Fast Recon Leveling Surveys

Rural Training Center-Thailand
Community-based Education Office
166 Moo 5, Ban Wangwa, Thawangpha District
Thawangpha City, Nan Province 55140
Thailand
www.neighborhoodlink.com/org/rtcth

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PREFACE

This RTC-TH publication is part of the RTC-TH AG-2010-4 Basic Recon Line Survey Methods series. Procedures common to all line surveys are contained in the Basic Recon Line Survey paper and are not repeated in subsequent line survey papers. Instead, each subsequent paper in the series provides specific details, insights, and procedures unique to that type of survey.

Leveling surveys could be used in the following:

- SOW / SOS: setting markers for terrace grading; soil sampling.
- IFS: determining stream flow head heights for water pumping site assessments
- SOW: determining elevation differences for drip irrigation lines or gravity flow irrigation systems
- BUGS: forest canopy density surveys

Line surveys are often part of a field study. The RTC-TH Publication AG-2010-2 Natural Terrain Study Guide may contain other information that can be used in conjunction with this paper.

RTC-TH Demonstration Farm Programs

Light green shading indicates this lesson can be used in the programs listed above.

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Lithosphere, Leveling Survey

Fast Recon Leveling Survey

Community-based Environmental Education for the Self-sufficiency and Sustainability of Small Rural Family Farms

1.0 INTRODUCTION

A Fast Recon Leveling Survey (FRLS) is used to make a preliminary site contour map when no contour maps exist. Data are collected from point to point recording leveling (elevation measurements), distance and direction. [**Note:** You should have read the RTC-TH publication AG 2010-4 "Basic Recon Line Survey Methods" before starting a leveling survey.]

The surveys can be "relative" to local referenced to recognizable / recoverable benchmarks of known elevation in the study area. The results are NOT intended to meet legal land description requirements. If no documented "datum" or point of known elevation is available, select a starting point that can be readily recognized and returned to if necessary.

All measurement involves various types of errors. Human error can only be minimized and avoided by systematic and repeated practice. Using standard procedures can be repetitive and boring. Standard checklists are reminders that should help improve survey accuracy. Repeated measuring and re-measuring provides hard data that can be mathematically averaged to help reduce error. So the procedures in this paper suggest taking at least 3 measurements (especially for direction).

BASIC EQUIPMENT			
Qty	**Item**	**Qty**	**Item**
2	Hand Sight Level	2	Sighting Poles
1	Long measuring tape	2	Magnetic Compass
Var	Marking pins / flagging	Min 2	Range Poles / Flags
Var	Survey Data Log sheets	Var	Pen / Pencils / Erasers

2.0 WORK TASKS

Person	Position	Job Functions
A	Anchor	• Occupies starting point with sighting pole and hand sight level • Makes and records forward (looking along survey line) elevation and direction measurements (azimuth) • Secures end of measuring tape.
B	Lead	• Moves along line of survey until at a point 4-5 ft higher / lower than Person A. • Occupies the subsequent point with sighting pole, • Secures end of measuring tape, makes and records forward (looking along survey line) distance measurements, • Makes and records backward (looking back along survey line) direction measurements (back azimuth) • If lower than Person A, uses hand sight level to make and record elevation measurements.

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3.0 SELECTING A REFERENCE POINT

The reference point for the survey should be a readily recoverable feature. For follow-up surveys (to monitor change over time), subsequent field teams must be able to find the same starting point. The feature should be relatively permanent (utility pole, gate, or other fairly permanent feature). If the survey covers a long distance, pick a starting point that can be easily seen when looking back along the survey line for visual reference. If the starting point cannot be easily seen, consider erecting a tall sighting pole with a flag.

3.1 Local Benchmark: For increased vertical accuracy, use an official benchmark close to the study area. This is usually an official permanent government marker (metal cap mounted to a concrete base).

3.2 No Local Benchmark: If no benchmark is found, try to reference to survey to any "unofficial" government marker (e.g. highway mileage marker), road intersection, or other easily recognizable landmark feature.

