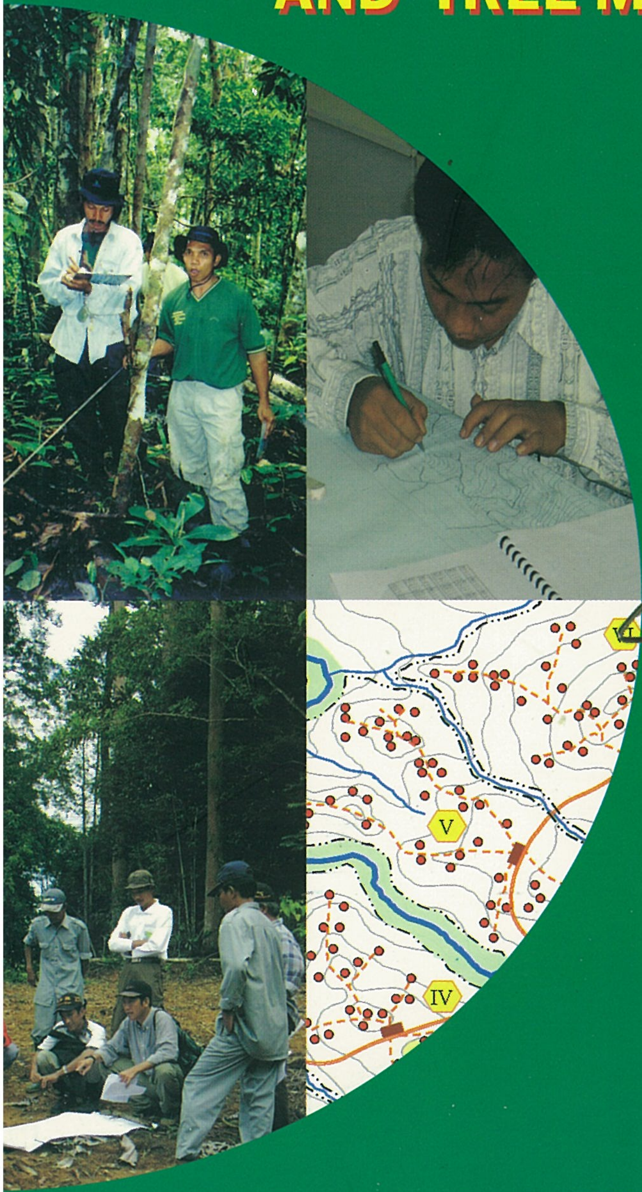
# TECHNICAL PROCEDURES FOR TOPOGRAPHIC FOREST SURVEYS AND TREE MAPPING




April 2004
Second Edition

TROPICAL FOREST FOUNDATION

ITTO

Ministry of Forestry

# TECHNICAL PROCEDURES FOR TOPOGRAPHIC FOREST SURVEYS AND TREE MAPPING

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April, 2004

Prepared for :

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by

Tropical Forest Foundation

# TECHNICAL PROCEDURES FOR TOPOGRAPHIC FOREST SURVEYS AND TREE MAPPING

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*TROPICAL FOREST FOUNDATION*

ITTO

Departemen Kehutanan
REPUBLIK INDONESIA

Association of Indonesian Forest Concession Holders

# FOREWORD

This procedures manual has been prepared as the first in a series of such manuals intended to provide clear, technical guidance on the various stages of implementing a Reduced Impact Logging strategy in the lowland and hill dipterocarp forests of Indonesia.

This manual provides implementation detail consistent with existing forest policy and regulation in Indonesia. From a technical perspective, however the principles and procedures described in this manual can also be applied to similar forest management conditions throughout the Southeast Asia and Pacific region.

This is the second edition of this manual prepared by the Tropical Forest Foundation (TFF) and endorsed by the Association of Indonesian Forest Concession Holders (APHI) under a funding grant from the International Tropical Timber Organization (ITTO). The purpose of this manual is to encourage and facilitate forest concessions to achieve sustainable forest management through the adoption of RIL practices.

Critical comments and suggestions for improvements are welcomed. Please address your correspondence to:

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# PREFACE

The production of contour maps for forest concessions (HPH's), is required by the Indonesian Ministry of Forests (MoF). The scale recommended by Government regulation is 1:25,000. These maps are useful for concession level planning but they are inadequate for the kind of planning required to implement Reduced Impact Logging (RIL). Without the implementation of RIL, or similar, low impact harvesting strategies, sustainable forest management cannot be achieved.

Operational contour maps can be produced from aerial photographs at a scale of 1:5,000. Although there are no significant technical barriers to the production of such contour maps for the Indonesian production forests, a combination of economic and policy disincentives have discouraged the adoption of such mapping technology.

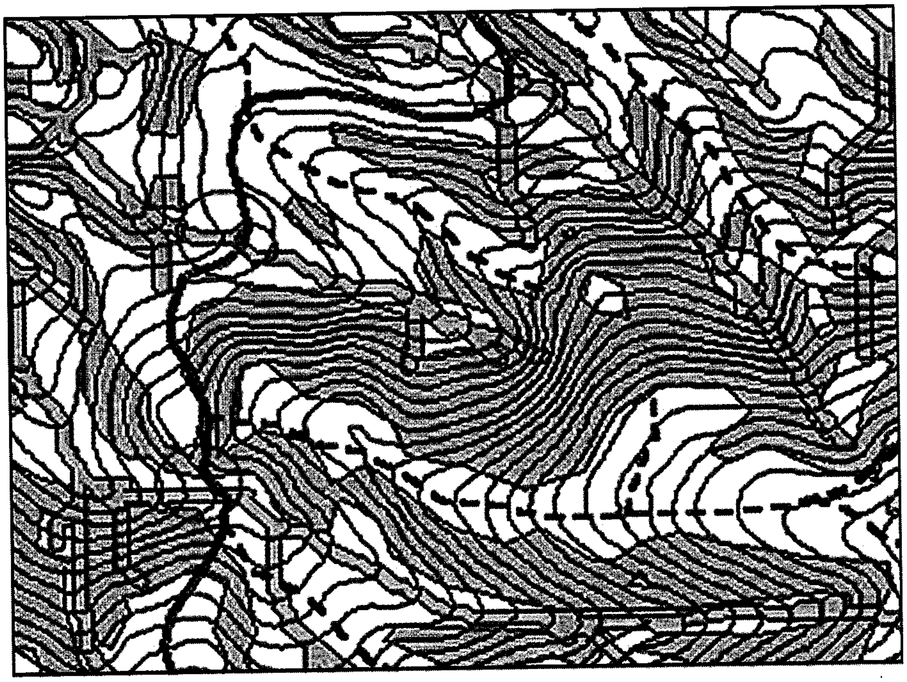


***Figure 1 : A typical contour map showing slope categories, stream buffer zones, and road and skid trail projections.***

Ultimately, Indonesian companies may acquire the capability to produce operational scale contour maps from aerial photographs. In the meantime, however, an opportunity exists to fill this information gap immediately through existing survey practices.

The TPTI[1] silvicultural system under which most of Indonesia's natural forests are managed, requires that 100% stock mapping be carried out before annual harvesting permits are issued. The resulting survey procedures implemented by the forest companies, can be modified to include the collection of elevation data from which contour maps can be prepared at an operational scale.

This procedures manual describes how to collect the necessary data to create operational scale contour and tree position maps as part of the 100% inventory procedure. This manual also describes how to process the data and how to prepare a contour map using manual cartographic methods.

Other Relevant Procedures Manuals in this Series

The manual, ***"Computer Assisted Contour Mapping From Systematic Ground Surveys"*** provides an effective alternative to the manual preparation of contour maps from the 100% inventory. This manual describes the application of the forest engineering program, ROADENG, for the purposes of processing ground survey data to create contour maps at any desired scale.

The manual **"Reduced Impact Logging Planning"** provides technical guidance on how to use contour and tree position map to create effective logging plans.

1) Tebang Pilih Tanaman Indonesia / Indonesian Selective Cutting and Planting Silvicultural System.

# CHAPTER I

## INTRODUCTION

Topographic surveys are best carried out simultaneously with 100% cruising and tree mapping. This guide book describes a topographic field survey and mapping procedure which is easy to implement and which will permit the production of reasonably accurate contour and tree position maps.

### 1.1 Objective

The main objective for conducting a topographic survey is to produce an accurate contour map which, together with tree position data, can be used to carry out detailed harvest planning and control.

### 1.2 What is a contour map ?

A contour map presents the 3-dimensional reality as a 2-dimensional map. Lines of altitude or "contour" represent regular changes in elevation. The elevation interval between contours should be adapted to suite the terrain. On gentle topography, an interval of 2 meters could be used while on the more typical, hilly topography, an interval of 5 meters is more appropriate.

For detailed logging planning, a scale of 1 : 2,000 or 1 : 1,000 is preferred. The smallest suitable scale is probably 1 : 5,000. Such contour maps should show the location of all streams and drainage patterns. Existing roads, boundaries, or miscellaneous physical features such as rock outcrops and swamps, should also be shown. Finally, to be an effective planning tool, contour maps should also show the location of all commercial trees.

### 1.3 Limitations

Although the data collection procedure described in this manual is fast and easy to implement, it is also prone to errors. This guide book will identify the major potential sources for error and will suggest ways to minimize and adjust for these errors.

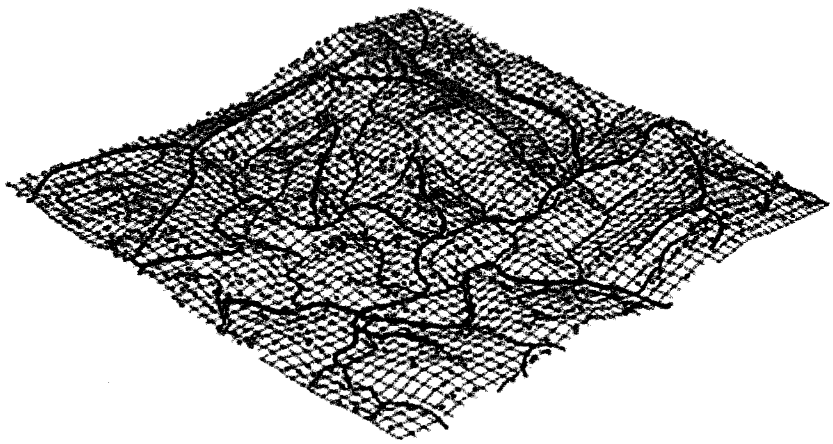


*Figure 2 : Example of a 3-dimensional representation of a contour map.*

The procedures described in this manual are not necessarily the only way to create a contour map from a ground survey. However, these procedures support the prescriptions of the Indonesian Selective Cutting and Planting Silvicultural System (TPTI). Variables such as block shape, survey line spacing and survey interval, relate directly to the prescriptions in the TPTI system but can easily be modified to suite different requirements.

## 1.4 Assumptions

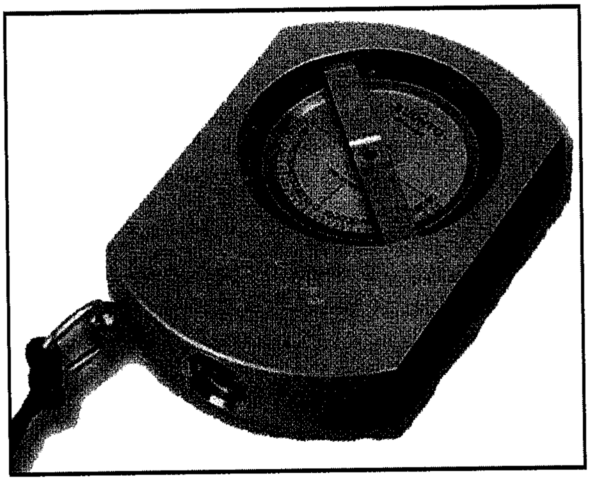
The survey procedures described in this technical manual, are built on the following assumptions.

- The basic mapping units will be operational areas or "petaks" of +/- 100 ha in size.

- Parallel strips will be surveyed at right angles from a baseline which will be established through a block. The baseline should be stablished at a north/south or east/west bearing. Strips will be established every 20m along the baseline and will be run at a fixed bearing, usually at right angles to the baseline. Block boundaries can also be used as a baseline.

- A constant field measurement of 20 horizontal meters will be used to collect data along each strip. Slope corrections will be carried out in the field.

- The 20 meter horizontal field measurement are intended solely to facilitate accurate tree position mapping. Twenty meter slope distances can also be used, however, the map interval will then not be a consistent 20 m interval.



Note: The Suunto compass is a reliable, handheld instrument used to establish a bearing. The most commonly used model does not have a magnetic correction capability, consequently all bearings will be magnetic. When relating field surveys and resulting block maps to a larger base map which has been produced from aerial photos, keep in mind that the base map is orientated to true North while your field surveys are orientated to magnetic North. Check your base maps for the magnetic declination in your area.

# CHAPTER II

## FIELD SURVEY PROCEDURES

An eight member inventory crew is commonly used on forest concessions to carry out the 100% cruising. This crew is divided into two teams. This division of the inventory crew into two teams is maintained under the RIL mapping system.

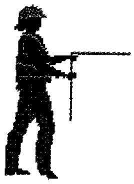
- Survey Team: (4 men)
  The survey team establishes the boundaries, baselines and survey lines. The survey team collects all data needed to make a contour map. Numbered stations are established along survey lines to facilitate tree mapping.
- Inventory Team: (4 men)
  The Inventory Team carries out the 100% inventory using the survey lines and survey stations established by the Survey Team.

It is important to remember that this division of labour is based on current practices within the forest sector in Indonesia. Companies who wish to achieve greater efficiency, may want to use less personnel or may want to organize the composition of the teams differently. The following procedures could be carried out by as few as two highly trained men.

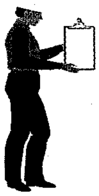
### 2.1 The Topographic Survey Team

It is assumed that the topographic survey team will consist of four persons.

***Compassman*** **:** This is the lead man. His job is to establish a straight line according to the desired bearing. He will also cut away any obstacles along the line and notch small trees along the way to make the line visible for the following members of the team.



***Head Chainman*** **:** This man will pull the survey chain along the cut line and will be responsible for marking each new survey point. He should also check the accuracy of the bearing which has been established by the Compassman.



***Rear Chainman :*** The Rear Chainmans job is to hold the end of the chain, measure the slope, and adjust the measured slope distance to achieve a horizontal distance of 20 meters.

