# LAND SURVEY FIELD PROCEDURES


**INSTITUTE OF SURVEY TECHNOLOGY OF ONTARIO**

1043 McNicoll Avenue,
SCARBOROUGH, Ontario.
M1W 3W6

# LAND SURVEY FIELD PROCEDURES
# HOW TO USE THIS MANUAL

There are a number of ways you may want to use this self-study guide. One popular method is to read through each lesson carefully. After doing so, answer each of the self-study questions without looking back at the text. Don't worry if you are unable to answer all the questions.

After trying to answer the self-study questions, read back through the text to see what material you may have missed. Continue to read through the remaining lessons.

Once you have read through the entire manual, put it away. The following week, test yourself at random with the self-study questions and see how much you recall.

Most importantly, work at a pace and in a way that you feel comfortable.

**Please Note:**
This document was originally prepared by Wm. G. Mates in May of 1990. It has been updated by ISTO in July 1993 to reflect changes in legislation and to add self-study questions for you to review. The principles of Land Survey Field Procedures remain unchanged.

# LAND SURVEY FIELD PROCEDURES COURSE SYLLABUS

Lesson 1 CARE, USE, CLEANING and MAINTENANCE OF EQUIPMENT

Lesson 2 ACCURACY, PRECISION AND POSITIONAL ACCURACY

Lesson 3 BOUNDARY EVIDENCE

Lesson 4 OFFSETS AND TRAVERSE LINES

Lesson 5 BOUNDARY SURVEYS

Lesson 6 SURVEYOR'S REAL PROPERTY REPORT

Lesson 7 FIELD NOTES

Lesson 8 FIELD CALCULATIONS

Lesson 9 TOPOGRAPHIC SURVEYS

Lesson 10 FIELD REPORTS

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 1

## SCOPE AND INTENT

a. This series is specifically designed to set out performance oriented concepts for support staff working in the field.

b. Each of the chosen subjects address a major concern of the Association of Ontario Land Surveyors.

c. The prime objective is to provide all Land Survey Field Staff an awareness and understanding, of the basic requirements of their profession.

d. The secondary objective is to assist all field personnel to focus on subject material which will provide the background for the examination and classification process of the Institute of Survey Technology of Ontario.

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 2

## SCOPE AND INTENT

1. Care, Use, Cleaning and Maintenance of Equipment.
2. Accuracy, Precision and Positional Accuracy.
3. Boundary Evidence.
4. Offsets and Traverse Lines.
5. Boundary Surveys.
6. Surveyor's Real Property Report.
7. Field Notes.
8. Field Calculations.
9. Topographic Surveys.
10. Field Reports.

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 3

## INTRODUCTION

The purpose is: -

a. To address the concerns of various A.O.L.S. Committees that have expressed concern about the quality of some surveys which have come under their scrutiny, and,

b. To bring to your individual attention some of the various field techniques which generate the low standards of some of the work now being completed, and show you how to change these low standards into very high standards.

In doing this it is hoped that the data you will collect, and the discussions that will take place, will be of great assistance in your quest for classification with the Institute of Survey Technology of Ontario.

It must be realized that an in-depth study of the subjects under discussion is not possible within the time allotted. For this reason it is strongly suggested that recourse be made to the reference material delineated in the hand out material for each subject, and a full discussion of the seminar be held with your supervising O.L.S.

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 1 CARE, USE, CLEANING AND MAINTENANCE OF EQUIPMENT

### Introduction

The field party of today is supplied with and are responsible for a wide range of expensive equipment to enable them to perform their work with speed, efficiency and precision.

The days of throwing all of this into the trunk of any old car to go out into the work place have passed into history.

The modern field party requires a modern vehicle. A van a 4-wheel drive truck depending on the area of operation or a car with a large trunk is recommended, not just to carry all of the equipment and personnel safely which is a paramount issue but also to present the professional image of the members of the Association of Ontario Land Surveyors and their assistants.

### Narrative

The list of equipment that a field survey party requires is both extensive and expensive. All of it must be used with care and discretion. Although all of it is specifically designed and manufactured for field use, it is not "unbreakable", and some of the equipment is rather delicate.

The specifications, limitations, "do's" and "don'ts" for each piece of equipment is listed in the applicable user's guide which must be read, digested and practised. This applies particularly to those instruments we use, which are very easily damaged by unskilled hands and rough usage, and to which a special set of instructions apply:

- When the instrument is not being used, return it to its case.

- NEVER leave an instrument standing by itself.

- NEVER carry the instrument and tripod as a unit over your shoulder and parallel to the ground. Doing so puts far too much strain on the standing axis and can easily lead to problems with the integrity of readings. It is safer and more expedient for very short moves to carry the tripod and instrument as a unit on your shoulder, with the tripod legs pointing downwards. For long moves it is wise to pack the instrument in its carrying case. Where a long move by transport is necessary the instrument should be set in its own carrying case, and kept upright in a padded transport box if available.

  In very cold conditions, when the instrument is in use on a daily basis, it is preferable to avoid heated storage areas during nonworking hours, and store the instrument in a safe and sheltered location at about the outside temperature.

Besides the many instruments we use to measure horizontal and vertical angles, and distances, we must be capable of using all other equipment in the correct manner, always selecting the right piece of equipment for the job at hand.

- A CLOTH TAPE is quite sufficient to locate certain topographic data (and it must be kept clean), but a correctly calibrated STEEL TAPE, with measurements corrected for slope, sag and temperature, must be used for accurate work.

- A HAND LEVEL is of great value for a variety of tasks, and when skilfully used can provide rough elevation checks, however a PRECISE LEVEL must be used for the acquisition and setting out of accurate elevations.

- The PLUMB-BOB, especially a heavy and well made variety is a necessity in daily routine. It must be kept clean, with an adequate point and clean, unknotted string. It is not a substitute hammer for the task of driving nails or creating scratch marks on concrete.

- The AXE, SLEDGE, PICK and SHOVEL are still basic tools which we use on a daily basis and are all designed for specific tasks. With correct care and handling they will last for years. Handles can become loose and repairs must be done correctly, on-the-job if necessary, for them to be of continuing service.

- LEVEL RODS are not designed for pole-vaulting hedges, fences or creeks, and when the markings become faded, or the shoe deteriorates, they must be correctly repaired.

- RANGE POLES must be kept clean, clearly marked and with an adequate point. They should be stowed in a protective case or holder when not in use and checked periodically for plumb. Those mounting a fisheye bubble and/or reflector prism housing must be specially protected, and never left lying loose in the vehicle. They must be calibrated periodically.

- MAGNETIC BAR LOCATORS receive far too much needless abuse when used to prod into snow and heavy undergrowth and, as with any precise instrument, should only be used for what they are intended.

