

University of Wales Trinity Saint
David

Module: Surveying

Module code: M4X01317

Assignment Title: Basic Site Levelling at the
SA1 Swansea Waterfront development (Land/site
surveying)

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Submission date: 28th January 2019

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1.0 Introduction

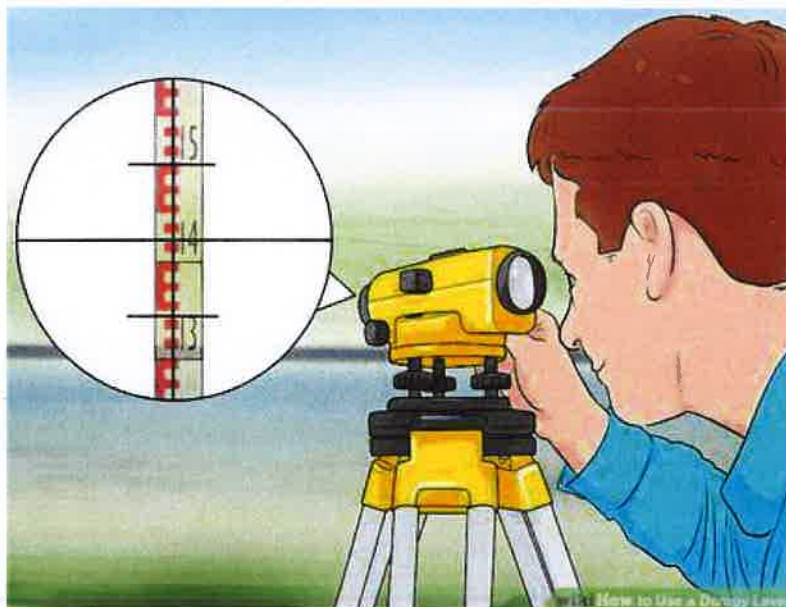
The University of Wales Trinity Saint David, Swansea have plans to create a new Gymnastic Centre for the students and staff by 2020. The new development will be positioned next to the library as shown below:



1.1 Aim of the report

Myself and 3 crew members will be carrying out Basic Levelling and Fly Levelling surveys to determine the difference in elevations for the proposed site. The site is an occupied open area used as a car park for the University staff and students. My observations will be presented in a field book with a report on how the survey was carried out. The Reduced Levels of various points will be calculated using both the Rise and Fall and Height of Collimation methods.

Relevant photos and sketches will also be provided.



1.2 Details of levelling equipment used

Below I have detailed the levelling equipment and setting out procedures used to carry out my survey:

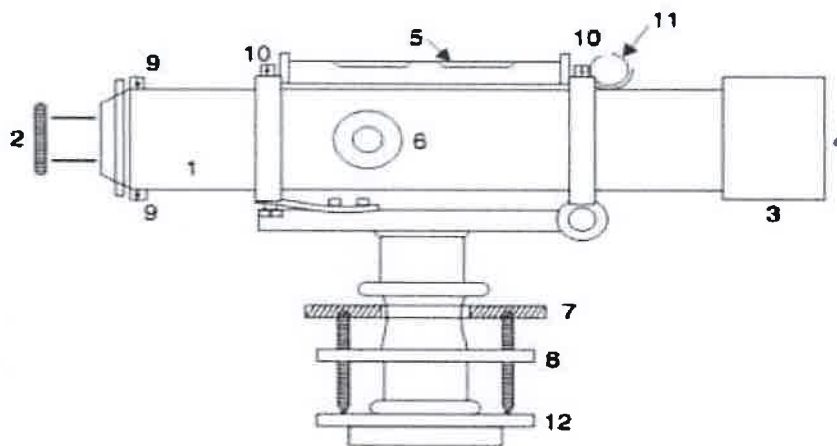
Level

A dumpy level, builder's auto level, leveling instrument, or automatic level is an optical instrument used to determine or verify points in the same horizontal plane of surveying land. It is used in surveying and building with a vertical staff to measure height differences and to transfer and establish heights relative to a datum. The level consists of a telescope fitted with a spirit level and is typically mounted on a tripod.