***Note Keeper*** **:** The Note keeper records the slope and the actual slope distance needed to achieve a horizontal distance of 20m. He must also record a sketch of the topographic and planimetric detail along the survey line.

## 2.2 Survey Equipment

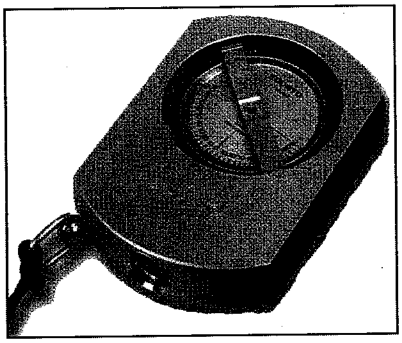
Topographic forest surveys require only simple hand instruments. The Survey and Inventory Teams should be equipped with the following:

- Two hand compasses per Survey Team. A variety of compasses are available. Make sure all compasses are calibrated consistently (all corrected or not corrected for magnetic declination). The Inventory Team should also have one compass for general orientation purposes.

- Each Survey Team should have two clinometers. Suunto and Silva clinometers are the most reliable and durable. If tree heights are being measured (instead of estimated), the Inventory Team should also have two clinometers.

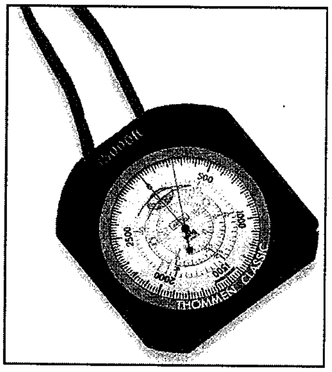
- One altimeter, should be assigned to the Survey Team. Gradations should be to the nearest 10m.

*Hand Compass*



*Clinometer*

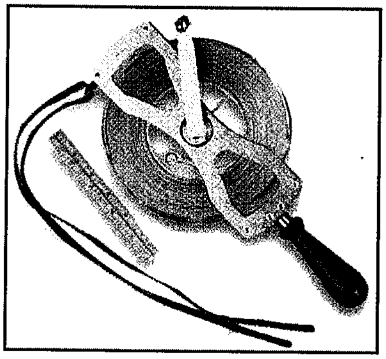
- One 35 or 30m survey tape for each Survey Team. If proper survey chains are not available, use a polypropylene rope. The first 20m should have marks at 5m intervals and the remaining section of the rope should have marks at one meter intervals.




***Altimeter***

- One note book or clip-board for both the Survey and the Inventory Teams (see Appendix I for a suggested note keeping format).

- Slope tables. Each survey team should have a general slope table showing variable slope distances and slopes in percent, as well as a fixed 20m horizontal slope table (see Appendix I).

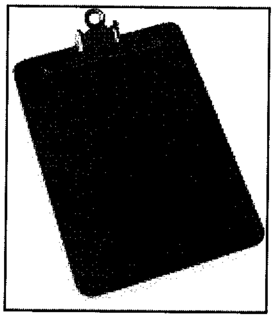


***35 m Survey Tape***

- The Survey Team should have a supply of plastic tags or survey flagging tape and felt pens for marking survey points.

- The Inventory Team will require tree number tags, paint and felt pens.

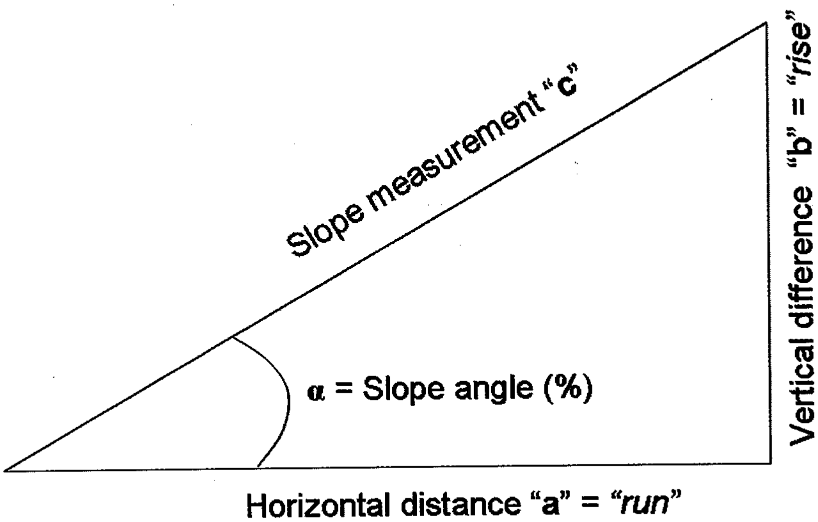
- Usually each man except the Note Keeper, carries a cutlass or *parang* for line clearing and general brushing.



***Clip-Board***

## 2.3 Slope Corrections

Indonesia's remaining dry-land forests are rarely found on flat terrain. However, since maps are always presented in horizontal format, field measurements must be corrected to adjust for slope. Basic trigonometric functions can be used to correct for measurement inaccuracies due to slope.




| | | |
|---|---|---|
| Sin α= b/c<br>b = (Sin α )(c)<br>c = b/ Sin α | Cos α = a/c<br>a = (Cos α )(c)<br>c = b/ Cos α | Tan α = b/a<br><br>Cotan α = a/b |

*Figure 3 : Slope correction using trigonometric functions.*

In forest surveys, it is common practice to measure slopes in percent. The relationship of *"rise"* over *"run"* expressed as a percent, is easy to visualize. For example, a 1% slope simply means that for every 100 horizontal meters there is a one meter change in elevation.

Trigonometric functions permit rapid calculation of any variable in a right angle triangle provided that two sides or one side and the angle $\alpha$ are known. In order to use trigonometric functions, however, angles must be converted from percent to degrees. This conversion can be achieved with the Cotan $\alpha$ function which states that :

$$\text{Cotan } \alpha = a/b$$

Since the angle $\alpha$ is measured in percent, the degree value for $\alpha$ can be calculated by recognizing the horizontal / veritical relationship represented by a percent angle. As an example, an angle of 51% is equal to 51 meters of elevation charge per 100 horizontal meters. Using a scientific calculator to find the Cotan value for 0.51, we find that 51% = 27 degrees.

$$\begin{aligned} \alpha &= \text{Cotan } a/b \\ &= \text{Cotan } 51/100 \\ &= 27\,^{\circ} \text{ (degree)} \end{aligned}$$

**Sample Problem :**

You are measuring up a hill at a slope of 70% and you would like to establish a 20 meter horizontal survey interval. How many meters slope distance would you have to measure?

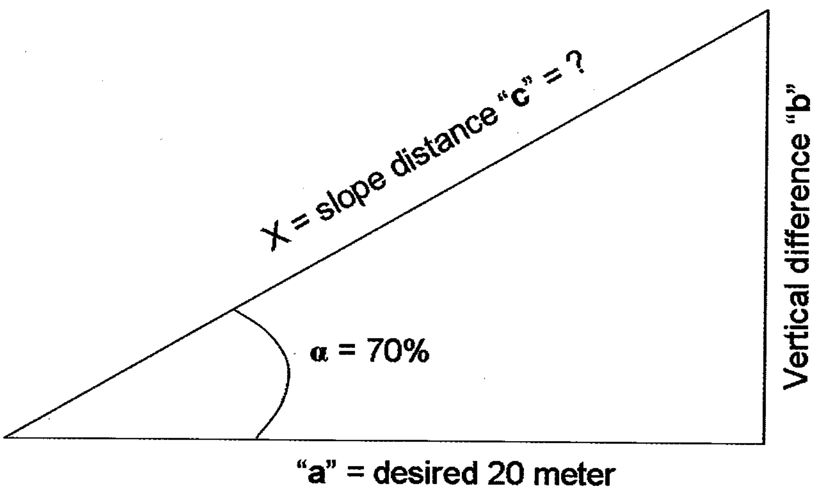



*Figure 4 : A practical application of trigonometric functions*

**Solution :**

***First,*** convert 70% to degrees using a scientific calculator.

**Cotan 70 / 100 = 35°**

Then solve for "**C**" where

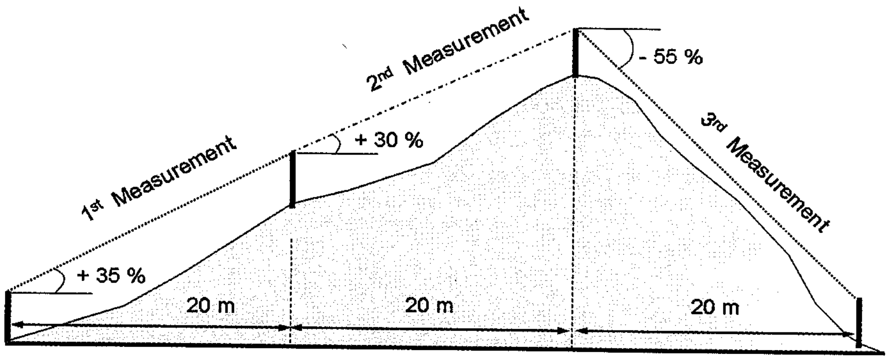
**Cos á = a / c**
**c = a / Cos á**
**c = 20 / Cos 35**
**c = 24.4 meter**

Since this type of questioned will have to be solved many times when carrying out topographic surveys, the slope distance values for a 20 meter horizontal survey interval have been calculated and presented in an easy to use table in Appendix II.

The solution to this question is now easy by looking up the slope distance value for a horizontal distance of 20 meters at a slope of 70%. (see table below).

| Slope (%) | Slope distance (m) | Vertical difference (m) |
|---|---|---|
| 68 | 24.2 | 13.6 |
| 69 | 24.3 | 13.8 |
| 70 | 24.4 | 14.0 |
| 71 | 24.5 | 14.2 |
| 72 | 24.6 | 14.4 |

It is recommended that copies of the slope correction table in Appendix II be plasticized for easy field use. Using the slope table method, field adjustment to slope measurements can be made quickly and accurately.




| Measurement | Horizontal Distance | Required Slope Distance |
|---|---|---|
| 1st interval = 35 % | 20 meter | 21.19 meter |
| 2nd interval = 30 % | 20 meter | 20.88 meter |
| 3rd interval = 55 % | 20 meter | 22.83 meter |

***Figure 5 :*** ***Using the slope table method to establish 20 meter horizontal survey intervals.***

## 2.4 Tieing to a Controlled Map Base

Inventory teams in forest concessions normally prepare tree position maps at a scale of 1:1,000 or 1:2,000. These maps are essential tools in planning for and implementing improved operational activities such as skidding and land use planning.

Unless these large scale maps are related to a smaller scale, controlled map base, such as the management maps which are available at a scale of 1:20,000 or 1:25,000 , the usefulness of the 100 ha block map will be short lived. If, however, the entire block map grid is accurately connected to the smaller scale, 1:25,000 map, logging records at the 1:1,000 operational scale become meaningful management tools for long-term planning and recording of management activities.

In order to establish a controlled mapping grid for an annual operating area or "RKT", a starting point should be chosen which can be recognized on the base map. A river junction is usually a reliable starting point. A systematic grid is then projected onto the map base and additional control points are identified. As the baseline and field surveys progress over annual mapping area, a surveyed connection should be made to these control points. This will often result in slight changes to the grid which should be reflected on the individual block maps.

If elevations have not already been established for control points, a number of methods can be used to determine the starting elevation for a baseline. The easiest method is to use an altimeter with has been calibrated against a known elevation point. A GPS receiver can also be used to set the starting elevation. If those instrument are not available, the starting elevation can be interpolated from the 1 : 25,000 contour basemap.

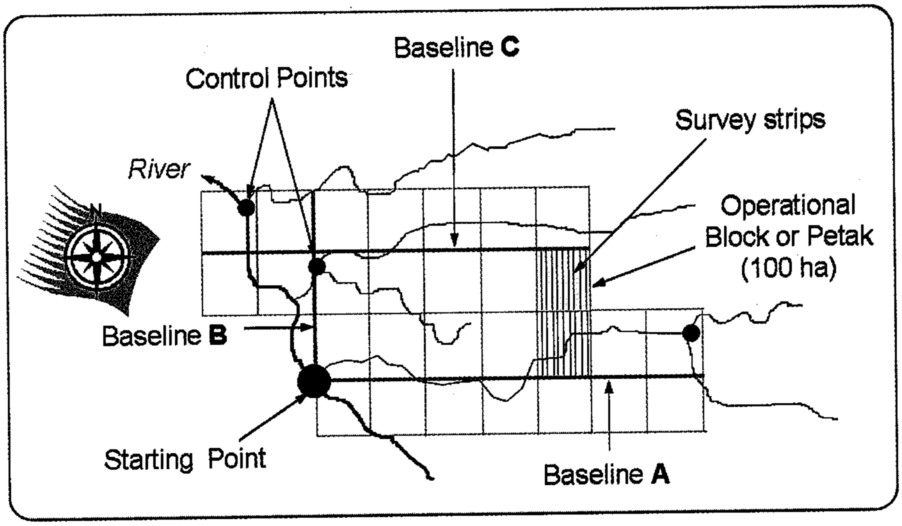



***Figure 6 :*** ***A proposed base line grid and block layout for an annual operating area.***

## 2.5 Establishing a Baseline

It is essential that a baseline or a boundary be established accurately and that elevations are determined for each survey point on the baseline since this information will provide the starting data for all subsequent survey work in the block. Baselines are usually established on a north/south or east/west (cardinal) bearing.

To ensure greater accuracy, the baseline should be established with a staff or a tripod compass and a reliable survey chain. If this equipment is not available, a hand-held compass can be used. Frequent back-shots should be taken to ensure the accuracy of the bearing.

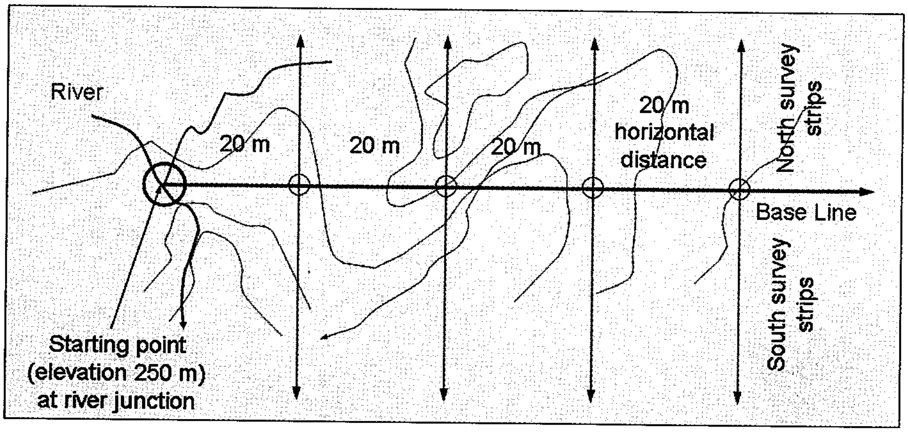



***Figure 7 : A sample baseline from a known starting point***

It will be assumed that the baseline is completely accurate. All survey strips and other survey work will be adjusted to the baseline. The baseline stations should, therefore be very clearly marked and labeled in the field.