- The PENTAPRISM or Right Angle Prism is an asset when used with skill and should always be replaced in its case when not in use.

This is just a short selection of the equipment in our care which needs careful handling. Other equipment which may be put into use such as a BAROMETER, TAPE THERMOMETER, TENSION HANDLES, etc. all require special care and attention.

It is unfortunate that many of our newer staff are not being trained, let along correctly, in the care, use and handling of this type of equipment, or in the skill and exactness in repairing steel tapes.

**Commentary**

We expect exactness from all of our measuring equipment and often express surprise when it lets us down. Like any other equipment it all requires care and maintenance to keep it in tip top condition.
The best precaution, that you should ensure does take place, to keep all of your equipment in dependable working order, is to do periodic testing and calibration.

Most of the normal tests can be done on the work site without interrupting the flow of work being done. All it takes is a little thinking and an equipment user who is on top of the job.

- After producing a line, read the angles both left and right face.

- When producing a line using the double centring technique any need for instrument adjustment is easily spotted.

- Range poles out of alignment are obvious when viewed through the instrument, as are the correctness of range poles with a fisheye bubble.

- The sum of individual distances along a tangent should always equal the total distance. Whether this measuring is done all by an E.D.M., a steel tape, or a combination of both, any discrepancies should immediately set you to think "Is it a blunder the E.D.M. or the steel tape and the correction(S) applied?"

- Rod readings from two Bench Marks must give you the same Height of Instrument. If not, is it a blunder, the Bench Mark, or the Instrument?

These daily observations, and others like them, will help you have confidence in the equipment, but they are never a substitute for thorough periodic inspection, testing and calibration.

The end of the working day is the time for cleanup and to prepare for the next day. All of your equipment must be cleaned, checked, repaired if necessary and stored ready for immediate use. That also includes the vehicle with its accumulation of tissues, paper towels, McDonald's and Wendy's cartons, empty soft drink bottles and cans, etc. as well as the normal routine of checking tires, oil, lubricants, master cylinder, fuel and windshield washer solution supply.

When the instruments get wet the exterior must be dried with some type of absorbent tissue special lens tissue where applicable and remember the tribrachs and targets while you are at it.

Steel tapes should be cleaned and lightly oiled.

Range poles, level rods, tripods etc. should be cleaned and dried and you can check the shoes, fasteners, threads, clips and their matching screwheads for reliability.
Axes, machetes, etc. should be cleaned, dried and sharpened if necessary and stored in their respective sheaths to retain their edge.
The supply of expendable materials can be replenished at this time.

**Conclusion**

All of the equipment and materials we use must be treated with care and respect, and all of it maintained and ready for immediate use.

We must get into the habit of using the correct equipment for the work required, and get out of the habit of improvising with what is at hand because we are just too lazy to go to the vehicle to get the correct equipment.

Take good care of your equipment, maintain it correctly, and when finished with it, put it back where it belongs.

When material becomes unserviceable it must be replaced immediately.

When equipment requires repair that is beyond your, or your Party Chief's skill, knowledge and ability to correct then your supervisor must be notified.

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. What type of vehicle is best suited for a field crew?

2. Where do you go to find out information about your survey instruments?

3. How should you store your instruments during long moves?

4. Why should you never carry the intrument and tripod over your shoulder or parallel to the ground?

5. How should you store equipment in very cold conditions?

6. A calibrated steel tape must be corrected for _____, _____, and _____.

7. When do you use a precise level over a hand level?

8. Be careful with axes, sledges, picks and shovels because _____, can become loose and repairs must be done correctly.

9. Instruments can often be used safely for purposes other than that which was intended. True?

10. What do you check to ensure range poles are ready for use?

11. How often should you check the calibration of your equipment?

12. What angle(s) do you check after producing a line?

13. Rod readings from two bench marks give you a different height of the instrument. What could be the cause?

14. The total distance should always equal what sum?

15. How do you check if the range poles are out of alignment?

16. Daily observations are not a substitute for periodic inspection and testing. True?

17. What must be done at the end of the day to prepare for the next day?

18. If you, personally, are unable to repair your equipment, what should you do?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 2 ACCURACY, PRECISION AND POSITIONAL ACCURACY

### Introduction

The quality of the measurements made in the field are a combination of the equipment in use and the skill of those operating that equipment.

The degree of precision of any measurement is relative to the natural definition of the objects we are measuring between. The degree of accuracy of any measurement is based upon how close we can get to the true measurement between those objects.

The degree of positional accuracy we can assign to any point is the combination of both accuracy in measurement and the precision of that measurement.

The Survey Industry has defined the minimum standards for the acceptance of various types of survey work and the one that is of most concern to us is that control points in surveys (ie. the monumentation) must have a positional accuracy of 2cm. at the 95% confidence level. This means that the distance actually measured between any two monuments in our survey must not differ by more than 2cm. from the calculated value derived from the actual surveyed limits.

### Narrative

To put ACCURACY and PRECISION into perspective in our daily work, imagine this scenario: -

Two members of the field party are measuring the length of the walls of a recently constructed building and determine that the length of one wall is 44.1 feet.

The cloth tape used is graduated to tenths of a foot so we can only measure to the least count of those graduations. We may guess at how much the length of the all is greater than 44.1 feet as the measurement falls between 44.1 feet and 44.2 feet, but by specifying 44.1 feet we are stating that the actual distance falls between 44.05 feet and 44.14 feet. In other words we are saying the distance is accurate to within 0.1 feet, ie. the degree of precision.

We measure this same wall with a steel tape, the least count marked on the tape being 0.01 feet and determine the length to be 44.12 feet. In this instance we are stating that the actual distance is between 44.115 fet and 44.124 feet, so that the real accuracy is within 0.01 feet, ie. the degree of precision.

In this scenario you can notice that by using more accurate tools or methods we are capable of achieving a greater precision.

PRECISION is the fineness of the measurement and ACCURACY is the correctness of the measurement.

**Commentary**

In the conduct of surveys it is mandatory that the lines used to establish the basic survey fabric form a closed figure so that we can prove that the positional accuracy of the traverse or boundary points fall within the required standard. This method also provides a safeguard to ensure there are no gross errors, blunders, or mistakes such as may be created by the transposition of figures; and that the work itself does indeed meet or exceed the required standard.

Such a field closure must result in an accuracy of one part in 14,000 parts, and with present day equipment we should easily exceed one part in 20,000 parts, irrespective of the size of the area covered by the survey.

This degree of precision may not present a true picture of the accuracy of the survey. If our equipment is not in true calibration we may still get a good field closure but our accuracy as shown on the Plan of Survey may be error.

One concern which occurs constantly in field notes is the method we use to tie other data into the survey traverse.