A Dumpy Level

The main components of dumpy level instrument are detailed below:



- | | |
|------------------------|----------------------------------|
| 1. Telescope | 7. Foot Screws |
| 2. Eyepiece | 8. Upper Parallel Plate |
| 3. Ray Shade | 9. Diaphragm Adjusting Screws |
| 4. Objective End | 10. Bubble Tube Adjusting Screws |
| 5. Longitudinal Bubble | 11. Transverse Bubble Tube |
| 6. Focusing Screws | 12. Foot Plate |

Tripod

Surveying instruments are supported by a tripod. A tripod is a portable three-legged frame or stand composed of aluminium and plastic. The legs of a tripod can be extended or lowered to provide stability against downward and horizontal forces, and movements about horizontal axes. Positioning the legs away from the vertical center allows the tripod better leverage for resisting lateral forces. A canvas carrying strap and belt secure the legs together during transportation.



Levelling Staff



A levelling staff is a graduated aluminium or wooden rod used to determine the difference in height between points; or heights of points above a vertical datum. Aluminium is more commonly used today due to its durability. One face has a graduated scale attached for reading with the cross-hairs of a level telescope. These faces can vary in pattern but 5mm graduations should be the maximum for precise levelling of station points.

To secure accurate readings a **Staff Bubble** should be used at all times. A **staff bubble** is a circular bubble enclosed within an angle plate that is held against the staff to ensure the staff is held in a vertical position. If a staff bubble is not available, the staff should be rocked back and forth and the lowest reading recorded.



Measuring Tape

A 50m / 165ft long tape is commonly known as a Surveyors' Tape measure. Tapes are used in surveying for measuring vertical, horizontal or slope distances. Surveyor's tapes are available in various lengths of different materials and numerous methods of graduation.



Field book

A book in which a surveyor logs technical notes taken in the field, such as angles, stations and distances. All observations and measurements are to be recorded in a standard field book with relevant notes on how the survey was conducted.



Plumb Bob

A plumb bob or plummet is a balanced weight, usually with a pointed tip, suspended from a string and used as a vertical reference line or plumb line.

Although not used in this exercise, surveyors can use plumb bobs for lining up points or transferring them. It can be used with a variety of instruments (including levels and steel tapes) to set the instrument exactly over the ground station mark or to record positions on the ground.



1.2.1 Setting out procedures of basic levelling equipment

When using surveying equipment always check that the equipment used has been calibrated.

Setting up the tripod

Open the latches/screws that release the legs and extend the sections. Extend the thickest sections first and tighten the screws to ensure the legs are secure. If the surface is uneven adjust the legs accordingly. Point one of the legs in the same direction that your camera will face to create a space between the other two legs for you to stand. When on soft ground or sand, push the tripod legs down into the ground to guarantee a firm foothold. Check the horizontal position of the tripod plate and ensure all bolts or screws are secure.

Setting out Dumpy Level

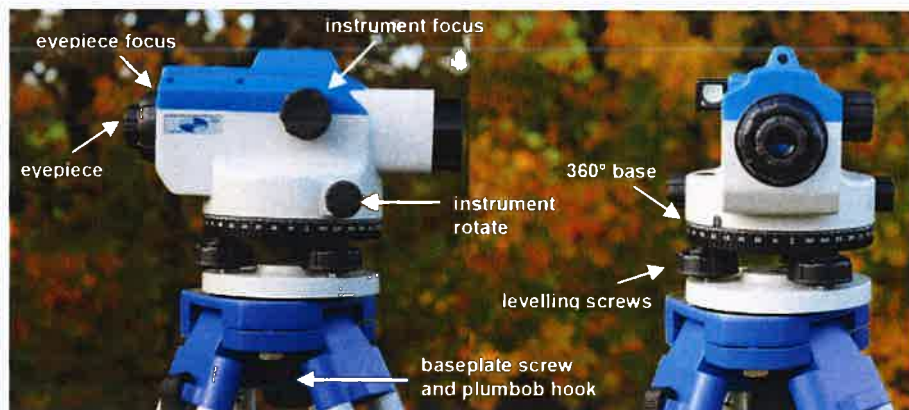
Place the level head onto the tripod and tighten central fixing screw beneath the baseplate. With the telescope parallel to two of the foot screws, turn the screws simultaneously in opposite directions until the bubble is central. Next turn the instrument 90 degrees towards the third foot screw and adjust the spirit level until the bubble is centred along the axis. Turn the instrument 180 degrees and check the levels again in all directions.



Focusing the Dumpy Level

Adjust eyepiece until the device's crosshairs are visible. Place a sheet of paper in front of the lens and turn the eyepiece until reticule appears clear, sharp and black.

Aim telescope on levelling staff at benchmark spot and turn primary focusing knob until the staff is brought into sharp focus.