<u>Field Procedure</u>:

1) Chose the starting point of the baseline. This should be a point which is easy to recognize on the base map. The junction of two rivers is often a suitable starting point.

2) Determine the elevation at the starting point of the baseline. An altimeter is the easiest way to determine the elevation. Ensure that the altimeter has been recently calibrated to a known elevation point since atmospheric pressure effects the elevation reading which can change significantly with changes in weather.

3) The Compassman will run the bearing line. He will continuously take back-bearings to blazes on saplings or, on the Head Chainman who should also take bearings to confirm the accuracy of the foreward bearing.

4) Make a preliminary measurement of the first 20 m slope distance.

5) The Rear Chainman takes the slope reading with his clinometer and checks the slope table for the required slope correction as the Head Chainman procedes along the line.

6) The Rear Chainman will tell the Head Chainman to go ahead the additional distance needed to obtain the corrected horizontal distance of 20 meters. Make sure that the chain is pulled tight and straight for each measurement.

> Tip : Use a 25 or 30m chain to allow for corrections an steepslopes. The Rear Chainman stays at the last survey point and the Head Chainman moves ahead.

7) The Head Chainman will mark the corrected survey point and will write the distance and line number on each point. A plastic tag or survey ribbon makes a suitable label for the survey points and can easily be attached to a stake (see Figure 8).

8) The Rear Chainman will take a final slope reading and the Note keeper will record this reading along with the corrected horizontal distance. The Note Keeper will also record the position of all streams on the compass sheet to the right of the data entry portion of the contour data form (see Appendix V). He will also make a sketch of topographic form lines extending approximately 20 m to the right and left of the survey line.

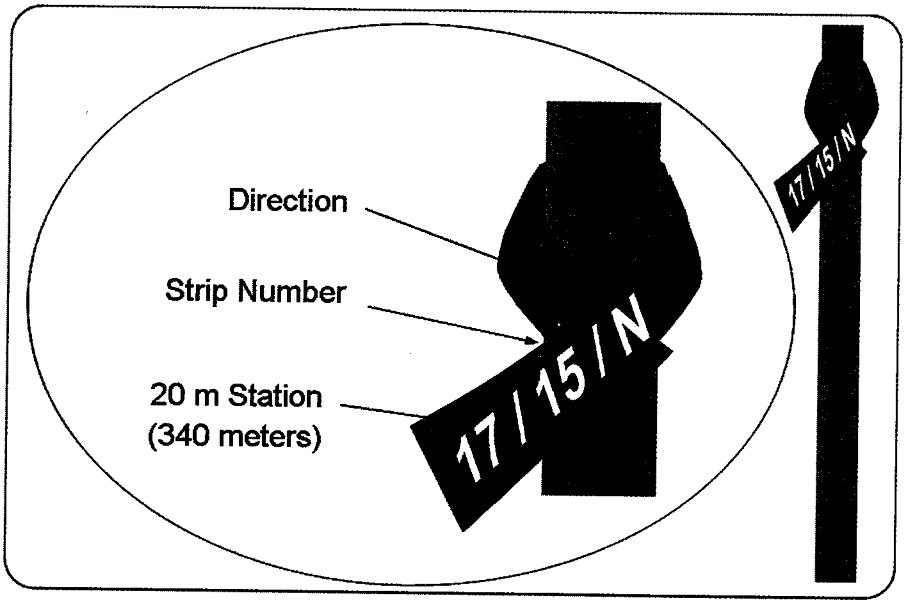
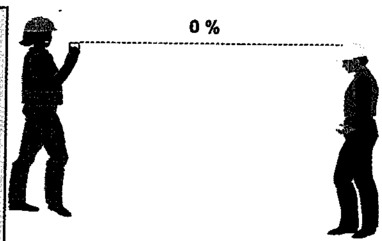



*Figure 8 :* ***An example of plastic tag/survey ribbon attached to a stake.***

> Tip: The Rear Chainman and the Head Chainman should compare their height before beginning the work so that the clinometer reading is taken consistently to the same height above the ground.




9) Once the distance measurement has been taken, the Head Chainman will make a mark on the ground where he was standing so that the Rear Chainman can stand on exactly the same spot.

10) Proceed to the next point and repeat the process.

**BLOCK :** 40 **DATE :** April 1, 2003
**STRIP :** Baseline A **AZIMUTH :** 180

| STAT. | S. D. | % | Vert. Diff. | ELEV. | Adjust. ELEV. |
|---|---|---|---|---|---|
| 5 | | | | 429.8 | |
| | 20.1 | -10 | -2 | | |
| 4 | | | | 431.8 | |
| | 20 | +5 | +5 | | |
| 3 = | Beginning of strip No. 3 | | | 430.8 | |
| | 20.4 | +20 | +4.0 | | |
| 2 | | | | 426.8 | |
| | 20.2 | -15 | -3 | | |
| 1 = | Beginning of strip No. 1 | | | 429.8 | |
| | 22.5 | -51 | -10.2 | | |
| 0 = | S.E. corner of block 40 | | | 440.0 | 440 |

Established by Altimeter

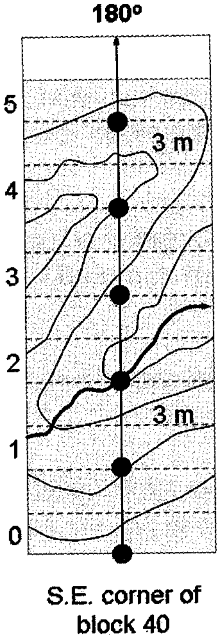



*Figure 9 :* ***An example of typical survey notes along a fixed bearing line.***

Note : The elevation columns can be filled out in the office.

> Tip : Survey notes should start at the bottom of the page and be recorded upwards. This will make the sketch mapping of the topographic and planimetric features on the right side of the page easier since the notebook is held in the direction of travel along the strip.

## 2.6 Establishing Strips or Survey Lines

The procedure for establishing the strips is the same as for establishing the baseline. The baseline starting point for each strips has an elevation which has been transferred from the baseline starting point. These baseline elevations become the starting elevation for each strip.

In order to monitor the accuracy of the field survey and, in order to effectively adjust any survey errors, it is recommended that strip be surveyed in pairs. The starting point of the first strip is on the baseline and the end point of the second strip is at the corresponding baseline station. This provides the means for *"self checking"* the accuracy of the work.

The exact distance of the second strip on the return bearing to the baseline must be recorded to the point where it meets the baseline. Also record the error of closure (bearing, slope distance and slope percent) to the station on the baseline which marks the beginning of the second strip. Figure 9 illustrates an error of closure where the second strip is 5m longer than the first and 4m from the baseline station.

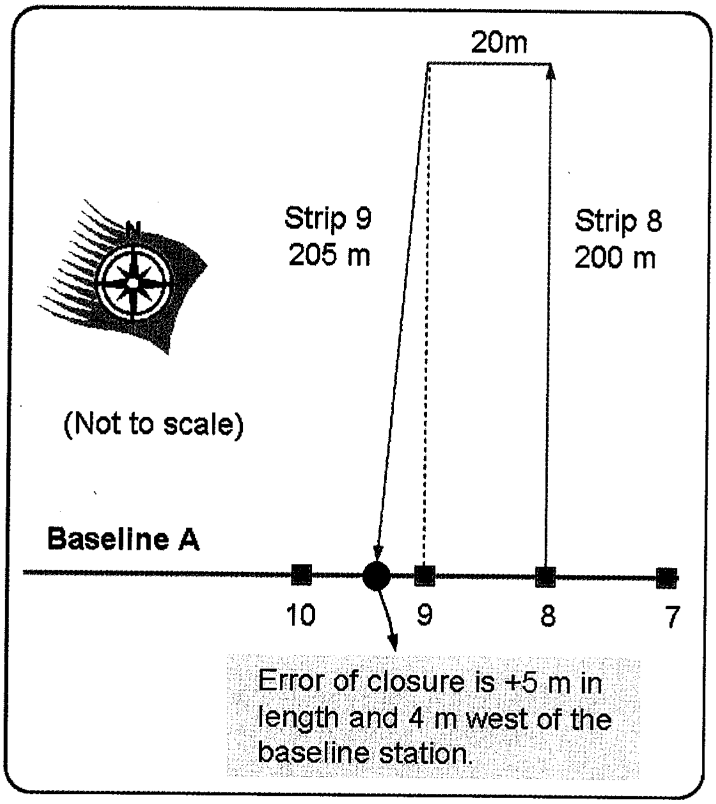



***Figure 10 :*** ***Illustration of a closed traverse for a pair of survey lines.***

**BLOCK :** 40 **DATE :** April 1, 2003

**STRIP :** 9 **AZIMUTH :** 180

| STAT. | S. D. | % | Vert. D. | ELEV. | Adjust. ELEV. |
|---|---|---|---|---|---|
| = Station 9 on Baseline A | | | | | |
| | Brg. 90° 4 m@ -20 % | | -0.8 | | |
| Baseline "A" | | | | | |
| | 5.0 | -22 | -0.2 | | |
| 10 | | | | | |
| | 20.5 | -22 | -4.4 | | |
| 9 | | | | | |
| | | | | | |
| 8 | | | | | |

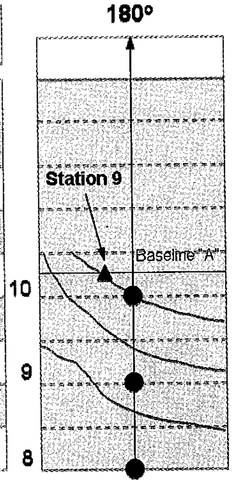



*Figure 11 : Illustration of note keeping protocol for an error of closure.*

# CHAPTER III

## Special Survey Situations

**Situation 1 :** You're line is going to cross a deep stream within the next 20 m shot.
You would like to know the distance to the stream and the elevation at the stream for the purpose of producing an accurate contour map.

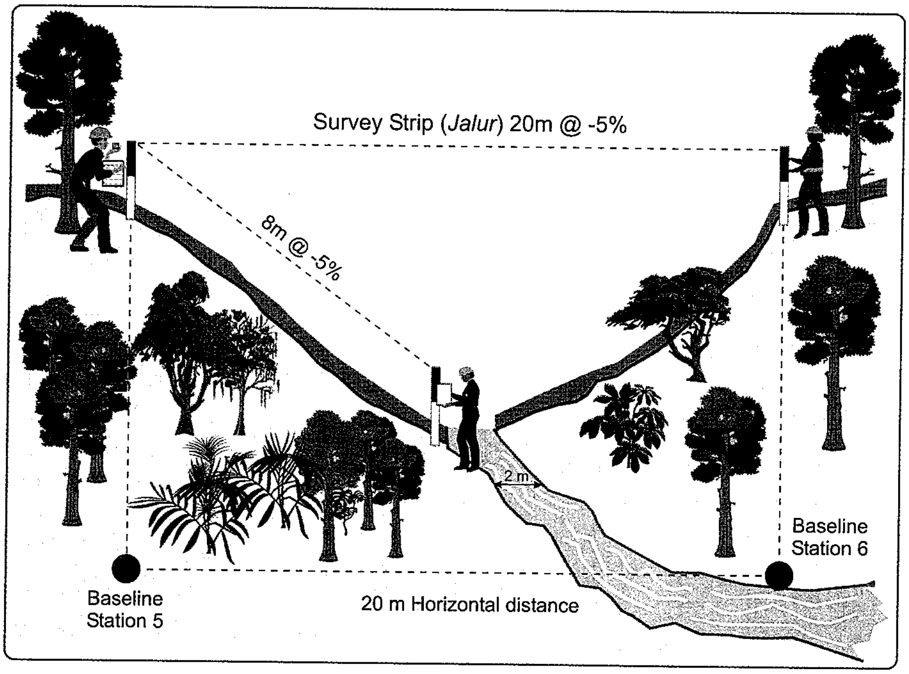



***Figure 12 :*** ***Survey protocol for crossing a stream and recording an Intermediate Foreshot (IFS).***

Field Procedure :

This is an important variation to the normal .20 meter horizontal measurement since it records important data concerning topographic relief which will be helpful to construct an accurate contour map and to accurately determine the location of the stream.

1) When the Head Chainman reaches the stream as he moves forward on the bearing, he will stop for a moment to take an intermediate measurement of the slope distance to the stream.

2) The Rear Chainman will take the slope reading and the slope measurement to the Head Chainman at the stream and the Note keeper will record this information as an ***"Intermediate Foreshot (IFS)".*** This ***"Intermediate Measurement"*** should be recorded in brackets opposite the station from which it originates. (see sample notes in *Figure 13*). The Note Keeper will accurately indicate the stream position on the sketch map and show the direction of stream flow with an arrow.

3) The Head Chainman will then proceed till he reaches 20m+ slope distance while the Rear Chainman remains at the last station.

4) The normal survey and note keeping procedure will now apply for slope correction and measurement (see Section 2.4, Establishing a Baseline). Note that the measurements to the stream do not require the establishment of a survey station.

**BLOCK :** **<u>28</u>** **DATE :** **<u>April 1, 2003</u>**

**STRIP :** **<u>4</u>** **AZIMUTH :** **<u>180</u>**

| STAT. | S. D. | % | Vert. Dist. | Elev. | Adjust. Elev. |
|---|---|---|---|---|---|
| 6 | | | | | |
| | 20 | -2 | -0.2 | | |
| 5 | (8 m @ - 25 % to stream) | | | | |
| | 20 | -5 | -1.0 | | |
| 4 | | | | | |

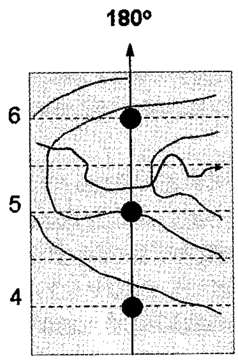



***Figure 13 : How to record intermediate survey information when crossing a stream or gully.***

**Situation 2 :** You're line is going to cross a ridge or an abrupt change in slope and the Note Keeper will not be able to see the Head Chainman in 20 meter.

