University of Southern Queensland

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Optimisation of Long Line GNSS Networks using Geoscience Australia’s AUSPOS service and Static Baselines

A dissertation submitted by

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Abstract

Global Navigation Satellite Systems (GNSS) are commonly used in the surveying industry for establishing large geodetic networks where conventional terrestrial methods are considered insufficient. A primary example of this is long line control networks, typical of a pipeline project, rail corridor, or long line easement survey. The nature of these surveys often mean that they require careful pre-planning and increased resourcing, resulting large overhead costs to complete.

The aim of this research is to analyse the current adopted techniques for establishing long line control networks via GNSS methods, and to expand on these methods by determining new methods that would optimise the process. Recommendations can then be made regarding the establishment of long line networks via GNSS based on the desired time constraints and network quality in terms of uncertainty and network redundancy.

Testing the different configurations determined in the methods chapter of this dissertation revealed that configurations that adopt a conventional approach to GNSS static and quick static are likely to provide a higher quality network that is also cost effective. Furthermore, network configurations that adopted a less conventional approach lacked network quality, and were also less cost effective, despite the reduced number of observations required to complete the network.

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Limitations of Use

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Signature

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Date

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Table of Contents

List of Figures

List of Tables

Glossary of Terms

CORS: Continuously Operating Reference Station – a permanent GNSS station

Datum: A spatial reference system or surface to which measurements or coordinates upon the earth may be defined or related

Fully Constrained: A least squares adjustment that is constrained to an existing set of parameters, used to propagate datum and uncertainty for the survey network

GDA94: Geocentric Datum of Australia 1994

GLONASS: A Russian Federation operated GNSS

GNSS: Global Navigation Satellite System

GPS: Global Positioning System **-** A United States operated GNSS

ICSM: Intergovernmental Committee on Surveying and Mapping – The body responsible for surveying and mapping standards in Australia and New Zealand

ITRF92: International Terrestrial Reference Frame 1992 – the reference frame that GDA94 is based upon

MGA94: Map Grid of Australia 1994

Minimally Constrained: A least squares adjustment that constrained to none or only one station to test the reliability of the surveyed network

Positional Uncertainty (PU): The uncertainty of the horizontal and/or vertical coordinates of a survey mark with respect to datum

ppm: Parts Per Million

PSM: Permanent Survey Mark

Relative Uncertainty (RU): The uncertainty between two horizontal and/or vertical coordinates of any two survey marks.

RINEX: Receiver Independent EXchange – a universally accepted GNSS observation file

RTK: Real Time Kinematic

SP1: Special Publication 1 – the standard for the Australian survey control network, published by ICSM

Survey Uncertainty (SU): The uncertainty of the horizontal and/or vertical coordinates of a survey control mark irrespective of an underlying datum definition. The SU of a coordinate is relative to the survey in which it was observed in

1.0 Introduction

1.1 Context

The Global Positioning System (GPS) was originally designed by the United States (US) Government for military and other government applications. In 1984 the first standards allowing civilian use of GPS were published which resulted in almost all geodetic standards around the world being GPS based (Pace et al. 1995).

Geodesy is defined by University of Southern Queensland (2013) as a category of applied mathematics and science that studies the size and shape of the Earth, particularly for making measurements of the Earth so large that the roundness of the Earth needs to be considered. Since the introduction of GNSS, which is a generic term for the combined use of different satellite navigation systems including GPS, GLONASS, BeiDou, Galileo, and QZSS (Venezia 2015), it has become the preferred tool for geodetic surveys undertaken on a regional, national, and continental scale (Ebner & Featherstone 2008). This is due to its lack of requiring line of sight to measure baselines, reducing the effort it takes to establish such networks that would normally be established terrestrially.

In 1995, the Russian Federation developed the GLObal NAvigation Satellite System (GLONASS). Consisting of 24 satellites, GLONASS was primarily developed for military purposes. However, in 1999, it was made available for civilian use (Polischuk & Revnivykh 2004). In 2009, GLONASS became fully operational (Sergey, Sergey & Suriya 2007) allowing users to utilise both the GPS and GLONASS satellite constellations for navigation and positioning purposes.

The combined use of GPS and GLONASS has multiple advantages for users in the navigation and positioning field. With a combined total of 48 available satellites when using both the GPS and GLONASS constellations, users can expect improved productivity, integrity, and accuracy in the observations recorded (Martin & Ladd 2010). In the future, oncoming satellite constellations such as the European Union’s Galileo system, the Chinese

BeiDou system, and Japan's Quasi-Zenith Satellite System (QZSS), means that users will experience even further improved productivity, integrity and accuracy.

There are several ways to establish survey control networks, using both conventional terrestrial methods and with the use of GNSS. Typically, GNSS is used to establish large geodetic networks, where conventional terrestrial methods are inefficient due to issues relating to time, line of sight, or it is simply more efficient to establish the network with GNSS.

Despite the obvious advantages, the use of GNSS for establishing control networks is still very labour intensive and requires immense logistical planning. These factors often result in high overhead expenses which are generally incurred by the client, however these costs can be reduced with careful time and resource planning. In addition to further planning, past research has found that a network optimisation method can be implemented to ease these costly factors without reducing the overall quality of the network. This is characterized by the overall precision, reliability and cost of the network (Amiri-Simkooei et al. 2012).

In Australia, the quality of a control station or network is governed by Positional Uncertainty (PU), Survey Uncertainty (SU) and Relative Uncertainty (RU) referred to in Intergovernmental Committee on Surveying and Mapping's (ICSM) Special Publication 1 (SP1). ICSM (2014a) define PU, SU, and RU as the following:

> *PU: The uncertainty of the horizontal and/or vertical coordinates of a survey control mark with respect to datum.*
>
> *SU: The uncertainty of the horizontal and/or vertical coordinates of a survey control mark independent of datum. That is, the uncertainty of a coordinate relative to the survey in which it was observed, without the contribution of the uncertainty in the underlying datum realisation.*

RU: The uncertainty between the horizontal and/or vertical coordinates of any two survey control marks.

By calculating these uncertainties, surveyors are able to make judgements on the overall quality of their survey and whether or not more work is required.

There is a vast array of research available comparing GNSS post-processing methods, and GNSS network optimisation. However, there is no current research available regarding the network optimisation in long line surveys using both the conventional post-processing technique and AUSPOS whereby these kinds of surveys would meet the SP1 Guideline for Control Surveys by GNSS and the Guideline for the Adjustment and Evaluation of Survey Control. Meeting the standards set out in this guideline is particularly important in Australia, as it is the guideline that certain legislation is based upon for GNSS surveys. Furthermore, there is a lack of research analysing network optimisation from a time/cost approach and the qualities that can be expected from reconfiguring the network.

1.2 Research Aim

The aim of this research is to determine an optimal configuration of a control network for a long line survey, typical of that of a long line easement, rail corridor, or infrastructure corridor. The network is to be established by GNSS measurement methods, but is to be post-processed using different methodologies. The data will be post-processed in a number of different configurations, which will ultimately achieve different positional, survey, and relative uncertainties.

The results will then be analysed and tabulated to allow current and future surveyors and GNSS users to make informed decisions regarding network design, dependant on the desired uncertainties required for the survey.

1.3 Justification

After conducting a brief search of the literature, it became apparent that comparisons of the AUSPOS service and relative static networks that are conducted in accordance with relevant Australian and Queensland standards is not widely documented. In addition, literature regarding combination of these processing techniques, and optimisation of these types of control networks is also very limited, resulting in a gap in the literature.

This research will be undertaken with the intention to fill the current gap in the literature and more importantly to benefit the surveying industry in Australia by providing a guideline on carrying out long line surveys in a way that is time, cost and resource efficient.

This will be achieved by carrying out a long line control network that would simulate a real world situation in a suitable area. In addition, this will also involve determining if similar positions and survey qualities can be achieved with the AUSPOS post-processing service, and whether a combination of these two processing methods is also a feasible outcome for these types of networks. Following this, an analysis on a time/cost basis would be carried out for each survey to determine the most practical outcome. These results will be laid out in a tabulated format so practitioners can make informed decisions on network optimisation methods to achieve the desired PU and SU.

2.0 Literature Review

2.1 Introduction

The purpose of the literature review is to analyse the current literature available to justify the need for this research and to critically analyse previous similar research. The literature review leads to a selection of testing methodologies, and also proves that the research being undertaken is contributing something new (Levy & Ellis 2006). This chapter will identify the background information required to analyse the extent and significance of the research problem; it identifies and discusses attempts by others to solve similar problems; and finally, it provides examples of methods previous researchers have employed in attempts to get to their solutions (Evans, Gruba & Zobel 2013).

This literature review will provide a critical analysis of the current research available relating to GNSS survey methods, network optimization, post-processing methods and the current standards in Australia for GNSS control surveys. By doing this, an appropriate methodology will be selected for the testing phase of this project to provide data for the analysis phase.

The overall aim of this chapter is to justify the need for this research and determine if the research can build upon the previous research available for determining a suitable method for establishing long line control networks with GNSS.

This will incorporate looking at the available field methods and selecting the most relevant technique The relevant control survey standards in relation to field survey and post-processing methodologies in Australia will also be addressed. In addition to these two topics, the literature review will also analyse past research on GNSS network optimisation and online post-processing services.

2.2 Standards for GNSS Control Surveys

2.2.1 ICSM Special Publication 1 – Standard for the Australian Control Network

The ICSM is the committee responsible for the development and maintenance of key national spatial datasets including geodetic, topographic and cadastral. The document SP1, published by ICSM, outlines the standards and best practices for undertaking control surveys in Australia and New Zealand. In SP1, ICSM provide guidelines for:

- the adjustment and evaluation of survey control;
- continuously operating reference stations;
- control surveys by differential levelling;
- control surveys by GNSS;
- conventional traverse surveys; and
- the installation and documentation of survey control marks.

The intention of this research is to determine optimal configuration for long line control surveys by GNSS. This includes post-processing in a suitable software package capable of handling GNSS data, and processing with an online post-processing service such as AUSPOS (which is mentioned in SP1). For this reason, only the guideline for control surveys by GNSS and the guideline for adjustment and evaluation of survey control are relevant to this research.

The guideline for control surveys by GNSS outlines the general considerations that the user should be aware of before carrying out a survey. There are many measurement and observation techniques available, however each has its own suitable applications. This literature review will analyse both the Quick Static and Classic Static methods. These methods allow the user to post-process the data, both online, and in a suitable software package.

SP1 often refers to the Positional Uncertainty (PU) of a station, and the Survey Uncertainty (SU) and Relative Uncertainty (RU) of the survey. PU is defined by ICSM (2014a) as the uncertainty of the horizontal and/or vertical coordinates of a survey control mark with respect to datum. RU is defined as the uncertainty between horizontal and/or vertical uncertainty of any two survey control marks. Finally, SU is defined as the uncertainty of the horizontal and/or vertical coordinates of a survey control mark independent of datum. This is the uncertainty of a coordinate relative to the survey in which it was observed, irrespective of datum (ICSM 2014a).

Section 3.1 of the *Guideline for Control Surveys by GNSS – SP1* published by ICSM (2014b) outlines some potential applications that would require the use of GNSS, it also includes the technique that should be used, and the survey uncertainties that can be expected using that method. Each method requires differing occupation times. In general, the longer the occupation, the better the survey uncertainty (Figure 2.2.1.1).

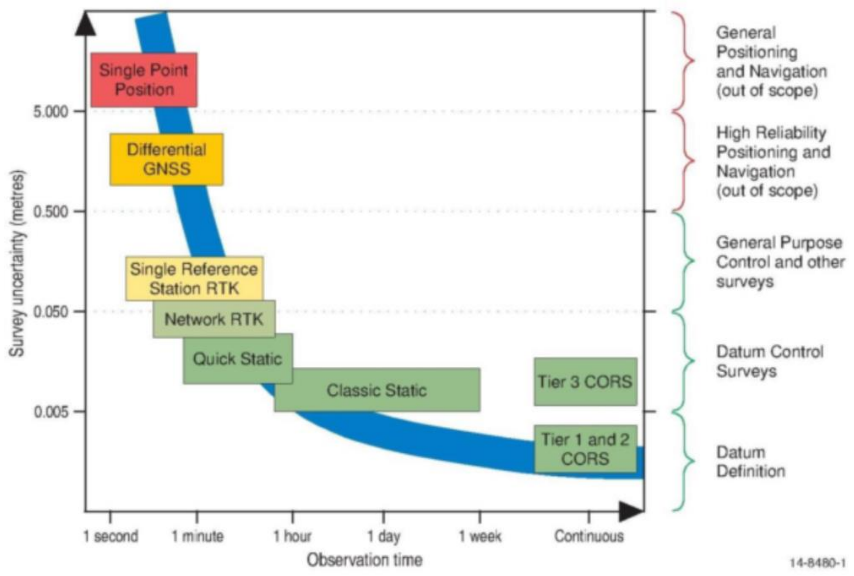

Figure 2.2.1.1: GNSS survey techniques and their inherent survey uncertainties (ICSM 2014b).

A number of guidelines for selection of GNSS equipment and observation techniques are also provided based on the survey uncertainty the user wishes to achieve. As this research intends to survey lines no longer than 10km and wishes to achieve an SU of less than 30mm for horizontal position, if possible the following guidelines will be adhered to when conducting the field survey:

- use of a receiver capable of dual frequency code and carrier phase tracking;
- minimum of a survey grade quality antenna (no choke-ring or ground-plane);
- 1 – 6 hours of occupation time (recommended 1 hour plus 5 minutes per kilometre);
- 15 – 30 second observation epoch interval; and
- the use of a zero-degree elevation mask.

ICSM (2014b) also outlines the minimum processing software recommendations for the classic static and quick static method. In section 3.2.1 of the *Guideline for Control Surveys by GNSS – SP1*, ICSM (2014b) states that to achieve an SU of less than 30mm for horizontal position, processing must use broadcast ephemerides or better (available from IGS), software should have antenna models built into the software, and the software must be capable of generating a reliable variance-covariance matrix for each measurement. Based on the requirements to meet this standard, and the resources available at the time of research, an SU of less than 30mm for horizontal position will be the desired uncertainty for the purpose of this project.

2.2.2 Department of Natural Resources and Mines

The Queensland Government's Department of Natural Resources and Mines (DNRM) is the governing body for all surveying and mapping in Queensland. The surveying standards are maintained by the Cadastral Survey Requirements (CSR) Version 7.1, a document which previous versions contained limited information and regulations on surveys using GNSS.

Chapter 8 of Version 7.1 of the CSR relates to the use of GNSS for cadastral and control surveys undertaken in Queensland. The chapter heavily relies upon the concepts and methodologies outlined in *ICSM's Special Publication 1 (SP1) – Standard for the*

Australian Control Network, and often refers the reader to that document for additional information.

There are a number of sections in chapter 8 that will be relied upon throughout this research to test whether different processing techniques meet an acceptable quality which are outlined below:

- Section 8.3 – GNSS Measurement Quality, addresses the nature of GNSS measurements and the effects that may influence observations. It outlines techniques to minimise site dependant effects, site selection, and observation time dependant on site obstructions.
    - Often, measurements are required in poor environments for GNSS, such as high multipath areas, urban canyons, obstructions, and vegetation. In this case, the CSR recommends making GNSS observations in an area suitable for GNSS occupation and then using conventional methods to make the observation in the required location. Additionally, a 15-degree elevation mask is recommended to exclude data between 0 and 15 degrees above the horizon to ensure good satellite geometry based on the dilution of precision (DOP) values to assist in minimising site dependant effects (DNRM 2015).
    - Where obstructions are present, and a GNSS observation is required, the mark must be occupied at least twice to ensure and outliers are detected. Furthermore, it is recommended that the observations are made at least 30 minutes apart to allow for a change in satellite geometry.
- Section 8.4.2 – Testing quality of GNSS measurements and their suitability for cadastral purposes, describes the methodologies used to calculate positional, relative and survey uncertainty, a large component of this research. However, these methods have been derived from SP1, and therefore, SP1 will be consulted for calculating the PU, SU, and RU.

- Section 8.7.2 – Data processing and archiving, provides clarity on how surveyors should approach data processing and archiving GNSS observations and related data. This includes analysis of how well the survey agrees with existing control networks (existing permanent marks and/or regulation 13 CORS sites). DNRM (2015) recommend that all project files including raw data, logging sheets, RINEX data, processing results, and configuration files should be correctly archived.

The CSR Version 7.1 provides a brief outline of the GNSS survey methodologies that surveyors need to follow to ensure the correct survey uncertainty is achieved for the survey being carried out. It often refers readers to the *ICSM's SP1* which provides a much more in depth guideline for users to follow, and while the CSR provides some information regarding GNSS surveys, SP1 will be relied upon for the purpose of this research.

2.3 GNSS Surveying Methods

Since the introduction of GPS to the civilian market, GNSS use has grown in popularity. Its wide range of applications including agriculture, navigation, surveying, and geodesy makes it extremely desirable to many users around the world.

There are a large number of measurement and processing techniques available to GNSS users, especially in the surveying and geodesy sectors. These include Pseudo-Kinematic, Kinematic, Real-Time Kinematic, Quick Static, and Classic Static. Based on the research conducted in section *2.2 Standards for GNSS Control Surveys* only the classic static and quick static methods will be further researched.

2.3.1 Classic Static

The classic static method requires two or more receivers, involves a number of observation sessions, and is one of the most commonly used techniques for establishing large geodetic control networks. In the first session, one base receiver occupies a known control station, and the remaining receivers occupy unknown points. During this session, all receivers make simultaneous precise code and carrier phase observations (ICSM 2014b) to four or more satellites for an extended period of time, usually dependant on baseline length and accuracy requirements.

At the end of the first session, one receiver becomes the new base station, while the remaining receivers can be moved or remain on the same position to form new baselines to the base station. This process is repeated until all points have been occupied, and the baselines observed form geometrically closed figures.

2.3.2 Quick Static

The quick static method often referred to as fast static or rapid static, is similar to the classic static method mentioned in section 2.2.1 and is commonly used to measure baselines less than 25km (Berber, Ustun & Yetkin 2012). However, the ICSM (2014b), the governing authority on survey control standards in Australia and New Zealand, mention in the *Guideline for Control Surveys by GNSS* that for baselines longer than 10km, the classic static method should be used.

Quick static is capable of achieving uncertainties comparable to that of the classic static method by using occupation times as short as 5 to 10 minutes. The shorter occupation times are a major advantage over the classic static method which requires much longer observations, however this means much less data is collected, resulting in fewer baselines to form in the network adjustment phase. It is also important to note that due to the shorter occupation times, this method does not experience a large change in satellite geometry (University of Southern Queensland 2013).

Ultimately, occupation times should be dependent on the number and geometry of the satellites being tracked, and the DOP values (University of Southern Queensland 2013).

As the purpose of this research is to determine an optimal configuration for long-line control network surveys, the classic static method will be employed for this research. The longer observation times will result in a greater change in satellite geometry, providing more redundancy in the observations. Furthermore, if more data is observed, more solutions can be computed.

2.4 Post-Processing GNSS Data

Currently, there are a number of methods available for post-processing GNSS data. These methods rely on the user to store raw observations in the receiver or in a data recorder and subsequently transfer the observations into a computer. The data can then be processed in a number of ways. These include conventional post-processing in a suitable software package these include Trimble Business Center (TBC), Leica Geo Office (LGO) which processes the data from two or more receivers to form baselines, Precise Point Positioning (PPP) which processes data from a single receiver using orbit and clock correction products provide by IGS to produce precise point coordinates, or by using services like AUSPOS, that takes data from the user's single receiver and processes with data from the closest available 15 IGS and Asia Pacific Reference Frame (APREF) stations. It is important to note at this stage that while PPP and AUSPOS are very similar in that both methods only require data from a single receiver, AUSPOS is a differential post-processing service that forms baselines to calculate the required position, while PPP produces precise coordinates using only orbit and clock correction products (Mireault et al. 2008).

For conventional post-processing, the data is loaded into a suitable software package and is analysed thoroughly to identify any noisy data, multipath and cycle slips. Typically, noisy data, dependant baselines and cycle slips are removed to improve the overall quality of the data. Although this trend is becoming less commonplace now due to technological advances in GNSS surveying equipment and the current amount of satellite constellations available today.

The PPP method simply requires one GNSS receiver to compute an accurate position on any reference frame. It uses a point positioning technique using orbit and clock correction information from services such as the International GNSS Service (IGS) to compute the position of the receiver (Grinter & Roberts 2011).

There are also many online post-processing services freely available to the public to use (Table 2.4.1). These services employ the use of either the PPP method or differential method to post-process data.

Service	**Provider**	**GNSS**	**Processing Method**
AUSPOS	Geoscience Australia	GPS	Differential (Bernese)
CSRS-PPP	Natural Resources Canada	GPS & GLONASS	PPP
GAPS	University of New Brunswick	GPS, Galileo & BeiDou	PPP
APPS	California Institute of Technology	GPS	PPP
MagicGNSS	GMV	GPS & GLONASS & Galileo	PPP
CenterPoint RTX	Trimble Navigation	GPS, GLONASS, QZSS & BeiDou	PPP
OPUS	National Oceanic and Atmospheric Administration	GPS	Differential (PAGES)
SCOUT	Scripps Orbit and Permanent Array Center	GPS	Differential (GAMIT)

Table 2.4.1: Available online GNSS post-processing services.

AUSPOS is the most commonly used online post-processing service in Australia, it has also been proven to provide the closest results to conventional post-processing (El-Mowafy 2011).

2.4.1 Differential Post-Processing

Differential post-processing can be divided into three segments; data analysis and validation, baseline processing, and network adjustment. The data analysis and validation phase occurs when the data is initially loading into the processing software. It involves examining the data and removing any noisy data, cycle slips and dependant baselines to better improve the survey.

Baseline processing is critical to the post-processing method. Baselines are formed by collecting carrier and phase data at two different points simultaneously. By processing the baselines before computing a network adjustment, any outliers or bad points in the survey can be easily identified and isolated by analysing the statistics that the baseline processor produces (University of Southern Queensland 2013).

In most software packages, baseline processing is carried out in the following steps comprehensively outlined by the University of Southern Queensland (2013) and Curran (2008) below:

1. Computes best fit value for point positions from code pseudoranges.
2. Creates undifferenced phase data from receiver carrier phase readings and satellite orbit data. Time tags may also be corrected.
3. Creates differenced phase data and computes their correlations.
4. Computes estimates of baseline vectors using triple-differencing processing. This method is insensitive to cycle slips and provides least accurate results.
5. Computes a double-difference solution solving for vector and (real) values of phase ambiguities.
6. Estimates integer values of phase ambiguities computed in step 5, and decides whether to continue with fixed ambiguities.
7. Computes fixed bias solution based upon best ambiguity estimates computed in step 6.
8. Computes several other fixed bias solutions using integer values differing slightly (e.g. by 1) from selected values.
9. Computes ratio of statistical fit between chosen fixed solution and the next best solution. This ratio should be at least 1.5 to 3 indicating that the chosen solution is at least 1.5 to 3 times better than the next most likely solution.

2.4.2 Network Adjustments

The network adjustment phase is carried out in two steps; firstly, a minimally constrained adjustment, secondly, a fully constrained adjustment. The minimally constrained adjustment is a quality assurance process, where one station is deemed fixed on known coordinates, and the remainder of the survey is processed to suit that fixed station. This allows the processing software to generate a report showing the shift in each point to make it consistent with the fixed point. This sort of adjustment assists with detection of gross errors or blunders in the survey and provides validation of the internal consistency of a network (University of Southern Queensland 2013). The fully constrained adjustment occurs when all blunders have been corrected or removed from the network and the survey can be coordinated to fit existing control networks.

In the Guideline for the Adjustment and Evaluation of Survey Control – Special Publication 1, ICSM (2014a) has made available the recommended procedure for the adjustment and evaluation of survey control defined below:

1. All survey control measurements should be corrected for all known calibration corrections and systematic error sources, and be accompanied by reliable values of uncertainty (or weights). To test the control survey for errors, redundant measurements sufficient to identify errors shall be used. The larger the degrees of freedom (DoF), the greater the confidence can be gained from a survey.
2. A minimally constrained adjustment should be tested using the local test and global test.
3. If required, estimated Survey Uncertainty (SU) and Relative Uncertainty (RU) values (or other reliable statistical methods) should be examined to assess whether the survey has achieved any predefined uncertainty or quality methods.

4. When attempting to propagate datum and uncertainty, a fully constrained and appropriately weighted adjustment should be undertaken.
5. The fully constrained adjustment should be tested using the local test to verify that the imposed constraints do not result in measurement failures.
6. The fully constrained adjustment should be tested using the global test. If this adjustment test fails, the quality of survey measurements and constraints needs to be examined to identify and rectify the cause of failure.
7. If required, estimated Positional Uncertainty (PU) and associated RU values (or other reliable statistical methods) should be examined to assess whether the survey control network has achieved any predefined uncertainty or quality thresholds.

2.4.3 Precise Point Positioning

The PPP technique utilizes a single GNSS receiver to achieve high accuracy positions using orbit and clock correction products provided by the IGS (Ebner & Featherstone 2008; Grinter & Roberts 2011). The PPP method of post-processing has many advantages over other differential post-processing methods, the most obvious two being, firstly its ability to achieve geodetic grade positioning within a global reference frame, anywhere in the world with only a single GNSS receiver, and secondly, removing much of the labour, equipment and logistical costs to provide this type of positioning. However, past research has found that when using online post-processing services, PPP is a less reliable method for deriving coordinates and a differential method, therefore this research will not be evaluating the use of PPP, rather AUSPOS will be used.

2.4.4 Online Post-Processing Services

There are currently a number of government and commercial online post-processing services freely available to GNSS users around the world offering both differential post processing and PPP (Table 2.4.1). These services require the user to gather raw GNSS data in static mode generally an hour or more of data is required for most services. The raw data is then converted to Receiver INdependent EXchange (RINEX) format and can then be submitted to the service via upload or File Transfer Protocol (FTP) site. The service post-processes the GNSS data, and provides results by email to the user in a short turn around period (Figure 2.4.4.1).

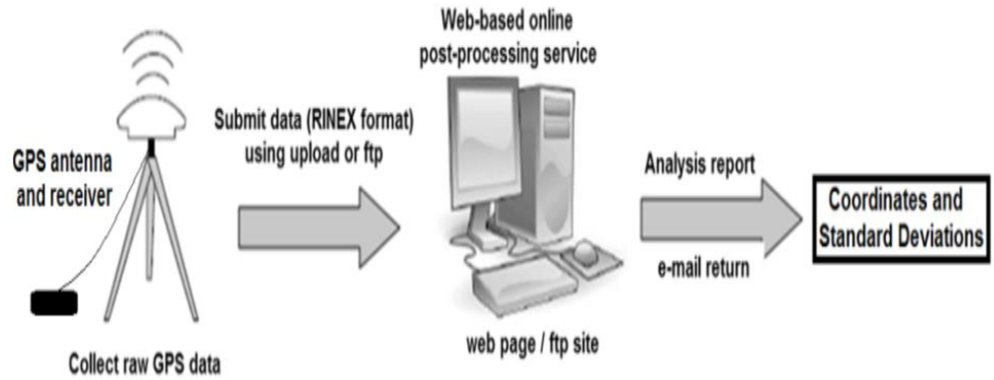

Figure 2.4.4.1: A basic illustration of most online post-processing services (Ocalan, Erdogan & Tunalioglu 2013).

Previous research conducted by El-Mowafy (2011) compared static and kinematic data captured by a single dual-frequency receiver. The data was post-processed by the AUSPOS and CSRS-PPP service. El-Mowafy (2011) also analysed the impact of varying data lengths and the effects of shorter and longer observation times and found that the results generally improve the longer the observation period.

Ocalan, Erdogan and Tunalioglu (2013) also conducted a comparison of the online GNSS post-processing services shown in Table 2.4.1 with the exception of the Trimble's CenterPoint RTX service. The analysis was split up into two parts comparing the PPP services and the differential post-processing services. Overall, the research found that the best results from a differential service came from AUSPOS as it used 12 reference stations to compute the unknown, in contrast the other services only used three. As for the PPP post-processing services, APPS was found to be the most reliable service. Overall, this research found that Geoscience Australia's AUSPOS service produced the closest results to those computed using the Bernese software.

2.4.5 Geoscience Australia's AUSPOS

Geoscience Australia's (GA) AUSPOS service is a freely available online post-processing service for users to upload RINEX data and receive highly accurate positions in generally less than 5 minutes (Geoscience Australia 2015). Using the Bernese software, AUSPOS employs a differential processing method that computes baselines to the nearest 15 IGS and APREF stations using only GPS data at a 30 second sampling rate. The coordinates for the 15 stations are fixed with uncertainties of 1mm for horizontal and 2mm for vertical.

For AUSPOS to be able to process the data the user simply has to ensure that:

- there is a minimum one hour of data in the RINEX file (preferably two);
- a dual frequency GPS receiver is used to collect data; and
- that the correct antenna type and height is recorded.

2.5 Network Design and Optimisation

Network optimisation is not a new concept. The main objective of network optimisation is to predetermine a mission plan that best suits the project requirements in regards to precision, reliability, and cost. This involves determining which observations are not required or can be removed from the network without affecting the quality of the network resulting in a reduced project cost (Khameneh 2015).

Baarda (1968) (as cited in Amiri-Simkooei et al. (2012)) first introduced the concept of network optimisation and found that the reliability of a geodetic network is divided into internal and external reliability. The internal reliability simply refers to the ability to detect gross errors made in observations, and the external reliability refers to the effect of undetectable errors on the estimated parameters of the network (Amiri-Simkooei et al. 2012). University of Southern Queensland (2013) mention that the intent of network design and optimisation should be the following:

- to design the location of new points and the observations between them;

- to provide error control in the minimum constraint solution, to enable data validation and analysis of the accuracy of the survey;
- to produce connections to integrate the survey into previously established control networks; and
- to design the location of ties to points with existing orthometric heights.

2.6 Previous Research

There is a large amount of research available regarding the comparison of GNSS post-processing methods, and network optimisation. This includes past University of Southern Queensland projects from former students in past years.

2.6.1 Ebner & Featherstone 2008

Ebner and Featherstone (2008) explored the use of the CSRS-PPP online post-processing service for establishing geodetic survey control networks. The research produced coordinates processed by the CSRS-PPP service for a moderate sized network of 46 stations covering an area of approximately 242,000 km^2. These coordinates were compared with coordinates derived from the Bernese Scientific Software which uses a differential approach to compute the solution.

The results produced by CSRS-PPP were rather similar to those derived by the Bernese software, however it is important to note, that observation periods of 48 and 144 hours were used to compute all solutions. The research found that a PPP approach can be used to establish geodetic survey control networks, however at a slightly lower quality and where observation periods of greater than two days are used.

2.6.2 Koschel 2009

Koschel (2009) investigated the reliability of AUSPOS results with a specific focus on the height component. This was tested by occupying a number of permanent marks with known Geocentric Datum of Australia (GDA94) coordinates for a period of 12 hours and comparing the results. The data was manipulated into 1, 2, 4, 6, 8, 10, and 12 hour periods and the results were compared with the known coordinates for each mark with respect to the time period observed.

Despite specifically evaluating the vertical component of AUSPOS, Koschel (2009) also briefly analysed the horizontal component of AUSPOS. The research found that the longer the observation period, a greater accuracy can be expected, generally six hours of data would provide results within +/-50mm of coordinates derived from a geodetic network survey.

The research being carried out in this dissertation is analysing only horizontal data. While the results will produce vertical data, they will be completely disregarded. Therefore, the evaluation of the vertical component of this research was of little importance to this research.

2.6.3 Cleaver 2013

In his project titled *Evaluation of the Performance of Web-Based GNSS Post-Processing Systems*, Cleaver (2013) assessed a number of online PPP and differential post-processing services. The services that were evaluated include AUSPOS, SCOUT, CSRS-PPP, Auto-GIPSY. These services were compared by occupying five stations with known GDA 94 coordinates for a 24-hour period. The data from these stations was then reduced to RINEX format and amended into 1, 2, 4, 6, 8, and 12 hour observations and uploaded to each of the online systems.

Cleaver (2013) found that with observation times longer than four hours, the results were negligible when compared to the residual difference of the published GDA94 coordinates of the stations selected when using the AUSPOS, CSRS-PPP, and SCOUT services. Cleaver (2013) also found that the differential post-processing services provided marginally better results to the services using a PPP approach, as the PPP approach is independent of site location and therefore bias of baselines cannot have an impact on the solution.

2.6.4 O'Sullivan 2014

O'Sullivan (2014) reported similarly to Cleaver (2013). Titled *Evaluation of Precise Point Positioning Services* O'Sullivan (2014) evaluated the performance of AUSPOS (which should be noted is a differential post-processing service as opposed to PPP), OPUS (also a differential service), CSRS-PPP and Magic PPP using a 6 hour and 24 hour observation.

The findings of this report were very similar to Cleaver (2013). O'Sullivan (2014) found that each service evaluated produced better results with longer observation times. Moreover, the author also found that the services that use a differential processing approach provide slightly better results than the PPP approach, agreeing with previous research. Of all online processing services tested, AUSPOS produced the best quality results.

3.0 Method

3.1 Introduction

The intention of this chapter is to establish a suitable method for carrying out the testing component of this project. In the literature reviewed in the previous chapter, a number of key research factors were established. These included employing the use of the classic static method for data collection, the use of AUSPOS as opposed to any other online differential or PPP post-process service, and following the guidelines laid out in SP1 for the calculation of SU and PU.

The aim of this chapter is to achieve the following outcomes:

- to determine a field scenario that can be used for the purpose of this project that will allow enough data to be collected to post-process in a number of different configurations;
- to determine a series of different post-processing scenarios, including network configurations, the combined use of conventional baseline processing integrated with online post-processing services; and
- to determine a way to analyse the different testing scenarios on a time/cost analysis to provide a guideline on the best practice for these kinds of surveys.

This chapter will address the method in which the research for this dissertation was carried out. This will be done by selecting a suitable study area to carry out a long line survey, compiling the required resources to complete the study, determining a suitable method to ensure enough data is collected to process in a number of different scenarios, and also an explanation of the post-processing scenarios that will be used.

3.2 Study Area

This research will investigate different methods of performing a long line survey control network. Examples of a long line network include service easements and corridors, road and infrastructure projects, or any other form of linear project that may require a control network established by GNSS. The study area where the survey was performed for this project is situated in South East Queensland running alongside a railway corridor, from Acacia Ridge, south to Kagaru, approximately 35 kilometres in length (Figure 3.2.1).

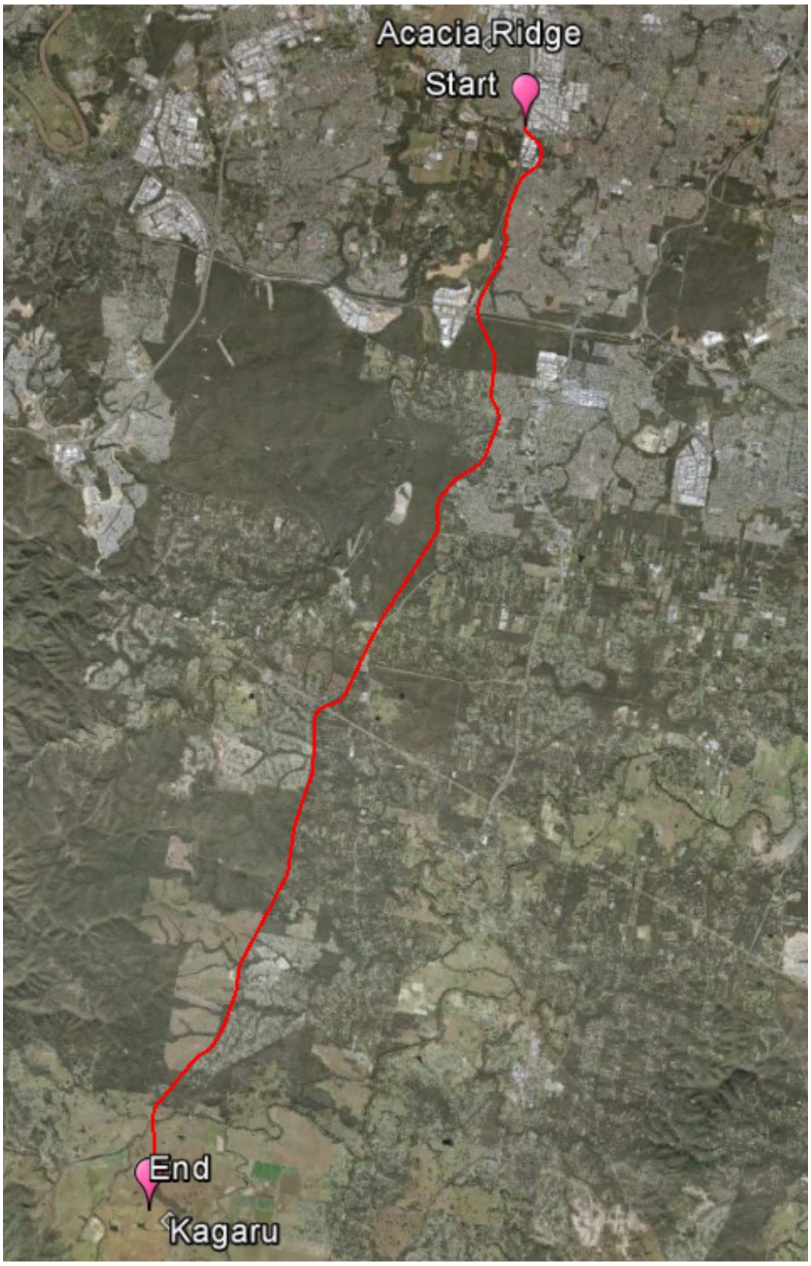

Figure 3.2.1: Study area with rail corridor highlighted in red (Google Earth 2016).

Survey stations were placed approximately every 1.5km along the rail corridor as the network was used for another purpose independent of this project. Stations were typically placed off the side of the rail corridor, or in adjoining road reserve for safety concerns. The type of stations placed included iron pins, and screws in concrete as these kind of marks were suitable for the purpose of a research project. Additionally, the survey also connected to nearby available and accessible “datum” PSM’s.

The term “datum” refers to the Geocentric Datum of Australia 1994 (GDA94) which is a three dimensional, static coordinate datum based on the International Terrestrial Reference Frame 1992 (ITRF92) (ICSM 2014a). A static datum refers to the fact that the ITRF92 is a dynamic system, meaning that it is constantly moving. The Australian tectonic plate is moving roughly 7cm per year in a North-Easterly direction and to combat this, GDA was held fixed at 1 January 1994 (Geoscience Australia 2016a).

The idea of making connections to local datum PSM’s was to provide some form of check against the published coordinates for each PSM. During the post-processing phase, this would ensure that no gross errors had been made during the field survey, and also that the survey was being processed on the correct datum and coordinate system.

3.3 Resources for Field Survey

To successfully carry out the field survey, the following resources were utilised.

- 4x Trimble R7 GNSS receivers (firmware version 4.19)
- 1x Trimble R8 Model 3 GNSS receiver
- 1x Trimble R10 GNSS receiver
- 4x Trimble Zephyr GNSS antennas
- 2x Trimble TSC3 data recorders with Trimble Access Software (version 2016.03)
- 5x Tripods
- 5x Recently adjusted tribrachs
- 2x Vehicles

- 2x Mobile Phones
- Ancillary surveying equipment
- Batteries to power equipment

3.4 Field Method

After reviewing the literature in Chapter 2, a number of factors have been identified that will influence the results of this research. These include occupation time, and the GNSS survey method to be used.

To post-process with AUSPOS, a minimum of one hour of observation data is required, therefore, at least a minimum of a one-hour occupation of every station was required for this project. However, as the data was also being post-processed in TBC (Trimble Navigation 2016c), simultaneous data logging between stations also needed to occur. To ensure enough data was logged simultaneously between stations, a minimum requirement of two-hour occupation times was necessary. This condition would allow for at least one hour of observation for each baseline measured in the network surveys.

Despite the field survey being made up of a combination of smaller (≥1km) and longer baselines, the fast static method is arguably the more suitable method. However, as it is a requirement of a minimum of one hour of observation data to post-process with AUSPSOS, the static method was employed. The selection of the classic static method also would provide more reliable data, as the longer observation times take advantage of the change in satellite geometry.

Following consultation of the *SP1* published by ICSM (2014a), the *CSR v7.1* published by the DNRM (2015), and the above factors determined by reviewing the appropriate literature, it was identified that the classic static survey method was the most suitable method for this research.

3.4.1 Survey Style

The survey style is used to define the parameters within the data recorder for configuring and communicating with instruments. It enables the user to specify the type of survey they wish to conduct, and apply the relevant settings to that survey and store it as a template for future use (Trimble Navigation 2016a).

A survey style relevant to this survey has been created and distributed to the two data recorders being used for the data collection process. The settings for a static survey outlined below have been applied to the survey style following consultation with SP1:

- measure a static point;
- use of a 15 second observation sampling rate;
- tracking only the GPS satellite constellation (as AUSPOS only processes GPS data); and
- a 0-degree elevation mask;
- a minimum of 1 – 6 hours of occupation time.

3.4.2 Field Procedure

The initial field procedure set out to survey a typical network that would comprise of no dependant baselines, good network geometry, and sufficient ties to existing local GDA94 control in the area. The network would eventually require two weeks to log all of the data in 19 sessions. Figure 3.4.2.1 illustrates a typical GNSS network similar to that surveyed in this project. It uses four GNSS receivers, the same amount that was used for a majority of this project, and measures three baselines per session which are represented by the different colours. In total, the network requires four sessions to have all figures closed and occupied more than twice.

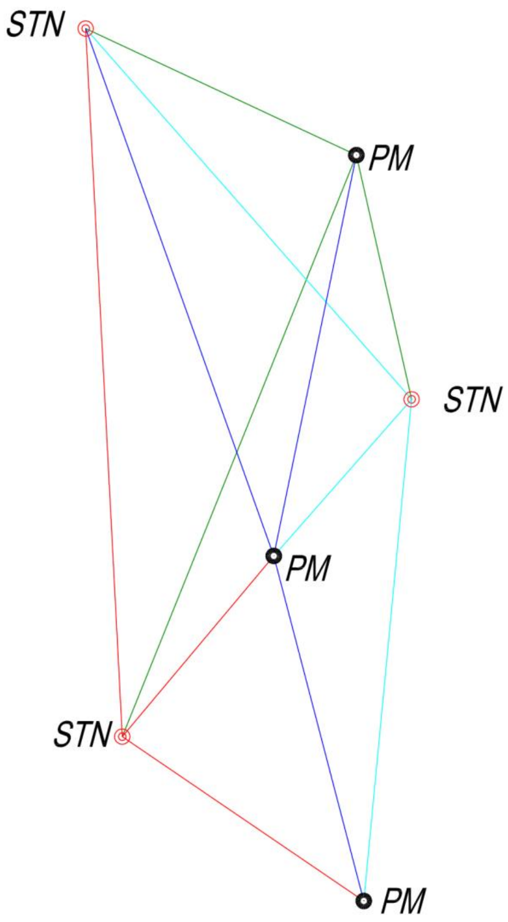

Figure 3.4.2.1: A typical GNSS network with closed figures and no dependant baselines.

To begin with, the survey was carried out unaccompanied. This was originally thought to be the “cheaper” method. The field procedure was to do the following:

1. Pre-plan sessions for the day.
2. Drive to and install or locate control mark, and set up GNSS receiver over control mark on tripod.
3. Record all relevant information onto a standard booking sheet (Appendix C).
4. Enter information into Trimble TSC3 data recorder, start logging.
5. Move to next station, repeat steps 1 – 4 until all receivers are set up and logging.
6. Record at least two hours of data, end logging sessions in the order that they were started.

7. Move onto next session, and repeat steps 1 – 6 until all stations have been occupied, all figures have been closed, and there are sufficient braces in the network.

The field survey began on Monday, 9th of May 2016. For the first three days, the survey was carried out the survey unaccompanied. This made the field survey much slower than it necessary, resulting in increased downtime where baselines weren't being measured while all other receivers were being set up. By the time four stations were visited, set up, logging, and had been packed up, six hours of the day had been consumed, resulting in one session per day. A colleague was brought in to assist with the survey allowing for multiple receivers to be set up at once, reducing downtime, therefore allowing two sessions to be surveyed in one day.

As this was the case, a revised field procedure was implemented, and followed as detailed below:

1. Pre-plan sessions for the day.
2. Drive to and install or locate control mark, and set up GNSS receiver over control mark on tripod.
3. Record all relevant information onto a standard booking sheet (Appendix C).
4. Enter information into Trimble TSC3 data recorder, call up other surveyor on UHF radio when ready, and start survey.
5. Record at least two hours of data, then end session.
6. Move to next control station.
7. Repeat process until all stations have been occupied, all figures have been closed, and there are sufficient braces in the network.

3.4.3 Post Survey Procedures

Following each survey undertaken daily, the raw data is downloaded, and backed up to a second location to ensure that there was a minimal chance of data loss. The raw data is also converted to RINEX format for post-processing in the future. Furthermore, the logging sheets used to record the set up information is scanned into the computer so a digital copy of the field records is available in the future (Appendix C).

3.5 Additional Data Required for Post-Processing

3.5.1 Ephemeris Products

To successfully post-process a GNSS survey, ephemeris products needs to be used. The broadcast ephemerides can be obtained directly from the GNSS receiver and used for post-processing, or ultra-rapid, rapid, of final/precise ephemerides can be obtained from IGS.

Ephemeris data provides information about the location, timing, and condition of the tracked satellites. This information is used to estimate the position of the GNSS receiver relative to the location of the tracked satellites, and therefore the position on the earth (Western Washington University 2016).

In a technical sense, ephemeris data is used in GNSS post-processing to access a desired reference frame such as the ITRF92, on which GDA94 is based (Geoscience Australia 2016b; ICSM 2014b).

Users can post-process data relative to the broadcast ephemerides of the GNSS receiver being used, or post-process relative to the appropriate IGS precise ephemerides. Differences in these two products can be expected however, as the broadcast ephemerides are provided by the GNSS at the epoch of the survey, whereas the precise ephemerides are based on the most current realisation of the ITRF.