Holding the levelling staff and taking readings

The use of a spirit level or staff bubble will ensure the staff is held exactly vertical and eliminate errors. The chainman should hold the staff in front of them with both hands down the side of the staff. The lowest reading should be recorded as the staff is rocked back and forth.

It is important that care is taken to ensure accurate readings. One of the most common errors is the observer misreading the staff through the dumpy level telescope.

1.2.2 Levelling terms and meanings:

Levelling is defined as 'an art of determining the relative height of different points on, above or below the surface'

Datum Line – A line which serves as a reference for which the levels of other station points are fixed.

Back Sight (BS) – The first reading taken from the staff level to obtain the elevation of plane of collimation.

Fore Sight (FS) – The last reading taken from the staff level. This sight is considered a Minus sight and subtracted from the plane of collimation to determine the Reduced Level of different points.

Intermediate Sight (IS) – All readings taken between the back sight and fore sight. These readings are also known as a minus sight.

Reduced Level – The vertical difference between the datum line and level points.

Change Point (CP) – Also known as a **Turning Point (TP)** Is a point on which back sights and fore sights are taken.

Benchmark (BM) – A post or permanent mark used as an elevation reference above or below a datum which is known or assumed.

Rise and Fall method – Determining the difference of elevation between consecutive points. The Reduced Level is calculated by adding the rise to, or subtracting the fall from the reduced level of the previous point.

Height of Instrument (Plane of Collimation) Method – Determining the elevation of the plane of collimation (H.I.) for every set up of the levelling instrument, and obtaining the reduced level of point with reference to the datum.

1.3 Basic Levelling exercise



1.3.1 Procedure adopted during Basic Levelling fieldwork at Singleton Park.

Myself and 3 crew members (Dan Lawrence, Greg Thompson, and Ellis Jones) were required to carry out a Basic Levelling land survey for the proposed development at The University of Wales Trinity Saint, Swansea.

Firstly, we gathered the surveying equipment from the University - A dumpy level, tripod and 5m staff. We all then put on high visibility vests as we were surveying a car park on occupied land and needed to ensure that our crew was clearly visible to pedestrians and vehicles.

The crew members all assembled at Point A – The Temporary Bench Mark (TBM) and reviewed the area we were going to survey. As the land was a live car park this made it difficult to carry out the survey. We had to ensure that there were no obstructions between the staff and the dumpy level.

We decided that when we had set up the equipment we would rotate and take it in turns holding the staff and taking staff readings through the dumpy level. Although this was a group exercise I believe that inconsistencies are likely to have arisen as a result of alternating the chainman and observer.

Myself and Dan set up the tripod at the Level 1 position. We made sure the land was solid and we had not set up on wet or soft ground as this could make the tripod uneven and affect our readings. We mounted the dumpy level on the tripod and attached it securely using the screws of the baseplate. We carefully followed the levelling procedure for a dumpy level ensuring the bubble was centred. We set the height of the dumpy level at shoulder height so that we both could look through the dumpy level and take the readings comfortably.

Due to time constraints of this exercise the equipment used was not adjusted specifically to suit each user, again this could have resulted in inconsistent readings throughout.

Ellis held the staff at Point A (TBM). This would be our Back Sight (BS) reading as it was the first staff reading taken through the dumpy level. The weather was windy making it difficult for the chainman to hold the staff exactly vertical. As a staff bubble was not available the observer asked the chainman to rock the staff back and forth so that the lowest reading could be recorded.

Once we were all happy that the levelling instrument, tripod and staff were all in the correct position, the readings were taken. Myself and Dan checked the first reading to ensure we both agreed on the measurements taken from the staff. By refocusing the dumpy level and ensuring the reticule was in sharp focus we were able to obtain readings to the closest millimetre (MM).

Greg was responsible for accurately recording our readings and observations in the field book provided.

The staff was then moved to Point B where the Intermediate Sight (IS) reading was taken from the Level 1 position. The dumpy level was rotated so it was in line with Point B and further readings were recorded. The process was repeated for Point C. These are Minus sights readings taken in between the first and last staff level readings.

At Point D, the Fore Sight (FS) reading was taken. This was the last reading before the level was moved to the Level 2 position. The staff was held at Point D (the Change Point) until the tripod and dumpy level had been relocated to Position 2.

From the Level 2 position, a further reading was taken from Point D. This became the Back Sight reading for the L2 position.