4.0 PLANNING THE SURVEY LINES

Generally the survey can be done following a regular grid pattern or be "free form" along any alignment (e.g. a trail, property boundary, streambed, etc.). Whatever the case, the key points to remember are:

- Survey lines need to be uniquely identified.
- Survey stations (points you survey) along a survey line need to be uniquely identified.
- All survey data must be recorded. Do not rely on your memory.
- All survey measurements should be repeated to minimize errors, provide data to for mathematical averaging to improve accuracy (repeatability), and avoid or eliminate the possibility of missing data.

5.0 THE LEVELING SURVEY

Measuring elevation (sometimes called "leveling") is a line of sight survey method. You must have a clear view of the point (survey station) you are leveling (taking a relative vertical measurement).

5.1 Set the Sighting Pole Height: The sighting poles can be adjusted to either 4 ft or 5 ft above the ground. Pick the setting that comes closest to eye level of the shortest person on the survey team. The sighting pole has 2 basic parts: the pole and a brightly colored target.

5.2 The Hand Sighting Level: To make a leveling measurement, place the hand sighting level on top of the sighting pole. If the sighting pole was set at a height of 4 ft, then the hand sighting level is about 4 ft above the ground. (See Figure 1.)

Look into the viewing end of the hand sighting level. The view in the hand sight level combines 2 views: a reference bubble level and a horizontal sight line. You must line up the reference bubble with the horizontal sight line. Then everything on the horizontal sight line is 4 ft above the ground on which you are standing.

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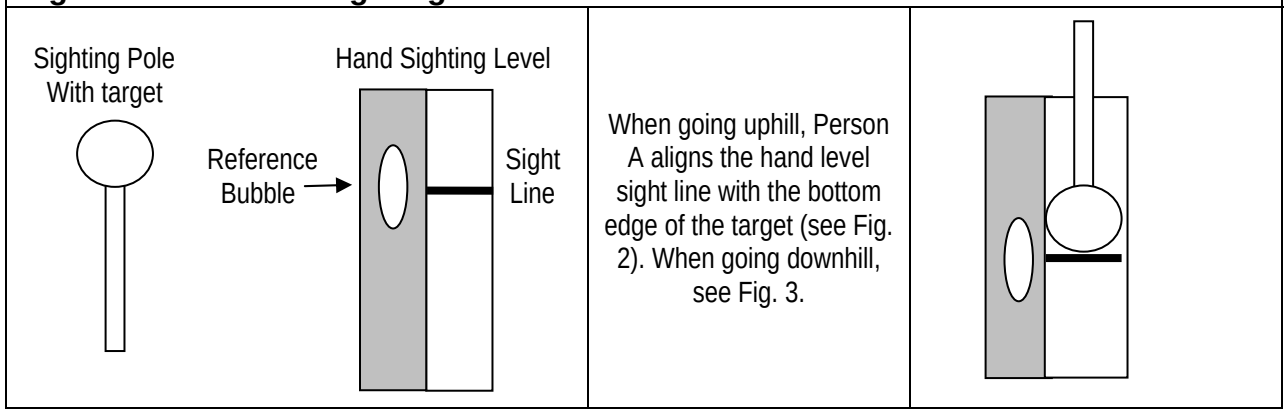
Figure 1: The Hand Sighting Level



[**Note:** For ease of orientation, the example survey starts at a low elevation and proceeds uphill.]

5.3 Sample First Survey Point

Person A

- Occupies the starting point, and places a marking pin and labels it “0” (zero)
- Secures the open end of the measuring tape to the marking pin.
- Holds the sighting pole with the colored target up, places the hand sight level on top of the sighting pole and observes Person B.
- When person B’s feet are level with the sight line in the hand sight level, signal Person B to stop. [**Note:** If the sighting poles were set to 4 ft, then Person B is now at a point that is 4 ft higher than Person A.]