While there would not have been much difference in the results of the survey based on the ephemeris product used for post-processing, all processing was carried out using the precise GPS ephemeris provided by IGS during the time of the survey. GLONASS ephemerides are also available, however as this survey was only processed using GPS, the GLONASS ephemerides were not required.

3.5.2 Data Provided from a Regulation 13 CORS Service

A Regulation 13 certificate is a legal document that provides station coordinates and the uncertainty of the coordinates provided. A regulation 13 certified Continuously Operation Reference Station (CORS) is often used by surveyors and GNSS users as a means to connect confidently to datum, in the case of Australia, GDA94 (Geoscience Australia 2016c).

Using RINEX data from Regulation 13 CORS sites provides GNSS users with legal traceability of their observations under the *National Measurement Act 1960* (Geoscience Australia 2016c). Legal traceability is a particularly important factor to consider when undertaking cadastral surveys such as a long line easement survey.

For the purpose of this dissertation, the Regulation 13 CORS sites at Woolloongabba and Beaudesert will be used. Regulation 13 Certificates for these sites are attached in Appendix B.

3.6 Post-Processing Testing Scenarios

Some of the various testing methodologies used in this project are often not regarded as "best practice" by industry standards. However, this research intends to test the alternative methodologies to determine what qualities can be expected if they were to be adopted, and how much time and money can be saved by adopting these methods.

3.6.1 Scenario One – Conventional Network Fixed to Local Control

The first method tested in this project was a conventional GNSS network that utilised multiple sessions to achieve two, three or in some cases four occupations and closed figures without the use of dependant baselines. The network was constrained to local GDA94 "datum" permanent marks and weighted accordingly.

Surveying a network of this kind is time consuming. It requires multiple sessions, resulting in multiple occupations of each station, often some hours or days apart depending on the size of the network. Figure 3.6.1.1 illustrates the sessions required to establish a typical static closed figure GNSS network. Each colour represents an individual session with four receivers, therefore each session can only produce three baselines, and four sessions would be required to complete the network.

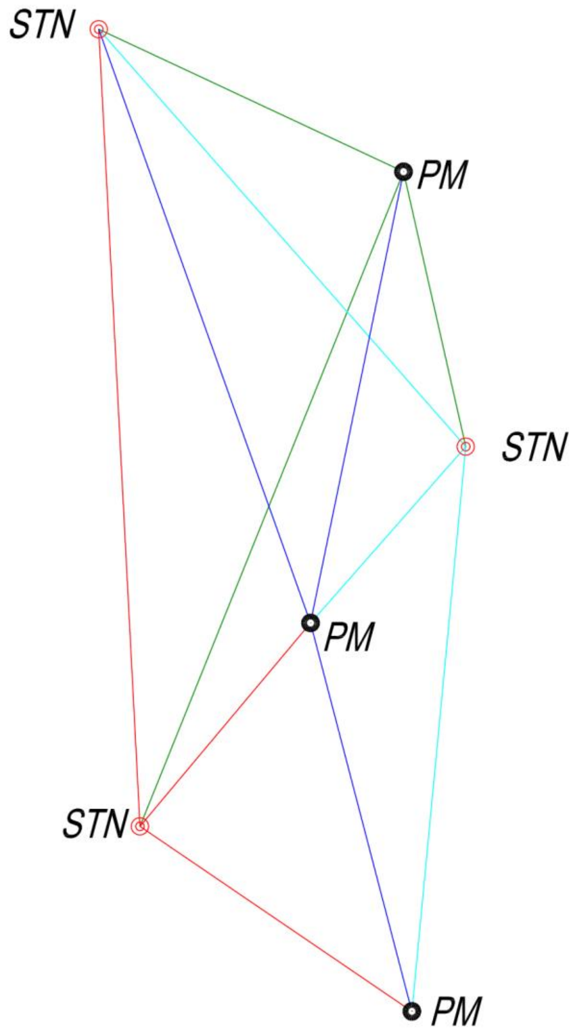

Figure 3.6.1.1: A typical GNSS network comprising of four sessions using four receivers fixed to local control.

3.6.2 Scenario Two – Conventional Network Fixed to Regulation 13 CORS

Method two was constructed around the ideology used in method one. However, rather than constraining the network to local control, the network was constrained to Regulation 13 CORS sites at each end of the survey. In this case, those sites are located at Beaudesert and Woolloongabba.

The surveyed part of the network uses the same baselines and occupations as those in method one, meaning that the field work will amount to be the same as method one, but constrains the network to Regulation 13 CORS sites, by computing a baseline from the CORS site to one or more stations at the end of the network (figure 3.6.2.1).

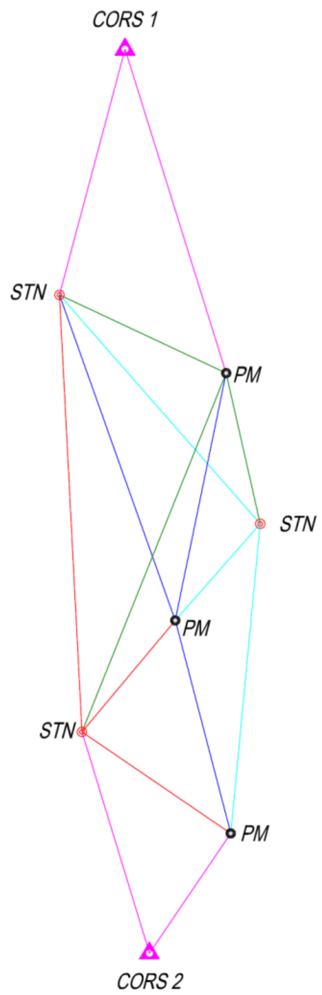

Figure 3.6.2.1: A GNSS network constrained to two CORS sites at each end of the network.

3.6.3 Scenario Three – Positioning using only Regulation 13 CORS

Computing precise coordinates using only one GNSS receiver logging static data can be done a number of ways, the easiest of which would be to post-process in an online service such as AUSPOS.

However, the method used in this scenario is based around a point positioning ideology and only requires one receiver to occupy one station at a time, until all stations in the network have been occupied. RINEX data for surrounding CORS sites for each day of survey should then be obtained to also use for the post-processing component.

Baselines are then computed between each station to surrounding CORS sites to compute precise coordinates for the occupied stations (figure 3.6.3.1). In this method, no baselines are computed between the occupied stations.

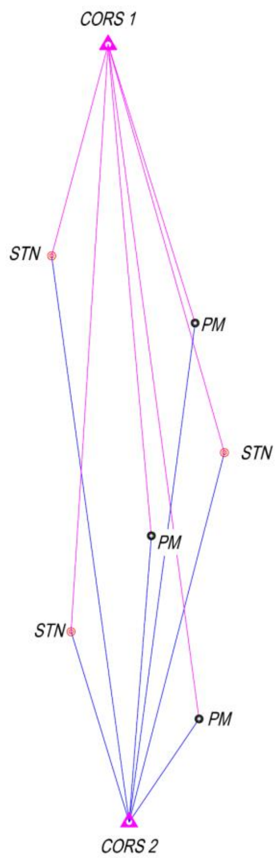

Figure 3.6.3.1: A GNSS network constrained to two CORS sites at each end of the network. Note the is no baselines between actual occupied stations.

3.6.4 Scenario Four – Single Baseline Traverse

The fourth method tested in this project is comparable to a conventional total station traverse that connects to two known points at each end of the traverse. However, carrying out this traverse by conventional terrestrial methods would be difficult due to issues with line of sight and the length of the observed lines.

This method would require two receivers to complete, computing a single baseline between two stations at a time. Initially, the two receivers would be set up simultaneously over two stations, and data would be logged for one session. In the next session, one receiver would be reset over the same mark that it was on, and the other would be move to a new mark in a leap-frog manner to compute another baseline, and so on until all stations had been occupied (Figure 3.6.4.1). This method would result in no closed figures, and therefore no redundancies and minimal degrees of freedom, making it in reality, an unreliable network.

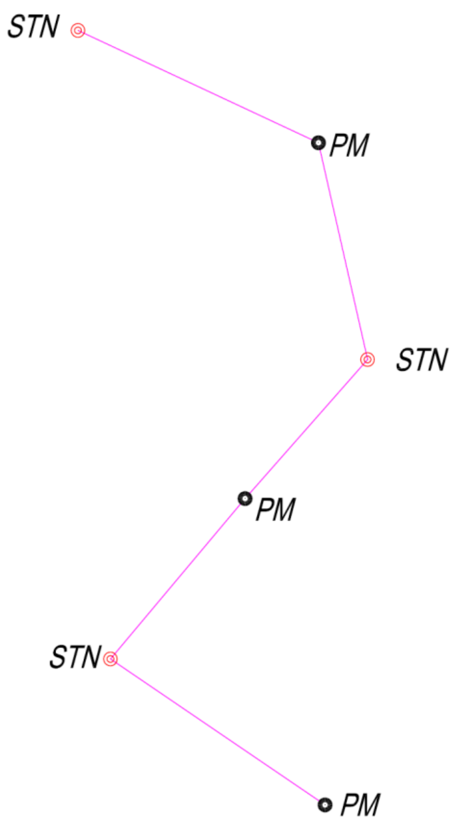

Figure 3.6.4.1: A single baseline GNSS network.

3.6.5 Scenario Five – Constrained to AUSPOS Solution

This method surveys a network in the same way as 3.4.6. However, the network is not constrained to any local control or CORS sites, but instead, AUSPOS computed coordinates using GNSS data from the survey that is being processed (figure 3.4.5.1). It is also possible to weight these coordinates accordingly as GA's AUSPOS service provides positional uncertainty at the 95% confidence interval with the report.

For the purpose of this network, stations at the northern and southern most ends of the network were post-processed by AUSPOS and used as the constraints for the network.

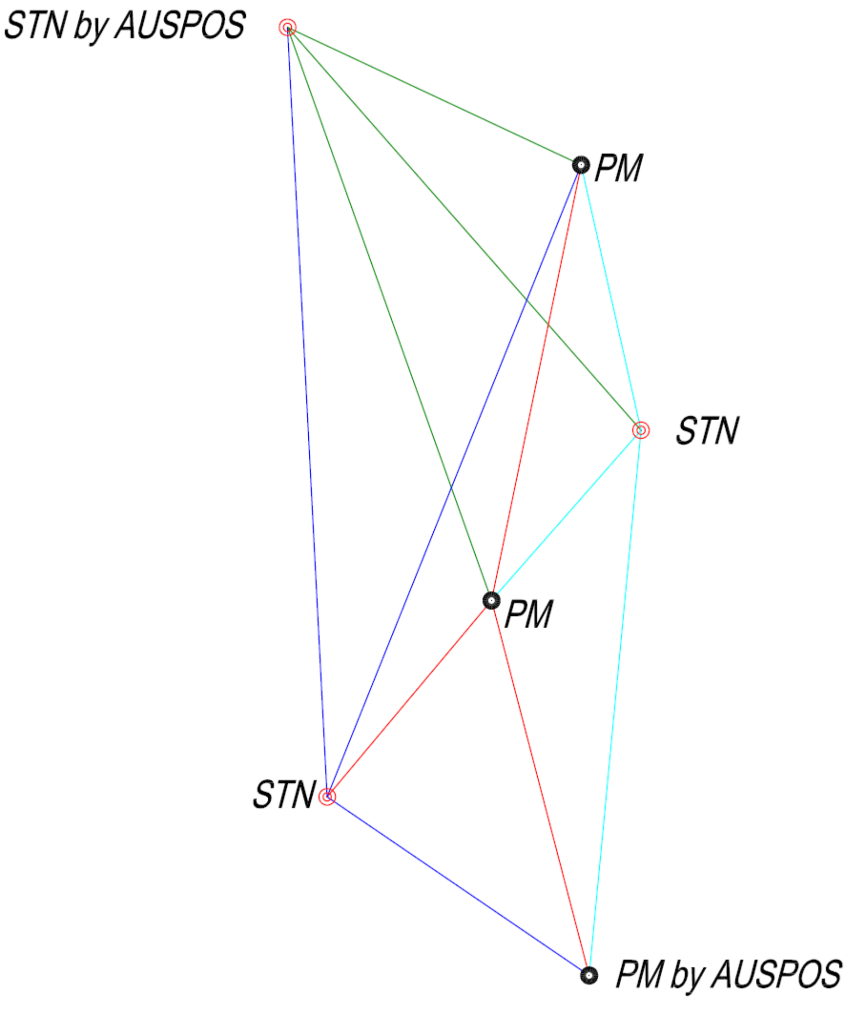

Figure 3.6.5.1: A GNSS network comprising of four sessions, constrained to two AUSPOS solutions.

3.6.6 Scenario Six – Conventional Network Including Baselines to CORS

This network utilises CORS data for the entire time span of the survey. A network is surveyed the same as 3.6.1 Scenario One – Conventional Network Fixed to Local Control, then data from the Woolloongabba and Beaudesert CORS stations were added into the project for every day of the survey. In terms of field survey, this method takes no longer to complete than Scenario One – Conventional Network Constrained to Local Control, however additional processing time can be expected as there is more data to process.

Traditionally, a session using four GNSS receivers would compute three independent baselines between the stations occupied. However, by adding CORS data into the project, an extra baseline can be computed between the base station and the CORS site (figure 3.6.6.1). This was done for each session in the network, without computing any dependent baselines. The CORS site used for each session was dependant on the distance between the base station, and the two CORS sites used. For example, if WOOL was closer to the station being occupied than BDST, than WOOL would be used in that session.

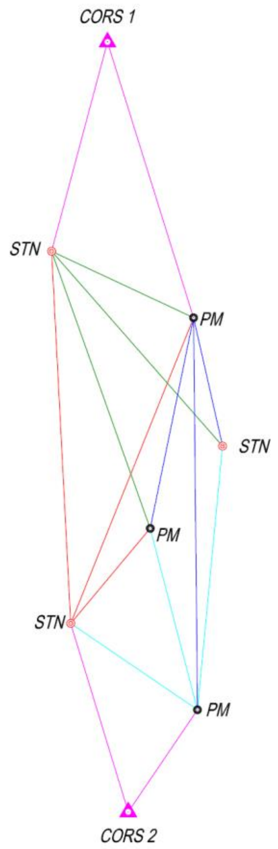

Figure 3.6.6.1: A GNSS network comprising of four sessions with additional baselines computed to the closest CORS site.

3.7 Post-Processing with AUSPOS

It is widely acknowledged that the PPP method is inherently less accurate that conventional network post-processed GNSS surveys (Ebner & Featherstone 2008). However, post-processing with AUSPOS, which is not the same as PPP (see section 2.4), has been proven to provide reliable coordinates, in a short amount of time (El-Mowafy 2011; Ocalan, Erdogan & Tunalioglu 2013).

The AUSPOS post-processing process is rather simple and easy to use. It requires the user to convert their raw GNSS observation data to RINEX format for submission and submit to the online form for post-processing.

The user should conduct some simple checks to ensure that the RINEX data that is submitted will provide a true result. Geoscience Australia (2016d) list all the items that the user needs to check before file submission to make sure that the result that they receive will be reliable. These are outlined below:

- The GPS RINEX file/s contains more than one hour (preferably two) of GPS data.
- The GPS RINEX file/s do not contain any data from the current UT day.
- The GPS RINEX file/s do not contain more than seven days of data.
- The GPS RINEX file/s names do not contain spaces.
- When submitting multiple files, ensure the first four characters/numbers of the file names are not the same.
- The selected antenna uses the IGS naming convention for the antenna type.

The only input the user is required to provide is an antenna height to the Antenna Reference Point (ARP) which is a location generally at the base of the antenna at a known offset from the antenna phase centre (APC), where all GNSS measurements are made to. The antenna type, using the IGS antenna naming convention, and the users email address for a computed result. Figures 3.7.1, 3.7.2, and 3.7.3 illustrate the ARP location on each antenna that was used as a part of this research. This is represented as the reference surface for National Geodetic Survey (NGS) offset measurements.

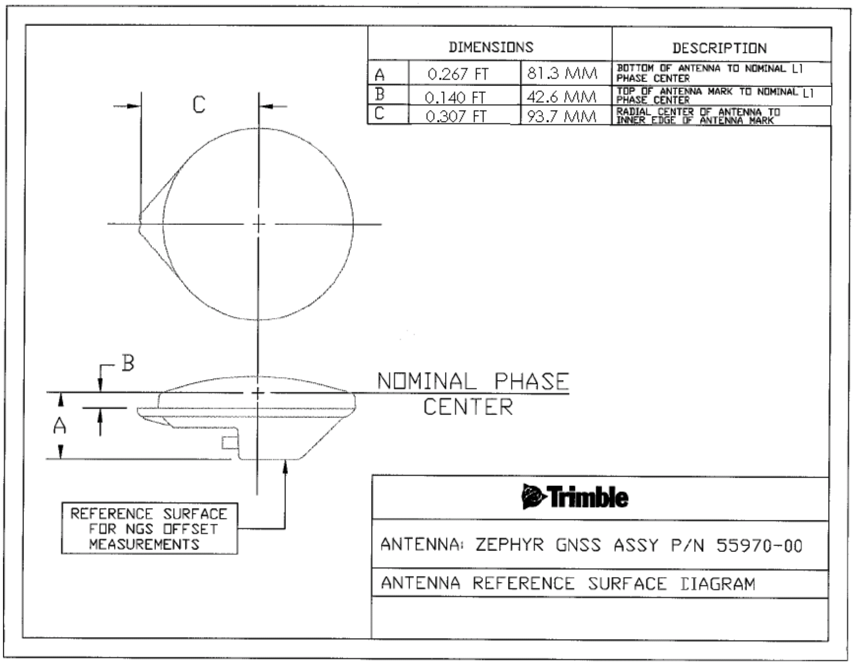

Figure 3.7.1: Antenna reference surface diagram for Trimble Zephyr and Zephyr model 2 antenna (National Geodetic Survey 2016).

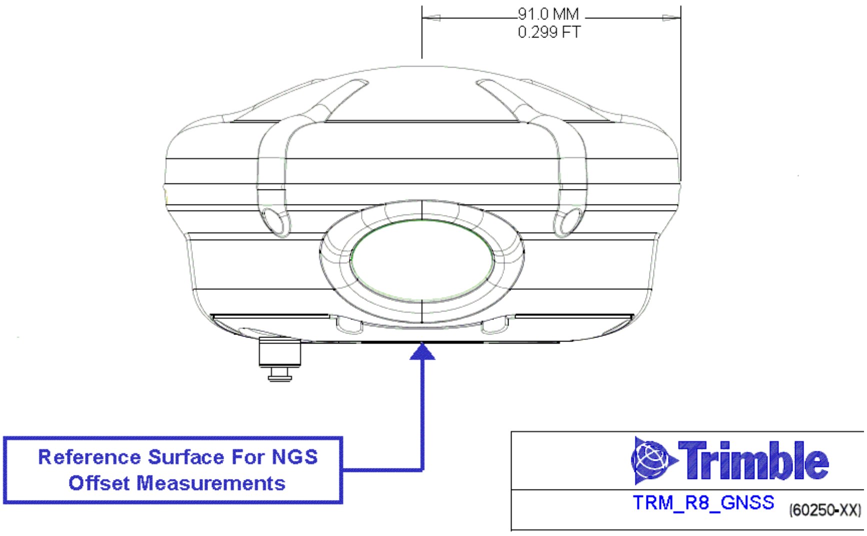

Figure 3.7.2 Antenna reference surface diagram for Trimble R8 GNSS receiver (National Geodetic Survey 2016).

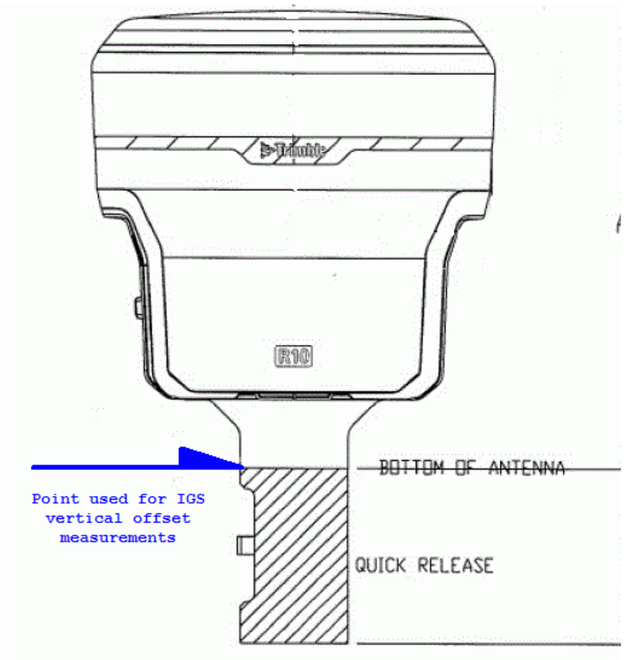

Figure 3.7.3: Antenna reference surface diagram for Trimble R10 GNSS receiver (National Geodetic Survey 2016).

Once the raw GNSS file containing the observation data was converted to RINEX format using Trimble's Convert to RINEX utility (Trimble Navigation 2016b), it was uploaded to the online AUSPOS service (Figure 3.7.4). The results for each file were then received by email and tabulated in Microsoft Excel. It is important to note that AUSPOS only looks at the antenna type and height to the ARP that the user provides on the interface shown in Figure 3.7.4. The antenna type and height in the RINEX file is ignored by AUSPOS.

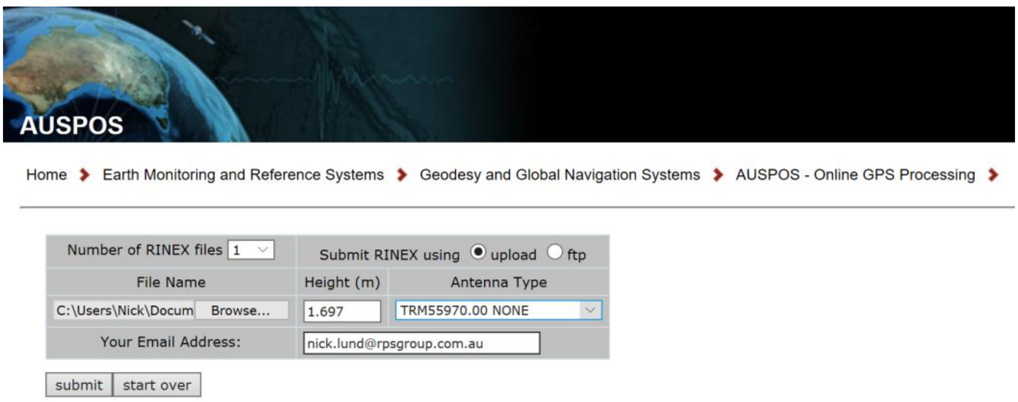

Figure 3.7.4: AUSPOS RINEX data submission for post-processing web page (Geoscience Australia 2016e).

3.8 Post-Processing

Upon completion of the field survey, and the download and conversion (if necessary) of all the required data to post-process the six networks, the following steps could be carried out to compute the networks; session editing, baseline processing, the minimally constrained network adjustment, and the fully constrained network adjustment.

The data was then imported into a suitable program that is capable of processing GNSS data. For this project the program selected was Trimble Business Centre (Trimble Navigation 2016c), as it is capable of baseline processing, and performing a least squares network adjustment.

After the data was imported into TBC (Trimble Navigation 2016c), the dependent baselines were removed, the baselines were processed, the logging sessions were analysed and cleaned, and the network was adjusted. The network adjustment process was carried out in two steps. Firstly, a zero constrained adjustment for each method was performed to a reference factor of approximately one. This was carried out to test the networks internal reliability, and to calculate the SU of each station. Following the zero constrained adjustment, a fully constrained adjustment was carried out. This was done to fit the network into an existing set of parameters, for example, a local control network or CORS network, and to also compute a PU for each station. This network adjustment was also carried out to a reference factor of approximately one.

3.8.1 Session Editing

The data was imported into a separate TBC project for each testing method and also one master project that contained all the raw data, that had not been manipulated.

Once the data was imported into the relevant TBC project and all the dependant baselines had been removed, the baselines were processed, and a baseline processing report was produced. From this report, baselines containing noisy data and cycle slips could be identified, and this data could be then removed.

An example of poor GNSS data is illustrated in the graph shown in Figure 3.8.1.1. This graph shows the data from GPS SV16 used to form baseline 155 from a session used in Method Four – Single Baseline Traverse. This sort of data is typically assessed and often removed from the baseline. If there is not enough good data to form the baseline, the data should be removed entirely and the baseline should be remeasured and reprocessed. Figure 3.8.1.2 is an example of good GNSS data from GPS SV16 used to form baseline 25 in method five.

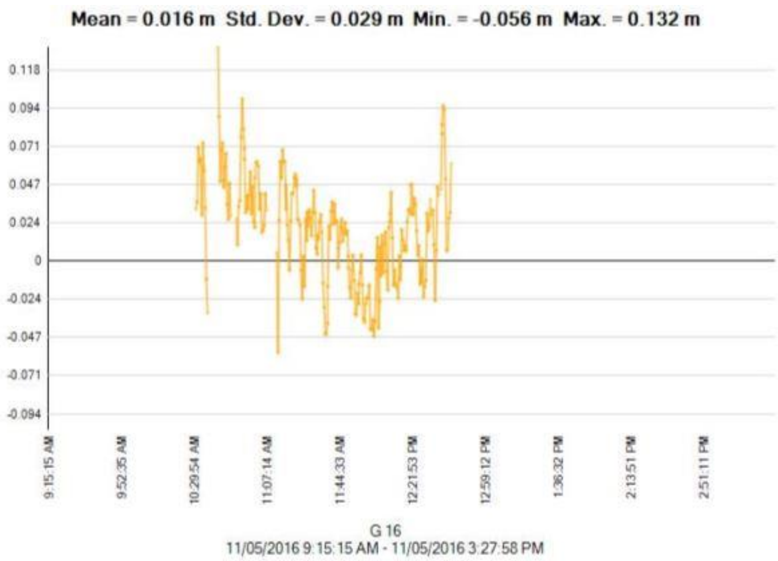

Figure 3.8.1.1: An example of poor data from GPS SV16 used in method four.

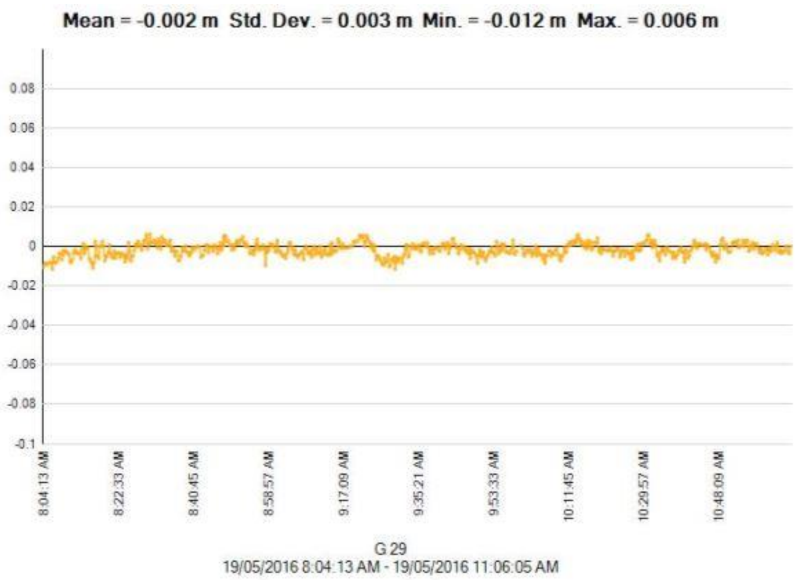

Figure 3.8.1.2: An example of good data from GPS SV29 used in method five.

3.8.2 Minimally Constrained Adjustments

The minimally constrained adjustment is carried out to determine the overall reliability of the network. It is a useful method for detecting gross errors or blunders such as incorrect antenna heights. It is also useful in computing a scalar to scale the baselines to get a more realistic error estimate, which is then used to calculate SU and RU (University of Southern Queensland 2013).

The minimally constrained adjustments were run for each method that was tested. Each method, except method four, initially failed the minimally constrained adjustment. The data was checked to confirm that no gross errors had been made, and subsquently a scalar was applied to the network and a new adjustment was performed. This resulted in a new network reference factor of approximately one which provided more realistic error ellipses for each of the stations. Using the resultant standard error ellipses, the SU for each station could then be calculated.

3.8.3 Fully Constrained Adjustments

A fully constrained adjustment should be performed to fit the survey into an existing set of parameters. Following the minimally constrained adjustment, a fully constrained adjustment was performed on each method. Methods one and four were constrained to existing local control networks in the form of GDA94 “datum” PSM’s. Methods two, three and six were constrained to Regulation 13 CORS sites that form part of a larger CORS network, and method five was constrained to an AUSPOS solution at each end of the survey.

Each method passed the first fully constrained adjustment as the scalar from the minimally constrained adjustment was applied to the baselines. The standard error ellipses were then used to calculate the PU for each station in each network.

3.9 Summary

The aim of this chapter was to determine a suitable location and method for conducting the field survey component of this dissertation so that enough data was collected to post-process in a series of different configurations. The field survey would inevitably employ the classic static method for data collection, and adhere to SP1 standards for a classic static survey.

The main objective of the chapter was to determine a series of post-processing configurations that would use conventional baseline post-processing techniques as well as integrating these techniques with online post-processing services.

Finally, a way of analysing the different testing scenarios was proposed. This will be carried out in the following chapter and will include an independent analysis of each network, addressing network reliability and redundancy, then assessing the networks together, on a time/cost and uncertainty basis to give some indication of what network configuration will provide the best uncertainty for the least amount of time. The results and analysis of each testing scenario are discussed in Chapter Four – Results and Analysis.

4.0 Results and Analysis

4.1 Introduction

The testing scenarios and procedures were outlined in Chapter 3. This chapter analyses the data and results that have been produced as an outcome of using testing the scnarios. This chapter will summarise the results produced by TBC (Trimble Navigation 2016c) and AUSPOS for each of the testing methodologies discussed in the previous chapter.

The results in this chapter will then be used in the following chapter which will analyse the results in comparison to time/cost and network reliability and uncertainty and present them in a way that advises surveyors on what accuracies can be expected based on the style of survey being conducted.

4.2 Independent Analysis

This section will provide an insight into the results of each scenario tested individually. This will include an assessment of the network adjustment reports (Appendix E), the computed SU and PU for each station, the number of independent occupations for each station, and the overall reliability of the network.

4.2.1 Post-processing with AUSPOS

During the field survey of this project, each station was occupied a number of times for 2-hours or more at a time. Each RINEX file for each station was submitted to AUSPOS for post-processing. The results for each occupation were provided in GDA94 format on ITRF92 in a pdf file and were received by email a short time after submission.

Realistically, only one RINEX file is required to obtain a position, however, all of the additional files were submitted as it required minimal extra effort to do so. Doing this also provides a gross check on the original positions computed and will detect if any blunders had been made during the field survey. This can be determined as the additional positions are computed using data from a different occupation of the same station, taking advantage of the change in satellite geometry and also different antenna heights and observation lengths.

In total, 68 files were submitted to AUSPOS, and 60 provided reliable results. The eight outliers provided poor PU at the 95% confidence level and were excluded from the rest of this project. According to the AUSPOS results, this is often the result of poor ambiguity resolution in the baselines used to calculate the position of the occupied station.

After all the AUSPOS reports had been received, the results were tabulated in a spreadsheet, and where multiple results had been received for one station, all results were averaged to obtain a single coordinate for the station (Table 4.2.1.1).

AUSPOS Results				
Pt Id	***Easting***	***Northing***	***Height (AHD)***	***PU h***
8000	502423.614	6945838.203	11.840	0.012
8001	501308.666	6942562.865	28.096	0.012
8002	501571.881	6941988.929	37.577	0.018
8003	501907.484	6940745.689	59.911	0.012
8004	501861.021	6939961.345	61.991	0.018
8005	501804.654	6938616.214	64.986	0.011
8006	500762.571	6936689.199	65.630	0.011
8007	499839.110	6935557.948	52.954	0.022
8008	498807.056	6933940.087	71.123	0.021
8009	498376.237	6933017.087	69.765	0.013
8010	497877.115	6931994.929	70.249	0.011
8011	497216.887	6931644.585	54.184	0.013
8012	496661.134	6929507.605	56.507	0.013
8013	497045.763	6928821.406	58.114	0.019
8014	495976.151	6926491.858	47.869	0.019
8015	494336.488	6922279.538	60.145	0.013
PM 58886	496932.704	6931847.773	76.078	0.014
PM 59279	502887.372	6946191.534	17.995	0.018
PM 61261	492475.275	6917933.873	52.991	0.014
PM 90501	499169.749	6933677.843	57.041	0.016
PM 101732	502055.227	6940700.739	59.933	0.012
PM 107142	495042.702	6924708.251	39.092	0.045
PM 121890	502287.574	6944569.174	34.432	0.012
PM 171104	492752.696	6920798.309	41.653	0.016

Table 4.2.1.1: AUSPOS computed MGA94 coordinates, AHD71 heights, and the respective computed horizontal PU for each station.

The AUSPOS post-processing method provided good quality results for a majority of the data, with the exception of eight poor results mentioned earlier. The average computed PU was 0.016m where the best PU was 0.011m at stations 8005, 8006 and 8010. The worst computed PU was 0.045m, this was observed at PM 107142. This station returned only one result that was not flagged as affected by poor ambiguity resolution. The result for PM 107142 has the highest PU of the AUSPOS dataset. The next highest computed PU is 0.022m at station 8007, almost half of the computed PU for PM 107142. A second independent occupation would be required to recompute a position that provides an acceptable uncertainty, and a third independent occupation would confirm the result of the second occupation.

In the AUSPOS dataset, only three of the 22 stations submitted produce a computed PU of 0.020m or more (as detailed in Figure 4.2.1.1). This dataset provides a good indication of the PU that can be expected from submitting two to three hours of GPS data to AUSPOS for post-processing.

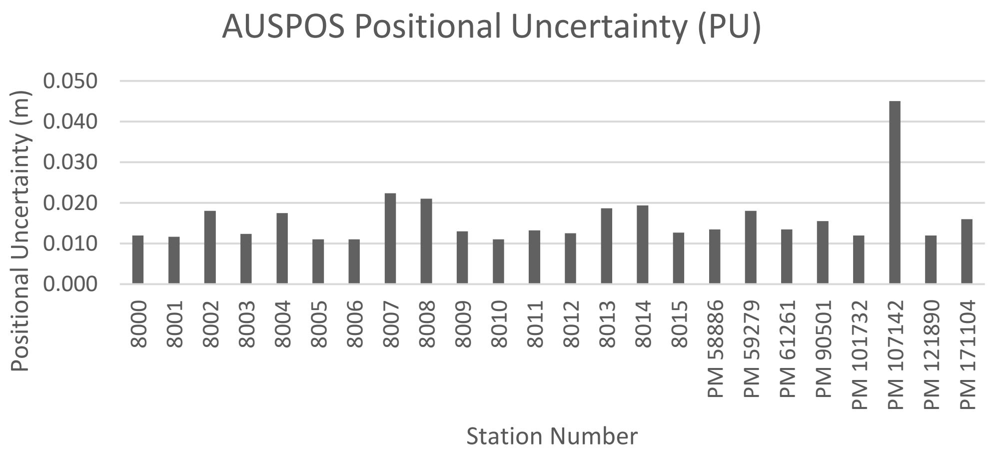

Figure 4.2.1.1: PU uncertainty as computed by the AUSPOS post-processing service.

4.2.2 Scenario One - Conventional Network Fixed to Local Control

The first method that was tested was the conventional network that was constrained to the local available control. As this method followed a relatively well researched approach to surveying a GNSS network using independent baselines and occupations, it was expected that it would provide reliable results that would produce uncertainties similar to the control that the network was constrained to.

The network consists of 24 stations, spanning approximately 35 km in length, and is constrained to two datum PSM's at each end of the network (Figure 4.2.2.2). The two staitons used to constrain the network were PSM 59279, and PSM 61261, which have horizontal PU's of 0.013m and 0.009m respectively (Queensland Government 2016).

Results from this network adjustment indicated that there was a correlation between the number of independent occupations made at a station and the SU for that station. It is evident that the more independent occupations made at a station, the high the SU will be for that station. This can likely be explained by the different antenna heights, small centring errors, and different satellite geometry at the time of each independent occupation.

The effect of the amount of independent occupations can be clearly seen at stations 90501, 101732, 107142, 121890, and 171104 in Figure 4.2.2.1, where the more independent occupations made at a station, the higher the SU.

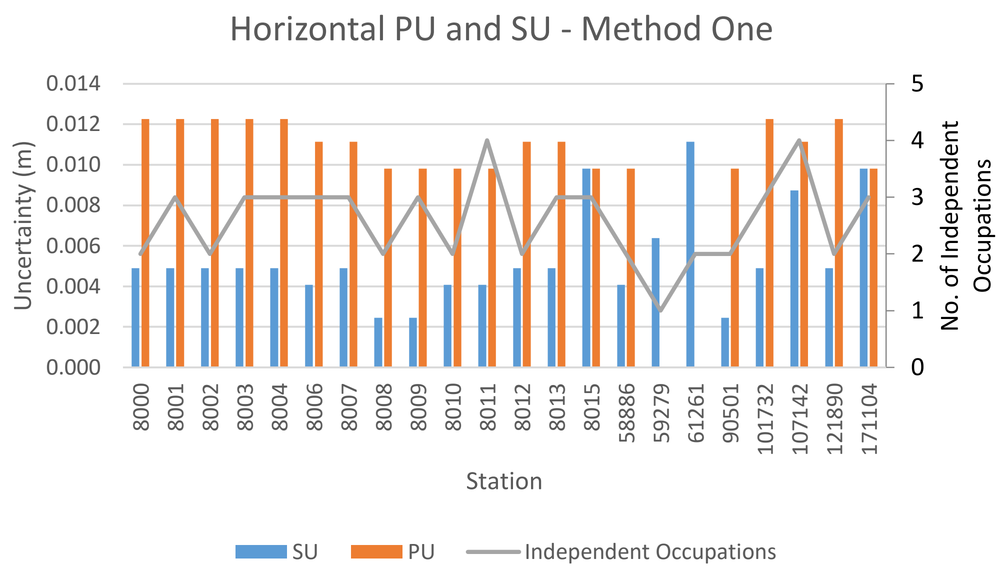

Figure 4.2.2.1: The computed horizontal SU and PU for each station surveyed in the network, and the number of independent occupations per station.

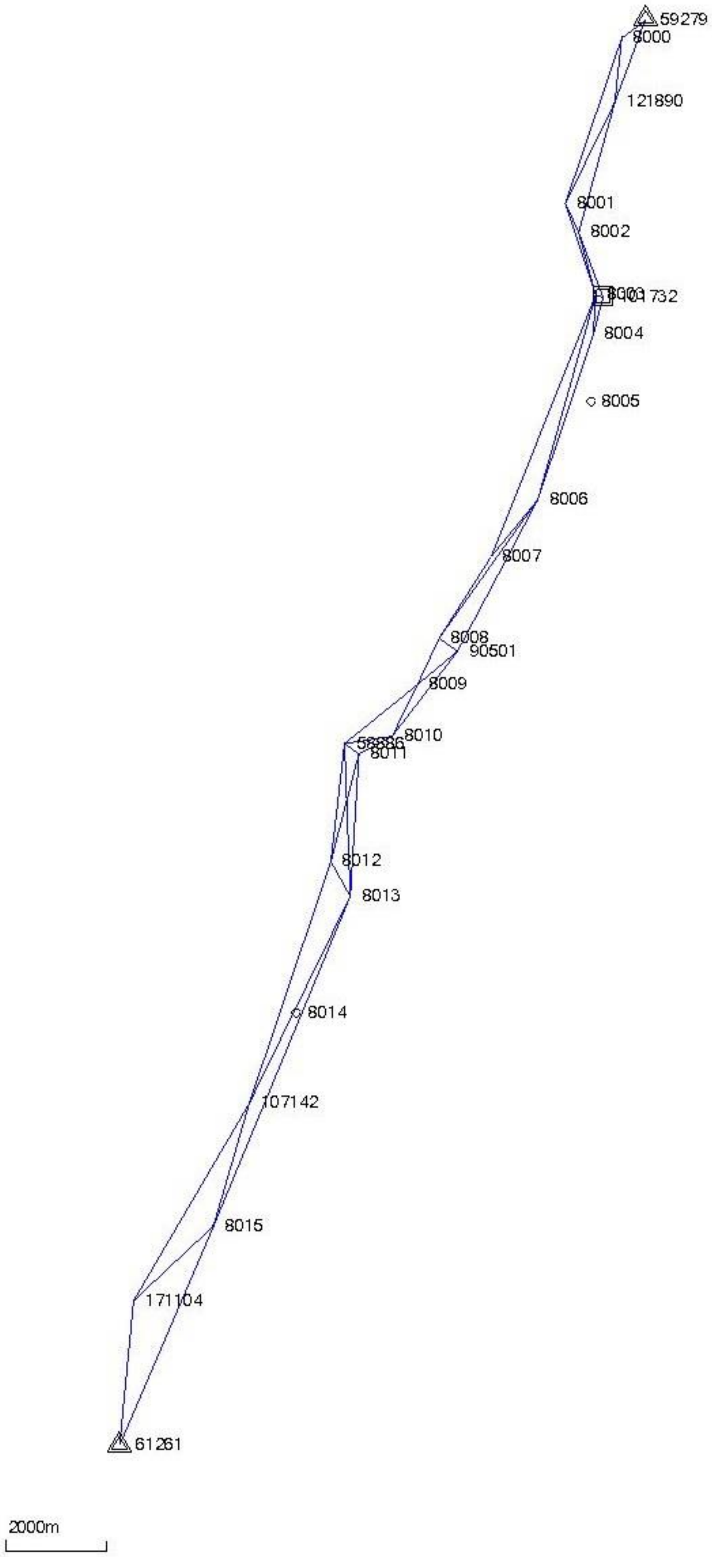

Figure 4.2.2.2: The network that was surveyed using Scenario One – Conventional Network Fixed to Local Control.

4.2.3 Scenario Two - Conventional Network Fixed to Regulation 13 CORS

In Scenario Two, an identical network to Scenario One – Conventional Network Fixed to Local Control was surveyed. However, this network included the use of Regulation 13 CORS data to provide a more reliable constraint (Figure 4.2.3.2).

This network was constrained to CORS stations at Beaudesert and Woolloongabba using the coordinates and uncertainties published on the Regulation 13 certificates (Appendix B) for each station.

Similar to the previous network, this network produced reliable coordinates. This is a result of the amount of independent occupations at each station, and the high number of redundancies and degrees of freedom in the network (Figure 4.2.3.1).

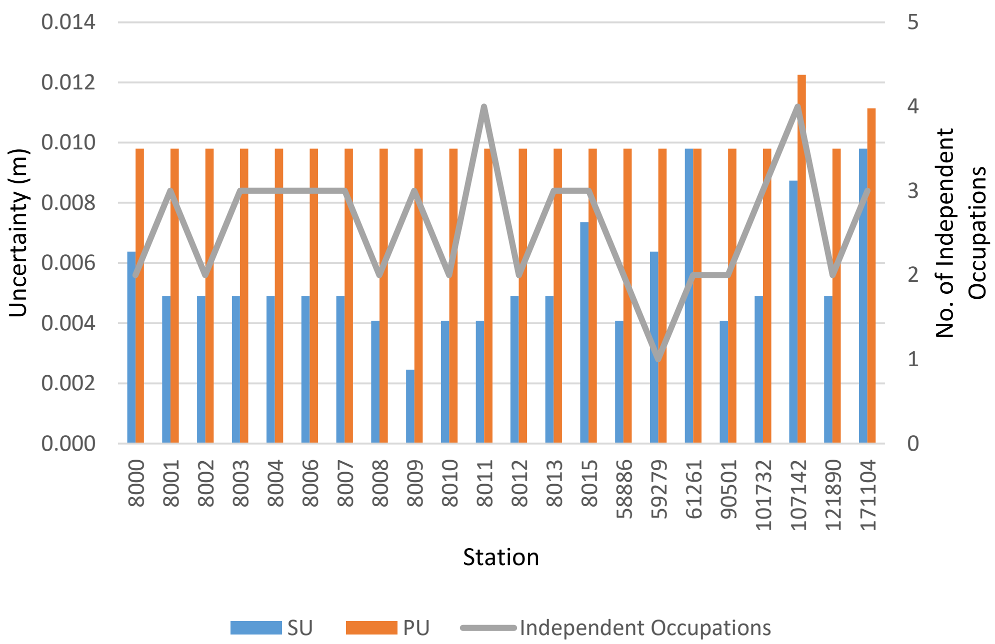

Figure 4.2.3.1: The computed horizontal SU and PU for each station surveyed in the network, and the number of independent occupations per station.

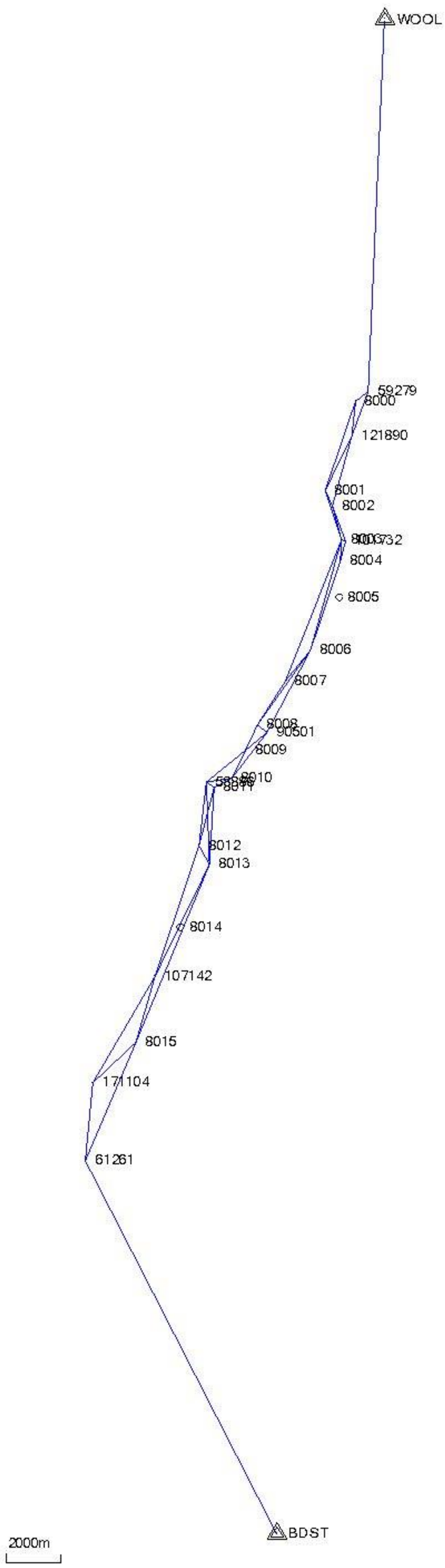

Figure 4.2.3.2: The network that was surveyed using Scenario Two – Conventional Network Fixed to Regulation 13 CORS.