At point E and F, our crew members were rotated. Ellis and Greg were responsible for taking the Intermediate sight level readings and I was required to hold the staff vertical while Dan recorded measurements in the field book.

Vehicles in the car park presented problems when carrying out the survey at points E and F. This meant our team were required to slightly change the proposed staff locations to work around vehicles remaining in situ.

Point G was the last Fore Sight reading for Level 2. The basic levelling exercise from both Level 1 and Level 2 stations were now complete.

Below are copies of my Basic Levelling Field Book readings. The Reduced Levels of various points have been calculated using both the Rise and Fall and Height of Collimation methods. My reduced level for this exercise is 500m.

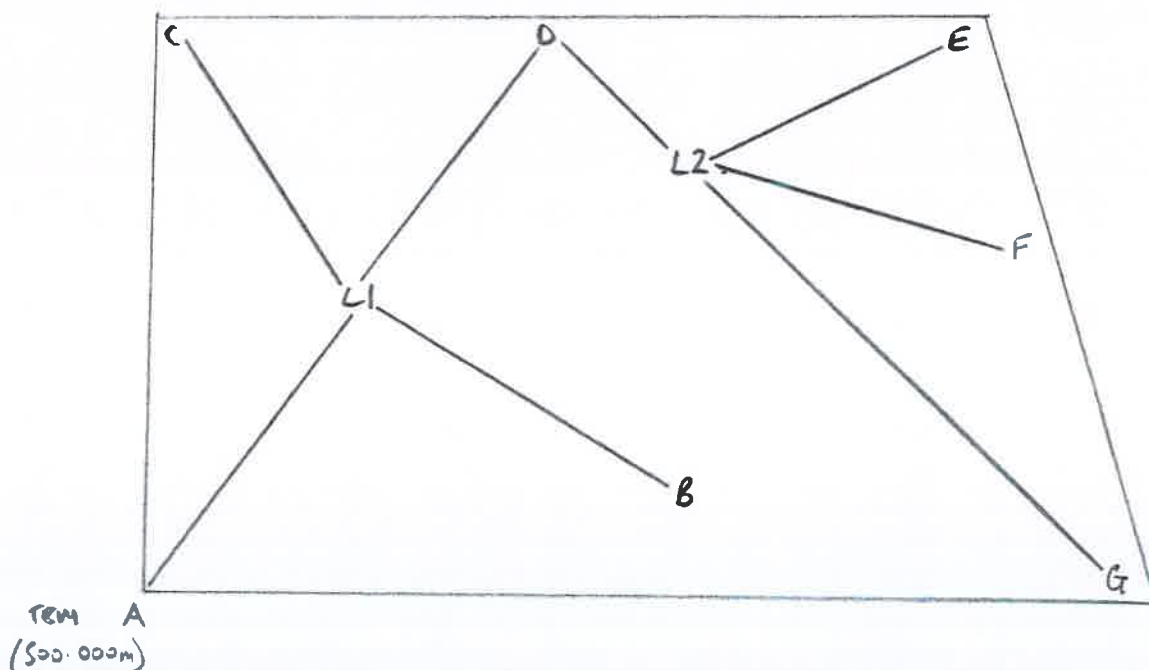
1.4 Copy of Basic Levelling Field book readings

Field Book readings: Rise and Fall Method

Project Title	SWANSEA LAND - SURVEY
Site Location	SAI SWANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABOULLAH
Surveyor	ELIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					REDUCTION		
Station	Points	BS	IS	FS	Rise	Fall	RL
1	TBM A	1.562					500.000
1	B		1.676			0.114	499.886
1	C		1.780			0.104	499.782
1	D			1.665	0.115		499.897
2	D	1.618					499.897
2	E		1.750			0.132	499.765
2	F		1.700		0.05		499.815
2	G			1.620	0.08		499.895
	Check	BS=3.18		FS=3.285			
		BS-FS=	0.105✓		RL-TBM =	0.105✓	

Drawings: Sketch of Car Park.