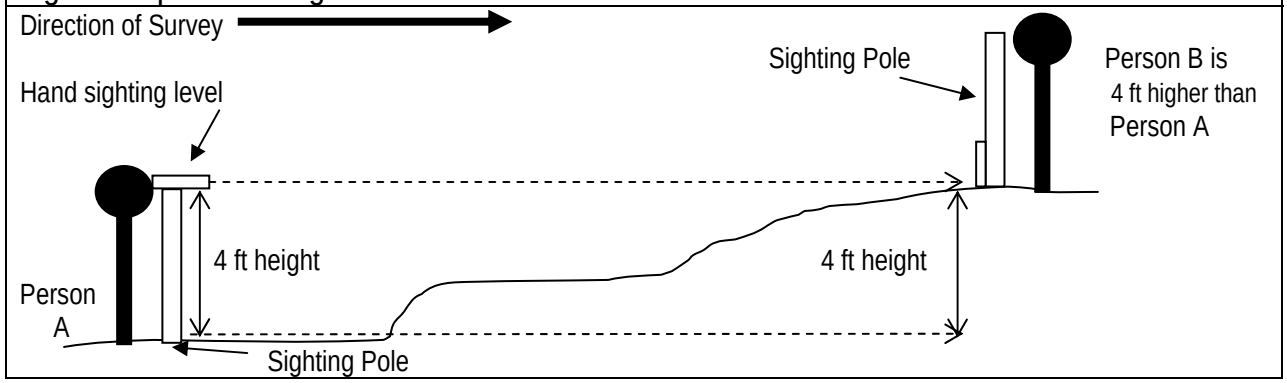
Person B

- Walks along the projected survey line away from Person B until told to stop by Person A.
- When told to stop, Person B turns around and places the sighting pole with the colored target on the ground. Make sure vegetation doesn’t obscure the target.

Person A

- Carefully aims at the target held by Person B and directs Person B to move until the target is leveled with the sight line in the hand sight level. Then records the elevation from Station 0 to Station 1 is +4 (+ indicates uphill).
- When the leveling is complete, direct Person B to mark and label the station. (See Figure 2.)

Figure 2: Uphill Leveling



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Person B

- Places and labels the station marking pin (in this example, Station 1).
- Turns the sighting pole so the colored target is up.
- Pulls the measuring tape snug (to remove slack and free the tape from snags on rocks or plants) in order to make and record the distance between the two stations.
- Places the magnetic compass on top of the sighting pole and makes and records 3 the back azimuth measurements from Station 1 to Station 0.

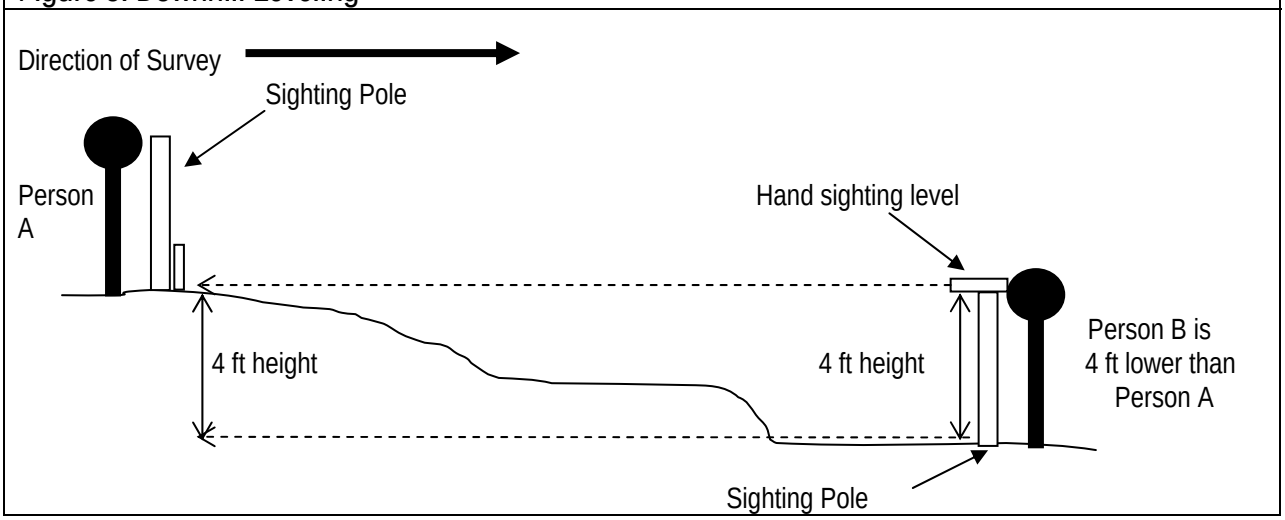
Person A

- Once Person B holds the sighting pole with the target up, Person A makes and records 3 azimuth measurements from Station 0 to Station 1.