4.2.4 Scenario Three - Positioning Using Only Regulation 13 CORS

In scenario three, a point positioning approach was adopted, whereby baselines were only computed between CORS stations and the occupied stations. No baselines were actually computed between occupied stations (Figure 4.2.4.2). The idea of this was to reduce the field observation time required to survey the network. This network would only also require one receiver to complete.

Despite the high number of redundancies and degrees of freedom in the network adjustment, this approach to long line network surveying produced a low and unrealistic SU (as seen in Figure 4.2.4.1). This is a result of only a single independent occupation at each station, so there is no real certainty in the observation itself. If a second or third independent occupation was observed, any blunders would be detected and a much higher, and more realistic SU and PU would be calculated.

To combat the unreliable result, at least a second independent occupation should be observed. This method of measuring a network for long line control purposes would then come into line with SP1 specifications (ICSM 2014b).

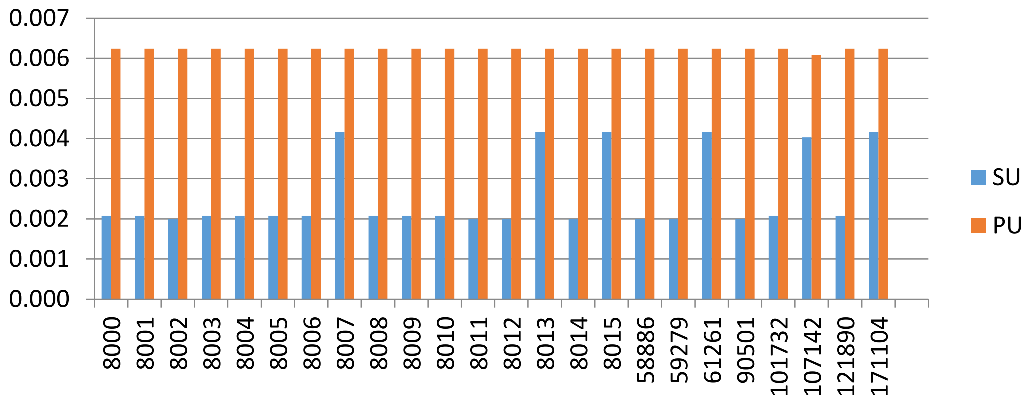

Figure 4.2.4.1: The computed horizontal SU and PU for each station surveyed in the network.

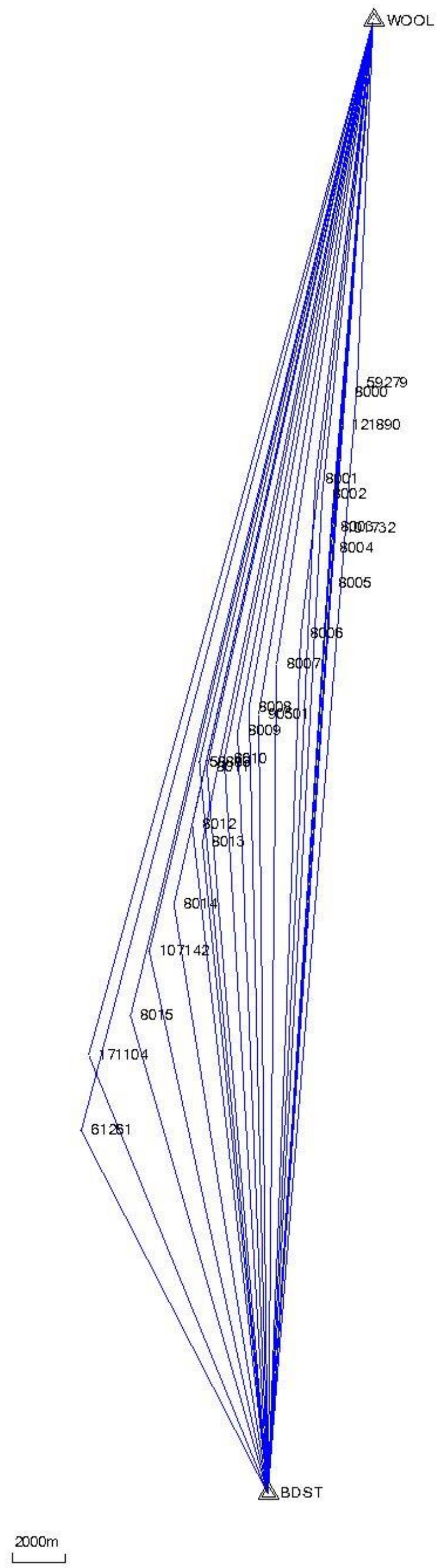

Figure 4.2.4.2: The network that was surveyed using Scenario Three – Positioning Using Only Regulation 13 CORS.

4.2.5 Scenario Four - Single Baseline Traverse

The fourth scenario tested computed a single baseline between each station, surveying the network in a leapfrog fashion with only two receivers.

Initially, a minimally constrained adjustment was attempted in order to calculate the corresponding SU's for each station, however, as there were no redundant observations or closed figures in the network, the minimally constrained adjustment failed to compute a solution. A fully constrained adjustment was the only adjustment that would compute a usable solution.

Originally, this network was to be constrained to the Beaudesert and Woolloongabba CORS sites used in Scenario Two and Three. However, when attempting to run the network adjustment for this scenario constrained to those CORS sites, the adjustment passed with a completely unrealistic network reference factor of 0.21.

The network reference factor is defined by The University of Southern Queensland (2013) as a comparison of observational residuals against the pre-adjustment expected observational residuals in a network adjustment. If the observational errors have been accurately estimated when the baselines are processed, it is expected that the residuals are approximately the same as the estimated errors. When this occurs, a network reference factor of one is achieved.

In this case, the network adjustment residuals had been grossly over estimated. The network was computing far better than anticipated resulting in unrealistically small error ellipses.

To analyse why this was occurring, the CORS data was removed from the project and the network was then constrained to local datum control at each end of the network, PM 59279 and PM 61261. When readjusted, the network returned a reference factor of 1.08, a more likely result for the type of survey performed.

The network in this scenario is a poor one. It is made up of no redundant observations, poor network geometry, and no degrees of freedom. Furthermore, the resulting PU of each station is on average, greater than 0.020m (Figure 4.2.5.1). The final adjusted network is illustrated in Figure 4.2.5.2.

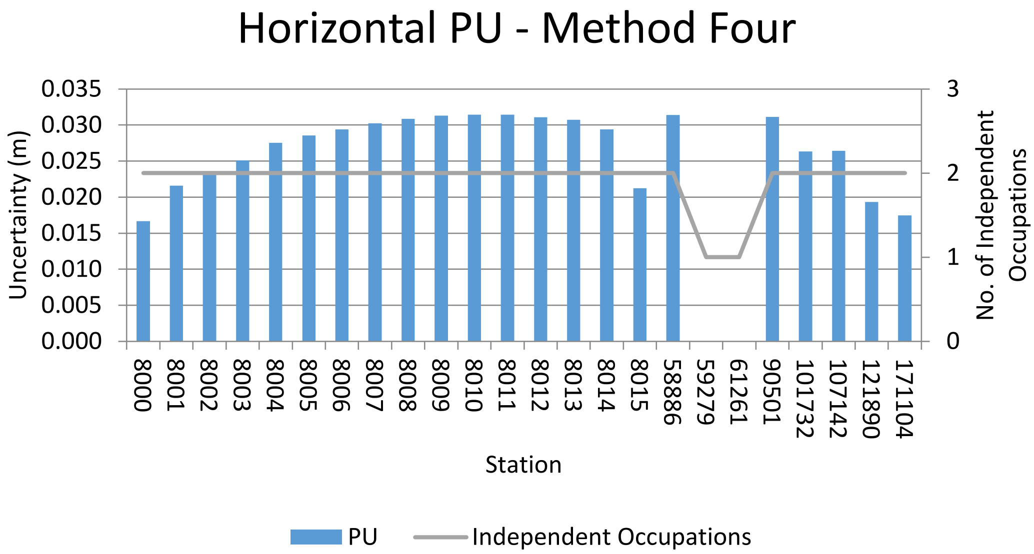

Figure 4.2.5.1: The computed horizontal SU and PU for each station surveyed in the network, and the number of independent occupations per station.

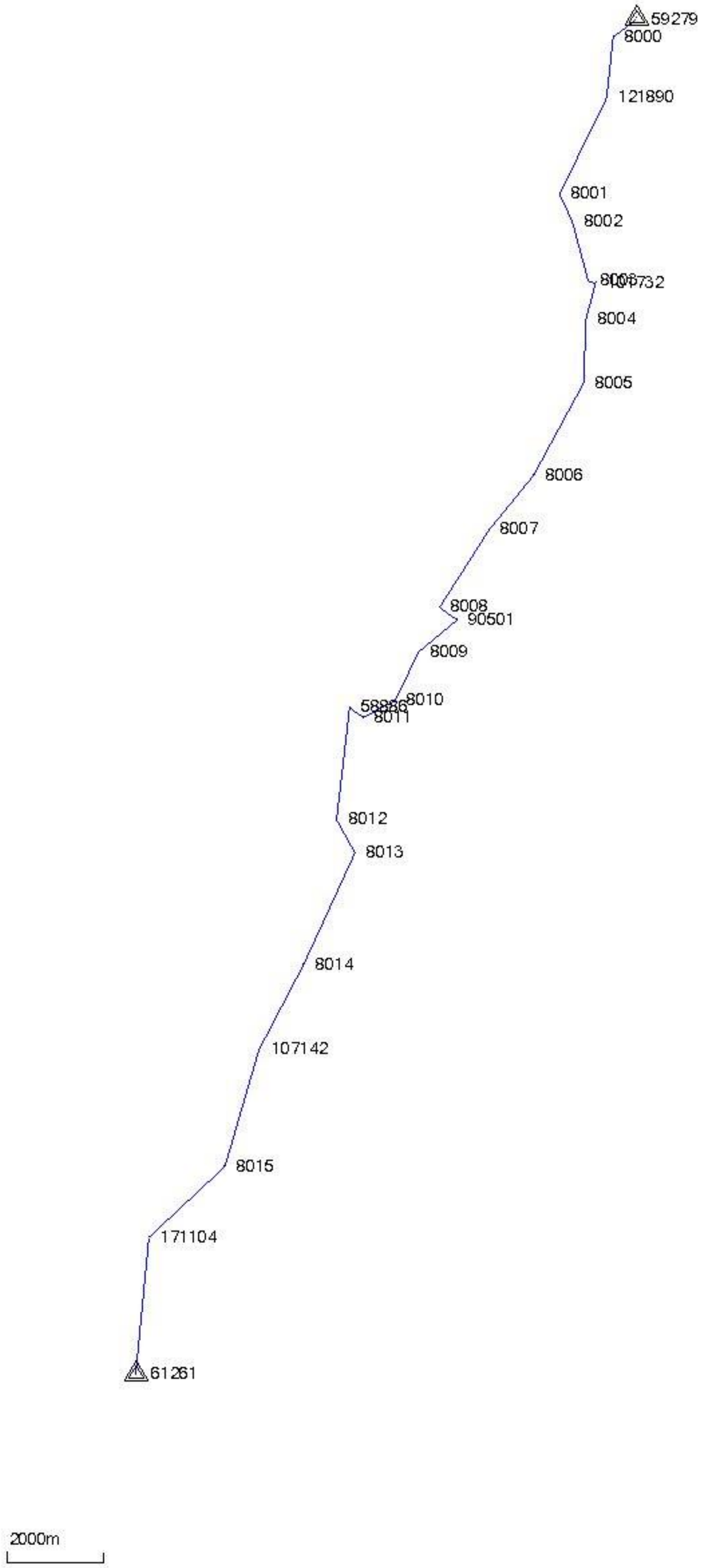

Figure 4.2.5.1: The network that was surveyed using Scenario Four – Single Baseline Traverse

4.2.6 Scenario Five - Constrained to AUSPOS Solution

The fourth scenario tested was an identical network as Scenario One – Constrained to Local Control. However, this network, instead of being constrained to local PSM's, GNSS observation data for the occupations at the fixed stations was post-processed with AUSPOS and the network was then fixed to the coordinates provided by AUSPOS and weighted accordingly. Figure 4.2.6.2 illustrates that the network geometry has not changed between this scenario, and scenario one.

This method produced reliable results, with slightly higher PU's than scenarios one and two, this is an effect created by the result of the PU for the constrained stations computed by AUSPOS, which were 0.018m for PM 59279, and 0.014m for PM 61261.

There was also a noticeable trend with the amount of independent occupations made at a station, and that stations resulting SU. This is a normal effect and is in-line with the trends found for scenarios one and two (Figure 4.2.6.1)

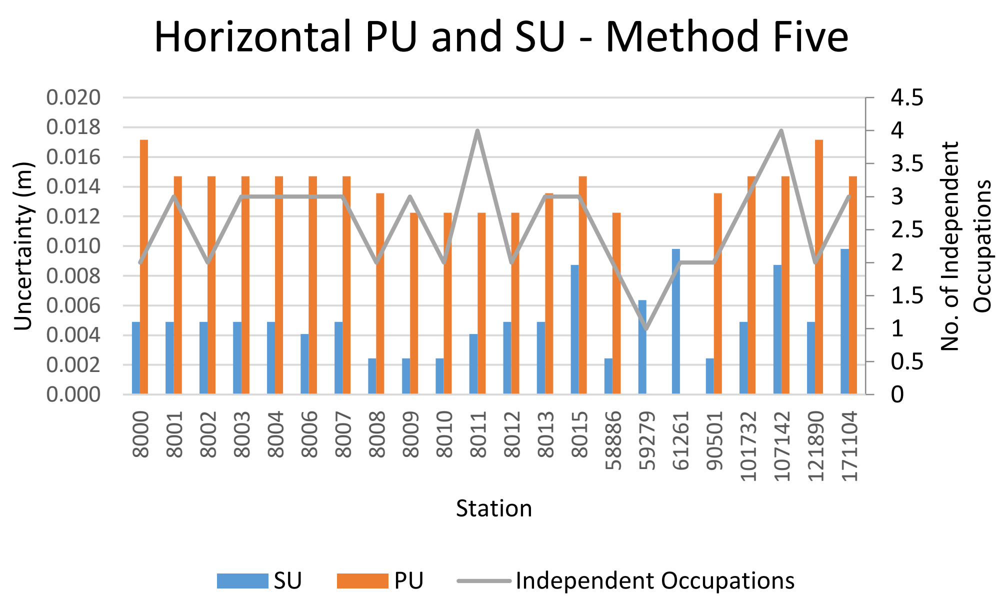

Figure 4.2.6.1: The computed horizontal SU and PU for each station surveyed in the network, and the number of independent occupations per station.

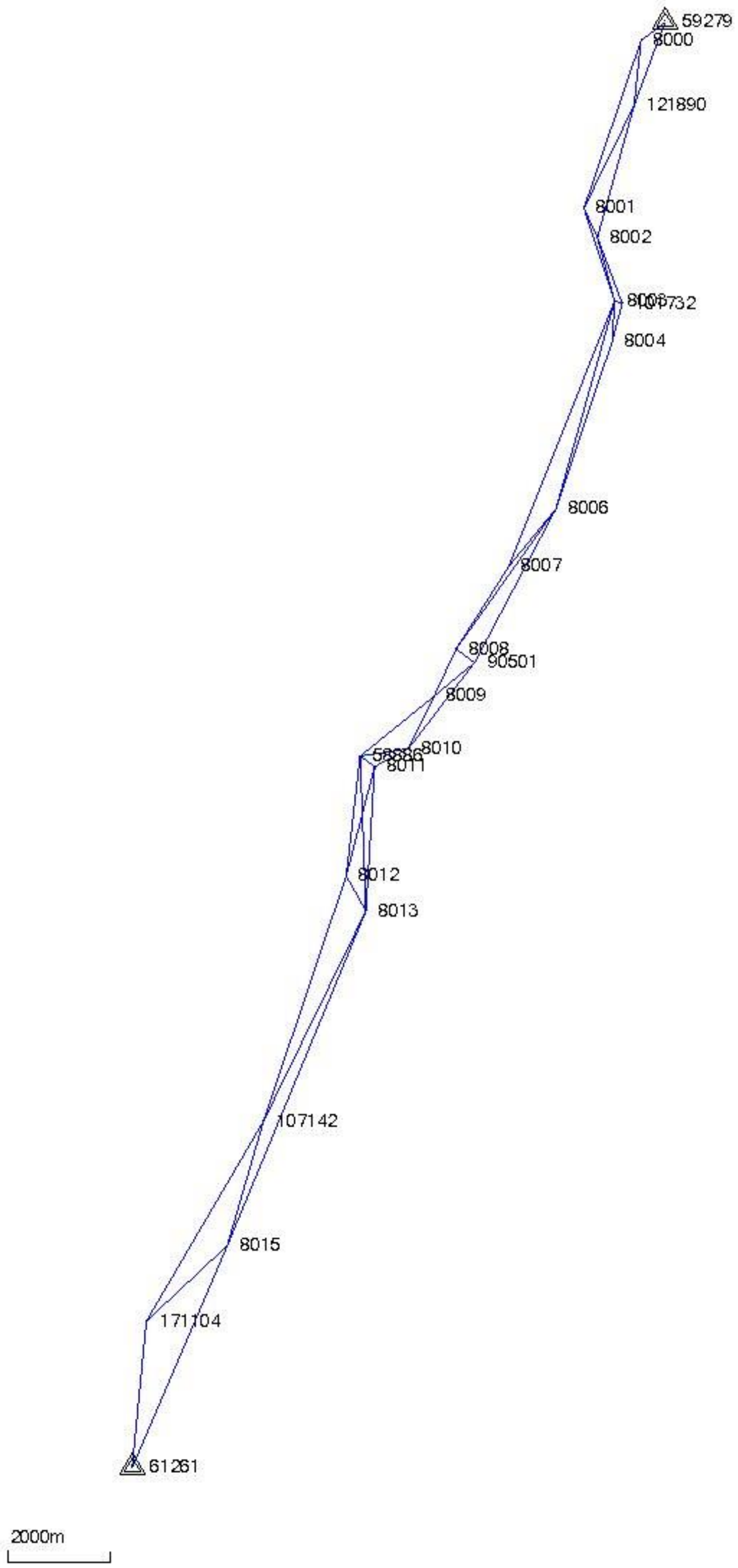

Figure 4.2.6.2: The network that was surveyed using method five.

4.2.7 Scenario Six - Conventional Network Including Baselines to CORS

This final testing scenario initially started as an identical network to Scenario Two – Conventional Network Fixed to Regulation 13 CORS. However, for every session surveyed in the network, an additional baseline from the base station to the closest CORS site was added to the session (Figure 4.2.7.2).

This added no extra field work, and only required the download of the CORS RINEX data for the time period that the survey was carried out, which was available from the other post-processing scenarios.

By adding the extra baseline to the CORS sites, the uncertainties calculated for the network were a few millimeters lower than Scenarios One and Two. This is a result of the extra observation to the fixed station of a high order, subsequently resulting in a more reliable and robust network (Figure 4.2.7.1).

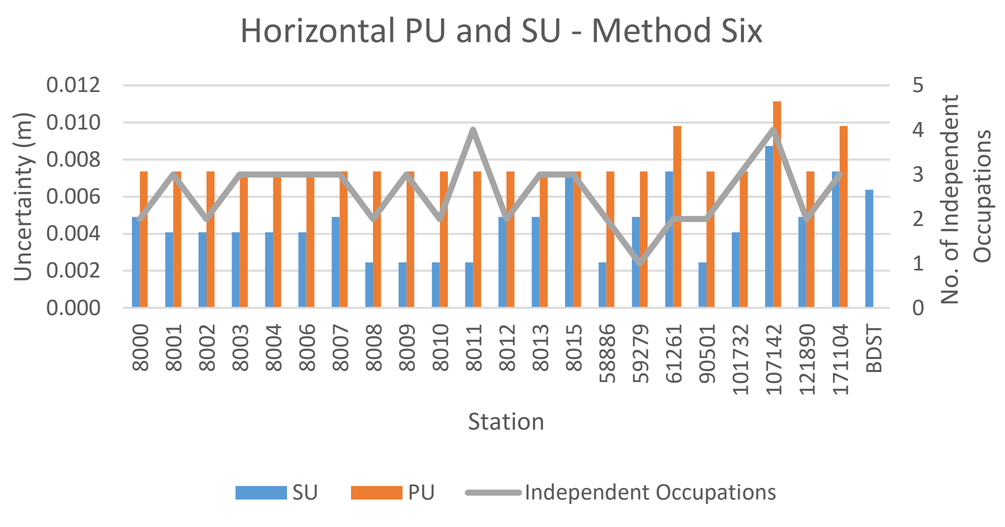

Figure 4.2.7.1: The computed horizontal SU and PU for each station surveyed in the network, and the number of independent occupations per station.

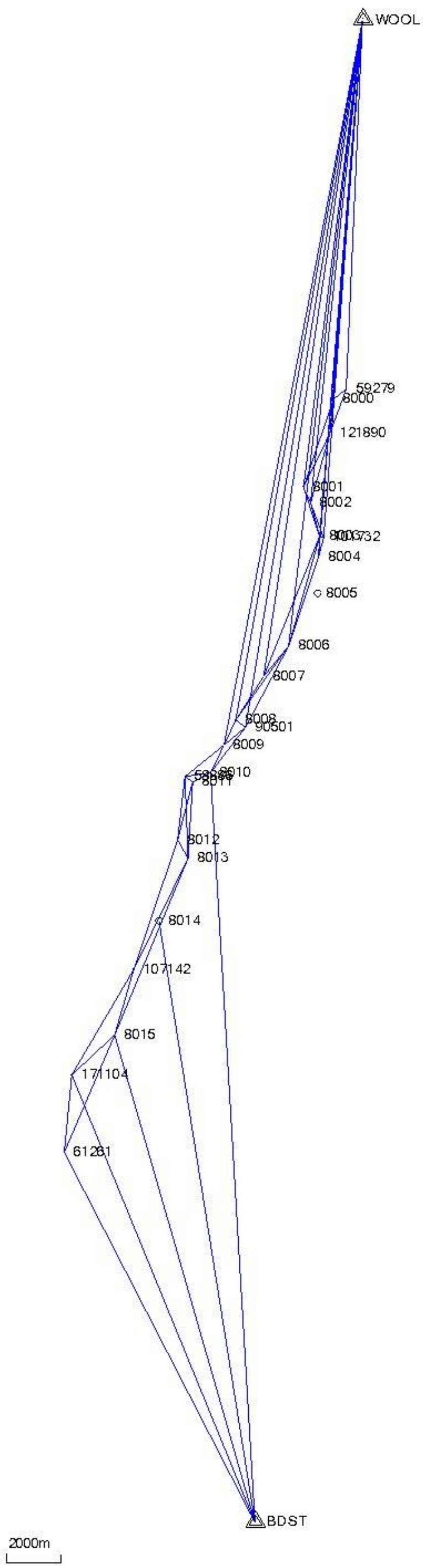

Figure 4.2.7.2: The network that was surveyed using method six.

4.3 Comparisons

Following the discussion of the independent results of each post-processing scenario, this section will analyse the results from each scenario against each other. This will provide some idea of what method is going to provide the best results based on reliability, uncertainty, and time and cost.

4.3.1 Uncertainty vs Time and Cost

To get some idea of the cost of establishing a long line network using one of these scenarios, the time and number of sessions required to survey each network must be addressed. Figure 4.3.1.1 illustrates the number of sessions required to survey each network, and also the time required to survey each network in hours.

The time for each network shown in Figure 4.3.1.1 is an approximation based on the field survey carried out that collect all the data. This takes into account the following:

- The amount of sessions in the network;
- the logging time which was a minimum two-hour occupation time (also inclusive of set up and pack up time, and also travel between stations, rounded to approximately three-hours);
- number of receivers required to survey the network;
- number of field staff;
- daily download and file conversion time;
- data import into TBC;
- data cleaning (noisy data, cycle slips, removal of dependant baselines);
- baseline processing; and
- network adjustment and analysis.

There is an obvious association between the number of sessions required to survey the network and the time required to survey the network, as one of these factors increases, so does the other. This result was expected and is not surprising. As more field work is completed, the amount of time will also rise.

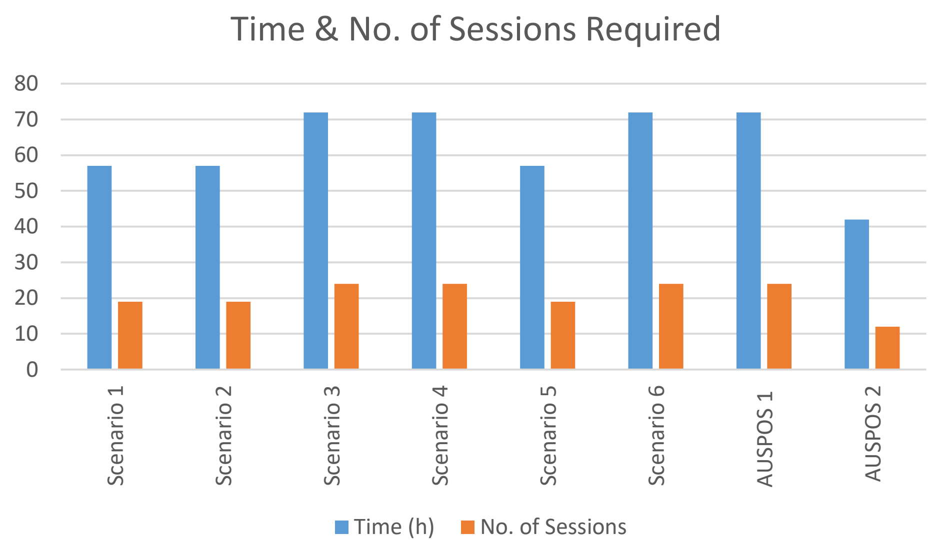

Figure 4.3.1.1: Number of sessions and receivers required to complete each method.

To look into what effect more time and observation sessions has on the results of a network, the resulting uncertainties and cost were analysed. There was a distinct correlation when comparing the cost of establishing a particular network to the uncertainty that the network may achieve. However, the outcome of this comparison was not what was originally expected.

It was initially expected that the greater quality of network (lesser uncertainty, higher redundancy) the more the network would cost. However, the opposite outcome was realised. Networks with more observations, and higher redundancy factors resulted in better SU and PU values and a lesser cost. Typically, these networks adopted a conventional style of GNSS network surveying where dependent baselines were disregarded, and the network was made up of multiple sessions and independent occupations.

Figure 4.3.1.2 demonstrates the fact that the testing scenarios that adopted conventional styles of GNSS network surveying proved to be more cost effective, and more reliable.

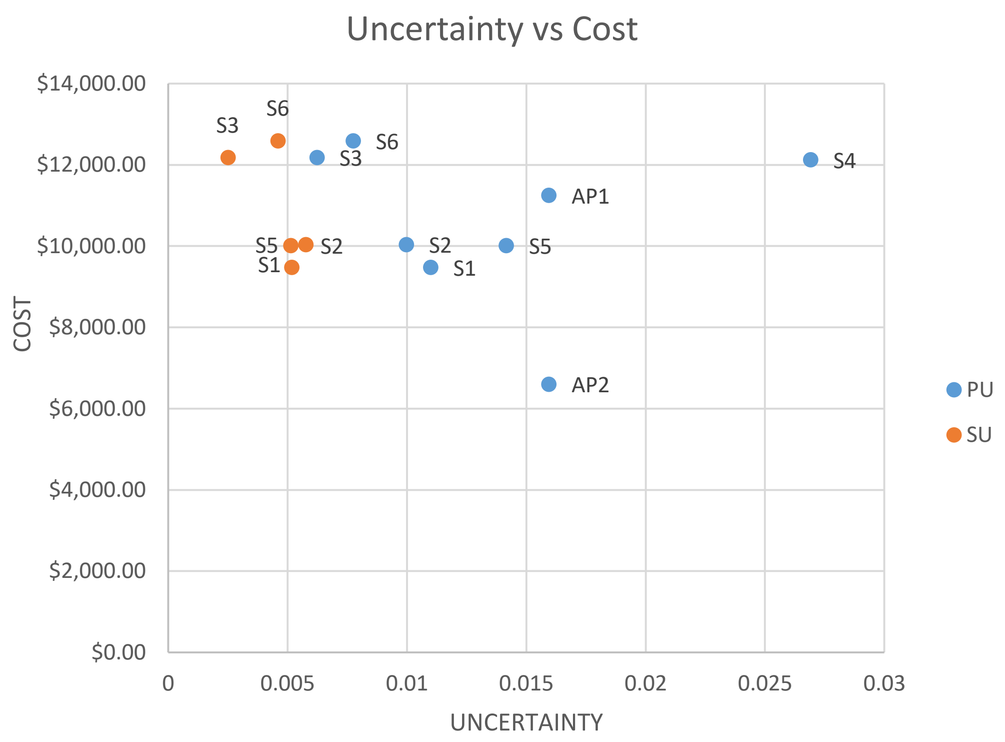

Figure 4.3.1.2: Scatterplot illustrating the average SU and PU against the cost required to complete the network based on an hourly rate of $150 per hour.

Testing Scenario Three – Positioning Using Only Regulation 13 CORS resulted in a false positive and should be disregarded as a reliable way to survey a long line network. The network is made up of a series of single occupations on each station, meaning that there is only one observation to form a coordinate for the station. A high degrees of freedom for the network is a result of two baselines from each station to two Regulation 13 CORS sites. Despite the high degrees of freedom in this network, there is no means of blunder detection due to the single occupations, and consequently this survey may contain a number of gross errors that are undetectable. Furthermore, this network is not a cost effective solution to GNSS long line network surveying.

Scenario Four – Single Baseline Traverse should also be disregarded due to its high cost and lack of network reliability.

4.4 Coordinate Comparisons

To confirm that each network was computing coordinates similar to the last, a coordinate comparison was conducted. This comparison tabulated the final coordinates into a spreadsheet and conducted an analysis based on the deviation from the computed mean coordinate from the station. If there was a large deviation from the computed mean coordinate, further analysis would be conducted to identify the cause of the deviation.

Figure 4.4.1 demonstrates that there was no significant deviation from the mean to further analyse. This also validates the reliability of the coordinates calculated for each of the testing scenarios for each station.

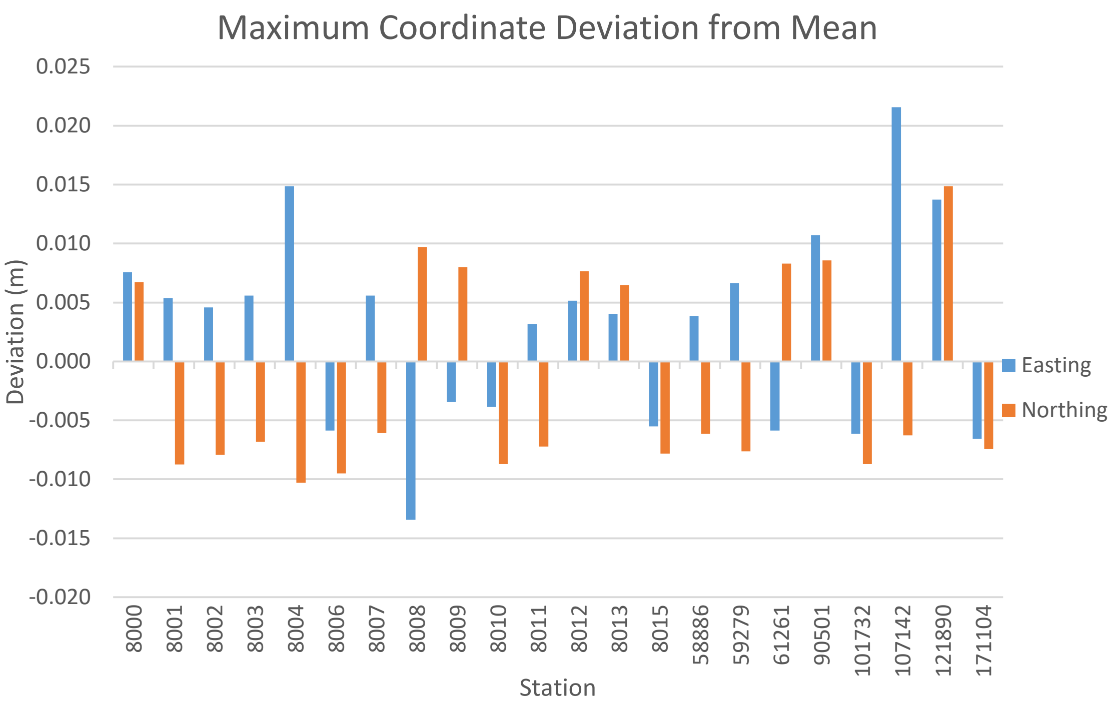

Figure 4.4.1: Maximum deviation from the computed mean coordinate for each station.

4.5 Summary

This chapter has analysed the results of post-processing a GNSS network in the configurations mentioned in Chapter 3 – Method. This has been carried out by analysing the networks independently of each other, in assessing network reliability and uncertainty, and also assessing the networks by assessing other factors, such as time/cost, final coordinate spread.

Networks one, two, five, and six were found to be the most reliable configurations as they provided good quality results in terms of redundancy and uncertainty. These configurations adopted a conventional style of GNSS network surveying where the network is made up of a number of sessions and independent occupations resulting in no dependent baselines.

Networks three and four adopted unconventional styles of GNSS network surveying and consequently produced poor quality results. These networks had minimal redundant observations and limited independent occupations, making blunder detection difficult and as a result it was hard to have any confidence in these networks.

The following chapter will address the effect that making independent occupations has on the reliability of a network, and how networks three and four would have improved if some form of redundant observation was made. In addition, the outcomes of each network and recommendations based on these results will be identified and explored.

5.0 Discussion

5.1 Introduction

After reviewing the relevant literature, and testing the developed scenarios established from the literature, some interesting results were produced.

This chapter explores the effect of these results in a broader sense than just narrowing the discussion to the relevant to the network that was tested. This chapter will analyse the graphs and results produced in chapter four, and discuss the benefits and shortfalls of each scenario tested in chapter three.

This will include looking at the suitability of the testing scenarios relevant to a series of applications, and how the testing scenarios can be can be improved. Furthermore, this chapter will also discuss some alternative scenarios that have not been addressed during the course of this research, but may provide a better result, than any network included in this dissertation.

5.2 Researched Scenarios

5.2.1 Positive Outcomes

For the purpose of this dissertation, a positive outcome is defined as an outcome that provides a quality result. This may be in terms of network reliability, uncertainty, time or cost.

A number of the scenarios tested in this dissertation produced some positive outcomes. Scenarios one, two, five and six all returned high quality networks, with low survey and positional uncertainties. These results are due to a number of common factors that are evident in each of the above mentioned scenarios.

The most important of these factors is the high amount of redundant observations in each network, this can be seen in the network adjustment reports for each network in the amount of degrees of freedom each network has in Figure 5.2.1.1 (Appendix E).

Testing Scenario	Scenario One	Scenario Two	Scenario Five	Scenario Six
Degrees of Freedom	66	67	66	118

Figure 5.2.1.1: The degrees of freedom in each network following the fully constrained least squares network adjustment.

The quality of each of these networks is put down to two key factors that are common among the four networks. Firstly, each of these networks is made up of closed figures with multiple baselines to each station. Secondly, each of these networks is 95% made up of two or more independent occupations and 55% of three or more independent occupations as seen in Figure 5.2.1.2. As a result of the larger number of independent occupations, more confidence can be held in the resultant coordinates of each station. By having multiple independent occupations, any blunders that may have occurred during the field survey such as antenna height or centring errors can be easily detected.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Average SU	0.005	0.006	0.003	-	0.005	0.005
Average PU	0.011	0.010	0.006	0.027	0.014	0.008
% of 2 or more Independent Occupations	95%	95%	0%	92%	95%	95%
% of 3 or more Independent Occupations	55%	55%	0%	0%	55%	55%

Table 5.2.1.2: Percentage of independent occupations used in each method and computed average SU and PU.

It is also important to note that Scenario Three – Positioning Using Only Regulation 13 CORS also returned a degrees of freedom of 70 following the fully constrained network adjustment. However, this value has been disregarded due to the lack of independent occupations in the network (Figure 5.2.1.2). This will be further discussed in section 5.2.2 Negative Outcomes.

5.2.2 Negative Outcomes

The remaining two testing scenarios, Scenario Three – Positioning Using Only Regulation 13 CORS and Scenario Four – Single Baseline Traverse produced results that are unreliable and also far costlier than some of the networks that produced quality results.

Scenario Three which used single occupations on each station to coordinate the station initially produced some good results. At a glance, it looks as if this network produces the best outcome of all the tested scenarios. This is a result of the uncertainties calculated for the network as well as the degrees of freedom in the network. However, this result is a false positive, as each station is made up of only one occupation. Having only one occupation on each station means that there is no way of detecting blunders in the occupation that may have been made during the field survey such as centring errors or antenna height errors. As a result, these errors would not show up in the least squares network adjustment, and less confidence is held in the coordinates computed for each station.

The final testing scenario, Scenario Four – Single Baseline Traverse is the opposite to Scenario Three in that each station except PM 61261 and PM 59279 has a second independent occupation, meaning there is more confidence held in this network. However, this network is made up of really poor network geometry. There are no closed figures in the network and no redundant observations, resulting in a degrees of freedom value of one. This method also has larger error ellipses than any other network tested in this dissertation, and consequently, the largest positional uncertainty.

Furthermore, these two networks are among the most expensive networks to establish (Figure 4.3.1.2). It is important to note however, that the cost calculated for Figure 4.3.1.2 is based on the use of one GNSS receiver to compute the network for scenario three, and the cost for scenario four is based on the use of two GNSS receivers, whereas the cost for scenarios one, two, five, and six are based on the use of four receivers.

5.3 Recommendations

Following the testing of scenarios mentioned in chapter three of this dissertation, some recommendations can be made in regards to how to carry out long line GNSS surveys for control network purposes based on the results.

Scenarios one, two, and five all produced good quality networks, in terms of both network adjustment quality and the calculated uncertainties. Scenario One – Conventional Network Fixed to Local Control, is a good method of establishing a long line control network if the network is to fit into an existing control network or set of parameters. It is a lower cost method that will provide results that can be confidently used for the purpose required.

The second testing scenario, a Conventional Network Fixed to Regulation 13 CORS sites will produce good results in both in terms of network adjustment and also uncertainty. It is a good method of achieving datum coordinates, with legally traceable observations, which is important when undertaking any sort of cadastral survey. Therefore, this method of establishing GNSS control would be well suited to the purpose of a long line easement survey where legal traceability is an important factor to consider. Furthermore, adding the extra baselines to the Regulation 13 CORS sites does not require much time or effort therefore making it not much more expensive than scenario one.

Scenario Five – Constrained to AUSPOS Solution is another method of surveying a long line network that is cost efficient and reliable. By post-processing an independent occupation with AUSPOS and constraining the network to the AUSPOS result, any movement or disturbance that may have occurred in the ground surrounding the survey mark will be accounted for.

The final tested scenario that is recommended based on the outcomes of this dissertation is Scenario Six – Conventional Network Including Baselines to CORS. This testing scenario produced the best results of all of the networks tested. However, this result comes at an additional cost due to the additional post-processing that is required from the added data from the CORS sites. As a result of the additional post-processing, it is expected that the network quality will be superior to that of scenarios one, two or five. This is influenced by the number of additional baselines to the CORS sites that the network is constrained to.

The remaining two testing scenarios, Scenario Three – Positioning Using Only Regulation 13 CORS and Scenario Four – Single Baseline traverse are not recommended for use for any purpose. This is due to a number of factors.

Scenario Three – Positioning Using Only Regulation 13 CORS initially produced good results. The network adjustment contained 70 degrees of freedom, and computed small error ellipses, so it seemed as if the results made up a reliable network. However, this is result was a false positive as the network is made up of single occupations of each station. Surveying a GNSS network following this method provides no means of blunder detection, so it is very difficult to have any sort of confidence in the observations. If a second independent occupation was made to each station it is expected that the error ellipses would become larger, but not by a significant amount, however this would provide network that the survey could have more confidence in.

Scenario Four – Single Baseline Traverse produces the worst result of all the networks surveyed. This finding is based on a combination of factors that are evident throughout the other testing scenarios. The geometry used in this network is the biggest contributing factor to the poor result achieved by this testing scenario. The network is made up of single baselines, and double occupations, however, there are no redundant observations in the network making it very difficult to confirm the reliability of the network and the position of each station, hence the large PU values calculated for each station. Furthermore, both Scenarios Three and Four are far more expensive methods of establishing a GNSS control network due to the amount of receivers required to survey the network, and also the increased logistical requirements that are a result of the lesser amount of receivers.

The final method of establishing a long line control network via GNSS that was tested was post-processing minimum two-hour occupations with AUSPOS. This method is cost efficient, and becomes more efficient depending on the amount of receivers that are utilised in the survey. However, this method of establishing a control network has its downfalls.

When post-processing with AUSPOS, there is always the chance that the GNSS data may not produce an acceptable solution. This may be the result of short occupation times, poor ambiguity resolution, or simply multipath. Despite the 3.5-hour occupation time, a station observed as part of this dissertation still returned a poor result from AUSPOS. The only way to confirm this result, is to make a second, longer independent occupation and re-process with AUSPOS. As this is the case, AUSPOS is not recommended for establishing long line GNSS control networks.

5.4 Alternative Methods

This dissertation has surveyed and analysed the results of seven different testing scenarios including post-processing with AUSPOS. However, there are still a number of scenarios that could produce better results than the ones tested in this dissertation. These may be a combination of the tested scenarios in this dissertation, or entirely new dissertations. They may also look at using a different GNSS observation method such as fast static or combining the classic static and fast static method together.

An example of an alternative method is the combination of Scenario Three – Positioning Using Only Regulation 13 CORS and also Scenario Four – Single Baseline Traverse. This method would also use quick static method in addition to the classic static method used throughout the course of this dissertation. The classic static baselines would make up the Positioning Using Only Regulation 13 CORS component of the survey while the quick static baselines would make up the Single Baseline Traverse Component of the survey. This is illustrated in Figure 5.4.1 where the magenta baselines from the CORS sites represent the static baselines, and the blue baselines between the internal stations represent the quick static baselines.

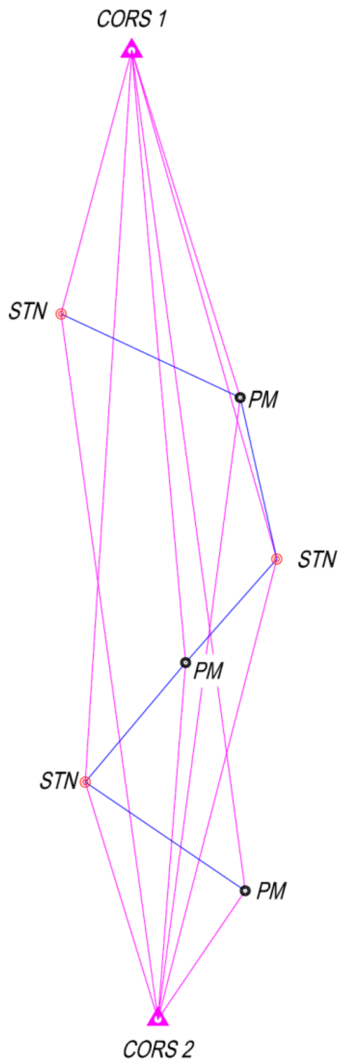

Figure 5.4.1: An example alternative testing scenario, where the magenta lines represent static baselines to CORS sites and the blue lines represent quick static baselines between the occupations.

The survey scenario would use two GNSS receivers to compute static baselines from the CORS sites to two of the stations that are occupied by the receivers. Once these static observations have been completed, an independent occupation is made at each station, and a 15 – 20-minute quick static baseline is then surveyed between the two stations. Following the quick static observation, one receiver is moved to the next station, while the other receiver is reset over the mark to make a third independent occupation on the station, and new static baselines are surveyed from the CORS sites to the two occupied stations. This process is repeated until all stations have been occupied, static baselines have been surveyed between each station and the chosen CORS sites, and quick static baselines have been surveyed between the stations, forming a single baseline traverse style quick static network.

5.5 Summary

The aim of this chapter was to analyse the effect of the results laid out in Chapter Four obtained from post-processing the surveyed network in a series of configurations determined in Chapter Three.

Some positive outcomes were realised from a series of the testing scenarios tested within this dissertation. They were deemed positive in terms of network reliability, redundancy, uncertainty, and time/cost to survey the network and have the ability to provide the end product. These outcomes prove that there is an optimal solution to establishing long line GNSS networks dependent on the application. However, some of the other testing scenarios proved to provide a negative outcome based on the same factors. This was often a result of a high degree of uncertainty or cost, or a low degree of redundancy or quality in the network.

Further to the outcomes of the tested scenarios in this dissertation, an example of an alternate testing method was provided. It is predicted that this scenario will provide a high quality network at a low cost due to the amount of redundancy in the network and the small amount of occupations required to actually survey the network. This alternate method and some further work and a review of this dissertation will be discussed in the following chapter.

6.0 Conclusion

6.1 Introduction

The analysis of the results in Chapter Four and the discussion of the impacts and implications of these results in chapter five, has proven that some testing scenarios produce better results in terms of network quality and cost than others.