Field Book readings: Height of Collimation Method

Project Title	SNANSEA LAND - SURVEY
Site Location	SAT SNANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABOULLAH
Surveyor	ELVIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					
BACKSIGHT	INTERMEDIATE	FORESIGHT	HEIGHT OF COLL	REDUCED LEVEL	REMARKS
1.562			501.562	500.000	BM A
	1.676			499.886	B
	1.780			499.782	C
1.618		1.665	501.515	499.897	D - CP. 1
	1.750			499.765	E
	1.700			499.815	F
		1.620		499.895	G

1.5 Further factors affecting accuracy of a levelling exercise.

- **Collimation** – Relative to the different sight length between set ups. This can be minimised by keeping site lengths equal with an even number of setups per section.
- **Parallax** – Parallax should be checked and eradicated by each observer when he begins to operate the instrument. The user should view an object through the telescope and move the eye whilst observing the relationship between the cross hairs and the object. It may then be necessary to refocus the telescope to ensure there is no movement of the cross hairs from the object.
- **Compensator malfunction** – The compensator maintains a horizontal line of sight when the instrument is levelled. Test the compensator is working correctly by turning the foot screw back and forth.
- **Staff defects** – Including wear and tear and incorrect extension of staff.
- **Tripod errors** – Including insecure head and extension of legs.
- **Calibration of instrument** – The measurements obtained using your instrument should be compared against the calibration standard of a known measurement. This can be tested through regular servicing of the instrument.

2.0 Fly Levelling exercise



2.1 Procedure adopted during Fly Levelling fieldwork at Singleton Park.

Our crew were also required to carry out a Fly Levelling land survey of the proposed site from Point A - The Temporary Bench Mark (TBM) to Point B as shown above.

Before setting out the required equipment we checked that there were no vehicles or obstructions within the line of sight from Point A to B. We then followed the setting out procedures as discussed previously under the Basic Levelling exercise.

Due to the distance between Points A and B, it was decided that a Change Point and two stations would be required. For more accurate Reduced Level readings additional change points should be considered.

After Back Sight and Fore Sight readings were taken from Station 1, the surveying equipment was then relocated to Station 2 and the process was repeated. In total, four readings were taken between the TBM at Point A and Point B and recorded in the field book provided.

The ground at Station 2 and Point B was soft and wet which may have affected the position of the tripod and staff. To reduce any significant reading errors, the crew took necessary precautions to ensure the tripod had a firm foothold and the staff was held vertical.

Once the survey had been completed, the equipment was carefully dismantled and packed away in protective cases. Upon returning to the lecture room, our crew members exchanged and discussed the readings and observations recorded.

The original copy of my Field Book has been enclosed and includes the crew's readings along with rough sketches indicating the points covered within our surveys.

Below are copies of my Fly Level Field Book readings. The Reduced Levels of various points have been calculated using both the Rise and Fall and Height of Collimation methods. My reduced level for this exercise is 500m.

2.2 Copy of Fly Level Field Book readings

Field Book readings: Rise and Fall Method - Fly Level

Project Title	SWANSEA LAND-SURVEY
Site Location	SAI SWANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABDOULLAH
Surveyor	EUIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					REDUCTION		
Station	Points	BS	IS	FS	Rise	Fall	RL
1	A TBM	1.608					500.000
1	B			1.693		0.085	499.915
2	B	1.462					499.915
2	C			1.878		0.416	499.499

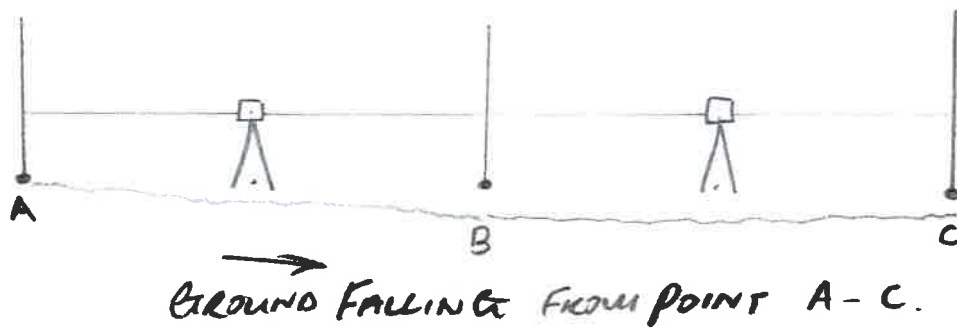
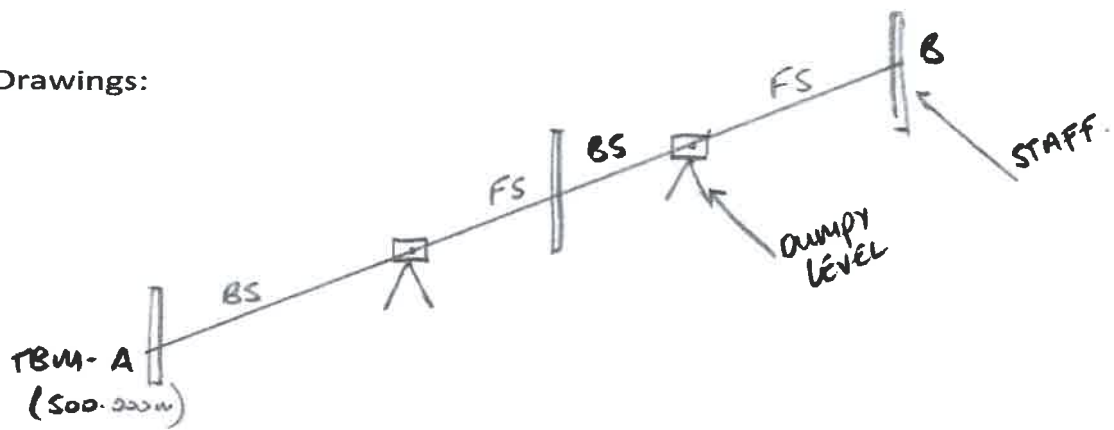
Field Book readings: Height of Collimation - Fly Level

