University of Southern Queensland

Faculty of Health, Engineering and Sciences

Integration of Trimble V10 Imaging Rover with R10 GNSS receiver for data collection under dense tree canopies

A dissertation submitted by

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ENG4111 and 4112 Research Project

Towards the degree of

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Abstract

Traditionally a level and detail (Topographic) survey has been conducted through the use of either the modern day total station or GNSS receiver, or both. The aim will be to assess whether the Trimble V10 rover is an adequate tool for conducting a topographical survey under a tree canopy where it is near impossible to conduct a "normal" GNSS survey because of obstructions between the receiver and satellites, and compare this to current surveying methods when confronted with such a situation.

Results will show differences in costing and time taken (both in the field and in the office) thus showing the feasibility of having such a piece of equipment and its "real world uses" when compared to more traditional surveying practices.

Accuracy, cost and time of conducting a topographical survey will be broken down into its base components and a comparative review between the two separate methodologies of conducting the same survey will be assessed, reviewed and commented upon.

The methodology used will be the survey of an area under a tree canopy utilising traditional survey methods and running a comparative survey while using the V10 imaging rover. The survey will be conducted, and marks placed in and around the survey area will be located for comparison. Each survey will be brought into our CAD based program (Trimble Business Centre) and once reductions are made, a comparison between the marks placed will be done.

The results of this project show that it is plausible to utilise this technology for these purposes. While it is possible, it should be noted that there are many different variables involved, and by reading my report to gain a better understanding, I hope surveyors will be able to make that judgement themselves.

Keywords: Survey, Trimble, V10 Imaging Rover, Terrestrial Photogrammetry, Total Station, Topography, GNSS, Trimble Business Centre.

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Certification of Dissertation

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.

Zaine Thompson

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Acknowledgements

I would like to give a special thanks to my supervisor, Zhenyu Zhang, for not only introducing the topic to me, but also giving most needed feedback throughout the project in order to fully understand what was required and identify specifics. A special thanks goes to the University of Southern Queensland for providing all the equipment required to undertake both surveys and an environment to perform said surveys. I would not have been able to compute and reduce any of my gathered data without a licence for TBC, a big thanks goes to UPG solutions for providing access to temporary licences to TBC for these purposes.

As with anything, thanks go to all those friends, family and colleagues who understood that I had this project in the back of my mind, and tried to offer support whenever they thought I needed it.

Thanks to USQ for teaching me everything that was necessary in order to undertake this project.

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Chapter One Introduction

1.1 Introduction

As with any field which has developing technologies, we strive to make tasks more autonomous, user friendly, faster and easier to perform, all the while keeping the level of quality and accuracy as high as humanly possible. In such a technological based field, surveying is no different, and as new technology is developed, so too is the race to develop new ways to make use of this technology in everyday surveying.

This report will look into the possibility of using Trimble's relatively new V10 Rover as a new means in gathering data when conducting topographic surveys in/near tree canopied areas.

In order for you to fully understand this report, you will need to have knowledge of topographic surveys, how they are conducted with both a Total Station and GNSS receivers together with both their strengths and weaknesses and an understanding of photogrammetry and its use to surveyors.

The aim is to prove that it can be done, with accuracies the same or similar to present accuracies attained through traditional methods. If I am correct in my hypothesis, this could become a completely new method of gathering topographical data, save the surveyor time and effort in the field and open up a world of possibilities in many other areas which may not exist as ofyet.

The main objective of this report is to help surveyors around the world understand that there may be other, easier ways to complete certain tasks, with lower costs with an enhanced interactive experience.

The Trimble V10 Imaging Rover is an integrated camera system that precisely captures 360 degree panoramas for visual documentation and measurement of the surrounding environment. Together with a Trimble S-Series robotic total station, V10 spatial station or R10 GNSS receiver, the Trimble V10 Imaging Rover provides an efficient means to quickly capture rich data in the field, perform measurements and modelling in the office, and create comprehensive deliverables.

The literature that I will be discussing is more so about terrestrial photography and its relevance to topographical surveying, as yet, I have not been able to find much information pertinent to the Trimble V10 rover itself, although Trimble does offer current uses for the V10 rover on its website, until the device has been tried and tested on “the world stage” by academics and surveyors alike, Trimble’s account for its functionality should not be taken in too high regard.

1. Terrestrial photogrammetry accuracies
2. Terrestrial photogrammetry and topographical surveying
3. Topographical surveying using GNSS
4. Topographical surveying using total stations

Cadastral surveying is the discipline of land surveying that relates to the laws of land ownership and the definition of property boundaries. It involves interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property, as well as the recording of such information for use on plans, maps, etc. It also involves the physical delineation of property boundaries and determination of dimensions, areas and certain rights associated with properties, whether they are on land, water or defined by natural or artificial features. (Surveyors Registration Board of Victoria, 2015)

It is important that we understand what it means to be a cadastral surveyor and what types of survey will generally be conducted under this particular field. More often than not, a topographical survey will be conducted by a cadastral surveyor.

1.2 Project Aim & Specific Objectives

If successful in proving my hypothesis, it will be interesting to see if using the V10 rover will be utilised by more surveyors over the coming years, not only because of its potential use for what I am trying to test, but in many other environments and fields in the entire industry. The V10 opens up the possibility of someone with very little knowledge of surveying and its methods, to undertake a topographic survey, gathering the data, for a surveyor to later reduce in the office, and the surveyor will have real time photographs of the site, allowing them to understand exactly what has been captured, without ever really stepping foot on the project site in question.

The unfortunate part, as with any dissertation, is the feeling as not being learned enough to be able to formulate a method, and thus results, from a strictly studies based stand point. Producing a report such as this has certain consequential effects on the industry if anything were to go awry and misleading due to any lack of knowledge. It should be noted, that the methodology for using and actually utilising the V10 rover in my scenario, can one day become a typical surveying practice, but at the moment it is only an idea, and should not be utilised until it has been tried and tested in many different situations.

1.3 Consequential Effects and Responsibility

The Surveyors Board of Queensland's code of ethics (Surveyors Board of Queensland, 2010) found in Appendix 1 it is the surveyor's responsibility that all work completed is of the highest standard, with the communities' interest always taken into consideration. As per sections 2.2, 2.3 and 2.4 of the code I shall strive to know my competence levels, not taking on a task above mine own competence and undertake all tasks with the highest level of both professional and personal conduct. Under section 2.8 of the code, the natural and Built environment should be taken in high regard with special consideration of any environmental effects that surveying works may have, and if so, reducing the effects of environmental damage should be of high importance. As always, the integrity and ethics behind every task completed should be taken into consideration and held in high repute.

Chapter Two Literature Review

2.1 Photogrammetry and Accuracies involved

Photogrammetry has been used for many years in the surveying industry and can be defined as; The art, science, and technology of obtaining reliable information about physical objects, and the environment, through processes of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomena. (Manual of Photogrammetry, 4th Ed., ASPRS, 1980)

The advantages of photogrammetry, its uses and relevance to the surveying industry far outweigh the disadvantages. When deciding "when Is the right time to implement photogrammetry", the following factors should be considered:

- It is a safe option in a hazardous area, as it can be completed from a distance
- It is a cost efficient way of mapping large areas
- Creates a photographic record of the site and surrounding area
- Produces a Digital Elevation Model

As of a 2006 article written by the Californian government describing Photogrammetric surveys (California Department of Transportation, 2006), the following was considered to be the main disadvantages of the use of photogrammetry if the survey presents the following conditions;

- The accuracy required for the project is greater than the achievable accuracy with photogrammetric methods
- The scope of the work is not large enough to justify the costs involved in performing the subsequent photogrammetric processes.

Six years on, I feel as though technology has come far enough to be able to combat these ‘disadvantages’, how far, well that is what we are here to find out.

In a recent journal published this year (Sapirstein, 2016) a table labelled as ‘Photogrammetric errors reported in recent studies’ takes the results of 20 studies completed in the last eight years, all with equally comparative project scale and with an easy to interpret error achieved (in mm) when compared to Total Station (a) and Scanner (b) data. I have included this data as Appendix 2

Although the compiled report was not conducted from a surveyors’ standpoint, where accuracy was key, many of the articles it lists have undertaken survey specific practices to test different photogrammetric principles and show a range of errors and discrepancies due to the different camera’s being used, the scale of each project and in some cases, broadcasts a sub millimetre error, which will be the difference between gathering the data through either the Total Station (a) or Scanner (b). This is a very promising article for my research, as, based on previous topographical surveys I have conducted, gathering data up to 20mm of accuracy can be seen as being accurate enough for this type of survey.

Many of the studies conducted when the subject body was a ‘building’ and the scale was over a larger area, we can see that sub 30mm errors are common throughout. This will be extremely prevalent information for the rest of this report.

2.2 Topographical Surveying

As defined by (Adobe Associates, inc, 2016) Topographic Surveys are used to identify and map the contours of the ground and existing features on the surface of the earth or slightly above or below the earth's surface (i.e. trees, buildings, streets, walkways, manholes, utility poles, retaining walls, etc.). If the purpose of the survey is to serve as a base map for the design of a residence or building of some type, or design a road or driveway, it may be necessary to show perimeter boundary lines and the lines of easements on or crossing the property being surveyed, in order for a designer to accurately show zoning and other agency required setbacks.

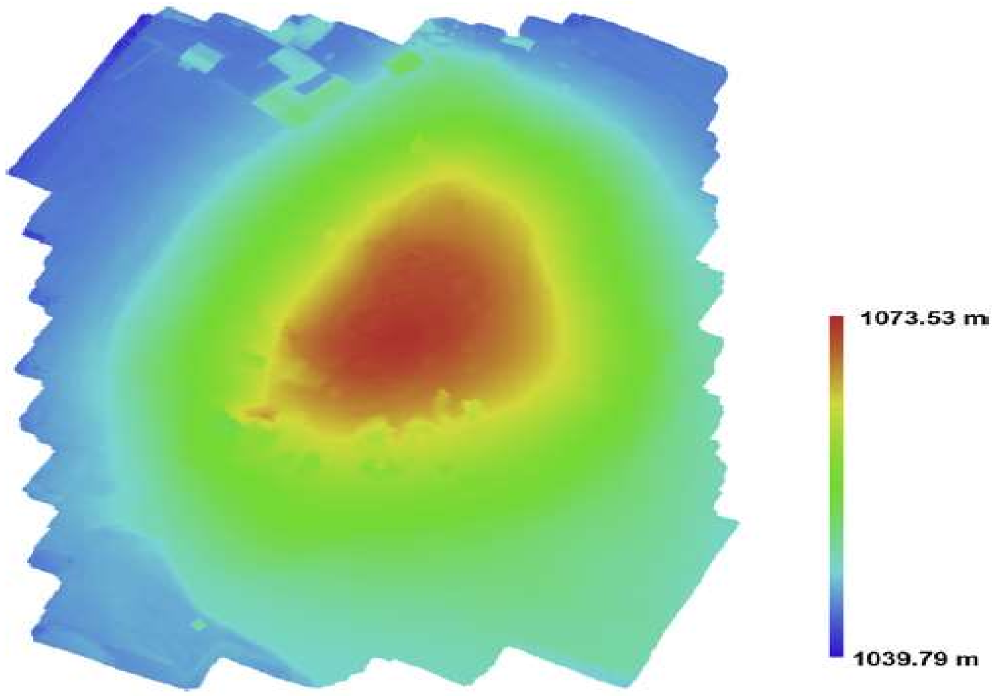
Figure 2.1 - Bench Mark (Z Thompson, 2016)

Topographic Surveys require "bench marks" to which ground contours are related, information regarding surface and underground utilities, determination of required setbacks, etc.

Through the use of topographic surveys, we can accurately show land form (with contours) for a specific area, in great detail. A "bench mark" is generally surveyors' mark which has been cut into a wall, pillar, building or placed as securely as possible in the ground. It has a fixed set of coordinates associated to it and has been as accurately surveyed as possible (Generally through the use of Total Stations to find the horizontal coordinates and a digital level for the vertical coordinates).

There are various different methods for ascertaining the data for a topographical survey, photogrammetry has been used for quite some time in order to gather data over extremely large areas, however, when a topographical survey is completed in a smaller area for cadastral purposes, it is generally done with the use of either a GNSS (Global Navigation Satellite System) receiver or a Total Station, both sporting their own advantages and disadvantages with varying accuracies, and it is generally up to the surveyor at the time to make an assessment as to which method they use.

Figure 2.2 - DTM from aerial photogrammetry (Uysal, Toprak, & Polat, 2015)



Once the data has been gathered through one of the varying methods, it is reduced through the help of software and a DTM (Digital Terrain Model) is formed. A DTM is a model of the terrain which has been surveyed and shows the rise and fall of the land in digital form. After producing this DTM a surveyor can choose to do many things with this information, such as create a topographical map of the surveyed area. An example of a typical DTM which has been created through the use of aerial photogrammetry with a UAV has been included.

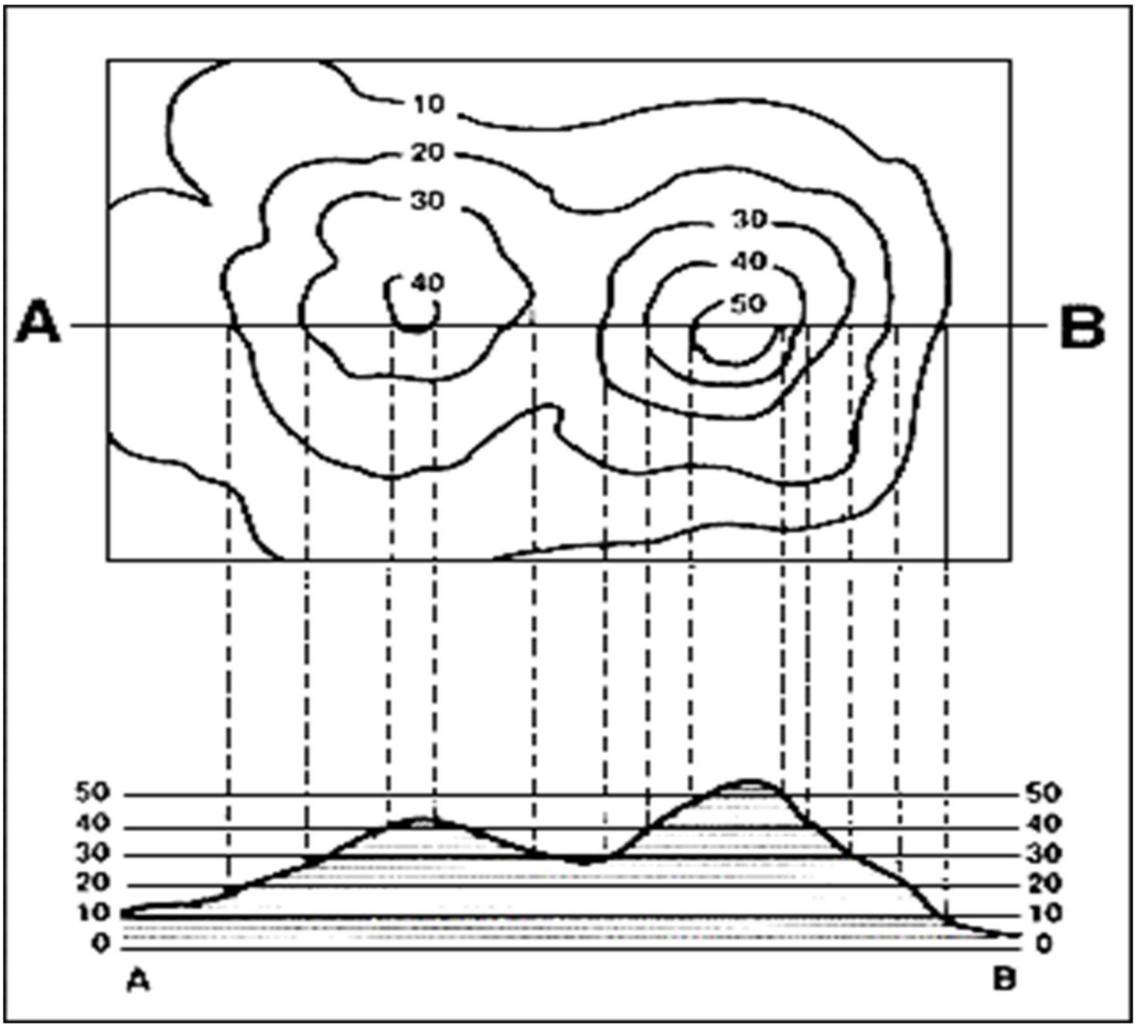


Figure 2.3 - Contours shown in 2D (Pro17 Engineering, 2016)

2.3 Surveying using the Global Satellite Navigation System

The Global Satellite Navigation System (GNSS) more commonly known by Global Positioning System (GPS) in the past is a highly advanced system of satellites which are run by many different countries and private enterprises the world over, which allow for the general public (whom has access to receivers) to get precise point positioning for x,y&z values with extremely high accuracy.

GNSS is a satellite system that is used to pinpoint the geographic location of a user's receiver anywhere in the world. There are three main segments that make up the GNSS as identified in USQ's course SVY1110 – Introduction to GPS (University of Southern Queensland, 2013);

1. The space segment
2. The control segment
3. The user segment

<u>2.3.1. The Space Segment</u> involves information which relates to the satellites, their orbit, speed location etc. for the purpose of this report we will not need to look into this segment.

<u>2.3.2. The control segment</u> involves information which relates to the tracking of said satellites, maintaining accuracy, timing and course projection. For the purpose of this report we will not need to look into this segment.

<u>2.3.3. The user segment</u> relates directly to this report. We as surveyors are the end user of this technology and only need look into the accuracy of our receiver to make sure that it correlates with the local surveyors' authority in possible error.

Differing accuracy is achievable depending on the type of receiver, observation technique and processing procedure used. USQ conducted a test of different receivers using different observation techniques and gathered their results into the following table;

Correction Method	Magellan Tracker	Trimble GeoXT	Trimble ProXR	Trimble 5800
Autonomous	15	15	15	15
Real-time code differential (short baseline)	N/A	<1	0.5 – 0.6	N/A
Post-processed code differential (DGPS)	N/A	<1	0.4 – 0.5	N/A
Post-processed carrier phase differential	N/A	0.05 – 0.2	0.05 – 0.1	N/A
Real-time carrier phase differential (RTK)	N/A	N/A	N/A	0.01 + 1ppm of baseline length

Figure 2.4 - Approximate horizontal accuracy (m) (2D RMS) (University of Southern Queensland, 2013)

Attached to the results was "Depending on satellite geometry, in general the vertical accuracy is from 1.5 to 5 times worse than the horizontal accuracy" thus it should be noted that GNSS is not the best tool for gathering vertical information.