This chapter will briefly review the findings of this research and asses how it addressed the aim presented in the initial chapter of this dissertation. Furthermore, this chapter will present some recommendations on how to carry out long line GNSS control surveys and also identify some further research that can be completed in this area to further fill the gaps in the literature.

6.2 Review

The initial aim of this research was to determine an optimal configuration of a control network for a long line survey. This survey was to be established by GNSS methods, and then post-processed using different testing configurations. The surveys would then be analysed in terms of network quality, addressing the redundancies in the network, the uncertainties of the stations that make up the network, and on a time and cost basis.

This research found that there was a series of scenarios that would provide results that were acceptable in terms of network quality and also cost. Furthermore, it was also identified that GNSS control networks could achieve better network quality for an additional cost by introducing data to the network from a series of CORS stations. This additional cost was not the result extra field work, but rather more post-processing from the extra baselines introduced into the network.

While there were a number of scenarios that were identified as acceptable for a number of applications, there were also some scenarios that failed to be deemed acceptable for use in most circumstances. These networks were comprised of poor field and observation techniques, and often lacked redundant observations, leaving the surveyor to question the reliability of the network regardless of the result of the baseline processing and network adjustment. It was proven that despite the result on the network adjustment report, a second or third independent occupation is required when undertaking a GNSS control survey to have any form of confidence in the coordinates of the station.

Overall, this dissertation addressed the aim by carrying out a long line GNSS control survey using a method that collected enough data to post-process in a series of different configurations. This allowed for the different scenarios to be assessed in terms of network reliability and also time/cost to survey the control network. It was then possible to identify the scenarios that would be more cost effective than others, and recommend those scenarios for use in a number of real world applications.

6.3 Further Research

This dissertation is not exhaustive in regards to the methods that were tested. There is a large amount of further work that can done by continuing this research. This may include testing a number of alternative scenarios, similar to the methods mentioned in section 5.4 of this dissertation or even the method in Figure 5.4.1, or also looking at the effect different observation methods have on the uncertainty. Furthermore, some of the scenarios mentioned in this dissertation can be combined to make alternative testing scenarios, and these may result in a better network than any one tested as a part of this dissertation.

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Appendix A – Project Specification

ENG4111/4112 Research Project
Project Specification

For: Nicholas Lund

Title: Optimization of GNSS Control Networks in Long Line Surveys using Precise Point Positioning (PPP) and Static Baselines

Major: Spatial Science (Honours)

Supervisors: Associate Professor Peter Gibbings

Enrolment: ENG4111 – EXT S1, 2016
ENG4112 – EXT S1, 2016

Project Aim: To determine the optimal configuration of a control network for a long line surveys established by the combination of Precise Point Positioning and static baselines.

Programme: Issue B, 4^{th} April 2016

1. Research GNSS data post-processing methods, including PPP, and conventional post-processing in a least squares package, standards for GNSS control networks in Queensland.
2. Conduct a static GNSS survey in accordance with the Department of Natural Resources and Mines (DNRM), and Intergovernmental Committee on Surveying and Mapping (ICSM) standards for GNSS control surveys and post-process in a suitable least squares package.
3. Post-process the GNSS data using an online PPP service.
4. Analyse the data; calculate individual positional uncertainties of each control station for each survey method, also, calculate survey uncertainty for each survey. Conduct a comparison of all the data and tabulate the results.
5. Analyse results on a time/cost basis and prepare guidelines for practicing surveyors and consultants to conduct these surveys in a more time and cost efficient way.
6. Prepare and submit dissertation.

Appendix B – Regulation 13 Certificates

BDST - Beaudesert CORS

Australian Government
Geoscience Australia

Certificate of Verification of a Reference Standard of a Position-Measurement in Accordance with Regulation 13 of the National Measurement Regulations 1999 and the National Measurement Act 1960

Name of Verifying Authority:

Name: National Geospatial Reference Systems
Organisation: Geoscience Australia
Address: Corner Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609 Australia
Telephone: (02) 6249 9111
Facsimile: (02) 6249 9969
Email: geodesy@ga.gov.au

Client detail:

Name: Darren Burns
Organisation: Department of Natural Resources and Mines
Address: GPO Box 2454, Brisbane, Queensland 4001 Australia
Telephone: (07) 3896 3349
Facsimile: (07) 3896 3697
Email: darren.burns@dnrm.qld.gov.au
Date of request: 30 July 2013

Description and denomination of standard of measurement:

The measurement was undertaken using an antenna LEIAT504GG NONE (International GNSS Service antenna naming convention) with the serial number 103226 and refers to a point located 0.0000 m below the antenna reference point. This antenna is attached to a threaded bolt on steel bracket. The station (4 character ID: BDST) is located at the Scenic Rim Regional Council Building, Lot 5 RP217537, 82 Brisbane Street, Beaudesert, QLD.

Permanent distinguishing marks:

Exempt under Regulation 16 (4)

Date of verification:

04 November 2013

Date of expiry of certificate:

03 November 2018

NATA

Accredited for compliance with ISO/IEC 17025. Accreditation No. 15002.

Page 1 of 2

Value of standard of measurement:

Station (4 character ID): BDST

South Latitude and its uncertainty of value:

$$27^\circ\ 59'\ 13.56952'' \pm 0.008\ \mathrm{m}$$

East Longitude and its uncertainty of value:

$$152^\circ\ 59'\ 42.27818'' \pm 0.007\ \mathrm{m}$$

Elevation above Ellipsoid and its uncertainty of value:

$$101.0957 \pm 0.018\ \mathrm{m}$$

Geocentric Datum of Australia (GDA94) coordinates referred to the GRS80 ellipsoid being in the ITRF92 reference frame at the epoch 1994. The uncertainties are calculated in accordance with the principles of the ISO Guide to the Expression of Uncertainty in Measurement (1995), with an interval estimated to have a confidence level of 95% at the time of verification. The combined standard uncertainty was converted to an expanded uncertainty using a coverage factor, k, of 2.

Details of any relevant environmental or other influence factor(s) at the time of verification:

Uncertainty of the coordinates of the recognized-value standard of measurement of position (i.e. GDA94); and Uncertainty due to instability of the GPS antenna mounting and modelling of the antenna phase centre variations.

Signature: ____________________

04 November 2013

Dr John Dawson
NATA approved signatory

Section Leader
National Geospatial Reference Systems Section
Geoscience Australia

Signature: ____________________

04 November 2013

Mr Gary Johnston
Geoscience Australia approved signatory

Group Leader
Earth Monitoring and Hazards Group
Geoscience Australia

Being a person, or a person representing a body, appointed as a verifying authority under Regulations 71 and 73 of the National Measurement Regulations 1999 in accordance with the National Measurement Act 1960, I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the Regulations, by the above-named authority.

WOOL - Woolloongabba CORS

Australian Government
Geoscience Australia

Certificate of Verification of a Reference Standard of a Position-Measurement in Accordance with Regulation 13 of the National Measurement Regulations 1999 and the National Measurement Act 1960

Name of Verifying Authority:

Name: National Geospatial Reference Systems
Organisation: Geoscience Australia
Address: Corner Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609 Australia
Telephone: (02) 6249 9111
Facsimile: (02) 6249 9969
Email: geodesy@ga.gov.au

Client detail:

Name: Darren Burns
Organisation: Department of Natural Resources and Mines
Address: GPO Box 2454, Brisbane, Queensland 4001 Australia
Telephone: (07) 3896 3349
Facsimile: (07) 3896 3697
Email: darren.burns@dnrm.qld.gov.au
Date of request: 30 July 2013

Description and denomination of standard of measurement:

The measurement was undertaken using an antenna `TRM29659.00 NONE` (International GNSS Service antenna naming convention) with the serial number 0220164017 and refers to a point located 0.0000 m below the antenna reference point. This antenna is attached to a threaded bolt on steel bracket. The station (4 character ID: WOOL) is located at the Landcentre, Lot 63 SP184386, 867 Main Street, Woolloongabba QLD.

Permanent distinguishing marks:

Exempt under Regulation 16 (4)

Date of verification:

04 November 2013

Date of expiry of certificate:

03 November 2018

NATA

Accredited for compliance with ISO/IEC 17025. Accreditation No. 15002.

Value of standard of measurement:

Station (4 character ID): `WOOL`

South Latitude and its uncertainty of value:

$$27^\circ\ 29'\ 5.88837''\ \pm\ 0.008\ \mathrm{m}$$

East Longitude and its uncertainty of value:

$$153^\circ\ 2'\ 6.96433''\ \pm\ 0.008\ \mathrm{m}$$

Elevation above Ellipsoid and its uncertainty of value:

$$91.0536\ \pm\ 0.018\ \mathrm{m}$$

Geocentric Datum of Australia (GDA94) coordinates referred to the GRS80 ellipsoid being in the ITRF92 reference frame at the epoch 1994. The uncertainties are calculated in accordance with the principles of the ISO Guide to the Expression of Uncertainty in Measurement (1995), with an interval estimated to have a confidence level of 95% at the time of verification. The combined standard uncertainty was converted to an expanded uncertainty using a coverage factor, k, of 2.

Details of any relevant environmental or other influence factor(s) at the time of verification:

Uncertainty of the coordinates of the recognized-value standard of measurement of position (i.e. GDA94); and Uncertainty due to instability of the GPS antenna mounting and modelling of the antenna phase centre variations.

Signature: ______________________	**Signature:** ______________________
04 November 2013	04 November 2013
Dr John Dawson NATA approved signatory	Mr Gary Johnston Geoscience Australia approved signatory
Section Leader National Geospatial Reference Systems Section Geoscience Australia	Group Leader Earth Monitoring and Hazards Group Geoscience Australia

Being a person, or a person representing a body, appointed as a verifying authority under Regulations 71 and 73 of the National Measurement Regulations 1999 in accordance with the National Measurement Act 1960, I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the Regulations, by the above-named authority.

Appendix C – Example Booking Sheet

GNSS Booking Sheet

Date ____________________ **File Name** ____________________

Station ____________________ **Description** ____________________

Start Time ____________________ **Finish Time** ____________________

Receiver Serial Number ______________________________

Antenna Serial Number ______________________________

Receiver Information

Trimble R10 ☐
Trimble R8 ☐
Trimble R7 GNSS ☐

Antenna Information

R10 Internal ☐
R8 Internal ☐
Zephyr Md 2 ☐

Antenna Height

	Before	**After**
Bottom of Quick Release (R10)	________	________
Centre of Bumper (R8)	________	________
Bottom of Antenna Mount	________	________
Top of Notch (Zephyr Md 2)	________	________

Comments

____
____
____
____

Appendix D – Baseline Processing Reports

Scenario One – Conventional Network Fixed to Local Control

Project file data		Coordinate System	
Name:	F:\PROJECT\TBC PROJECTS\1-Normal.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	17/09/2016 9:12:11 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
8001 --- 8000 (B10)	8001	8000	Fixed	0.004	0.019	18°47'33"	3461.283	-16.151
121890 --- 59279 (B2)	59279	121890	Fixed	0.003	0.005	200°16'35"	1730.385	16.384
8002 --- 121890 (B15)	121890	8002	Fixed	0.004	0.028	195°29'30"	2678.718	3.130
8001 --- 121890 (B12)	121890	8001	Fixed	0.002	0.012	205°59'50"	2233.263	-6.339
8000 --- 121890 (B6)	8000	121890	Fixed	0.002	0.004	186°06'28"	1276.827	22.468
8000 --- 59279 (B1)	59279	8000	Fixed	0.002	0.003	232°41'02"	583.251	-6.083
8001 --- 8002 (B16)	8002	8001	Fixed	0.001	0.003	335°21'22"	631.664	-9.458
101732 --- 8002 (B17)	8002	101732	Fixed	0.002	0.004	159°25'34"	1376.438	22.319
8002 --- 8003 (B20)	8002	8003	Fixed	0.002	0.005	164°53'09"	1288.251	22.366
8001 --- 8003 (B24)	8003	8001	Fixed	0.003	0.006	341°45'08"	1914.065	-31.831
8003 --- 101732 (B23)	8003	101732	Fixed	0.001	0.002	106°54'57"	154.483	-0.048
8003 --- 8007 (B25)	8003	8007	Fixed	0.006	0.031	201°43'43"	5587.108	-7.146
8003 --- 8004 (B28)	8003	8004	Fixed	0.003	0.005	183°22'58"	786.044	2.038
8008 --- 8007 (B51)	8008	8007	Fixed	0.003	0.006	32°32'21"	1919.780	-18.106
8003 --- 8006 (B33)	8003	8006	Fixed	0.004	0.019	195°45'09"	4216.660	5.566
8008 --- 90501 (B60)	8008	90501	Fixed	0.002	0.003	125°52'32"	447.716	-14.075
8008 --- 8009 (B55)	8008	8009	Fixed	0.002	0.003	205°01'40"	1019.002	-1.352
8007 --- 8006 (B41)	8006	8007	Fixed	0.003	0.005	219°13'19"	1460.885	-12.681
8008 --- 8006 (B45)	8006	8008	Fixed	0.005	0.008	215°25'16"	3375.009	5.430
8003 --- 8004 (B38)	8004	8003	Fixed	0.004	0.005	3°23'00"	786.047	-2.032
8004 --- 8006 (B39)	8004	8006	Fixed	0.005	0.022	198°32'52"	3452.968	3.496

101732 --- 8004 (B48)	101732	8004	Fixed	0.002	0.003	194°42'28"	764.787	2.085
90501 --- 8009 (B64)	90501	8009	Fixed	0.002	0.003	230°13'09"	1033.005	12.724
90501 --- 8006 (B63)	90501	8006	Fixed	0.004	0.016	27°52'49"	3408.022	8.669
90501 --- 8010 (B67)	90501	8010	Fixed	0.003	0.013	217°31'52"	2122.896	13.152
8010 --- 8011 (B71)	8010	8011	Fixed	0.002	0.003	242°03'28"	747.718	-16.069
8010 --- 58886 (B74)	8010	58886	Fixed	0.002	0.003	261°09'13"	956.184	5.836
8010 --- 8009 (B69)	8010	8009	Fixed	0.002	0.003	26°02'11"	1137.966	-0.414
8009 --- 58886 (B81)	58886	8009	Fixed	0.002	0.004	51°00'21"	1858.446	-6.254
58886 --- 8011 (B82)	58886	8011	Fixed	0.001	0.002	125°34'46"	349.490	-21.904
58886 --- 8012 (B83)	58886	8012	Fixed	0.003	0.011	186°38'02"	2356.818	-19.632
58886 --- 8013 (B84)	58886	8013	Fixed	0.005	0.019	177°52'30"	3029.683	-18.048
8012 --- 8011 (B90)	8012	8011	Fixed	0.002	0.010	14°35'36"	2208.947	-2.287
8013 --- 8012 (B91)	8012	8013	Fixed	0.002	0.004	150°44'38"	786.946	1.569
107142 --- 8012 (B92)	8012	107142	Fixed	0.009	0.031	198°39'04"	5066.919	-17.546
8013 --- 8011 (B94)	8013	8011	Fixed	0.005	0.018	3°28'57"	2829.481	-3.855
8015 --- 107142 (B106)	8015	107142	Fixed	0.010	0.035	16°14'22"	2530.304	-20.937
8013 --- 107142 (B95)	8013	107142	Fixed	0.010	0.049	205°58'48"	4576.807	-19.144
8013 --- 8015 (B103)	8013	8015	Fixed	0.009	0.049	202°30'38"	7083.528	1.827
107142 --- 171104 (B107)	107142	171104	Fixed	0.011	0.042	210°22'49"	4533.006	2.427
8015 --- 171104 (B110)	8015	171104	Fixed	0.003	0.016	226°56'37"	2169.375	-18.536
8015 --- 61261 (B111)	8015	61261	Fixed	0.004	0.016	203°12'43"	4729.334	-7.299
171104 --- 61261 (B113)	171104	61261	Fixed	0.004	0.025	185°33'57"	2878.975	11.207

Acceptance Summary

Processed	Passed	Flag	Fail
43	43	0	0

Scenario Two – Conventional Network Fixed to Regulation 13 CORS

Project file data		Coordinate System	
Name:	F:\PROJECT\TBC PROJECTS\2-Normal to CORS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	17/09/2016 9:13:06 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
WOOL --- 59279 (B133)	59279	WOOL	Fixed	0.005	0.022	2°29'17"	13674.597	31.587
121890 --- 59279 (B2)	121890	59279	Fixed	0.003	0.005	20°16'45"	1730.385	-16.384
8000 --- 121890 (B6)	8000	121890	Fixed	0.002	0.004	186°06'28"	1276.827	22.468
8000 --- 59279 (B1)	8000	59279	Fixed	0.002	0.003	52°41'10"	583.251	6.083
8001 --- 8003 (B24)	8001	8003	Fixed	0.003	0.006	161°45'18"	1914.065	31.831
8001 --- 121890 (B12)	8001	121890	Fixed	0.002	0.012	26°00'07"	2233.263	6.339
8001 --- 8000 (B10)	8001	8000	Fixed	0.004	0.019	18°47'33"	3461.283	-16.151
101732 --- 8004 (B48)	101732	8004	Fixed	0.002	0.003	194°42'28"	764.787	2.085
101732 --- 8002 (B17)	101732	8002	Fixed	0.002	0.005	339°25'26"	1376.438	-22.319
8002 --- 121890 (B15)	8002	121890	Fixed	0.004	0.028	15°29'42"	2678.718	-3.130
8001 --- 8002 (B16)	8002	8001	Fixed	0.001	0.003	335°21'22"	631.664	-9.458
8003 --- 8007 (B25)	8003	8007	Fixed	0.006	0.031	201°43'43"	5587.108	-7.146
8003 --- 8004 (B38)	8003	8004	Fixed	0.004	0.006	183°22'59"	786.046	2.033
8003 --- 8004 (B28)	8003	8004	Fixed	0.003	0.005	183°22'58"	786.044	2.038
8003 --- 101732 (B23)	8003	101732	Fixed	0.001	0.002	106°54'57"	154.483	-0.048
8002 --- 8003 (B20)	8003	8002	Fixed	0.003	0.005	344°53'03"	1288.251	-22.365
8004 --- 8006 (B39)	8006	8004	Fixed	0.005	0.022	18°33'11"	3452.968	-3.496
8003 --- 8006 (B33)	8006	8003	Fixed	0.004	0.019	15°45'28"	4216.660	-5.566
8007 --- 8006 (B41)	8007	8006	Fixed	0.003	0.005	39°13'35"	1460.885	12.681
90501 --- 8010 (B67)	90501	8010	Fixed	0.003	0.013	217°31'52"	2122.896	13.153

90501 --- 8006 (B63)	90501	8006	Fixed	0.004	0.016	27°52'49"	3408.022	8.669
8008 --- 90501 (B60)	8008	90501	Fixed	0.002	0.003	125°52'32"	447.716	-14.076
8008 --- 8006 (B45)	8008	8006	Fixed	0.005	0.008	35°25'50"	3375.009	-5.430
8008 --- 8007 (B51)	8008	8007	Fixed	0.003	0.006	32°32'21"	1919.780	-18.106
8010 --- 8009 (B69)	8010	8009	Fixed	0.002	0.003	26°02'11"	1137.966	-0.414
8010 --- 8011 (B71)	8010	8011	Fixed	0.002	0.003	242°03'28"	747.718	-16.069
90501 --- 8009 (B64)	8009	90501	Fixed	0.002	0.003	50°13'23"	1033.005	-12.724
8008 --- 8009 (B55)	8009	8008	Fixed	0.002	0.003	25°01'48"	1019.002	1.352
8012 --- 8011 (B90)	8012	8011	Fixed	0.002	0.010	14°35'36"	2208.947	-2.287
58886 --- 8012 (B83)	58886	8012	Fixed	0.003	0.011	186°38'02"	2356.818	-19.632
58886 --- 8011 (B82)	58886	8011	Fixed	0.001	0.002	125°34'46"	349.490	-21.904
8010 --- 58886 (B74)	58886	8010	Fixed	0.002	0.003	81°09'29"	956.184	-5.836
8009 --- 58886 (B81)	58886	8009	Fixed	0.002	0.004	51°00'21"	1858.446	-6.254
107142 --- 171104 (B107)	107142	171104	Fixed	0.011	0.042	210°22'49"	4533.006	2.427
107142 --- 8012 (B92)	107142	8012	Fixed	0.009	0.031	18°39'32"	5066.919	17.546
8013 --- 107142 (B95)	8013	107142	Fixed	0.010	0.049	205°58'48"	4576.807	-19.144
8013 --- 8012 (B91)	8013	8012	Fixed	0.002	0.004	330°44'32"	786.946	-1.569
58886 --- 8013 (B84)	8013	58886	Fixed	0.005	0.019	357°52'28"	3029.682	18.052
8013 --- 8011 (B94)	8013	8011	Fixed	0.005	0.018	3°28'57"	2829.481	-3.855
8015 --- 171104 (B110)	8015	171104	Fixed	0.003	0.017	226°56'37"	2169.375	-18.536
8015 --- 107142 (B106)	8015	107142	Fixed	0.007	0.028	16°14'22"	2530.306	-20.938
8013 --- 8015 (B103)	8015	8013	Fixed	0.008	0.036	22°31'24"	7083.527	-1.830
171104 --- 61261 (B113)	61261	171104	Fixed	0.004	0.025	5°34'02"	2878.975	-11.204
8015 --- 61261 (B111)	61261	8015	Fixed	0.004	0.017	23°13'15"	4729.335	7.301
BDST --- 61261 (B139)	BDST	61261	Fixed	0.005	0.034	332°48'57"	15416.149	-7.425

Acceptance Summary

Processed	Passed	Flag	Fail
45	45	0	0

Scenario Three – Positioning Using Only Regulation 13 CORS

Project file data		Coordinate System	
Name:	F:\PROJECT\TBC PROJECTS\3 - External Baselines Only.vce	Name:	Map Grid of Australia (GDA)
Size:	3 MB	Datum:	ITRF
Modified:	17/09/2016 10:26:01 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
BDST --- 59279 (B673)	BDST	59279	Fixed	0.003	0.014	4°35'44"	42117.267	-41.679
WOOL --- 61261 (B763)	WOOL	61261	Fixed	0.004	0.017	194°42'01"	43352.702	2.636
WOOL --- 8007 (B761)	WOOL	8007	Fixed	0.005	0.021	188°31'04"	24571.453	3.142
WOOL --- 171104 (B759)	WOOL	171104	Fixed	0.004	0.025	195°21'00"	40513.229	-8.629
WOOL --- 8014 (B750)	WOOL	8014	Fixed	0.004	0.019	192°40'07"	34203.951	-2.208
WOOL --- 8015 (B753)	WOOL	8015	Fixed	0.004	0.020	193°40'06"	38681.185	9.942
WOOL --- 107142 (B748)	WOOL	107142	Fixed	0.011	0.033	193°29'30"	36153.513	-11.043
WOOL --- 8013 (B734)	WOOL	8013	Fixed	0.005	0.023	191°42'24"	31699.849	8.096
WOOL --- 8012 (B737)	WOOL	8012	Fixed	0.004	0.015	192°39'27"	31110.162	6.527
WOOL --- 8011 (B741)	WOOL	8011	Fixed	0.004	0.015	192°30'43"	28902.529	4.261
WOOL --- 58886 (B746)	WOOL	58886	Fixed	0.004	0.014	193°09'09"	28767.567	26.167
WOOL --- 8010 (B729)	WOOL	8010	Fixed	0.003	0.012	191°21'56"	28422.801	20.332
WOOL --- 90501 (B722)	WOOL	90501	Fixed	0.004	0.017	189°20'42"	26533.617	7.181
WOOL --- 8009 (B725)	WOOL	8009	Fixed	0.004	0.013	190°45'44"	27323.318	19.866
WOOL --- 8008 (B713)	WOOL	8008	Fixed	0.004	0.017	190°13'00"	26336.836	21.277
WOOL --- 8006 (B711)	WOOL	8006	Fixed	0.003	0.013	186°41'09"	23327.106	15.846

WOOL --- 8005 (B707)	WOOL	8005	Fixed	0.003	0.011	184°30'22"	21306.237	15.260
WOOL --- 8004 (B704)	WOOL	8004	Fixed	0.003	0.013	184°38'58"	19960.382	12.333
WOOL --- 8003 (B702)	WOOL	8003	Fixed	0.003	0.017	184°42'06"	19174.538	10.264
WOOL --- 101732 (B697)	WOOL	101732	Fixed	0.003	0.014	184°15'04"	19207.803	10.258
WOOL --- 8002 (B693)	WOOL	8002	Fixed	0.005	0.021	186°05'42"	17967.954	-12.063
WOOL --- 8001 (B690)	WOOL	8001	Fixed	0.003	0.013	187°09'24"	17428.073	-21.565
WOOL --- 121890 (B679)	WOOL	121890	Fixed	0.003	0.014	184°27'40"	15331.353	-15.179
WOOL --- 59279 (B672)	WOOL	59279	Fixed	0.004	0.017	182°29'07"	13674.594	-31.567
WOOL --- 8000 (B675)	WOOL	8000	Fixed	0.003	0.014	184°18'44"	14055.116	-37.705
BDST --- 61261 (B764)	BDST	61261	Fixed	0.005	0.019	332°48'57"	15416.149	-7.430
BDST --- 8007 (B762)	BDST	8007	Fixed	0.005	0.020	0°35'36"	31345.832	-6.926
BDST --- 171104 (B760)	BDST	171104	Fixed	0.004	0.025	337°48'05"	17906.095	-18.653
BDST --- 8014 (B751)	BDST	8014	Fixed	0.004	0.018	350°58'08"	22554.168	-12.259
BDST --- 8015 (B754)	BDST	8015	Fixed	0.005	0.022	343°59'39"	18789.021	-0.126
BDST --- 107142 (B749)	BDST	107142	Fixed	0.010	0.034	347°40'56"	20973.099	-21.126
BDST --- 8013 (B735)	BDST	8013	Fixed	0.006	0.023	354°16'02"	24728.709	-1.972
BDST --- 8012 (B738)	BDST	8012	Fixed	0.004	0.015	353°33'35"	25452.133	-3.535
BDST --- 8011 (B742)	BDST	8011	Fixed	0.004	0.014	355°12'33"	27525.487	-5.801
BDST --- 58886 (B747)	BDST	58886	Fixed	0.004	0.014	354°39'34"	27753.079	16.104
BDST --- 8010 (B730)	BDST	8010	Fixed	0.003	0.011	356°37'29"	27828.050	10.264
BDST --- 90501 (B723)	BDST	90501	Fixed	0.004	0.016	359°19'44"	29465.346	-2.883
BDST --- 8009 (B726)	BDST	8009	Fixed	0.004	0.013	357°44'07"	28824.843	9.808
BDST --- 8008 (B714)	BDST	8008	Fixed	0.003	0.016	358°38'09"	29734.104	11.205
BDST --- 8006 (B712)	BDST	8006	Fixed	0.003	0.011	2°12'05"	32499.799	5.783

BDST --- 8005 (B708)	BDST	8005	Fixed	0.003	0.010	3°48'36"	34479.758	5.200
BDST --- 8004 (B705)	BDST	8004	Fixed	0.003	0.011	3°45'25"	35826.209	2.274
BDST --- 8003 (B703)	BDST	8003	Fixed	0.003	0.016	3°44'57"	36612.244	0.203
BDST --- 101732 (B698)	BDST	101732	Fixed	0.003	0.011	3°59'05"	36577.328	0.194
BDST --- 8002 (B694)	BDST	8002	Fixed	0.004	0.017	3°07'07"	37833.661	-22.140
BDST --- 8001 (B691)	BDST	8001	Fixed	0.003	0.010	2°40'47"	38393.794	-31.632
BDST --- 121890 (B680)	BDST	121890	Fixed	0.003	0.012	3°55'57"	40454.137	-25.236
BDST --- 8000 (B676)	BDST	8000	Fixed	0.003	0.011	3°59'58"	41730.038	-47.775

Acceptance Summary

Processed	Passed	Flag	Fail
48	48	0	0

Scenario Four – Single Baseline Traverse

Project file data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\4 - Single Baseline Trav.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	3/09/2016 4:50:18 PM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
171104 --- 61261 (B109)	61261	171104	Fixed	0.00435	0.02236	5°34'02"	2878.97748	-11.21796
8015 --- 171104 (B105)	8015	171104	Fixed	0.00355	0.01851	226°56'37"	2169.38612	-18.49651
107142 --- 8015 (B102)	107142	8015	Fixed	0.00680	0.03209	196°14'10"	2530.30926	20.96871
8014 --- 107142 (B98)	8014	107142	Fixed	0.00637	0.02930	207°38'43"	2013.91454	-8.82325
8013 --- 8014 (B99)	8013	8014	Fixed	0.00501	0.02224	204°40'34"	2564.40153	-10.30877
8013 --- 8012 (B91)	8012	8013	Fixed	0.00229	0.00411	150°44'38"	786.94648	1.56924
58886 --- 8012 (B83)	58886	8012	Fixed	0.00282	0.01121	186°38'02"	2356.81805	-19.63223
58886 --- 8011 (B82)	8011	58886	Fixed	0.00116	0.00190	305°34'41"	349.49043	21.90400
8010 --- 8011 (B71)	8010	8011	Fixed	0.00151	0.00277	242°03'28"	747.71816	-16.06853
8009 --- 8010 (B66)	8009	8010	Fixed	0.00165	0.00280	206°02'02"	1137.96602	0.41151
90501 --- 8009 (B64)	90501	8009	Fixed	0.00182	0.00320	230°13'09"	1033.00475	12.72379
8008 --- 90501 (B60)	8008	90501	Fixed	0.00170	0.00330	125°52'32"	447.71596	-14.07552
8008 --- 8007 (B51)	8007	8008	Fixed	0.00280	0.00597	212°32'03"	1919.78033	18.10560
8007 --- 8006 (B41)	8006	8007	Fixed	0.00345	0.00492	219°13'19"	1460.88471	-12.68111
8005 --- 8006 (B40)	8005	8006	Fixed	0.00299	0.01123	208°23'42"	2191.61564	0.57862
8004 --- 8005 (B36)	8004	8005	Fixed	0.00203	0.00372	182°23'24"	1346.84568	2.90941

101732 --- 8004 (B48)	101732	8004	Fixed	0.00185	0.00313	194°42'28"	764.78739	2.08544
101732 --- 8003 (B19)	8003	101732	Fixed	0.00101	0.00185	106°55'04"	154.48534	-0.05037
8002 --- 8003 (B20)	8002	8003	Fixed	0.00236	0.00491	164°53'09"	1288.25142	22.36599
8001 --- 8002 (B16)	8001	8002	Fixed	0.00147	0.00295	155°21'26"	631.66374	9.45740
8001 --- 121890 (B12)	121890	8001	Fixed	0.00239	0.01196	205°59'50"	2233.26276	-6.34173
8000 --- 121890 (B6)	8000	121890	Fixed	0.00206	0.00422	186°06'28"	1276.82711	22.46765
8000 --- 59279 (B1)	59279	8000	Fixed	0.00171	0.00316	232°41'02"	583.25146	-6.08277

Acceptance Summary

Processed	Passed	Flag	Fail
23	23	0	0

Scenario Five – Constrained to AUSPOS Solution

Project file data		Coordinate System	
Name:	F:\PROJECT\TBC PROJECTS\5 - Fixed to AUSPOS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	17/09/2016 9:15:59 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
8001 --- 8000 (B10)	8001	8000	Fixed	0.004	0.019	18°47'33"	3461.283	-16.151
121890 --- 59279 (B2)	59279	121890	Fixed	0.003	0.005	200°16'35"	1730.385	16.384
8002 --- 121890 (B15)	121890	8002	Fixed	0.004	0.028	195°29'30"	2678.718	3.130
8001 --- 121890 (B12)	121890	8001	Fixed	0.002	0.012	205°59'50"	2233.263	-6.339
8000 --- 121890 (B6)	8000	121890	Fixed	0.002	0.004	186°06'28"	1276.827	22.468
8000 --- 59279 (B1)	59279	8000	Fixed	0.002	0.003	232°41'02"	583.251	-6.083
8001 --- 8002 (B16)	8002	8001	Fixed	0.001	0.003	335°21'22"	631.664	-9.458
101732 --- 8002 (B17)	8002	101732	Fixed	0.002	0.004	159°25'34"	1376.438	22.319
8002 --- 8003 (B20)	8002	8003	Fixed	0.002	0.005	164°53'09"	1288.251	22.366
8001 --- 8003 (B24)	8003	8001	Fixed	0.003	0.006	341°45'08"	1914.065	-31.831
8003 --- 101732 (B23)	8003	101732	Fixed	0.001	0.002	106°54'57"	154.483	-0.048
8003 --- 8007 (B25)	8003	8007	Fixed	0.006	0.031	201°43'43"	5587.108	-7.146
8003 --- 8004 (B28)	8003	8004	Fixed	0.003	0.005	183°22'58"	786.044	2.038
8008 --- 8007 (B51)	8008	8007	Fixed	0.003	0.006	32°32'21"	1919.780	-18.106
8003 --- 8006 (B33)	8003	8006	Fixed	0.004	0.019	195°45'09"	4216.660	5.566
8008 --- 90501 (B60)	8008	90501	Fixed	0.002	0.003	125°52'32"	447.716	-14.075
8008 --- 8009 (B55)	8008	8009	Fixed	0.002	0.003	205°01'40"	1019.002	-1.352
8007 --- 8006 (B41)	8006	8007	Fixed	0.003	0.005	219°13'19"	1460.885	-12.681
8008 --- 8006 (B45)	8006	8008	Fixed	0.005	0.008	215°25'16"	3375.009	5.430
8003 --- 8004 (B38)	8004	8003	Fixed	0.004	0.005	3°23'00"	786.047	-2.032
8004 --- 8006 (B39)	8004	8006	Fixed	0.005	0.022	198°32'52"	3452.968	3.496

101732 --- 8004 (B48)	101732	8004	Fixed	0.002	0.003	194°42'28"	764.787	2.085
90501 --- 8009 (B64)	90501	8009	Fixed	0.002	0.003	230°13'09"	1033.005	12.724
90501 --- 8006 (B63)	90501	8006	Fixed	0.004	0.016	27°52'49"	3408.022	8.669
90501 --- 8010 (B67)	90501	8010	Fixed	0.003	0.013	217°31'52"	2122.896	13.152
8010 --- 8011 (B71)	8010	8011	Fixed	0.002	0.003	242°03'28"	747.718	-16.069
8010 --- 58886 (B74)	8010	58886	Fixed	0.002	0.003	261°09'13"	956.184	5.836
8010 --- 8009 (B69)	8010	8009	Fixed	0.002	0.003	26°02'11"	1137.966	-0.414
8009 --- 58886 (B81)	58886	8009	Fixed	0.002	0.004	51°00'21"	1858.446	-6.254
58886 --- 8011 (B82)	58886	8011	Fixed	0.001	0.002	125°34'46"	349.490	-21.904
58886 --- 8012 (B83)	58886	8012	Fixed	0.003	0.011	186°38'02"	2356.818	-19.632
58886 --- 8013 (B84)	58886	8013	Fixed	0.005	0.019	177°52'30"	3029.683	-18.048
8012 --- 8011 (B90)	8012	8011	Fixed	0.002	0.010	14°35'36"	2208.947	-2.287
8013 --- 8012 (B91)	8012	8013	Fixed	0.002	0.004	150°44'38"	786.946	1.569
107142 --- 8012 (B92)	8012	107142	Fixed	0.009	0.031	198°39'04"	5066.919	-17.546
8013 --- 8011 (B94)	8013	8011	Fixed	0.005	0.018	3°28'57"	2829.481	-3.855
8015 --- 107142 (B106)	107142	8015	Fixed	0.007	0.028	196°14'10"	2530.305	20.940
8013 --- 107142 (B95)	8013	107142	Fixed	0.010	0.049	205°58'48"	4576.807	-19.144
8013 --- 8015 (B103)	8013	8015	Fixed	0.008	0.036	202°30'38"	7083.527	1.832
107142 --- 171104 (B107)	107142	171104	Fixed	0.011	0.042	210°22'49"	4533.006	2.427
8015 --- 171104 (B110)	171104	8015	Fixed	0.003	0.018	46°57'04"	2169.376	18.538
8015 --- 61261 (B111)	61261	8015	Fixed	0.004	0.019	23°13'15"	4729.335	7.304
171104 --- 61261 (B113)	61261	171104	Fixed	0.005	0.052	5°34'02"	2878.976	-11.232

Acceptance Summary

Processed	Passed	Flag	Fail
43	43	0	0

Scenario Six – Conventional Network Including Baselines to CORS

Project file data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\6 - Bulk Fix to CORS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	17/09/2016 9:17:32 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
8001 --- 8000 (B10)	8001	8000	Fixed	0.004	0.019	18°47'33"	3461.283	-16.151
121890 --- 59279 (B2)	59279	121890	Fixed	0.003	0.005	200°16'35"	1730.385	16.384
8002 --- 121890 (B15)	121890	8002	Fixed	0.004	0.028	195°29'30"	2678.718	3.130
8001 --- 121890 (B12)	121890	8001	Fixed	0.002	0.012	205°59'50"	2233.263	-6.339
8000 --- 121890 (B6)	8000	121890	Fixed	0.002	0.004	186°06'28"	1276.827	22.468
8000 --- 59279 (B1)	59279	8000	Fixed	0.002	0.003	232°41'02"	583.251	-6.083
8001 --- 8002 (B16)	8002	8001	Fixed	0.001	0.003	335°21'22"	631.664	-9.458
101732 --- 8002 (B17)	8002	101732	Fixed	0.002	0.004	159°25'34"	1376.438	22.319
8002 --- 8003 (B20)	8002	8003	Fixed	0.002	0.005	164°53'09"	1288.251	22.366
8001 --- 8003 (B24)	8003	8001	Fixed	0.003	0.006	341°45'08"	1914.065	-31.831
8003 --- 101732 (B23)	8003	101732	Fixed	0.001	0.002	106°54'57"	154.483	-0.048
8003 --- 8007 (B25)	8003	8007	Fixed	0.006	0.031	201°43'43"	5587.108	-7.146
8003 --- 8004 (B28)	8003	8004	Fixed	0.003	0.005	183°22'58"	786.044	2.038
8008 --- 8007 (B51)	8008	8007	Fixed	0.003	0.006	32°32'21"	1919.780	-18.106
8003 --- 8006 (B33)	8003	8006	Fixed	0.004	0.019	195°45'09"	4216.660	5.566
8008 --- 90501 (B60)	8008	90501	Fixed	0.002	0.003	125°52'32"	447.716	-14.075
8008 --- 8009 (B55)	8008	8009	Fixed	0.002	0.003	205°01'40"	1019.002	-1.352
8007 --- 8006 (B41)	8006	8007	Fixed	0.003	0.005	219°13'19"	1460.885	-12.681
8008 --- 8006 (B45)	8006	8008	Fixed	0.005	0.008	215°25'16"	3375.009	5.430
8003 --- 8004 (B38)	8004	8003	Fixed	0.004	0.005	3°23'00"	786.047	-2.032
8004 --- 8006 (B39)	8004	8006	Fixed	0.005	0.022	198°32'52"	3452.968	3.496

101732 --- 8004 (B48)	101732	8004	Fixed	0.002	0.003	194°42'28"	764.787	2.085
90501 --- 8009 (B64)	90501	8009	Fixed	0.002	0.003	230°13'09"	1033.005	12.724
90501 --- 8006 (B63)	90501	8006	Fixed	0.004	0.016	27°52'49"	3408.022	8.669
90501 --- 8010 (B67)	90501	8010	Fixed	0.003	0.013	217°31'52"	2122.896	13.152
8010 --- 8011 (B71)	8010	8011	Fixed	0.002	0.003	242°03'28"	747.718	-16.069
8010 --- 58886 (B74)	8010	58886	Fixed	0.002	0.003	261°09'13"	956.184	5.836
8010 --- 8009 (B69)	8010	8009	Fixed	0.002	0.003	26°02'11"	1137.966	-0.414
8009 --- 58886 (B81)	58886	8009	Fixed	0.002	0.004	51°00'21"	1858.446	-6.254
58886 --- 8011 (B82)	58886	8011	Fixed	0.001	0.002	125°34'46"	349.490	-21.904
58886 --- 8012 (B83)	58886	8012	Fixed	0.003	0.011	186°38'02"	2356.818	-19.632
58886 --- 8013 (B84)	58886	8013	Fixed	0.005	0.019	177°52'30"	3029.683	-18.048
8012 --- 8011 (B90)	8012	8011	Fixed	0.002	0.010	14°35'36"	2208.947	-2.287
8013 --- 8012 (B91)	8012	8013	Fixed	0.002	0.004	150°44'38"	786.946	1.569
107142 --- 8012 (B92)	8012	107142	Fixed	0.009	0.031	198°39'04"	5066.919	-17.546
8013 --- 8011 (B94)	8013	8011	Fixed	0.005	0.018	3°28'57"	2829.481	-3.855
8015 --- 107142 (B106)	107142	8015	Fixed	0.007	0.028	196°14'10"	2530.305	20.940
8013 --- 107142 (B95)	8013	107142	Fixed	0.010	0.049	205°58'48"	4576.807	-19.144
8013 --- 8015 (B103)	8013	8015	Fixed	0.008	0.036	202°30'38"	7083.527	1.832
107142 --- 171104 (B107)	107142	171104	Fixed	0.011	0.042	210°22'49"	4533.006	2.427
8015 --- 171104 (B110)	8015	171104	Fixed	0.003	0.016	226°56'37"	2169.375	-18.536
8015 --- 61261 (B111)	8015	61261	Fixed	0.004	0.016	203°12'43"	4729.334	-7.299
171104 --- 61261 (B113)	171104	61261	Fixed	0.004	0.025	185°33'57"	2878.975	11.207
WOOL --- 59279 (B133)	59279	WOOL	Fixed	0.005	0.022	2°29'17"	13674.597	31.588
BDST --- 61261 (B187)	BDST	61261	Fixed	0.005	0.028	332°48'57"	15416.149	-7.425
WOOL --- 8000 (B130)	WOOL	8000	Fixed	0.004	0.018	184°18'44"	14055.116	-37.728
WOOL --- 121890 (B131)	WOOL	121890	Fixed	0.004	0.019	184°27'40"	15331.356	-15.218

WOOL --- 8001 (B138)	WOOL	8001	Fixed	0.003	0.012	187°09'24"	17428.074	-21.566
WOOL --- 8002 (B137)	WOOL	8002	Fixed	0.004	0.020	186°05'42"	17967.953	-12.065
WOOL --- 101732 (B136)	WOOL	101732	Fixed	0.003	0.013	184°15'04"	19207.802	10.261
WOOL --- 8003 (B135)	WOOL	8003	Fixed	0.003	0.016	184°42'06"	19174.538	10.265
WOOL --- 8004 (B142)	WOOL	8004	Fixed	0.004	0.018	184°38'58"	19960.381	12.336
WOOL --- 8004 (B146)	WOOL	8004	Fixed	0.004	0.013	184°38'58"	19960.382	12.334
WOOL --- 8004 (B152)	WOOL	8004	Fixed	0.004	0.013	184°38'58"	19960.382	12.320
WOOL --- 8006 (B144)	WOOL	8006	Fixed	0.003	0.015	186°41'09"	23327.108	15.856
WOOL --- 8007 (B150)	WOOL	8007	Fixed	0.004	0.022	188°31'04"	24571.448	3.178
WOOL --- 8008 (B151)	WOOL	8008	Fixed	0.003	0.016	190°13'00"	26336.836	21.280
WOOL --- 90501 (B148)	WOOL	90501	Fixed	0.005	0.026	189°20'42"	26533.618	7.217
WOOL --- 8009 (B149)	WOOL	8009	Fixed	0.003	0.016	190°45'44"	27323.324	19.907
BDST --- 8010 (B158)	BDST	8010	Fixed	0.004	0.015	356°37'29"	27828.047	10.282
BDST --- 8014 (B175)	BDST	8014	Fixed	0.005	0.023	350°58'08"	22554.170	-12.258
BDST --- 8015 (B172)	BDST	8015	Fixed	0.004	0.028	343°59'39"	18789.022	-0.110
BDST --- 171104 (B186)	BDST	171104	Fixed	0.005	0.022	337°48'05"	17906.100	-18.637

Acceptance Summary

Processed	Passed	Flag	Fail
63	63	0	0

Appendix E - Scenario One

Project File Data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\1-Normal.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	17/09/2016 9:10:11 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.000 m

Centering Error: 0.000 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	3
Network Reference Factor:	1.00
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	66

Post Processed Vector Statistics

Reference Factor:	1.00
Redundancy Number:	66.00
A Priori Scalar:	1.78

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	-0.005	-0.004	?	?
107142	-0.017	0.005	-0.028	?
121890	-0.005	0.003	0.019	?
58886	-0.012	0.002	-0.043	?
59279	0.000	0.000	0.067	?
61261	0.000	0.000	-0.047	?
90501	0.002	0.024	-0.051	?