Project Title	SWANSEA LAND-SURVEY
Site Location	SAI SWANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABDOULLAH
Surveyor	EUIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					
BACKSIGHT	INTERMEDIATE	FORSIGHT	HEIGHT OF COLL	REDUCED LEVEL	REMARKS
1.608			501.608	500.000	A
1.462		1.693	501.377	499.915	B.CPI
		1.878		499.499	C

2.3 Sketch of fieldwork mapping out Stations from A(TBM) to B

Drawings:



Phillip Abdullah - Field Book

University of Wales Trinity Saint David

Module: Surveying

Module code: M4X01317

Assignment Title: Basic Site Levelling at the SA1 Swansea Waterfront development (Land/Site surveying)

Date of survey: 5th November 2018

Crew members:

Phillip Abdullah

Greg Thompson

Dan Lawrence

Ellis Jones

Equipment used:

Dumpy Level

Tripod

5m Staff

High Visibility Vests

Field Book

Weather conditions:

Wet and cold. Very windy at times

Ground conditions:

Wet and soft - Deep puddles in various locations.

Ground materials varied from tarmac, loose stone, mud and grass.

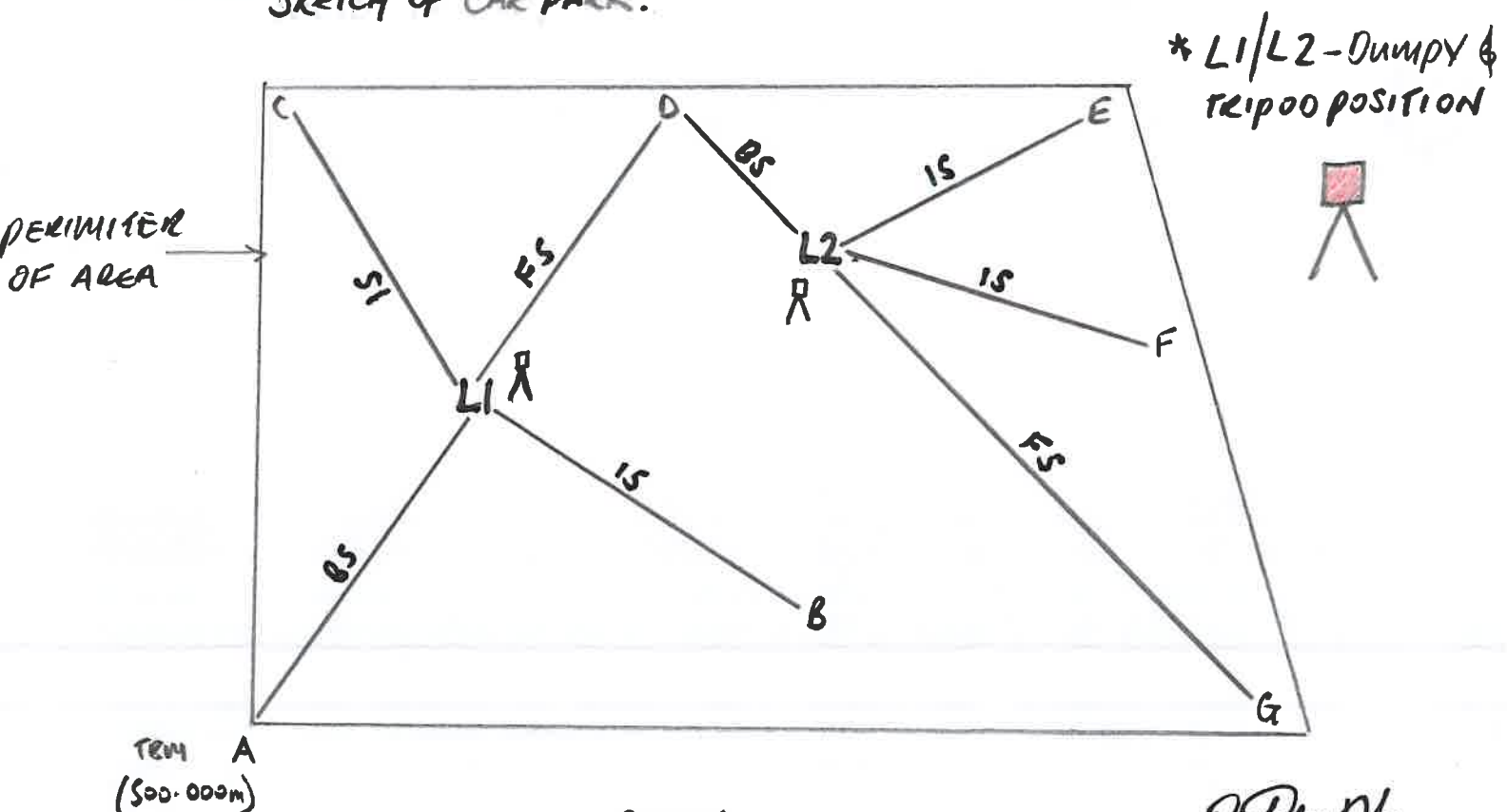
Field Book readings: Rise and Fall Method