Due to there being a large number of observation techniques utilised by surveyors, it should also be noted that RTK (Real Time Kinematic) will be the sole observation technique throughout this project. It is the most commonly used method of observation with GNSS receivers for both 'stop and go' (contour and detail pickup) and 'continuous' (photogrammetric control and defining linear features such as roads), thus other observation techniques will not be looked into.

Figure 2.5 - Typical RTK rover configuration (University of Southern Queensland, 2013)

RTK allows information from the base station to be processed in the receiver in real time. It is very useful for detail surveys. One of its major issues is multipath (bouncing of signal off street furniture).

2.4 Surveying using a Total Station

Over the course of history, the profession of surveying saw many advancements in technology, and built equipment to suite. The modern day total station (jigger) has come a long way from the old theodolite and steel chain used decades ago. Total stations, combined with prism's can perform many different tasks and aid surveyors in their work in much more than even they can possibly imagine. While a total station can be used to perform a wide range of tasks, at its core, when broken down, we can say that it performs two tasks, with extremely high accuracy. It can measure angles (between many points) and measure distances (between itself and a specialised prism) using EDME (electronic distance measurement).

Figure 2.6 - Trimble S6 Total Station (University of Southern Queensland, 2014)

By regulation, total stations must be inspected and corrected to tolerance at least once a year. The tolerance (allowable error) varies from product to product, but it is generally accepted as being menial/negligible as it is common practice to keep in mind that nothing is going to be totally accurate.

The use of Total station for topographic surveying is commonplace in the surveying industry. Although a total station will always have some form of error involved, for the purpose of this project, we will be using total station data as our control survey, thus, inaccuracies will be null and void and our total station data will be the benchmark for our tests in our comparative review.

2.5 Review

In order to conduct a topographical survey using the V10 in conjunction with the R10 GNSS receiver, disadvantages of current techniques and advantages of the new technology have to be assessed to prove viability.

Table 2.1 - The advantages and disadvantages of detail surveys with a total station.

Advantages	**Disadvantages**
Utilised by the broad surveying community	Expensive
Understood to be accurate and acceptable	Bulky with lots of pieces of equipment
Easily understood with minor instruction required for new personnel in the field	Limited to line of site
Safe	Limited to where control is placed and inaccuracies of traversing through multiple stations
Pickup of only what is required	Can have disastrous implications if equipment is bumped
Reduction is simple	Time consuming pickup on large jobs

Table 2.2 - The advantages and disadvantages of detail surveys with a GNSS receiver.

Advantages	**Disadvantages**
Utilised by the broad surveying community	Expensive
Understood to be accurate and acceptable	Possibility of multipath error from obstructions
Easily understood with minor instruction required for new personnel in the field	Limited to line of site to satellites
Safe	Can have disastrous implications if equipment is bumped or dropped
Pickup of only what is required	Trees greatly affect signal quality and accuracies
Reduction is simple	Possibility of the satellites being inaccessible due to uncontrollable events (war)
Compact	
Can move about the site freely and have large distances between control and survey site	
Pickups on large sites can be done faster through the use of vehicles	

Table 2.3 - The advantages and disadvantages of detail surveys with a GNSS receiver paired with a V10

Advantages	**Disadvantages**
Inexpensive if an R10 is already in the inventory	New technology
No possibility of loss of signal to satellites as all shots are taken from an area not covered by tree canopy	Possibility of multipath error from obstructions
Easily understood with minor instruction required for new personnel in the field	Reduction of data is time consuming due to computer processing of photogrammetric points
Safe	Can have disastrous implications if equipment is bumped or dropped
Pickup of entire site for future reference	Needs a specific controller to use
Pickup is quick and easy	Possibility of the satellites being inaccessible due to uncontrollable events (war)
Compact	
Can move about the site freely and have large distances between control and survey site	
Pickups on large sites can be done faster through the use of vehicles	

While it may not seem as though there are large differences between the different methodologies in advantages and disadvantages, it should be noted that all methodologies do require almost identical type surveys to be conducted and the only difference therein lies in the equipment being utilised, which all has the same type of ease of use to pick up and reduce data due to it all being manufactured by the same company to undertake the same task.

The major advantage of using the Trimble V10 over a generic GNSS survey is that, in only using the GNSS receiver, parts of the site may be impossible to pick up due solely to tree canopies. The V10 is unobtrusive, sits just under the R10 and can be utilised at any point. This opens up a world of possibility for the surveyor as they will no longer need to have their $50 000 total station on standby in order to complete the survey.

The major advantages of using the Trimble V10 in conjunction with the R10 over a generic survey using a total station is that, the time taken in order to gather all the data over a whole site is much greater using a total station, and there are limitations as to what data is obtainable from specific stations due solely to line of site, which is an important issue in a high vegetation environment.

The disadvantage of using the V10 over other methodologies is time taken in the office. Reducing the data of a topographic survey using either R10 or total station is quick and easy, the points file is not too large and can be computed in a matter of minutes. Because the V10 takes 12 high quality photographs from each surveyed station, the reduction of the data is a very labour intensive task on the computer, and can quite often cause the program to crash due to graphics limitations.

Chapter Three Methodology

3.1 Method to be used

Direct testing will be the only way through which we will be able to verify our hypothesis. A mock survey will need to be performed in an area well suited to conditions which will need to meet a pre-defined set of conditions. Once a specific location has been chosen, a baseline topographic survey will need to be completed through the use of a total station. Pegs will be placed in and around a subject area which will make up a reliable test scenario. Once this survey has been completed and compiled, the DTM will become somewhat of a baseline or reference survey. Our second survey will be conducted with our GNSS/V10 receiver, the results between the location of the pegs picked up with the two different pieces of equipment will be identified, proving whether or not a DTM will be able to be constructed from this data thus proving the hypothesis. A detailed listing of methodology has been listed below;

1. Research and understand all relevant theory involved in and around the Trimble V10 rover
2. Have a reasonable understanding of terrestrial photogrammetry and its uses toward topographic surveying
3. Have an understanding of the general hardware and software that I will require throughout the testing of my dissertation
4. Conceptualise an appropriate area to undertake all testing
5. Organise to borrow equipment for the use of a ground based survey
6. Gather data in the correct method, firstly base data, then comparative data in order to ascertain results
7. Organise the use of appropriate software in order to reduce all collected data
8. Reduce collected data

9. Analyse collected data and complete a comparative review of base data vs test data

10. Review results, record and publish results to this report.

3.2 Equipment

For this project I will not only require the survey specific equipment, but also other equipment which will help me undertake the survey.

3.2.1 Survey

All pertinent equipment will be leased out by the University of Southern Queensland, if not, I will endeavour to get a hold of Trimble to lease out the equipment required which includes;

- Trimble V10 Rover
- Trimble Robotic Total Station
- Trimble R10 GNSS Receiver
- Typical survey based equipment (tripod, stakes, measuring tape, etc.)

Figure 3.1 - Trimble S6 Total Station (Trimble Navigation Limited, 2016)

Figure 3.2 - Trimble R10 GNSS Receiver (Trimble Navigation Limited, 2016)

Figure 3.3 - Trimble V10 Receiver (Trimble Navigation Limited, 2013)

3.2.2 Software

In order to reduce any of the data after collection I will require access to Trimble Business Centre (TBC). Unfortunately, as an external student at the USQ, I do not meet the requirements to get a licence through the university. I have been in touch, however, with Chris Power at UPG (Ultimate Positioning Group - https://www.upgsolutions.com/ who have gratefully provided me with a month licence for TBC.

Microsoft office has become a staple program among students, and will be utilised for this report.

3.2.3 Resource Analysis

Table 3.1 - Resource Requirements

ITEM REQUIRED	FROM
Trimble V10 Imaging Rover	USQ
Trimble R10 GNSS Receiver	USQ
Trimble GNSS 2m Pole	USQ
Trimble Controller	USQ
Trimble Robotic Total Station	USQ
Trimble Traversing Set	USQ
Tripod Legs (1-3)	USQ
Pegs and GI Nails for control marks	USQ
Sledge Hammer	USQ
Measuring Tape (8m)	USQ
Survey Ribbon	USQ
High Powered PC (Able to run TBC)	Zaine Thompson
Trimble Business Centre	UPG & Trimble
Camera (capture proceedings)	Zaine Thompson
Vehicle to transport equipment to allocated site	Zaine Thompson

As can be seen above, mostly all requirements are covered either by USQ having supplied the equipment, or myself. There are however some exceptions.

UPG have provided me with a month licence for me to do my project work and data reduction. I have had access to all equipment and software thanks to UPG and USQ.

3.3 Site specification/Study area

The site will need to meet a predetermined set of requirements, which not only test the V10 in the natural built environment, but also represents a typical location that a topographic survey would take place, and make it somewhat difficult for the surveyor to complete due to the terrain, tree coverage and location. The site will need to be;

1. Of appropriate size in a suburban environment where a topographical survey would normally be required if work were to be conducted.
2. Have a diverse range of furniture to pick up, as well as a variable and changing landscape
3. Have an area which has a dense tree canopy for a specified distance greater than 20m long and be greater than 10m wide, with an open view to satellites when standing away from the drip line of the tree canopies
4. Have a changing modulating topography to test the equipment to the extents of its capabilities.
5. Place marks in the ground to create a partially controlled test.
6. The site has been selected and is located at 121 Baker Street, Darling Heights, Toowoomba.

Figure 3.4 - Proposed Survey Site (Google, 2016)

Figure 3.5 - Proposed survey site (Standing East, looking North West) (Thompson)

Figure 3.6 - Proposed survey site (Standing West, looking North East) (Thompson)

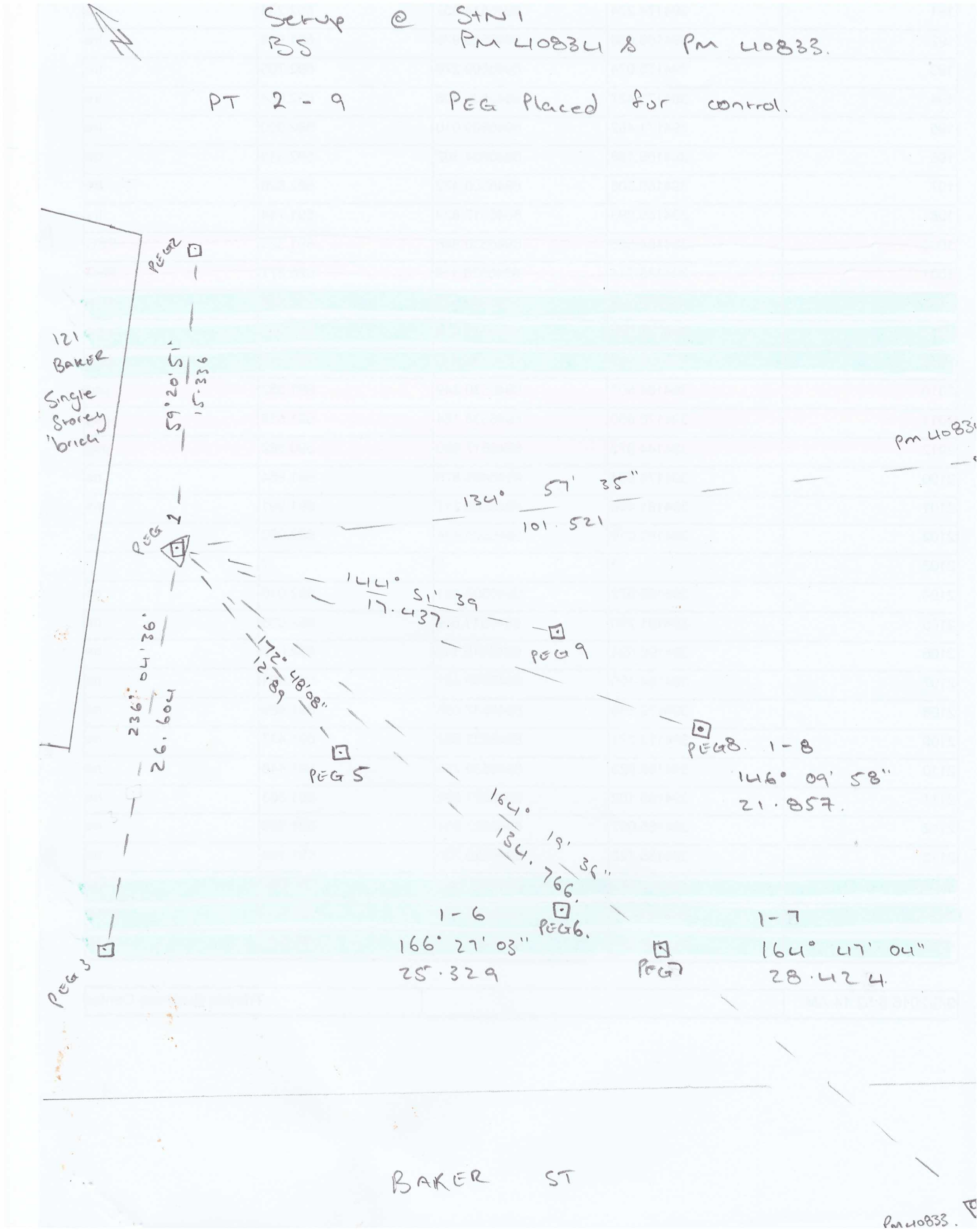
3.4 Data Collection

The collection of data has been made utilising both sets of equipment.

3.4.1 Total Station

By setting up the total station on peg #1 by resection, back sighting to PM 40833 and PM 40835 I was able to setup the jigger without much difficulty and quite accurately, one important note is that due to inaccurate target heights, the whole project was brought down by 0.280m by editing the RAW data. This has no consequences upon the quality of the data, it does however mean that the survey will not be on AHD, the whole survey will be below AHD by 0.28m. I commenced placing stations in and around my project area (pegs which would be stable to compare levels off of) and conducted topographic survey of the area using the total station. Time taken for the Total Station field survey of the entire site was 3 hours. The following drawings describes said survey.

Figure 3.7 - Visual representation of conducted survey (Thompson)



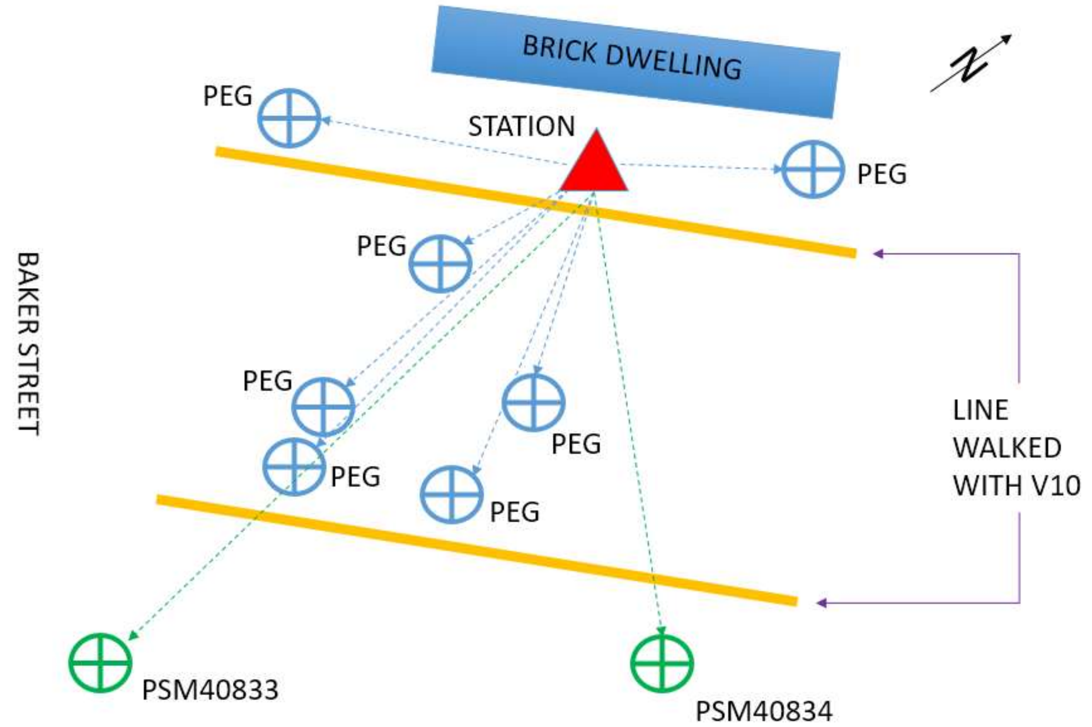


Figure 3.8 - Visual representation of conducted survey

3.4.2 GNSS receiver with V10 Rover

Upon completion of my topographic survey using the total station I conducted the same survey with the GNSS receiver paired with the V10 rover. By using the USQ's base (ANANGA1), RTK was established and check shots were taken on the same PM's as used previously. On the pegs that were placed which had no obstructions, I took a shot on with the GGNSS receiver. Then by walking parallel to the tree line and taking ground shots, the V10, in theory, should pick up all the data under the tree line. Time taken to conduct survey was 30 minutes.

Figure 3.9 - Pickup using the V10

3.5 Data Reduction

3.5.1 Data Reduction of Total Station survey

1. The whole job file from the total station survey should be exported from the faceplate of the S6 total station
2. The points file from the total station survey was imported into Trimble Business Centre through the use of the import function in the program
3. A quick review was done to make sure everything had been imported correctly
4. The accuracy of the survey was double checked against the locations of the two PSM's compared to where the targets were setup on
5. A points file of easting, northings and vertical levels with codes was created for later review
6. This concluded the total station reduction. Time taken to reduce the data was 30 minutes.