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
101732	Grid				Fixed
59279	Grid	0.005	0.005		
61261	Grid	0.004	0.004		
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.222	0.009	6940700.734	0.009	59.891	?	e
107142	495042.678	0.010	6924708.248	0.009	39.106	0.050	

121890	502287.556	0.010	6944569.163	0.010	34.355	0.017	
171104	492752.690	0.008	6920798.309	0.008	41.650	0.061	
58886	496932.708	0.009	6931847.770	0.009	76.064	0.025	
59279	502887.364	?	6946191.529	?	17.939	0.018	EN
61261	492475.284	?	6917933.883	?	52.968	0.064	EN
8000	502423.603	0.010	6945838.207	0.010	11.861	0.018	
8001	501308.667	0.009	6942562.863	0.009	28.069	0.007	
8002	501571.879	0.009	6941988.929	0.009	37.540	0.006	
8003	501907.489	0.009	6940745.689	0.009	59.938	0.003	
8004	501861.002	0.009	6939961.335	0.009	61.993	0.004	
8006	500762.566	0.009	6936689.192	0.009	65.601	0.023	
8007	499839.104	0.009	6935557.952	0.009	52.954	0.024	
8008	498807.073	0.009	6933940.074	0.009	71.110	0.025	
8009	498376.238	0.009	6933017.081	0.008	69.785	0.025	
8010	497877.114	0.009	6931994.923	0.008	70.230	0.025	
8011	497216.890	0.009	6931644.579	0.009	54.168	0.026	
8012	496661.141	0.009	6929507.596	0.009	56.510	0.028	
8013	497045.768	0.009	6928821.409	0.009	58.104	0.028	
8015	494336.489	0.008	6922279.534	0.008	60.131	0.059	
90501	499169.736	0.009	6933677.842	0.009	57.044	0.025	

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17839"	E153°01'15.01466"	101.273	?	e
107142	S27°48'07.89954"	E152°56'58.82143"	80.019	0.050	
121890	S27°37'22.45325"	E153°01'23.46826"	75.819	0.017	
171104	S27°50'14.93147"	E152°55'35.04206"	82.437	0.061	
58886	S27°44'15.89008"	E152°58'07.96363"	117.196	0.025	
59279	S27°36'29.72210"	E153°01'45.34001"	59.433	0.018	EN
61261	S27°51'48.01681"	E152°55'24.83500"	93.660	0.064	EN
8000	S27°36'41.20840"	E153°01'28.42314"	53.349	0.018	
8001	S27°38'27.66271"	E153°00'47.75847"	69.494	0.007	
8002	S27°38'46.31454"	E153°00'57.36679"	78.953	0.006	
8003	S27°39'26.71814"	E153°01'09.62223"	101.321	0.003	
8004	S27°39'52.20980"	E153°01'07.92985"	103.358	0.004	
8006	S27°41'38.55758"	E153°00'27.84248"	106.869	0.023	
8007	S27°42'15.32327"	E152°59'54.12489"	94.188	0.024	
8008	S27°43'07.90182"	E152°59'16.43450"	112.295	0.025	
8009	S27°43'37.89709"	E152°59'00.69593"	110.943	0.025	
8010	S27°44'11.11425"	E152°58'42.46009"	111.360	0.025	
8011	S27°44'22.49590"	E152°58'18.34201"	95.292	0.026	
8012	S27°45'31.94210"	E152°57'58.02082"	97.573	0.028	
8013	S27°45'54.24602"	E152°58'12.06635"	99.143	0.028	
8015	S27°49'26.82058"	E152°56'32.97029"	100.966	0.059	
90501	S27°43'16.42525"	E152°59'29.67822"	98.219	0.025	

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.431	?	2564808.208	?	-2943019.330	?	?	e
107142	-5028412.387	0.040	2567670.109	0.023	-2957170.308	0.025	0.052	
121890	-5039933.495	0.015	2565405.937	0.011	-2939579.114	0.012	0.022	
171104	-5025745.977	0.049	2568882.681	0.026	-2960629.865	0.030	0.063	
58886	-5032266.171	0.021	2567511.626	0.013	-2950868.330	0.014	0.028	
59279	-5040863.118	?	2565206.155	?	-2938133.273	?	?	EN
61261	-5024435.766	?	2568526.578	?	-2963168.645	?	?	EN
8000	-5040501.878	0.015	2565542.800	0.012	-2938443.759	0.012	0.023	
8001	-5038654.705	0.008	2565853.448	0.009	-2941354.512	0.009	0.015	

8002	-5038544.307	0.007	2565501.664	0.009	-2941867.502	0.008	0.014	
8003	-5038200.009	0.006	2564949.409	0.008	-2942979.539	0.008	0.013	
8004	-5037855.939	0.007	2564826.291	0.009	-2943675.491	0.008	0.014	
8006	-5036005.122	0.019	2565116.569	0.012	-2946576.119	0.013	0.026	
8007	-5035107.020	0.020	2565695.820	0.013	-2947572.262	0.013	0.027	
8008	-5033981.864	0.020	2566281.284	0.013	-2949013.534	0.014	0.028	
8009	-5033402.310	0.021	2566469.727	0.013	-2949830.242	0.014	0.028	
8010	-5032751.852	0.021	2566698.715	0.013	-2950735.494	0.014	0.028	
8011	-5032293.774	0.021	2567206.601	0.013	-2951038.110	0.014	0.028	
8012	-5031156.047	0.023	2567250.892	0.014	-2952931.050	0.015	0.031	
8013	-5031047.217	0.023	2566763.585	0.014	-2953539.323	0.015	0.031	
8015	-5027097.569	0.047	2567793.098	0.025	-2959328.830	0.028	0.060	
90501	-5034026.793	0.021	2565896.979	0.013	-2949239.246	0.014	0.028	

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.011	0.011	54°
107142	0.013	0.011	84°
121890	0.012	0.012	66°
171104	0.011	0.010	62°
58886	0.011	0.011	82°
8000	0.012	0.012	77°
8001	0.012	0.011	48°
8002	0.012	0.011	54°
8003	0.011	0.011	54°
8004	0.011	0.011	53°
8006	0.011	0.011	44°
8007	0.011	0.011	47°
8008	0.011	0.011	62°
8009	0.011	0.011	70°
8010	0.011	0.011	75°
8011	0.011	0.011	80°
8012	0.011	0.011	86°
8013	0.011	0.011	85°
8015	0.010	0.010	22°
90501	0.011	0.011	65°

Adjusted GNSS Observations

Transformation Parameters

Azimuth Rotation:	0.011 sec **(95%)** 0.118 sec
Scale Factor:	1.00000066 **(95%)** 0.00000056

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
8002 --> 8003 (PV20)	**Az.**	164°53'09"	0.356 sec	-0.027 sec	-0.125
	ΔHt.	22.368 m	0.005 m	0.002 m	0.636
	Ellip Dist.	1288.256 m	0.002 m	0.004 m	3.383
121890 --> 8001 (PV12)	**Az.**	205°59'50"	0.217 sec	0.149 sec	1.716
	ΔHt.	-6.324 m	0.016 m	0.014 m	2.158
	Ellip Dist.	2233.259 m	0.003 m	-0.004 m	-3.249
8001 --> 8000 (PV10)	**Az.**	18°47'33"	0.161 sec	-0.097 sec	-0.912
	ΔHt.	-16.145 m	0.017 m	0.006 m	0.410
	Ellip Dist.	3461.289 m	0.003 m	0.007 m	2.561
8000 --> 121890 (PV6)	**Az.**	186°06'27"	0.339 sec	-0.125 sec	-0.985
	ΔHt.	22.469 m	0.006 m	0.002 m	0.691
	Ellip Dist.	1276.825 m	0.002 m	-0.002 m	-2.423
8003 --> 8001 (PV24)	**Az.**	341°45'08"	0.279 sec	0.055 sec	0.275
	ΔHt.	-31.827 m	0.006 m	0.004 m	1.058
	Ellip Dist.	1914.062 m	0.002 m	-0.004 m	-2.129
107142 --> 171104 (PV107)	**Az.**	210°22'49"	0.372 sec	-0.116 sec	-0.449
	ΔHt.	2.419 m	0.045 m	-0.008 m	-0.276
	Ellip Dist.	4532.996 m	0.007 m	-0.009 m	-1.957
90501 --> 8006 (PV63)	**Az.**	27°52'49"	0.194 sec	-0.200 sec	-1.730
	ΔHt.	8.649 m	0.010 m	-0.020 m	-1.443
	Ellip Dist.	3408.021 m	0.004 m	-0.001 m	-0.504
8002 --> 101732 (PV17)	**Az.**	159°25'34"	0.347 sec	-0.106 sec	-0.566
	ΔHt.	22.320 m	0.006 m	0.001 m	0.337
	Ellip Dist.	1376.437 m	0.002 m	-0.002 m	-1.712
8015 --> 171104 (PV110)	**Az.**	226°56'37"	0.376 sec	0.013 sec	0.097
	ΔHt.	-18.528 m	0.025 m	0.008 m	0.978

	Ellip Dist.	2169.377 m	0.004 m	0.002 m	1.697
121890 --> 8002 (PV15)	**Az.**	195°29'30"	0.211 sec	-0.330 sec	-1.663
	ΔHt.	3.134 m	0.017 m	0.004 m	0.162
	Ellip Dist.	2678.719 m	0.003 m	0.001 m	0.453
8015 --> 107142 (PV106)	**Az.**	16°14'22"	0.685 sec	0.345 sec	0.750
	ΔHt.	-20.947 m	0.043 m	-0.010 m	-0.437
	Ellip Dist.	2530.309 m	0.006 m	0.005 m	1.641
101732 --> 8004 (PV48)	**Az.**	194°42'28"	0.492 sec	0.373 sec	1.628
	ΔHt.	2.085 m	0.004 m	0.000 m	-0.152
	Ellip Dist.	764.788 m	0.002 m	0.000 m	0.316
8008 --> 8009 (PV55)	**Az.**	205°01'40"	0.306 sec	0.153 sec	1.593
	ΔHt.	-1.352 m	0.004 m	0.000 m	0.002
	Ellip Dist.	1019.002 m	0.002 m	0.000 m	0.564
8010 --> 8011 (PV71)	**Az.**	242°03'28"	0.398 sec	-0.245 sec	-1.454
	ΔHt.	-16.068 m	0.004 m	0.001 m	0.403
	Ellip Dist.	747.718 m	0.002 m	0.000 m	0.441
8003 --> 8006 (PV33)	**Az.**	195°45'09"	0.150 sec	0.017 sec	0.281
	ΔHt.	5.548 m	0.023 m	-0.018 m	-1.427
	Ellip Dist.	4216.660 m	0.004 m	0.000 m	-0.047
8006 --> 8008 (PV45)	**Az.**	215°25'17"	0.191 sec	0.235 sec	1.334
	ΔHt.	5.426 m	0.009 m	-0.004 m	-0.648
	Ellip Dist.	3375.010 m	0.004 m	0.000 m	0.107
90501 --> 8009 (PV64)	**Az.**	230°13'09"	0.335 sec	-0.194 sec	-1.110
	ΔHt.	12.724 m	0.004 m	0.000 m	0.126
	Ellip Dist.	1033.004 m	0.002 m	-0.001 m	-1.329
8004 --> 8003 (PV38)	**Az.**	3°22'59"	0.487 sec	-0.423 sec	-1.049
	ΔHt.	-2.037 m	0.005 m	-0.006 m	-1.316
	Ellip Dist.	786.045 m	0.002 m	-0.002 m	-0.723
8003 --> 8007 (PV25)	**Az.**	201°43'43"	0.144 sec	-0.148 sec	-1.297
	ΔHt.	-7.133 m	0.024 m	0.013 m	0.525
	Ellip Dist.	5587.107 m	0.005 m	-0.001 m	-0.410
8003 --> 101732 (PV23)	**Az.**	106°54'58"	1.898 sec	0.723 sec	1.249
	ΔHt.	-0.048 m	0.003 m	0.000 m	-0.237
	Ellip Dist.	154.483 m	0.001 m	0.000 m	-1.024
8010 --> 58886 (PV74)	**Az.**	261°09'13"	0.322 sec	0.219 sec	1.205

	ΔHt.	5.837 m	0.004 m	0.000 m	0.182
	Ellip Dist.	956.184 m	0.002 m	0.000 m	-0.577
58886 --> 8012 (PV83)	**Az.**	186°38'02"	0.201 sec	0.109 sec	0.801
	ΔHt.	-19.623 m	0.012 m	0.010 m	1.160
	Ellip Dist.	2356.818 m	0.002 m	0.000 m	0.307
58886 --> 8011 (PV82)	**Az.**	125°34'45"	0.805 sec	-0.299 sec	-1.109
	ΔHt.	-21.904 m	0.003 m	0.000 m	-0.555
	Ellip Dist.	349.490 m	0.001 m	0.000 m	-0.371
8010 --> 8009 (PV69)	**Az.**	26°02'11"	0.323 sec	-0.089 sec	-0.580
	ΔHt.	-0.416 m	0.005 m	-0.002 m	-1.062
	Ellip Dist.	1137.966 m	0.002 m	0.000 m	-0.119
90501 --> 8010 (PV67)	**Az.**	217°31'52"	0.210 sec	-0.050 sec	-0.334
	ΔHt.	13.140 m	0.006 m	-0.011 m	-1.033
	Ellip Dist.	2122.896 m	0.002 m	0.000 m	-0.090
8004 --> 8006 (PV39)	**Az.**	198°32'52"	0.198 sec	0.156 sec	1.011
	ΔHt.	3.510 m	0.023 m	0.015 m	0.928
	Ellip Dist.	3452.970 m	0.004 m	0.002 m	0.665
8015 --> 61261 (PV111)	**Az.**	203°12'43"	0.182 sec	-0.046 sec	-0.760
	ΔHt.	-7.306 m	0.026 m	-0.007 m	-0.973
	Ellip Dist.	4729.334 m	0.005 m	0.000 m	-0.237
8006 --> 8007 (PV41)	**Az.**	219°13'20"	0.427 sec	0.199 sec	0.966
	ΔHt.	-12.680 m	0.007 m	0.001 m	0.305
	Ellip Dist.	1460.886 m	0.003 m	0.002 m	0.937
171104 --> 61261 (PV113)	**Az.**	185°33'57"	0.329 sec	0.132 sec	0.865
	ΔHt.	11.223 m	0.030 m	0.016 m	0.962
	Ellip Dist.	2878.975 m	0.005 m	0.000 m	-0.038
8002 --> 8001 (PV16)	**Az.**	335°21'22"	0.605 sec	0.045 sec	0.286
	ΔHt.	-9.459 m	0.005 m	-0.001 m	-0.755
	Ellip Dist.	631.664 m	0.002 m	0.000 m	0.669
8012 --> 8011 (PV90)	**Az.**	14°35'36"	0.205 sec	-0.067 sec	-0.695
	ΔHt.	-2.282 m	0.012 m	0.005 m	0.719
	Ellip Dist.	2208.947 m	0.002 m	0.000 m	-0.208
58886 --> 8009 (PV81)	**Az.**	51°00'21"	0.215 sec	0.081 sec	0.658
	ΔHt.	-6.253 m	0.005 m	0.001 m	0.504
	Ellip Dist.	1858.447 m	0.002 m	0.001 m	0.463

8003 --> 8004 (PV28)	**Az.**	183°22'58"	0.487 sec	-0.110 sec	-0.256
	ΔHt.	2.037 m	0.005 m	-0.001 m	-0.318
	Ellip Dist.	786.045 m	0.002 m	0.001 m	0.628
8013 --> 107142 (PV95)	**Az.**	205°58'47"	0.363 sec	-0.166 sec	-0.609
	ΔHt.	-19.125 m	0.042 m	0.019 m	0.499
	Ellip Dist.	4576.809 m	0.007 m	0.001 m	0.235
8008 --> 90501 (PV60)	**Az.**	125°52'32"	0.833 sec	-0.213 sec	-0.574
	ΔHt.	-14.076 m	0.005 m	-0.001 m	-0.429
	Ellip Dist.	447.716 m	0.002 m	0.000 m	0.520
59279 --> 121890 (PV2)	**Az.**	200°16'35"	0.310 sec	-0.003 sec	-0.013
	ΔHt.	16.386 m	0.007 m	0.002 m	0.566
	Ellip Dist.	1730.385 m	0.003 m	0.000 m	-0.067
59279 --> 8000 (PV1)	**Az.**	232°41'02"	0.643 sec	0.012 sec	0.078
	ΔHt.	-6.083 m	0.005 m	-0.001 m	-0.550
	Ellip Dist.	583.251 m	0.002 m	0.000 m	0.051
8012 --> 8013 (PV91)	**Az.**	150°44'38"	0.717 sec	0.026 sec	0.109
	ΔHt.	1.570 m	0.007 m	0.001 m	0.532
	Ellip Dist.	786.947 m	0.002 m	0.000 m	0.406
58886 --> 8013 (PV84)	**Az.**	177°52'30"	0.206 sec	0.011 sec	0.057
	ΔHt.	-18.053 m	0.013 m	-0.004 m	-0.281
	Ellip Dist.	3029.681 m	0.003 m	-0.002 m	-0.504
8012 --> 107142 (PV92)	**Az.**	198°39'04"	0.333 sec	0.030 sec	0.157
	ΔHt.	-17.555 m	0.042 m	-0.009 m	-0.457
	Ellip Dist.	5066.918 m	0.007 m	-0.001 m	-0.243
8013 --> 8015 (PV103)	**Az.**	202°30'38"	0.265 sec	0.057 sec	0.397
	ΔHt.	1.823 m	0.052 m	-0.004 m	-0.124
	Ellip Dist.	7083.528 m	0.008 m	0.000 m	-0.001
8008 --> 8007 (PV51)	**Az.**	32°32'21"	0.311 sec	0.031 sec	0.302
	ΔHt.	-18.107 m	0.009 m	-0.001 m	-0.395
	Ellip Dist.	1919.781 m	0.003 m	0.000 m	0.390
8013 --> 8011 (PV94)	**Az.**	3°28'57"	0.216 sec	-0.028 sec	-0.139
	ΔHt.	-3.852 m	0.013 m	0.004 m	0.254
	Ellip Dist.	2829.481 m	0.003 m	0.000 m	0.107

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
101732	8003	**Az.**	286°54'55"	1.908 sec	1 : 119236	1 : 119226
		ΔHt.	0.048 m	0.003 m		
		ΔElev.	0.047 m	0.003 m		
		Ellip Dist.	154.483 m	0.001 m		
101732	8004	**Az.**	194°42'28"	0.502 sec	1 : 387639	1 : 387804
		ΔHt.	2.085 m	0.004 m		
		ΔElev.	2.102 m	0.004 m		
		Ellip Dist.	764.788 m	0.002 m		
107142	171104	**Az.**	210°22'49"	0.355 sec	1 : 647513	1 : 647287
		ΔHt.	2.419 m	0.045 m		
		ΔElev.	2.544 m	0.045 m		
		Ellip Dist.	4532.999 m	0.007 m		
107142	8015	**Az.**	196°14'10"	0.659 sec	1 : 437829	1 : 435914
		ΔHt.	20.947 m	0.043 m		
		ΔElev.	21.024 m	0.043 m		
		Ellip Dist.	2530.311 m	0.006 m		
121890	8001	**Az.**	205°59'50"	0.236 sec	1 : 800306	1 : 800974
		ΔHt.	-6.324 m	0.016 m		
		ΔElev.	-6.286 m	0.016 m		
		Ellip Dist.	2233.261 m	0.003 m		
121890	8002	**Az.**	195°29'30"	0.228 sec	1 : 849879	1 : 849806
		ΔHt.	3.134 m	0.017 m		
		ΔElev.	3.186 m	0.017 m		
		Ellip Dist.	2678.721 m	0.003 m		
171104	61261	**Az.**	185°33'57"	0.331 sec	1 : 635051	1 : 637316
		ΔHt.	11.223 m	0.030 m		
		ΔElev.	11.318 m	0.030 m		
		Ellip Dist.	2878.977 m	0.005 m		
58886	8012	**Az.**	186°38'02"	0.224 sec	1 : 913742	1 : 911231
		ΔHt.	-19.623 m	0.012 m		
		ΔElev.	-19.554 m	0.012 m		
		Ellip Dist.	2356.820 m	0.003 m		
58886	8013	**Az.**	177°52'30"	0.224 sec	1 : 924924	1 : 923613
		ΔHt.	-18.053 m	0.013 m		

		ΔElev.	-17.960 m	0.013 m		
		Ellip Dist.	3029.683 m	0.003 m		
59279	121890	**Az.**	200°16'35"	0.316 sec	1 : 655338	1 : 656279
		ΔHt.	16.386 m	0.007 m		
		ΔElev.	16.416 m	0.007 m		
		Ellip Dist.	1730.386 m	0.003 m		
8000	121890	**Az.**	186°06'27"	0.352 sec	1 : 561507	1 : 562895
		ΔHt.	22.469 m	0.006 m		
		ΔElev.	22.493 m	0.006 m		
		Ellip Dist.	1276.826 m	0.002 m		
8000	59279	**Az.**	52°41'10"	0.645 sec	1 : 273533	1 : 272890
		ΔHt.	6.083 m	0.005 m		
		ΔElev.	6.078 m	0.005 m		
		Ellip Dist.	583.252 m	0.002 m		
8000	8001	**Az.**	198°47'14"	0.186 sec	1 : 1024912	1 : 1022056
		ΔHt.	16.145 m	0.017 m		
		ΔElev.	16.208 m	0.017 m		
		Ellip Dist.	3461.292 m	0.003 m		
8001	8002	**Az.**	155°21'26"	0.611 sec	1 : 375964	1 : 377308
		ΔHt.	9.459 m	0.005 m		
		ΔElev.	9.471 m	0.005 m		
		Ellip Dist.	631.664 m	0.002 m		
8001	8003	**Az.**	161°45'18"	0.291 sec	1 : 761141	1 : 762783
		ΔHt.	31.827 m	0.006 m		
		ΔElev.	31.869 m	0.006 m		
		Ellip Dist.	1914.063 m	0.003 m		
8002	101732	**Az.**	159°25'34"	0.359 sec	1 : 632207	1 : 634464
		ΔHt.	22.320 m	0.006 m		
		ΔElev.	22.351 m	0.006 m		
		Ellip Dist.	1376.437 m	0.002 m		
8002	8003	**Az.**	164°53'09"	0.366 sec	1 : 603630	1 : 605927
		ΔHt.	22.368 m	0.005 m		
		ΔElev.	22.397 m	0.005 m		
		Ellip Dist.	1288.257 m	0.002 m		
8003	8004	**Az.**	183°22'58"	0.499 sec	1 : 387430	1 : 387602
		ΔHt.	2.037 m	0.005 m		
		ΔElev.	2.055 m	0.005 m		
		Ellip Dist.	786.045 m	0.002 m		

8003	8006	**Az.**	195°45'09"	0.176 sec	1 : 1004283	1 : 1004610
		ΔHt.	5.548 m	0.023 m		
		ΔElev.	5.663 m	0.023 m		
		Ellip Dist.	4216.663 m	0.004 m		
8003	8007	**Az.**	201°43'43"	0.169 sec	1 : 1107164	1 : 1106785
		ΔHt.	-7.133 m	0.024 m		
		ΔElev.	-6.984 m	0.024 m		
		Ellip Dist.	5587.111 m	0.005 m		
8004	8006	**Az.**	198°32'52"	0.216 sec	1 : 805637	1 : 805835
		ΔHt.	3.510 m	0.023 m		
		ΔElev.	3.608 m	0.023 m		
		Ellip Dist.	3452.972 m	0.004 m		
8006	8008	**Az.**	215°25'17"	0.209 sec	1 : 907181	1 : 907734
		ΔHt.	5.426 m	0.009 m		
		ΔElev.	5.510 m	0.009 m		
		Ellip Dist.	3375.012 m	0.004 m		
8006	90501	**Az.**	207°52'22"	0.211 sec	1 : 910666	1 : 909740
		ΔHt.	-8.649 m	0.010 m		
		ΔElev.	-8.556 m	0.010 m		
		Ellip Dist.	3408.024 m	0.004 m		
8007	8006	**Az.**	39°13'35"	0.437 sec	1 : 417375	1 : 415762
		ΔHt.	12.680 m	0.007 m		
		ΔElev.	12.647 m	0.007 m		
		Ellip Dist.	1460.887 m	0.004 m		
8007	8008	**Az.**	212°32'03"	0.323 sec	1 : 575239	1 : 577872
		ΔHt.	18.107 m	0.009 m		
		ΔElev.	18.157 m	0.009 m		
		Ellip Dist.	1919.782 m	0.003 m		
8008	8009	**Az.**	205°01'40"	0.321 sec	1 : 552242	1 : 552002
		ΔHt.	-1.352 m	0.004 m		
		ΔElev.	-1.325 m	0.004 m		
		Ellip Dist.	1019.003 m	0.002 m		
8008	90501	**Az.**	125°52'32"	0.844 sec	1 : 269564	1 : 264235
		ΔHt.	-14.076 m	0.005 m		
		ΔElev.	-14.066 m	0.005 m		
		Ellip Dist.	447.717 m	0.002 m		
8009	58886	**Az.**	230°59'56"	0.237 sec	1 : 792183	1 : 792377
		ΔHt.	6.253 m	0.005 m		

		ΔElev.	6.279 m	0.005 m		
		Ellip Dist.	1858.448 m	0.002 m		
8009	8010	**Az.**	206°02'03"	0.336 sec	1 : 557846	1 : 557881
		ΔHt.	0.416 m	0.005 m		
		ΔElev.	0.445 m	0.005 m		
		Ellip Dist.	1137.966 m	0.002 m		
8009	90501	**Az.**	50°13'22"	0.351 sec	1 : 566578	1 : 567101
		ΔHt.	-12.724 m	0.004 m		
		ΔElev.	-12.741 m	0.004 m		
		Ellip Dist.	1033.004 m	0.002 m		
8010	58886	**Az.**	261°09'13"	0.343 sec	1 : 584612	1 : 585147
		ΔHt.	5.837 m	0.004 m		
		ΔElev.	5.834 m	0.004 m		
		Ellip Dist.	956.184 m	0.002 m		
8010	8011	**Az.**	242°03'28"	0.412 sec	1 : 448284	1 : 445757
		ΔHt.	-16.068 m	0.004 m		
		ΔElev.	-16.062 m	0.004 m		
		Ellip Dist.	747.719 m	0.002 m		
8011	58886	**Az.**	305°34'41"	0.815 sec	1 : 291056	1 : 282959
		ΔHt.	21.904 m	0.003 m		
		ΔElev.	21.896 m	0.003 m		
		Ellip Dist.	349.490 m	0.001 m		
8011	8012	**Az.**	194°35'27"	0.228 sec	1 : 873819	1 : 873981
		ΔHt.	2.282 m	0.012 m		
		ΔElev.	2.341 m	0.012 m		
		Ellip Dist.	2208.949 m	0.003 m		
8011	8013	**Az.**	183°28'54"	0.232 sec	1 : 877577	1 : 877763
		ΔHt.	3.852 m	0.013 m		
		ΔElev.	3.936 m	0.013 m		
		Ellip Dist.	2829.483 m	0.003 m		
8012	107142	**Az.**	198°39'04"	0.318 sec	1 : 757608	1 : 756696
		ΔHt.	-17.555 m	0.042 m		
		ΔElev.	-17.403 m	0.042 m		
		Ellip Dist.	5066.921 m	0.007 m		
8013	107142	**Az.**	205°58'47"	0.349 sec	1 : 669192	1 : 668496
		ΔHt.	-19.125 m	0.042 m		
		ΔElev.	-18.998 m	0.042 m		
		Ellip Dist.	4576.812 m	0.007 m		

8013	8012	**Az.**	330°44'32"	0.720 sec	1 : 317511	1 : 317522
		ΔHt.	-1.570 m	0.007 m		
		ΔElev.	-1.594 m	0.007 m		
		Ellip Dist.	786.947 m	0.002 m		
8013	8015	**Az.**	202°30'38"	0.228 sec	1 : 984682	1 : 984808
		ΔHt.	1.823 m	0.052 m		
		ΔElev.	2.027 m	0.052 m		
		Ellip Dist.	7083.533 m	0.007 m		
8015	171104	**Az.**	226°56'37"	0.389 sec	1 : 523202	1 : 523324
		ΔHt.	-18.528 m	0.025 m		
		ΔElev.	-18.481 m	0.025 m		
		Ellip Dist.	2169.379 m	0.004 m		
8015	61261	**Az.**	203°12'43"	0.193 sec	1 : 1014966	1 : 1014176
		ΔHt.	-7.306 m	0.026 m		
		ΔElev.	-7.163 m	0.026 m		
		Ellip Dist.	4729.337 m	0.005 m		
90501	8010	**Az.**	217°31'52"	0.232 sec	1 : 829408	1 : 830183
		ΔHt.	13.140 m	0.006 m		
		ΔElev.	13.186 m	0.006 m		
		Ellip Dist.	2122.897 m	0.003 m		

Date: 17/09/2016 9:11:44 AM	Project: F:\PROJECT\TBC PROJECTS\1-Normal.vce	Trimble Business Center

Appendix E - Scenario Two

Project File Data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\2-Normal to CORS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	4/09/2016 3:26:22 PM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.000 m

Centering Error: 0.000 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	0.99
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	67

Post Processed Vector Statistics

Reference Factor:	0.99
Redundancy Number:	66.94
A Priori Scalar:	1.78

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	0.000	0.002	-0.028	?
107142	-0.013	0.006	-0.055	?
121890	-0.001	0.010	-0.010	?
58886	-0.007	0.006	-0.071	?
59279	0.004	0.008	0.038	?
61261	0.002	0.000	-0.066	?
90501	0.007	0.028	-0.078	?
BDST	0.000	0.000	?	-0.001
WOOL	0.000	0.000	?	0.001

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
BDST	Local	0.003	0.003	0.009	
WOOL	Local	0.003	0.003	0.009	
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.217	0.008	6940700.728	0.008	59.919	0.041	
107142	495042.674	0.010	6924708.247	0.009	39.133	0.053	

121890	502287.552	0.008	6944569.156	0.007	34.384	0.039	
171104	492752.688	0.009	6920798.309	0.009	41.673	0.052	
58886	496932.703	0.008	6931847.766	0.008	76.092	0.044	
59279	502887.360	0.007	6946191.521	0.007	17.968	0.039	
61261	492475.282	0.008	6917933.883	0.008	52.987	0.048	
8000	502423.600	0.008	6945838.199	0.007	11.890	0.039	
8001	501308.664	0.008	6942562.856	0.007	28.098	0.041	
8002	501571.875	0.008	6941988.922	0.007	37.569	0.041	
8003	501907.485	0.008	6940745.683	0.008	59.966	0.041	
8004	501860.998	0.008	6939961.329	0.008	62.022	0.041	
8006	500762.561	0.008	6936689.186	0.008	65.628	0.044	
8007	499839.100	0.008	6935557.947	0.008	52.981	0.044	
8008	498807.069	0.008	6933940.070	0.008	71.138	0.044	
8009	498376.233	0.008	6933017.077	0.008	69.812	0.044	
8010	497877.110	0.008	6931994.919	0.008	70.258	0.044	
8011	497216.886	0.008	6931644.576	0.008	54.196	0.044	
8012	496661.137	0.008	6929507.594	0.009	56.537	0.045	
8013	497045.763	0.008	6928821.406	0.009	58.130	0.045	
8015	494336.486	0.008	6922279.533	0.008	60.153	0.049	
90501	499169.731	0.008	6933677.838	0.008	57.071	0.044	
BDST	499515.927	?	6904226.324	?	60.702	?	LLh
WOOL	503483.973	?	6959847.629	?	49.247	?	LLh

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17860"	E153°01'15.01451"	101.301	0.041	
107142	S27°48'07.89957"	E152°56'58.82127"	80.046	0.053	
121890	S27°37'22.45350"	E153°01'23.46813"	75.848	0.039	
171104	S27°50'14.93149"	E152°55'35.04199"	82.460	0.052	
58886	S27°44'15.89020"	E152°58'07.96348"	117.223	0.044	
59279	S27°36'29.72236"	E153°01'45.33988"	59.462	0.039	
61261	S27°51'48.01679"	E152°55'24.83491"	93.679	0.048	
8000	S27°36'41.20865"	E153°01'28.42301"	53.379	0.039	
8001	S27°38'27.66293"	E153°00'47.75833"	69.523	0.041	
8002	S27°38'46.31475"	E153°00'57.36665"	78.982	0.041	
8003	S27°39'26.71835"	E153°01'09.62208"	101.349	0.041	
8004	S27°39'52.21000"	E153°01'07.92970"	103.387	0.041	
8006	S27°41'38.55775"	E153°00'27.84232"	106.896	0.044	
8007	S27°42'15.32342"	E152°59'54.12474"	94.216	0.044	
8008	S27°43'07.90195"	E152°59'16.43434"	112.323	0.044	
8009	S27°43'37.89722"	E152°59'00.69578"	110.971	0.044	
8010	S27°44'11.11436"	E152°58'42.45994"	111.387	0.044	
8011	S27°44'22.49601"	E152°58'18.34186"	95.319	0.044	
8012	S27°45'31.94219"	E152°57'58.02067"	97.600	0.045	
8013	S27°45'54.24610"	E152°58'12.06618"	99.169	0.045	
8015	S27°49'26.82061"	E152°56'32.97020"	100.988	0.049	
90501	S27°43'16.42539"	E152°59'29.67805"	98.246	0.044	
BDST	S27°59'13.56952"	E152°59'42.27818"	101.096	?	LLh
WOOL	S27°29'05.88837"	E153°02'06.96433"	91.053	?	LLh

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.449	0.033	2564808.222	0.018	-2943019.349	0.020	0.042	
107142	-5028412.406	0.042	2567670.124	0.024	-2957170.321	0.025	0.054	
121890	-5039933.513	0.031	2565405.951	0.017	-2939579.134	0.019	0.041	

171104	-5025745.994	0.041	2568882.692	0.023	-2960629.877	0.025	0.053	
58886	-5032266.190	0.035	2567511.640	0.020	-2950868.346	0.022	0.046	
59279	-5040863.136	0.031	2565206.168	0.017	-2938133.294	0.019	0.040	
61261	-5024435.779	0.038	2568526.587	0.021	-2963168.654	0.023	0.049	
8000	-5040501.896	0.031	2565542.814	0.017	-2938443.779	0.019	0.040	
8001	-5038654.723	0.032	2565853.461	0.018	-2941354.531	0.020	0.042	
8002	-5038544.325	0.033	2565501.678	0.018	-2941867.522	0.020	0.042	
8003	-5038200.027	0.033	2564949.422	0.018	-2942979.558	0.020	0.042	
8004	-5037855.957	0.033	2564826.305	0.018	-2943675.510	0.020	0.043	
8006	-5036005.140	0.035	2565116.583	0.019	-2946576.136	0.022	0.045	
8007	-5035107.038	0.035	2565695.834	0.019	-2947572.279	0.022	0.046	
8008	-5033981.882	0.035	2566281.298	0.019	-2949013.550	0.022	0.046	
8009	-5033402.328	0.035	2566469.740	0.020	-2949830.258	0.022	0.046	
8010	-5032751.869	0.035	2566698.729	0.020	-2950735.510	0.022	0.046	
8011	-5032293.792	0.035	2567206.615	0.020	-2951038.126	0.022	0.046	
8012	-5031156.065	0.036	2567250.906	0.020	-2952931.065	0.022	0.047	
8013	-5031047.234	0.036	2566763.599	0.020	-2953539.337	0.022	0.047	
8015	-5027097.585	0.039	2567793.109	0.022	-2959328.842	0.023	0.050	
90501	-5034026.811	0.035	2565896.993	0.020	-2949239.263	0.022	0.046	
BDST	-5021920.611	?	2559339.870	?	-2975290.667	?	?	LLh
WOOL	-5046788.338	?	2567555.322	?	-2926034.800	?	?	LLh

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.010	0.009	66°
107142	0.012	0.011	78°
121890	0.010	0.009	76°
171104	0.011	0.010	32°
58886	0.011	0.010	39°
59279	0.009	0.009	82°
61261	0.010	0.010	20°
8000	0.009	0.009	80°
8001	0.010	0.009	71°
8002	0.010	0.009	69°
8003	0.010	0.009	66°
8004	0.010	0.010	62°

8006	0.010	0.010	46°
8007	0.011	0.010	41°
8008	0.010	0.010	41°
8009	0.011	0.010	41°
8010	0.011	0.010	39°
8011	0.011	0.010	39°
8012	0.011	0.010	37°
8013	0.011	0.010	31°
8015	0.011	0.010	24°
90501	0.010	0.010	42°

Adjusted GNSS Observations

Transformation Parameters

Azimuth Rotation: -0.016 sec **(95%)** 0.060 sec

Scale Factor: 1.00000040 **(95%)** 0.00000030

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
8003 --> 8002 (PV20)	**Az.**	344°53'03"	0.352 sec	-0.040 sec	-0.188
	ΔHt.	-22.368 m	0.005 m	-0.003 m	-0.696
	Ellip Dist.	1288.256 m	0.002 m	0.005 m	3.429
8001 --> 121890 (PV12)	**Az.**	26°00'07"	0.215 sec	0.149 sec	1.725
	ΔHt.	6.325 m	0.016 m	-0.014 m	-2.050
	Ellip Dist.	2233.259 m	0.003 m	-0.004 m	-3.281
8001 --> 8000 (PV10)	**Az.**	18°47'33"	0.160 sec	-0.097 sec	-0.916
	ΔHt.	-16.144 m	0.016 m	0.007 m	0.457
	Ellip Dist.	3461.289 m	0.003 m	0.007 m	2.575
8000 --> 121890 (PV6)	**Az.**	186°06'27"	0.336 sec	-0.126 sec	-1.005
	ΔHt.	22.469 m	0.006 m	0.001 m	0.675
	Ellip Dist.	1276.825 m	0.002 m	-0.002 m	-2.457
8001 --> 8003 (PV24)	**Az.**	161°45'18"	0.275 sec	0.063 sec	0.322
	ΔHt.	31.826 m	0.006 m	-0.005 m	-1.219
	Ellip Dist.	1914.062 m	0.002 m	-0.004 m	-2.138
107142 --> 171104 (PV107)	**Az.**	210°22'49"	0.328 sec	-0.230 sec	-0.840
	ΔHt.	2.415 m	0.040 m	-0.012 m	-0.372

	Ellip Dist.	4532.996 m	0.007 m	-0.010 m	-1.985
101732 --> 8002 (PV17)	**Az.**	339°25'26"	0.343 sec	-0.104 sec	-0.562
	ΔHt.	-22.320 m	0.006 m	-0.001 m	-0.308
	Ellip Dist.	1376.437 m	0.002 m	-0.002 m	-1.753
90501 --> 8006 (PV63)	**Az.**	27°52'49"	0.191 sec	-0.199 sec	-1.735
	ΔHt.	8.650 m	0.010 m	-0.019 m	-1.431
	Ellip Dist.	3408.021 m	0.004 m	-0.001 m	-0.427
8015 --> 171104 (PV110)	**Az.**	226°56'37"	0.360 sec	0.033 sec	0.258
	ΔHt.	-18.528 m	0.025 m	0.008 m	0.993
	Ellip Dist.	2169.377 m	0.004 m	0.002 m	1.716
8002 --> 121890 (PV15)	**Az.**	15°29'42"	0.209 sec	-0.332 sec	-1.687
	ΔHt.	-3.134 m	0.016 m	-0.004 m	-0.165
	Ellip Dist.	2678.719 m	0.003 m	0.001 m	0.452
8009 --> 8008 (PV55)	**Az.**	25°01'48"	0.303 sec	0.154 sec	1.605
	ΔHt.	1.352 m	0.004 m	0.000 m	0.093
	Ellip Dist.	1019.002 m	0.002 m	0.000 m	0.765
101732 --> 8004 (PV48)	**Az.**	194°42'28"	0.494 sec	0.357 sec	1.602
	ΔHt.	2.085 m	0.004 m	0.000 m	-0.013
	Ellip Dist.	764.788 m	0.002 m	0.000 m	0.201
8006 --> 8003 (PV33)	**Az.**	15°45'28"	0.149 sec	0.016 sec	0.261
	ΔHt.	-5.547 m	0.022 m	0.019 m	1.487
	Ellip Dist.	4216.660 m	0.004 m	0.000 m	-0.049
8009 --> 90501 (PV64)	**Az.**	50°13'22"	0.330 sec	-0.188 sec	-1.091
	ΔHt.	-12.724 m	0.004 m	0.000 m	-0.190
	Ellip Dist.	1033.003 m	0.002 m	-0.001 m	-1.467
8015 --> 107142 (PV106)	**Az.**	16°14'22"	0.568 sec	0.168 sec	0.581
	ΔHt.	-20.943 m	0.036 m	-0.004 m	-0.259
	Ellip Dist.	2530.309 m	0.006 m	0.004 m	1.466
8010 --> 8011 (PV71)	**Az.**	242°03'28"	0.394 sec	-0.243 sec	-1.453
	ΔHt.	-16.068 m	0.004 m	0.001 m	0.390
	Ellip Dist.	747.718 m	0.002 m	0.000 m	0.427
8008 --> 8006 (PV45)	**Az.**	35°25'50"	0.189 sec	0.235 sec	1.348
	ΔHt.	-5.426 m	0.009 m	0.004 m	0.666
	Ellip Dist.	3375.010 m	0.003 m	0.000 m	0.080
8003 --> 8007 (PV25)	**Az.**	201°43'43"	0.142 sec	-0.148 sec	-1.316

	ΔHt.	-7.133 m	0.023 m	0.012 m	0.479
	Ellip Dist.	5587.107 m	0.005 m	-0.001 m	-0.438
8003 --> 101732 (PV23)	**Az.**	106°54'58"	1.882 sec	0.694 sec	1.213
	ΔHt.	-0.048 m	0.003 m	0.000 m	-0.105
	Ellip Dist.	154.483 m	0.001 m	0.000 m	-0.972
58886 --> 8010 (PV74)	**Az.**	81°09'29"	0.319 sec	0.219 sec	1.212
	ΔHt.	-5.837 m	0.004 m	0.000 m	-0.179
	Ellip Dist.	956.184 m	0.002 m	0.000 m	-0.579
58886 --> 8011 (PV82)	**Az.**	125°34'45"	0.797 sec	-0.309 sec	-1.156
	ΔHt.	-21.904 m	0.003 m	0.000 m	-0.574
	Ellip Dist.	349.490 m	0.001 m	0.000 m	-0.388
90501 --> 8010 (PV67)	**Az.**	217°31'52"	0.208 sec	-0.049 sec	-0.328
	ΔHt.	13.140 m	0.006 m	-0.012 m	-1.117
	Ellip Dist.	2122.896 m	0.002 m	0.000 m	-0.155
58886 --> 8012 (PV83)	**Az.**	186°38'02"	0.199 sec	0.106 sec	0.783
	ΔHt.	-19.623 m	0.012 m	0.009 m	1.097
	Ellip Dist.	2356.818 m	0.002 m	0.000 m	0.249
61261 --> 8015 (PV111)	**Az.**	23°13'15"	0.178 sec	-0.045 sec	-0.732
	ΔHt.	7.310 m	0.025 m	0.009 m	1.081
	Ellip Dist.	4729.334 m	0.004 m	0.000 m	-0.270
8010 --> 8009 (PV69)	**Az.**	26°02'11"	0.320 sec	-0.088 sec	-0.581
	ΔHt.	-0.416 m	0.005 m	-0.002 m	-1.063
	Ellip Dist.	1137.966 m	0.002 m	0.000 m	-0.091
8006 --> 8004 (PV39)	**Az.**	18°33'11"	0.197 sec	0.162 sec	1.056
	ΔHt.	-3.509 m	0.022 m	-0.013 m	-0.852
	Ellip Dist.	3452.970 m	0.004 m	0.002 m	0.706
8003 --> 8004 (PV38)	**Az.**	183°22'58"	0.494 sec	-0.392 sec	-0.882
	ΔHt.	2.038 m	0.005 m	0.005 m	1.025
	Ellip Dist.	786.045 m	0.002 m	-0.001 m	-0.407
8007 --> 8006 (PV41)	**Az.**	39°13'35"	0.423 sec	0.200 sec	0.980
	ΔHt.	12.680 m	0.007 m	-0.001 m	-0.303
	Ellip Dist.	1460.886 m	0.003 m	0.002 m	0.915
61261 --> 171104 (PV113)	**Az.**	5°34'02"	0.321 sec	0.119 sec	0.803
	ΔHt.	-11.219 m	0.029 m	-0.015 m	-0.898
	Ellip Dist.	2878.975 m	0.004 m	0.000 m	0.029

8002 --> 8001 (PV16)	**Az.**	335°21'22"	0.599 sec	0.036 sec	0.229
	ΔHt.	-9.459 m	0.005 m	-0.001 m	-0.868
	Ellip Dist.	631.664 m	0.002 m	0.000 m	0.663
8008 --> 90501 (PV60)	**Az.**	125°52'32"	0.796 sec	-0.268 sec	-0.802
	ΔHt.	-14.076 m	0.005 m	-0.001 m	-0.376
	Ellip Dist.	447.716 m	0.002 m	0.000 m	0.463
8012 --> 8011 (PV90)	**Az.**	14°35'36"	0.203 sec	-0.070 sec	-0.721
	ΔHt.	-2.281 m	0.012 m	0.005 m	0.802
	Ellip Dist.	2208.947 m	0.002 m	0.000 m	-0.282
58886 --> 8009 (PV81)	**Az.**	51°00'21"	0.213 sec	0.080 sec	0.654
	ΔHt.	-6.253 m	0.005 m	0.001 m	0.518
	Ellip Dist.	1858.447 m	0.002 m	0.001 m	0.490
8000 --> 59279 (PV1)	**Az.**	52°41'10"	0.637 sec	0.013 sec	0.087
	ΔHt.	6.084 m	0.005 m	0.001 m	0.592
	Ellip Dist.	583.251 m	0.002 m	0.000 m	0.057
8013 --> 107142 (PV95)	**Az.**	205°58'47"	0.334 sec	-0.163 sec	-0.587
	ΔHt.	-19.124 m	0.038 m	0.020 m	0.508
	Ellip Dist.	4576.809 m	0.007 m	0.001 m	0.216
8003 --> 8004 (PV28)	**Az.**	183°22'58"	0.494 sec	-0.138 sec	-0.324
	ΔHt.	2.038 m	0.005 m	-0.001 m	-0.229
	Ellip Dist.	786.045 m	0.002 m	0.001 m	0.577
121890 --> 59279 (PV2)	**Az.**	20°16'45"	0.307 sec	-0.003 sec	-0.012
	ΔHt.	-16.386 m	0.007 m	-0.002 m	-0.553
	Ellip Dist.	1730.385 m	0.003 m	0.000 m	-0.069
59279 --> WOOL (PV133)	**Az.**	2°29'17"	0.099 sec	0.001 sec	0.409
	ΔHt.	31.591 m	0.036 m	0.003 m	0.409
	Ellip Dist.	13674.597 m	0.005 m	0.000 m	-0.456
8015 --> 8013 (PV103)	**Az.**	22°31'24"	0.215 sec	0.028 sec	0.320
	ΔHt.	-1.819 m	0.040 m	0.011 m	0.421
	Ellip Dist.	7083.527 m	0.008 m	0.001 m	0.155
BDST --> 61261 (PV139)	**Az.**	332°48'57"	0.090 sec	-0.002 sec	-0.409
	ΔHt.	-7.417 m	0.047 m	0.008 m	0.409
	Ellip Dist.	15416.149 m	0.007 m	0.000 m	0.374
107142 --> 8012 (PV92)	**Az.**	18°39'32"	0.308 sec	0.026 sec	0.128
	ΔHt.	17.554 m	0.038 m	0.008 m	0.401