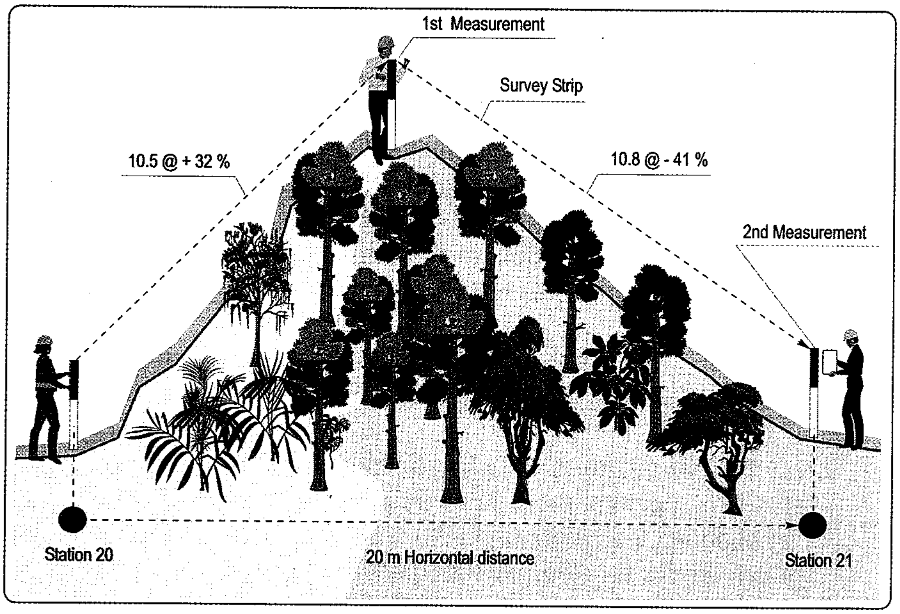



***Figure 14 : Survey protocol for crossing a ridge.***

Tip : Try to break the 20 meter interval into two, 10 meter measurements. The slope table in Appendix IV provides the necessary slope distances for a 10m horizontal measurement.

If a 10m measurement is not possible or, for some other reason not desirable, you will need to use the general slope tables for distances other than 20m. Always try to measure to the nearest even meter since these tables are set up in two meter intervals. This will make slope correction much easier.

Field Procedure :

1) As the Head Chainman reaches the top of the ridge, he will see that he will soon be going down and will be out of sight of the Rear Chainman. He should stop and tell the Rear Chainman to take a slope reading on him and adjust the measurement to approximately 10 meters.

2) The Rear Chainman will take the slope reading and adjust the slope measurement to achieve a horizontal distance of 10 meters. The appropriate slope measurement can be determined from the 20 meter slope table by dividing the slope distance value for the appropriate percentage, by two.

3) The Head Chainman will pull the chain tight to the corrected 10 meter slope distance and will make a mark on the ground with his foot. Both men will then proceed along the bearing line.

4) When the Rear Chainman and Note Keeper reach the mark on the ground, they will stop and allow the Head Chainman to proceed for another 10 meters.

5) The second reading can now be taken in the normal way and the necessary adjustment made to the slope distance to achieve a second 10 meter horizontal measurement.

6) Note that a survey stake will not be established at the intermediate measurements but will be required at the second, 10 meter measurement to maintain the 20 meter sequence of horizontal survey points.

**BLOCK : <u>28</u>** **DATE : <u>April 1, 2003</u>**
**STRIP : <u>15</u>** **AZIMUTH : <u>360</u>**

| STAT. | S. D. | % | Vert. Dist. | Elev. | Adjust. Elev. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| 15 | | | | 362.8 | |
| | 10.0 | -2 | -0.2 | | |
| 14 | 10.1 | +15 | +1.5 | 361.5 | |

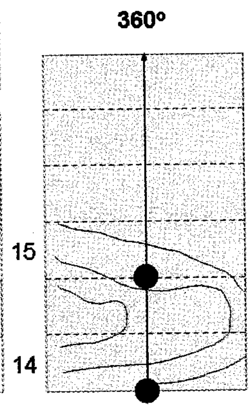



***Figure 15 : How to record intermediate survey information when crossing a ridge.***

7) The note keeping protocol for this situation is illustrated in *Figure 15*. Note that brackets are not used. This indicates that both measurements are part of the continuous measurement of the survey line.

| | |
|---|---|
| **Situation 3 :** | You're line has reached a cliff which you cannot climb. How do you carry the line forward and still maintain the accuracy of the survey pattern? |

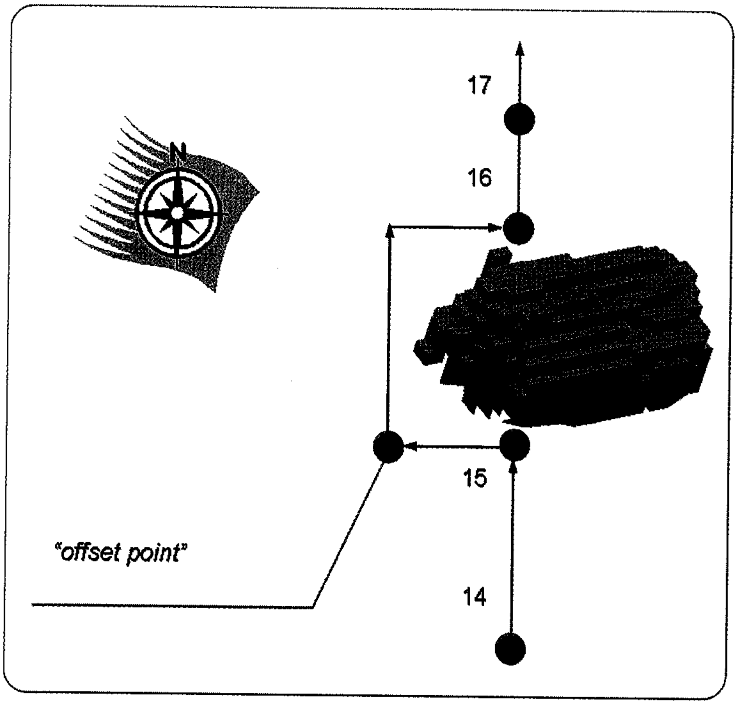



***Figure 16 : Survey protocol for avoiding an obstacle.***

Field Procedure:

1) The Head Chainman has reached a small cliff which he cannot climb on bearing. He decides that it is possible to go around the cliff to the left of the line.

2) He returns to the last survey point (15) and sets a new bearing at right angles to the original line (Bearing 270° in the following example).

3) After 10m (or a suitable distance), he checks the original bearing to see if it can get past the rock. If he thinks he can get past, he will tell the Rear Chainman to take the measurement at 10m.

4) The Note Keeper must record the bearing, slope distance and slope % to this off-set point. The Head Chainman makes a mark on the ground to note the point.

5) The Head Chainman then proceeds at the original bearing of North until he is past the cliff and tells the Rear Chainman to take the measurement.

6) The Chainman pulls the chain tight and the Note Keeper records the new bearing, slope distance and slope %.

7) The survey team then proceeds on the reverse of the original off-set bearing for the same distance to get back on the line (90° for 10m).

8) The point at which the original line is re-established should be the next survey point on the line or an even multiple of the standard, horizontal 20m survey interval.

**BLOCK : 28**     **DATE : April 1, 2003**
**STRIP : 15**     **AZIMUTH : 360**

| STAT. | S. D. | % | Vert. Dist. | Elev. | Adjust. Elev. |
|---|---|---|---|---|---|
| 17 | | | | | |
| | | | | | |
| 16 | | | | 354.5 | |
| | 90° 10 m | - 10% | - 1.0 | | |
| | 0° 25 m | + 75% | + 25.0 | | |
| | 270° 10.1m | - 15% | - 1.5 | | |
| 15 | | | | 342.0 | |

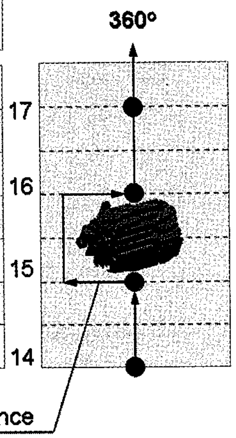



*Figure 17 : How to keep notes for an off-set around an obstacle.*

9) To ensure that the measurement interval of 20m horizontal distance is maintained on the line, slope correction using the general slope correction table, should be applied to all off-set measurements.

This kind of situation requires a flexible approach. The field crew will made the decision on the appropriated off-set distance and the distance required to get past the obstacle. It is important to calculate horizontal distance in the field so that you can position the first survey stake past the obstacle on the origin bearing line.

**Situation 4 :** How to deal with major obstacles during the survey of a block.

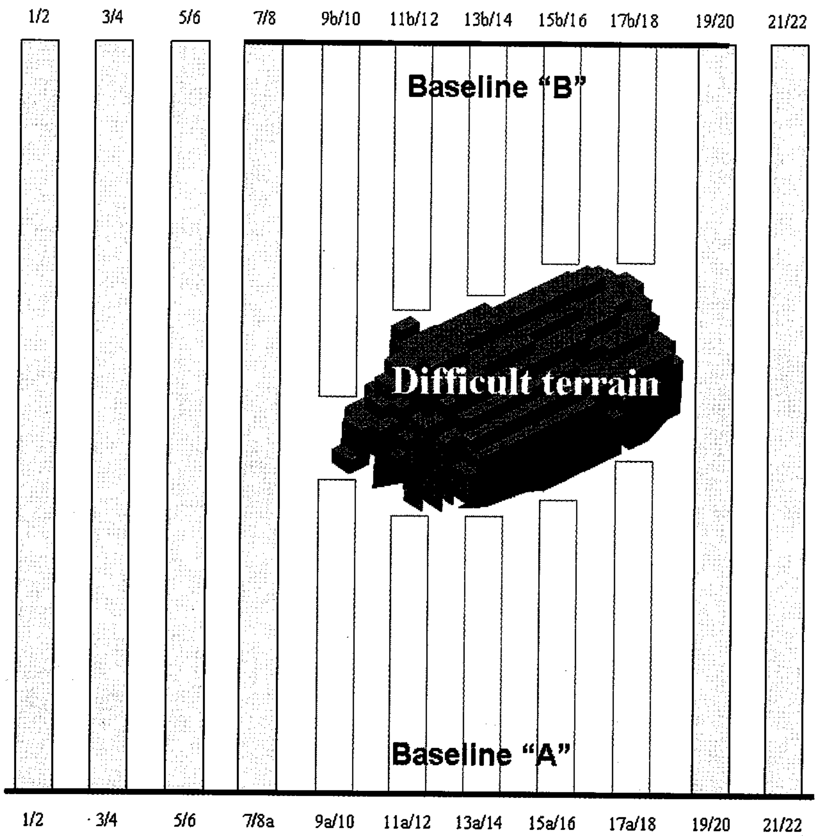



***Figure 18 : How to deal with a major obstacle occurring within the block.***

In some blocks, major problems with difficult terrain such as extensive swampy areas or very rugged or rocky terrain, may be encountered. In such situation it may not be possible to implement a systematic survey of strips.

The solution to dealing with such a situation will, of necessity, have to be site-specific. Strips may have to be shortened to avoid the difficult terrain. If the difficult terrain occurs within a block, care must be taken to extend the strip survey around the difficult portion of the strip in a manner which maintains a high level of accuracy and re-establishes the survey grid beyond the major obstacle or difficult terrain.

Distance, slope, and azimuth for every measurement must be recorded in a clear and consistent manner. Ties to adjacent strips must be made in the field and clearly recorded in the notes. An illustration of such a mapping situation is provided in *Figure 18* where a rugged rock outcrop makes it impossible to maintain the strip network.

# CHAPTER IV

## POTENTIAL SOURCES OF ERROR

Contour mapping surveys are low order surveys. They represent a pragmatic solution to the need for contour maps where aerial photo based contour maps are not available at an operational scale. Since contour mapping is very labour intensive and time consuming, and, since the area which must be mapped in one year is often quite large, the survey procedure is a compromise between the need for accuracy and the need for productivity.

It is recommended that all contour mapping strips should be tied to a controlled baseline so that survey errors can be adjusted more easily when preparing the maps. The procedure described in the preceding sections recommends that two lines should constitute one continuous survey. The survey must close. It must start and end at the same survey point or at traverse points which are already connected by a previous survey. The recorded data must clearly describe what was done in the field. Each section of the survey must record bearing, slope distance and % slope.

In order to minimize field survey errors, it is helpfull to examine the sources of error. The following list of potential sources of error is by no means complete, however it covers the most common sources of survey error.

### 4.1 Error in Compass Reading

Error in compass reading will result in a deviation of the line from the intended bearing. This error may be caused by :

(a) Holding the compass incorrectly
(b) Not checking the bearing line carefully

Corrective Measures

(a) Always ensure that the compass is held level and that the compass needle (or wheel) is rotating freely.
(b) Take frequent back shots on your line to make sure that you do not deviate from the correct bearing.

(c) The Head Chainman should also have a compass and should check the bearing of the Compassman frequently. If there is a deviation in the line established by the compassman the actual bearing should be recorded in the notes. Don't pretend that the line has been correctly established when in fact, there is a deviation. This will only create problems in the mapping process.

(d) Keep metal objects, such as a wrist watch, away from the compass. Close proximity to certain metals can cause incorect compass readings.

**4.2 Error in Slope Reading** resulting in a high vertical error of closure. This error may be caused by :

(a) Using uncalibrated instruments,
(b) Failing to record the correct sign (+/-)
(c) Recording degrees instead of percent.
(d) The Rear Chainman is taller (or shorter) than the Head Chainman but takes his slope readings at the "eye level" of the Head Chainman. The result is a small but consistent error which becomes quite significant over the length of the survey strip.

<u>Corrective Measures</u>

(a) Check the clinometer. It may not be calibrated correctly.
- Establish two targets 20m apart Mark the first target at eye level. Hold the instrument against this mark and establish the zero slope mark on the second target.
- Move the instrument to the zero slope mark on the second target. Hold the instrument next to this mark and establish the zero slope mark on the first target. If the instrument is accurate, the zero slope mark will be the same as the original instrument position.
- If the zero mark is below the original instrument position, the clinometer is reading **too low.** Determine the correction required by dividing the distance in half and adjusting all subsequent field readings **upwards** by the resulting angle.

- If the zero mark is above the original instrument position, the clinometer is reading **too high**. Determine the correction required by dividing the distance in half and adjusting all subsequent field readings **downwards** by the resulting angle.
- A much easier way to determine if your clinometer is reading correctly is to take it to a lake or river and shoot across to the opposite shore. Your reading will determine whether your instrument has a negative or a positive bias.