We have a field closure where all distances are measured in both metric and imperial, all angles are measured twice on both sides of the lines. We obtain

a good angular closure, a great field closure, and minor discrepancies are dealt with by a least squares adjustment. Yet, with all of this superb effort we usually find that the monumentation found and set from this wonderful traverse are shown by one angle and one distance. These are the actual monuments we give credence to and which are supposed to be accurate to within 2cm. in positional accuracy.

When we have the survey fabric, and all of the monuments fixed accurately, we may need to tie in specific physical features to meet the requirements. It is in this category of our client's work where we must use judgement in the equipment to be used and the degree of accuracy and precision necessary to provide this data. Physical features are of two types for our purposes, natural and man-made, and there is little point in measuring to such features with an accuracy greater than their natural
definition. Showing a distance to the nearest millimetre when measuring to the edge of a swamp or the brow of a hill is unnecessary.

We can rationalize specific tolerances for various features of their natural definition, such as: -

| | |
|---|---|
| BUILDING CORNERS and MONUMENTS | to within 1 cm. |
| EDGES OF CURBS, SIDEWALKS and WIRE FENCES | to within 2cm. |
| UTILITY POLES | to within 5cm. |
| TREES | to within 7cm. |
| LIMITS OF CULTIVATION | to within 20cm. |

In doing this calibre of measurement we must be perfectly sure that we measure to the correct definition of the feature. The judged centre of a monument and the sharp corner of a building are quite well defined. So are curbs and sidewalks. Utility poles and trees are a little more difficult as we must judge their centre at right angles to the line of sight from the defined survey point.

Another type of work we are required to accomplish is the request from certain utilities to provide a plot of an area to show all topographic details with no distances shown. If the plot is to be at a scale of 1:1000 we realize that the plotting accuracy is no greater than the representation on the plan of 0.5 metre, which means that there is little point of tying in data any closer than 0.1 metre.

At the other end of the spectrum may be the requirement to set base lines inside a manufacturing plan which intends to use robotics and have set the standards along a 1000 metre line for all distances to be accurate to within 1mm.

In examining the various requests from clients we must be capable of knowing the correct survey techniques to use in order to get the correct answers, and the equipment necessary to provide those answers.

## Conclusion

The survey industry is one area of our economic existence that demands perfection in all of our endeavours, in all types of weather and under all types of conditions.

We must be ACCURATE in the performance of our duties and be capable of producing the PRECISION required by our many and diverse clients.

Knowing the probability of error that can occur in the measurements we make is the first step.

Understanding that one angle and one distance does not ensure positional accuracy is the second step.

Putting these together in all we do can guarantee success.

## ADDITIONAL READING


| | | | |
|---|---|---|---|
| 1. | Surveying<br>Appendix 1 | Kavanagh and Bird | Prentice Hall |
| 2. | Urban Surveying and Mapping | Blachut, Chrzanowski and Saastomoinen | Springer Verlag |
| | -Chapters 3, 4 & 5 | | |

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. The quality of measurements made in the field are a combination of what two things?

2. What is the difference between accuracy and precision?

3. What is positional accuracy?

4. What does closure prove (with respect to positional accuracy)?

5 What does closure safeguard against?

6. If your equipment is not properly calibrated, you may get (accuracy, precision, closure) but your (accuracy, precision, closure) may be in error.

7. What would be the natural tolerance for utility poles?

8. Why is it necessary to measure all angles, twice, on both sides of the line?

9. You determine the length to be 67.243 metres. You know the real accuracy to be within 0.01 metres. How long could the distance actually be?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 3 BOUNDARY EVIDENCE

### Introduction

One of the many problems facing the field party is the location, evaluation and determination of evidence to be used for the re-establishment of boundaries of land holdings.

It is quite logical to realize that the field notes of the survey must show clearly exactly what was found and used as the evidence to substantiate the location of a boundary, as well as other evidence in the area which was found but not used, with an explanation for both.

This data that we record in the field is transcribed to create the Plan of Survey, and we must ensure that ALL of the boundaries of the survey are substantiated by either physical or documentary evidence, with a clear and rational explanation of the how and why certain data was used and other data rejected.

To this end we must understand what is meant by the terms "BOUNDARY" and "EVIDENCE", so we can set the boundaries as nearly as possible to the location where they were originally established.

### Narrative

Boundaries of land, that is to say, the limit between parcels of land, can be created by different means.

FIRST, by the acts of abutting owners erecting a fence or creating some known line of demarcation;

SECOND, by statute - such as the Expropriation Act;

THIRD, by legal presumption based on Court decisions.

In the retracement of these original boundaries we are required to use the best evidence available to re-create and substantiate the original location, and EVIDENCE as far as we are concerned falls into three distinct categories: -

Documentary Evidence, such as original field notes and plans, written documents such as the Land Registry Office deeds and conveyances,and

Physical Evidence which is that found on the ground by the intelligent use of the Documentary Evidence.

Historical Evidence which is obtained by talking to people and finding out how and when the physical evidence came into being and how it relates to documentary evidence.

When evaluating evidence, we must remember two valuable statements: -

1. The description of registered land is not conclusive as to the boundaries or extent of land. RSO 1980, c230 & 141

2. It is by the work executed on the ground, not as projected before execution or represented on the Plan afterwards, that the actual boundaries are created. McGregor v. Calcutt (1868).

One of the areas giving most concern is this aspect of using the Documentary data to find the Physical Evidence to substantiate the correctness of our work.

First, we must have all of the documentary data available to us, and second, should the evidence we are looking for be missing, we must prove that is missing. Which is a far cry from saying we just did not find it.

In our assessment of the Evidence we must adhere to the priority as set out in law.

FIRST, we give priority to Natural Boundaries.

SECOND, original monuments that can be proven to be in their original location and undisturbed.[1]

---

[1] Editor's Note: The Survey Review Department views the issue differently. They argue that it is necessary to prove that it is not the original monument. "...(T)he idea that it is necessary to prove that it marks the corner before it can be accepted is a faulty application of the burden of proof principle...." (see Ontario Land Surveyor, Spring 1993, p.11)

THIRD, any evidence on the ground which can substantiate the original location.

FOURTH, when all else fails we can resort to the information contained in the documentary data, ie. the measurements.

When we compare the title records with what we find on the ground it is inevitable that there will be discrepancies. It is the skill, knowledge and capability of the surveyor who will analyze the information and provide a professional opinion about the location of the boundary

**Commentary**

Where we are required to survey up to the middle of a river it is never sufficient to survey to the centre line only. Attention must be given to the top and the bottom of the bank, the actual edge of the water at the date of the first conveyance and at the date of your survey, the apparent "tide-mark" of the water, and the direction of the flow. There are many reasons for acquiring this data, and a complete discussion is beyond the scope of this short discussion.

