

①

APPENDIX D2 – NIKON INVESTIGATION – Nikon as RAW FILE

NIKON RAW TEXT FILE

PROJECT-NIKON-RAW.RAW

Nikon V 2.00
CO,Nikon RAW data format v2.00
CO,PROJ2
CO,Description:
CO,Client:
CO,Comments:
CO,Downloaded 13-Aug-2006 08:31:04
CO,Software: Pre-install version: 1.20
CO,Instrument: Nikon NPL-352
CO,Dist Units: Metres
CO,Angle Units: DDDMMSS
CO,Zero azimuth: North
CO,Zero VA: Zenith
CO,Coord Order: ENZ
CO,HA Raw data: Azimuth
CO,Tilt Correction: VA:ON HA:ON
CO, PROJ2 <JOB> Created 12-Aug-2006 12:16:09
CO,S/N:032058
MP,9001,,1000.000,5000.000,600.000,00200
CO,Temp:20C Press:1013hPa Prism:0 12-Aug-2006 12:20:33
ST,9001,,270,,1.600,270.0000,270.0000
F1,270,0.000,,0.0000,91.4925,12:20:33
F2,270,0.000,,180.0012,268.1028,12:20:33
F1,1000,1.500,10.458,12.0702,88.5441,12:59:19
F2,1000,1.500,10.458,192.0731,271.0548,12:59:19
SS,1000,1.500,10.458,12.0711,88.5427,12:59:19,00200
CO,BSchk HA=270.0009 Reset to HA=270.0000 13:01:30
CO,Temp:20C Press:1013hPa Prism:0 12-Aug-2006 13:05:19
ST,1000,,9001,,1.500,192.0705,192.0705
F1,9001,1.600,10.457,0.0000,91.0436,13:05:19
F2,9001,1.600,10.457,180.0021,268.5517,13:05:19
F1,1001,1.300,8.614,290.2512,91.5340,13:07:44
F2,1001,1.300,8.615,110.2535,268.0601,13:07:44
SS,1001,1.300,8.615,290.2513,91.5350,13:07:44,00200
SS,1,1.500,3.481,172.1035,97.3412,13:11:13,90600
SS,2,1.600,10.460,192.0721,91.0425,13:14:17,00500
CO,BSchk HA=192.0710 Reset to HA=192.0705 13:15:08
CO,Temp:20C Press:1013hPa Prism:0 12-Aug-2006 13:41:22
ST,1001,,1000,,1.300,110.2511,110.2511
F1,1000,1.500,8.615,0.0000,88.0533,13:41:22
F2,1000,1.500,8.615,180.0008,271.5459,13:41:22
SS,3,1.500,8.615,290.2517,271.5459,13:43:30,00500
F1,4,1.500,14.473,156.0235,89.3849,13:45:10
F2,4,1.500,14.474,336.0248,270.2107,13:45:10
SS,4,1.500,14.474,156.0238,89.3851,13:45:10,00500
SS,5,1.500,2.680,167.4503,104.0957,13:48:09,90600
CO,BSchk HA=110.2456 Reset to HA=110.2511 14:03:03
CO,Pt:12002 SO deltas E:0.004 N:-0.002 Z:
SO,12002,,1.500,4.753,121.5643,99.0414,14:12:46,
CO,BSchk HA=110.2512 Reset to HA=110.2511 14:15:36