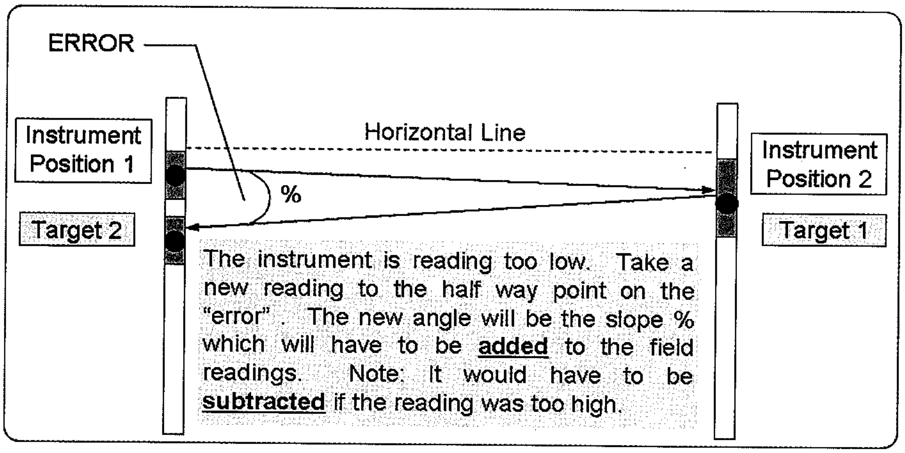



***Figure 19 : Checking the accuracy of a clinometer.***

(b) When adding a slope correction during the strip survey, take a second reading to the corrected horizontal survey point. Record this second reading.

(c) The Note Keeper should always determine his "eye level" relative to his partner (Head Chainman) by standing next to his partner on a flat place and taking a zero slope reading on his partner's head.

### 4.3 Distance Measurement Error

When closing a return traverse along the second strip to the baseline, the distance should be the same. If it is longer or shorter than it should be but if the bearing is correct, an error in the distance measurement has probably occurred.

Corrective Measures.

(a) Use the correct survey tool. The preferred measurement tool is a nylon survey chain or survey tape calibrated at one meter intervals.
(b) Always pull the chain tight and straight when measuring from point to point.
(c) If using a polypropylene rope, check it periodically against a proper survey tape. Polypropylene will stretch with time.

**4.4 Incorrect, Incomplete or Unclear Notes** are a very common source of error in low order field surveys.

Corrective Measures

(a) Always start the notes by clearly identifying the block number, strip number, bearing of the strip, date, and the name of the Note Keeper.
(b) Clearly identify any changes of bearing in the notes.
(c) Make sure that each survey is tied to the next survey line. Record bearing, slope distance and slope for all ties.
(d) Provide a sketch for each tie.
(e) Sketch in all creeks and important physical features on the compass sheet.
(f) Sketch in form lines to illustrate the direction of the contours for 20m on either side of the strip.
(g) Record all errors of closure no matter how small. Make sure that distance, azimuth, and slope is recorded for each measurement.

| | |
|---|---|
| Tip : | The field notes should be easy for anyone to interpret. Don't leave anything to the imagination. Record all possibly useful information; don't rely on your memory. |

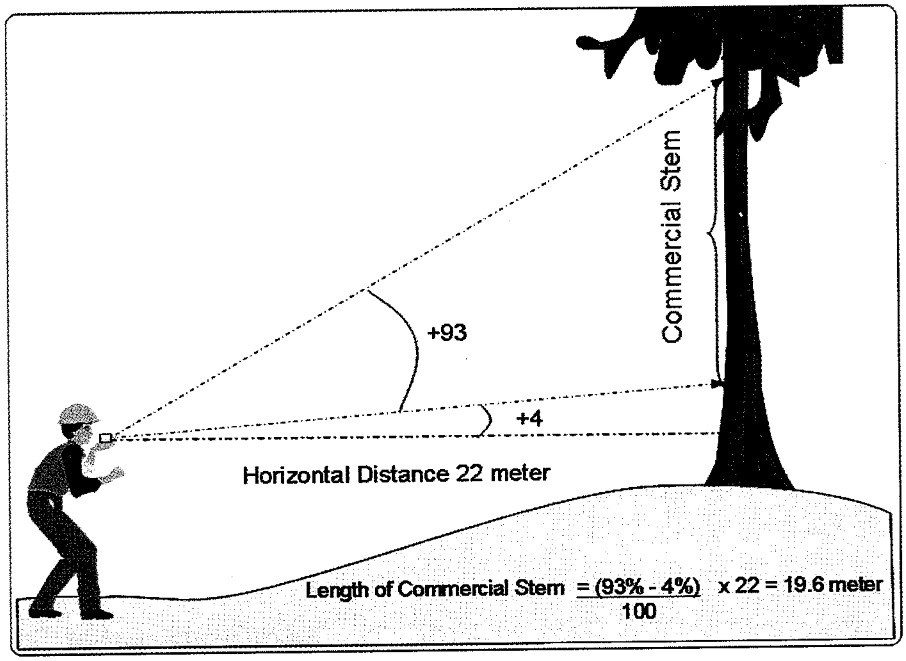



**Figure 21 :** ***Height measurement – Situation 2***

***Which trees to record ?***

Regulatory requirements as well as operational considerations will dictate which trees to record and map. Under the TPTI system, the regulation requires that commercial trees above the minimum feeling diameter limit be tallied. The TPTI also requires that all protected species be marked and labeled and that a forest management unit demonstrate that at least 25 future crop trees be marked and labeled.

| Description | Felling Diameter Limit | Future Crop Trees |
|---|---|---|
| Production Forest | 50 cm + | 20 - 49 cm |
| Limited Production Forest | 60 cm + | 20 - 59 cm |
| Protected Species | Ulin, Jelutung, Ttengkawan, etc. | Ulin, Jelutung, Ttengkawan, etc. |

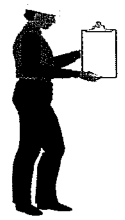
Operational considerations are just as important as regulatory requirements when deciding which trees to tally and mark.

The definition of "commercial" is largely up to the individual company's discretion and is influenced by the industrial configuration of the company. The primary consideration is anticipated quality of the log. If a forest management unit produce logs only for a plywood factory, the company policy regarding permissible defect will be more demanding than if logs are being produced to a fully integrated industrial complex.

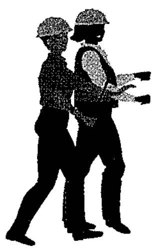
Location and transport considerations are also important. If the concession is remote and river transport using barges is not possible, then sinker species would not be considered commercial since they cannot be floated down the river.

## 5.2 The Inventory Team

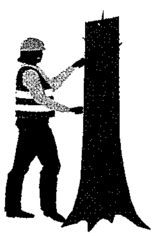
The inventory team usually consists of four people.



*Note Keeper*: This is the key man in the inventory team. He directs the work and receives and records all data (species, tree category, diameter, length of stem and tree position). He also creates a sketch showing the relative position of each recorded tree within a 20 x 20 meter plot.



*Cruiser*: There are usually two cruisers in the team. Their job is to measure tree diameters and heights of the stem to the first major branch. The cruisers also number and label the trees and, where tree position is recorded using a co-ordinate system, they estimate the **"X"** and **"Y"** values for the tree positions. Cruisers must communicate continuously with each other and convey their measurements and estimates to the Note Keeper verbally.



*Tree Identifier* : This man is a specialist in tree identification. His job also includes helping the cruisers with tree labeling and tagging.

## 5.3 Field Procedure

Cruising and tree mapping is carried out by the Inventory Team which follows the survey grid established by the Topographic Survey Team. The basic sampling unit is a 20 x 20 meter plot.

One strip should be kept as the reference line. Tree positions are recorded in relation to this line. These positions are then related to the **"0"** point of each 20 x 20 meter plot (Figure 21).

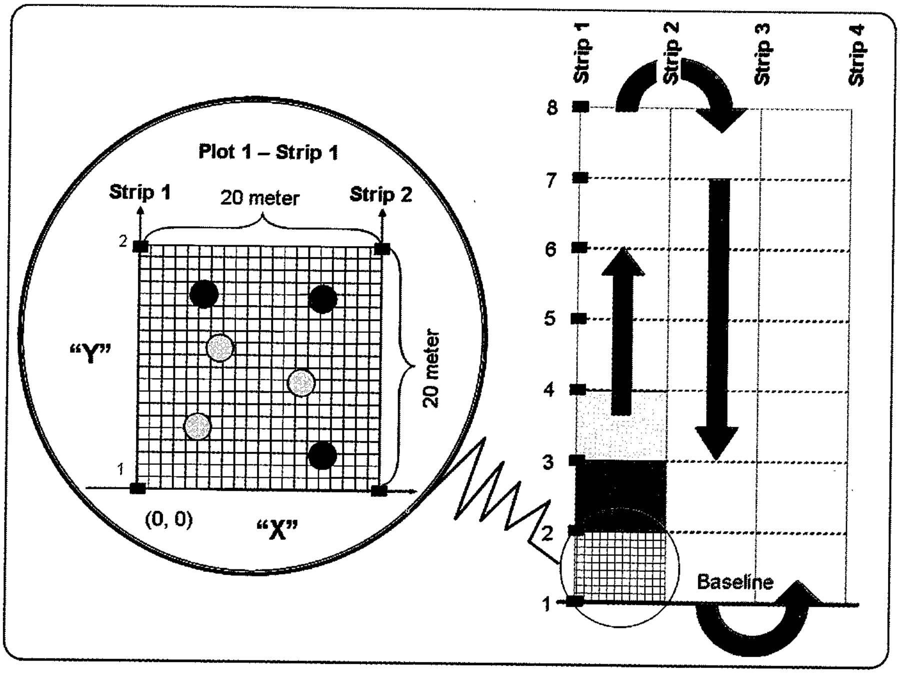



*Figure 22 : Field procedure for tree mapping*

1). The Note Keeper records all tree data given to him by the two Cruisers and the Tree Identifier. The Note Keeper assigns consecutive tree numbers and tells the other crew members what number to write on the tree labels.

The Note Keeper should always keep the reference strip in sight since he must also confirm the tree position within each plot. Any stream or distinct physical feature should also be recorded on the tally sheet.

2). The two Cruisers will each cover half of the plot as they proceed in the sampling direction. Their job is to chose which trees should be recorded and labeled according to the approved sampling criteria.

This could include :

- Trees above a certain diameter limit which are of commercial species and quality. Note that commercial species and quality considerations may vary between forest management units.
- Future crop trees which conform to species, diameter, and quality considerations.
- Protected trees according to regulatory requirements.

**Tip** : When establishing sampling criteria, clear distinction should be made between necessary information and desired information. A common mistake in sampling is to collect desired information. This can result in information overload and reduce the practical effectiveness of the inventory. Establish the sampling criteria on the basis of needed information only.

3). The Cruisers will measure or estimate the diameter and height to the first major branch. If they require assistance in tree identification and tree labeling, the Tree Identifier will be able to help.

4). The cruisers will shout this information to the Note Keeper who will tell them what tree number to use.

5). This information will be recorded on a 3-part red plastic label which will be attached to the tree with a nail or staple. Future crop trees will be labeled with a simple yellow tag containing just the tree number, species and diameter.

6). Additional tree marking could involve painting a yellow line on protected species.

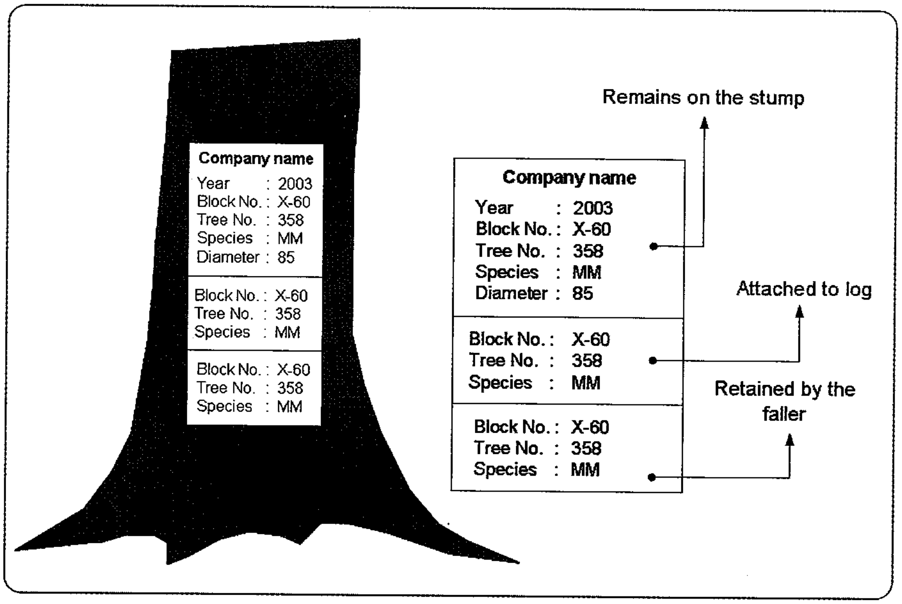



*Figure 23 : 3-part label on a tree marked for felling.*

7). The Cruisers should also tell the Note Keeper the position co-ordinates of each tree using the bottom left hand corner of each plot as the zero point for the **X / Y** coordinate system. The Note Keeper will confirm the **"X"** and **"Y"** values and may adjust them if he is in a better position to see the tree location relative to the **0,0** point.

8). The Note Keeper will record all tree data including a sketch of the tree location. Figure 25 illustrates a typical tally sheet including a sketch map. Tree number, species code, diameter, and height are required entries. "Tree code" is an optional column and can be used to identify the category of tree for easy sorting of information on a computerized data base. The **"X"** and **"Y"** coordinate information and the sketch map are necessary information for tree position mapping whether this data is transferred onto a map manually or whether a computerized mapping system is applied.