M.N.R. has jurisdiction over Navigable Waters, but it is the purview of the Courts to determine what is navigable.

Conservation Authorities get most upset if your client intends to set buildings below their floodline. They also get upset at the idea of removing or adding to the present physical status of the land.

The extent of the original conveyance may be limited by the waters edge at the date of the original field notes or the date of the patent. So, the prudent approach may be to show everything on the plan and discuss the legal status later. After all, it is rather difficult to argue about the status of certain areas until we have a Plan of Survey showing where everything is actually located.

The definition of "original monument" can be said to be any object used to set and define the first location of the corner or limit of a parcel of land. Such "monuments" have included stone and marble blocks, car axles, tire irons, gas pipes, wood posts, pottery and even steel bars. In our search for these "originals" we must not only use the Documentary Data, but also pay close attention to the words and directions of local owners who may have knowledge of their location. When we find these "originals" or some evidence of where they were, we must also secure sufficient information to substantiate the original, or evidence of it, by measurements to other data of known reliability. Even agreement between adjacent owners as to the location of a corner or line

must be taken into consideration, although this may disagree with documentary data.

Where original monumentation is indeed lost then recourse to other evidence must be made to establish the original location and the direction of the first running of a boundary from it. Fences are a good indication of what was originally intended to delineate a boundary, but the onus is on the surveyor to find out from local sources who erected the fence, when was it erected, why was it erected where it is, and have the abutting owners always acquiesced to its location by actions on the ground.

In the downtown area where buildings have stood for many years it is not unreasonable to suggest that individual owners do have title to the outside face of the wall of the building, or to the centre line of a party wall, irrespective of what the deed stipulates by its directions and measurements.

The same is true for a farm holding which has been fenced for many years.

Where there is absolutely no evidence available, such as an open field, then we can fall back on our last resort of using deed distances and bearings to establish the limits of the survey. Although, even in this case we must be careful to ensure we establish the priority of title of the deeds in the documentary record before attempting to establish the boundaries on the ground.

**Conclusion**

The search for, and discovery of, evidence is the major part of any survey. When found and used intelligently it becomes the basic framework for the actual survey to be done. The surveyor can only uncover the original work by diligent use of spade, pick axe or shovel, and by sharp and enquiring mind and eye. Modern day construction techniques, the lack of supervisory control of construction personnel, the hesitancy of individual O.L.S. to enlighten all non-survey workers respecting Sections 442 and 443 of the Criminal Code of Canada (see AOLS bulletin, appended), all conspire to ensure that the monuments we so carefully set will be disturbed or demolished.

Modern farming techniques in many areas have already eradicated hundreds of old and well established lot lines and property fences, and to a great degree are destroying the original survey fabric.

We are called upon to perform accurate surveys in less and less time as the social and economic crunch of today's world demands instantaneous results.

In all of this we must be the steadying influence, and ensure our work in the establishment and re-establishment of boundaries is clear, accurate and unambiguous.

In doing our work so that the courts can easily follow our steps and come to the same conclusions, we must make every effort to determine all the available evidence, give most weight to those things about which men are less likely to err, and determine the corner or boundary according to the best available evidence.

**ADDITIONAL READING**


The Survey and the Real Estate Transaction — N.L. Petzold, O.L.S.

The Concept of Boundaries — R. Stewart, O.L.S.

Boundaries and Surveys — Lambden and deRijcke, O.L.S.

Survey Law in Canada

Chapters 4, Boundaries

7, Evidence

8, Settlement of Boundary Uncertainties.

A.O.L.S. Bulletin

# N O T I C E

Please note that the Criminal Code, as amended to January 1, 1987, reads:

**Interfering with boundary lines.**

now 442 398. Every one who wilfully pulls down, defaces, alters or removes anything planted or set up as the boundary line or part of the boundary line of land is guilty of an offence punishable on summary conviction. 1953-54, c. 51, s. 383.

**Interfering with international boundary marks, etc. - Saving provision.**

now 443 399. (1) Every one who wilfully pulls down, defaces, alters or removes

(a) a boundary mark lawfully placed to mark an international, provincial, county or municpal boundary, or

(b) a boundary mark lawfully placed by a land surveyor to mark a limit, boundary or angle of a concession, range, lot or parcel of land,

is guilty of an indictable offence and is liable to imprisonment for five years.

**(2) A land surveyor does not commit an offence under subsection (a) where, in his operation as a land surveyor,**

(a) he takes up, when necessary, a boundary mark mentioned in paragraph (1)(b) and carefully replaces it as it was before he took it up, or

(b) he takes up a boundary mark mentioned in paragraph (1)(b) in the course of surveying for a highway or other work that, when completed, will make it impossible or impracticable for such boundary mark to occupy its original position, and he establishes a permanent record of the original position sufficient to permit such position to be ascertained. 1953-54, c.51, s.384; 1960-61 c.43, s.11.

April 7, 1987

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. List three ways in which boundaries can be created.

2. How do field notes assist us in determining boundary locations?

3. All boundaries of the survey must be substantiated by one of two types of evidence. What are they?

4. What is the hierarchy of evidence?

5. "The description of registered land (is/is not) conclusive as to the boundaries or extent of land."

6. Of the work done on the ground and the Plan of Survey, which has greater importance?

7. If you cannot find documentary evidence, what must you prove?

8. In addition to surveying the centre-line of a river, what six other physical features must you be aware of?

9. Who has jurisdiction over navigable waters? Who determines what is navigable?

10. What is the definition of "original monuments"?

11. How does a monument become an "original" monument?

12. If you are unable to find an original monument, what might be a good recourse?

13. List five things you should know about a fence before accepting it as a boundary.

14. If you must resort to using deed distances and bearings, what must you first establish?

15. When is it satisfactory to disturb monuments? Who may do it?

16. It is always necessary to plant new monuments, if the original monuments were planted in the wrong location. True?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 4 OFFSETS AND TRAVERSE LINES

The survey plan produced from your field notes will show the limits of the parcel surveyed by bearings and distances. Other data shown on the plan, such as a tie to the lot angle, the location of the monuments defining the bearing reference, etc., are all shown as if they were all measured along true limits of Road Allowances, etc. In the field it is generally very difficult to occupy these true limits (although we should do our best to do so) because of trees, street hardware, buildings and the like.

When it is impossible to actually occupy the true limits we resort to the use of offset lines parallel to the true limits. These are used to create a mathematical figure which is either larger or smaller than the configuration of the actual parcel being surveyed.

When the use of parallel offsets is prevented by physical obstacles we can revert to traverse lines which create a closed mathematical figure with the actual corners of the survey being a series of points on the traverse, or tied into the traverse points by angle(s) and distance(s).