CO'S BY
DIP
LALBY
INTSN

PLEASE CHECK
NO RECORD

NO RECORD USE HOW
GOOD RECORD

APPENDIX D3 – NIKON INVESTIGATION – Nikon as LISCAD FIELD FILE

NIKON FIELD FILE BY LISCAD

```

PROJECT-NIKON-RAW
1 010 Nikon V 2.00 project-nikon-raw.raw
2 011 Sunday, 13 August 2006
3 ; Nikon RAW data format V2.00
4 ; PROJ2
5 ; Downloaded 13-Aug-2006 08:31:04
6 008 Pre-install version: 1.20
7 008 Nikon NPL-352
8 053 M
9 051 DM
10 035 Z
11 021 XY
12 ; Tilt Correction: VA:ON HA:ON
13 ; PROJ2 <JOB> Created 12-Aug-2006 12:16:09
14 ; S/N:032058
15 061 9001 1000.00000 5000.00000 600.00000 00200
16 ; ; Temp:20C Press:1013hPa Prism:0 12-Aug-2006 12:20:33

17 ; F1,270,0.000,,0.0000,91.4925,12:20:33
18 ; F2,270,0.000,,180.0012,268.1028,12:20:33
19 ; F1,1000,1.500,10.458,12.0702,88.5441,12:59:19
20 ; F2,1000,1.500,10.458,192.0731,271.0548,12:59:19
21 ;
22 102 9001 1.6000 1.5000 270 270.00000
23 111 1000 12.07110 88.54270 10.4580 00200
24 ; ; BSchk HA=270.0009 Reset to HA=270.0000 13:01:30

25 ; ; Temp:20C Press:1013hPa Prism:0 12-Aug-2006 13:05:19

26 ; F1,9001,1.600,10.457,0.0000,91.0436,13:05:19
27 ; F2,9001,1.600,10.457,180.0021,268.5517,13:05:19
28 ; F1,1001,1.300,8.614,290.2512,91.5340,13:07:44
29 ; F2,1001,1.300,8.615,110.2535,268.0601,13:07:44
30 ;
31 102 1000 1.5000 1.3000 9001 192.07050
32 111 1001 290.25130 91.53500 8.6150 00200
33 105 1.5000
34 111 1 172.10350 97.34120 3.4810 90600
35 105 1.6000
36 111 2 192.07210 91.04250 10.4600 00500
37 ; ; BSchk HA=192.0710 Reset to HA=192.0705 13:15:08

38 ; ; Temp:20C Press:1013hPa Prism:0 12-Aug-2006 13:41:22

39 ; F1,1000,1.500,8.615,0.0000,88.0533,13:41:22
40 ; F2,1000,1.500,8.615,180.0008,271.5459,13:41:22
41 ;
42 102 1001 1.3000 1.5000 1000 110.25110
43 111 3 290.25170 271.54590 8.6150 00500
44 ; F1,4,1.500,14.473,156.0235,89.3849,13:45:10
45 ; F2,4,1.500,14.474,336.0248,270.2107,13:45:10
46 111 4 156.02380 89.38510 14.4740 00500
47 111 5 167.45030 104.09570 2.6800 90600
CORR BY 48 061 2000 994.12600 5012.22700 600.21400 90100 } NO RECORD
CIP 49 061 2001 1002.19500 5009.22300 600.29900 90100 } OF NEW
CORR BY 50 062 2002 998.10500 5010.74600 90100
INTSN 51 ; ; Int BB P1:9001 AZ:350.0000+0.0000 } GOOD RECORD
52 ; ; P2:2000 AZ:110.2511+0.0000 } OF NEW

53 ; ; BSchk HA=110.2456 Reset to HA=110.2511 14:03:03

54 ; ; Pt:12002 so deltas E:0.004 N:-0.002 Z:
RECORD
55 ; ; BSchk HA=110.2512 Reset to HA=110.2511 14:15:36
BACKSITE CHECKED & RECORDED.