	Ellip Dist.	5066.918 m	0.007 m	-0.001 m	-0.332
8013 --> 8012 (PV91)	**Az.**	330°44'32"	0.690 sec	0.009 sec	0.041
	ΔHt.	-1.569 m	0.007 m	0.000 m	-0.387
	Ellip Dist.	786.947 m	0.002 m	0.000 m	0.312
8008 --> 8007 (PV51)	**Az.**	32°32'21"	0.308 sec	0.031 sec	0.306
	ΔHt.	-18.107 m	0.008 m	-0.001 m	-0.376
	Ellip Dist.	1919.781 m	0.003 m	0.000 m	0.349
8013 --> 8011 (PV94)	**Az.**	3°28'57"	0.211 sec	-0.029 sec	-0.142
	ΔHt.	-3.851 m	0.012 m	0.005 m	0.315
	Ellip Dist.	2829.481 m	0.003 m	0.000 m	0.061
8013 --> 58886 (PV84)	**Az.**	357°52'28"	0.201 sec	0.031 sec	0.169
	ΔHt.	18.054 m	0.012 m	0.002 m	0.147
	Ellip Dist.	3029.681 m	0.003 m	-0.001 m	-0.237

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
101732	8003	**Az.**	286°54'55"	1.890 sec	1 : 120175	1 : 120165
		ΔHt.	0.048 m	0.003 m		
		ΔElev.	0.047 m	0.003 m		
		Ellip Dist.	154.483 m	0.001 m		
101732	8004	**Az.**	194°42'28"	0.495 sec	1 : 395924	1 : 396095
		ΔHt.	2.085 m	0.004 m		
		ΔElev.	2.102 m	0.004 m		
		Ellip Dist.	764.788 m	0.002 m		
107142	171104	**Az.**	210°22'49"	0.320 sec	1 : 707038	1 : 706907
		ΔHt.	2.415 m	0.040 m		
		ΔElev.	2.540 m	0.040 m		
		Ellip Dist.	4532.998 m	0.006 m		
107142	8015	**Az.**	196°14'10"	0.558 sec	1 : 461878	1 : 461686
		ΔHt.	20.943 m	0.036 m		
		ΔElev.	21.020 m	0.036 m		
		Ellip Dist.	2530.310 m	0.005 m		
121890	8001	**Az.**	205°59'50"	0.217 sec	1 : 850969	1 : 851747

		ΔHt.	-6.325 m	0.016 m		
		ΔElev.	-6.286 m	0.016 m		
		Ellip Dist.	2233.260 m	0.003 m		
121890	8002	**Az.**	195°29'30"	0.209 sec	1 : 906922	1 : 906835
		ΔHt.	3.134 m	0.016 m		
		ΔElev.	3.185 m	0.016 m		
		Ellip Dist.	2678.720 m	0.003 m		
171104	61261	**Az.**	185°33'57"	0.316 sec	1 : 669846	1 : 672497
		ΔHt.	11.219 m	0.029 m		
		ΔElev.	11.314 m	0.029 m		
		Ellip Dist.	2878.977 m	0.004 m		
58886	8012	**Az.**	186°38'02"	0.202 sec	1 : 1000634	1 : 997346
		ΔHt.	-19.623 m	0.012 m		
		ΔElev.	-19.555 m	0.012 m		
		Ellip Dist.	2356.819 m	0.002 m		
58886	8013	**Az.**	177°52'30"	0.201 sec	1 : 1021069	1 : 1019342
		ΔHt.	-18.054 m	0.012 m		
		ΔElev.	-17.961 m	0.012 m		
		Ellip Dist.	3029.682 m	0.003 m		
59279	121890	**Az.**	200°16'35"	0.304 sec	1 : 678984	1 : 680045
		ΔHt.	16.386 m	0.007 m		
		ΔElev.	16.415 m	0.007 m		
		Ellip Dist.	1730.385 m	0.003 m		
59279	WOOL	**Az.**	2°29'17"	0.092 sec	1 : 2460197	1 : 2462909
		ΔHt.	31.591 m	0.036 m		
		ΔElev.	31.279 m	0.036 m		
		Ellip Dist.	13674.602 m	0.006 m		
61261	BDST	**Az.**	152°50'57"	0.091 sec	1 : 2290139	1 : 2291335
		ΔHt.	7.417 m	0.047 m		
		ΔElev.	7.715 m	0.047 m		
		Ellip Dist.	15416.155 m	0.007 m		
8000	121890	**Az.**	186°06'27"	0.337 sec	1 : 581292	1 : 582786
		ΔHt.	22.469 m	0.006 m		
		ΔElev.	22.493 m	0.006 m		
		Ellip Dist.	1276.825 m	0.002 m		
8000	59279	**Az.**	52°41'10"	0.636 sec	1 : 276288	1 : 275636
		ΔHt.	6.084 m	0.005 m		
		ΔElev.	6.078 m	0.005 m		

		Ellip Dist.	583.252 m	0.002 m		
8000	8001	**Az.**	198°47'14"	0.163 sec	1 : 1131133	1 : 1127391
		ΔHt.	16.144 m	0.016 m		
		ΔElev.	16.207 m	0.016 m		
		Ellip Dist.	3461.291 m	0.003 m		
8001	8002	**Az.**	155°21'26"	0.598 sec	1 : 384821	1 : 386258
		ΔHt.	9.459 m	0.005 m		
		ΔElev.	9.472 m	0.005 m		
		Ellip Dist.	631.664 m	0.002 m		
8001	8003	**Az.**	161°45'18"	0.274 sec	1 : 809266	1 : 811487
		ΔHt.	31.827 m	0.006 m		
		ΔElev.	31.868 m	0.006 m		
		Ellip Dist.	1914.062 m	0.002 m		
8002	101732	**Az.**	159°25'34"	0.343 sec	1 : 660641	1 : 663394
		ΔHt.	22.320 m	0.006 m		
		ΔElev.	22.350 m	0.006 m		
		Ellip Dist.	1376.437 m	0.002 m		
8002	8003	**Az.**	164°53'09"	0.351 sec	1 : 625413	1 : 628222
		ΔHt.	22.368 m	0.005 m		
		ΔElev.	22.397 m	0.005 m		
		Ellip Dist.	1288.256 m	0.002 m		
8003	8004	**Az.**	183°22'58"	0.496 sec	1 : 395635	1 : 395810
		ΔHt.	2.038 m	0.005 m		
		ΔElev.	2.056 m	0.005 m		
		Ellip Dist.	786.045 m	0.002 m		
8003	8006	**Az.**	195°45'09"	0.151 sec	1 : 1084284	1 : 1084751
		ΔHt.	5.547 m	0.022 m		
		ΔElev.	5.662 m	0.022 m		
		Ellip Dist.	4216.661 m	0.004 m		
8003	8007	**Az.**	201°43'43"	0.144 sec	1 : 1220116	1 : 1219552
		ΔHt.	-7.133 m	0.023 m		
		ΔElev.	-6.985 m	0.023 m		
		Ellip Dist.	5587.109 m	0.005 m		
8004	8006	**Az.**	198°32'52"	0.197 sec	1 : 842145	1 : 842393
		ΔHt.	3.509 m	0.022 m		
		ΔElev.	3.606 m	0.022 m		
		Ellip Dist.	3452.972 m	0.004 m		
8006	8008	**Az.**	215°25'17"	0.190 sec	1 : 972443	1 : 973140

		ΔHt.	5.426 m	0.009 m		
		ΔElev.	5.510 m	0.009 m		
		Ellip Dist.	3375.011 m	0.003 m		
8006	90501	**Az.**	207°52'22"	0.192 sec	1 : 975462	1 : 974301
		ΔHt.	-8.650 m	0.010 m		
		ΔElev.	-8.557 m	0.010 m		
		Ellip Dist.	3408.023 m	0.003 m		
8007	8006	**Az.**	39°13'35"	0.424 sec	1 : 427347	1 : 425641
		ΔHt.	12.680 m	0.007 m		
		ΔElev.	12.647 m	0.007 m		
		Ellip Dist.	1460.887 m	0.003 m		
8007	8008	**Az.**	212°32'03"	0.309 sec	1 : 592943	1 : 595825
		ΔHt.	18.107 m	0.008 m		
		ΔElev.	18.156 m	0.008 m		
		Ellip Dist.	1919.781 m	0.003 m		
8008	8009	**Az.**	205°01'40"	0.305 sec	1 : 576075	1 : 575814
		ΔHt.	-1.352 m	0.004 m		
		ΔElev.	-1.325 m	0.004 m		
		Ellip Dist.	1019.003 m	0.002 m		
8008	90501	**Az.**	125°52'32"	0.800 sec	1 : 277287	1 : 271666
		ΔHt.	-14.076 m	0.005 m		
		ΔElev.	-14.066 m	0.005 m		
		Ellip Dist.	447.716 m	0.002 m		
8009	58886	**Az.**	230°59'56"	0.218 sec	1 : 842389	1 : 842631
		ΔHt.	6.253 m	0.005 m		
		ΔElev.	6.279 m	0.005 m		
		Ellip Dist.	1858.448 m	0.002 m		
8009	8010	**Az.**	206°02'03"	0.321 sec	1 : 577029	1 : 577068
		ΔHt.	0.416 m	0.005 m		
		ΔElev.	0.445 m	0.005 m		
		Ellip Dist.	1137.966 m	0.002 m		
8009	90501	**Az.**	50°13'22"	0.334 sec	1 : 596194	1 : 596741
		ΔHt.	-12.724 m	0.004 m		
		ΔElev.	-12.741 m	0.004 m		
		Ellip Dist.	1033.004 m	0.002 m		
8010	58886	**Az.**	261°09'13"	0.326 sec	1 : 610359	1 : 610967
		ΔHt.	5.837 m	0.004 m		
		ΔElev.	5.834 m	0.004 m		

		Ellip Dist.	956.184 m	0.002 m		
8010	8011	**Az.**	242°03'28"	0.398 sec	1 : 459474	1 : 456781
		ΔHt.	-16.068 m	0.004 m		
		ΔElev.	-16.062 m	0.004 m		
		Ellip Dist.	747.719 m	0.002 m		
8011	58886	**Az.**	305°34'41"	0.800 sec	1 : 296702	1 : 288278
		ΔHt.	21.904 m	0.003 m		
		ΔElev.	21.896 m	0.003 m		
		Ellip Dist.	349.490 m	0.001 m		
8011	8012	**Az.**	194°35'27"	0.206 sec	1 : 948564	1 : 948774
		ΔHt.	2.281 m	0.012 m		
		ΔElev.	2.341 m	0.012 m		
		Ellip Dist.	2208.948 m	0.002 m		
8011	8013	**Az.**	183°28'55"	0.210 sec	1 : 957801	1 : 958029
		ΔHt.	3.851 m	0.012 m		
		ΔElev.	3.935 m	0.012 m		
		Ellip Dist.	2829.482 m	0.003 m		
8012	107142	**Az.**	198°39'04"	0.298 sec	1 : 775485	1 : 774408
		ΔHt.	-17.554 m	0.038 m		
		ΔElev.	-17.403 m	0.038 m		
		Ellip Dist.	5066.920 m	0.007 m		
8013	107142	**Az.**	205°58'47"	0.326 sec	1 : 689375	1 : 688534
		ΔHt.	-19.124 m	0.038 m		
		ΔElev.	-18.997 m	0.038 m		
		Ellip Dist.	4576.811 m	0.007 m		
8013	8012	**Az.**	330°44'32"	0.688 sec	1 : 327713	1 : 327751
		ΔHt.	-1.569 m	0.007 m		
		ΔElev.	-1.594 m	0.007 m		
		Ellip Dist.	786.947 m	0.002 m		
8013	8015	**Az.**	202°30'38"	0.198 sec	1 : 1017913	1 : 1018031
		ΔHt.	1.819 m	0.040 m		
		ΔElev.	2.023 m	0.040 m		
		Ellip Dist.	7083.530 m	0.007 m		
8015	171104	**Az.**	226°56'37"	0.362 sec	1 : 548847	1 : 548703
		ΔHt.	-18.528 m	0.025 m		
		ΔElev.	-18.480 m	0.025 m		
		Ellip Dist.	2169.378 m	0.004 m		
8015	61261	**Az.**	203°12'43"	0.175 sec	1 : 1094727	1 : 1093684

		ΔHt.	-7.310 m	0.025 m		
		ΔElev.	-7.167 m	0.025 m		
		Ellip Dist.	4729.336 m	0.004 m		
90501	8010	**Az.**	217°31'52"	0.212 sec	1 : 891281	1 : 892231
		ΔHt.	13.140 m	0.006 m		
		ΔElev.	13.186 m	0.006 m		
		Ellip Dist.	2122.896 m	0.002 m		

Date: 17/09/2016 9:12:33 AM	Project: F:\PROJECT\TBC PROJECTS\2-Normal to CORS.vce	Trimble Business Center

Appendix E - Scenario Three

Project File Data		Coordinate System	
Name:	F:\PROJECT\TBC PROJECTS\3 - External Baselines Only.vce	Name:	Map Grid of Australia (GDA)
Size:	4 MB	Datum:	ITRF
Modified:	17/09/2016 9:14:19 AM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.001 m

Centering Error: 0.001 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	1.07
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	70

Post Processed Vector Statistics

Reference Factor:	1.05
Redundancy Number:	69.03
A Priori Scalar:	1.00

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	-0.010	-0.009	-0.028	?
107142	-0.013	0.003	-0.001	?
121890	-0.013	-0.016	-0.030	?
58886	-0.009	0.000	-0.058	?
59279	-0.001	-0.004	0.052	?
61261	0.006	0.008	-0.065	?
90501	0.003	0.014	-0.056	?
BDST	0.000	0.000	?	-0.011
WOOL	0.000	0.000	?	0.011

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
BDST	Global	0.003	0.003	0.009	
WOOL	Global	0.003	0.003	0.009	
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.227	0.005	6940700.739	0.005	59.919	0.016	
107142	495042.674	0.008	6924708.250	0.007	39.079	0.029	

121890	502287.564	0.006	6944569.182	0.006	34.404	0.017	
171104	492752.693	0.006	6920798.308	0.006	41.647	0.023	
58886	496932.705	0.005	6931847.772	0.005	76.079	0.017	
59279	502887.365	0.006	6946191.533	0.006	17.954	0.018	
61261	492475.278	0.006	6917933.875	0.006	52.986	0.019	
8000	502423.611	0.006	6945838.206	0.006	11.846	0.016	
8001	501308.672	0.005	6942562.868	0.005	28.051	0.016	
8002	501571.885	0.006	6941988.929	0.006	37.560	0.020	
8003	501907.496	0.005	6940745.700	0.005	59.925	0.018	
8004	501861.007	0.005	6939961.342	0.005	62.013	0.016	
8005	501804.651	0.005	6938616.219	0.005	64.979	0.016	
8006	500762.575	0.005	6936689.199	0.005	65.621	0.016	
8007	499839.104	0.006	6935557.952	0.005	52.948	0.020	
8008	498807.073	0.005	6933940.083	0.005	71.131	0.018	
8009	498376.235	0.005	6933017.091	0.005	69.754	0.017	
8010	497877.116	0.005	6931994.930	0.005	70.244	0.016	
8011	497216.885	0.005	6931644.584	0.005	54.182	0.017	
8012	496661.134	0.006	6929507.605	0.005	56.508	0.018	
8013	497045.763	0.006	6928821.410	0.006	58.098	0.022	
8014	495976.160	0.006	6926491.855	0.005	47.873	0.019	
8015	494336.493	0.006	6922279.538	0.006	60.148	0.021	
90501	499169.735	0.006	6933677.852	0.005	57.049	0.018	
BDST	499515.927	?	6904226.324	?	60.712	?	LLh

WOOL	503483.973	?	6959847.629	?	49.237	?	LLh

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17824"	E153°01'15.01485"	101.301	0.016	
107142	S27°48'07.89946"	E152°56'58.82127"	79.991	0.029	
121890	S27°37'22.45263"	E153°01'23.46854"	75.868	0.017	
171104	S27°50'14.93152"	E152°55'35.04219"	82.435	0.023	
58886	S27°44'15.88999"	E152°58'07.96354"	117.211	0.017	
59279	S27°36'29.72199"	E153°01'45.34005"	59.448	0.018	
61261	S27°51'48.01708"	E152°55'24.83478"	93.678	0.019	
8000	S27°36'41.20841"	E153°01'28.42342"	53.334	0.016	
8001	S27°38'27.66254"	E153°00'47.75865"	69.476	0.016	
8002	S27°38'46.31453"	E153°00'57.36703"	78.972	0.020	
8003	S27°39'26.71779"	E153°01'09.62250"	101.309	0.018	
8004	S27°39'52.20954"	E153°01'07.93005"	103.379	0.016	
8005	S27°40'35.92608"	E153°01'05.88022"	106.306	0.016	
8006	S27°41'38.55734"	E153°00'27.84282"	106.890	0.016	
8007	S27°42'15.32327"	E152°59'54.12490"	94.183	0.020	
8008	S27°43'07.90154"	E152°59'16.43449"	112.316	0.018	
8009	S27°43'37.89676"	E152°59'00.69583"	110.912	0.017	
8010	S27°44'11.11402"	E152°58'42.46018"	111.373	0.016	
8011	S27°44'22.49575"	E152°58'18.34183"	95.305	0.017	
8012	S27°45'31.94181"	E152°57'58.02057"	97.571	0.018	
8013	S27°45'54.24598"	E152°58'12.06618"	99.137	0.022	
8014	S27°47'09.94495"	E152°57'32.95970"	88.842	0.019	
8015	S27°49'26.82043"	E152°56'32.97044"	100.983	0.021	
90501	S27°43'16.42492"	E152°59'29.67820"	98.224	0.018	
BDST	S27°59'13.56952"	E152°59'42.27818"	101.107	?	LLh
WOOL	S27°29'05.88837"	E153°02'06.96433"	91.043	?	LLh

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.457	0.013	2564808.216	0.008	-2943019.339	0.009	0.018	
107142	-5028412.364	0.023	2567670.102	0.014	-2957170.293	0.014	0.031	
121890	-5039933.545	0.014	2565405.954	0.008	-2939579.120	0.009	0.018	
171104	-5025745.976	0.019	2568882.677	0.011	-2960629.865	0.012	0.025	
58886	-5032266.183	0.014	2567511.635	0.009	-2950868.334	0.009	0.019	
59279	-5040863.131	0.014	2565206.161	0.009	-2938133.277	0.010	0.019	
61261	-5024435.774	0.015	2568526.589	0.010	-2963168.661	0.010	0.021	
8000	-5040501.869	0.013	2565542.787	0.008	-2938443.752	0.009	0.018	
8001	-5038654.695	0.013	2565853.438	0.008	-2941354.499	0.009	0.018	
8002	-5038544.325	0.016	2565501.667	0.010	-2941867.511	0.010	0.021	
8003	-5038200.007	0.015	2564949.400	0.009	-2942979.524	0.010	0.020	
8004	-5037855.961	0.013	2564826.296	0.008	-2943675.494	0.009	0.018	
8005	-5037275.881	0.013	2564594.007	0.008	-2944868.641	0.009	0.017	
8006	-5036005.146	0.013	2565116.571	0.008	-2946576.122	0.009	0.018	
8007	-5035107.016	0.016	2565695.818	0.010	-2947572.259	0.011	0.022	
8008	-5033981.883	0.015	2566281.294	0.009	-2949013.536	0.010	0.020	
8009	-5033402.289	0.014	2566469.719	0.008	-2949830.219	0.009	0.018	
8010	-5032751.866	0.013	2566698.720	0.008	-2950735.494	0.009	0.018	
8011	-5032293.784	0.014	2567206.612	0.009	-2951038.112	0.009	0.019	
8012	-5031156.046	0.014	2567250.899	0.009	-2952931.041	0.010	0.019	
8013	-5031047.210	0.018	2566763.587	0.011	-2953539.319	0.011	0.023	
8014	-5029585.171	0.016	2567219.575	0.009	-2955596.247	0.010	0.021	
8015	-5027097.586	0.017	2567793.103	0.010	-2959328.834	0.011	0.022	
90501	-5034026.801	0.015	2565896.984	0.009	-2949239.240	0.010	0.020	
BDST	-5021920.620	?	2559339.874	?	-2975290.672	?	?	LLh
WOOL	-5046788.330	?	2567555.318	?	-2926034.796	?	?	LLh

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.007	0.007	47°
107142	0.010	0.008	90°
121890	0.007	0.007	62°
171104	0.007	0.007	95°
58886	0.007	0.007	62°

59279	0.007	0.007	76°
61261	0.008	0.008	40°
8000	0.007	0.007	68°
8001	0.007	0.007	67°
8002	0.007	0.007	69°
8003	0.007	0.007	42°
8004	0.007	0.007	74°
8005	0.007	0.007	55°
8006	0.007	0.006	32°
8007	0.007	0.007	73°
8008	0.007	0.007	36°
8009	0.007	0.007	72°
8010	0.007	0.006	66°
8011	0.007	0.007	57°
8012	0.007	0.007	60°
8013	0.008	0.007	45°
8014	0.007	0.007	60°
8015	0.007	0.007	22°
90501	0.007	0.007	77°

Adjusted GNSS Observations

Transformation Parameters

Azimuth Rotation: 0.028 sec **(95%)** 0.033 sec

Scale Factor: 1.00000004 **(95%)** 0.00000016

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
BDST --> 59279 (PV673)	**Az.**	4°35'44"	0.015 sec	0.001 sec	0.097
	ΔHt.	-41.659 m	0.012 m	0.019 m	4.080
	Ellip Dist.	42117.263 m	0.003 m	-0.004 m	-2.886
WOOL --> 59279 (PV672)	**Az.**	182°29'07"	0.048 sec	-0.002 sec	-0.071
	ΔHt.	-31.595 m	0.012 m	-0.028 m	-4.027
	Ellip Dist.	13674.590 m	0.003 m	-0.004 m	-2.817
WOOL --> 121890 (PV679)	**Az.**	184°27'40"	0.038 sec	-0.025 sec	-1.230
	ΔHt.	-15.175 m	0.010 m	0.004 m	0.728
	Ellip Dist.	15331.348 m	0.003 m	-0.004 m	-2.898

BDST --> 121890 (PV680)	**Az.**	3°55'57"	0.014 sec	-0.008 sec	-1.238
	ΔHt.	-25.239 m	0.010 m	-0.003 m	-0.650
	Ellip Dist.	40454.134 m	0.003 m	-0.004 m	-2.855
BDST --> 171104 (PV760)	**Az.**	337°48'05"	0.039 sec	0.025 sec	1.262
	ΔHt.	-18.672 m	0.019 m	-0.019 m	-2.077
	Ellip Dist.	17906.095 m	0.003 m	0.001 m	0.469
WOOL --> 171104 (PV759)	**Az.**	195°21'00"	0.017 sec	0.005 sec	0.583
	ΔHt.	-8.608 m	0.019 m	0.021 m	2.073
	Ellip Dist.	40513.232 m	0.003 m	0.002 m	1.248
WOOL --> 8006 (PV711)	**Az.**	186°41'09"	0.024 sec	0.008 sec	0.685
	ΔHt.	15.846 m	0.009 m	0.001 m	0.144
	Ellip Dist.	23327.108 m	0.003 m	0.003 m	2.011
WOOL --> 8005 (PV707)	**Az.**	184°30'22"	0.026 sec	0.011 sec	0.857
	ΔHt.	15.263 m	0.009 m	0.002 m	0.488
	Ellip Dist.	21306.239 m	0.003 m	0.003 m	1.975
BDST --> 8005 (PV708)	**Az.**	3°48'36"	0.016 sec	0.006 sec	0.864
	ΔHt.	5.199 m	0.009 m	-0.002 m	-0.485
	Ellip Dist.	34479.761 m	0.003 m	0.002 m	1.967
BDST --> 8006 (PV712)	**Az.**	2°12'05"	0.017 sec	0.007 sec	0.825
	ΔHt.	5.783 m	0.009 m	-0.001 m	-0.136
	Ellip Dist.	32499.801 m	0.003 m	0.003 m	1.955
WOOL --> 8004 (PV704)	**Az.**	184°38'58"	0.030 sec	0.015 sec	0.993
	ΔHt.	12.335 m	0.010 m	0.002 m	0.483
	Ellip Dist.	19960.385 m	0.003 m	0.002 m	1.833
BDST --> 8004 (PV705)	**Az.**	3°45'25"	0.016 sec	0.008 sec	0.996
	ΔHt.	2.272 m	0.009 m	-0.002 m	-0.490
	Ellip Dist.	35826.211 m	0.003 m	0.002 m	1.812
BDST --> 61261 (PV764)	**Az.**	332°48'57"	0.047 sec	-0.035 sec	-1.343
	ΔHt.	-7.429 m	0.014 m	0.001 m	0.130
	Ellip Dist.	15416.148 m	0.003 m	-0.001 m	-0.434
WOOL --> 8000 (PV675)	**Az.**	184°18'44"	0.041 sec	-0.020 sec	-0.887
	ΔHt.	-37.709 m	0.010 m	-0.003 m	-0.614
	Ellip Dist.	14055.114 m	0.003 m	-0.002 m	-1.337
BDST --> 8000 (PV676)	**Az.**	3°59'58"	0.014 sec	-0.005 sec	-0.860
	ΔHt.	-47.773 m	0.009 m	0.002 m	0.604

	Ellip Dist.	41730.037 m	0.003 m	-0.002 m	-1.327
WOOL --> 61261 (PV763)	**Az.**	194°42'01"	0.015 sec	-0.006 sec	-0.794
	ΔHt.	2.635 m	0.014 m	-0.001 m	-0.139
	Ellip Dist.	43352.700 m	0.003 m	-0.002 m	-1.189
BDST --> 8014 (PV751)	**Az.**	350°58'08"	0.029 sec	0.015 sec	1.017
	ΔHt.	-12.265 m	0.014 m	-0.007 m	-0.976
	Ellip Dist.	22554.169 m	0.003 m	0.001 m	0.692
WOOL --> 8014 (PV750)	**Az.**	192°40'07"	0.019 sec	0.006 sec	0.709
	ΔHt.	-2.201 m	0.014 m	0.007 m	0.963
	Ellip Dist.	34203.953 m	0.003 m	0.001 m	1.009
BDST --> 8002 (PV694)	**Az.**	3°07'07"	0.018 sec	0.004 sec	0.491
	ΔHt.	-22.135 m	0.015 m	0.005 m	0.906
	Ellip Dist.	37833.662 m	0.003 m	0.001 m	0.397
WOOL --> 8002 (PV693)	**Az.**	186°05'42"	0.038 sec	0.009 sec	0.455
	ΔHt.	-12.071 m	0.015 m	-0.008 m	-0.903
	Ellip Dist.	17967.954 m	0.003 m	0.001 m	0.442
BDST --> 107142 (PV749)	**Az.**	347°40'56"	0.064 sec	-0.022 sec	-0.742
	ΔHt.	-21.116 m	0.026 m	0.010 m	0.737
	Ellip Dist.	20973.101 m	0.005 m	0.002 m	0.869
WOOL --> 8012 (PV737)	**Az.**	192°39'27"	0.021 sec	-0.005 sec	-0.486
	ΔHt.	6.528 m	0.012 m	0.001 m	0.123
	Ellip Dist.	31110.160 m	0.003 m	-0.001 m	-0.827
WOOL --> 107142 (PV748)	**Az.**	193°29'30"	0.037 sec	-0.016 sec	-0.780
	ΔHt.	-11.052 m	0.026 m	-0.009 m	-0.687
	Ellip Dist.	36153.514 m	0.005 m	0.001 m	0.330
BDST --> 8010 (PV730)	**Az.**	356°37'29"	0.021 sec	-0.004 sec	-0.442
	ΔHt.	10.266 m	0.009 m	0.002 m	0.453
	Ellip Dist.	27828.051 m	0.003 m	0.001 m	0.727
BDST --> 8012 (PV738)	**Az.**	353°33'35"	0.026 sec	-0.009 sec	-0.708
	ΔHt.	-3.536 m	0.012 m	-0.001 m	-0.121
	Ellip Dist.	25452.132 m	0.003 m	-0.001 m	-0.640
WOOL --> 8008 (PV713)	**Az.**	190°13'00"	0.023 sec	0.006 sec	0.507
	ΔHt.	21.273 m	0.013 m	-0.004 m	-0.589
	Ellip Dist.	26336.837 m	0.003 m	0.001 m	0.702
WOOL --> 58886 (PV746)	**Az.**	193°09'09"	0.022 sec	0.000 sec	-0.002

	ΔHt.	26.167 m	0.011 m	0.001 m	0.155
	Ellip Dist.	28767.566 m	0.003 m	-0.001 m	-0.694
BDST --> 58886 (PV747)	**Az.**	354°39'34"	0.023 sec	-0.002 sec	-0.216
	ΔHt.	16.104 m	0.011 m	-0.001 m	-0.147
	Ellip Dist.	27753.078 m	0.003 m	-0.001 m	-0.679
WOOL --> 8013 (PV734)	**Az.**	191°42'24"	0.025 sec	0.000 sec	-0.022
	ΔHt.	8.094 m	0.018 m	-0.002 m	-0.198
	Ellip Dist.	31699.848 m	0.004 m	-0.001 m	-0.658
BDST --> 8013 (PV735)	**Az.**	354°16'02"	0.033 sec	-0.004 sec	-0.224
	ΔHt.	-1.970 m	0.018 m	0.002 m	0.199
	Ellip Dist.	24728.707 m	0.004 m	-0.001 m	-0.631
BDST --> 8008 (PV714)	**Az.**	358°38'09"	0.021 sec	0.006 sec	0.627
	ΔHt.	11.209 m	0.013 m	0.003 m	0.567
	Ellip Dist.	29734.104 m	0.003 m	0.001 m	0.575
WOOL --> 8010 (PV729)	**Az.**	191°21'56"	0.021 sec	-0.006 sec	-0.614
	ΔHt.	20.330 m	0.010 m	-0.002 m	-0.448
	Ellip Dist.	28422.802 m	0.003 m	0.001 m	0.578
BDST --> 8007 (PV762)	**Az.**	0°35'36"	0.023 sec	-0.007 sec	-0.591
	ΔHt.	-6.924 m	0.016 m	0.002 m	0.271
	Ellip Dist.	31345.831 m	0.003 m	-0.001 m	-0.408
WOOL --> 8007 (PV761)	**Az.**	188°31'04"	0.030 sec	-0.008 sec	-0.551
	ΔHt.	3.140 m	0.016 m	-0.002 m	-0.284
	Ellip Dist.	24571.452 m	0.003 m	-0.001 m	-0.497
BDST --> 8009 (PV726)	**Az.**	357°44'07"	0.022 sec	0.000 sec	-0.003
	ΔHt.	9.805 m	0.010 m	-0.003 m	-0.545
	Ellip Dist.	28824.844 m	0.003 m	0.001 m	0.462
WOOL --> 8009 (PV725)	**Az.**	190°45'44"	0.023 sec	-0.001 sec	-0.100
	ΔHt.	19.869 m	0.010 m	0.003 m	0.537
	Ellip Dist.	27323.319 m	0.003 m	0.001 m	0.434
WOOL --> 8011 (PV741)	**Az.**	192°30'43"	0.022 sec	0.000 sec	-0.042
	ΔHt.	4.262 m	0.012 m	0.001 m	0.183
	Ellip Dist.	28902.528 m	0.003 m	-0.001 m	-0.514
BDST --> 8011 (PV742)	**Az.**	355°12'33"	0.024 sec	-0.002 sec	-0.190
	ΔHt.	-5.802 m	0.012 m	-0.001 m	-0.186
	Ellip Dist.	27525.487 m	0.003 m	-0.001 m	-0.496

BDST --> 90501 (PV723)	**Az.**	359°19'44"	0.023 sec	-0.001 sec	-0.079
	ΔHt.	-2.883 m	0.013 m	0.000 m	0.031
	Ellip Dist.	29465.347 m	0.003 m	0.001 m	0.386
WOOL --> 90501 (PV722)	**Az.**	189°20'42"	0.025 sec	-0.002 sec	-0.139
	ΔHt.	7.181 m	0.013 m	0.000 m	-0.029
	Ellip Dist.	26533.618 m	0.003 m	0.001 m	0.360
BDST --> 8001 (PV691)	**Az.**	2°40'47"	0.015 sec	0.001 sec	0.163
	ΔHt.	-31.631 m	0.009 m	0.001 m	0.319
	Ellip Dist.	38393.794 m	0.003 m	0.000 m	0.112
WOOL --> 8001 (PV690)	**Az.**	187°09'24"	0.033 sec	0.003 sec	0.147
	ΔHt.	-21.567 m	0.009 m	-0.002 m	-0.317
	Ellip Dist.	17428.073 m	0.003 m	0.000 m	0.131
BDST --> 8003 (PV703)	**Az.**	3°44'57"	0.016 sec	-0.001 sec	-0.156
	ΔHt.	0.202 m	0.013 m	-0.002 m	-0.301
	Ellip Dist.	36612.244 m	0.003 m	0.000 m	-0.174
WOOL --> 8003 (PV702)	**Az.**	184°42'06"	0.030 sec	-0.002 sec	-0.149
	ΔHt.	10.266 m	0.013 m	0.002 m	0.295
	Ellip Dist.	19174.538 m	0.003 m	0.000 m	-0.173
WOOL --> 8015 (PV753)	**Az.**	193°40'06"	0.017 sec	-0.002 sec	-0.268
	ΔHt.	9.940 m	0.016 m	-0.001 m	-0.204
	Ellip Dist.	38681.185 m	0.003 m	0.000 m	-0.069
BDST --> 8015 (PV754)	**Az.**	343°59'39"	0.036 sec	-0.005 sec	-0.262
	ΔHt.	-0.124 m	0.016 m	0.002 m	0.209
	Ellip Dist.	18789.021 m	0.003 m	0.000 m	0.064
WOOL --> 101732 (PV697)	**Az.**	184°15'04"	0.030 sec	-0.004 sec	-0.241
	ΔHt.	10.258 m	0.010 m	0.000 m	-0.067
	Ellip Dist.	19207.803 m	0.003 m	0.000 m	-0.017
BDST --> 101732 (PV698)	**Az.**	3°59'05"	0.015 sec	-0.002 sec	-0.241
	ΔHt.	0.194 m	0.010 m	0.000 m	0.068
	Ellip Dist.	36577.328 m	0.003 m	0.000 m	-0.016

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision	3D Precision

					(PPM)	(PPM)
101732	BDST	**Az.**	183°58'22"	0.036 sec	0.175	0.175
		ΔHt.	-0.194 m	0.010 m		
		ΔElev.	0.794 m	0.010 m		
		Ellip Dist.	36577.330 m	0.006 m		
101732	WOOL	**Az.**	4°15'28"	0.044 sec	0.212	0.212
		ΔHt.	-10.258 m	0.010 m		
		ΔElev.	-10.682 m	0.010 m		
		Ellip Dist.	19207.804 m	0.004 m		
107142	BDST	**Az.**	167°42'13"	0.072 sec	0.280	0.280
		ΔHt.	21.116 m	0.026 m		
		ΔElev.	21.634 m	0.026 m		
		Ellip Dist.	20973.102 m	0.006 m		
107142	WOOL	**Az.**	13°31'53"	0.049 sec	0.209	0.209
		ΔHt.	11.052 m	0.026 m		
		ΔElev.	10.158 m	0.026 m		
		Ellip Dist.	36153.515 m	0.008 m		
121890	BDST	**Az.**	183°55'10"	0.036 sec	0.173	0.173
		ΔHt.	25.239 m	0.010 m		
		ΔElev.	26.308 m	0.010 m		
		Ellip Dist.	40454.135 m	0.007 m		
121890	WOOL	**Az.**	4°28'00"	0.050 sec	0.239	0.239
		ΔHt.	15.175 m	0.010 m		
		ΔElev.	14.833 m	0.010 m		
		Ellip Dist.	15331.349 m	0.004 m		
58886	BDST	**Az.**	174°40'18"	0.040 sec	0.189	0.189
		ΔHt.	-16.104 m	0.011 m		
		ΔElev.	-15.366 m	0.011 m		
		Ellip Dist.	27753.080 m	0.005 m		
58886	WOOL	**Az.**	13°11'00"	0.039 sec	0.189	0.189
		ΔHt.	-26.167 m	0.011 m		
		ΔElev.	-26.842 m	0.011 m		
		Ellip Dist.	28767.567 m	0.005 m		
59279	BDST	**Az.**	184°34'47"	0.036 sec	0.173	0.173
		ΔHt.	41.659 m	0.012 m		
		ΔElev.	42.758 m	0.012 m		
		Ellip Dist.	42117.265 m	0.007 m		
59279	WOOL	**Az.**	2°29'17"	0.057 sec	0.262	0.262

		ΔHt.	31.595 m	0.012 m		
		ΔElev.	31.283 m	0.012 m		
		Ellip Dist.	13674.590 m	0.004 m		
61261	BDST	**Az.**	152°50'57"	0.057 sec	0.262	0.262
		ΔHt.	7.429 m	0.014 m		
		ΔElev.	7.726 m	0.014 m		
		Ellip Dist.	15416.149 m	0.004 m		
61261	WOOL	**Az.**	14°45'07"	0.036 sec	0.178	0.178
		ΔHt.	-2.635 m	0.014 m		
		ΔElev.	-3.749 m	0.014 m		
		Ellip Dist.	43352.702 m	0.008 m		
90501	BDST	**Az.**	179°19'50"	0.040 sec	0.187	0.187
		ΔHt.	2.883 m	0.013 m		
		ΔElev.	3.663 m	0.013 m		
		Ellip Dist.	29465.348 m	0.006 m		
90501	WOOL	**Az.**	9°21'55"	0.041 sec	0.194	0.194
		ΔHt.	-7.181 m	0.013 m		
		ΔElev.	-7.812 m	0.013 m		
		Ellip Dist.	26533.619 m	0.005 m		
BDST	171104	**Az.**	337°48'05"	0.051 sec	0.244	0.244
		ΔHt.	-18.672 m	0.019 m		
		ΔElev.	-19.065 m	0.019 m		
		Ellip Dist.	17906.096 m	0.004 m		
BDST	8000	**Az.**	3°59'58"	0.036 sec	0.171	0.171
		ΔHt.	-47.773 m	0.009 m		
		ΔElev.	-48.866 m	0.009 m		
		Ellip Dist.	41730.038 m	0.007 m		
BDST	8001	**Az.**	2°40'47"	0.036 sec	0.173	0.173
		ΔHt.	-31.631 m	0.009 m		
		ΔElev.	-32.661 m	0.009 m		
		Ellip Dist.	38393.796 m	0.007 m		
BDST	8002	**Az.**	3°07'07"	0.037 sec	0.178	0.178
		ΔHt.	-22.135 m	0.015 m		
		ΔElev.	-23.153 m	0.015 m		
		Ellip Dist.	37833.664 m	0.007 m		
BDST	8003	**Az.**	3°44'57"	0.036 sec	0.176	0.176
		ΔHt.	0.202 m	0.013 m		
		ΔElev.	-0.787 m	0.013 m		

		Ellip Dist.	36612.246 m	0.006 m		
BDST	8004	**Az.**	3°45'25"	0.037 sec	0.175	0.175
		ΔHt.	2.272 m	0.009 m		
		ΔElev.	1.301 m	0.009 m		
		Ellip Dist.	35826.212 m	0.006 m		
BDST	8005	**Az.**	3°48'36"	0.036 sec	0.176	0.176
		ΔHt.	5.199 m	0.009 m		
		ΔElev.	4.266 m	0.009 m		
		Ellip Dist.	34479.762 m	0.006 m		
BDST	8006	**Az.**	2°12'05"	0.037 sec	0.179	0.179
		ΔHt.	5.783 m	0.009 m		
		ΔElev.	4.909 m	0.009 m		
		Ellip Dist.	32499.803 m	0.006 m		
BDST	8007	**Az.**	0°35'36"	0.040 sec	0.189	0.189
		ΔHt.	-6.924 m	0.016 m		
		ΔElev.	-7.764 m	0.016 m		
		Ellip Dist.	31345.832 m	0.006 m		
BDST	8008	**Az.**	358°38'09"	0.039 sec	0.187	0.187
		ΔHt.	11.209 m	0.013 m		
		ΔElev.	10.418 m	0.013 m		
		Ellip Dist.	29734.106 m	0.006 m		
BDST	8009	**Az.**	357°44'07"	0.039 sec	0.185	0.185
		ΔHt.	9.805 m	0.010 m		
		ΔElev.	9.042 m	0.010 m		
		Ellip Dist.	28824.845 m	0.005 m		
BDST	8010	**Az.**	356°37'29"	0.039 sec	0.186	0.186
		ΔHt.	10.266 m	0.009 m		
		ΔElev.	9.531 m	0.009 m		
		Ellip Dist.	27828.053 m	0.005 m		
BDST	8011	**Az.**	355°12'33"	0.040 sec	0.191	0.191
		ΔHt.	-5.802 m	0.012 m		
		ΔElev.	-6.531 m	0.012 m		
		Ellip Dist.	27525.488 m	0.005 m		
BDST	8012	**Az.**	353°33'35"	0.042 sec	0.198	0.198
		ΔHt.	-3.536 m	0.012 m		
		ΔElev.	-4.205 m	0.012 m		
		Ellip Dist.	25452.133 m	0.005 m		
BDST	8013	**Az.**	354°16'02"	0.046 sec	0.222	0.222

		ΔHt.	-1.970 m	0.018 m		
		ΔElev.	-2.614 m	0.018 m		
		Ellip Dist.	24728.708 m	0.005 m		
BDST	8014	**Az.**	350°58'08"	0.043 sec	0.206	0.206
		ΔHt.	-12.265 m	0.014 m		
		ΔElev.	-12.840 m	0.014 m		
		Ellip Dist.	22554.170 m	0.005 m		
BDST	8015	**Az.**	343°59'39"	0.049 sec	0.239	0.239
		ΔHt.	-0.124 m	0.016 m		
		ΔElev.	-0.564 m	0.016 m		
		Ellip Dist.	18789.022 m	0.004 m		
WOOL	171104	**Az.**	195°21'00"	0.037 sec	0.179	0.179
		ΔHt.	-8.608 m	0.019 m		
		ΔElev.	-7.590 m	0.019 m		
		Ellip Dist.	40513.233 m	0.007 m		
WOOL	8000	**Az.**	184°18'44"	0.052 sec	0.247	0.247
		ΔHt.	-37.709 m	0.010 m		
		ΔElev.	-37.391 m	0.010 m		
		Ellip Dist.	14055.114 m	0.003 m		
WOOL	8001	**Az.**	187°09'24"	0.046 sec	0.220	0.220
		ΔHt.	-21.567 m	0.009 m		
		ΔElev.	-21.186 m	0.009 m		
		Ellip Dist.	17428.074 m	0.004 m		
WOOL	8002	**Az.**	186°05'42"	0.050 sec	0.232	0.232
		ΔHt.	-12.071 m	0.015 m		
		ΔElev.	-11.677 m	0.015 m		
		Ellip Dist.	17967.955 m	0.004 m		
WOOL	8003	**Az.**	184°42'06"	0.044 sec	0.215	0.215
		ΔHt.	10.266 m	0.013 m		
		ΔElev.	10.688 m	0.013 m		
		Ellip Dist.	19174.539 m	0.004 m		
WOOL	8004	**Az.**	184°38'58"	0.044 sec	0.207	0.207
		ΔHt.	12.335 m	0.010 m		
		ΔElev.	12.776 m	0.010 m		
		Ellip Dist.	19960.386 m	0.004 m		
WOOL	8005	**Az.**	184°30'22"	0.042 sec	0.201	0.201
		ΔHt.	15.263 m	0.009 m		
		ΔElev.	15.742 m	0.009 m		

		Ellip Dist.	21306.240 m	0.004 m		
WOOL	8006	**Az.**	186°41'09"	0.040 sec	0.196	0.196
		ΔHt.	15.846 m	0.009 m		
		ΔElev.	16.384 m	0.009 m		
		Ellip Dist.	23327.109 m	0.005 m		
WOOL	8007	**Az.**	188°31'04"	0.044 sec	0.206	0.206
		ΔHt.	3.140 m	0.016 m		
		ΔElev.	3.711 m	0.016 m		
		Ellip Dist.	24571.453 m	0.005 m		
WOOL	8008	**Az.**	190°13'00"	0.040 sec	0.195	0.195
		ΔHt.	21.273 m	0.013 m		
		ΔElev.	21.894 m	0.013 m		
		Ellip Dist.	26336.839 m	0.005 m		
WOOL	8009	**Az.**	190°45'44"	0.040 sec	0.189	0.189
		ΔHt.	19.869 m	0.010 m		
		ΔElev.	20.517 m	0.010 m		
		Ellip Dist.	27323.320 m	0.005 m		
WOOL	8010	**Az.**	191°21'56"	0.038 sec	0.185	0.185
		ΔHt.	20.330 m	0.010 m		
		ΔElev.	21.007 m	0.010 m		
		Ellip Dist.	28422.804 m	0.005 m		
WOOL	8011	**Az.**	192°30'43"	0.039 sec	0.190	0.190
		ΔHt.	4.262 m	0.012 m		
		ΔElev.	4.945 m	0.012 m		
		Ellip Dist.	28902.530 m	0.005 m		
WOOL	8012	**Az.**	192°39'27"	0.039 sec	0.187	0.187
		ΔHt.	6.528 m	0.012 m		
		ΔElev.	7.271 m	0.012 m		
		Ellip Dist.	31110.162 m	0.006 m		
WOOL	8013	**Az.**	191°42'24"	0.041 sec	0.201	0.201
		ΔHt.	8.094 m	0.018 m		
		ΔElev.	8.861 m	0.018 m		
		Ellip Dist.	31699.849 m	0.006 m		
WOOL	8014	**Az.**	192°40'07"	0.038 sec	0.182	0.182
		ΔHt.	-2.201 m	0.014 m		
		ΔElev.	-1.364 m	0.014 m		
		Ellip Dist.	34203.954 m	0.006 m		
WOOL	8015	**Az.**	193°40'06"	0.037 sec	0.183	0.183

		ΔHt.	9.940 m	0.016 m
		ΔElev.	10.911 m	0.016 m
		Ellip Dist.	38681.187 m	0.007 m

Date: 17/09/2016 10:25:27 AM	Project: F:\PROJECT\TBC PROJECTS\3 - External Baselines Only.vce	Trimble Business Center

Appendix E - Scenario Four

Project File Data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\4 - Single Baseline Trav.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	3/09/2016 4:50:18 PM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.00100 m

Centering Error: 0.00100 m

Covariance Display

Horizontal:

Propagated Linear Error [E]:	U.S.
Constant Term [C]:	0.00000 m
Scale on Linear Error [S]:	1.960

Three-Dimensional

Propagated Linear Error [E]:	U.S.
Constant Term [C]:	0.00000 m
Scale on Linear Error [S]:	1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	1.08
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	1

Post Processed Vector Statistics

Reference Factor:	1.08
Redundancy Number:	0.97
A Priori Scalar:	2.57

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	-0.00278	-0.00029	-0.03562	?
107142	-0.01967	-0.00182	0.02408	?
121890	-0.00431	0.00393	-0.04417	?
58886	-0.01499	0.00317	-0.04207	?
59279	0.00000	0.00000	0.00155	?
61261	0.00000	0.00000	-0.00128	?
90501	0.00043	0.02609	-0.05740	?