3.5.2 Data Reduction of V10 survey

1. Upon completion of reducing the total station survey, the job file from the V10 survey was exported to the V10's designated controller
2. Both the photo control stations (17) and their corresponding panoramic photographs were imported into the same job as used to reduce the total station data for ease of analysis later on.
3. The process of importing the data was very time consuming (30 minutes)
4. After importing the V10 data into TBC, the "V10 workflow tab was made more easily accessible
5. To reduce this data, firstly the photographs have to be matched and rendered.
6. Stations views were created at each photogrammetric station

7. All the photo stations should be given an adjustment type; the adjustment should be set to a “Full Orientation” setup type. This adjusts the stations compass and tilt values, while holding the 3D coordinate of the station fixed.
8. After setting the adjustment type, an automatic tie point adjustment was conducted. After pressing the button “Find Tie Points” in TBC, the program goes through each pixel in each photograph to distinguish common features which it can then utilise to tie the survey together. As I was not using photogrammetric targets this process took around 2 hours to complete.
9. Due to the amount of stations and bad geometry, it was necessary to run this reduction a number of time as well as computing manual tie points within the survey in order to finish the adjustment. This took a further 3 hours.
10. After the adjustment had been completed, TBC automatically computes a results of the adjusted photo stations. These help provide a metric analysis of the quality of the adjustment.
11. Additional results were accessed by opening the “Terrestrial Bundle Adjustment Report” window in TBC.
12. The panoramas were then processed and stitched together to make for better viewing.
13. Finally, by panning through the environment in Trimble Business Centre, points were created on all of the pegs through the use of a pixel picker in the program.
14. By then creating a points file for these points identified on top of the middle of the pegs as accurate as possible, an analysis can be conducted between the pegs measured with a total station, and the pegs measured through the use of the V10 and identified in TBC.

3.6 Achieving Results and Analysing

Results can be found under Chapter 5 Results and Discussion. By identifying the difference in accuracies, a reliable solution between the two methodologies can be shown, and a proof can be concluded.

Chapter Four Results and Discussion

The assessment between our two methods of the gathering of data will be done in two stages. Firstly, the viability of control will be assessed, by checking differences in both horizontal and vertical, the horizontal and vertical position of arbitrary marks placed on the ground will also be checked for accuracy, This will form my main "proof" to dictate the viability of the survey, as the main aim in any survey is accuracy, and by comparing the accuracy of the pegs placed on the ground, essentially, the accuracy over a whole site utilising the two different methods can be understood. Secondly, a cost and time evaluation between the two separate methodologies will be done. Lastly, if time permits a DTM (Digital Terrain Model – 3-dimensional representation of the terrain) will be created using the two separate datasets, the DTM will be contoured as this will be a visual representation of the same surface, measured through the two separate methods.

Please refer to Appendix 5 for all point data.

4.1 Survey

The survey using the two separate methodologies went well overall. The following table shows the major differences between the two methodologies in variable constraints

Table 4.1- Differences between field surveys

	Using Total Station	**Using V10**
Time taken to conduct field survey	3 hours	30 minutes
Ease of survey	Moderate	Easy
Equipment required for survey	• Total Station • Survey controller • 3 x Tripod • 2 x Prism's & tribrach's • Survey pole & 360 prism • Other	• R10 GNSS Receiver • V10 panoramic camera • Survey controller • V10 survey pole • Other

As can be seen from the table above, gathering data with the V10 is much faster than by using the traditional method of pickup with total station., by doing detail over the entire site with the total station, there is no need of a revisit, sometimes this does take a significant amount of time more than perhaps getting a few required points, but as with surveying, revisiting a site to get one more shot on something will always be more painstaking than just going the extra mile at the time and getting more than what is required. Through using the V10, setup was easy, the checks were easy to conduct in the field and the entire survey was easy, because at each photo station a full 360-degree photograph is taken, there is no need to revisit the site as you are then able to create points on any of the visible area's in the photographs.

This methodology will be a far cheaper option for those looking at conducting this type of survey on a daily basis, it limits the use of the total station to almost negligible, and, if need be, the buying of a total station could be totally ignored to reduce costs and improve profits.

4.2 Reduction

Table 4.2 - Differences between reductions of survey

	Using Total Station	**Using V10**
Time taken to conduct reductions	30 minutes	5+ hours
Ease of reductions	Easy	Moderate/Time consuming
Possible processing power required by computer	Low	High

The amount of time taken to reduce the data is an extremely important aspect and will be discussed later in Chapter 5.

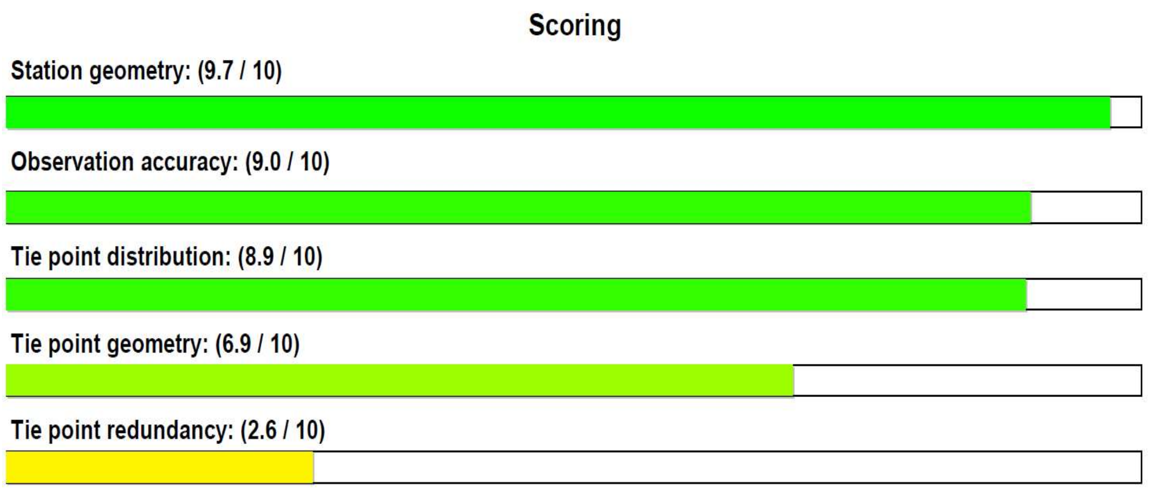


Figure 4.1 - Terrestrial adjustment results

The above results showing the accuracy of the terrestrial adjustment is an automatic table created within TBC to allow the surveyor understand the quality of their adjustment. The different scores represent a scoring out of 10 on different variables, being;

1. Station geometry

   This is a metric for how large the angles are between connected stations. Connected stations being those which share tie points.

2. Observations accuracy

   This is a metric for how accurately observations have been made. Multipath reflections and weak satellite coverage can lead to poor RTK position observations.

3. Tie point distribution

   This is a metric for how evenly tie points are distributed. Poor distribution causes station resections and tie points in sparse areas to be less accurate.

4. Tie point geometry

   This is a metric for how large the angles are between photogrammetry observations to the same tie points. When a lot of the tie points have small angles, it tends to make the adjustment less stable and less accurate.

5. Tie point redundancy

   This is a metric for how much redundancy is present in the tie point observations. Without redundancy, the software cannot detect certain blunders. It should be noted that it is common for redundancy to be low when tie points are found automatically.

Due to this, the reduction and adjustment of the V10 survey was accurate and good enough to create a points file on the pegs placed.

4.3 Quality of Control

Table 4.3 - Control Evaluation

*(T) = Shot with Total Station
*(G) = Shot with GNSS Receiver

POINT	CODE	EASTING	NORTHING	RL	ΔHZ	ΔVZ
40833	PSM (T)	394200.967	6946401.086	693.664		
2000	PSM (G)	394200.986	6946401.115	693.658	0.035	-0.006
40834	PSM (T)	394236.379	6946459.108	693.863		
2001	PSM (G)	394236.386	6946459.114	693.865	0.009	0.002
40835	PSM (T)	394256.528	6946492.489	693.837		
2002	PSM (G)	394256.532	6946492.482	693.846	0.008	0.009
AVERAGE OVER CONTROL MARKS STORED					0.017	0.006

Firstly, I will address table 7. The purpose of table 7 is to provide a representation between the data gathered from the Total Station and the GNSS receiver. It is an assessment of how accurate the GNSS fix is, and thus, how viable the proceeding survey conducted was. Although coming back quite well, the 35mm in horizontal difference between PSM40833 located with the Total Station and point 2000 located with the GNSS receiver. This error can be put down too many different variables, it was my first point stored using the GNSS receiver, so I may not have waited long enough for an accurate fix, PSM40833 is surrounded by large bushy trees which, too, may have played an integral part in this error of 35mm. But at the end of the day, this report is here to identify the differences between the two methodologies in a "real world" environment, and discrepancies like this are an integral part of surveying, so I am happy to accept this differential, because, although being out, my other control marks have come back quite reasonable, thus, I see this as being an isolated error.

When averaged out the delta's come back under tolerance when using a GNSS receiver in normal conditions. What is more interesting is the differences between heights (RL's) of the three stations. Because this survey is being mainly conducted as a topographic survey, with the goal to create a DTM of the area, heights play an integral role in the evaluation between the two survey methodologies, so I am very glad to see, at this early a stage, the differentials between station heights being so low, under 10mm is very desirable when considering GNSS and all its theoretical errors that are present.

It should be noted once again, that although I have used PSM's and their coordinates, this survey does not fit on AHD as heights have had to be changed due to an early error on my part, due to wrong target heights. The whole job has been dropped 0.280m, thus not affecting the survey, except holding that all points will not be on AHD.

4.4 Quality of Marks Placed

Table 4.4 - Control Pegs Point Evaluation

*(T) = Shot with Total Station
*(G) = Shot with GNSS Receiver
*(P) = Shot with V10 Receiver

POINT	CODE	EASTING	NORTHING	RL	ΔHZ	ΔVZ
1	PEG (T)	394164.565	6946530.821	691.321		
2010	PEG (G)	394164.503	6946530.849	691.352	0.068	0.031
2	PEG (T)	394176.898	6946538.130	691.495		
2011	PEG (G)	394176.860	6946538.184	691.516	0.066	0.021
3	PEG (T)	394144.149	6946517.090	690.881		
2012	PEG (G)	394114.072	6946517.080	690.882	0.077	0.001
AVERAGE OVER CONTROL PEGS PLACED BETWEEN GNSS & TS DATA					**0.071**	**0.018**
5	PEG (T)	394166.180	6946518.033	691.612		
4020	PEG (P)	394166.161	6946518.026	691.612	0.020	0.000
6	PEG (T)	394170.499	6946506.197	691.903		
4023	PEG (P)	394170.475	6946506.266	691.863	0.073	-0.040
7	PEG (T)	394172.025	6946503.393	692.488		
4024	PEG (P)	394172.002	6946503.376	692.433	0.029	-0.055
8	PEG (T)	394176.735	6946512.665	692.477		
4021	PEG (P)	394176.738	6946512.686	692.441	0.022	-0.036
9	PEG (T)	394174.601	6946516.562	691.749		
4022	PEG (P)	394174.596	6946516.575	691.737	0.014	-0.012
AVERAGE OVER CONTROL PEGS PLACED BETWEEN V10 & TS DATA					**0.032**	**0.029**

Table 8 gives us two different, yet, relatable sets of data. This data can be more easily represented in the below graph.

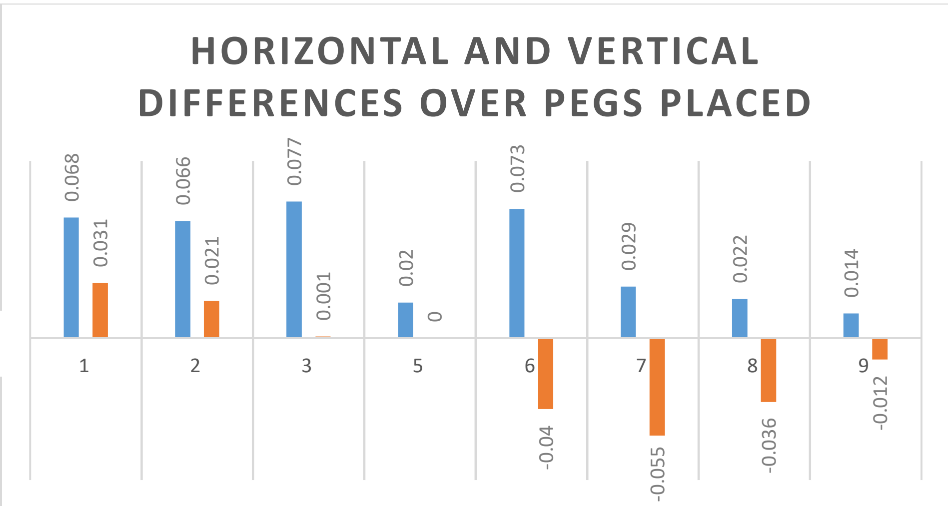


Figure 4.2 - Differences between marks placed

4.5 Review of Results

These results have been achieved after conducting the survey using the two separate methodologies, reducing all the data and doing a direct comparison between these two sets of data. A full discussion of these results will take place in Chapter Six under discussion, however, I would like to address this data very briefly to discuss the technicalities.

Through placing pegs both in and out of the tree line I was able to have a network of “control” pegs which I was able to check upon utilising firstly the GNSS receiver, and eventually the V10 under the tree canopy, I am left with a situation on which I can base my findings. It should be noted that in this situation, the accuracy and precision of total stations are not brought into light as I am assuming my survey done with the total station is wholly correct, due solely to the fact that it is accepted by the broader surveying community to be ‘the’ most accurate way to gather this kind of data.

After establishing that my control came back within tolerance. I am then left to distinguish the accuracy and precision of my V10 survey. Because I am ignoring errors from my total station survey, we have to understand that there is a 10 – 20mm possible error in these readings for whatever reason. Furthermore, we should also understand that in general GNSS topographical surveys there is the possible of errors, generally around the +-30mm mark depending on many factors, and can sometimes be worse when considering vertical readings. Finally, we have to take into consideration the errors that come into effect in terrestrial photogrammetric surveys. With three lots of possibilities in error in all axis’ I believe that my differential over all marks placed all comes back within tolerance, even with some very large outliers.

In figure 17, the x axis is the pegs placed and their corresponding point number, the y axis represents a difference in mm, where the horizontal line at zero is a points location picked up with the total station and the distance from that its differential off the control. The blue columns represent the differential in the horizontal direction, which is why all the differentials are in the positive. The orange columns represent the differential in the vertical direction (which is more important to us when considering topographical surveying) and ranges between being above the control by a certain distance and below the control.

The largest outlier in the horizontal was around the 75mm mark and the larges outlier in the vertical was around 55mm. Although being substantially large, and this large an error would not meet standards when conducting topographical surveys, it should be noted that these are the outliers. The smallest outlier in the horizontal was 14mm and the smallest outlier in the vertical was zero mm, going to show, that there is an issue on accuracy of the pickup.

4.6 Costing and Time

While it can be quite difficult to get an accurate costing on different pieces of equipment in the surveying industry due to resellers pricing each item dependent on a specific client, and the manufacturer not providing a recommended retail price for their items, creating an accurate costing differential between these two methodologies can be quite difficult, especially because some of the equipment that I used is approximately 4 years old, and while it might have had a retail price of $50 000 when new, and still be worth this much to a surveyor, when sold second hand we might only expect $15000 - $25000 or $10 000 when traded in for a new instrument.

While it can be quite easy for a surveyor to pick up second hand total stations for this price, I have decided to use a total stations and GNSS receiver's worth to an individual surveyor as the basis for which I base my assessment. My reasoning for this is, when a surveyor buys a new total station for $50 000, the total station is worth this much to the individual surveyor. As time goes on and new models are released and depreciation affects the worth of the instrument, after four years the instrument might only have a resale value of say $25 000. However, the surveyor, having bought their instrument four years ago for its full price, is still using their instrument the same way they have been every day for the past four years, the performance of the instrument has not depreciated over time and it still meets the needs of the surveyor, the surveyor has no need of a new total station, thus, their total station may have a market value of $25 000 but has a worth of $50 000 to the individual, because if the surveyor were to loose use of the instrument for whatever reason, they would then have to go and spend another $50 000 on a new instrument to perform the same tasks.

The time that it takes to conduct a survey plays an integral role in the costing of different jobs and thus the buying of the equipment to suite surveyors needs. The following two tables firstly look into the pricing of the different equipment for the two different survey methodologies, and secondly look into the amount the two surveys took, keeping in mind that time plays a very important factor in surveying.

Table 4.5 - Cost/Time table

Item	V10 Survey	Total Station Survey	Cost (Approx.)
Total Station		X	$50 000
GNSS Receiver	X		$25 000
V10 Panoramic camera	X		$15 000
Pole	X	X	X
360 Prism		X	$800
Sets of legs (x3)		X	$500
Prism (x2)		X	$1000
Survey Controller	X	X	X
Miscellaneous	X	X	X
TOTAL **total station survey**		X	**$52 000**
TOTAL **V10 survey**	X		**$40 000**
TIME			
Total Station field survey		X	$300
Total Station office reductions		X	$50
V10 field survey	X		$50
V10 office reductions	X		$500
TOTAL **total station survey**		X	**$350**
TOTAL **V10 survey**	X		**$550**

4.7 Discussion

4.7.1 Survey

The actual survey itself went well overall, there were no issues with either survey, and the results obtained from the survey were not impacted in any way by outside effects. I believe that the time it took me to conduct each survey could be decreased by a fraction over time after getting to know the equipment and gaining more first-hand field experience. If I was to make a comment on the difference on the ease of conducting either field survey, I would definitely say that conducting the topographical survey with the V10 was by far a simpler and faster method.

4.7.2 Reductions

The reduction of each survey had their own positives and negatives respectively. While the reduction of the total station data is fairly simple and non-time consuming, if just one point was missed, or was picked up wrong, this requires another site visit. The reduction of the V10 data was not a difficult one, it was a little more challenging than that of the total station data, but after some time, it would not be challenging, the only issue with the reductions is the processing time taken by the computer in order then create points was a lengthy one. Obviously, things as such can be mitigated and worked around by the surveyor and each person would have to create a solution to this problem that best works for them. My recommendation in such a situation would be to leave the program to process the data over night. This allows the surveyor to not require too much processing power from the computer throughout the day when they might be required to perform other tasks, and less can be charged to the client for processing time, as the computer is processing information when it would otherwise be sitting in the office not doing anything.

Beside the time taken to process the data, I more prefer the usable data presented after reductions have occurred from the V10 data over the total station data. Because the data is gathered from photographs, the options for creating points on features is virtually limitless, with the only restriction then coming from how far marks are placed from the nearest photo station. This allows the surveyor to spend less time in the field and more time in the office with less of a chance of missing points, and even when a point is missed, simply opening the program and measuring to the missing feature solves this issue and avoids a site revisit.

4.7.3 Control

Control used were local PSM's in the area, as seen from table 7 the control of the survey was accurate and thus proved the legitimacy of the survey. By checking on three different control marks with my resection and with the GNSS receiver I was able to confirm my datum and thus my pegs placed under the tree canopy in having an accurate fix.