In these systems of parallel offset lines and traverse lines the dimensioning of the true limits results from a quantity calculation, and as with any work, is liable to error. It is obvious that a direct measurement between any two monuments will likely be relied upon more than a calculated one, and when that measurement is taken in both metric and imperial units it gives little chance for error.

### Narrative

In densely built-up areas we must take special care how parallel offset points are set as distances between points are in general quite short and the requirement to set points at 90 degrees from monuments becomes more critical. Setting an offset point at 33 feet from a monument and being only 0.8 feet from being at 90 degrees to the boundary results in an angular displacement in a 100 feet sight of 20 seconds of arc. The method to use for

absolute precision is to set preliminary points at the ends of the offset line from the monuments, read the angle into the monument and the displacement from the 90 degree angle as a check and re-set the point accordingly. This takes time we can ill afford, except for very precise work, and skilled use of a pentaprism will set the alignment very close to what we require, although it is still necessary to read the angle into the monument as a check.

In selecting the distance to use for a parallel offset line it is preferable that all the offsets used around the parcel be the same and at an even distance of 5 feet or 2 metres, or multiples of these, as it make calculations much easier, and also easier for other personnel who may be checking the work at a later date to verify its integrity and correctness.

It is not always possible to perfect this approach, but it should be noted that the use of 9.05 feet or 2.762 metres for offset lines do nothing but create opportunities for errors to creep into the survey data.

When we are satisfied that the offset lines are correctly set in place we can intersect these lines, measure all the distances between the intersection points, read all the angles at these intersecting points and provide a field closure to ensure the accuracy of the work meets the required minimum standards.

It is from these offset lines, creating the closed mathematical figure, that we set new monumentation or locate physical features on and around the parcel of land being surveyed. The parallel offset makes it quite simple to verify the correctness of all locations.

Although we are discussing offset lines and traverse lines you should be fully capable of using the many and varied methods available to locate physical plant, such as: -

1. Location by distances from two known points.

2. Location by angles from two known points.

3. The extension method.

4. The orthogonal method.

5. Angle and distance from two points.

6. The polar method.

7. Angle and distance from one point only.

Knowledge of these simple procedures, and understanding the errors that may accrue to each, will help in the selection of field methods to use in any given circumstance.

Where occupation of the true limits and the use of parallel offset lines are denied us we can drop down to one other simple procedure - that of the use of traverse lines. Such lines are arbitrarily set to locate the evidence necessary to substantiate the validity of the survey, and from which we can calculate and set new monumentation and locate any necessary topographic detail. In a traverse circuit we begin at Point A and end at Point A and thus by creating a closure of the field traverse, determine the precision of the measurements.

In an open-ended traverse, that is a line, or a series of lines in a continuous path that bends at specific points and ends at a location distant from a verifiable survey point, we require the use of specific measures to guarantee a reasonable positional accuracy of the end point of the traverse. All angles at the bends set on the traverse must be read twice on both sides of the traverse lines, all distances must be measured in both metric and imperial units, great care must be taken in setting backsights and foresights, and in setting up the instrument.

When you consider the accuracy of most instruments (direct reading to 6 seconds), E.M.I (5mm plus or minus 5 p.p.m), the frailty of the human eye in perfecting the sight picture, then we may have an error of up to 0.5 feet in 1000 feet, if we have stations about 200 feet apart.

General survey procedures, error distribution analysis and care in the setting of sights will normally reduce this error by half, but it is still significant.

**Commentary**

The understanding of sources of error, and care in making sure all personnel follow correct procedures can go a long way to obviate blunders and outright mistakes.

In selecting the survey method to use, personnel must set the survey lines which will give the most accurate answers.

As we have discussed, occupation of the true limits is the first preference; parallel offset lines correctly set are mostly used in open lands; traverse lines are least preferred.

Those in our profession who utilize the sophistication of "Total Stations" and enhanced computer work stations will argue that the additional calculations, accrued in the use of traverse lines, offsets the time spent in using parallel offsets. However, why do these calculations in the first place if they can be easily dispensed with using a simple offset line, and, more important, what procedures are in place in the use of Total Stations which will guarantee positional accuracy?

**Conclusion**

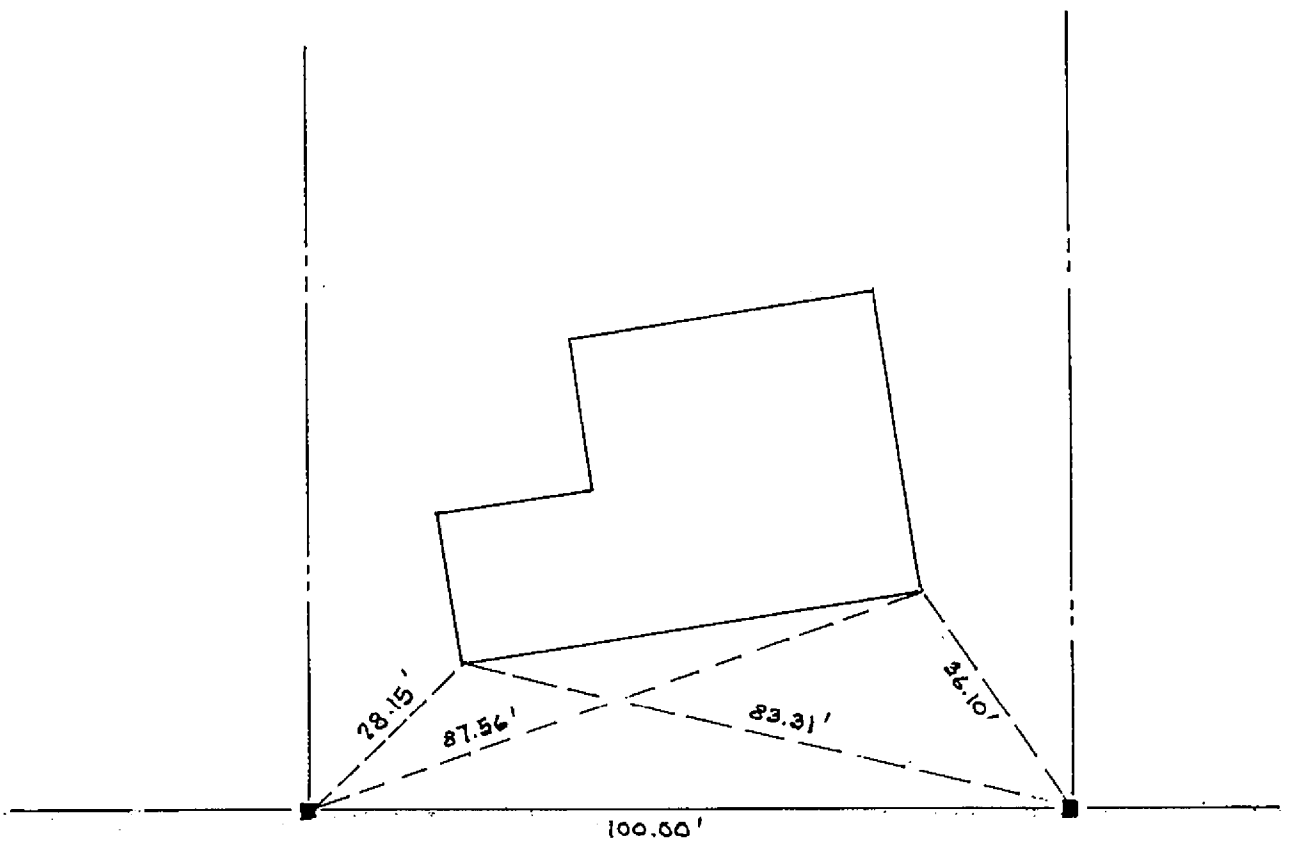
The initial work of locating useable evidence and the setting of the survey fabric to complete the work required takes up the most time in any survey. However, it must be carefully done to ensure all the other work dependent upon it is also correct.