When both persons complete all measurements, Person A advances to occupy Station 1 and sets up to make survey measurements from Station 1 to Station 2.

Person B moves away from Station 1 continuing along the survey line away from Person A. Station 2 will be located with Person A sees Person B is at a position that is 4 ft elevation different from Station 1. [**Note:** If Person B is going downhill from Person A, then Person B must monitor the elevation change and make the elevation measurement. In Figure 3, the elevation going from Person A to Person B is recorded as –4, indicating downhill.)]

Figure 3: Downhill Leveling



To take a downhill elevation sighting, Person B sets the sighting pole on the Station marker pin; Places the hand sight level on top of the sighting pole; Aims the hand sighting level back toward the last survey Station (where Person A is holding a sighting pole with the target down, but facing Person B); Positions the Sight line across the bottom of the target and at the same time positions the reference bubble so it is centered on the horizontal sight line. If the top of the targets were set at 4 ft, then Person B is at a survey station that is 4 ft lower elevation Person A. The elevation from Person B to A is recorded as -4 ft (- indicating down). The diagram below shows the situation when the trend of the line survey is downhill. This fast recon leveling

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procedure ONLY takes elevation readings at points that are 4 ft vertically different from each other. [**Note:** Person A must be prepared to clear the ground so the target is not blocked by vegetation.]

5.4 Marking Pins

The survey proceeds sequentially. Leave the Station marking pins in place. They will be recovered on the way back. At the end of the survey line, the team reverses positions (Person A changes places with B and vice versa). The team goes back along the same survey line, but in reverse order. They repeat all the measurements. This provides a safety check to validate the original measurements and to be sure no data are missing. The additional measurements, when averaged with the earlier measurements increase the survey's accuracy. The Station markers can be recovered or left in place if additional follow-on surveys will take place using the same Stations.

5.5 Distance Measurements

Linear distance measurements should be decimal based (e.g. either metric or using measuring tapes marked in decimal feet) to facilitate computer data processing. If using measuring tapes marked in decimal feet, be sure distance data are properly recorded. For example, be sure an indicated tape measurement of 10.6 is recorded as 10.6 feet and NOT as 10 feet 6 inches.

When making distance measurements, Person A secures the open end of the measuring tape (the end outside of the storage reel) with a survey pin. Person B gently pulls the tape to remove all slack from the tape. Person B records the distance measurement to the nearest fully marked increment on the measuring tape. *Do not estimate fractional measurements between the marked increments.* Instead, round the measurement to the nearest increment. For example, on a measuring tape with decimal feet/inches, a station maker located between 10.6 and 10.7 should not be recorded as 10.65 or 10.68 but instead recorded as 10.7. [**Note:** Follow the math conventions for rounding.]

5.6 Measuring Direction (Azimuth)

Directional measurements should be made using a magnetic compass. The azimuth method uses a full circle (360º) to specify a horizontal angle for direction. The "0º" (zero) direction line is coincident with the 360º direction line. Azimuth numbers are read going clockwise around the circle. Thus each direction (N, E, S, W and all points in between) is given a unique horizontal angular measurement. This eliminated confusion. The center of the circle represents the occupied station point. (See Figure

All field measurements should be referenced to Magnetic North. *It is highly recommended not to correct for magnetic declination in the field.* Any errors in the field data may be very difficult or impossible to correct later. Make declination corrections in the office.