4.7.4 Pegs Placed

All pegs placed were placed in varying locations where the topography of the ground was changing and diverse, i.e. pegs were placed at the bottom of a bank, top of the bank, behind trees, clearly visible from all stations etc. In doing so I was hoping for as much of a real world scenario as possible and tried to place all pegs in areas that would generally need to be located as such.

All of the pegs have been given coordinates from stitching that has been conducted in the Trimble Business Centre program. It should be noted that each time an iteration is conducted by the program, we will see different results, and that this iteration has only been conducted once. If the same process were to take place in many different occasions, utilising the very same data, it would not be uncommon to see different results on each occasion.

It should also be noted once more that all the pegs placed were placed arbitrarily, in doing so, none of the pegs placed had a positioning up until they were picked up using the total station. This does not have any effect on our results, only in that, if the pegs were to be relocated once more with total station, we might see differences due to another setup, with different instruments with different types of accuracies. As mentioned previously, this has no effect on my results due to the fact that I am comparing data picked up with total station to that picked up with V10 and so where the pegs lie in the real world have little to no relevance except to have been there on the day of the surveys.

One thing that I do think I should have done, although it would not have impacted on my actual survey too severely would have been to have placed more pegs in and around the surveyed area. This would have helped confirm my findings, as, while having ten pegs placed in the area is an accurate representation for an area of roughly 200 square meters, it is not enough pegs placed to get a substantial understanding of the results, except for them being simplified and easily understandable.

Another possibility for error could have been that all pegs were only located from one station with the total station, in order to reduce all risks of error, another station should have been placed and the pegs should have been located from this second station in order to confirm their location picked up with the total station.

The overall results from the two methodologies was extremely exciting, although not having high expectations due to having read different articles relating to terrestrial photogrammetry over the past year, seeing my verticals come back at an average of around 30mm was extremely pleasing. I was not only able to confirm that this type of survey is possible. But also establish that through the use of the V10 with the R10, we may see a new way of conducting this type of survey, without the purchase of a total station.

With the average vertical data coming back within tolerance and the average horizontal data coming back just outside of tolerance, I believe that I have proved that this type of technology is able to be used in a daily setting when conducting this type of survey where accuracy is not so key but general landform and topography are the main concern.

4.7.5 Costing & Time

If a surveyor were to conduct a large topographic survey with the use of a GNSS receiver, they would be expected to have a total station with them in order to gather any missing data that was impossible to have been picked up with the GNSS receiver for whatever reason. With this method of using the V10, the surveyor no longer needs rely on having the total station with them, but only a small camera which sits just under the R10 GNSS receiver.

In my costing/time (table 9) above I have gone through and identified the initial costs required in order to conduce the survey with the two separate methodologies. If a surveyor chooses only to use a total station, the time taken to complete the field survey is far greater than completing the survey using only GNSS. However, the issue lies then, when the surveyor is unable to complete the survey due to obstructions, whether they use the V10 or the traditional total station approach. If the surveyor only owns a GNSS unit to conduct their survey, but are required to purchase a piece of equipment if this scenario were to occur, then purchasing the V10 is by far the cheaper option as it would only cost the surveyor an additional $15 000 instead of an additional $50 000.

Also looked into was the costing of the survey itself based upon hours worked and a rate of $100/hr. In this particular case, the V10 survey did take more time, and thus, costed more than the traditional survey, however, it should be noted that the V10 field survey took a substantially less amount of time, and the reason the V10 office work took so long to reduce can be brought down to computer performance and did not actually require personnel feedback at the station while the reductions were being made. Making the V10 office work the same length of time as the traditional survey, when subtracting the amount of time, the computer can be left alone to perform its reductions.

This leads me to state that the V10 survey in all areas is the more viable option when it comes to costing. If the surveyor were to choose to use this method, they will be effectively saving themselves tens of thousands of dollars, having not purchased a $50 000 piece of equipment.

Chapter Six Conclusion

6.1 Conclusion

To conclude, it is a viable option to use the Trimble V10 Imaging rover in conjunction with an R10 GNSS receiver for the purposes of data collection under dense tree canopies in accordance with the necessary accuracies involved in a generic topographical survey. This report, hereby confirms the application, but does include constraints and limitations which should be taken under due consideration.

While I have proven that the V10 is an accurate tool for the purposes of gathering topographic data under dense tree canopies, it should be noted that this survey has been completed in one specific environment and this environment had an adverse appeal to this type of survey. As the surveying methodology will remain the same, yet the environment in which the survey will be conducted will no doubt change on a daily basis, it is difficult to guarantee the same type of results in any given environment.

If utilising this technology for the first time in personal surveys, I would highly recommend the testing of the equipment in the first few surveys to see that it not only meets accuracy standards, but too, meets personal and company standards. Results should be put forward to a group such as LinkedIn so that more and more surveyors can understand the strengths and limitations of the technology to its full.

As the technology becomes cheaper, more accessible and more accurate, this technology will be a definite contender in undertaking topographic survey's. With technology and especially surveying specific technology advancing at an alarming rate, it is our duty as surveyors, to not only be sceptics as many would happily portray to the wider community, but to also be initiators of new technology. I feel as though it is general practice in surveying to shun, talk down and disregard new technology for many years before it becomes an accepted surveying practice and utilised by the majority. We have a duty, to not only ourselves, but the broader surveying community to try and test these new pieces of equipment, and if they do not meet our expectations, then to push the manufacturers to create a product with which we can work with in our daily tasks.

Through this report I hope that I have opened the publics eyes on the uses/possible uses of these new technologies and hope that they will walk away with more knowledge and possibly come up with new ideas on which they can implement this technology. It has never before been so easily accessible to gather terrestrial photogrammetric data, it is this ease which I hope will push the next generation of surveyors to utilise this new type of equipment and incorporate into their jobs.

To reiterate, the Trimble V10 can be used for such a task, but is still limited to many factors, I recommend that whomever uses this technology, identifies all these factors and makes sure they are happy with the accuracy they are achieving before moving forward with any works/projects.

6.2 Further Work

Further work in the field is quite extensive, while having proved the viability of the equipment for such a task, I feel as though this piece of equipment could be used in countless different scenario's. In terms of my project, further work can definitely be undertaken. One of my main gaols when beginning the project was to have created a surface from both sets of data and done a volumetric comparison between these two surfaces. Unfortunately, due to licencing and lack of knowledge, I was unable to create a surface, however I have included a preliminary photograph of a surface which I managed to take and is included as Appendix 6. Other further works could have been to have paired the V10 with the total station and run another set of data from this. There is nothing to confirm my findings throughout this project and all data is all relative to itself. To fully prove my findings, I would recommend conducting the same survey once more with different setups in order to create a set of un-relatable data which will be independent to this report.

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Appendix A

ENG4111/4112 Research Project

Project Specification

For: Zaine Michael Thompson

Title: Integration of Trimble V10 Imaging Rover with R10 GNSS receiver for data collection under dense tree canopies.

Major: Surveying

Supervisor: Dr Zhenyu Zhang
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Enrolment: ENG4111 – EXT S1, 2016
ENG4112 – EXT S2, 2016

Project Aim: To assess the feasibility of using the Trimble V10 Rover to conduct high accuracy topographic surveys under tree canopies, compared to usual surveying methods.

Programme: Issue V5, 10th October 2016

1. Research into the current uses of the V10 Rover
2. Review current standards set by the Surveyors Board of Queensland for topographic surveys and a list of the equipment which can be utilised
3. Identify the methodology for the undertaking of a majority of the testing and a generic location suited to this proposal
4. Conduct a topographic survey with all aforementioned equipment to Surveyors Board of Queensland's specifications
5. Reduce gathered data and prepare for evaluation
6. Evaluate all differences at each specified marker and identify accuracies and inaccuracies.
7. Compare results and liaise with USQ Professional Staff to discuss main aspects of reduced data
8. Write the report on my findings and identify pros and cons of using the V10 rover in such an environment
9. Advise Trimble and UPG on the possibility of using the V10 rover for this purpose

If time and resources permit:

10. Compare results with that of other photogrammetric means (i.e. terrestrial photogrammetry) and a change of location

Appendix 1

1.1. The Profession

Professionals are distinguished by certain characteristics including:

- mastery of a particular intellectual skill, acquired by education¬† and training;
- acceptance of duties to the community as a whole in addition to duties to the client or employer;
- an outlook which is essentially objective; and
- rendering personal service to a high standard of competence, conduct and performance, for which they can be personally liable.

1.2. The Public Interest

The surveyor's role in the public interest poses several ethical obligations with regard to the exercise of professional duties. Clients and the public at large must be able to rely on the objectivity and integrity of the surveyor in rendering professional opinions regarding spatial information and data. Professional surveyors recognise that their ethical responsibilities extend to the public, to their clients and employers, to their peers and to their employees. Accordingly, they acknowledge the need for integrity, independence, care and competence and a sense of duty.

1.3. Reasons For A Code

The Code of Practice for Surveyors provides benefits for consumers of spatial information including survey services specifically and to the community in general. The record of surveys through the data depicting those surveys provides for public confidence in surveying and surveyors. The Code of Practice for Surveyors may be supported by a range of technical standards and a level of directions and guidelines in support of the accepted rules governing the practice of surveying.

2. The Code

2.1. Survey Standards

Surveyors shall abide by the survey standards and survey guidelines prescribed at an international, national and state level as they apply to surveys being undertaken by the Surveyor.

2.2 Professional Competence

In general, surveyors shall assist in maintaining the integrity and competence of the surveying profession, their own competence and also improving survey systems, and must:

(a) Abide by the principles and standards of professional practice and apply best practice.

(b) Not accept assignments beyond the surveyor‚Äôs professional competence, unless making satisfactory arrangements to engage persons appropriately qualified. These arrangements will address the question of responsibility and liability to the client.

(c) Be competent and maintain competence to ensure the capacity of the surveyor to continue to provide high quality advice to the client and to safeguard the community interest.

(d) Maintain, for as long as is practicable and for a reasonable time, adequate records directly pertinent to the surveys undertaken, whilst in control of those records.

(e) At all times, serve the client or employer with integrity and diligence and to the best of their knowledge and ability.

(f) Not accept assignments that a competent surveyor could not reasonably expect to complete in a timely and professional manner.

2.3. Professional Conduct

Surveyors shall assist in preventing unauthorised practice of the profession, and shall:

(a) Only sign a certificate, report, or plan relating to work that was completed and prepared by the surveyor personally or under the surveyor's supervision.

(b) Assume professional responsibility for all works carried out under their control and direction.

(c) Where the surveyor becomes aware of a significant error in a survey undertaken by the surveyor, correct the error.

(d) Not knowingly enter into any arrangement that would enable any unauthorised person or unauthorised body corporate to practice the profession of surveying directly or indirectly.

(e) Inform their clients or any relevant party of any conditions, requirements, limitations or assumptions arising from the implementation of their instructions or enquiries or imposed from any other source as may affect the conduct of the work, or relate to or qualify the data provided as a result of that work.

(f) Not knowingly make false or misleading statements in relation to the practice of surveying.

(g) Take all necessary steps to complete instructions promptly and inform clients of any significant delays, the reasons for those delays, and any actions to be taken to rectify same.

(h) Not claim the work of another person, body or authority as their own.

(i) Not falsify any plan, document or data or knowingly misuse any data or deliberately misuse their position to achieve a predetermined result which is:

(i) Inconsistent with normally accepted survey practice; or

(ii) Has been specified by the client or a third party.

(j) Not knowingly become an accessory to a misdemeanour by failing to report what appears to be a breach of the Act or Regulation.

(k) Employ the expertise of others when their knowledge and ability are inadequate for addressing specific issues.

(l) Act in accordance with the Codes of Ethics of the relevant professional associations.

(m) Consider the appropriate level of insurance for the surveying service being provided by the surveyor.

2.4. Personal Conduct

Surveyors shall maintain the dignity of the profession in association with clients and colleagues, and shall:

(a) At all times abide by the highest moral, ethical, business and professional standards and should avoid any conduct which would knowingly or reasonably be expected to bring the profession into disrepute.

(b) Not further the application for registration and endorsement by the Board of any person known by the surveyor to be unqualified or unsuitable for such advancement.

(c) Not knowingly make false or misleading statements which would injure another person or surveyor.

(d) Fully co-operate with any request for information or directives, where a complaint has been lodged or a prima facie breach of the Surveyors Act and / or Code of Practice for Surveyors has been determined, unless advised or prevented from doing so for legal reasons.

2.5. Client Relations

Surveyors shall preserve the confidences of clients and regard as privileged, all information regarding the affairs of clients, and shall:

(a) Maintain confidentiality with respect to the client's business affairs.

(b) Act with loyalty to clients and not take any action which would serve to disadvantage the lawful and correct interests of their client save that they should exercise a duty of disclosure where such is necessary in the interests of integrity or in the public interest generally.

(c) Where possible injury could occur to the public, recognise the interests of the community as being paramount and resolution should be sought within the area of responsibility or jurisdiction of the surveyor.

(d) Establish and maintain a system, within their company, firm or organisation, for the internal resolution of disputes with clients or other members of the public affected by the surveyor,Äôs professional conduct.

(e) Where a dispute relates to the surveyor,Äôs professional conduct, as defined in the *Surveyors Act 2003*, provide the complainant with a written statement to the effect that if they are dissatisfied with the outcome of the internal dispute resolution process, the complainant may take their complaint to the Surveyors Board of Queensland. Such a statement is to be accompanied by all current contact details of the Board.

2.6. Conflict of Interest

Surveyors shall at all times act with propriety and exercise unbiased independent professional judgment on behalf of clients, and should represent clients competently, and shall:

(a) Where possible, avoid or attempt to manage, conflicts of interest and compromising situations.

(b) Disclose to clients any potential conflicts of interest, affiliations, or prior involvement that could impair the quality of services to the client.

2.7. Employees

Surveyors, as employers, shall:

(a) Assume responsibility for all work carried out by their professional and other staff and, where appropriate, by contractors and subcontractors.

(b) Assist their employees to achieve their optimum levels of technical or professional advancement in relation to the requirements of the position in which they have been employed.

(c) Ensure their employees have working conditions and remuneration at least in accordance with relevant awards or employment contracts.

(d) Cultivate integrity and an understanding of the professional obligations of surveyors to the community in their employees.

2.8. Natural And Built Environment

Surveyors shall approach environmental concerns with perception, diligence and integrity, and shall:

(a) Develop and maintain a reasonable level of understanding of environmental issues and the principles of sustainable development.

(b) Bring any matter of concern relating to the physical environment and sustainable development to the attention of their clients or employers.

(c) Include the principles of environmental sustainability among the essential factors used for project evaluation.

(d) Where possible, ensure that environmental assessment, planning and management are integrated into projects that are likely to impact on the environment.

2.9. Business Practice

Surveyors shall maintain appropriate standards of ethical business practice and shall:

(a) Not make false or misleading statements in advertising or other marketing media.

(b) Not, either directly or indirectly, act to undermine the reputation or business prospects of other surveyors by unfair, dishonest or derogatory conduct.

(c) Not attempt to supplant by unfair, dishonest or derogatory actions, other surveyors whom have current agreements with their clients.

(d) Provide and maintain safe working practices and workplaces.

3. Administering the Code

3.1. This code shall be administered by the Surveyors Board of Queensland.

3.2. It is the responsibility of the Board to provide publicity and reporting on the Code to include:

(a) Monitoring of adherence to industry standards of quality, safety and conduct and compliance with the principles and procedures of the code;

(b) Publicity and education programs;

(c) Confirmed breaches of the code and the remedial action taken;

(d) Steps taken to address identified systemic complaints;

(e) Statistics on complaints and disputes, and their resolution, classified in appropriate detail;

(f) Costs and other details of administration;

(g) Continuous improvement in code principles and administration.

3.3. It is the responsibility of the Board to review and amend the Code.

Appendix 2

Accuracy table taken from the Journal of Archaeological Science which looks into accurate photogrammetry at large sites.

Table 1
Photogrammetric errors reported in recent studies.

Study	Subject	Scale (m)	Error (mm)	Precision (1-σ)
a: Ground Control Point measurement errors reported in SfM-based surveys				
Reinoso et al. 2014	Buildings	10–20	10–26	<1:1000
Olson et al. 2013	Trenches	5–35	~20–40	1:500
Remondino et al. 2012	Buildings	~15	35	1:400
Green et al. 2014	Buildings	5–15	19–39	<1:400
De Reu et al. 2014	Trenches	~10	8–15	1:1000
Koutsoudis et al. 2014	Building	10	14	1:700
Riveiro et al. 2011	Building	<10	12	1:800
De Reu et al. 2013	Trenches	2.5–6	9–25	1:500
Dai and Lu 2010	Object	<2.5	2	1:1000*
Dellepiane et al. 2013	Trenches	~2.0	2	1:1000*
Martínez et al. 2015	Pavement	~0.6	2	1:300*
b: Errors in vertex positions of meshes created by MVS				
Doneus et al. 2011	Trenches	~10	18	<1:600
Koutsoudis et al. 2014	Building	~10	14	1:700
Dellepiane et al. 2013	Trenches	~2.0	6	>1:300*
Remondino et al. 2008	Building	~1-2	1.4	<1:1500
Remondino et al. 2009	Building	<1.2	<0.4	1:3000
Lerma and Muir 2014	Object	1.0	0.2	1:5000
Jennings and Black 2012	Objects	0.5	0.2	1:2500*
Kersten and Lindstaedt 2012	Objects	0.5	0.3	>1:1500
Koutsoudis et al. 2013	Object	0.2	0.07	>1:2500

a: All studies in the first group used a Total Station to measure control points to establish SfM errors, except those starred (*) used a tape measure or callipers to check distances between two points measured by SfM. Normally error is reported as the standard deviation (1-σ) or RMS.
b: All studies in the second group used laser hardware as the reference for quantifying error in the MVS-generated vertices, except (*) Jennings and Black 2012 used 3D-printed models of known geometry, and Dellepiane et al. 2013 used repeatability tests—comparing models of the same area from separate batches of photographs.

Appendix 3

SCS040835 V0 Page 1 of 1 Not To Scale

40835

SCS040835

The Survey Co-ordination Act of 1952 1981
(Regulation 16)
FORM 6

QUEENSLAND

REGD. No. 40835
WITHIN DRAYTON PSA 5
Other Ref. No.