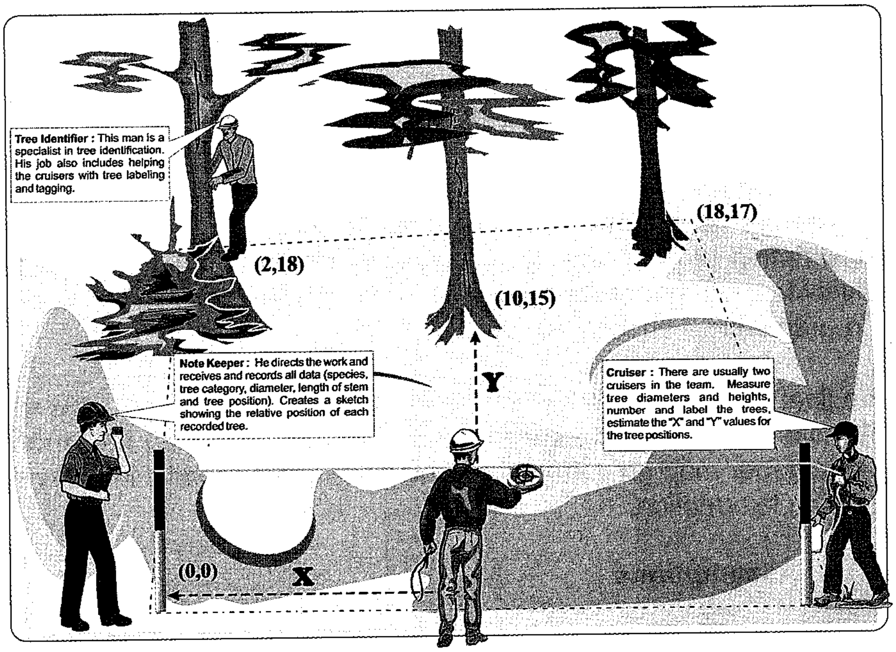



*Figure 24 : Locating tree positions within a plot.*

## INVENTORY DATA FORM

Block No. XX-20 Strip No. 10 Bearing 360 Date : 10 April 2003

| Tree No. | Sp. Code | Diam. (cm) | Ht. (m) | Tree Code | Vol. (m3) | X | Y | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| 332 | KR | 90 | 22 | 1 | | 16 | 17 | |
| 331 | MM | 110 | 25 | 1 | | 12 | 11 | |
| | | | | | | | | |
| 330 | KR | 45 | 20 | 3 | | 4 | 17 | |
| 329 | KR | 80 | 24 | 1 | | 14 | 8 | |
| 328 | BKR | 75 | 16. | 2 | | 17 | 16 | |
| | | | | | | | | |
| 327 | MP | 40 | 18 | 3. | | 8 | 18 | |
| 326 | MLP | 35 | 12 | 3 | | 15 | 4 | |
| 325 | MM | 90 | 22 | 1 | | 7 | 7 | |

Tree Map

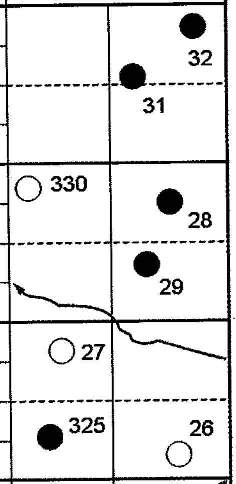



*Figure 25 : Tally sheet including a sketch of tree positions.*

# CHAPTER VI

## OFFICE MAPPING PROCEDURES

Low order surveys such as those used in collecting contour information, will always have some error of closure. The key to successful transcription of field data to produce a reliable contour map, is to acknowledge the errors of closure and to adjust for them in a consistent and pragmatic manner.

The final map should reflect the corrected errors of closure. This will minimize localized distortion of field data by distributing the errors over a larger map area and maintaining the overall spatial integrity of the map information.

### 6.1 Assumptions

Certain assumptions are necessary in order to successfully adjust both the horizontal and vertical errors of closure.

- One part of the total survey work must be assumed to be correct. All adjustments will be made to this "correct" survey. The assumed "correct" survey will usually be the baseline, or boundary survey. All other surveys will be adjusted to this work.

- It will be assumed that an error of closure, both vertical and horizontal, is evenly distributed along the length of the survey. This will make it easier to adjust the error over the total distance of the survey.

### 6.2 Preparing the Field Notes

This preparatory stage must be done on a daily basis in the field camp. Failure to check the field notes in this way will lead to errors or omissions going undetected and will result in significant mapping problems.

1) Check the field notes for completeness on a daily basis. Make sure that all information necessary to plot the field notes has been clearly noted and that all ties are accurately recorded and complete.

2) Enter the vertical distances from the slope table.

3) Calculate the elevation for each station.

4) Calculate the horizontal error of closure.

5) Calculate the vertical error of closure.

## 6.3 Preparing the Contour Map

Procedure:

1) Plot the baseline on a piece of graph paper large enough to accommodate the entire survey work, usually one block. Show all stations and their elevations carried forward from the starting point. This sheet of paper will be used to create a corrected composite map.

2) Plot each piece of the survey work on a separate strip of graph paper. All corrections should be made on these individual working maps and then traced onto the composite map.

3) On the individual pieces of paper, lightly plot the approximate position of the strips according to the work plan.

4) Adjust for horizontal error of closure :
The sample notes in Figure 26 show a continuous survey of two strips starting at baseline station 20 and ending at baseline station 21. The survey strips also show an error of closure of + 10m in the North / South direction and 8.5 m in the East / West direction. According to the field survey procedures, station 10 strip 21 should have landed directly on baseline station 21 (Figure 27).

| Station | Brg. (%) | Slope Distance | Slope (%) | Vert. Diffrence | Elev. (m) | Adjust. Elev. |
|---|---|---|---|---|---|---|
| = B.L. Station 21 | | | | | 532.0 | 527.0 |
| | 270 | 8.5 | -10 | -0.8 | | |
| = Baseline "A" | | | | | 532.8 | 527.8 |
| | 180 | 10 | -2 | -0.2 | | |
| 10 | | | | | 533.0 | 528.0 |
| | 180 | 20 | -2 | -0.4 | | |
| 9 | | | | | 533.4 | 528.64 |
| | 180 | 20.1 | -12 | -2.4 | | |
| 8 | | | | | 535.8 | 531.28 |
| | 180 | 22.5 | -51 | -10.2 | | |
| 7 | | | | | 546.0 | 541.72 |
| | 180 | 10.1m @14% | | -1.4 | 547.4 | 543.46 |
| 6 | | 10.8m @+41% | | +4.1 | 543.3 | 539.25 |
| | 180 | 24.7 | +73 | +14.6 | | |
| 5 | | | | | 528.7 | 524.89 |
| | 180 | 22.3 | +49 | +9.8 | | |
| 4 | | | | | 518.9 | 515.33 |
| | 180 | 20.7 | +27 | +5.4 | | |
| 3 | | | | | 513.5 | 510.17 |
| | 180 | 20 | +6 | +1.2 | | |
| 2 | | | | | 512.3 | 509.21 |
| | 180 | 20 | +5 | +1.0 | | |
| 1 = | (11.9m@65% = Stream) | | | | 511.3 | 508.44 |
| | 180 | 21.4 | -37 | -7.4 | | |
| 0 = | Begin Strip 21 | | | | 518.7 | 516.08 |
| | 90 | 20.0 | -5 | -1.0 | | |
| 10 | | | | | 519.7 | 517.32 |
| | 360 | +20.9 | +31 | +6.2 | | |
| 9 | | | | | 513.5 | 511.36 |
| | 360 | 20.4 | -21 | -4.2 | | |
| 8 | (12m @62% = Stream) | | | | 517.7 | 515.80 |
| | 360 | 20.1 | -10 | -2.0 | | |
| 7 | | | | | 519.7 | 518.03 |
| | 360 | 20.8 | -29 | -5.8 | | |
| 6 | | | | | 525.5 | 524.07 |
| | 360 | 22.6 | -53 | -10.6 | | |
| 5 | | | | | 536.1 | 534.91 |
| | 360 | 23.4 | -61 | -12.2 | | |
| 4 | | | | | 548.3 | 547.35 |
| | 360 | 10.6 m @35% | | -3.5 | 551.8 | 551.16 |
| 3 | | 11.2 m @+50% +5.0 | | | 546.8 | 546.09 |
| | 360 | 22.7 | +54 | +10.8 | | |
| 2 | | | | | 536.0 | 535.52 |
| | 360 | 21.3 | +36 | +7.2 | | |
| 1 | | | | | 528.8 | 528.56 |
| | 360 | 20 | +5 | +1.0 | | |
| 0 = | B.L. Station 20; begin Strip 20 | | | | 527.8 | 527.8 |

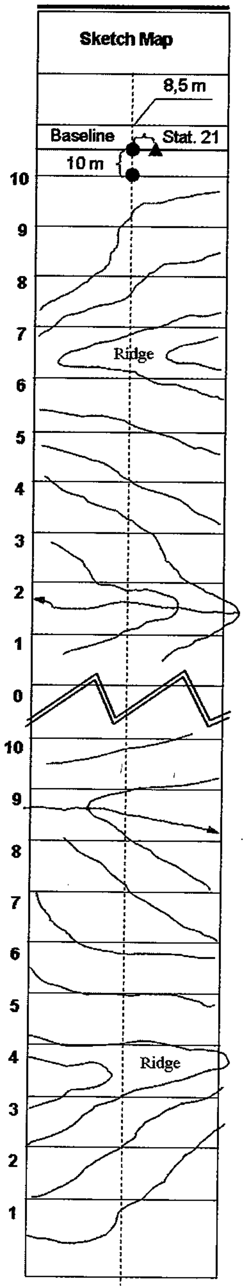



*Figure 26 : A completed and corrected set of field notes for a closed traverse.*

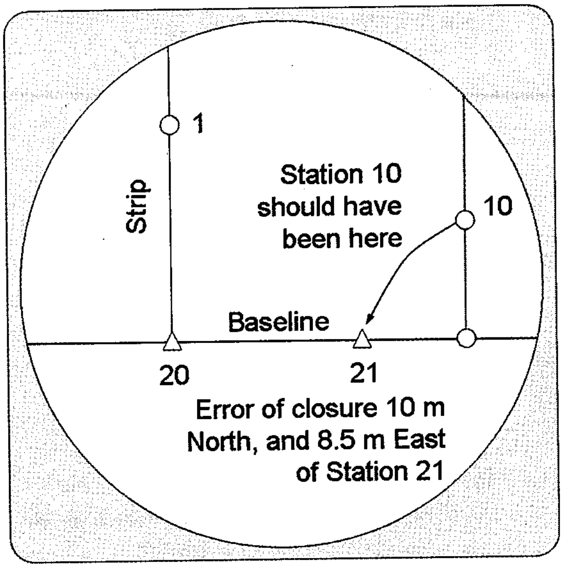



***Figure 27 : Error of Closure***

This is an error both in distance measurement and in bearing. Since we don't know where the error occurred, we must assume that it was accumulative and, therefore we will adjust each 20 meter measurement.

5) The easiest way of dealing with the adjustment of a horizontal error of closure involving two strips of equal length, is to divide the error in half and adjust the end points of each strip.

North / South Error : $$\frac{10\ m}{2} = 5\ m\ North$$

East / West Error : $$\frac{8.5\ m}{2} = 4.25\ m\ East$$

Figure 28 illustrates the adjusted positions for station 10 on strip 20 and station 0 on strip 21.

6) Reposition Strip 20 from the baseline station 20 to the new position of station 10. Reposition all stations on the strip by accumulating increments of :

$$\frac{5\ m}{10} = 0.50\ m\ North\ and\ \frac{4.25}{10} = 0.425\ m\ East$$

| | |
|---|---|
| Station 1 | 0.5 m North and 0.42 m East |
| Station 2 | 1.0 m North and 0.85 m East |
| Station 3 | 1.5 m North and 1.27 m East |
| Station 4 | 2.0 m North and 1.70 m East |

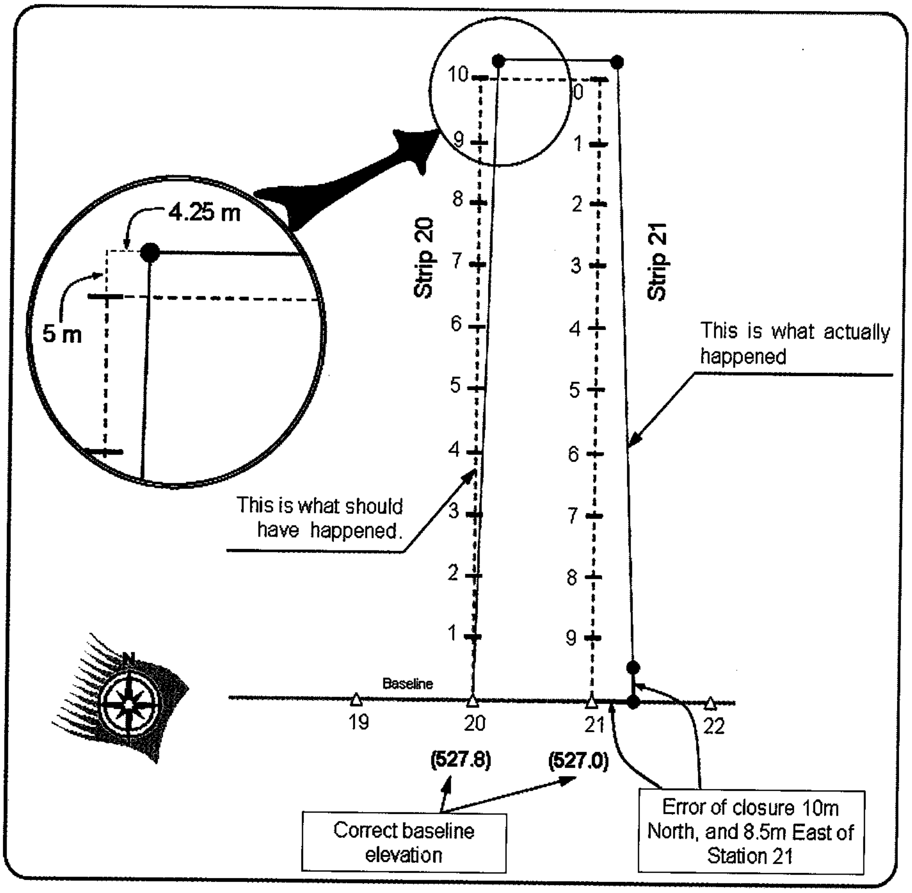



*Figure 28 : Adjusting the horizontal error of closure.*

7) Reposition Strip 21 from where the strip <u>actually</u> reached the baseline to the new position of station 0 by using the same increments as for strip 20.

8) From the field notes sketch in the location of the streams and any other physical information.

9) Adjust for vertical error of closure

The sample notes in *Figure 26* show a baseline elevation of station 21 of 527.0 m, however, the elevation at this station calculated from the field notes, is 532.0 m. This is an error of closure of + 5.0 m.