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
59279	Grid	0.00500	0.00500		0.01100
61261	Grid	0.00400	0.00400		0.01000
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.220	0.02105	6940700.730	0.02119	59.927	0.04803	
107142	495042.681	0.02061	6924708.255	0.02177	39.054	0.08924	
121890	502287.555	0.01550	6944569.162	0.01545	34.418	0.02923	

171104	492752.692	0.01383	6920798.310	0.01421	41.620	0.06145	
58886	496932.711	0.02478	6931847.769	0.02557	76.063	0.06510	
59279	502887.364	?	6946191.529	?	18.004	?	ENe
61261	492475.284	?	6917933.883	?	52.922	?	ENe
8000	502423.603	0.01345	6945838.207	0.01327	11.927	0.02582	
8001	501308.667	0.01723	6942562.859	0.01734	28.112	0.04375	
8002	501571.878	0.01860	6941988.925	0.01871	37.582	0.04499	
8003	501907.486	0.02004	6940745.691	0.02018	59.976	0.04727	
8004	501861.001	0.02199	6939961.331	0.02211	62.029	0.04920	
8005	501804.654	0.02279	6938616.204	0.02295	64.976	0.05058	
8006	500762.565	0.02338	6936689.188	0.02376	65.610	0.05812	
8007	499839.106	0.02398	6935557.949	0.02452	52.962	0.05970	
8008	498807.076	0.02440	6933940.073	0.02505	71.116	0.06172	
8009	498376.238	0.02476	6933017.079	0.02545	69.790	0.06334	
8010	497877.117	0.02484	6931994.920	0.02556	70.231	0.06400	
8011	497216.893	0.02481	6931644.578	0.02558	54.168	0.06464	
8012	496661.146	0.02451	6929507.597	0.02536	56.496	0.07008	
8013	497045.772	0.02421	6928821.410	0.02505	58.089	0.07091	
8014	495976.161	0.02309	6926491.854	0.02408	47.840	0.08319	
8015	494336.497	0.01693	6922279.540	0.01712	60.077	0.07425	
90501	499169.738	0.02464	6933677.840	0.02528	57.050	0.06256	

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17852"	E153°01'15.01460"	101.309	0.04803	
107142	S27°48'07.89932"	E152°56'58.82152"	79.966	0.08924	
121890	S27°37'22.45329"	E153°01'23.46823"	75.882	0.02923	
171104	S27°50'14.93145"	E152°55'35.04216"	82.408	0.06145	
58886	S27°44'15.89011"	E152°58'07.96375"	117.195	0.06510	
59279	S27°36'29.72210"	E153°01'45.34001"	59.498	?	ENe
61261	S27°51'48.01681"	E152°55'24.83500"	93.614	?	ENe
8000	S27°36'41.20839"	E153°01'28.42315"	53.415	0.02582	
8001	S27°38'27.66284"	E153°00'47.75845"	69.537	0.04375	
8002	S27°38'46.31465"	E153°00'57.36676"	78.994	0.04499	
8003	S27°39'26.71810"	E153°01'09.62213"	101.359	0.04727	
8004	S27°39'52.20992"	E153°01'07.92984"	103.394	0.04920	
8005	S27°40'35.92660"	E153°01'05.88035"	106.303	0.05058	
8006	S27°41'38.55770"	E153°00'27.84246"	106.878	0.05812	
8007	S27°42'15.32335"	E152°59'54.12497"	94.197	0.05970	
8008	S27°43'07.90187"	E152°59'16.43460"	112.301	0.06172	
8009	S27°43'37.89714"	E152°59'00.69596"	110.949	0.06334	
8010	S27°44'11.11433"	E152°58'42.46020"	111.360	0.06400	
8011	S27°44'22.49594"	E152°58'18.34212"	95.291	0.06464	
8012	S27°45'31.94208"	E152°57'58.02099"	97.560	0.07008	
8013	S27°45'54.24598"	E152°58'12.06650"	99.128	0.07091	
8014	S27°47'09.94495"	E152°57'32.95970"	88.808	0.08319	
8015	S27°49'26.82039"	E152°56'32.97058"	100.912	0.07425	
90501	S27°43'16.42531"	E152°59'29.67828"	98.225	0.06256	

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.457	0.04055	2564808.223	0.02716	-2943019.350	0.02858	0.05656	
107142	-5028412.350	0.07226	2567670.087	0.04160	-2957170.277	0.04369	0.09414	
121890	-5039933.544	0.02523	2565405.963	0.01816	-2939579.144	0.01916	0.03651	

171104	-5025745.955	0.04968	2568882.667	0.02870	-2960629.851	0.02962	0.06457	
58886	-5032266.172	0.05421	2567511.623	0.03515	-2950868.330	0.03650	0.07420	
59279	-5040863.169	?	2565206.181	?	-2938133.304	?	?	ENe
61261	-5024435.730	?	2568526.559	?	-2963168.624	?	?	ENe
8000	-5040501.930	0.02204	2565542.827	0.01594	-2938443.789	0.01684	0.03199	
8001	-5038654.737	0.03643	2565853.465	0.02358	-2941354.535	0.02508	0.05012	
8002	-5038544.338	0.03766	2565501.681	0.02478	-2941867.525	0.02622	0.05215	
8003	-5038200.038	0.03977	2564949.427	0.02630	-2942979.556	0.02775	0.05516	
8004	-5037855.965	0.04158	2564826.305	0.02820	-2943675.511	0.02947	0.05825	
8005	-5037275.874	0.04277	2564593.999	0.02919	-2944868.654	0.03038	0.06003	
8006	-5036005.128	0.04847	2565116.573	0.03181	-2946576.127	0.03358	0.06700	
8007	-5035107.027	0.04992	2565695.821	0.03277	-2947572.268	0.03427	0.06885	
8008	-5033981.869	0.05158	2566281.284	0.03374	-2949013.538	0.03513	0.07094	
8009	-5033402.314	0.05286	2566469.728	0.03454	-2949830.246	0.03585	0.07261	
8010	-5032751.852	0.05337	2566698.712	0.03483	-2950735.496	0.03613	0.07326	
8011	-5032293.775	0.05386	2567206.598	0.03502	-2951038.111	0.03635	0.07381	
8012	-5031156.039	0.05790	2567250.882	0.03670	-2952931.043	0.03816	0.07846	
8013	-5031047.207	0.05847	2566763.575	0.03682	-2953539.315	0.03831	0.07901	
8014	-5029585.144	0.06778	2567219.561	0.04061	-2955596.232	0.04231	0.08963	
8015	-5027097.532	0.05987	2567793.071	0.03452	-2959328.800	0.03630	0.07806	
90501	-5034026.798	0.05225	2565896.980	0.03417	-2949239.251	0.03552	0.07183	

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.02659	0.02614	33°
107142	0.02722	0.02568	170°
121890	0.01947	0.01917	51°
171104	0.01800	0.01699	149°
58886	0.03193	0.03093	4°
8000	0.01680	0.01656	78°
8001	0.02179	0.02138	35°
8002	0.02349	0.02308	35°
8003	0.02533	0.02488	34°
8004	0.02775	0.02731	35°
8005	0.02878	0.02833	32°
8006	0.02975	0.02911	21°
8007	0.03068	0.02987	17°
8008	0.03130	0.03043	11°
8009	0.03178	0.03090	8°
8010	0.03191	0.03101	4°
8011	0.03194	0.03097	3°
8012	0.03166	0.03059	176°
8013	0.03129	0.03021	173°
8014	0.03013	0.02877	168°
8015	0.02152	0.02098	148°
90501	0.03159	0.03074	10°

Adjusted GNSS Observations

Transformation Parameters

Azimuth Rotation: -0.012 sec **(95%)** 0.341 sec

Scale Factor: 1.00000011 **(95%)** 0.00000169

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
8015 --> 171104 (PV105)	**Az.**	226°56'37"	1.022 sec	-0.007 sec	-1.000
	ΔHt.	-18.50424 m	0.04979 m	-0.00773 m	-1.000
	Ellip Dist.	2169.38611 m	0.01096 m	0.00001 m	1.294

121890 --> 8001 (PV12)	**Az.**	205°59'50"	0.833 sec	-0.003 sec	-1.000
	ΔHt.	-6.34506 m	0.03352 m	-0.00333 m	-1.000
	Ellip Dist.	2233.26279 m	0.00937 m	0.00003 m	1.036
8013 --> 8014 (PV99)	**Az.**	204°40'34"	1.070 sec	-0.011 sec	-1.000
	ΔHt.	-10.31986 m	0.05842 m	-0.01109 m	-1.000
	Ellip Dist.	2564.40163 m	0.01349 m	0.00015 m	1.030
58886 --> 8012 (PV83)	**Az.**	186°38'02"	0.852 sec	-0.004 sec	-1.000
	ΔHt.	-19.63517 m	0.03160 m	-0.00294 m	-1.000
	Ellip Dist.	2356.81802 m	0.00977 m	0.00004 m	1.029
107142 --> 8015 (PV102)	**Az.**	196°14'10"	1.222 sec	-0.025 sec	-1.000
	ΔHt.	20.94581 m	0.07751 m	-0.02291 m	-1.000
	Ellip Dist.	2530.30997 m	0.01662 m	0.00075 m	1.012
8014 --> 107142 (PV98)	**Az.**	207°38'43"	1.618 sec	-0.077 sec	-1.000
	ΔHt.	-8.84238 m	0.07277 m	-0.01913 m	-1.000
	Ellip Dist.	2013.91501 m	0.01533 m	0.00050 m	1.012
8002 --> 8003 (PV20)	**Az.**	164°53'09"	1.482 sec	0.006 sec	1.000
	ΔHt.	22.36529 m	0.01561 m	-0.00070 m	-1.000
	Ellip Dist.	1288.25144 m	0.00913 m	0.00002 m	1.006
101732 --> 8004 (PV48)	**Az.**	194°42'28"	2.323 sec	-0.006 sec	-1.000
	ΔHt.	2.08506 m	0.01160 m	-0.00039 m	-1.000
	Ellip Dist.	764.78739 m	0.00857 m	0.00001 m	1.006
8004 --> 8005 (PV36)	**Az.**	182°23'24"	1.338 sec	-0.001 sec	-1.000
	ΔHt.	2.90894 m	0.01286 m	-0.00047 m	-1.000
	Ellip Dist.	1346.84568 m	0.00878 m	0.00002 m	1.006
8000 --> 121890 (PV6)	**Az.**	186°06'28"	1.408 sec	0.004 sec	1.000
	ΔHt.	22.46708 m	0.01401 m	-0.00056 m	-1.000
	Ellip Dist.	1276.82713 m	0.00889 m	0.00002 m	1.005
8009 --> 8010 (PV66)	**Az.**	206°02'02"	1.521 sec	-0.002 sec	-1.000
	ΔHt.	0.41117 m	0.01095 m	-0.00034 m	-1.000
	Ellip Dist.	1137.96598 m	0.00853 m	0.00001 m	1.005
8007 --> 8008 (PV51)	**Az.**	212°32'03"	1.010 sec	-0.005 sec	-1.000
	ΔHt.	18.10465 m	0.01822 m	-0.00096 m	-1.000
	Ellip Dist.	1919.78034 m	0.00980 m	0.00006 m	1.005
59279 --> 8000 (PV1)	**Az.**	232°41'02"	2.941 sec	0.006 sec	1.000
	ΔHt.	-6.08316 m	0.01167 m	-0.00039 m	-1.000

	Ellip Dist.	583.25147 m	0.00852 m	0.00001 m	1.005
8001 --> 8002 (PV16)	**Az.**	155°21'26"	2.733 sec	0.005 sec	1.000
	ΔHt.	9.45704 m	0.01123 m	-0.00036 m	-1.000
	Ellip Dist.	631.66374 m	0.00822 m	0.00001 m	1.004
8010 --> 8011 (PV71)	**Az.**	242°03'28"	2.274 sec	0.000 sec	-0.998
	ΔHt.	-16.06886 m	0.01087 m	-0.00034 m	-1.000
	Ellip Dist.	747.71814 m	0.00839 m	0.00001 m	1.004
8011 --> 58886 (PV82)	**Az.**	305°34'41"	4.790 sec	-0.001 sec	-1.002
	ΔHt.	21.90375 m	0.00933 m	-0.00025 m	-1.000
	Ellip Dist.	349.49041 m	0.00802 m	-0.00001 m	-0.998
8006 --> 8007 (PV41)	**Az.**	219°13'19"	1.423 sec	-0.012 sec	-1.000
	ΔHt.	-12.68182 m	0.01566 m	-0.00071 m	-1.000
	Ellip Dist.	1460.88477 m	0.01079 m	0.00008 m	1.002
8008 --> 90501 (PV60)	**Az.**	125°52'32"	3.906 sec	0.008 sec	1.000
	ΔHt.	-14.07593 m	0.01197 m	-0.00041 m	-1.000
	Ellip Dist.	447.71597 m	0.00839 m	0.00002 m	1.001
90501 --> 8009 (PV64)	**Az.**	230°13'09"	1.711 sec	-0.005 sec	-1.000
	ΔHt.	12.72340 m	0.01176 m	-0.00040 m	-1.000
	Ellip Dist.	1033.00474 m	0.00866 m	0.00000 m	-0.916
8012 --> 8013 (PV91)	**Az.**	150°44'38"	2.423 sec	0.006 sec	1.000
	ΔHt.	1.56870 m	0.01374 m	-0.00054 m	-1.000
	Ellip Dist.	786.94646 m	0.00893 m	0.00000 m	-0.900
8005 --> 8006 (PV40)	**Az.**	208°23'42"	0.879 sec	0.003 sec	1.000
	ΔHt.	0.57567 m	0.03165 m	-0.00296 m	-1.000
	Ellip Dist.	2191.61559 m	0.01016 m	-0.00002 m	-0.957
61261 --> 171104 (PV109)	**Az.**	5°34'02"	0.843 sec	-0.012 sec	-1.000
	ΔHt.	-11.20675 m	0.05868 m	0.01121 m	1.000
	Ellip Dist.	2878.97791 m	0.01191 m	0.00041 m	0.988
8003 --> 101732 (PV19)	**Az.**	106°55'04"	10.705 sec	0.012 sec	1.000
	ΔHt.	-0.05061 m	0.00925 m	-0.00024 m	-1.000
	Ellip Dist.	154.48534 m	0.00795 m	0.00000 m	-0.996

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (PPM)	3D Precision (PPM)
101732	8003	**Az.**	286°55'02"	10.751 sec	51.41222	51.41210
		ΔHt.	0.05061 m	0.00925 m		
		ΔElev.	0.04934 m	0.00925 m		
		Ellip Dist.	154.48536 m	0.00794 m		
101732	8004	**Az.**	194°42'28"	2.287 sec	11.07751	11.07630
		ΔHt.	2.08506 m	0.01160 m		
		ΔElev.	2.10193 m	0.01160 m		
		Ellip Dist.	764.78747 m	0.00847 m		
107142	8014	**Az.**	27°38'59"	1.546 sec	7.31155	7.33312
		ΔHt.	8.84238 m	0.07277 m		
		ΔElev.	8.78565 m	0.07277 m		
		Ellip Dist.	2013.91523 m	0.01472 m		
107142	8015	**Az.**	196°14'10"	1.165 sec	6.26085	6.22580
		ΔHt.	20.94581 m	0.07752 m		
		ΔElev.	21.02299 m	0.07752 m		
		Ellip Dist.	2530.31024 m	0.01584 m		
121890	8001	**Az.**	205°59'50"	0.841 sec	4.23629	4.23816
		ΔHt.	-6.34506 m	0.03352 m		
		ΔElev.	-6.30632 m	0.03352 m		
		Ellip Dist.	2233.26303 m	0.00946 m		
171104	61261	**Az.**	185°33'58"	0.831 sec	4.12853	4.11505
		ΔHt.	11.20675 m	0.05868 m		
		ΔElev.	11.30192 m	0.05868 m		
		Ellip Dist.	2878.97822 m	0.01189 m		
58886	8012	**Az.**	186°38'02"	0.856 sec	4.18413	4.19052
		ΔHt.	-19.63518 m	0.03160 m		
		ΔElev.	-19.56693 m	0.03160 m		
		Ellip Dist.	2356.81827 m	0.00986 m		
8000	121890	**Az.**	186°06'28"	1.390 sec	6.90168	6.89073
		ΔHt.	22.46709 m	0.01401 m		
		ΔElev.	22.49137 m	0.01401 m		
		Ellip Dist.	1276.82727 m	0.00881 m		
8000	59279	**Az.**	52°41'10"	2.918 sec	14.47636	14.48218
		ΔHt.	6.08317 m	0.01167 m		
		ΔElev.	6.07765 m	0.01167 m		
		Ellip Dist.	583.25153 m	0.00844 m		

8001	8002	**Az.**	155°21'26"	2.713 sec	12.96551	12.95704
		ΔHt.	9.45704 m	0.01123 m		
		ΔElev.	9.46977 m	0.01123 m		
		Ellip Dist.	631.66381 m	0.00819 m		
8002	8003	**Az.**	164°53'09"	1.469 sec	7.05736	7.04668
		ΔHt.	22.36530 m	0.01561 m		
		ΔElev.	22.39434 m	0.01561 m		
		Ellip Dist.	1288.25158 m	0.00909 m		
8004	8005	**Az.**	182°23'24"	1.324 sec	6.47614	6.47503
		ΔHt.	2.90894 m	0.01286 m		
		ΔElev.	2.94736 m	0.01286 m		
		Ellip Dist.	1346.84583 m	0.00872 m		
8005	8006	**Az.**	208°23'42"	0.882 sec	4.61728	4.61737
		ΔHt.	0.57567 m	0.03165 m		
		ΔElev.	0.63433 m	0.03165 m		
		Ellip Dist.	2191.61583 m	0.01012 m		
8007	8006	**Az.**	39°13'35"	1.402 sec	7.24917	7.26366
		ΔHt.	12.68182 m	0.01565 m		
		ΔElev.	12.64821 m	0.01565 m		
		Ellip Dist.	1460.88493 m	0.01059 m		
8007	8008	**Az.**	212°32'03"	1.006 sec	5.07309	5.06360
		ΔHt.	18.10465 m	0.01822 m		
		ΔElev.	18.15429 m	0.01822 m		
		Ellip Dist.	1919.78055 m	0.00974 m		
8008	90501	**Az.**	125°52'32"	3.916 sec	18.73603	18.79710
		ΔHt.	-14.07594 m	0.01197 m		
		ΔElev.	-14.06591 m	0.01197 m		
		Ellip Dist.	447.71602 m	0.00839 m		
8009	8010	**Az.**	206°02'02"	1.501 sec	7.42550	7.42534
		ΔHt.	0.41117 m	0.01095 m		
		ΔElev.	0.44034 m	0.01095 m		
		Ellip Dist.	1137.96610 m	0.00845 m		
8009	90501	**Az.**	50°13'23"	1.697 sec	8.30868	8.30904
		ΔHt.	-12.72340 m	0.01176 m		
		ΔElev.	-12.74006 m	0.01176 m		
		Ellip Dist.	1033.00486 m	0.00858 m		
8010	8011	**Az.**	242°03'28"	2.265 sec	11.13327	11.14550
		ΔHt.	-16.06887 m	0.01087 m		

		ΔElev.	-16.06297 m	0.01087 m		
		Ellip Dist.	747.71822 m	0.00832 m		
8011	58886	**Az.**	305°34'41"	4.828 sec	23.08024	23.09896
		ΔHt.	21.90375 m	0.00933 m		
		ΔElev.	21.89523 m	0.00933 m		
		Ellip Dist.	349.49045 m	0.00807 m		
8013	8012	**Az.**	330°44'32"	2.406 sec	11.31029	11.31041
		ΔHt.	-1.56870 m	0.01374 m		
		ΔElev.	-1.59307 m	0.01374 m		
		Ellip Dist.	786.94655 m	0.00890 m		
8013	8014	**Az.**	204°40'34"	1.033 sec	5.09759	5.10430
		ΔHt.	-10.31986 m	0.05842 m		
		ΔElev.	-10.24964 m	0.05842 m		
		Ellip Dist.	2564.40190 m	0.01307 m		
8015	171104	**Az.**	226°56'37"	1.014 sec	5.01796	5.02391
		ΔHt.	-18.50424 m	0.04979 m		
		ΔElev.	-18.45654 m	0.04979 m		
		Ellip Dist.	2169.38634 m	0.01089 m		

Date: 17/09/2016 9:14:35 AM	Project: F:\PROJECT\TBC PROJECTS\4 - Single Baseline Trav.vce	Trimble Business Center

Appendix E - Scenario Five

Project File Data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\5 - Fixed to AUSPOS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	4/09/2016 3:35:34 PM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.000 m
Centering Error: 0.000 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.
Constant Term [C]: 0.000 m
Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.
Constant Term [C]: 0.000 m
Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	1.00
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	66

Post Processed Vector Statistics

Reference Factor:	1.00
Redundancy Number:	66.00
A Priori Scalar:	1.75

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	0.004	-0.009	0.002	?
107142	-0.013	-0.010	-0.029	?
121890	0.003	0.001	0.022	?
58886	-0.006	-0.008	-0.041	?
59279	0.017	0.004	0.058	?
61261	-0.007	-0.029	0.020	?
90501	0.009	0.015	-0.049	?

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.213	0.003	6940700.739	0.004	59.889	0.018	
107142	495042.674	0.007	6924708.263	0.006	39.107	0.036	
121890	502287.548	0.004	6944569.165	0.004	34.352	0.023	
171104	492752.689	0.008	6920798.326	0.007	41.643	0.045	

58886	496932.702	0.003	6931847.780	0.003	76.062	0.013	
59279	502887.355	0.005	6946191.530	0.005	17.937	0.023	
61261	492475.282	0.008	6917933.902	0.008	52.971	0.049	
8000	502423.595	0.004	6945838.208	0.005	11.859	0.023	
8001	501308.659	0.004	6942562.866	0.004	28.067	0.018	
8002	501571.870	0.003	6941988.932	0.004	37.538	0.018	
8003	501907.480	0.003	6940745.694	0.003	59.935	0.018	
8004	501860.993	0.003	6939961.339	0.004	61.991	0.018	
8006	500762.558	0.003	6936689.199	0.003	65.598	0.013	
8007	499839.097	0.003	6935557.960	0.003	52.952	0.014	
8008	498807.067	0.003	6933940.083	0.003	71.108	0.013	
8009	498376.231	0.003	6933017.090	0.003	69.783	0.013	
8010	497877.108	0.003	6931994.933	0.003	70.228	0.013	
8011	497216.884	0.003	6931644.590	0.003	54.166	0.013	
8012	496661.136	0.003	6929507.608	0.003	56.508	0.015	
8013	497045.762	0.003	6928821.421	0.004	58.102	0.016	
8015	494336.487	0.007	6922279.551	0.007	60.132	0.039	
90501	499169.729	0.003	6933677.851	0.003	57.042	0.013	

Coordinates from a free adjustment should only be used for analysis of the inner accuracy of the network. They should not be distributed as final results.

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17825"	E153°01'15.01435"	101.271	0.018	
107142	S27°48'07.89904"	E152°56'58.82127"	80.019	0.036	
121890	S27°37'22.45320"	E153°01'23.46796"	75.816	0.023	
171104	S27°50'14.93092"	E152°55'35.04202"	82.431	0.045	
58886	S27°44'15.88975"	E152°58'07.96342"	117.194	0.013	
59279	S27°36'29.72209"	E153°01'45.33970"	59.431	0.023	
61261	S27°51'48.01620"	E152°55'24.83491"	93.663	0.049	
8000	S27°36'41.20837"	E153°01'28.42283"	53.347	0.023	
8001	S27°38'27.66261"	E153°00'47.75818"	69.492	0.018	
8002	S27°38'46.31443"	E153°00'57.36650"	78.951	0.018	
8003	S27°39'26.71800"	E153°01'09.62192"	101.319	0.018	
8004	S27°39'52.20964"	E153°01'07.92955"	103.356	0.018	
8006	S27°41'38.55735"	E153°00'27.84220"	106.867	0.013	
8007	S27°42'15.32301"	E152°59'54.12463"	94.186	0.014	
8008	S27°43'07.90153"	E152°59'16.43425"	112.293	0.013	
8009	S27°43'37.89678"	E152°59'00.69570"	110.941	0.013	
8010	S27°44'11.11391"	E152°58'42.45987"	111.357	0.013	
8011	S27°44'22.49556"	E152°58'18.34180"	95.289	0.013	
8012	S27°45'31.94171"	E152°57'58.02062"	97.571	0.015	
8013	S27°45'54.24562"	E152°58'12.06613"	99.141	0.016	
8015	S27°49'26.82004"	E152°56'32.97021"	100.967	0.039	
90501	S27°43'16.42495"	E152°59'29.67796"	98.217	0.013	

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Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.427	0.014	2564808.215	0.008	-2943019.326	0.009	0.018	
107142	-5028412.391	0.029	2567670.116	0.017	-2957170.294	0.017	0.038	
121890	-5039933.490	0.018	2565405.944	0.010	-2939579.111	0.011	0.023	
171104	-5025745.978	0.036	2568882.683	0.020	-2960629.847	0.022	0.046	
58886	-5032266.171	0.010	2567511.633	0.006	-2950868.320	0.006	0.013	
59279	-5040863.112	0.019	2565206.162	0.010	-2938133.272	0.011	0.024	

61261	-5024435.775	0.039	2568526.585	0.021	-2963168.630	0.023	0.050	
8000	-5040501.872	0.018	2565542.807	0.010	-2938443.757	0.011	0.024	
8001	-5038654.701	0.015	2565853.455	0.008	-2941354.508	0.009	0.019	
8002	-5038544.303	0.015	2565501.671	0.008	-2941867.498	0.009	0.019	
8003	-5038200.005	0.014	2564949.416	0.008	-2942979.534	0.008	0.018	
8004	-5037855.935	0.014	2564826.299	0.008	-2943675.486	0.009	0.018	
8006	-5036005.120	0.011	2565116.577	0.006	-2946576.112	0.006	0.014	
8007	-5035107.018	0.011	2565695.827	0.006	-2947572.254	0.007	0.014	
8008	-5033981.863	0.010	2566281.291	0.006	-2949013.525	0.006	0.013	
8009	-5033402.309	0.010	2566469.733	0.006	-2949830.233	0.006	0.013	
8010	-5032751.851	0.010	2566698.722	0.006	-2950735.484	0.006	0.014	
8011	-5032293.774	0.010	2567206.608	0.006	-2951038.100	0.006	0.014	
8012	-5031156.048	0.012	2567250.898	0.007	-2952931.039	0.007	0.016	
8013	-5031047.217	0.013	2566763.592	0.007	-2953539.311	0.008	0.016	
8015	-5027097.576	0.032	2567793.104	0.017	-2959328.816	0.019	0.041	
90501	-5034026.792	0.010	2565896.986	0.006	-2949239.237	0.006	0.014	

Coordinates from a free adjustment should only be used for analysis of the inner accuracy of the network. They should not be distributed as final results.

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.005	0.004	26°
107142	0.009	0.008	91°
121890	0.006	0.005	28°
171104	0.010	0.009	68°
58886	0.004	0.003	29°
59279	0.006	0.006	35°
61261	0.010	0.010	35°
8000	0.006	0.005	23°
8001	0.005	0.004	28°
8002	0.005	0.004	28°
8003	0.004	0.004	23°
8004	0.005	0.004	28°
8006	0.004	0.003	26°
8007	0.004	0.004	18°

8008	0.004	0.003	20°
8009	0.003	0.003	26°
8010	0.004	0.003	27°
8011	0.004	0.003	30°
8012	0.004	0.004	35°
8013	0.005	0.004	31°
8015	0.009	0.008	42°
90501	0.004	0.003	26°

Adjusted GNSS Observations

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
8002 --> 8003 (PV20)	**Az.**	164°53'09"	0.350 sec	-0.027 sec	-0.127
	ΔHt.	22.368 m	0.005 m	0.002 m	0.647
	Ellip Dist.	1288.256 m	0.002 m	0.004 m	3.442
121890 --> 8001 (PV12)	**Az.**	205°59'50"	0.213 sec	0.149 sec	1.746
	ΔHt.	-6.324 m	0.016 m	0.014 m	2.195
	Ellip Dist.	2233.259 m	0.003 m	-0.004 m	-3.305
8001 --> 8000 (PV10)	**Az.**	18°47'33"	0.158 sec	-0.097 sec	-0.928
	ΔHt.	-16.145 m	0.016 m	0.006 m	0.417
	Ellip Dist.	3461.289 m	0.003 m	0.007 m	2.605
8000 --> 121890 (PV6)	**Az.**	186°06'27"	0.333 sec	-0.125 sec	-1.002
	ΔHt.	22.469 m	0.006 m	0.002 m	0.703
	Ellip Dist.	1276.825 m	0.002 m	-0.002 m	-2.466
8003 --> 8001 (PV24)	**Az.**	341°45'08"	0.274 sec	0.055 sec	0.280
	ΔHt.	-31.827 m	0.006 m	0.004 m	1.077
	Ellip Dist.	1914.062 m	0.002 m	-0.004 m	-2.166
107142 --> 171104 (PV107)	**Az.**	210°22'49"	0.327 sec	-0.228 sec	-0.856
	ΔHt.	2.412 m	0.042 m	-0.015 m	-0.494
	Ellip Dist.	4532.996 m	0.007 m	-0.010 m	-1.946
90501 --> 8006 (PV63)	**Az.**	27°52'49"	0.190 sec	-0.200 sec	-1.760
	ΔHt.	8.649 m	0.010 m	-0.020 m	-1.468
	Ellip Dist.	3408.021 m	0.003 m	-0.001 m	-0.513
8002 --> 101732 (PV17)	**Az.**	159°25'34"	0.341 sec	-0.106 sec	-0.575

	ΔHt.	22.320 m	0.005 m	0.001 m	0.343
	Ellip Dist.	1376.437 m	0.002 m	-0.002 m	-1.741
121890 --> 8002 (PV15)	**Az.**	195°29'30"	0.207 sec	-0.330 sec	-1.692
	ΔHt.	3.134 m	0.017 m	0.004 m	0.165
	Ellip Dist.	2678.719 m	0.003 m	0.001 m	0.461
101732 --> 8004 (PV48)	**Az.**	194°42'28"	0.484 sec	0.373 sec	1.656
	ΔHt.	2.085 m	0.004 m	0.000 m	-0.154
	Ellip Dist.	764.788 m	0.002 m	0.000 m	0.321
8008 --> 8009 (PV55)	**Az.**	205°01'40"	0.301 sec	0.153 sec	1.620
	ΔHt.	-1.352 m	0.004 m	0.000 m	0.002
	Ellip Dist.	1019.002 m	0.002 m	0.000 m	0.573
8010 --> 8011 (PV71)	**Az.**	242°03'28"	0.391 sec	-0.245 sec	-1.479
	ΔHt.	-16.068 m	0.004 m	0.001 m	0.410
	Ellip Dist.	747.718 m	0.002 m	0.000 m	0.448
8003 --> 8006 (PV33)	**Az.**	195°45'09"	0.147 sec	0.017 sec	0.286
	ΔHt.	5.548 m	0.023 m	-0.018 m	-1.452
	Ellip Dist.	4216.660 m	0.004 m	0.000 m	-0.047
107142 --> 8015 (PV106)	**Az.**	196°14'10"	0.562 sec	0.162 sec	0.570
	ΔHt.	20.948 m	0.037 m	0.008 m	0.502
	Ellip Dist.	2530.309 m	0.006 m	0.003 m	1.429
8006 --> 8008 (PV45)	**Az.**	215°25'17"	0.188 sec	0.235 sec	1.358
	ΔHt.	5.426 m	0.009 m	-0.004 m	-0.659
	Ellip Dist.	3375.010 m	0.003 m	0.000 m	0.109
90501 --> 8009 (PV64)	**Az.**	230°13'09"	0.329 sec	-0.194 sec	-1.130
	ΔHt.	12.724 m	0.004 m	0.000 m	0.128
	Ellip Dist.	1033.004 m	0.002 m	-0.001 m	-1.352
8004 --> 8003 (PV38)	**Az.**	3°22'59"	0.478 sec	-0.423 sec	-1.068
	ΔHt.	-2.037 m	0.004 m	-0.006 m	-1.339
	Ellip Dist.	786.045 m	0.002 m	-0.002 m	-0.735
8003 --> 8007 (PV25)	**Az.**	201°43'43"	0.141 sec	-0.148 sec	-1.319
	ΔHt.	-7.133 m	0.023 m	0.013 m	0.534
	Ellip Dist.	5587.107 m	0.005 m	-0.001 m	-0.417
8003 --> 101732 (PV23)	**Az.**	106°54'58"	1.866 sec	0.723 sec	1.271
	ΔHt.	-0.048 m	0.003 m	0.000 m	-0.242
	Ellip Dist.	154.483 m	0.001 m	0.000 m	-1.042

8010 --> 58886 (PV74)	**Az.**	261°09'13"	0.317 sec	0.219 sec	1.226
	ΔHt.	5.837 m	0.004 m	0.000 m	0.185
	Ellip Dist.	956.184 m	0.002 m	0.000 m	-0.587
58886 --> 8012 (PV83)	**Az.**	186°38'02"	0.198 sec	0.109 sec	0.813
	ΔHt.	-19.623 m	0.012 m	0.010 m	1.181
	Ellip Dist.	2356.818 m	0.002 m	0.000 m	0.310
58886 --> 8011 (PV82)	**Az.**	125°34'45"	0.791 sec	-0.299 sec	-1.129
	ΔHt.	-21.904 m	0.003 m	0.000 m	-0.565
	Ellip Dist.	349.490 m	0.001 m	0.000 m	-0.377
171104 --> 8015 (PV110)	**Az.**	46°57'04"	0.372 sec	-0.021 sec	-0.171
	ΔHt.	18.536 m	0.028 m	-0.002 m	-0.257
	Ellip Dist.	2169.378 m	0.004 m	0.002 m	1.124
8010 --> 8009 (PV69)	**Az.**	26°02'11"	0.318 sec	-0.089 sec	-0.590
	ΔHt.	-0.416 m	0.005 m	-0.002 m	-1.080
	Ellip Dist.	1137.966 m	0.002 m	0.000 m	-0.121
90501 --> 8010 (PV67)	**Az.**	217°31'52"	0.207 sec	-0.050 sec	-0.340
	ΔHt.	13.140 m	0.006 m	-0.011 m	-1.051
	Ellip Dist.	2122.896 m	0.002 m	0.000 m	-0.091
8004 --> 8006 (PV39)	**Az.**	198°32'52"	0.195 sec	0.156 sec	1.029
	ΔHt.	3.510 m	0.023 m	0.015 m	0.944
	Ellip Dist.	3452.970 m	0.004 m	0.002 m	0.677
8006 --> 8007 (PV41)	**Az.**	219°13'20"	0.420 sec	0.199 sec	0.983
	ΔHt.	-12.680 m	0.007 m	0.001 m	0.310
	Ellip Dist.	1460.886 m	0.003 m	0.002 m	0.953
8002 --> 8001 (PV16)	**Az.**	335°21'22"	0.594 sec	0.045 sec	0.291
	ΔHt.	-9.459 m	0.005 m	-0.001 m	-0.768
	Ellip Dist.	631.664 m	0.002 m	0.000 m	0.681
8012 --> 8011 (PV90)	**Az.**	14°35'36"	0.202 sec	-0.068 sec	-0.710
	ΔHt.	-2.282 m	0.012 m	0.005 m	0.729
	Ellip Dist.	2208.947 m	0.002 m	0.000 m	-0.215
58886 --> 8009 (PV81)	**Az.**	51°00'21"	0.211 sec	0.081 sec	0.669
	ΔHt.	-6.253 m	0.005 m	0.001 m	0.513
	Ellip Dist.	1858.447 m	0.002 m	0.001 m	0.471
8003 --> 8004 (PV28)	**Az.**	183°22'58"	0.478 sec	-0.110 sec	-0.260
	ΔHt.	2.037 m	0.004 m	-0.001 m	-0.324

	Ellip Dist.	786.045 m	0.002 m	0.001 m	0.639
8013 --> 107142 (PV95)	**Az.**	205°58'47"	0.332 sec	-0.170 sec	-0.616
	ΔHt.	-19.122 m	0.039 m	0.022 m	0.564
	Ellip Dist.	4576.809 m	0.007 m	0.001 m	0.199
8008 --> 90501 (PV60)	**Az.**	125°52'32"	0.819 sec	-0.213 sec	-0.584
	ΔHt.	-14.076 m	0.005 m	-0.001 m	-0.436
	Ellip Dist.	447.716 m	0.002 m	0.000 m	0.529
59279 --> 121890 (PV2)	**Az.**	200°16'35"	0.304 sec	-0.003 sec	-0.013
	ΔHt.	16.386 m	0.007 m	0.002 m	0.576
	Ellip Dist.	1730.385 m	0.003 m	0.000 m	-0.068
59279 --> 8000 (PV1)	**Az.**	232°41'02"	0.632 sec	0.012 sec	0.080
	ΔHt.	-6.083 m	0.005 m	-0.001 m	-0.560
	Ellip Dist.	583.251 m	0.002 m	0.000 m	0.052
58886 --> 8013 (PV84)	**Az.**	177°52'30"	0.202 sec	0.012 sec	0.063
	ΔHt.	-18.053 m	0.013 m	-0.004 m	-0.289
	Ellip Dist.	3029.681 m	0.003 m	-0.002 m	-0.510
8012 --> 8013 (PV91)	**Az.**	150°44'38"	0.704 sec	0.032 sec	0.134
	ΔHt.	1.570 m	0.007 m	0.001 m	0.494
	Ellip Dist.	786.947 m	0.002 m	0.000 m	0.414
8008 --> 8007 (PV51)	**Az.**	32°32'21"	0.306 sec	0.031 sec	0.307
	ΔHt.	-18.107 m	0.008 m	-0.001 m	-0.402
	Ellip Dist.	1919.781 m	0.003 m	0.000 m	0.397
8013 --> 8015 (PV103)	**Az.**	202°30'38"	0.214 sec	0.034 sec	0.390
	ΔHt.	1.826 m	0.044 m	-0.006 m	-0.261
	Ellip Dist.	7083.527 m	0.007 m	0.000 m	0.100
8012 --> 107142 (PV92)	**Az.**	198°39'04"	0.306 sec	0.026 sec	0.129
	ΔHt.	-17.552 m	0.039 m	-0.006 m	-0.316
	Ellip Dist.	5066.918 m	0.007 m	-0.001 m	-0.305
8013 --> 8011 (PV94)	**Az.**	3°28'57"	0.212 sec	-0.028 sec	-0.137
	ΔHt.	-3.852 m	0.013 m	0.004 m	0.261
	Ellip Dist.	2829.481 m	0.003 m	0.000 m	0.112
61261 --> 171104 (PV113)	**Az.**	5°34'02"	0.352 sec	-0.004 sec	-0.021
	ΔHt.	-11.232 m	0.040 m	0.000 m	-0.002
	Ellip Dist.	2878.976 m	0.005 m	0.000 m	-0.017
61261 --> 8015 (PV111)	**Az.**	23°13'15"	0.186 sec	0.001 sec	0.014

	ΔHt.	7.304 m	0.031 m	0.000 m	0.006
	Ellip Dist.	4729.335 m	0.005 m	0.000 m	0.021

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
101732	8003	**Az.**	286°54'55"	1.872 sec	1 : 121546	1 : 121536
		ΔHt.	0.048 m	0.003 m		
		ΔElev.	0.047 m	0.003 m		
		Ellip Dist.	154.483 m	0.001 m		
101732	8004	**Az.**	194°42'28"	0.483 sec	1 : 401217	1 : 401394
		ΔHt.	2.085 m	0.004 m		
		ΔElev.	2.102 m	0.004 m		
		Ellip Dist.	764.788 m	0.002 m		
107142	171104	**Az.**	210°22'49"	0.327 sec	1 : 694262	1 : 694128
		ΔHt.	2.412 m	0.042 m		
		ΔElev.	2.537 m	0.042 m		
		Ellip Dist.	4532.996 m	0.007 m		
107142	8015	**Az.**	196°14'10"	0.561 sec	1 : 456067	1 : 455947
		ΔHt.	20.948 m	0.037 m		
		ΔElev.	21.025 m	0.037 m		
		Ellip Dist.	2530.309 m	0.006 m		
121890	8001	**Az.**	205°59'50"	0.213 sec	1 : 859582	1 : 860540
		ΔHt.	-6.324 m	0.016 m		
		ΔElev.	-6.286 m	0.016 m		
		Ellip Dist.	2233.259 m	0.003 m		
121890	8002	**Az.**	195°29'30"	0.207 sec	1 : 911263	1 : 911116
		ΔHt.	3.134 m	0.017 m		
		ΔElev.	3.186 m	0.017 m		
		Ellip Dist.	2678.719 m	0.003 m		
171104	61261	**Az.**	185°33'58"	0.351 sec	1 : 612038	1 : 613988
		ΔHt.	11.232 m	0.040 m		
		ΔElev.	11.327 m	0.040 m		
		Ellip Dist.	2878.976 m	0.005 m		
58886	8012	**Az.**	186°38'02"	0.198 sec	1 : 1017118	1 : 1013652

		ΔHt.	-19.623 m	0.012 m		
		ΔElev.	-19.554 m	0.012 m		
		Ellip Dist.	2356.818 m	0.002 m		
58886	8013	**Az.**	177°52'30"	0.202 sec	1 : 1023889	1 : 1022083
		ΔHt.	-18.053 m	0.013 m		
		ΔElev.	-17.960 m	0.013 m		
		Ellip Dist.	3029.681 m	0.003 m		
59279	121890	**Az.**	200°16'35"	0.304 sec	1 : 682047	1 : 683097
		ΔHt.	16.386 m	0.007 m		
		ΔElev.	16.416 m	0.007 m		
		Ellip Dist.	1730.385 m	0.003 m		
8000	121890	**Az.**	186°06'27"	0.333 sec	1 : 587532	1 : 589099
		ΔHt.	22.469 m	0.006 m		
		ΔElev.	22.493 m	0.006 m		
		Ellip Dist.	1276.825 m	0.002 m		
8000	59279	**Az.**	52°41'10"	0.633 sec	1 : 278267	1 : 277613
		ΔHt.	6.083 m	0.005 m		
		ΔElev.	6.078 m	0.005 m		
		Ellip Dist.	583.251 m	0.002 m		
8000	8001	**Az.**	198°47'14"	0.158 sec	1 : 1143645	1 : 1139438
		ΔHt.	16.145 m	0.016 m		
		ΔElev.	16.208 m	0.016 m		
		Ellip Dist.	3461.289 m	0.003 m		
8001	8002	**Az.**	155°21'26"	0.594 sec	1 : 387861	1 : 389317
		ΔHt.	9.459 m	0.005 m		
		ΔElev.	9.471 m	0.005 m		
		Ellip Dist.	631.664 m	0.002 m		
8001	8003	**Az.**	161°45'18"	0.274 sec	1 : 815498	1 : 817767
		ΔHt.	31.827 m	0.006 m		
		ΔElev.	31.869 m	0.006 m		
		Ellip Dist.	1914.062 m	0.002 m		
8002	101732	**Az.**	159°25'34"	0.340 sec	1 : 670198	1 : 672983
		ΔHt.	22.320 m	0.005 m		
		ΔElev.	22.351 m	0.005 m		
		Ellip Dist.	1376.437 m	0.002 m		
8002	8003	**Az.**	164°53'09"	0.350 sec	1 : 632740	1 : 635451
		ΔHt.	22.368 m	0.005 m		
		ΔElev.	22.397 m	0.005 m		