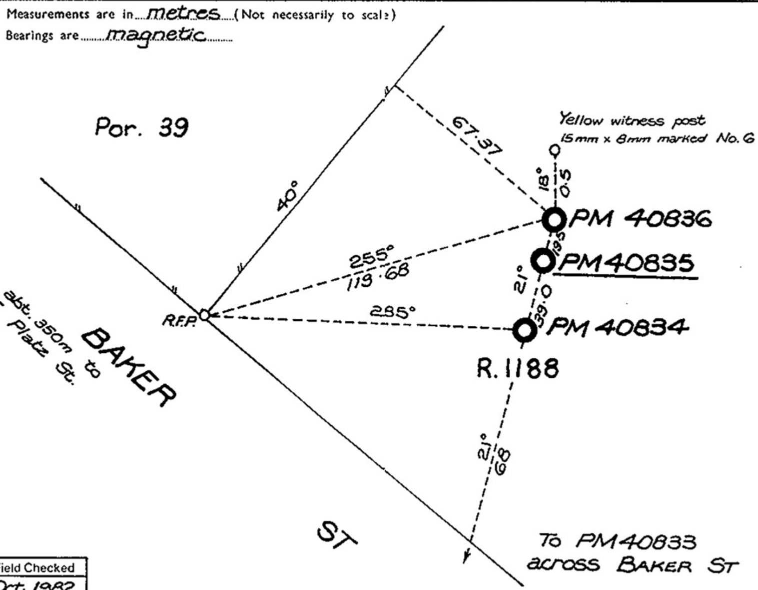
PERMANENT MARK SKETCH PLAN

Description of Mark Standard D.M.S. District Toowoomba

Parish of DRAYTON City or Town of Toowoomba

Local Authority Toowoomba City Council Map 9242 - 11321

Measurements are in metres (Not necessarily to scale)
Bearings are magnetic



Field Checked
Oct. 1982

Note:- P.S.M. 40835 is No. 5 station of E.D.M.E. Calibration Baseline.

PERMANENT SURVEY MARK INSTALLATION DETAILS

Installed by D.M.S. Date 1976
Placed in Connection with (Type of survey/project) survey Plan and / or Field Bk. Ref. Form 78A
Connd. on Cadastral Plan No

VERTICAL DATA

AUSTRALIAN HEIGHT DATUM (This section to be completed by D.M.S. when Official Lin-adj. Values are available)
Adj. Height Analysis Ref. L. Book No.
Origin Secn. Secn. Nos. Book No.

OTHER DATUMS (Relevant information columns to be completed in full)
Reduced Level (i) (ii) A.H.D.(der.) Datum Adopted (i) A.H.D. (ii) L. Book No. (i) (ii)
Levelled by (i) (ii) Date (i) (ii)
Origin Mark (i) (ii) Origin R.L. (i) (ii)

HOR DATA

A.M.G. CO-ORDINATES E N Zone Date
Origin Stns. for Co-ordinates with values adopted (i) E N (ii) (iii)
Local Co-ords. available on Plan Ref. Estab. by

Amended
24.5.84
9.5.85

I certify that the permanent mark shown in this sketch has been placed on the ground in accordance with the regulations under "The Survey Co-ordination Act of 1952-1981".

Date 16 - 12 - 1983. Signature M. Lisle

Authority Dept. Mapping & Surveying

THIS MARGIN VACANT

PLEASE LEAVE THIS MARGIN VACANT

The Queensland Survey Control Register is the authoritative source for coordinate and height information.
The coordinate and height information contained on this document may not be the current information regarding this mark.

SCS040833 V0 Page 1 of 1 Not To Scale

40833

SCS040833

The Survey Co-ordination Act of 1952-1981
(Regulation 16)
FORM 6

QUEENSLAND

REGD. No. 40833
WITHIN DRAYTON PSA 5
Other Ref. No.

PERMANENT MARK SKETCH PLAN

Description of Mark Standard Plaque D.M.S. District Toowoomba

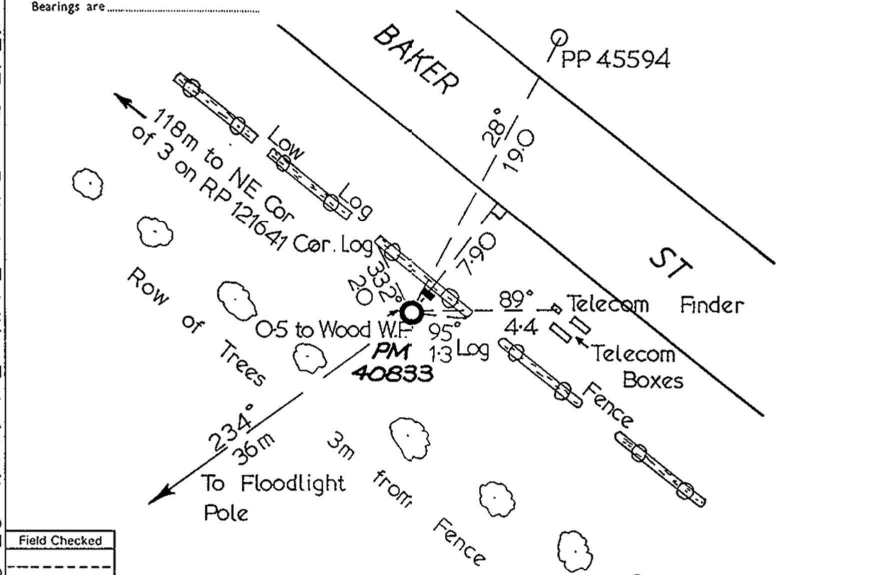
Parish of Drayton City or Town of Toowoomba

Local Authority Toowoomba City Council Map 1:2,500 9242-11321

VACANT MARGIN THIS LEAVE PLEASE

PERMANENT SURVEY MARK INSTALLATION DETAILS

Measurements are in metres (Not necessarily to scale)
Bearings are



Field Checked

STN 03 Calibration Range

Installed by D.M.S. Date 1975
Placed in Connection with (Type of survey/project) survey Plan and / or Field Bk. Ref.
Connd. on Cadastral Plan No

VERTICAL DATA

AUSTRALIAN HEIGHT DATUM (This section to be completed by D.M.S. when Official Lin-adj. Values are available)
Adj. Height Analysis Ref. L. Book No.
Origin Secn. Secn. Nos. Book No.

OTHER DATUMS (Relevant information columns to be completed in full)
Reduced Level (i) A.H.D.(der.) (ii) Datum Adopted (i) A.H.D. (ii) L. Book No. (i) (ii)
Levelled by (i) (ii) Date (i) (ii)
Origin Mark (i) (ii) Origin R.L. (i) (ii)

HOR DATA

A.M.G. CO-ORDINATES E N Zone Date
Origin Stns. for Co-ordinates with values adopted (i) E N (ii) (iii)
Local Co-ords. available on Plan Ref. Estab. by

Amended
9.5.85

I certify that the permanent mark shown in this sketch has been placed on the ground in accordance with the regulations under "The Survey Co-ordination Act of 1952-1981".

Date 10 Nov. 1983 Signature [signature]
Authority DMS

The Queensland Survey Control Register is the authoritative source for coordinate and height information.
The coordinate and height information contained on this document may not be the current information regarding this mark.

Appendix 4

Project file data		Coordinate System	
Name:	F:\Y4S2 - ENG4112 - Research Project Part 2\DRAFTV1.vce	Name:	Australia/GDA94
Size:	788 KB	Datum:	GDA94
Modified:	6/09/2016 3:15:46 PM (UTC:10)	Zone:	Zone 56
Time zone:	AUS Eastern Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			
Comment 1:			
Comment 2:			
Comment 3:			

Additional Coordinate System Details

Local Site Settings			
Project latitude:	?	Ground scale factor:	1
Project longitude:	?	False northing offset:	0.000
Project height:	685.000	False easting offset:	0.000

Terrestrial Bundle Adjustment Report

Adjustment Group 'MTP'

Adjustment date:	9/6/2016 4:42:52 PM	**Number of tie points:**	855
Number of stations:	16	**Station setup type:**	Standard Resection

Passed stations: 12					
2010 (Q17)	2011 (Q18)	2012 (Q19)	2100 (Q4)	2101 (Q5)	2107 (Q10)
2108 (Q11)	2109 (Q12)	2110 (Q13)	2111 (Q14)	2112 (Q15)	2113 (Q16)

Failed stations: 4					
2102 (Q6)	2104 (Q7)	2105 (Q8)	2106 (Q9)		

Failed positions: 2					
2111 (Q14)	2112 (Q15)				

Scoring

Station geometry: (9.7 / 10)

Observation accuracy: (9.0 / 10)

Tie point distribution: (8.9 / 10)

Tie point geometry: (6.9 / 10)

Tie point redundancy: (2.6 / 10)

General

Number of equations:	4408	**Reference factor:**	0.92
Number of unknowns:	2637	**Chi square test:**	Non-optimal weighting
Redundancy:	1771	**Number of iterations:**	4

The reference factor, also known as the standard error of unit weight, is the ratio of the a-posteriori residuals to the a-priori error estimates. A value in the range 0.95 to 1.05 is desirable. An overall reference factor is given in the General section above, but a more useful reference factor is given in the Group Statistics section. For example, if the reference factor for photogrammetry is greater than 1, it indicates the back projection residuals are larger than the anticipated value specified in Project Settings > Default Standard Errors > Photogrammetry > Pixel picking error. Optimal weighting is achieved when reference factors in the Group Statistics are close to 1, which, in the example, means increasing the pixel picking error setting.

Group Statistics

Group	Reference factor	A priori scalar	Redundancy
Photogrammetry	0.92	1.00	1714.31
Position	1.36	1.00	21.82
Tilt	0.06	1.00	34.87

Station Connections

Total Tie Points	Station	Shared Tie Points @ Connected Station
9	2106 (Q9)	3 @ 2012 (Q19), 4 @ 2112 (Q15), 4 @ 2113 (Q16), 4 @ 2110 (Q13), 5 @ 2107 (Q10), 5 @ 2108 (Q11), 5 @ 2011 (Q18), 5 @ 2111 (Q14), 5 @ 2010 (Q17), 6 @ 2109 (Q12), 7 @ 2100 (Q4), 7 @ 2104 (Q7), 8 @ 2102 (Q6), 8 @ 2105 (Q8), 9 @ 2101 (Q5)
10	2100 (Q4)	4 @ 2012 (Q19), 4 @ 2112 (Q15), 5 @ 2108 (Q11), 5 @ 2011 (Q18), 5 @ 2111 (Q14), 5 @ 2113 (Q16), 5 @ 2010 (Q17), 5 @ 2110 (Q13), 6 @ 2107 (Q10), 6 @ 2109 (Q12), 7 @ 2104 (Q7), 7 @ 2106 (Q9), 9 @ 2101 (Q5), 9 @ 2102 (Q6), 9 @ 2105 (Q8)
11	2105 (Q8)	5 @ 2012 (Q19), 6 @ 2107 (Q10), 6 @ 2112 (Q15), 6 @ 2113 (Q16), 6 @ 2110 (Q13), 7 @ 2108 (Q11), 7 @ 2011 (Q18), 7 @ 2111 (Q14), 7 @ 2010 (Q17), 8 @ 2109 (Q12), 8 @ 2106 (Q9), 9 @ 2100 (Q4), 9 @ 2104 (Q7), 10 @ 2101 (Q5), 10 @ 2102 (Q6)
11	2104 (Q7)	6 @ 2012 (Q19), 7 @ 2100 (Q4), 7 @ 2107 (Q10), 7 @ 2112 (Q15), 7 @ 2113 (Q16), 7 @ 2110 (Q13), 7 @ 2106 (Q9), 8 @ 2108 (Q11), 8 @ 2109 (Q12), 8 @ 2011 (Q18), 8 @ 2111 (Q14), 8 @ 2010 (Q17), 8 @ 2102 (Q6), 9 @ 2101 (Q5), 9 @ 2105 (Q8)
11	2102 (Q6)	4 @ 2012 (Q19), 5 @ 2107 (Q10), 5 @ 2112 (Q15), 5 @ 2113 (Q16), 5 @ 2110 (Q13), 6 @ 2108 (Q11), 6 @ 2011 (Q18), 6 @ 2111 (Q14), 6 @ 2010 (Q17), 7 @ 2109 (Q12), 8 @ 2104 (Q7), 8 @ 2106 (Q9), 9 @ 2100 (Q4), 10 @ 2105 (Q8), 11 @ 2101 (Q5)
12	2101 (Q5)	5 @ 2012 (Q19), 6 @ 2107 (Q10), 6 @ 2112 (Q15), 6 @ 2113 (Q16), 6 @ 2110 (Q13), 7 @ 2108 (Q11), 7 @ 2011 (Q18), 7 @ 2111 (Q14), 7 @ 2010 (Q17), 8 @ 2109 (Q12), 9 @ 2100 (Q4), 9 @ 2104 (Q7), 9 @ 2106 (Q9), 10 @ 2105 (Q8), 11 @ 2102 (Q6)
89	2012 (Q19)	3 @ 2106 (Q9), 4 @ 2100 (Q4), 4 @ 2102 (Q6), 5 @ 2101 (Q5), 5 @ 2105 (Q8), 6 @ 2104 (Q7), 8 @ 2107 (Q10), 8 @ 2011 (Q18), 10 @ 2108 (Q11), 10 @ 2109 (Q12), 13 @ 2110 (Q13), 14 @ 2010 (Q17), 29 @ 2111 (Q14), 42 @ 2112 (Q15), 66 @ 2113 (Q16)

155	2107 (Q10)	5 @ 2102 (Q6), 5 @ 2106 (Q9), 6 @ 2100 (Q4), 6 @ 2101 (Q5), 6 @ 2105 (Q8), 7 @ 2104 (Q7), 8 @ 2012 (Q19), 8 @ 2113 (Q16), 9 @ 2111 (Q14), 11 @ 2112 (Q15), 12 @ 2010 (Q17), 25 @ 2110 (Q13), 75 @ 2011 (Q18), 79 @ 2109 (Q12), 83 @ 2108 (Q11)
199	2111 (Q14)	5 @ 2100 (Q4), 5 @ 2106 (Q9), 6 @ 2102 (Q6), 7 @ 2101 (Q5), 7 @ 2105 (Q8), 8 @ 2104 (Q7), 9 @ 2107 (Q10), 16 @ 2109 (Q12), 17 @ 2108 (Q11), 22 @ 2011 (Q18), 29 @ 2012 (Q19), 53 @ 2112 (Q15), 95 @ 2110 (Q13), 99 @ 2113 (Q16), 101 @ 2010 (Q17)
213	2112 (Q15)	4 @ 2100 (Q4), 4 @ 2106 (Q9), 5 @ 2102 (Q6), 6 @ 2101 (Q5), 6 @ 2105 (Q8), 7 @ 2104 (Q7), 11 @ 2107 (Q10), 16 @ 2011 (Q18), 19 @ 2108 (Q11), 39 @ 2109 (Q12), 42 @ 2012 (Q19), 53 @ 2111 (Q14), 91 @ 2010 (Q17), 99 @ 2110 (Q13), 103 @ 2113 (Q16)
218	2108 (Q11)	5 @ 2100 (Q4), 5 @ 2106 (Q9), 6 @ 2102 (Q6), 7 @ 2101 (Q5), 7 @ 2105 (Q8), 8 @ 2104 (Q7), 10 @ 2012 (Q19), 15 @ 2113 (Q16), 17 @ 2111 (Q14), 19 @ 2112 (Q15), 24 @ 2010 (Q17), 83 @ 2107 (Q10), 90 @ 2110 (Q13), 105 @ 2011 (Q18), 106 @ 2109 (Q12)
225	2109 (Q12)	6 @ 2100 (Q4), 6 @ 2106 (Q9), 7 @ 2102 (Q6), 8 @ 2101 (Q5), 8 @ 2104 (Q7), 8 @ 2105 (Q8), 10 @ 2012 (Q19), 14 @ 2113 (Q16), 16 @ 2111 (Q14), 26 @ 2010 (Q17), 39 @ 2112 (Q15), 79 @ 2107 (Q10), 84 @ 2110 (Q13), 91 @ 2011 (Q18), 106 @ 2108 (Q11)
253	2011 (Q18)	5 @ 2100 (Q4), 5 @ 2106 (Q9), 6 @ 2102 (Q6), 7 @ 2101 (Q5), 7 @ 2105 (Q8), 8 @ 2012 (Q19), 8 @ 2104 (Q7), 16 @ 2112 (Q15), 18 @ 2113 (Q16), 22 @ 2111 (Q14), 75 @ 2107 (Q10), 76 @ 2010 (Q17), 91 @ 2109 (Q12), 99 @ 2110 (Q13), 105 @ 2108 (Q11)
256	2113 (Q16)	4 @ 2106 (Q9), 5 @ 2100 (Q4), 5 @ 2102 (Q6), 6 @ 2101 (Q5), 6 @ 2105 (Q8), 7 @ 2104 (Q7), 8 @ 2107 (Q10), 14 @ 2109 (Q12), 15 @ 2108 (Q11), 18 @ 2011 (Q18), 66 @ 2012 (Q19), 95 @ 2010 (Q17), 99 @ 2111 (Q14), 100 @ 2110 (Q13), 103 @ 2112 (Q15)
278	2010 (Q17)	5 @ 2100 (Q4), 5 @ 2106 (Q9), 6 @ 2102 (Q6), 7 @ 2101 (Q5), 7 @ 2105 (Q8), 8 @ 2104 (Q7), 12 @ 2107 (Q10), 14 @ 2012 (Q19), 24 @ 2108 (Q11), 26 @ 2109 (Q12), 76 @ 2011 (Q18), 91 @ 2112 (Q15), 95 @ 2113 (Q16), 101 @ 2111 (Q14), 110 @ 211 (Q13)
348	2110 (Q13)	4 @ 2106 (Q9), 5 @ 2100 (Q4), 5 @ 2102 (Q6), 6 @ 2101 (Q5), 6 @ 2105 (Q8), 7 @ 2104 (Q7), 13 @ 2012 (Q19), 25 @ 2107 (Q10), 84 @ 2109 (Q12), 90 @ 2108 (Q11), 95 @ 2111 (Q14), 99 @ 2011 (Q18), 99 @ 2112 (Q15), 100 @ 2113 (Q16), 110 @ 2010 (Q17)