```

APPENDIX D4 – NIKON INVESTIGATION – Nikon as TRANSIT FILE

Job: c:\documents and settings\owner\my documents\dmc assignments etc\eng4111 project\data\project-nikon-raw.trn Date:

Invalid Record

NIKON RAW FILE IN "TRANSIT"

Nikon V 2.00

*** Nikon RAW data format V2.00 ***
 *** PROJ2 ***
 *** Description: ***
 *** Client: ***
 *** Comments: ***
 *** Downloaded 13-Aug-2006 08:31:04 ***
 *** Software: Pre-install version: 1.20 ***
 *** Instrument: Nikon NPL-352 ***
 *** Tilt Correction: VA:ON HA:ON ***
 *** PROJ2 <JOB> Created 12-Aug-2006 12:16:09 ***
 *** S/N:032058 ***

Manual Input

9001 1000.0000 5000.0000 600.0000 00200

*** Temp:20C Press:1013hPa Prism:0 12-Aug-2006 12:20:33 ***

Station Setup

9001 1.6000 270 270.0000 270.0000

Face 1

270 0.0000 0.0000 0.0000 91.4925

Face 2

270 0.0000 180.0012 0.0000 268.1028

Face 1

1000 1.5000 12.0702 10.4580 88.5441

Face 2

1000 1.5000 192.0731 10.4580 271.0548

Side Shot

1000 1.5000 12.0711 10.4580 88.5427
 1000 1002.1953 5010.2230 600.2994 00200

*** BSchk HA=270.0009 Reset to HA=270.0000 13:01:30 ***
 *** Temp:20C Press:1013hPa Prism:0 12-Aug-2006 13:05:19 ***

Station Setup

1000 1.5000 9001 192.0705 192.0711

BACKSITE STN
BACKSITE BEARING PL
PR.

Face 1

9001 1.6000 0.0000 10.4570 91.0436

Face 2

9001 1.6000 180.0021 10.4570 268.5517

TWO FACES.

Face 1

1001 1.3000 290.2512 8.6140 91.5340

Face 2

1001 1.3000 110.2535 8.6150 268.0601

Side Shot

1001 1.3000 290.2513 8.6150 91.5350
 1001 994.1262 5013.2274 600.2142 00200
 1 1.5000 172.1035 3.4810 97.3412
 1 1002.6649 5006.8045 599.8408 90600

← AVERAGED M-MENT FLIER
← CAL'D COORS.

APPENDIX D4 – NIKON INVESTIGATION – Nikon as TRANSIT FILE

o: c:\documents and settings\owner\my documents\dmc assignments etc\eng4111 project\data\project-nikon-raw.trn Date:

Side Shot

2	1.6000	192.0721	10.4600	91.0425
2	999.9988	4999.9982	600.0034	00500

*** BSchk HA=192.0710 Reset to HA=192.0705 13:15:08 ***
 *** Temp:20C Press:1013hPa Priem:0 12-Aug-2006 13:41:22 ***

Station Setup

1001	1.3000	1000	110.2511	110.2519
------	--------	------	----------	----------

Face 1

1000	1.5000	0.0000	8.6150	88.0533
------	--------	--------	--------	---------

Face 2

1000	1.5000	180.0008	8.6150	271.5459
------	--------	----------	--------	----------

Side Shot

3	1.5000	290.2517	8.6150	271.5459
3	986.0573	5016.2320	600.3023	00500

Face 1

4	1.5000	156.0235	14.4730	89.3849
---	--------	----------	---------	---------

Face 2

4	1.5000	336.0248	14.4740	270.2107
---	--------	----------	---------	----------

Side Shot

4	1.5000	156.0238	14.4740	89.3851
4	1000.0026	5000.0003	600.1033	00500
5	1.5000	167.4503	2.6800	104.0957
5	994.6774	5010.6881	599.3583	90600

Calculated Coordinates

2000	994.1260	5012.2270	600.2140	90100
2001	1002.1950	5009.2230	600.2990	90100
2002	998.1050	5010.7460	0.0000	90100

3 NO INFO ON HOW CREATED

*** Int BE P1:9001 AZ:350.0000+0.0000 ***
 *** P2:2000 AZ:110.2511+0.0000 ***
 *** BSchk HA=110.2456 Reset to HA=110.2511 14:03:03 ***
 *** Pt:12002 SO deltas E:0.004 N:-0.002 Z: ***