**ADDITIONAL READING**

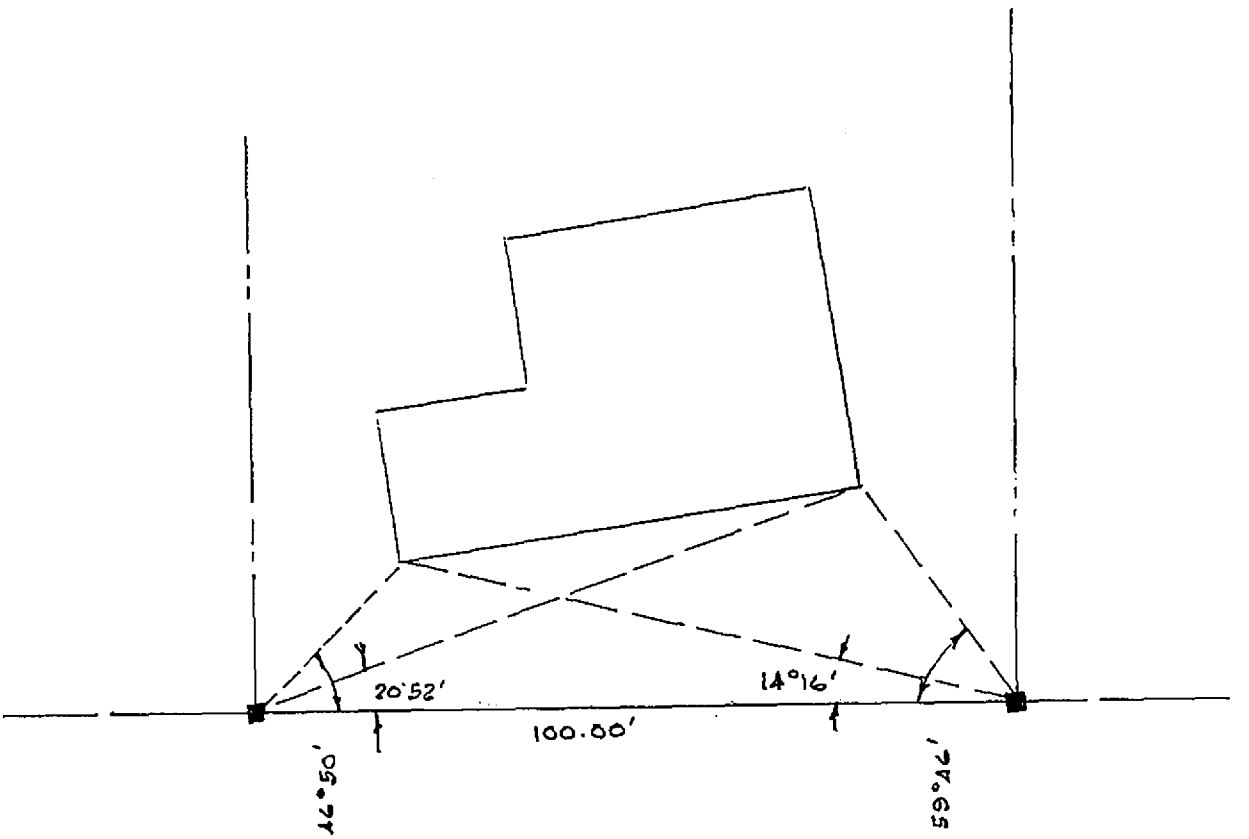
URBAN SURVEYING AND MAPPING — Blachut, Chrzanowski and Saastomoinen.

Chapters 5 and 7

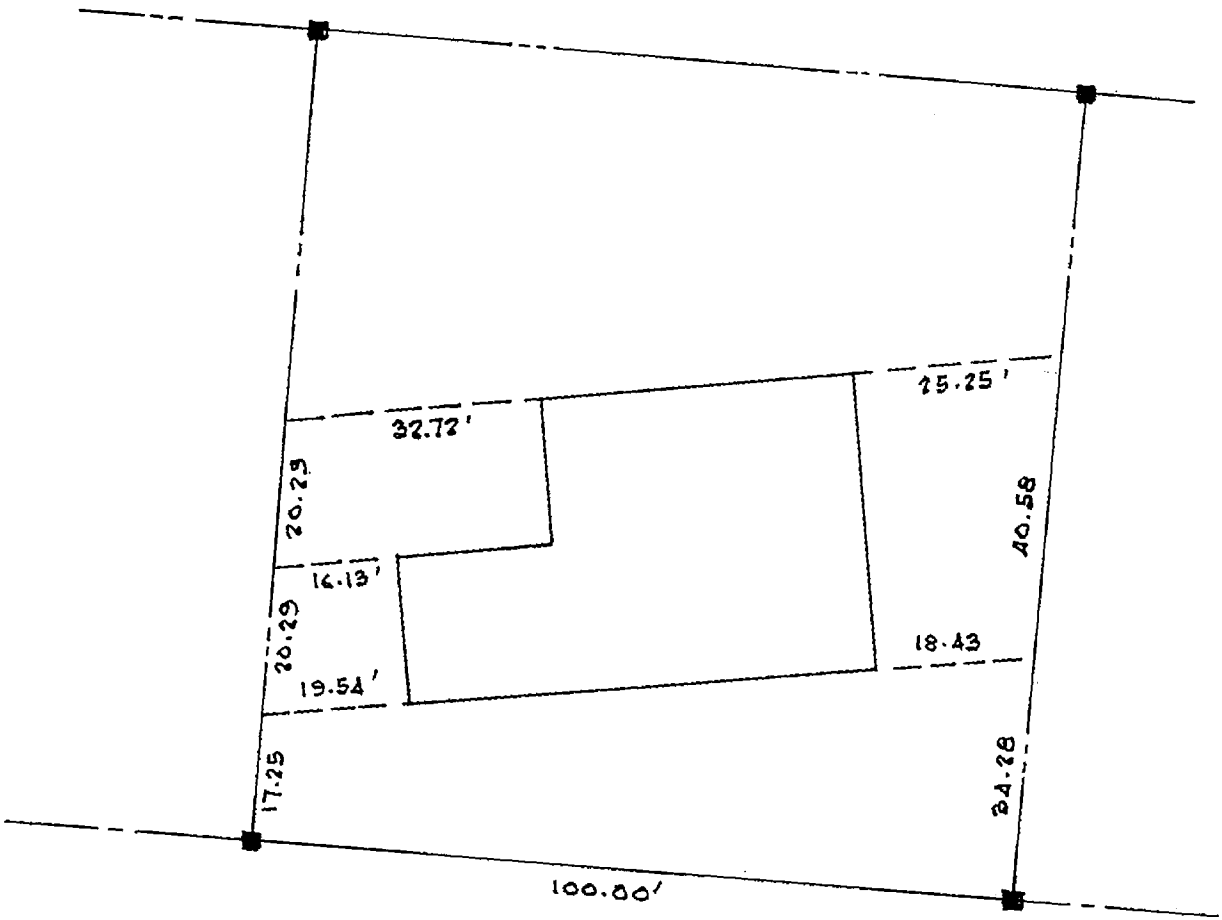
① LOCATION BY DISTANCES FROM TWO KNOWN POINTS.