		Ellip Dist.	1288.256 m	0.002 m		
8003	8004	**Az.**	183°22'58"	0.478 sec	1 : 402356	1 : 402544
		ΔHt.	2.037 m	0.004 m		
		ΔElev.	2.055 m	0.004 m		
		Ellip Dist.	786.045 m	0.002 m		
8003	8006	**Az.**	195°45'09"	0.147 sec	1 : 1076010	1 : 1076451
		ΔHt.	5.548 m	0.023 m		
		ΔElev.	5.663 m	0.023 m		
		Ellip Dist.	4216.660 m	0.004 m		
8003	8007	**Az.**	201°43'43"	0.141 sec	1 : 1215238	1 : 1214679
		ΔHt.	-7.133 m	0.023 m		
		ΔElev.	-6.984 m	0.023 m		
		Ellip Dist.	5587.107 m	0.005 m		
8004	8006	**Az.**	198°32'52"	0.194 sec	1 : 836030	1 : 836264
		ΔHt.	3.510 m	0.023 m		
		ΔElev.	3.608 m	0.023 m		
		Ellip Dist.	3452.970 m	0.004 m		
8006	8008	**Az.**	215°25'17"	0.188 sec	1 : 978540	1 : 979290
		ΔHt.	5.426 m	0.009 m		
		ΔElev.	5.510 m	0.009 m		
		Ellip Dist.	3375.010 m	0.003 m		
8006	90501	**Az.**	207°52'22"	0.190 sec	1 : 976042	1 : 974814
		ΔHt.	-8.649 m	0.010 m		
		ΔElev.	-8.556 m	0.010 m		
		Ellip Dist.	3408.021 m	0.003 m		
8007	8006	**Az.**	39°13'35"	0.421 sec	1 : 431327	1 : 429587
		ΔHt.	12.680 m	0.007 m		
		ΔElev.	12.647 m	0.007 m		
		Ellip Dist.	1460.886 m	0.003 m		
8007	8008	**Az.**	212°32'03"	0.306 sec	1 : 595122	1 : 598081
		ΔHt.	18.107 m	0.008 m		
		ΔElev.	18.157 m	0.008 m		
		Ellip Dist.	1919.781 m	0.003 m		
8008	8009	**Az.**	205°01'40"	0.301 sec	1 : 577391	1 : 577120
		ΔHt.	-1.352 m	0.004 m		
		ΔElev.	-1.325 m	0.004 m		
		Ellip Dist.	1019.002 m	0.002 m		
8008	90501	**Az.**	125°52'32"	0.821 sec	1 : 277173	1 : 271570

		ΔHt.	-14.076 m	0.005 m		
		ΔElev.	-14.066 m	0.005 m		
		Ellip Dist.	447.716 m	0.002 m		
8009	58886	**Az.**	230°59'56"	0.212 sec	1 : 859149	1 : 859416
		ΔHt.	6.253 m	0.005 m		
		ΔElev.	6.279 m	0.005 m		
		Ellip Dist.	1858.447 m	0.002 m		
8009	8010	**Az.**	206°02'03"	0.318 sec	1 : 582563	1 : 582603
		ΔHt.	0.416 m	0.005 m		
		ΔElev.	0.445 m	0.005 m		
		Ellip Dist.	1137.966 m	0.002 m		
8009	90501	**Az.**	50°13'22"	0.330 sec	1 : 599281	1 : 599924
		ΔHt.	-12.724 m	0.004 m		
		ΔElev.	-12.741 m	0.004 m		
		Ellip Dist.	1033.004 m	0.002 m		
8010	58886	**Az.**	261°09'13"	0.318 sec	1 : 623766	1 : 624409
		ΔHt.	5.837 m	0.004 m		
		ΔElev.	5.834 m	0.004 m		
		Ellip Dist.	956.184 m	0.002 m		
8010	8011	**Az.**	242°03'28"	0.392 sec	1 : 465296	1 : 462532
		ΔHt.	-16.068 m	0.004 m		
		ΔElev.	-16.062 m	0.004 m		
		Ellip Dist.	747.718 m	0.002 m		
8011	58886	**Az.**	305°34'41"	0.793 sec	1 : 299953	1 : 291383
		ΔHt.	21.904 m	0.003 m		
		ΔElev.	21.896 m	0.003 m		
		Ellip Dist.	349.490 m	0.001 m		
8011	8012	**Az.**	194°35'27"	0.201 sec	1 : 964778	1 : 965003
		ΔHt.	2.282 m	0.012 m		
		ΔElev.	2.341 m	0.012 m		
		Ellip Dist.	2208.947 m	0.002 m		
8011	8013	**Az.**	183°28'54"	0.212 sec	1 : 959436	1 : 959684
		ΔHt.	3.852 m	0.013 m		
		ΔElev.	3.936 m	0.013 m		
		Ellip Dist.	2829.481 m	0.003 m		
8012	107142	**Az.**	198°39'04"	0.306 sec	1 : 746284	1 : 745133
		ΔHt.	-17.552 m	0.039 m		
		ΔElev.	-17.401 m	0.039 m		

		Ellip Dist.	5066.918 m	0.007 m		
8013	107142	**Az.**	205°58'47"	0.332 sec	1 : 670050	1 : 669080
		ΔHt.	-19.122 m	0.039 m		
		ΔElev.	-18.995 m	0.039 m		
		Ellip Dist.	4576.809 m	0.007 m		
8013	8012	**Az.**	330°44'32"	0.704 sec	1 : 326894	1 : 326907
		ΔHt.	-1.570 m	0.007 m		
		ΔElev.	-1.594 m	0.007 m		
		Ellip Dist.	786.947 m	0.002 m		
8013	8015	**Az.**	202°30'38"	0.214 sec	1 : 945673	1 : 945800
		ΔHt.	1.826 m	0.044 m		
		ΔElev.	2.030 m	0.044 m		
		Ellip Dist.	7083.527 m	0.007 m		
8015	171104	**Az.**	226°56'37"	0.373 sec	1 : 535048	1 : 535467
		ΔHt.	-18.536 m	0.028 m		
		ΔElev.	-18.489 m	0.028 m		
		Ellip Dist.	2169.378 m	0.004 m		
8015	61261	**Az.**	203°12'43"	0.186 sec	1 : 1028880	1 : 1027591
		ΔHt.	-7.304 m	0.031 m		
		ΔElev.	-7.161 m	0.031 m		
		Ellip Dist.	4729.335 m	0.005 m		
90501	8010	**Az.**	217°31'52"	0.207 sec	1 : 905483	1 : 906531
		ΔHt.	13.140 m	0.006 m		
		ΔElev.	13.186 m	0.006 m		
		Ellip Dist.	2122.896 m	0.002 m		

Date: 17/09/2016 9:15:20 AM	Project: F:\PROJECT\TBC PROJECTS\5 - Fixed to AUSPOS.vce	Trimble Business Center

Appendix E - Scenario Six

Project File Data		**Coordinate System**	
Name:	F:\PROJECT\TBC PROJECTS\6 - Bulk Fix to CORS.vce	Name:	Map Grid of Australia (GDA)
Size:	2 MB	Datum:	ITRF
Modified:	4/09/2016 3:38:20 PM (UTC:10)	Zone:	Zone 56
Time zone:	E. Australia Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.000 m

Centering Error: 0.000 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	1.00
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	118

Post Processed Vector Statistics

Reference Factor:	1.00
Redundancy Number:	117.66
A Priori Scalar:	2.23

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
101732	-0.008	-0.009	-0.017	?
107142	-0.019	-0.001	-0.053	?
121890	-0.008	0.001	0.010	?
58886	-0.014	-0.003	-0.069	?
59279	-0.002	0.000	0.057	?
61261	-0.002	-0.005	-0.065	?
90501	0.001	0.020	-0.078	?
BDST	0.000	0.000	?	-0.002
WOOL	0.000	0.000	?	0.002

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
BDST	Local	0.003	0.003	0.009	
WOOL	Local	0.003	0.003	0.009	
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
101732	502055.225	0.005	6940700.739	0.005	59.908	0.019	
107142	495042.680	0.009	6924708.254	0.008	39.131	0.045	

121890	502287.559	0.006	6944569.165	0.006	34.364	0.024	
171104	492752.692	0.007	6920798.315	0.007	41.671	0.036	
58886	496932.710	0.005	6931847.775	0.006	76.090	0.020	
59279	502887.366	0.006	6946191.529	0.006	17.949	0.024	
61261	492475.286	0.007	6917933.888	0.007	52.986	0.039	
8000	502423.606	0.006	6945838.207	0.006	11.870	0.024	
8001	501308.670	0.005	6942562.866	0.005	28.083	0.020	
8002	501571.882	0.005	6941988.932	0.005	37.555	0.020	
8003	501907.492	0.005	6940745.694	0.005	59.954	0.019	
8004	501861.006	0.005	6939961.340	0.005	62.010	0.019	
8006	500762.569	0.005	6936689.196	0.006	65.628	0.021	
8007	499839.105	0.006	6935557.956	0.006	52.981	0.021	
8008	498807.075	0.005	6933940.079	0.005	71.137	0.020	
8009	498376.239	0.005	6933017.085	0.005	69.811	0.020	
8010	497877.116	0.005	6931994.928	0.005	70.256	0.020	
8011	497216.892	0.005	6931644.584	0.006	54.194	0.020	
8012	496661.143	0.006	6929507.602	0.006	56.536	0.024	
8013	497045.770	0.006	6928821.415	0.006	58.130	0.025	
8015	494336.493	0.006	6922279.539	0.007	60.151	0.034	
90501	499169.737	0.005	6933677.846	0.005	57.071	0.020	
BDST	499515.927	?	6904226.324	?	60.704	?	LLh
WOOL	503483.973	?	6959847.629	?	49.245	?	LLh

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
101732	S27°39'28.17825"	E153°01'15.01479"	101.290	0.019	
107142	S27°48'07.89935"	E152°56'58.82150"	80.043	0.045	
121890	S27°37'22.45319"	E153°01'23.46835"	75.828	0.024	
171104	S27°50'14.93130"	E152°55'35.04215"	82.459	0.036	
58886	S27°44'15.88993"	E152°58'07.96370"	117.222	0.020	
59279	S27°36'29.72212"	E153°01'45.34008"	59.442	0.024	
61261	S27°51'48.01665"	E152°55'24.83508"	93.678	0.039	
8000	S27°36'41.20839"	E153°01'28.42323"	53.359	0.024	
8001	S27°38'27.66262"	E153°00'47.75858"	69.508	0.020	
8002	S27°38'46.31444"	E153°00'57.36692"	78.968	0.020	
8003	S27°39'26.71799"	E153°01'09.62236"	101.338	0.019	
8004	S27°39'52.20962"	E153°01'07.93001"	103.375	0.019	
8006	S27°41'38.55743"	E153°00'27.84260"	106.896	0.021	
8007	S27°42'15.32314"	E152°59'54.12490"	94.216	0.021	
8008	S27°43'07.90167"	E152°59'16.43454"	112.322	0.020	
8009	S27°43'37.89695"	E152°59'00.69598"	110.970	0.020	
8010	S27°44'11.11409"	E152°58'42.46016"	111.386	0.020	
8011	S27°44'22.49574"	E152°58'18.34208"	95.318	0.020	
8012	S27°45'31.94192"	E152°57'58.02090"	97.599	0.024	
8013	S27°45'54.24583"	E152°58'12.06641"	99.169	0.025	
8015	S27°49'26.82040"	E152°56'32.97043"	100.986	0.034	
90501	S27°43'16.42510"	E152°59'29.67828"	98.246	0.020	
BDST	S27°59'13.56952"	E152°59'42.27818"	101.098	?	LLh
WOOL	S27°29'05.88837"	E153°02'06.96433"	91.051	?	LLh

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
101732	-5038248.448	0.016	2564808.213	0.009	-2943019.334	0.010	0.021	
107142	-5028412.409	0.036	2567670.118	0.021	-2957170.314	0.022	0.047	
121890	-5039933.504	0.019	2565405.939	0.011	-2939579.117	0.012	0.025	

171104	-5025745.997	0.029	2568882.688	0.016	-2960629.871	0.018	0.037	
58886	-5032266.195	0.017	2567511.636	0.010	-2950868.338	0.010	0.022	
59279	-5040863.126	0.019	2565206.157	0.011	-2938133.278	0.012	0.026	
61261	-5024435.782	0.031	2568526.584	0.017	-2963168.649	0.019	0.040	
8000	-5040501.886	0.019	2565542.802	0.011	-2938443.763	0.012	0.025	
8001	-5038654.719	0.016	2565853.451	0.009	-2941354.516	0.010	0.021	
8002	-5038544.322	0.016	2565501.668	0.009	-2941867.507	0.010	0.021	
8003	-5038200.025	0.016	2564949.413	0.009	-2942979.543	0.010	0.021	
8004	-5037855.957	0.016	2564826.295	0.009	-2943675.494	0.010	0.021	
8006	-5036005.147	0.017	2565116.578	0.010	-2946576.127	0.011	0.022	
8007	-5035107.044	0.017	2565695.832	0.010	-2947572.271	0.011	0.023	
8008	-5033981.887	0.016	2566281.295	0.009	-2949013.543	0.010	0.021	
8009	-5033402.333	0.016	2566469.737	0.009	-2949830.251	0.010	0.021	
8010	-5032751.875	0.016	2566698.725	0.009	-2950735.502	0.010	0.022	
8011	-5032293.798	0.017	2567206.611	0.010	-2951038.118	0.010	0.022	
8012	-5031156.071	0.020	2567250.901	0.011	-2952931.057	0.012	0.026	
8013	-5031047.240	0.020	2566763.595	0.012	-2953539.330	0.013	0.027	
8015	-5027097.589	0.027	2567793.104	0.015	-2959328.835	0.017	0.036	
90501	-5034026.817	0.016	2565896.989	0.010	-2949239.255	0.010	0.022	
BDST	-5021920.613	?	2559339.871	?	-2975290.668	?	?	LLh
WOOL	-5046788.337	?	2567555.321	?	-2926034.799	?	?	LLh

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
101732	0.007	0.007	36°
107142	0.012	0.010	88°
121890	0.007	0.007	36°
171104	0.009	0.009	35°
58886	0.007	0.007	34°
59279	0.008	0.007	60°
61261	0.009	0.009	23°
8000	0.007	0.007	35°
8001	0.007	0.007	38°
8002	0.007	0.007	40°
8003	0.007	0.006	32°
8004	0.007	0.007	39°

8006	0.007	0.007	25°
8007	0.007	0.007	20°
8008	0.007	0.007	25°
8009	0.007	0.006	30°
8010	0.007	0.006	29°
8011	0.007	0.007	34°
8012	0.008	0.007	40°
8013	0.008	0.008	34°
8015	0.008	0.008	31°
90501	0.007	0.007	28°

Adjusted GNSS Observations

Transformation Parameters

Azimuth Rotation: 0.012 sec **(95%)** 0.038 sec

Scale Factor: 1.00000019 **(95%)** 0.00000019

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
8000 --> 121890 (PV6)	**Az.**	186°06'27"	0.398 sec	-0.077 sec	-0.443
	ΔHt.	22.470 m	0.008 m	0.002 m	0.782
	Ellip Dist.	1276.824 m	0.003 m	-0.004 m	-2.888
WOOL --> 90501 (PV148)	**Az.**	189°20'42"	0.022 sec	0.067 sec	2.883
	ΔHt.	7.195 m	0.016 m	-0.023 m	-0.796
	Ellip Dist.	26533.619 m	0.003 m	0.000 m	0.113
WOOL --> 121890 (PV131)	**Az.**	184°27'40"	0.039 sec	-0.026 sec	-0.791
	ΔHt.	-15.223 m	0.018 m	-0.005 m	-0.241
	Ellip Dist.	15331.364 m	0.003 m	0.008 m	2.741
BDST --> 8015 (PV172)	**Az.**	343°59'39"	0.050 sec	-0.068 sec	-2.420
	ΔHt.	-0.112 m	0.032 m	-0.002 m	-0.082
	Ellip Dist.	18789.019 m	0.004 m	-0.002 m	-1.041
BDST --> 61261 (PV187)	**Az.**	332°48'57"	0.071 sec	0.106 sec	2.409
	ΔHt.	-7.420 m	0.036 m	0.005 m	0.184
	Ellip Dist.	15416.154 m	0.005 m	0.004 m	1.343
8015 --> 171104 (PV110)	**Az.**	226°56'37"	0.417 sec	0.097 sec	0.477
	ΔHt.	-18.527 m	0.028 m	0.009 m	0.761

	Ellip Dist.	2169.380 m	0.005 m	0.005 m	2.347
WOOL --> 8007 (PV150)	**Az.**	188°31'04"	0.026 sec	-0.045 sec	-2.281
	ΔHt.	3.165 m	0.016 m	-0.013 m	-0.556
	Ellip Dist.	24571.445 m	0.004 m	-0.003 m	-0.988
121890 --> 8001 (PV12)	**Az.**	205°59'50"	0.237 sec	0.121 sec	0.954
	ΔHt.	-6.320 m	0.017 m	0.018 m	1.799
	Ellip Dist.	2233.259 m	0.003 m	-0.004 m	-2.245
8002 --> 8003 (PV20)	**Az.**	164°53'09"	0.394 sec	-0.108 sec	-0.374
	ΔHt.	22.370 m	0.007 m	0.004 m	0.757
	Ellip Dist.	1288.255 m	0.002 m	0.004 m	2.128
8006 --> 8007 (PV41)	**Az.**	219°13'20"	0.468 sec	0.460 sec	1.598
	ΔHt.	-12.680 m	0.009 m	0.001 m	0.338
	Ellip Dist.	1460.889 m	0.004 m	0.005 m	1.925
WOOL --> 8000 (PV130)	**Az.**	184°18'44"	0.044 sec	0.031 sec	0.844
	ΔHt.	-37.693 m	0.018 m	0.035 m	1.911
	Ellip Dist.	14055.112 m	0.003 m	-0.005 m	-1.711
WOOL --> 8001 (PV138)	**Az.**	187°09'24"	0.030 sec	-0.006 sec	-0.232
	ΔHt.	-21.543 m	0.012 m	0.023 m	1.877
	Ellip Dist.	17428.074 m	0.003 m	0.000 m	-0.151
8003 --> 8001 (PV24)	**Az.**	341°45'08"	0.286 sec	-0.038 sec	-0.141
	ΔHt.	-31.830 m	0.007 m	0.002 m	0.330
	Ellip Dist.	1914.061 m	0.002 m	-0.004 m	-1.867
WOOL --> 8009 (PV149)	**Az.**	190°45'44"	0.021 sec	-0.019 sec	-1.305
	ΔHt.	19.918 m	0.015 m	0.012 m	0.724
	Ellip Dist.	27323.320 m	0.003 m	-0.004 m	-1.806
WOOL --> 8004 (PV152)	**Az.**	184°38'58"	0.025 sec	0.066 sec	1.762
	ΔHt.	12.324 m	0.011 m	0.004 m	0.334
	Ellip Dist.	19960.384 m	0.002 m	0.002 m	0.556
59279 --> WOOL (PV133)	**Az.**	2°29'17"	0.055 sec	-0.048 sec	-0.844
	ΔHt.	31.609 m	0.018 m	0.021 m	0.899
	Ellip Dist.	13674.592 m	0.003 m	-0.005 m	-1.736
WOOL --> 8006 (PV144)	**Az.**	186°41'09"	0.024 sec	0.029 sec	1.731
	ΔHt.	15.845 m	0.016 m	-0.011 m	-0.724
	Ellip Dist.	23327.109 m	0.003 m	0.001 m	0.407
WOOL --> 8008 (PV151)	**Az.**	190°13'00"	0.020 sec	-0.029 sec	-1.653

	ΔHt.	21.271 m	0.015 m	-0.009 m	-0.577
	Ellip Dist.	26336.837 m	0.003 m	0.001 m	0.556
8002 --> 101732 (PV17)	**Az.**	159°25'34"	0.384 sec	-0.180 sec	-0.711
	ΔHt.	22.322 m	0.007 m	0.003 m	0.711
	Ellip Dist.	1376.436 m	0.002 m	-0.002 m	-1.635
WOOL --> 8003 (PV135)	**Az.**	184°42'06"	0.023 sec	0.014 sec	0.586
	ΔHt.	10.286 m	0.011 m	0.022 m	1.231
	Ellip Dist.	19174.542 m	0.002 m	0.004 m	1.631
WOOL --> 101732 (PV136)	**Az.**	184°15'04"	0.025 sec	-0.011 sec	-0.483
	ΔHt.	10.239 m	0.011 m	-0.022 m	-1.604
	Ellip Dist.	19207.800 m	0.002 m	-0.001 m	-0.607
8001 --> 8000 (PV10)	**Az.**	18°47'33"	0.171 sec	-0.080 sec	-0.561
	ΔHt.	-16.149 m	0.017 m	0.002 m	0.076
	Ellip Dist.	3461.288 m	0.003 m	0.006 m	1.601
121890 --> 8002 (PV15)	**Az.**	195°29'30"	0.224 sec	-0.378 sec	-1.467
	ΔHt.	3.140 m	0.017 m	0.009 m	0.302
	Ellip Dist.	2678.719 m	0.003 m	0.001 m	0.331
8006 --> 8008 (PV45)	**Az.**	215°25'17"	0.188 sec	0.331 sec	1.431
	ΔHt.	5.426 m	0.010 m	-0.004 m	-0.539
	Ellip Dist.	3375.013 m	0.004 m	0.003 m	0.705
107142 --> 8015 (PV106)	**Az.**	196°14'10"	0.666 sec	0.171 sec	0.445
	ΔHt.	20.943 m	0.042 m	0.003 m	0.140
	Ellip Dist.	2530.310 m	0.007 m	0.005 m	1.413
8002 --> 8001 (PV16)	**Az.**	335°21'22"	0.709 sec	-0.054 sec	-0.226
	ΔHt.	-9.460 m	0.006 m	-0.002 m	-1.400
	Ellip Dist.	631.664 m	0.002 m	0.000 m	0.642
8015 --> 61261 (PV111)	**Az.**	203°12'43"	0.197 sec	0.016 sec	0.168
	ΔHt.	-7.308 m	0.029 m	-0.010 m	-0.876
	Ellip Dist.	4729.338 m	0.005 m	0.003 m	1.324
8010 --> 8011 (PV71)	**Az.**	242°03'28"	0.492 sec	-0.266 sec	-1.251
	ΔHt.	-16.068 m	0.005 m	0.001 m	0.297
	Ellip Dist.	747.719 m	0.002 m	0.000 m	0.533
WOOL --> 8004 (PV142)	**Az.**	184°38'58"	0.025 sec	0.019 sec	0.670
	ΔHt.	12.324 m	0.011 m	-0.012 m	-0.623
	Ellip Dist.	19960.384 m	0.002 m	0.003 m	1.251

WOOL --> 8002 (PV137)	**Az.**	186°05'42"	0.029 sec	0.024 sec	0.612
	ΔHt.	-12.083 m	0.012 m	-0.018 m	-0.814
	Ellip Dist.	17967.949 m	0.003 m	-0.004 m	-1.245
BDST --> 171104 (PV186)	**Az.**	337°48'05"	0.058 sec	0.044 sec	1.245
	ΔHt.	-18.639 m	0.033 m	-0.003 m	-0.138
	Ellip Dist.	17906.099 m	0.005 m	-0.001 m	-0.313
8008 --> 90501 (PV60)	**Az.**	125°52'31"	1.009 sec	-0.364 sec	-0.757
	ΔHt.	-14.076 m	0.006 m	-0.001 m	-0.485
	Ellip Dist.	447.717 m	0.002 m	0.001 m	1.211
8004 --> 8003 (PV38)	**Az.**	3°22'59"	0.554 sec	-0.578 sec	-1.116
	ΔHt.	-2.038 m	0.006 m	-0.006 m	-1.187
	Ellip Dist.	786.044 m	0.002 m	-0.003 m	-0.746
8004 --> 8006 (PV39)	**Az.**	198°32'52"	0.184 sec	0.193 sec	0.920
	ΔHt.	3.520 m	0.017 m	0.024 m	1.071
	Ellip Dist.	3452.973 m	0.004 m	0.005 m	1.178
8003 --> 101732 (PV23)	**Az.**	106°54'58"	2.288 sec	0.924 sec	1.177
	ΔHt.	-0.048 m	0.004 m	0.000 m	0.217
	Ellip Dist.	154.483 m	0.002 m	0.000 m	-0.715
90501 --> 8006 (PV63)	**Az.**	27°52'49"	0.192 sec	-0.130 sec	-0.804
	ΔHt.	8.650 m	0.011 m	-0.019 m	-1.111
	Ellip Dist.	3408.024 m	0.004 m	0.001 m	0.542
107142 --> 171104 (PV107)	**Az.**	210°22'49"	0.377 sec	-0.151 sec	-0.432
	ΔHt.	2.416 m	0.045 m	-0.011 m	-0.265
	Ellip Dist.	4532.999 m	0.007 m	-0.007 m	-1.071
8008 --> 8009 (PV55)	**Az.**	205°01'40"	0.365 sec	0.128 sec	0.968
	ΔHt.	-1.352 m	0.005 m	0.000 m	-0.256
	Ellip Dist.	1019.003 m	0.002 m	0.001 m	0.989
58886 --> 8011 (PV82)	**Az.**	125°34'45"	1.003 sec	-0.300 sec	-0.893
	ΔHt.	-21.904 m	0.004 m	0.000 m	-0.469
	Ellip Dist.	349.490 m	0.001 m	0.000 m	-0.274
58886 --> 8012 (PV83)	**Az.**	186°38'02"	0.248 sec	0.118 sec	0.692
	ΔHt.	-19.623 m	0.014 m	0.009 m	0.879
	Ellip Dist.	2356.819 m	0.003 m	0.001 m	0.382
BDST --> 8010 (PV158)	**Az.**	356°37'29"	0.038 sec	-0.007 sec	-0.675
	ΔHt.	10.287 m	0.021 m	0.006 m	0.449

	Ellip Dist.	27828.045 m	0.005 m	-0.001 m	-0.864
90501 --> 8010 (PV67)	**Az.**	217°31'52"	0.259 sec	-0.011 sec	-0.060
	ΔHt.	13.140 m	0.008 m	-0.012 m	-0.851
	Ellip Dist.	2122.896 m	0.003 m	0.000 m	0.196
8010 --> 58886 (PV74)	**Az.**	261°09'13"	0.398 sec	0.194 sec	0.850
	ΔHt.	5.837 m	0.005 m	0.000 m	0.134
	Ellip Dist.	956.184 m	0.002 m	0.000 m	-0.333
101732 --> 8004 (PV48)	**Az.**	194°42'28"	0.564 sec	0.253 sec	0.814
	ΔHt.	2.085 m	0.005 m	0.000 m	0.006
	Ellip Dist.	764.787 m	0.002 m	-0.001 m	-0.625
59279 --> 121890 (PV2)	**Az.**	200°16'35"	0.361 sec	0.027 sec	0.096
	ΔHt.	16.386 m	0.008 m	0.002 m	0.536
	Ellip Dist.	1730.383 m	0.003 m	-0.002 m	-0.799
8010 --> 8009 (PV69)	**Az.**	26°02'11"	0.402 sec	-0.118 sec	-0.616
	ΔHt.	-0.416 m	0.006 m	-0.002 m	-0.754
	Ellip Dist.	1137.965 m	0.002 m	0.000 m	-0.256
8003 --> 8007 (PV25)	**Az.**	201°43'43"	0.126 sec	-0.046 sec	-0.296
	ΔHt.	-7.122 m	0.018 m	0.024 m	0.717
	Ellip Dist.	5587.111 m	0.004 m	0.003 m	0.714
WOOL --> 8004 (PV146)	**Az.**	184°38'58"	0.025 sec	-0.015 sec	-0.400
	ΔHt.	12.324 m	0.011 m	-0.010 m	-0.715
	Ellip Dist.	19960.384 m	0.002 m	0.002 m	0.517
171104 --> 61261 (PV113)	**Az.**	185°33'57"	0.363 sec	0.146 sec	0.686
	ΔHt.	11.219 m	0.034 m	0.012 m	0.551
	Ellip Dist.	2878.977 m	0.005 m	0.002 m	0.696
59279 --> 8000 (PV1)	**Az.**	232°41'02"	0.776 sec	-0.030 sec	-0.141
	ΔHt.	-6.084 m	0.006 m	-0.001 m	-0.615
	Ellip Dist.	583.251 m	0.003 m	0.000 m	-0.692
8003 --> 8006 (PV33)	**Az.**	195°45'09"	0.140 sec	0.033 sec	0.331
	ΔHt.	5.558 m	0.017 m	-0.007 m	-0.378
	Ellip Dist.	4216.662 m	0.004 m	0.002 m	0.675
8013 --> 8015 (PV103)	**Az.**	202°30'38"	0.181 sec	0.038 sec	0.247
	ΔHt.	1.817 m	0.036 m	-0.015 m	-0.405
	Ellip Dist.	7083.531 m	0.007 m	0.004 m	0.632
8012 --> 8011 (PV90)	**Az.**	14°35'36"	0.252 sec	-0.060 sec	-0.492

	ΔHt.	-2.281 m	0.014 m	0.005 m	0.616
	Ellip Dist.	2208.947 m	0.003 m	0.000 m	0.033
90501 --> 8009 (PV64)	**Az.**	230°13'09"	0.404 sec	-0.128 sec	-0.571
	ΔHt.	12.724 m	0.006 m	0.000 m	0.052
	Ellip Dist.	1033.004 m	0.002 m	0.000 m	-0.290
8003 --> 8004 (PV28)	**Az.**	183°22'58"	0.554 sec	-0.265 sec	-0.480
	ΔHt.	2.038 m	0.006 m	-0.001 m	-0.102
	Ellip Dist.	786.044 m	0.002 m	0.000 m	0.171
58886 --> 8009 (PV81)	**Az.**	51°00'21"	0.267 sec	0.071 sec	0.459
	ΔHt.	-6.253 m	0.006 m	0.001 m	0.476
	Ellip Dist.	1858.447 m	0.003 m	0.001 m	0.325
8013 --> 107142 (PV95)	**Az.**	205°58'47"	0.377 sec	-0.170 sec	-0.469
	ΔHt.	-19.126 m	0.043 m	0.018 m	0.355
	Ellip Dist.	4576.811 m	0.008 m	0.004 m	0.448
8012 --> 8013 (PV91)	**Az.**	150°44'38"	0.884 sec	0.078 sec	0.255
	ΔHt.	1.570 m	0.009 m	0.000 m	0.318
	Ellip Dist.	786.947 m	0.003 m	0.000 m	0.397
8012 --> 107142 (PV92)	**Az.**	198°39'04"	0.343 sec	0.041 sec	0.151
	ΔHt.	-17.556 m	0.043 m	-0.010 m	-0.361
	Ellip Dist.	5066.920 m	0.007 m	0.002 m	0.318
58886 --> 8013 (PV84)	**Az.**	177°52'30"	0.248 sec	0.030 sec	0.128
	ΔHt.	-18.053 m	0.016 m	-0.005 m	-0.254
	Ellip Dist.	3029.682 m	0.004 m	-0.001 m	-0.300
8013 --> 8011 (PV94)	**Az.**	3°28'57"	0.260 sec	-0.010 sec	-0.039
	ΔHt.	-3.851 m	0.016 m	0.004 m	0.232
	Ellip Dist.	2829.482 m	0.004 m	0.001 m	0.209
8008 --> 8007 (PV51)	**Az.**	32°32'21"	0.334 sec	-0.019 sec	-0.120
	ΔHt.	-18.106 m	0.010 m	-0.001 m	-0.149
	Ellip Dist.	1919.781 m	0.004 m	0.000 m	0.221

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)

101732	8003	**Az.**	286°54'55"	2.296 sec	1 : 99153	1 : 99145
		ΔHt.	0.048 m	0.004 m		
		ΔElev.	0.046 m	0.004 m		
		Ellip Dist.	154.483 m	0.002 m		
101732	8004	**Az.**	194°42'28"	0.565 sec	1 : 345915	1 : 346070
		ΔHt.	2.085 m	0.005 m		
		ΔElev.	2.102 m	0.005 m		
		Ellip Dist.	764.787 m	0.002 m		
101732	WOOL	**Az.**	4°15'28"	0.045 sec	1 : 4456825	1 : 4457156
		ΔHt.	-10.239 m	0.011 m		
		ΔElev.	-10.663 m	0.011 m		
		Ellip Dist.	19207.804 m	0.004 m		
107142	171104	**Az.**	210°22'49"	0.376 sec	1 : 608267	1 : 608148
		ΔHt.	2.416 m	0.045 m		
		ΔElev.	2.541 m	0.045 m		
		Ellip Dist.	4533.000 m	0.007 m		
107142	8015	**Az.**	196°14'10"	0.662 sec	1 : 386863	1 : 386665
		ΔHt.	20.943 m	0.042 m		
		ΔElev.	21.020 m	0.042 m		
		Ellip Dist.	2530.311 m	0.007 m		
121890	8001	**Az.**	205°59'50"	0.240 sec	1 : 767056	1 : 767091
		ΔHt.	-6.320 m	0.017 m		
		ΔElev.	-6.282 m	0.017 m		
		Ellip Dist.	2233.260 m	0.003 m		
121890	8002	**Az.**	195°29'30"	0.227 sec	1 : 839733	1 : 839918
		ΔHt.	3.140 m	0.017 m		
		ΔElev.	3.191 m	0.017 m		
		Ellip Dist.	2678.719 m	0.003 m		
121890	WOOL	**Az.**	4°28'01"	0.054 sec	1 : 3665370	1 : 3664771
		ΔHt.	15.223 m	0.018 m		
		ΔElev.	14.881 m	0.018 m		
		Ellip Dist.	15331.367 m	0.004 m		
171104	61261	**Az.**	185°33'57"	0.365 sec	1 : 561579	1 : 563495
		ΔHt.	11.219 m	0.034 m		
		ΔElev.	11.314 m	0.034 m		
		Ellip Dist.	2878.978 m	0.005 m		
171104	BDST	**Az.**	157°50'00"	0.068 sec	1 : 3091529	1 : 3093526
		ΔHt.	18.639 m	0.033 m		

		ΔElev.	19.032 m	0.033 m		
		Ellip Dist.	17906.103 m	0.006 m		
58886	8012	**Az.**	186°38'02"	0.249 sec	1 : 812704	1 : 809942
		ΔHt.	-19.623 m	0.014 m		
		ΔElev.	-19.555 m	0.014 m		
		Ellip Dist.	2356.819 m	0.003 m		
58886	8013	**Az.**	177°52'30"	0.248 sec	1 : 825511	1 : 824021
		ΔHt.	-18.053 m	0.016 m		
		ΔElev.	-17.961 m	0.016 m		
		Ellip Dist.	3029.682 m	0.004 m		
59279	121890	**Az.**	200°16'35"	0.363 sec	1 : 576101	1 : 576989
		ΔHt.	16.386 m	0.008 m		
		ΔElev.	16.416 m	0.008 m		
		Ellip Dist.	1730.383 m	0.003 m		
59279	WOOL	**Az.**	2°29'17"	0.066 sec	1 : 3226465	1 : 3226703
		ΔHt.	31.609 m	0.018 m		
		ΔElev.	31.296 m	0.018 m		
		Ellip Dist.	13674.594 m	0.004 m		
61261	BDST	**Az.**	152°50'57"	0.079 sec	1 : 2661004	1 : 2661908
		ΔHt.	7.420 m	0.036 m		
		ΔElev.	7.718 m	0.036 m		
		Ellip Dist.	15416.157 m	0.006 m		
8000	121890	**Az.**	186°06'27"	0.399 sec	1 : 492675	1 : 494136
		ΔHt.	22.470 m	0.008 m		
		ΔElev.	22.494 m	0.008 m		
		Ellip Dist.	1276.824 m	0.003 m		
8000	59279	**Az.**	52°41'10"	0.778 sec	1 : 227820	1 : 227291
		ΔHt.	6.084 m	0.006 m		
		ΔElev.	6.078 m	0.006 m		
		Ellip Dist.	583.251 m	0.003 m		
8000	8001	**Az.**	198°47'14"	0.175 sec	1 : 1063982	1 : 1061810
		ΔHt.	16.149 m	0.017 m		
		ΔElev.	16.212 m	0.017 m		
		Ellip Dist.	3461.289 m	0.003 m		
8000	WOOL	**Az.**	4°19'02"	0.058 sec	1 : 3401585	1 : 3401563
		ΔHt.	37.693 m	0.018 m		
		ΔElev.	37.375 m	0.018 m		
		Ellip Dist.	14055.115 m	0.004 m		

8001	8002	**Az.**	155°21'26"	0.710 sec	1 : 323232	1 : 324483
		ΔHt.	9.460 m	0.006 m		
		ΔElev.	9.473 m	0.006 m		
		Ellip Dist.	631.664 m	0.002 m		
8001	8003	**Az.**	161°45'18"	0.288 sec	1 : 760031	1 : 762023
		ΔHt.	31.830 m	0.007 m		
		ΔElev.	31.871 m	0.007 m		
		Ellip Dist.	1914.061 m	0.003 m		
8001	WOOL	**Az.**	7°10'01"	0.048 sec	1 : 4172619	1 : 4171839
		ΔHt.	21.543 m	0.012 m		
		ΔElev.	21.162 m	0.012 m		
		Ellip Dist.	17428.077 m	0.004 m		
8002	101732	**Az.**	159°25'34"	0.385 sec	1 : 591497	1 : 594029
		ΔHt.	22.322 m	0.007 m		
		ΔElev.	22.352 m	0.007 m		
		Ellip Dist.	1376.436 m	0.002 m		
8002	8003	**Az.**	164°53'09"	0.395 sec	1 : 555785	1 : 558175
		ΔHt.	22.370 m	0.007 m		
		ΔElev.	22.399 m	0.007 m		
		Ellip Dist.	1288.255 m	0.002 m		
8002	WOOL	**Az.**	6°06'14"	0.048 sec	1 : 4219081	1 : 4218572
		ΔHt.	12.083 m	0.012 m		
		ΔElev.	11.690 m	0.012 m		
		Ellip Dist.	17967.953 m	0.004 m		
8003	8004	**Az.**	183°22'58"	0.555 sec	1 : 349567	1 : 349725
		ΔHt.	2.038 m	0.006 m		
		ΔElev.	2.056 m	0.006 m		
		Ellip Dist.	786.044 m	0.002 m		
8003	8006	**Az.**	195°45'09"	0.143 sec	1 : 1176388	1 : 1177191
		ΔHt.	5.558 m	0.017 m		
		ΔElev.	5.674 m	0.017 m		
		Ellip Dist.	4216.663 m	0.004 m		
8003	8007	**Az.**	201°43'43"	0.129 sec	1 : 1376901	1 : 1375987
		ΔHt.	-7.122 m	0.018 m		
		ΔElev.	-6.973 m	0.018 m		
		Ellip Dist.	5587.112 m	0.004 m		
8003	WOOL	**Az.**	4°42'32"	0.044 sec	1 : 4486638	1 : 4486941
		ΔHt.	-10.286 m	0.011 m		

		ΔElev.	-10.709 m	0.011 m		
		Ellip Dist.	19174.546 m	0.004 m		
8004	8006	**Az.**	198°32'52"	0.186 sec	1 : 924596	1 : 925029
		ΔHt.	3.520 m	0.017 m		
		ΔElev.	3.617 m	0.017 m		
		Ellip Dist.	3452.974 m	0.004 m		
8004	WOOL	**Az.**	4°39'25"	0.045 sec	1 : 4444367	1 : 4444661
		ΔHt.	-12.324 m	0.011 m		
		ΔElev.	-12.765 m	0.011 m		
		Ellip Dist.	19960.388 m	0.004 m		
8006	8008	**Az.**	215°25'17"	0.189 sec	1 : 951997	1 : 952788
		ΔHt.	5.426 m	0.010 m		
		ΔElev.	5.509 m	0.010 m		
		Ellip Dist.	3375.013 m	0.004 m		
8006	90501	**Az.**	207°52'22"	0.192 sec	1 : 942068	1 : 940817
		ΔHt.	-8.650 m	0.011 m		
		ΔElev.	-8.557 m	0.011 m		
		Ellip Dist.	3408.024 m	0.004 m		
8006	WOOL	**Az.**	6°41'55"	0.043 sec	1 : 4477246	1 : 4477976
		ΔHt.	-15.845 m	0.016 m		
		ΔElev.	-16.383 m	0.016 m		
		Ellip Dist.	23327.113 m	0.005 m		
8007	8006	**Az.**	39°13'35"	0.469 sec	1 : 386947	1 : 385253
		ΔHt.	12.680 m	0.009 m		
		ΔElev.	12.646 m	0.009 m		
		Ellip Dist.	1460.890 m	0.004 m		
8007	8008	**Az.**	212°32'03"	0.334 sec	1 : 544741	1 : 547468
		ΔHt.	18.106 m	0.010 m		
		ΔElev.	18.156 m	0.010 m		
		Ellip Dist.	1919.781 m	0.004 m		
8007	WOOL	**Az.**	8°32'05"	0.044 sec	1 : 4384150	1 : 4384297
		ΔHt.	-3.165 m	0.016 m		
		ΔElev.	-3.736 m	0.016 m		
		Ellip Dist.	24571.450 m	0.006 m		
8008	8009	**Az.**	205°01'40"	0.364 sec	1 : 477097	1 : 476867
		ΔHt.	-1.352 m	0.005 m		
		ΔElev.	-1.326 m	0.005 m		
		Ellip Dist.	1019.003 m	0.002 m		

8008	90501	**Az.**	125°52'31"	1.012 sec	1 : 225179	1 : 220612
		ΔHt.	-14.076 m	0.006 m		
		ΔElev.	-14.066 m	0.006 m		
		Ellip Dist.	447.717 m	0.002 m		
8008	WOOL	**Az.**	10°14'19"	0.039 sec	1 : 5009423	1 : 5010144
		ΔHt.	-21.271 m	0.015 m		
		ΔElev.	-21.892 m	0.015 m		
		Ellip Dist.	26336.842 m	0.005 m		
8009	58886	**Az.**	230°59'56"	0.267 sec	1 : 684065	1 : 684272
		ΔHt.	6.253 m	0.006 m		
		ΔElev.	6.279 m	0.006 m		
		Ellip Dist.	1858.447 m	0.003 m		
8009	8010	**Az.**	206°02'03"	0.397 sec	1 : 465972	1 : 466004
		ΔHt.	0.416 m	0.006 m		
		ΔElev.	0.445 m	0.006 m		
		Ellip Dist.	1137.966 m	0.002 m		
8009	90501	**Az.**	50°13'22"	0.405 sec	1 : 488167	1 : 488733
		ΔHt.	-12.724 m	0.006 m		
		ΔElev.	-12.741 m	0.006 m		
		Ellip Dist.	1033.005 m	0.002 m		
8009	WOOL	**Az.**	10°47'10"	0.038 sec	1 : 5174059	1 : 5174648
		ΔHt.	-19.919 m	0.015 m		
		ΔElev.	-20.566 m	0.015 m		
		Ellip Dist.	27323.325 m	0.005 m		
8010	58886	**Az.**	261°09'13"	0.402 sec	1 : 493374	1 : 493870
		ΔHt.	5.837 m	0.005 m		
		ΔElev.	5.834 m	0.005 m		
		Ellip Dist.	956.184 m	0.002 m		
8010	8011	**Az.**	242°03'28"	0.495 sec	1 : 369425	1 : 367247
		ΔHt.	-16.068 m	0.005 m		
		ΔElev.	-16.062 m	0.005 m		
		Ellip Dist.	747.719 m	0.002 m		
8010	BDST	**Az.**	176°37'57"	0.039 sec	1 : 5230519	1 : 5229989
		ΔHt.	-10.287 m	0.021 m		
		ΔElev.	-9.553 m	0.021 m		
		Ellip Dist.	27828.050 m	0.005 m		
8011	58886	**Az.**	305°34'41"	1.005 sec	1 : 236438	1 : 229693
		ΔHt.	21.904 m	0.004 m		

		ΔElev.	21.896 m	0.004 m		
		Ellip Dist.	349.490 m	0.001 m		
8011	8012	**Az.**	194°35'27"	0.254 sec	1 : 769528	1 : 769708
		ΔHt.	2.281 m	0.014 m		
		ΔElev.	2.341 m	0.014 m		
		Ellip Dist.	2208.948 m	0.003 m		
8011	8013	**Az.**	183°28'54"	0.260 sec	1 : 772907	1 : 773117
		ΔHt.	3.851 m	0.016 m		
		ΔElev.	3.935 m	0.016 m		
		Ellip Dist.	2829.482 m	0.004 m		
8012	107142	**Az.**	198°39'04"	0.340 sec	1 : 702843	1 : 702200
		ΔHt.	-17.556 m	0.043 m		
		ΔElev.	-17.405 m	0.043 m		
		Ellip Dist.	5066.921 m	0.007 m		
8013	107142	**Az.**	205°58'47"	0.375 sec	1 : 606234	1 : 605856
		ΔHt.	-19.126 m	0.043 m		
		ΔElev.	-18.999 m	0.043 m		
		Ellip Dist.	4576.812 m	0.008 m		
8013	8012	**Az.**	330°44'32"	0.884 sec	1 : 259219	1 : 259229
		ΔHt.	-1.570 m	0.009 m		
		ΔElev.	-1.594 m	0.009 m		
		Ellip Dist.	786.947 m	0.003 m		
8013	8015	**Az.**	202°30'38"	0.174 sec	1 : 1081668	1 : 1081749
		ΔHt.	1.817 m	0.036 m		
		ΔElev.	2.021 m	0.036 m		
		Ellip Dist.	7083.532 m	0.007 m		
8015	171104	**Az.**	226°56'37"	0.419 sec	1 : 479998	1 : 480002
		ΔHt.	-18.527 m	0.028 m		
		ΔElev.	-18.480 m	0.028 m		
		Ellip Dist.	2169.380 m	0.005 m		
8015	61261	**Az.**	203°12'43"	0.199 sec	1 : 932137	1 : 931362
		ΔHt.	-7.308 m	0.029 m		
		ΔElev.	-7.165 m	0.029 m		
		Ellip Dist.	4729.339 m	0.005 m		
8015	BDST	**Az.**	164°01'08"	0.060 sec	1 : 3495613	1 : 3495458
		ΔHt.	0.112 m	0.032 m		
		ΔElev.	0.553 m	0.032 m		
		Ellip Dist.	18789.023 m	0.005 m		

90501	8010	**Az.**	217°31'52"	0.256 sec	1 : 732243	1 : 733089
		ΔHt.	13.140 m	0.008 m		
		ΔElev.	13.186 m	0.008 m		
		Ellip Dist.	2122.897 m	0.003 m		
90501	WOOL	**Az.**	9°21'55"	0.040 sec	1 : 5019358	1 : 5019587
		ΔHt.	-7.195 m	0.016 m		
		ΔElev.	-7.826 m	0.016 m		
		Ellip Dist.	26533.624 m	0.005 m		

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