Mean Station Displacement

Easting	Northing	Elevation
0.000 m	0.000 m	0.000 m

Station Displacement

Station	Easting	Northing	Elevation	Position
2010 (Q17)	0.012 m	0.008 m	0.014 m	Enabled
2011 (Q18)	0.008 m	0.013 m	0.042 m	Enabled
2012 (Q19)	-0.017 m	-0.009 m	0.005 m	Enabled
2100 (Q4)	-0.006 m	-0.007 m	-0.107 m	Enabled
2101 (Q5)	0.004 m	0.007 m	-0.102 m	Enabled
2107 (Q10)	-0.030 m	0.004 m	0.057 m	Enabled
2108 (Q11)	0.006 m	-0.031 m	0.028 m	Enabled
2109 (Q12)	-0.009 m	0.014 m	0.039 m	Enabled
2110 (Q13)	0.026 m	-0.009 m	0.014 m	Enabled
2111 (Q14)	-0.016 m	0.042 m	0.068 m	Disabled

2112 (Q15)	-3.795 m	-3.212 m	-0.049 m	Disabled
2113 (Q16)	0.007 m	0.008 m	0.009 m	Enabled

Station Relative Precision Estimates (95%)

Station	Easting	Northing	Elevation	Strength of figure
2010 (Q17)	0.027 m	0.027 m	0.000 m	0.17
2011 (Q18)	0.026 m	0.026 m	0.000 m	0.11
2012 (Q19)	0.022 m	0.021 m	0.000 m	0.31
2100 (Q4)	0.139 m	0.157 m	0.001 m	0.25
2101 (Q5)	0.138 m	0.149 m	0.002 m	0.26
2107 (Q10)	0.025 m	0.026 m	0.000 m	0.09
2108 (Q11)	0.027 m	0.027 m	0.000 m	0.10
2109 (Q12)	0.027 m	0.027 m	0.000 m	0.14
2110 (Q13)	0.027 m	0.027 m	0.000 m	0.16
2111 (Q14)	0.026 m	0.026 m	0.000 m	0.15
2112 (Q15)	0.026 m	0.026 m	0.000 m	0.17
2113 (Q16)	0.023 m	0.023 m	0.000 m	0.24

Station Statistics

Station	Geometry score	Distribution score	Redundancy
2010 (Q17)	10.00 / 10	9.59 / 10	185.5
2011 (Q18)	10.00 / 10	8.82 / 10	201.4
2012 (Q19)	9.26 / 10	8.66 / 10	54.9
2100 (Q4)	8.60 / 10	10.00 / 10	11.8
2101 (Q5)	9.50 / 10	7.42 / 10	13.9
2107 (Q10)	9.27 / 10	9.02 / 10	109.1
2108 (Q11)	10.00 / 10	9.63 / 10	196.8
2109 (Q12)	10.00 / 10	8.82 / 10	173.7
2110 (Q13)	10.00 / 10	9.25 / 10	293.8
2111 (Q14)	10.00 / 10	9.90 / 10	168.4
2112 (Q15)	10.00 / 10	8.81 / 10	184.2
2113 (Q16)	10.00 / 10	7.87 / 10	177.4

Station Status

Station	Setup type	Adjustment	Position	Orientation
2010 (Q17)	Standard Resection	Optimal weighting	Enabled	Enabled
2011 (Q18)	Standard Resection	Optimal weighting	Enabled	Enabled
2012 (Q19)	Standard Resection	Optimal weighting	Enabled	Enabled
2100 (Q4)	Standard Resection	Optimal weighting	Enabled	Enabled

2101 (Q5)	Standard Resection	Optimal weighting	Enabled	Enabled
2102 (Q6)	Standard Resection	Non-optimal weighting	Disabled	Disabled
2104 (Q7)	Standard Resection	Non-optimal weighting	Disabled	Disabled
2105 (Q8)	Standard Resection	Non-optimal weighting	Disabled	Disabled
2106 (Q9)	Standard Resection	Non-optimal weighting	Disabled	Disabled
2107 (Q10)	Standard Resection	Optimal weighting	Enabled	Enabled
2108 (Q11)	Standard Resection	Optimal weighting	Enabled	Enabled
2109 (Q12)	Standard Resection	Optimal weighting	Enabled	Enabled
2110 (Q13)	Standard Resection	Optimal weighting	Enabled	Enabled
2111 (Q14)	Standard Resection	Optimal weighting	Disabled	Enabled
2112 (Q15)	Standard Resection	Optimal weighting	Disabled	Enabled
2113 (Q16)	Standard Resection	Optimal weighting	Enabled	Enabled

Tie Point Statistics

Observations per point: 2.54 **Disabled manual observations:** 27

Tie Point Back Projections

Residual (adjustment type)	Pixels	Distance @ 10 meters
Standard deviation (free)	0.53	
Standard deviation (constrained)	0.56	0.002 m
Maximum deviation (constrained)	3.75	0.011 m

Tie Point Relative Precision Estimates (95%)

Point	Easting	Northing	Elevation	Strength of figure	Redundancy	Minimum redundancy
4000	0.001 m	0.001 m	0.014 m	6.41	10.32	0.14
4001	0.000 m	0.001 m	0.014 m	6.60	13.41	0.21
4002	0.003 m	0.002 m	0.016 m	3.24	0.68	0.03
4003	0.004 m	0.002 m	0.019 m	3.19	0.72	0.00
4004	0.000 m	0.000 m	0.014 m	8.55	14.57	0.40
4005	0.000 m	0.000 m	0.014 m	8.17	17.48	0.33
4006	0.000 m	0.000 m	0.014 m	9.28	11.75	0.34
4007	0.000 m	0.000 m	0.014 m	6.66	10.71	0.38
4009	0.001 m	0.001 m	0.019 m	5.28	8.09	0.16
4010	0.000 m	0.000 m	0.014 m	6.88	8.15	0.44
4011	0.001 m	0.001 m	0.018 m	6.19	10.07	0.14
4012	0.000 m	0.000 m	0.014 m	7.79	9.89	0.21
4013	0.001 m	0.000 m	0.016 m	6.74	1.87	0.02
4020	0.000 m	0.000 m	0.013 m	9.24	16.18	0.35

4021	0.000 m	0.000 m	0.014 m	6.87	2.27	0.07
4022	0.000 m	0.000 m	0.014 m	8.67	8.26	0.54
4023	0.000 m	0.000 m	0.014 m	6.97	6.69	0.35
4024	0.000 m	0.000 m	0.014 m	8.02	1.49	0.02

9/6/2016 6:02:31 PM	F:\Y4S2 - ENG4112 - Research Project Part 2\DRAFTV1.vce	Trimble Business Center

Appendix 5

Project file data		Coordinate System	
Name:	F:\Y4S2 - ENG4112 - Research Project Part 2\DRAFTV1.vce	Name:	Australia/GDA94
Size:	1 MB	Datum:	GDA94
Modified:	6/09/2016 10:29:25 PM (UTC:10)	Zone:	Zone 56
Time zone:	AUS Eastern Standard Time	Geoid:	AUSGeoid09 (Australia)
Reference number:		Vertical datum:	
Description:			
Comment 1:			
Comment 2:			
Comment 3:			

Additional Coordinate System Details

Local Site Settings			
Project latitude:	?	Ground scale factor:	1
Project longitude:	?	False northing offset:	0.000
Project height:	685.000	False easting offset:	0.000

Point List

ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Feature Code
2000	394200.986	6946401.115	693.658	psm
2001	394236.386	6946459.114	693.865	psm
2002	394256.532	6946492.482	693.846	psm
2010	394164.515	6946530.858	691.366	peg
2011	394176.869	6946538.198	691.558	peg
2012	394144.055	6946517.071	690.887	peg
2100	394174.858	6946495.871	691.857	ns
2101	394181.450	6946502.223	691.890	ns
2102	394185.010	6946505.424	692.000	ns
2103	?	?	?	
2104	394188.572	6946508.441	692.016	ns
2105	394191.790	6946511.569	692.036	ns
2106	394196.024	6946515.112	692.099	ns
2107	394184.125	6946540.497	691.659	ns
2108	394178.194	6946537.008	691.517	ns
2109	394173.262	6946533.647	691.476	ns
2110	394168.949	6946530.745	691.462	ns
2111	394165.086	6946527.965	691.431	ns
2112	394161.303	6946524.722	691.300	ns

2113	394156.735	6946520.744	691.117	ns
4000	394150.897	6946527.612	693.454	
4001	394171.183	6946538.105	693.514	
4002	394207.165	6946504.607	701.516	
4003	394219.083	6946490.859	701.509	
4004	394168.042	6946537.290	692.099	
4005	394153.634	6946529.853	692.066	
4006	394156.187	6946530.616	691.559	
4007	394179.733	6946519.889	693.411	
4008	?	?	?	
4009	394205.164	6946481.007	692.894	
4010	394179.594	6946520.038	693.177	
4011	394209.249	6946493.129	692.824	
4012	394161.094	6946533.701	692.358	
4013	394204.224	6946504.820	693.349	
4020	394166.161	6946518.026	691.612	
4021	394176.738	6946512.686	692.441	
4022	394174.596	6946516.575	691.737	
4023	394170.475	6946506.266	691.863	
4024	394172.002	6946503.376	692.433	
5000	394165.819	6946517.897	691.636	TRE
5001	394169.616	6946521.068	691.813	TRE
5002	394172.820	6946521.031	691.808	TRE
5003	394173.844	6946523.949	691.843	TRE
5004	394178.344	6946523.520	691.765	TRE
5005	394178.192	6946527.210	691.873	TRE
5006	394180.418	6946534.554	691.723	TRE
5007	394183.249	6946530.109	691.938	TRE
5008	394189.772	6946523.603	692.366	TRE
5009	394183.212	6946518.940	691.938	TRE
5010	394177.887	6946516.601	692.106	TRE
5012	394171.545	6946508.921	691.891	TRE
5013	394167.044	6946517.655	692.030	TRE
5014	?	?	?	TRE
5015	?	?	?	TRE
5016	?	?	?	TRE
5017	394174.985	6946509.177	692.523	TRE
5018	394177.179	6946524.318	691.930	TRE
5019	394174.232	6946514.149	692.006	TRE

5020	?	?	?	TRE
5021	?	?	?	TRE
5022	394180.579	6946510.127	691.580	TRE
5023	?	?	?	TRE
5024	?	?	?	TRE
5025	?	?	?	NS
5026	?	?	?	NS
5028	?	?	?	NS
5029	?	?	?	NS
5030	394168.599	6946528.197	692.819	NS
5032	?	?	?	NS
5034	?	?	?	NS
5035	?	?	?	NS
5036	?	?	?	NS
5037	?	?	?	NS
5040	?	?	?	BOB
5042	?	?	?	BOB
5043	?	?	?	BOB
5044	?	?	?	BOB
5046	?	?	?	BOB
5047	394155.405	6946503.161	689.816	BOB
5049	?	?	?	BOB
5050	?	?	?	BOB
5051	394184.407	6946512.884	692.260	BOB
5053	394189.006	6946517.045	692.641	BOB
5054	394189.846	6946520.952	692.764	BOB
5055	394186.462	6946521.858	692.042	BOB
5056	394188.581	6946506.300	690.451	BOB
5059	?	?	?	BOB
ANANGA1	394586.985	6946490.639	718.427	1
ATP1	394207.965	6946550.876	696.581	
ATP2	394197.550	6946527.566	692.873	
ATP3	394200.124	6946577.548	694.143	
ATP4	394207.457	6946549.573	694.584	
ATP5	394157.782	6946531.879	691.272	
ATP6	?	?	?	
ATP7	394181.760	6946587.626	691.700	
ATP8	394206.820	6946575.060	701.508	
ATP9	394204.671	6946570.194	693.132	

ATP10	394223.232	6946566.337	695.907	
ATP11	394062.802	6946524.434	706.666	
ATP12	394113.670	6946504.252	704.640	
ATP13	394114.639	6946519.008	697.042	
ATP14	394118.143	6946506.226	701.228	
ATP15	394217.333	6946561.349	703.146	
ATP16	394117.311	6946511.055	696.762	
ATP17	394121.142	6946501.128	691.931	
ATP18	394167.857	6946537.328	693.429	
ATP19	394170.266	6946538.541	693.441	
ATP20	394168.769	6946538.729	693.424	
ATP21	394211.138	6946551.937	692.561	
ATP22	394199.344	6946577.054	692.711	
ATP23	394189.764	6946586.395	694.667	
ATP24	394225.974	6946717.402	705.846	
ATP25	394213.619	6946558.423	699.834	
ATP26	394197.487	6946580.751	692.296	
ATP27	394214.032	6946556.210	699.918	
ATP28	394204.997	6946570.297	693.487	
ATP29	394209.198	6946574.575	700.917	
ATP30	394206.301	6946545.744	694.345	
ATP31	394156.632	6946531.096	691.276	
ATP32	394117.849	6946502.373	709.452	
ATP33	394135.975	6946516.233	690.902	
ATP34	394134.021	6946519.156	691.495	
ATP35	394117.328	6946503.208	706.802	
ATP36	394156.655	6946530.990	691.679	
ATP37	394163.844	6946535.134	691.948	
ATP38	394161.084	6946533.717	692.382	
ATP39	394111.613	6946568.720	692.891	
ATP40	394157.339	6946535.385	694.012	
ATP41	394208.558	6946550.749	698.000	
ATP42	394207.487	6946552.194	694.661	
ATP43	394217.004	6946519.178	693.979	
ATP44	394179.924	6946527.282	692.584	
ATP45	394179.993	6946526.124	690.871	
ATP46	394202.512	6946533.281	692.964	
ATP47	394177.532	6946516.577	692.502	
ATP48	394177.936	6946503.262	693.662	

ATP49	394180.923	6946521.672	693.484	
ATP50	394164.970	6946524.395	691.388	
ATP51	394136.026	6946515.680	694.694	
ATP52	394126.173	6946496.056	701.745	
ATP53	394119.242	6946498.956	711.940	
ATP54	394139.850	6946513.241	690.999	
ATP55	394142.459	6946508.089	691.659	
ATP56	394115.230	6946504.722	703.864	
ATP57	394120.976	6946494.798	706.803	
ATP58	394141.121	6946510.072	691.019	
ATP59	394135.129	6946517.532	691.221	
ATP60	394122.835	6946498.854	709.748	
ATP61	394135.333	6946516.963	690.866	
ATP62	394175.560	6946595.191	691.567	
ATP63	394222.059	6946573.923	695.453	
ATP64	394199.600	6946575.949	692.439	
ATP65	394221.722	6946569.369	694.919	
ATP66	394220.224	6946568.177	692.865	
ATP67	394200.697	6946573.695	692.186	
ATP68	394189.364	6946587.482	692.476	
ATP69	394202.047	6946573.458	693.395	
ATP70	394167.570	6946543.607	692.471	
ATP71	394210.212	6946535.053	693.282	
ATP72	394190.388	6946535.780	693.560	
ATP73	394217.153	6946519.271	694.596	
ATP74	394210.664	6946574.934	700.230	
ATP75	394208.025	6946528.302	693.672	
ATP76	394183.168	6946583.408	692.006	
ATP77	394196.491	6946590.190	696.533	
ATP78	394181.032	6946584.658	691.805	
ATP79	394175.541	6946595.508	691.562	
ATP80	394218.053	6946557.296	701.538	
ATP81	394216.054	6946567.437	693.036	
ATP82	394206.604	6946556.426	692.310	
ATP83	?	?	?	
ATP84	394201.072	6946576.014	692.864	
ATP85	394197.754	6946580.742	692.294	
ATP86	394209.601	6946576.234	701.144	
ATP87	394222.229	6946565.743	705.631	

ATP88	394214.333	6946556.326	704.635	
ATP89	394212.778	6946553.597	692.658	
ATP90	?	?	?	
ATP91	394169.789	6946537.380	693.300	
ATP92	394165.121	6946534.728	691.140	
ATP93	394162.475	6946533.488	690.987	
ATP94	394169.885	6946539.094	693.245	
ATP95	394168.085	6946542.615	693.254	
ATP96	394154.316	6946546.135	693.503	
ATP97	394167.143	6946544.487	693.273	
ATP98	394166.364	6946545.804	693.258	
ATP99	394167.987	6946543.853	691.373	
ATP100	394168.701	6946541.595	693.733	
ATP101	394168.318	6946543.607	691.151	
ATP102	394206.182	6946548.871	692.338	
ATP103	394217.289	6946553.823	703.884	
ATP104	394196.755	6946528.614	692.552	
ATP105	394201.137	6946538.970	697.161	
ATP106	394195.167	6946529.535	692.241	
ATP107	394208.818	6946535.250	693.347	
ATP108	394185.601	6946533.727	691.940	
ATP109	394184.291	6946532.916	692.944	
ATP110	394197.261	6946530.241	693.178	
ATP111	394200.587	6946537.998	695.123	
ATP112	394182.453	6946534.522	692.723	
ATP113	?	?	?	
ATP114	394184.629	6946521.725	691.864	
ATP115	394178.578	6946527.269	693.223	
ATP116	394178.570	6946527.271	691.974	
ATP117	394162.918	6946516.033	691.679	
ATP118	?	?	?	
ATP119	394129.128	6946504.444	705.100	
ATP120	394161.797	6946534.011	691.423	
ATP121	394153.504	6946529.966	693.143	
ATP122	394156.789	6946530.932	690.751	
ATP123	394214.260	6946557.143	700.171	
ATP124	394220.239	6946568.424	693.660	
ATP125	?	?	?	
ATP126	394114.135	6946499.487	707.080	

ATP127	394120.281	6946500.505	691.995	
ATP128	?	?	?	
ATP129	394157.387	6946535.260	693.515	
ATP130	394166.432	6946536.478	692.108	
ATP131	394179.551	6946580.965	691.615	
ATP132	394167.755	6946543.694	691.849	
ATP133	394167.757	6946543.699	691.429	
ATP134	394188.290	6946587.549	696.127	
ATP135	394198.062	6946576.208	692.241	
ATP136	394206.936	6946567.571	692.796	
ATP137	394200.265	6946574.207	695.940	
ATP138	394216.547	6946559.043	699.801	
ATP139	394210.429	6946568.984	692.769	
ATP140	394208.203	6946572.456	696.652	
ATP141	394200.578	6946573.541	692.180	
ATP142	394199.859	6946574.152	694.349	
ATP143	394191.716	6946586.227	694.635	
ATP144	394202.618	6946573.006	692.346	
ATP145	394204.300	6946570.791	692.867	
ATP146	394111.744	6946500.756	709.263	
ATP147	394137.624	6946517.321	690.991	
ATP148	394161.099	6946533.710	693.236	
ATP149	394158.365	6946532.328	692.101	
ATP150	394163.189	6946533.724	691.078	
ATP151	394166.468	6946536.504	691.954	
ATP152	394168.045	6946537.247	692.008	
ATP153	394163.796	6946535.129	691.941	
ATP154	394162.546	6946534.447	692.317	
ATP155	394165.408	6946535.883	691.995	
ATP156	394207.967	6946548.185	697.816	
ATP157	394219.513	6946554.840	704.310	
ATP158	394220.253	6946557.156	704.780	
ATP159	394210.347	6946552.767	692.693	
ATP160	394216.342	6946556.685	706.875	
ATP161	394200.300	6946531.603	692.963	
ATP162	394209.714	6946535.833	693.345	
ATP163	394201.300	6946542.129	693.239	
ATP164	394202.844	6946535.425	695.131	
ATP165	394183.775	6946527.433	692.218	