DATE: 05.11.18

Project Title	SWANSEA LAND - SURVEY
Site Location	SAI SWANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABOULLAH
Surveyor	ELIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					REDUCTION		
Station	Points	BS	IS	FS	Rise	Fall	RL
1	TBM A	1.562					500.000
1	B		1.676			0.114	499.886
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2	G			1.620	0.08		499.815
	check	BS=3.18		FS=3.285			
		BS-FS=	0.105✓			RL-TBM = 0.105✓	

Drawings: SKETCH OF CAR PARK.



Field Book readings: Height of Collimation Method

DATE: 05-11-18

Project Title	SNANSEA LAND - SURVEY
Site Location	SAI SNANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABDULLAH
Surveyor	ELLIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					
BACKSIGHT	INTERMEDIATE	FORESIGHT	HEIGHT OF COLL	REDUCED LEVEL	REMARKS
1.562			501.562	500.000	TBM A
	1.676			499.886	B
	1.780			499.782	C
1.618		1.665	501.515	499.897	D-CP.1
	1.750			499.765	E
	1.700			499.815	F
		1.620		499.895	G

Drawings

AS PER PAGE 1 (RISE & FALL METHOD).

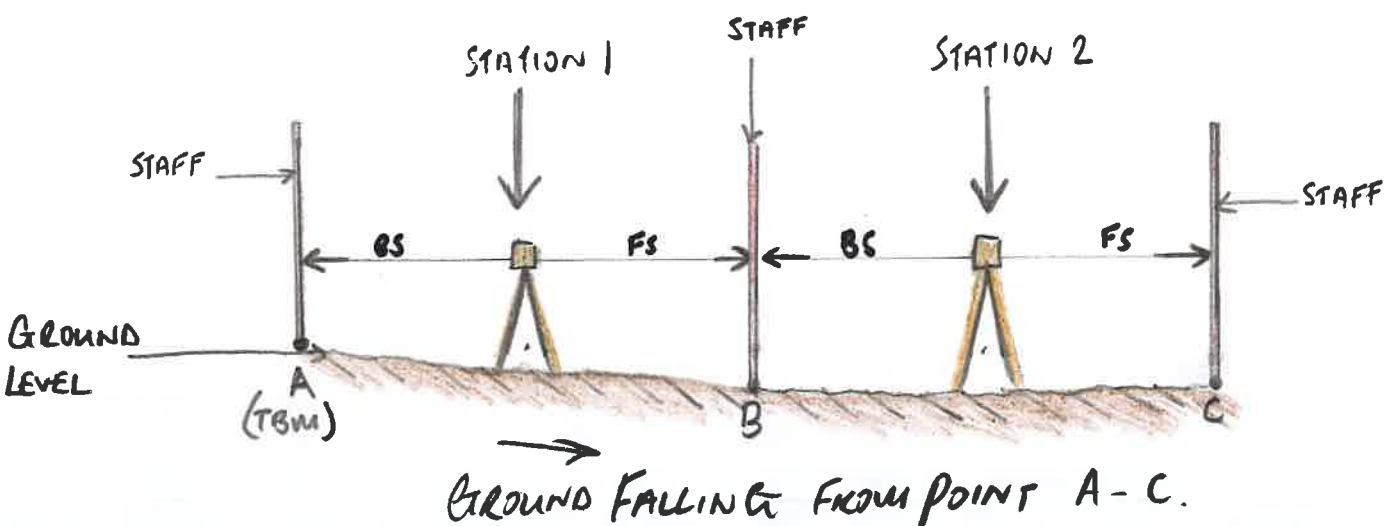
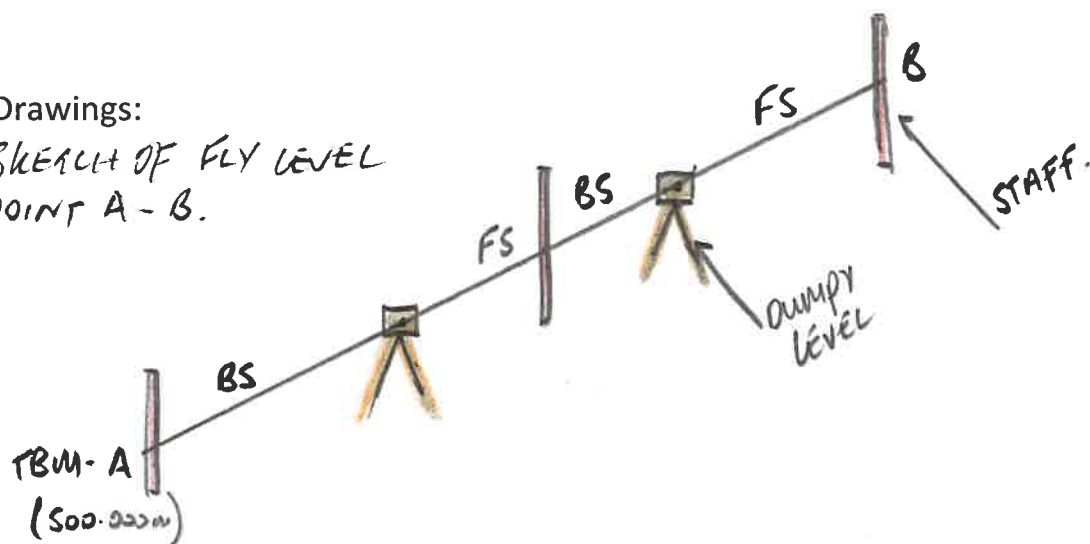
Field Book readings: Rise and Fall Method - Fly Level

DATE: 05.11.18

Project Title	SWANSEA LAND - SURVEY
Site Location	SAI SWANSEA WATER FRONT DEVELOPMENT
Surveyor	PHILLIP ABOULLAH
Surveyor	EUIS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					REDUCTION		
Station	Points	BS	IS	FS	Rise	Fall	RL
1	A TBM	1.608					500.000
1	B			1.693		0.085	499.915
2	B	1.462					499.915
2	C			1.878		0.416	499.499

Drawings:

SKETCH OF FLY LEVEL
POINT A - B.

Field Book readings: Height of Collimation - Fly Level

DATE: 05-11-18

Project Title	SWANSEA LAND-SURVEY
Site Location	SA1 SWANSEA WATERFRONT DEVELOPMENT
Surveyor	PHILLIP ABDOULLAH
Surveyor	EWS JONES
Surveyor	DAN LAWRENCE
Surveyor	GREG THOMPSON

BOOKINGS					
BACKSIGHT	INTERMEDIATE	FORSIGHT	HEIGHT OF COLL	REDUCED LEVEL	REMARKS
1.608			501.608	500.000	A
1.462		1.693	501.377	499.915	B-CPI
		1.878		499.499	C

Drawings:

AS PER PAGE 3 (RISE & FALL METHOD).

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