*BSchk/BSchk
INTSIN*
 (12002) IS A POINT CO-ORIGINATED FROM S-OUT DS OF DESIGN POINT(2002)

Stakeout Point

12002	1.5000	121.5643	4.7530	99.0414
12002	998.1088	5010.7439	599.2649	

← MEASURED TO SETOUT POINT - GOOD
 ← MEASURED COORDS

*** BSchk HA=110.2512 Reset to HA=110.2511 14:15:36 *** CHECK TO PARKSITE ✓

APPENDIX E1 - TOPCON INVESTIGATION - Paper Field Notes

TOPCON GTS-701

At (9001) BS (9000) 270° 0'
to (1004) 12° 06' 59" 10.459
check BS 270° 00' 00" ✓

At (1000) BS (9000) 172° 06' 59"
to (1002) 27° 25' 00" 8.614
to (1) 90600 5m RFP
to (2) 00500 check to BS
check BS 172° 06' 45"

At (1002) BS (9000) 110° 25' 55"
(3) 00500 check to (9000)
(4) 00500 (to (1004) (9001)
close 156° 34' 2"

(5) 90600 5m RFP
CHECK CLOSE (4) → (9001) 120° 24' 01.0004

check

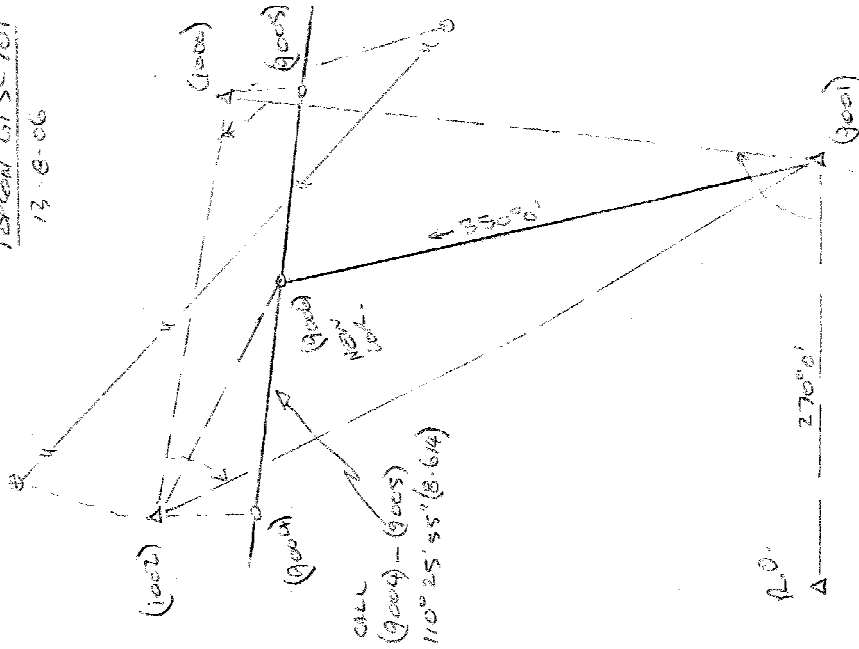
check (9004), (9005) By Brg/Dist 1000' 10 each.
check (9006) By Brg/Dist into
(9001) → 350' + (9004) → 110° 25' 55"

SETUP NEW W/L

(9006) 121° 57' 20" 4.692
check BS 110° 25' 40"
(6) 00500 check to (1000)