ATP166	394178.672	6946528.562	693.321	
ATP167	394185.554	6946516.241	692.542	
ATP168	394188.144	6946517.800	692.743	
ATP169	394169.979	6946520.811	691.946	
ATP170	394169.868	6946520.916	692.550	
ATP171	394104.639	6946509.753	691.870	
ATP172	394113.534	6946493.088	712.405	
ATP173	394118.632	6946498.688	709.443	
ATP174	394159.128	6946531.467	691.119	
ATP175	394113.339	6946501.423	710.599	
ATP176	394113.177	6946500.200	711.960	
ATP177	394115.665	6946497.973	711.724	
ATP178	394154.957	6946530.511	692.045	
ATP179	394155.493	6946529.643	691.075	
ATP180	394175.937	6946595.556	691.591	
ATP181	394167.085	6946591.714	703.749	
ATP182	394167.246	6946554.488	691.610	
ATP183	394188.573	6946587.231	694.944	
ATP184	394210.385	6946552.762	692.739	
ATP185	394205.255	6946547.897	695.502	
ATP186	394199.344	6946530.509	692.700	
ATP187	394205.456	6946543.663	692.598	
ATP188	?	?	?	
ATP189	394180.445	6946534.599	693.492	
ATP190	394180.468	6946534.542	693.618	
ATP191	394178.341	6946527.191	691.898	
ATP192	394177.662	6946524.222	691.905	
ATP193	394169.911	6946520.841	692.548	
ATP194	394174.056	6946523.865	692.660	
ATP195	394166.508	6946536.543	692.167	
ATP196	394169.506	6946538.020	693.198	
ATP197	394169.811	6946537.543	693.309	
ATP198	394118.865	6946495.534	704.851	
ATP199	394170.238	6946538.408	692.512	
ATP200	394161.798	6946533.991	691.413	
ATP201	394113.939	6946482.550	697.858	
ATP202	394118.242	6946498.112	712.229	
ATP203	?	?	?	
ATP204	394135.497	6946517.111	691.503	

ATP205	394168.950	6946540.391	693.204	
ATP206	394169.798	6946539.132	692.727	
ATP207	394168.544	6946541.743	692.266	
ATP208	394169.629	6946539.654	692.018	
ATP209	394165.382	6946546.825	690.946	
ATP210	394170.226	6946538.423	691.391	
ATP211	394169.498	6946541.738	691.144	
ATP212	394166.927	6946541.596	694.272	
ATP213	394161.877	6946539.317	696.485	
ATP214	394168.708	6946541.722	691.175	
ATP215	394170.444	6946537.958	693.446	
ATP216	394136.563	6946512.935	695.293	
ATP217	?	?	?	
ATP218	394209.545	6946570.611	692.732	
ATP219	394200.186	6946577.813	699.896	
ATP220	394168.530	6946536.855	693.352	
ATP221	394208.222	6946521.137	693.882	
ATP222	394115.063	6946519.808	697.081	
ATP223	394151.320	6946568.050	705.570	
ATP224	394206.418	6946570.504	692.467	
ATP225	?	?	?	
ATP226	394208.785	6946571.215	692.678	
ATP227	394201.935	6946577.516	700.793	
ATP228	394210.466	6946549.694	704.359	
ATP229	394209.564	6946565.642	706.642	
ATP230	394209.504	6946565.746	707.902	
ATP231	394218.133	6946554.347	702.045	
ATP232	394204.325	6946569.941	693.366	
ATP233	394217.310	6946571.886	696.496	
ATP234	394199.696	6946555.205	701.425	
ATP235	394214.879	6946556.547	706.221	
ATP236	?	?	?	
ATP237	394133.669	6946519.673	690.798	
ATP238	?	?	?	
ATP239	394056.455	6946542.807	682.817	
ATP240	394211.780	6946511.387	692.806	
ATP241	394213.091	6946512.409	693.413	
ATP242	394207.125	6946548.019	698.104	
ATP243	394202.794	6946479.244	692.804	

ATP244	394130.853	6946488.967	691.751	
ATP245	394143.076	6946507.412	691.136	
ATP246	394150.422	6946506.070	691.325	
ATP247	394128.365	6946489.775	697.255	
ATP248	394054.676	6946442.507	730.207	
ATP249	394119.308	6946504.308	707.922	
ATP250	394139.636	6946511.576	690.942	
ATP251	394135.995	6946515.434	690.907	
ATP252	394134.237	6946518.644	691.052	
ATP253	394112.561	6946504.782	707.519	
ATP254	394118.845	6946496.958	710.904	
ATP255	394135.344	6946516.985	690.872	
ATP256	394137.150	6946514.811	690.949	
ATP257	394140.326	6946510.859	691.351	
ATP258	394133.334	6946519.874	691.359	
ATP259	?	?	?	
ATP260	394112.943	6946479.332	705.555	
ATP261	?	?	?	
ATP262	394117.554	6946500.205	708.200	
ATP263	394115.187	6946501.363	711.555	
ATP264	394138.799	6946512.564	691.503	
ATP265	394131.318	6946518.828	694.822	
ATP266	394162.412	6946542.031	689.127	
ATP267	394167.882	6946541.999	693.545	
ATP268	394168.250	6946539.192	693.933	
ATP269	394216.570	6946571.438	702.805	
ATP270	394202.886	6946573.854	692.342	
ATP271	394195.675	6946585.727	692.456	
ATP272	394195.617	6946590.009	696.346	
ATP273	394198.154	6946579.745	696.987	
ATP274	394207.275	6946572.818	698.420	
ATP275	394211.056	6946566.855	708.242	
ATP276	394183.462	6946580.506	692.571	
ATP277	394209.893	6946566.145	706.876	
ATP278	394200.399	6946574.819	695.675	
ATP279	394133.633	6946519.753	690.823	
ATP280	394066.006	6946527.656	705.873	
ATP281	394161.925	6946539.316	695.981	
ATP282	394222.029	6946563.959	705.150	

ATP283	?	?	?	
ATP284	394180.032	6946527.426	692.552	
ATP285	394174.922	6946524.264	693.112	
ATP286	394182.143	6946507.441	692.190	
ATP287	394182.969	6946507.591	692.104	
ATP288	394159.064	6946514.668	691.635	
ATP289	394146.371	6946504.433	691.324	
ATP290	394117.731	6946503.994	707.992	
ATP291	394135.663	6946512.573	695.725	
ATP292	394121.556	6946495.161	707.684	
ATP293	394139.748	6946511.486	690.928	
ATP294	394120.607	6946501.885	701.415	
ATP295	394118.650	6946497.103	712.206	
ATP296	394141.710	6946508.518	691.094	
ATP297	394124.834	6946495.296	702.807	
ATP298	394116.847	6946501.717	709.796	
ATP299	394141.033	6946509.765	691.021	
ATP300	394123.167	6946493.057	700.061	
ATP301	394118.795	6946497.617	708.163	
ATP302	394141.330	6946509.755	691.688	
ATP303	394113.487	6946500.592	711.094	
ATP304	394117.065	6946504.366	707.986	
ATP305	394136.914	6946515.237	690.940	
ATP306	394200.130	6946574.158	693.768	
ATP307	394205.661	6946570.392	693.439	
ATP308	394175.697	6946544.141	694.708	
ATP309	394174.878	6946554.706	695.945	
ATP310	?	?	?	
ATP311	394216.662	6946555.464	703.686	
ATP312	394206.439	6946576.879	701.359	
ATP313	394216.481	6946559.467	705.055	
ATP314	394209.872	6946551.499	692.788	
ATP315	394194.600	6946585.877	692.422	
ATP316	394200.021	6946574.170	692.626	
ATP317	394207.160	6946549.723	694.716	
ATP318	394212.334	6946569.374	702.868	
ATP319	394185.655	6946555.733	694.933	
ATP320	394209.641	6946545.945	693.184	
ATP321	394217.935	6946554.679	702.789	

ATP322	394207.855	6946548.538	698.311	
ATP323	394169.658	6946537.967	693.101	
ATP324	394169.061	6946539.936	692.992	
ATP325	394168.559	6946541.753	693.244	
ATP326	394167.590	6946543.536	691.994	
ATP327	394167.090	6946544.505	693.253	
ATP328	394221.185	6946542.144	692.833	
ATP329	394194.584	6946526.980	692.343	
ATP330	394200.823	6946536.566	696.759	
ATP331	394178.562	6946527.327	691.986	
ATP332	394183.886	6946521.495	691.866	
ATP333	394178.487	6946527.275	693.436	
ATP334	?	?	?	
ATP335	394116.010	6946494.746	711.654	
ATP336	394163.549	6946535.053	693.202	
ATP337	394135.665	6946517.791	690.888	
ATP338	394139.932	6946511.510	690.994	
ATP339	?	?	?	
ATP340	?	?	?	
ATP341	394220.709	6946563.930	706.233	
ATP342	394236.803	6946571.159	693.305	
ATP343	394218.543	6946543.901	692.880	
ATP344	394207.236	6946546.418	694.454	
ATP345	394208.874	6946548.653	699.299	
ATP346	394184.401	6946513.442	692.286	
ATP347	394187.476	6946517.949	692.652	
ATP348	394195.687	6946522.849	692.686	
ATP349	394161.818	6946517.577	691.698	
ATP350	394163.105	6946516.168	691.664	
ATP351	394161.775	6946516.196	691.558	
ATP352	394169.925	6946520.829	692.186	
ATP353	394173.064	6946520.997	692.379	
ATP354	394117.528	6946493.108	704.815	
ATP355	394111.455	6946499.496	711.734	
ATP356	394162.280	6946521.767	697.859	
ATP357	394142.404	6946508.542	691.132	
ATP358	394181.406	6946583.470	691.783	
ATP359	394188.083	6946599.329	692.539	
ATP360	394188.809	6946587.629	694.923	

ATP361	394220.462	6946559.998	692.966	
ATP362	394162.784	6946533.792	693.227	
ATP363	394113.647	6946487.188	702.574	
ATP364	394114.176	6946494.611	709.369	
ATP365	394161.762	6946534.039	691.457	
ATP366	394162.585	6946534.445	692.315	
ATP367	394135.737	6946516.429	690.867	
ATP368	394162.034	6946539.332	697.275	
ATP369	394170.819	6946538.295	693.444	
ATP370	394115.025	6946519.206	696.826	
ATP371	394165.394	6946535.887	691.993	
ATP372	394167.745	6946543.702	691.835	
ATP373	?	?	?	
ATP374	394153.457	6946550.524	698.123	
ATP375	394208.522	6946569.340	692.735	
ATP376	?	?	?	
ATP377	394220.515	6946570.877	700.252	
ATP378	?	?	?	
ATP379	394202.155	6946573.650	692.410	
ATP380	394199.958	6946574.295	694.078	
ATP381	394219.908	6946559.533	693.032	
ATP382	394205.457	6946570.448	693.424	
ATP383	394219.464	6946569.876	701.389	
ATP384	394203.130	6946573.422	692.498	
ATP385	394184.602	6946531.892	692.128	
ATP386	394184.849	6946516.009	692.278	
ATP387	394175.243	6946520.588	692.245	
ATP388	394171.418	6946514.478	691.817	
ATP389	394180.644	6946501.091	692.566	
ATP390	394174.294	6946507.659	692.597	
ATP391	394169.971	6946538.092	693.439	
ATP392	394156.594	6946530.997	691.396	
ATP393	394156.643	6946531.210	691.880	
ATP394	394157.775	6946531.955	691.436	
ATP395	394124.546	6946495.394	701.056	
ATP396	394121.408	6946499.184	704.608	
ATP397	394217.477	6946554.971	704.286	
ATP398	394200.616	6946538.276	695.447	
ATP399	394198.232	6946537.806	692.532	

ATP400	394190.554	6946523.767	693.795	
ATP401	?	?	?	
ATP402	394186.875	6946527.162	691.940	
ATP403	394182.201	6946528.365	692.063	
ATP404	394180.223	6946530.182	691.792	
ATP405	394179.952	6946529.558	693.267	
ATP406	394113.223	6946505.086	705.756	
ATP407	394117.820	6946496.208	705.633	
ATP408	394130.004	6946491.467	691.919	
ATP409	394153.758	6946529.940	693.174	
ATP410	394113.566	6946495.654	710.140	
ATP411	394115.384	6946494.820	713.193	
ATP412	394142.197	6946511.035	691.149	
ATP413	394115.355	6946491.719	709.476	
ATP414	394141.435	6946508.143	691.069	
ATP415	394187.852	6946588.024	695.935	
ATP416	394210.387	6946553.189	692.649	
ATP417	394214.554	6946556.488	699.959	
ATP418	394203.857	6946572.690	692.445	
ATP419	394216.215	6946568.678	692.906	
ATP420	394218.722	6946554.186	700.820	
ATP421	394218.783	6946554.073	702.579	
ATP422	394161.843	6946534.021	691.465	
ATP423	394162.727	6946533.891	693.261	
ATP424	394163.968	6946533.733	691.262	
ATP425	394164.469	6946536.922	690.038	
ATP426	394163.529	6946534.218	690.963	
ATP427	394132.888	6946569.529	703.116	
ATP428	394205.451	6946545.990	694.093	
ATP429	394178.958	6946532.118	692.553	
ATP430	394184.099	6946530.893	692.769	
ATP431	394190.267	6946524.062	693.433	
ATP432	394176.563	6946527.121	692.771	
ATP433	394169.941	6946520.988	691.852	
ATP434	394173.058	6946521.104	692.071	
ATP435	394172.351	6946529.230	693.175	
ATP436	394143.993	6946506.658	691.150	
ATP437	394121.846	6946501.645	707.431	
ATP438	394126.164	6946502.768	704.228	

ATP439	394142.738	6946507.868	691.198	
ATP440	394138.228	6946515.172	690.945	
ATP441	394120.372	6946509.258	701.475	
ATP442	394164.123	6946524.007	691.291	
ATP443	394130.287	6946490.704	692.713	
ATP444	394200.260	6946574.123	692.129	
ATP445	394217.335	6946559.727	703.739	
ATP446	394215.430	6946556.191	702.086	
ATP447	394210.091	6946570.620	693.033	
ATP448	394207.676	6946574.002	699.206	
ATP449	394156.456	6946531.153	691.146	
ATP450	394167.768	6946534.885	693.321	
ATP451	?	?	?	
ATP452	?	?	?	
ATP453	394166.728	6946537.055	693.224	
ATP454	394139.591	6946511.851	691.200	
ATP455	394139.688	6946511.231	691.936	
ATP456	394138.367	6946513.404	691.492	
ATP457	394140.294	6946510.688	691.670	
ATP458	394135.021	6946517.374	691.281	
ATP459	?	?	?	
ATP460	394202.343	6946571.775	696.573	
ATP461	394165.893	6946539.676	694.866	
ATP462	394206.854	6946572.872	697.882	
ATP463	394109.248	6946513.053	698.942	
ATP464	394129.297	6946524.946	691.180	
ATP465	394138.977	6946512.542	690.959	
ATP466	394199.089	6946579.144	699.145	
ATP467	394200.710	6946571.369	692.342	
ATP468	394159.113	6946537.070	695.260	
ATP469	394170.756	6946538.696	693.225	
ATP470	394204.204	6946578.851	700.974	
ATP471	394163.745	6946533.830	691.135	
ATP472	394161.677	6946533.304	693.411	
ATP473	394159.353	6946532.270	693.408	
ATP474	394155.870	6946530.546	693.412	
ATP475	394209.860	6946576.439	701.244	
ATP476	394156.088	6946530.502	693.409	
ATP477	394202.263	6946573.077	697.273	

ATP478	394214.232	6946565.954	699.590	
ATP479	394180.527	6946534.683	691.761	
ATP480	394216.375	6946578.520	700.494	
ATP481	394139.991	6946511.543	691.023	
ATP482	394139.037	6946512.537	691.462	
ATP483	394137.396	6946514.741	690.879	
ATP484	394131.461	6946522.283	691.276	
ATP485	394137.813	6946514.186	691.615	
ATP486	?	?	?	
ATP487	394245.348	6946541.566	690.868	
ATP488	394207.138	6946548.670	694.297	
ATP489	394198.354	6946523.954	690.079	
ATP490	394168.303	6946515.340	690.704	
ATP491	394184.767	6946510.249	692.172	
ATP492	394169.029	6946515.661	691.672	
ATP493	394205.274	6946502.452	692.445	
ATP494	394113.355	6946478.451	705.674	
ATP495	394120.364	6946493.510	706.261	
ATP496	394142.808	6946508.533	691.039	
ATP497	394143.449	6946507.285	691.091	
ATP498	394141.235	6946508.091	691.052	
ATP499	394141.092	6946509.675	691.660	
ATP500	394143.256	6946507.145	691.722	
ATP501	394122.271	6946499.828	691.776	
ATP502	?	?	?	
ATP503	394112.575	6946478.223	702.827	
ATP504	394121.598	6946492.380	700.796	
ATP505	394113.808	6946481.739	704.354	
ATP506	394125.859	6946495.489	701.389	
ATP507	394142.210	6946507.758	691.630	
ATP508	394139.669	6946511.704	691.632	
ATP509	394127.712	6946491.063	694.905	
ATP510	394118.562	6946507.741	702.206	
ATP511	394139.533	6946511.823	691.456	
ATP512	394122.234	6946500.015	691.785	
ATP513	394215.725	6946572.061	700.819	
ATP514	394206.527	6946597.248	702.971	
ATP515	394164.524	6946533.310	693.306	
ATP516	394161.609	6946533.951	692.429	