Since we don't know where or how this error occurred, we must assume an equal distribution of the error.

Since there are 21 roughly equal survey intervals, we must reduce the elevation of each station by accumulating increments of :

$$\frac{5.0\ m}{21} = -\ 0.238\ m$$

Stat. 1 / Strip 21 528.8 – 0.238 = 528.6 Adjusted Elev.
Stat. 2 / Strip 21 536.0 – 0.476 = 535.6 Adjusted Elev.
Stat. 3 / Strip 21 546.8 – 0.714 = 546.1 Adjusted Elev.
Stat. 4 / Strip 21 548.3 – 0.952 = 547.4 Adjusted Elev.
etc.

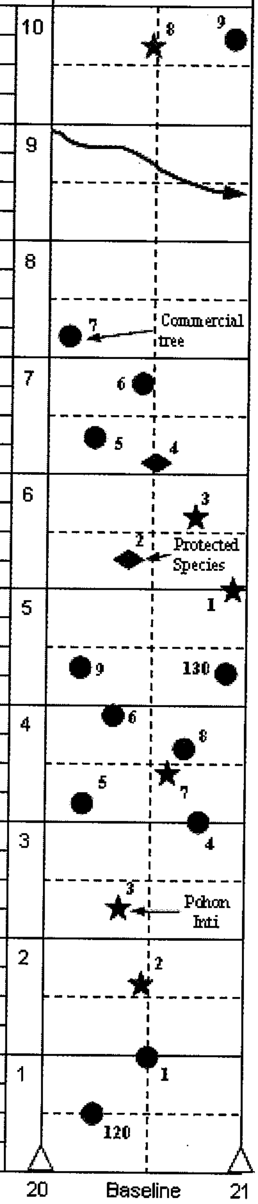
Write these corrected elevations (rounded to the nearest 0.1 meter) lightly in pencil on your adjusted plot of the two stripes.

10) You are now ready to sketch in the contours on the adjusted strip map. Use the field notes as a guide to interpret the direction and shape of the contours. Extend the contours approximately 10 meter on either side of your sketch map (*Figure 29*).

11) When you have completed and checked all the individual strip maps for the block, you are ready to start compiling the composite map. On a light table, place the individual strip maps under the large composite map and match the starting points on the baseline. Make sure that the grid lines of the two maps match.

| Tree No. | Sp. Code | Diam. (cm) | Ht. (m) | Tree Code | X | Y | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| 139 | MK | 105 | 28 | 1 | 19 | 11 | |
| 138 | MM | 45 | 20 | 3 | 10 | 10 | |
| | | | | | | | |
| | | | | | | | 2 m stream |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 137 | MK | 98 | 22 | 1 | 2 | 2 | |
| | | | | | | | |
| 136 | BKR | 73 | 18 | 2 | 9 | 12 | |
| 135 | MB | 60 | 26 | 2 | 4 | 4 | |
| 134 | ULI | 42 | 12 | 4 | 0 | 10 | |
| | | | | | | | |
| | | | | | | | |
| 133 | KRU | 36 | 19 | 3 | 16 | 10 | |
| 132 | ULN | 55 | 14 | 4 | 8 | 6 | |
| | | | | | | | |
| 131 | MLP | 28 | 14 | 3 | 19 | 18 | |
| 130 | MLP | 58 | 17 | 2 | 18 | 3 | |
| 129 | MM | 74 | 20 | 1 | 3 | 3 | |
| 128 | KPR | 60 | 15 | 2 | 13 | 11 | |
| 127 | KPR | 40 | 16 | 3 | 12 | 7 | Top of Ridge |
| 126 | BKR | 75 | 21 | 2 | 7 | 15 | |
| 125 | MM | 68 | 19 | 1 | 6 | 2 | |
| | | | | | | | |
| | | | | | | | |
| 124 | KRU | 72 | 21 | 1 | 16 | 18 | |
| 123 | MM | 45 | 22 | 3 | 7 | 3 | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 122 | KRU | 38 | 18 | 3 | 9 | 10 | |
| | | | | | | | |
| | | | | | | | |
| 121 | MK | 95 | 28 | 1 | 10 | 8 | |
| 120 | MK | 120 | 30 | 1 | 5 | 4 | |

**Tree Map**




Cruiser Name : ____________

Comments : Tree No., Species Code, Diameter and Height are required, Tree Code is optional. "X" and "Y" are strongly recommended. Tree map is required.

***Figure 31 : Sample inventory field notes with tree position data.***

# APPENDIX I

## English / Indonesian Terms

| | | |
|---|---|---|
| A P H I | : | Asosiasi Pengusaha Hutan Indonesia / *Association of Indonesian Forest Concession Holders.* |
| Baseline | : | batas garis ikat |
| Block | : | petak, (usually 1000m x 1000m management unit |
| Compassman | : | pengompas, kompasmen |
| Countour | : | kontur, transes |
| Contour Interval | : | interval, jarak antara kontur, skala trases |
| Corner post | : | patok batas |
| Creek | : | parit, sungai kecil |
| DEPHUT | : | Department Kehutanan Indonesia / *Ministry of Forestry* |
| Elevation | : | elevasi, ketinggian |
| G P S | : | Geographical Positioning System |
| Gully | : | celah |
| Head Chainman | : | penarik tali depan |
| Horizontal distance | : | jarak datar |
| H P H | : | Hak Pengusahaan Hutan / *Forest Concession* |
| I F S | : | Intermediate Fore Shot |
| I T S P | : | Inventarisasi Tegakan Sebelum Penebangan / *Forest Inventory Before Cutting* |

| | | |
|---|---|---|
| I T T O | : | International Tropical Timber Organization |
| Jalur | : | strip or survey line |
| Note Keeper | : | pencatat, record |
| Pohon Inti | : | future crop tree |
| R I L | : | *Reduced Impact Logging* / Pembalakan Berdampak Lingkungan |
| River | : | sungai |
| R K T | : | Rencana Kerja Tahunan/*Annual Operating Area* |
| Slope | : | kelerengan |
| Slope distance | : | jarak datar |
| Stake | : | ajir, patok |
| Starting point | : | titik ikat |
| Station | : | stopan |
| Stream | : | parit, sungai kecil |
| Strip | : | jalur |
| Survey point | : | stopan |
| T F F | : | Tropical Forest Foundation |
| Tie | : | ikatan |
| T P T I | : | Tebang Pilih Tanam Indonesia / *Indonesian Selective Cutting and landing system.* |
| Traverse | : | survei |
| Vertical distance | : | beda tinggi |

# APPENDIX II

## Horzontal Slope Table (20 m)

| Slope (%) | H. D. | V. D. | Slope (%) | H. D. | V. D. | Slope (%) | H. D. | V. D. |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.0 | *0.2* | 46 | 22.0 | *9.2* | 91 | 27.0 | *18.2* |
| 2 | 20.0 | *0.4* | 47 | 22.1 | *9.4* | 92 | 27.2 | *18.4* |
| 3 | 20.0 | *0.6* | 48 | 22.2 | *9.6* | 93 | 27.3 | *18.6* |
| 4 | 20.0 | *0.8* | 49 | 22.3 | *9.8* | 94 | 27.5 | *18.8* |
| 5 | 20.0 | *1.0* | 50 | 22.4 | *10.0* | 95 | 27.6 | *19.0* |
| 6 | 20.0 | *1.2* | 51 | 22.5 | *10.2* | 96 | 27.7 | *19.2* |
| 7 | 20.1 | *1.4* | 52 | 22.5 | *10.4* | 97 | 27.9 | *19.4* |
| 8 | 20.1 | *1.6* | 53 | 22.6 | *10.6* | 98 | 28.0 | *19.6* |
| 9 | 20.1 | *1.8* | 54 | 22.7 | *10.8* | 99 | 28.1 | *19.8* |
| 10 | 20.1 | *2.0* | 55 | 22.8 | *11.0* | 100 | 28.3 | *20.0* |
| 11 | 20.1 | *2.2* | 56 | 22.9 | *11.2* | 101 | 28.4 | *20.2* |
| 12 | 20.1 | *2.4* | 57 | 23.0 | *11.4* | 102 | 28.6 | *20.4* |
| 13 | 20.2 | *2.6* | 58 | 23.1 | *11.6* | 103 | 28.7 | *20.6* |
| 14 | 20.2 | *2.8* | 59 | 23.2 | *11.8* | 104 | 28.9 | *20.8* |
| 15 | 20.2 | *3.0* | 60 | 23.3 | *12.0* | 105 | 29.0 | *21.0* |
| 16 | 20.3 | *3.2* | 61 | 23.4 | *12.2* | 106 | 29.2 | *21.2* |
| 17 | 20.3 | *3.4* | 62 | 23.5 | *12.4* | 107 | 29.3 | *21.4* |
| 18 | 20.3 | *3.6* | 63 | 23.6 | *12.6* | 108 | 29.4 | *21.6* |
| 19 | 20.4 | *3.8* | 64 | 23.8 | *12.8* | 109 | 29.6 | *21.8* |
| 20 | 20.4 | *4.0* | 65 | 23.9 | *13.0* | 110 | 29.7 | *22.0* |
| 21 | 20.4 | *4.2* | 66 | 24.0 | *13.2* | 111 | 29.9 | *22.2* |
| 22 | 20.5 | *4.4* | 67 | 24.1 | *13.4* | 112 | 30.0 | *22.4* |
| 23 | 20.5 | *4.6* | 68 | 24.2 | *13.6* | 113 | 30.2 | *22.6* |
| 24 | 20.6 | *4.8* | 69 | 24.3 | *13.8* | 114 | 30.3 | *22.8* |
| 25 | 20.6 | *5.0* | 70 | 24.4 | *14.0* | 115 | 30.5 | *23.0* |
| 26 | 20.7 | *5.2* | 71 | 24.5 | *14.2* | 116 | 30.6 | *23.2* |
| 27 | 20.7 | *5.4* | 72 | 24.6 | *14.4* | 117 | 30.8 | *23.4* |
| 28 | 20.8 | *5.6* | 73 | 24.7 | *14.6* | 118 | 30.9 | *23.6* |
| 29 | 20.8 | *5.8* | 74 | 24.9 | *14.8* | 119 | 31.1 | *23.8* |
| 30 | 20.9 | *6.0* | 75 | 25.0 | *15.0* | 120 | 31.2 | *24.0* |
| 31 | 20.9 | *6.2* | 76 | 25.1 | *15.2* | 121 | 31.4 | *24.2* |
| 32 | 21.0 | *6.4* | 77 | 25.2 | *15.4* | 122 | 31.6 | *24.4* |
| 33 | 21.1 | *6.6* | 78 | 25.4 | *15.6* | 123 | 31.7 | *24.6* |
| 34 | 21.1 | *6.8* | 79 | 25.5 | *15.8* | 124 | 31.9 | *24.8* |
| 35 | 21.2 | *7.0* | 80 | 25.6 | *16.0* | 125 | 32.0 | *25.0* |
| 36 | 21.3 | *7.2* | 81 | 25.7 | *16.2* | 126 | 32.2 | *25.2* |
| 37 | 21.4 | *7.4* | 82 | 25.9 | *16.4* | 127 | 32.3 | *25.4* |
| 38 | 21.4 | *7.6* | 83 | 26.0 | *16.6* | 128 | 32.5 | *25.6* |
| 39 | 21.5 | *7.8* | 84 | 26.1 | *16.8* | 129 | 32.6 | *25.8* |
| 40 | 21.5 | *8.0* | 85 | 26.3 | *17.0* | 130 | 32.8 | *26.0* |
| **41** | 21.6 | *8.2* | 86 | 26.4 | *17.2* | 131 | 33.0 | *26.2* |
| **42** | 21.7 | *8.4* | 87 | 26.5 | *17.4* | 132 | 33.2 | *26.4* |
| **43** | 21.8 | *8.6* | 88 | 26.6 | *17.6* | 133 | 33.4 | *26.6* |
| **44** | 21.9 | *8.8* | 89 | 26.8 | *17.8* | 134 | 33.6 | *26.8* |
| **45** | 21.9 | *9.0* | 90 | 26.9 | *18.0* | 135 | 33.8 | *27.0* |
| | | | | | | *Tropical Forest Foundation, 2002* | | |

# APPENDIX III

## Standard Slope Table (20 m)

| HELL. (%) | JRK. DTR. | BD. TG. |
|---|---|---|
| 1 | 20 | *0.20* |
| 2 | 20 | *0.40* |
| 3 | 19.99 | *0.60* |
| 4 | 19.98 | *0.80* |
| 5 | 19.98 | *1.00* |
| 6 | 19.96 | *1.20* |
| 7 | 19.95 | *1.40* |
| 8 | 19.94 | *1.59* |
| 9 | 19.92 | *1.79* |
| 10 | 19.90 | *1.99* |
| 11 | 19.88 | *2.19* |
| 12 | 19.86 | *2.38* |
| 13 | 19.83 | *2.58* |
| 14 | 19.81 | *2.77* |
| 15 | 19.78 | *2.97* |
| 16 | 19.75 | *3.16* |
| 17 | 19.72 | *3.35* |
| 18 | 19.68 | *3.54* |
| 19 | 19.65 | *3.73* |
| 20 | 19.61 | *3.92* |
| 21 | 19.57 | *4.11* |
| 22 | 19.53 | *4.30* |
| 23 | 19.49 | *4.48* |
| 24 | 19.45 | *4.67* |
| 25 | 19.40 | *4.85* |
| 26 | 19.36 | *5.03* |
| 27 | 19.31 | *5.21* |
| 28 | 19.26 | *5.39* |
| 29 | 19.21 | *5.57* |
| 30 | 19.16 | *5.75* |
| 31 | 19.10 | *5.92* |
| 32 | 19.05 | *6.10* |
| 33 | 18.99 | *6.27* |
| 34 | 18.94 | *6.44* |
| 35 | 18.88 | *6.61* |
| 36 | 18.82 | *6.77* |
| 37 | 18.76 | *6.97* |
| 38 | 18.70 | *7.10* |
| 39 | 18.63 | *7.27* |
| 40 | 18.57 | *7.43* |
| 41 | 18.51 | *7.59* |
| 42 | 18.44 | *7.74* |
| 43 | 18.37 | *7.90* |
| 44 | 18.31 | *8.05* |
| 45 | 18.24 | *8.21* |