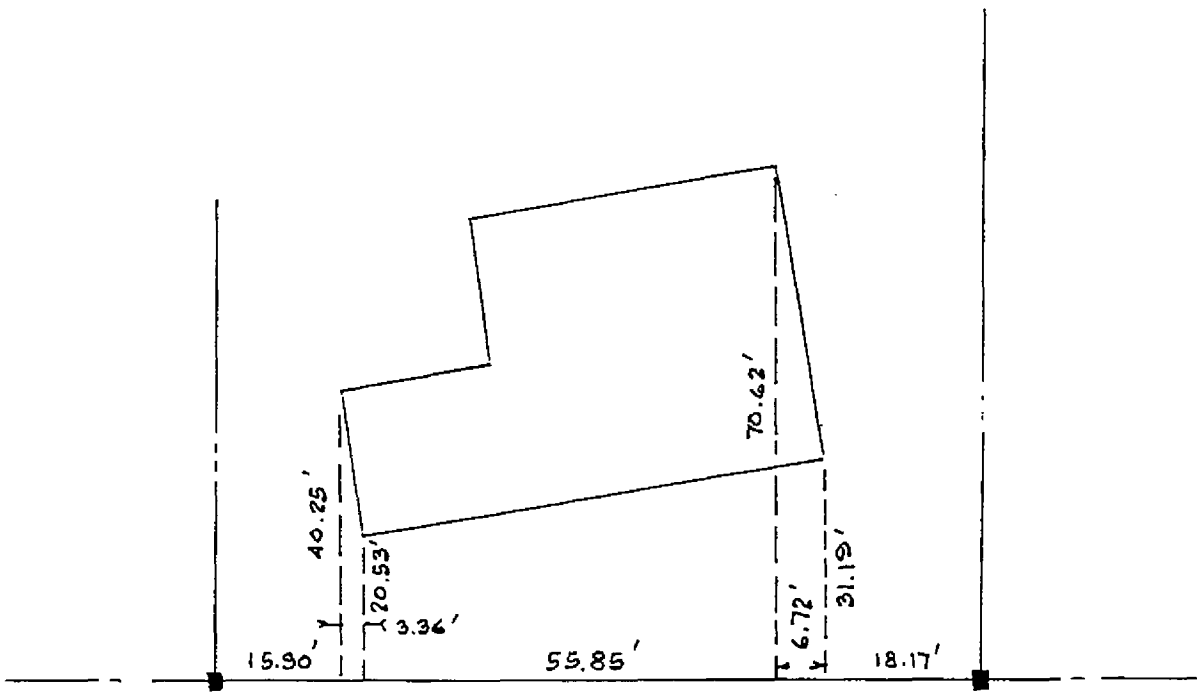
② LOCATION BY ANGLES FROM TWO KNOWN POINTS.



## ③ THE EXTENSION METHOD



## ① THE ORTHOGONAL METHOD



## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. List four reasons why it is difficult to occupy the true limits.

2. What do you use when it is impossible to occupy the true limits?

3. What method can you use when you are unable to use parallel offsets?

4. What does a traverse line give you?

5. Why would you prefer to occupy the true limits?

6. Why must you be careful how parallel offset points are set in densely built-up areas?

7. What method do you use for absolute precision?

8. How should the parallel offset line be set? Why?

9. In addition to offset lines and traverse lines, list six additional methods to locate physical plant.

10. What is an open-ended traverse?

11. How do you guarantee positional accuracy at the end point of the traverse?

12. What is a p.p.m? Why is it important in setting traverse and other types of lines?

13. What procedures do you have in place to guarantee positional accuracy with a Total Station?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 5 BOUNDARY SURVEYS

### Introduction

"A survey is a survey is a survey, and anyone believing otherwise is a simpleton and a fool." - so said a learned gentleman of our profession many years ago.

What he was referring to was the undeniable fact that any survey must always follow specific rules and methods, abide by all the Statutes and agree with the A.O.L.S. Standards, whether the survey is done for First Application under the Land Titles Act, a Reference Plan under the Registry Act, or a Surveyor's Real Property Report.

When a survey of specific lands is authorized by any client having an interest in those lands, the surveyor's duties and responsibilities are quite clear. All boundaries of the lands under review must be surveyed and monumented.

Reference to one bar surveys, or "only the front corners must be set", is an out-right evasion of the surveyor's responsibility to the public who use the plans for many reasons which are beyond the surveyor's control, and have created many problems. The same can be said of anyone who follows the client's instructions to "lay out the deed", or "just send a fellow out this morning to give me a line to build my fence".

We always must be fully aware that any corner or line set by a surveyor is looked upon by the courts as having been set correctly, with all the care and diligence expected of one who is a professional, and therefore skilled and knowledgeable in the matters of what he professes to be.

Any survey we do must have full documentation that must include: -

1. What was ordered by the client, and, what additional instructions provided by the O.L.S. are required to accomplish the work in such a way that it will meet the client's needs.

2. Title and survey history pertaining to each boundary.

3. The evidence used to establish or re-establish each boundary.

4. The reasons for accepting or disregarding prior survey evidence relating to each boundary.

This documentation is not as onerous as it sounds.