TOPCON GTS-701

13-8-06



APPENDIX E2 – TOPCON INVESTIGATION – Topcon as RAW FC-5 FILE

TOPCON RAW FC-5 TEXT FILE

project-topcon-raw

Topcon FC-5

1_!_"_#_11/08/01_'9001_(_)1.600_+9000_a+2700000d_b+0914941d_*BS_,0.000_+1000_
a+0120659d_b+0885433d_c+00010461m_*00200_,1.500047^l
0_'9001_(_)0.000_'1000_(_)1.500_+9001_a+1920658d_b+0910507d_*BS_,0.000_+9001_
a+0120706d_b+2685458d_*BS_,0.000_+1002_a+290251123^l
58d_b+0915405d_c+00008619m_*00200_,1.300_+1_a+1721400d_b+0973358d_
c+00003476m_*90600_,1.500_+2_a+1920645d_b+0910455d_c+02057^l
0010462m_*00500_,1.600_'1002_(_)1.300_+1000_a+1102554d_b+0880556d_*BS_,0.000_+4_
a+1560342d_b+0893902d_c+00014477m_*00500_,13120^l
600_+3_a+1102555d_b+0880541d_c+00008618m_*00500_,1.500_+5_a+1664418d_
b+1051221d_c+00002501m_*90600_,1.500_'1002_(_)1.300_4035^l
+6_a+1102541d_b+0880533d_c+00008621m_*00500_,1.500_
5061^l

- * FC-5 RAW FILE - HARD TO READ
- * ONLY RECORDS MEASUREMENTS TAKEN
- * NO TIME STAMPS
- * SEPARATE FILE TO SET OUT INFORMATION

APPENDIX E3 – TOPCON INVESTIGATION – Topcon as LISCAD FIELD

FILE

1	010	Topcon FC-5	project-topcon-raw	FIELD FILE BY
2	011	Sunday, 13 August 2006	project-topcon-raw.raw	LISCAD
3	021	xy		OF TOPCON RAW FILE
4	002			
5	032			
6	009	11/08/01		
7	;			
8	101		9001 1.6000 0.0000	← NO RECORD OF WHAT THE BACKSITE BEARING IS (CAN BE DONE BY FIELD WORK)
9	105	1.5000		
10	111		1000 12.06590 88.54330 10.4610 00200	
11	;			
12	101		1000 1.5000 0.0000	
13	105	1.3000		
14	111		1002 290.25580 91.54050 8.6190 00200	
15	105	1.5000		
16	111		1 172.14000 97.33580 3.4760 90600	
17	105	1.6000		
18	111		2 192.06450 91.04550 10.4620 00500	CHECK RECORDED AS A POINT ONLY - NO RECORD OF RESETTING BACKSITE
19	;			
20	101		1002 1.3000 0.0000	
21	105	1.6000		
22	111		4 156.03420 89.39020 14.4770 00500	CHECK SHOT TO FSIDE & CLOSE
23	105	1.5000		
24	111		3 110.25550 88.05410 8.6180 00500	CHECK SHOT TO BS
25	111		5 166.44180 105.12210 2.5010 90600	FENCE POST
26	;			
27	101		1002 1.3000 1.5000	← CHECK WAS PERFORMED HERE BETWEEN (1-000) BUT NO RECORD.
28	111		6 110.25410 88.05330 8.6210 00500	

NO RECORD OF CALCS BETWEEN (2000-2001) OR POSITION OF NEW CORNER (2002)

ONLY RECORD OF SETUP IS IN SEPARATE SYSTEM- SEE OVER.

**APPENDIX E4 – TOPCON INVESTIGATION – Topcon as GTS-6 SET-OUT
FILE**

Topcon GTS-6
Job: D:\PROJ3

project-topcon-raw-setout

Page 1

	East	North	Elevation	Cut
Pt# 9006				
Design:	998.104	5010.750	0.000	
Collect:	998.094	5010.756	6000.273	
Diff:	0.010	-0.006	-6000.273	6000.27

♀

*NO RECORD OF SETUP STATION OR BACKSITE
NO RECORD OF BEARING/DISTANCE TO SETOUT POINT
NO TIMESTAMPS
THIS FILE COULD MEAN ANYTHING (OR NOTHING)*

APPENDIX F – LISCAD.SEE SCREEN PRINT of NIKON DATA

REINSTATEMENT SIMULATION

LISCAD.SEE COMPUTATIONS
OF NIKON DATA.