| HELL. (%) | JRK. DTR. | BD. TG. |
|---|---|---|
| 46 | 18.17 | *8.36* |
| 47 | 18.10 | *8.51* |
| 48 | 18.03 | *8.65* |
| 49 | 17.45 | *8.80* |
| 50 | 17.38 | *8.94* |
| 51 | 17.82 | *9.09* |
| 52 | 17.74 | *9.23* |
| 53 | 17.67 | *9.37* |
| 54 | 17.60 | *9.50* |
| 55 | 17.52 | *9.64* |
| 56 | 17.45 | *9.77* |
| 57 | 17.38 | *9.90* |
| 58 | 17.30 | *10.03* |
| 59 | 17.23 | *10.16* |
| 60 | 17.15 | *10.29* |
| 61 | 17.07 | *10.42* |
| 62 | 17.00 | *10.54* |
| 63 | 16.92 | *10.66* |
| 64 | 16.85 | *10.78* |
| 65 | 16.77 | *10.90* |
| 66 | 16.69 | *11.02* |
| 67 | 16.62 | *11.13* |
| 68 | 16.54 | *11.25* |
| 69 | 16.46 | *11.36* |
| 70 | 16.38 | *11.47* |
| 71 | 16.31 | *11.58* |
| 72 | 16.23 | *11.69* |
| 73 | 16.15 | *11.79* |
| 74 | 16.08 | *11.90* |
| 75 | 16.00 | *12.00* |
| 76 | 15.92 | *12.10* |
| 77 | 15.85 | *12.20* |
| 78 | 15.77 | *12.30* |
| 79 | 15.69 | *12.40* |
| 80 | 15.62 | *12.49* |
| 81 | 15.54 | *12.59* |
| 82 | 15.47 | *12.68* |
| 83 | 15.39 | *12.77* |
| 84 | 15.31 | *12.86* |
| 85 | 15.24 | *12.95* |
| 86 | 15.16 | *13.04* |
| 87 | 15.09 | *13.13* |
| 88 | 15.01 | *13.21* |
| 89 | 14.94 | *13.30* |
| 90 | 14.87 | *13.38* |

| HELL. (%) | JRK. DTR. | BD. TG. |
|---|---|---|
| 91 | 14.74 | *13.46* |
| 92 | 14.72 | *13.54* |
| 93 | 14.65 | *13.62* |
| 94 | 14.57 | *13.70* |
| 95 | 14.50 | *13.77* |
| 96 | 14.43 | *13.85* |
| 97 | 14.36 | *13.93* |
| 98 | 14.28 | *14.00* |
| 99 | 14.21 | *14.07* |
| 100 | 14.14 | *14.14* |
| 101 | 14.07 | *14.21* |
| 102 | 14.00 | *14.28* |
| 103 | 13.93 | *14.35* |
| 104 | 13.86 | *14.42* |
| 105 | 13.79 | *14.48* |
| 106 | 13.72 | *14.55* |
| 107 | 13.66 | *14.61* |
| 108 | 13.59 | *14.68* |
| 109 | 13.52 | *14.74* |
| 110 | 13.45 | *14.80* |
| 111 | 13.39 | *14.86* |
| 112 | 13.32 | *14.92* |
| 113 | 13.25 | *14.98* |
| 114 | 13.19 | *15.04* |
| 115 | 13.12 | *15.09* |
| 116 | 13.06 | *15.15* |
| 117 | 12.99 | *15.20* |
| 118 | 12.93 | *15.26* |
| 119 | 12.87 | *15.31* |
| 120 | 12.80 | *15.36* |
| 121 | 12.74 | *15.42* |
| 122 | 12.68 | *15.47* |
| 123 | 12.62 | *15.52* |
| 124 | 12.56 | *15.57* |
| 125 | 12.49 | *15.62* |
| 126 | 12.43 | *15.67* |
| 127 | 12.37 | *15.71* |
| 128 | 12.31 | *15.76* |
| 129 | 12.25 | *15.81* |
| 130 | 12.19 | *15.85* |
| 131 | 12.10 | *15.90* |
| 132 | 12.10 | *15.94* |
| 133 | 12.00 | *15.99* |
| 134 | 12.00 | *16.03* |
| 135 | 11.90 | *16.70* |

*Tropical Forest Foundation, 2000*

# APPENDIX IV

## SLOPE TABLE 20 / 10 / 1 M, INTERVAL

| Slope % | Horizonatal Distance (m) | | | Slope % | Horizonatal Distance (m) | | |
|---|---|---|---|---|---|---|---|
| | **20.00** | 10.00 | 1.00 | | **20.00** | 10.00 | 1.00 |
| | S. D. | S. D. | S. D. | | S. D. | S. D. | S. D. |
| 1 | 20.00 | 10.00 | 1.00 | 26 | 20.66 | 10.33 | 1.03 |
| 2 | 20.00 | 10.00 | 1.00 | 27 | 20.72 | 10.36 | 1.04 |
| 3 | 20.01 | 10.00 | 1.00 | 28 | 20.77 | 10.38 | 1.04 |
| 4 | 20.02 | 10.01 | 1.00 | 29 | 20.82 | 10.41 | 1.04 |
| **5** | **20.02** | **10.01** | **1.00** | **30** | **20.88** | **10.44** | **1.04** |
| 6 | 20.04 | 10.02 | 1.00 | 31 | 20.94 | 10.47 | 1.05 |
| 7 | 20.05 | 10.02 | 1.00 | 32 | 21.00 | 10.50 | 1.05 |
| 8 | 20.06 | 10.03 | 1.00 | 33 | 21.06 | 10.53 | 1.05 |
| 9 | 20.08 | 10.04 | 1.00 | 34 | 21.12 | 10.56 | 1.06 |
| **10** | **20.10** | **10.05** | **1.00** | **35** | **21.19** | **10.59** | **1.06** |
| 11 | 20.12 | 10.06 | 1.01 | 36 | 21.26 | 10.63 | 1.06 |
| 12 | 20.14 | 10.07 | 1.01 | 37 | 21.33 | 10.66 | 1.07 |
| 13 | 20.17 | 10.08 | 1.01 | 38 | 21.40 | 10.70 | 1.07 |
| 14 | 20.20 | 10.10 | 1.01 | 39 | 21.47 | 10.73 | 1.07 |
| **15** | **20.22** | **10.11** | **1.01** | **40** | **21.54** | **10.77** | **1.08** |
| 16 | 20.25 | 10.13 | 1.01 | 41 | 21.62 | 10.81 | 1.08 |
| 17 | 20.29 | 10.14 | 1.01 | 42 | 21.69 | 10.85 | 1.08 |
| 18 | 20.32 | 10.16 | 1.02 | 43 | 21.77 | 10.89 | 1.09 |
| 19 | 20.36 | 10.18 | 1.02 | 44 | 21.85 | 10.93 | 1.09 |
| **20** | **20.40** | **10.20** | **1.02** | **45** | **21.93** | **10.97** | **1.10** |
| 21 | 20.44 | 10.22 | 1.02 | 46 | 22.01 | 11.01 | 1.10 |
| 22 | 20.48 | 10.24 | 1.02 | 47 | 22.10 | 11.05 | 1.10 |
| 23 | 20.52 | 10.26 | 1.03 | 48 | 22.18 | 11.09 | 1.11 |
| 24 | 20.57 | 10.28 | 1.03 | 49 | 22.27 | 11.14 | 1.11 |
| **25** | **20.62** | **10.31** | **1.03** | **50** | **22.36** | **11.18** | **1.12** |

# APPENDIX IV

## Slope Table 20 / 10 / 1 m, Interval

| Slope % | Horizonatal Distance (m) | | | Slope % | Horizonatal Distance (m) | | |
|---|---|---|---|---|---|---|---|
| | 20.00 | 10.00 | 1.00 | | 20.00 | 10.00 | 1.00 |
| | S. D. | S. D. | S. D. | | S. D. | S. D. | S. D. |
| 51 | 22.45 | 11.23 | 1.12 | 76 | 25.12 | 12.56 | 1.26 |
| 52 | 22.54 | 11.27 | 1.13 | 77 | 25.24 | 12.62 | 1.26 |
| 53 | 22.64 | 11.32 | 1.13 | 78 | 25.36 | 12.68 | 1.27 |
| 54 | 22.73 | 11.36 | 1.14 | 79 | 25.49 | 12.74 | 1.27 |
| **55** | **22.83** | **11.41** | **1.14** | **80** | **25.61** | **12.81** | **1.28** |
| 56 | 22.92 | 11.46 | 1.15 | 81 | 25.74 | 12.87 | 1.29 |
| 57 | 23.02 | 11.51 | 1.15 | 82 | 25.86 | 12.93 | 1.29 |
| 58 | 23.12 | 11.56 | 1.16 | 83 | 25.99 | 13.00 | 1.30 |
| 59 | 23.22 | 11.61 | 1.16 | 84 | 26.12 | 13.06 | 1.31 |
| **60** | **23.32** | **11.66** | **1.17** | **85** | **26.25** | **13.12** | **1.31** |
| 61 | 23.43 | 11.71 | 1.17 | 86 | 26.38 | 13.19 | 1.32 |
| 62 | 23.53 | 11.77 | 1.18 | 87 | 26.51 | 13.25 | 1.33 |
| 63 | 23.64 | 11.82 | 1.18 | 88 | 26.64 | 13.32 | 1.33 |
| 64 | 23.75 | 11.87 | 1.19 | 89 | 26.77 | 13.39 | 1.34 |
| **65** | **23.85** | **11.93** | **1.19** | **90** | **26.91** | **13.45** | **1.35** |
| 66 | 23.96 | 11.98 | 1.20 | 91 | 27.04 | 13.52 | 1.35 |
| 67 | 24.07 | 12.04 | 1.20 | 92 | 27.18 | 13.59 | 1.36 |
| 68 | 24.19 | 12.09 | 1.21 | 93 | 27.31 | 13.66 | 1.37 |
| 69 | 24.30 | 12.15 | 1.21 | 94 | 27.45 | 13.72 | 1.37 |
| **70** | **24.41** | **12.21** | **1.22** | **95** | **27.59** | **13.79** | **1.38** |
| 71 | 24.53 | 12.26 | 1.23 | 96 | 27.72 | 13.86 | 1.39 |
| 72 | 24.64 | 12.32 | 1.23 | 97 | 27.86 | 13.93 | 1.39 |
| 73 | 24.76 | 12.38 | 1.24 | 98 | 28.00 | 14.00 | 1.40 |
| 74 | 24.88 | 12.44 | 1.24 | 99 | 28.14 | 14.07 | 1.41 |
| **75** | **25.00** | **12.50** | **1.25** | **100** | **28.28** | **14.14** | **1.41** |

# APPENDIX IV

## SLOPE TABLE 20 / 10 / 1 M, INTERVAL

| Slope % | Horizonatal Distance (m) | | | Slope % | Horizonatal Distance (m) | | |
|---|---|---|---|---|---|---|---|
| | 20.00 | 10.00 | 1.00 | | 20.00 | 10.00 | 1.00 |
| | S. D. | S. D. | S. D. | | S. D. | S. D. | S. D. |
| 101 | 28.43 | 14.21 | 1.42 | 126 | 32.17 | 16.09 | 1.61 |
| 102 | 28.57 | 14.28 | 1.43 | 127 | 32.33 | 16.16 | 1.62 |
| 103 | 28.71 | 14.36 | 1.44 | 128 | 32.49 | 16.24 | 1.62 |
| 104 | 28.86 | 14.43 | 1.44 | 129 | 32.64 | 16.32 | 1.63 |
| 105 | 29.00 | 14.50 | 1.45 | 130 | 32.80 | 16.40 | 1.64 |
| 106 | 29.15 | 14.57 | 1.46 | 131 | 32.96 | 16.48 | 1.65 |
| 107 | 29.29 | 14.65 | 1.46 | 132 | 33.12 | 16.56 | 1.66 |
| 108 | 29.44 | 14.72 | 1.47 | 133 | 33.28 | 16.64 | 1.66 |
| 109 | 29.58 | 14.79 | 1.48 | 134 | 33.44 | 16.72 | 1.67 |
| 110 | 29.73 | 14.87 | 1.49 | 135 | 33.60 | 16.80 | 1.68 |
| 111 | 29.88 | 14.94 | 1.49 | 136 | 33.76 | 16.88 | 1.69 |
| 112 | 30.03 | 15.01 | 1.50 | 137 | 33.92 | 16.96 | 1.70 |
| 113 | 30.18 | 15.09 | 1.51 | 138 | 34.08 | 17.04 | 1.70 |
| 114 | 30.33 | 15.16 | 1.52 | 139 | 34.25 | 17.12 | 1.71 |
| 115 | 30.48 | 15.24 | 1.52 | 140 | 34.41 | 17.20 | 1.72 |
| 116 | 30.63 | 15.32 | 1.53 | 141 | 34.57 | 17.29 | 1.73 |
| 117 | 30.78 | 15.39 | 1.54 | 142 | 34.74 | 17.37 | 1.74 |
| 118 | 30.93 | 15.47 | 1.55 | 143 | 34.90 | 17.45 | 1.74 |
| 119 | 31.09 | 15.54 | 1.55 | 144 | 35.06 | 17.53 | 1.75 |
| 120 | 31.24 | 15.62 | 1.56 | 145 | 35.23 | 17.61 | 1.76 |
| 121 | 31.39 | 15.70 | 1.57 | 146 | 35.39 | 17.70 | 1.77 |
| 122 | 31.55 | 15.77 | 1.58 | 147 | 35.56 | 17.78 | 1.78 |
| 123 | 31.70 | 15.85 | 1.59 | 148 | 35.72 | 17.86 | 1.79 |
| 124 | 31.86 | 15.93 | 1.59 | 149 | 35.89 | 17.94 | 1.79 |
| 125 | 32.02 | 16.01 | 1.60 | 150 | 36.06 | 18.03 | 1.80 |

# APPENDIX V

## CONTOUR DATA SHEET

Block ________ Strip ________ Azimuth ________ Date ________

| Stat. | Azimut (deg.) | Slope Distance | Slope (%) | Vertical Distance | Elevation (m) | Adjusted Elevation |
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| Contour map, river, Direction, etc. | |
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Starting Point : ____________________

Cruiser Name : ____________________

# APPENDIX VI

## Inventory Sheet

Block_______ Strip _______ Azimuth_____________ Date _______

| Tree No. | Spec. Code | Diam. (cm) | Hight (m) | Tree Code | Volume (m3) | X | Y | Comments |
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| Tree Map | |
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Cruiser Name : ______________________

Description : ______________________

The Tropical Forest Foundation

Manggala Wanabakti Build.,
Block IV, 9th Floor, Wing B
Jl. Jend. Gatot Subroto,
Jakarta 10270, Indonesia