ATP517	394162.345	6946534.349	692.177	
ATP518	394163.819	6946535.140	692.144	
ATP519	394162.982	6946534.681	691.190	
ATP520	394161.772	6946534.053	691.484	
ATP521	394200.697	6946578.561	700.029	
ATP522	394211.498	6946564.508	709.541	
ATP523	394167.286	6946537.042	692.175	
ATP524	394199.500	6946576.925	692.679	
ATP525	394169.430	6946537.994	691.378	
ATP526	394194.087	6946590.726	696.148	
ATP527	394206.064	6946546.572	694.583	
ATP528	394129.846	6946524.127	691.417	
ATP529	394137.981	6946513.509	691.481	
ATP530	394151.510	6946538.080	693.565	
ATP531	394160.605	6946531.894	693.420	
ATP532	394152.987	6946529.410	691.285	
ATP533	394128.407	6946526.156	691.275	
ATP534	394181.063	6946534.992	691.982	
ATP535	394180.811	6946534.490	692.088	
ATP536	394180.732	6946534.410	693.166	
ATP537	394183.825	6946533.051	692.018	
ATP538	394183.511	6946529.905	692.343	
ATP539	394205.743	6946547.236	694.807	
ATP540	394132.082	6946490.065	695.045	
ATP541	394131.332	6946491.415	695.844	
ATP542	394114.425	6946499.328	708.224	
ATP543	394148.681	6946506.576	691.349	
ATP544	394110.191	6946512.501	692.179	
ATP545	394142.690	6946507.449	691.147	
ATP546	394164.379	6946534.883	693.429	
ATP547	394160.730	6946532.687	693.414	
ATP548	394150.158	6946569.747	704.837	
ATP549	394163.378	6946532.791	694.238	
ATP550	394166.465	6946536.462	692.148	
ATP551	394169.665	6946537.466	693.314	
ATP552	394203.492	6946570.847	696.153	
ATP553	?	?	?	
ATP554	394165.581	6946535.193	693.430	
ATP555	394163.559	6946533.715	691.153	

ATP556	394209.502	6946567.548	699.971	
ATP557	394119.032	6946512.040	697.034	
ATP558	394138.459	6946512.933	691.143	
ATP559	394129.408	6946524.579	690.672	
ATP560	394154.650	6946529.636	693.347	
ATP561	394129.146	6946525.031	691.219	
ATP562	394129.876	6946524.084	691.434	
ATP563	394132.132	6946521.409	691.258	
ATP564	394130.510	6946523.529	690.733	
ATP565	394195.136	6946526.641	692.698	
ATP566	394180.551	6946534.391	691.737	
ATP567	394175.941	6946497.409	692.442	
ATP568	394209.560	6946493.292	692.668	
ATP569	394172.006	6946515.707	697.261	
ATP570	394185.074	6946516.237	692.329	
ATP571	394158.112	6946515.628	691.244	
ATP572	394163.445	6946515.873	691.573	
ATP573	394119.381	6946496.849	708.876	
ATP574	394141.475	6946508.798	691.061	
ATP575	394130.334	6946489.563	692.018	
ATP576	394124.680	6946496.077	703.410	
ATP577	394142.399	6946507.005	691.140	
ATP578	394134.778	6946518.054	691.421	
ATP579	394130.952	6946487.005	690.985	
ATP580	394117.047	6946473.592	700.843	
ATP581	?	?	?	
ATP582	394154.938	6946523.508	692.304	
ATP583	394141.036	6946509.764	691.010	
ATP584	394137.424	6946514.342	691.556	
ATP585	394140.642	6946509.911	691.600	
ATP586	394142.517	6946508.578	691.665	
ATP587	394125.392	6946494.901	698.641	
ATP588	394164.827	6946535.948	692.995	
ATP589	394162.254	6946568.321	704.105	
ATP590	?	?	?	
ATP591	394162.701	6946533.704	693.416	
ATP592	394163.209	6946533.978	693.422	
ATP593	394164.185	6946534.480	693.427	
ATP594	394162.111	6946535.817	694.256	

ATP595	394164.229	6946532.565	693.332	
ATP596	394140.791	6946599.652	716.393	
ATP597	394165.179	6946532.668	693.335	
ATP598	?	?	?	
ATP599	394214.707	6946556.877	699.940	
ATP600	394211.039	6946562.275	710.489	
ATP601	394170.989	6946538.313	693.447	
ATP602	394169.430	6946537.985	691.386	
ATP603	394179.103	6946526.414	692.331	
ATP604	394178.598	6946527.062	692.603	
ATP605	394163.677	6946531.554	693.349	
ATP606	394161.643	6946533.948	692.325	
ATP607	394159.766	6946532.973	692.144	
ATP608	394159.775	6946532.949	691.984	
ATP609	394158.433	6946531.657	693.412	
ATP610	394157.851	6946531.879	691.218	
ATP611	394178.437	6946527.091	691.804	
ATP612	394177.886	6946517.021	692.483	
ATP613	394173.513	6946525.545	693.122	
ATP614	394143.891	6946506.419	691.179	
ATP615	394127.358	6946487.563	697.672	
ATP616	394165.727	6946517.793	692.203	
ATP617	394130.455	6946523.281	690.738	
ATP618	394156.616	6946530.948	691.087	
ATP619	394153.139	6946529.622	690.996	
ATP620	394155.026	6946530.517	692.148	
ATP621	394155.368	6946529.873	693.350	
ATP622	394138.029	6946513.645	690.920	
ATP623	394139.848	6946511.444	690.978	
ATP624	394142.762	6946507.742	691.894	
ATP625	394113.165	6946482.647	698.053	
ATP626	394152.512	6946528.640	691.047	
ATP627	394156.011	6946530.600	691.104	
ATP628	394132.738	6946520.614	691.008	
ATP629	394158.463	6946532.647	692.165	
ATP630	394158.505	6946532.340	691.949	
ATP631	394157.520	6946531.595	692.275	
ATP632	394157.405	6946531.592	691.124	
ATP633	394159.288	6946531.937	693.413	

ATP634	394178.146	6946527.164	691.844	
ATP635	?	?	?	
ATP636	394160.268	6946532.452	693.413	
ATP637	394156.402	6946530.460	693.408	
ATP638	394209.435	6946575.964	699.391	
ATP639	394137.855	6946514.054	691.073	
ATP640	394139.024	6946512.473	690.988	
ATP641	394154.553	6946529.330	693.402	
ATP642	394155.914	6946530.112	693.404	
ATP643	394199.042	6946581.136	697.374	
ATP644	394203.090	6946582.487	700.300	
ATP645	394139.576	6946511.842	691.081	
ATP646	?	?	?	
ATP647	394204.315	6946577.995	700.654	
ATP648	394167.965	6946537.368	693.227	
ATP649	394156.528	6946531.314	693.220	
ATP650	?	?	?	
ATP651	394208.841	6946566.878	693.575	
ATP652	394209.761	6946565.552	708.787	
ATP653	394204.080	6946570.515	692.820	
ATP654	394205.745	6946571.617	694.724	
ATP655	394140.179	6946511.226	690.938	
ATP656	394126.341	6946496.024	692.020	
ATP657	394109.808	6946476.084	704.768	
ATP658	394139.573	6946511.677	690.915	
ATP659	394137.876	6946514.004	691.030	
ATP660	394125.019	6946495.281	700.830	
ATP661	394138.588	6946513.141	690.993	
ATP662	394134.299	6946518.543	691.576	
ATP663	394137.058	6946515.012	691.112	
ATP664	394137.463	6946514.535	690.859	
ATP665	394132.731	6946520.583	690.925	
ATP666	394135.927	6946516.528	691.329	
ATP667	394211.839	6946564.936	710.832	
ATP668	394180.483	6946534.591	691.975	
ATP669	394170.259	6946516.012	693.506	
ATP670	394177.334	6946512.989	692.406	
ATP671	?	?	?	
ATP672	394131.015	6946488.283	697.096	

ATP673	394150.782	6946506.299	691.271	
ATP674	394115.422	6946474.703	704.945	
ATP675	394115.224	6946483.284	696.579	
ATP676	394129.013	6946490.544	697.236	
ATP677	394139.480	6946468.981	707.657	
ATP678	394141.314	6946508.026	691.045	
ATP679	394140.374	6946510.744	691.686	
ATP680	394118.496	6946477.634	701.430	
ATP681	394142.716	6946507.431	691.694	
ATP682	?	?	?	
ATP683	394128.104	6946481.386	696.758	
ATP684	394129.694	6946484.895	699.802	
ATP685	394146.064	6946499.921	699.364	
ATP686	394141.355	6946509.395	691.006	
ATP687	394142.181	6946507.923	691.076	
ATP688	394129.935	6946476.010	700.634	
ATP689	394165.376	6946535.982	692.099	
ATP690	394160.108	6946571.403	703.393	
ATP691	394165.582	6946535.225	693.430	
ATP692	394167.327	6946537.086	692.192	
ATP693	394166.480	6946536.412	692.009	
ATP694	394168.361	6946532.850	693.344	
ATP695	394232.782	6946572.128	692.940	
ATP696	394205.483	6946575.218	701.516	
ATP697	?	?	?	
ATP698	394203.962	6946569.613	693.338	
ATP699	394168.205	6946538.899	694.225	
ATP700	394168.591	6946532.266	693.438	
ATP701	394180.489	6946534.631	693.438	
ATP702	394172.716	6946506.325	692.290	
ATP703	394173.831	6946523.996	691.856	
ATP704	394169.816	6946521.004	692.812	
ATP705	394170.433	6946524.681	691.627	
ATP706	394169.634	6946521.001	693.205	
ATP707	394173.857	6946523.956	693.620	
ATP708	394163.025	6946516.096	691.429	
ATP709	394164.389	6946515.619	691.616	
ATP710	394165.017	6946536.019	693.006	
ATP711	394163.455	6946533.933	693.420	

ATP712	394163.797	6946535.149	692.098	
ATP713	394164.077	6946534.586	693.313	
ATP714	394162.044	6946534.177	692.399	
ATP715	394163.774	6946535.216	692.384	
ATP716	394163.805	6946535.025	692.834	
ATP717	394159.219	6946515.136	691.695	
ATP718	394160.546	6946515.501	691.470	
ATP719	?	?	?	
ATP720	?	?	?	
ATP721	394156.482	6946531.323	693.237	
ATP722	394154.967	6946530.501	691.970	
ATP723	394140.654	6946510.176	690.919	
ATP724	394161.811	6946533.725	693.417	
ATP725	394157.764	6946531.921	693.241	
ATP726	394158.044	6946532.123	691.219	
ATP727	394160.880	6946533.587	692.141	
ATP728	394159.290	6946532.734	691.972	
ATP729	394165.316	6946536.023	693.232	
ATP730	394163.816	6946534.264	693.427	
ATP731	394166.173	6946535.483	693.430	
ATP732	394172.113	6946547.767	697.012	
ATP733	394170.227	6946547.926	697.870	
ATP734	394207.346	6946576.898	701.730	
ATP735	394169.482	6946539.333	693.462	
ATP736	394171.100	6946548.443	697.865	
ATP737	394179.547	6946535.141	693.211	
ATP738	394166.478	6946531.356	693.420	
ATP739	394174.567	6946514.032	692.605	
ATP740	394189.291	6946514.989	693.368	
ATP741	394175.490	6946517.517	692.991	
ATP742	394162.855	6946516.947	691.574	
ATP743	394164.590	6946523.409	693.741	
ATP744	394163.743	6946515.926	691.526	
ATP745	394137.663	6946470.612	704.428	
ATP746	394135.595	6946483.941	700.267	
ATP747	394158.819	6946514.418	691.433	
ATP748	?	?	?	
ATP749	394148.585	6946505.719	691.184	
ATP750	394146.074	6946499.955	699.359	

ATP751	394137.489	6946474.350	705.703	
ATP752	394123.026	6946494.887	704.607	
ATP753	394135.113	6946517.355	691.532	
ATP754	394116.228	6946521.114	696.866	
ATP755	394142.124	6946508.282	691.115	
ATP756	394144.295	6946553.752	693.735	
ATP757	394159.507	6946532.889	691.274	
ATP758	394157.126	6946531.656	692.709	
ATP759	394159.180	6946531.876	693.414	
ATP760	394157.520	6946533.473	693.438	
ATP761	394158.564	6946532.400	691.296	
ATP762	394160.249	6946533.266	692.733	
ATP763	394141.303	6946509.738	691.686	
ATP764	394142.901	6946507.600	691.710	
ATP765	394143.220	6946507.199	691.775	
ATP766	394142.441	6946508.222	690.972	
ATP767	394120.609	6946557.023	701.648	
ATP768	?	?	?	
ATP769	394153.904	6946528.786	691.024	
ATP770	394157.007	6946530.963	693.413	
ATP771	?	?	?	
ATP772	394167.213	6946535.646	691.244	
ATP773	394181.469	6946534.688	691.978	
ATP774	394217.255	6946545.145	692.877	
ATP775	394115.622	6946537.949	700.395	
ATP776	394126.220	6946529.227	691.213	
ATP777	394122.037	6946534.362	691.142	
ATP778	394175.497	6946527.851	691.774	
ATP779	394174.807	6946525.467	691.952	
ATP780	394174.254	6946513.487	692.615	
ATP781	394158.066	6946519.255	692.651	
ATP782	394168.863	6946516.411	691.899	
ATP783	394152.972	6946505.902	691.477	
ATP784	394155.865	6946513.830	694.966	
ATP785	394130.837	6946489.609	692.588	
ATP786	394140.983	6946510.400	690.957	
ATP787	394150.699	6946506.135	691.235	
ATP788	394141.944	6946507.396	690.961	
ATP789	394142.932	6946506.816	691.597	

ATP790	394141.694	6946509.310	691.739	
ATP791	394120.009	6946488.778	699.913	
ATP792	?	?	?	
ATP793	394145.908	6946499.853	698.748	
ATP794	?	?	?	
ATP795	394218.197	6946563.729	692.835	
ATP796	394218.755	6946571.679	693.717	
ATP797	394223.112	6946567.313	697.761	
ATP798	394204.682	6946576.788	700.620	
ATP799	394220.198	6946568.193	693.491	
ATP800	394225.339	6946566.797	694.705	
ATP801	394218.158	6946571.873	696.465	
ATP802	394222.619	6946565.996	696.653	
ATP803	394222.045	6946568.769	694.927	
ATP804	394225.031	6946568.124	697.707	
ATP805	394150.547	6946507.338	691.204	
ATP806	394149.759	6946506.991	691.215	
ATP807	394140.761	6946510.319	691.480	
ATP808	394133.959	6946494.050	690.821	
ATP809	394141.358	6946509.578	691.696	
ATP810	394129.679	6946490.228	692.020	
ATP811	394129.367	6946490.760	691.723	
ATP812	394137.192	6946475.028	702.023	
ATP813	394131.489	6946481.301	700.849	
ATP814	394156.411	6946530.753	691.117	
ATP815	394159.782	6946532.210	693.416	
ATP816	?	?	?	
ATP817	394200.668	6946571.140	692.425	
ATP818	394155.858	6946529.970	690.986	
ATP819	394115.577	6946501.033	706.415	
ATP820	394129.222	6946524.881	691.320	
ATP821	394126.856	6946528.349	691.167	
ATP822	394099.283	6946528.392	695.635	
ATP823	394126.044	6946529.377	691.188	
ATP824	394177.469	6946525.406	692.409	
ATP825	394176.482	6946525.842	691.832	
ATP826	394178.465	6946531.463	691.722	
ATP827	394168.666	6946515.984	690.617	
ATP828	394177.563	6946511.563	692.421	

ATP829	394190.353	6946508.374	691.991	
ATP830	394169.632	6946516.008	691.679	
ATP831	394140.976	6946508.766	691.682	
ATP832	394117.871	6946487.878	698.440	
ATP833	394115.696	6946478.530	701.778	
ATP834	394112.430	6946479.942	702.285	
ATP835	?	?	?	
ATP836	394124.738	6946495.694	702.920	
ATP837	394140.617	6946510.485	690.967	
ATP838	394128.952	6946491.273	691.645	
ATP839	?	?	?	
ATP840	394134.566	6946481.420	701.319	
ATP841	394126.635	6946498.502	699.246	
ATP842	394138.379	6946513.162	691.514	
ATP843	394131.971	6946521.589	691.178	
ATP844	394115.689	6946537.551	698.135	
ATP845	394115.974	6946556.959	696.045	
ATP846	394153.943	6946541.094	693.917	
ATP847	394145.962	6946533.692	696.314	
ATP848	394146.843	6946533.237	691.001	
ATP849	394152.944	6946529.370	691.170	
ATP850	394155.492	6946529.648	691.063	
ATP851	394157.740	6946531.900	693.727	
ATP852	?	?	?	
ATP853	394151.493	6946528.743	693.418	
ATP854	394174.191	6946524.068	692.454	
ATP855	394133.793	6946519.287	691.001	
ATP856	394134.237	6946518.728	691.487	
ATP857	394134.693	6946518.158	690.838	
ATP858	394169.011	6946518.498	692.922	
ATP859	394154.518	6946511.539	691.996	
ATP860	394152.294	6946506.800	691.361	
ATP861	394148.830	6946498.113	690.199	
ATP862	394152.535	6946505.328	691.177	
ATP863	394141.992	6946508.675	690.972	
ATP864	394139.487	6946511.972	691.550	
ATP865	394139.038	6946512.494	691.601	
ATP866	394141.130	6946509.958	690.972	
ATP867	394138.649	6946512.982	691.638	

ATP868	394140.313	6946510.927	691.619	
ATP869	?	?	?	
ATP870	?	?	?	
ATP871	394143.488	6946506.962	691.039	
ATP872	394130.678	6946508.475	692.365	
ATP873	394138.426	6946513.261	691.339	
ATP874	394137.829	6946514.073	691.609	
ATP875	394135.543	6946517.118	691.506	
ATP876	394136.893	6946515.285	690.903	
ATP877	394135.425	6946517.076	690.802	
ATP878	394136.362	6946515.999	691.353	
ATP879	394136.068	6946516.427	691.408	
ATP880	394138.108	6946513.665	690.894	
ATP881	394236.603	6946573.287	693.690	
ATP882	394224.546	6946564.935	694.763	
ATP883	394206.606	6946577.266	701.373	
ATP884	394221.053	6946570.999	696.371	
ATP885	394210.705	6946565.136	709.908	
ATP886	394213.277	6946557.010	700.680	
ATP887	394213.626	6946557.212	699.426	
ATP888	394192.392	6946522.979	689.580	
ATP889	394206.012	6946524.699	691.402	

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Appendix 6

Screenshot taken directly from TBC showing a preliminary surface of the chosen site.