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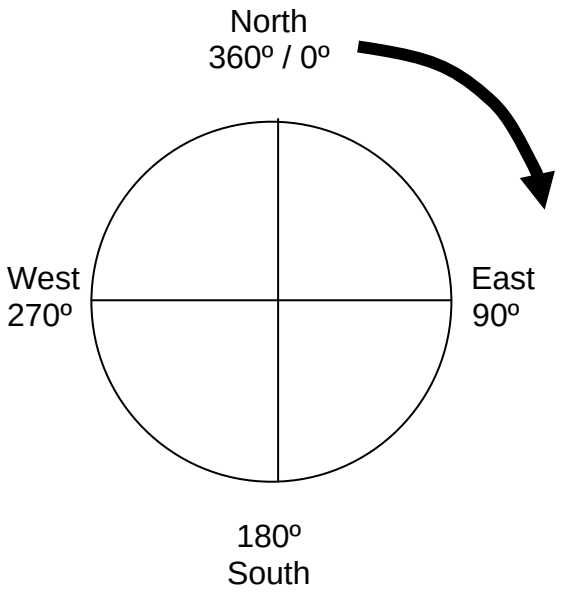
Figure 4: Measuring Azimuth



To Measure Azimuth:

Imagine you are standing in the middle of the circle in the picture on the left.

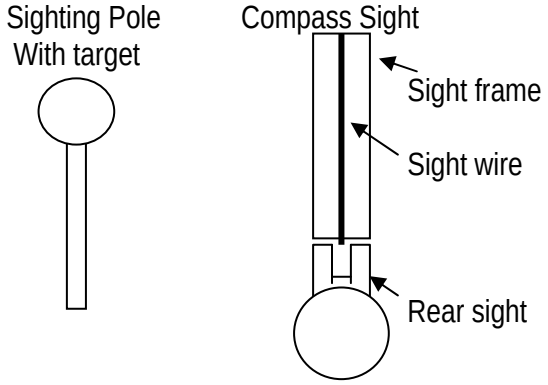
Step 1. Stand on the station looking toward the next survey station.
Step 2. Aim the magnetic compass directly down sighting pole, but keep the compass level so the needle swings freely.
Step 3. Read off the azimuth angle in degrees ranging from 0º (starting at North) going clockwise around the circle.
Step 4. Record the azimuth number. Take a total of 3 azimuth readings.

Do Not Correct for Magnetic Declination while in the field.
Make magnetic declination corrections in the office/

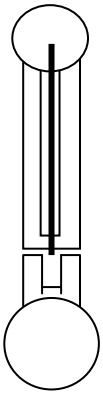
0º & 360º = North	180º = South
45º = Northeast	225º = Southwest
90º = East	270º = West
135 – Southeast	315 = Northwest

To make magnetic azimuth measurements, place the compass on top of the sighting pole. Make sure the compass dial / needle moves freely. Align the sights of the compass so the compass sight wire is lined up on the pole of the sighting pole at the survey station you are measuring and also centered in the notch of the rear sight on the compass. Then carefully look at the azimuth number lined up with the compass sights.

Figure 4: Aiming the Magnetic Compass



Align the compass sight wire on the pole of the Sight Pole and make the azimuth measurement. Repeat this until you have 3 azimuth / back azimuth measurements



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Lithosphere

Fast Recon Leveling Survey

Data Log Sheet

Community-based Environmental Education for Families and Sustainable Communities

Site:			Date
Start Point: ☐ Official Benchmark ☐ Other (describe) ☐ Photo taken of marker			
Geodetic Control: ☐ BM ☐ TBM ☐ Other			Cal Elev
GPS	Lat	Long	GPS Elev
Survey Line #	Survey Team:		

DO NOT ADJUST FOR MAGNETIC DECLINATION WHILE IN THE FIELD

Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		
Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		
Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
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			Sight 3		
Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		

DO NOT ADJUST FOR MAGNETIC DECLINATION WHILE IN THE FIELD

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Site:		Date
Survey Line #	Survey Team:	

DO NOT ADJUST FOR MAGNETIC DECLINATION

Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		
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From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
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			Sight 3		
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From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
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From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
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From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
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			Sight 2		
			Sight 3		
Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		
Station Numbers	Distance	Elevation	Mag Azimuth		Notes
From ☐ Up ☐ Down To	☐ m ☐ ft	☐ 4ft ☐ 5 ft ☐	☐ Az ☐ Back Az		
			Sight 1		
			Sight 2		
			Sight 3		

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