The authorization to do the work is approved by the O.L.S. and in most cases written out on the Project File envelope or set out in a Contract, the O.L.S.'s instructions are probably verbal and your field notes will reflect those instructions; the L.R.O. search and other documentary data will be included in the Project File envelope; the evidence used for the survey will be reflected in your field notes and in your Report of Survey.

**Narrative**

Once we arrive at the survey site there ate two items to solve prior to any other work: -

1. Setting the limit of the road to establish a solid base for the remainder of the work, and,

2. Determining the bearing reference.

From that stage on we must determine what information is available on the ground, using the documentary data as a guide, to establish all the other boundaries necessary to complete the work.

When we are satisfied as to what evidence is to be used, and what evidence is to be rejected, we can begin the technical part of the work of setting offset or traverse lines and the measuring of angles and distances. Sufficient checks must be made to ensure all of the measurements are as accurate as we can make them, and that all monumentation complies with O.Reg 525/91 (monumentation regulation).

We must ensure that all easements and rights-of-way are located, (and monumented where required) and all overhead utility wires are tied into our survey fabric.

Key points of the survey should be referenced so that in the event they are destroyed the re-monumentation is easily effected.

**Commentary**

In establishing the limit of a road on the front of a parcel to be surveyed we must realize that the line between two township lot corners, or the line between two SIB's in a subdivision, are not necessarily the real road limit, not unless they are substantiated by measurements to other points of known accuracy. In the township we must take care to ensure the road fences, and/or the travelled roadbed, across the township lot fall within the required right-of-way width we have established. If not, we must reason why not, and decide if bends should take place at specific locations.

In a subdivision the finding of monuments at the terminal points of a long tangent do not necessarily establish the true street line, not unless each one is proved to be in its original location by reference to other monumentation. And do not expect the intermediate monuments to be exactly on the street line nor measure between individual sets of monuments to give the exact distance. There are many factors in this problem which can include soil conditions, construction methods, and the fact that they were not accurately placed in the original work. The use of Radial Stake-out by a "Total Station" in new plans of subdivision may not be as accurate as theory (and survey instrument salespeople) have led us to believe.

Although the courts have stated that any monument set by a surveyor which becomes public knowledge, ie. on a plan of record, mentioned in a registered document, or accepted by use by owners, is the true corner whether it be correctly set or not, we must view certain small discrepancies with a jaundiced eye. Should you find monuments on a street line between two proven SIB's to be up to 0.1 foot off line, and vary in linear distance up to 0.1 foot from plan distance then a considered opinion is that human error is the cause.

The surveying of sidelines and rear limits of parcels of land may be the result of accepting well established limits such as fences of long standing, walls of buildings, tree lines planted for that express purpose, etc., but always provided we can obtain proof for their being where they are located.[2] In the acceptance of such lines it is never sufficient to join from corner post to corner post in a straight line without adequate proof to indicate there are no bends or jogs.

---

[2] See previous footnote.

The same hold true in the surveying of buildings downtown. Sufficient ties must be made for both lateral and horizontal shift in walls from front to rear of the building. This can mean entry into adjacent buildings must be done to locate walls correctly.

When surveying in all types of subdivisions, (but especially the older subdivisions where no monumentation was set at lot corners,) and there is no evidence to prove the location of the rear limit of a lot, it is then necessary to establish adjacent streets and other lines to determine where the rear limit should be monumented.

In Condominium Surveys it is a wise move to liaise with both developer and solicitor respecting the actual limits of the unit(s) prior to field measurement and design the work accordingly.

**Conclusion**

One requirement of any field work is that the site of the survey should be left as you found it, which means removing all offset and traverse point nails, filling in all holes and the replacement of turf, as well as leaving a business card with a note explaining who it was that ruined the bed of prize petunias.

The other requirement is that when you turn your back on that survey you are positive that no one ever can prove your every measurement was incorrect.

**ADDITIONAL READING**

1.Survey Law in Canada C.C.L.S.

Chapters 4 and 8

2.Boundaries A.O.L.S.

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. (Why would you/Why would you not) conduct a "one-bar" survey?

2. What does a court assume about how a monument was set?

3. What documentation must be included in a survey? (4 items)

4. What two matters must be solved prior to arriving on a survey site?

5. All monumentation must comply with what authority?

6. In addition to things such as easements and rights-of-way, what other physical matters should be tied in?

7. How do you ensure re-monumentation is made easier?

8. The line between two township lot corners is not necessarily the true road limit. True?

9. Why is it not sufficient to draw a straight line from rear corner to rear corner? What do you do in such circumstances?

10. What should you do if there is no evidence to prove the location of a rear limit of a lot?

11. Upon finishing the field work, how do you leave the site?

12. What gives you permission to enter the site in the first place?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 6 THE SURVEYOR'S REAL PROPERTY REPORT

### Introduction

The Surveyor's Real Property Report is the up-dated name for what most of us recognize as the Building Location Survey. It still is a "limited use" plan in that the "topographic data", i.e. the man-made physical features, shown on the plan can only be accepted as correct up to the time and date of the field work. Changes to the "Topographic data" can, and do, occur at very short notice after the field party leaves the site.

The Surveyor's Real Property Report plan can be amended by the surveyor to produce sketches for such uses as:[3] -

- Building Permit Application
- Zoning Change
- Severance Application
- Site Plan, etc.

Its prime purpose is to provide data certified by an O.L.S. for the benefit of lending institutions in mortgage transactions and will show all the man-made improvements pertinent to a specific parcel of land. It will also indicate all rights, title and interest in the land.

The lending institutions require to know if the land they are dealing with has a marketable title.

---

[3] See appended AOLS bulletin on Sketches for the types of plans that must be called a "sketch."

The solicitors involved in the transaction must know the extent of the property and whether the structures thereof conform to the Restricted Area Zoning By-Laws, the location and dimensions of easements, rights-of-way, (including overhead utility wires) to be able to certify title to the property.

The owner may need to know how much space is available to construct improvements to his holdings and the exact location of all corners for fencing purposes.

In many cases there is a requirement for the O.L.S. to certify the extent of coverage of the parcel by the buildings situate on the parcel as well as the height of buildings and fences.

From this brief overview it can easily be realized that the Surveyor's Real Property Report must begin with a complete Boundary Survey and that the field staff must keep their eyes open all of the time.

**Narrative**

In the selection of field methods to use in locating the required survey data, we must be conscious of what the end result must be and how the drafting must be done, and then select the most efficient method to satisfy those problems. It may be advantageous to establish more than one parallel offset line from an established boundary due to the location of, and the density of, buildings, fences, hedges, trees etc.. The main feature we should always bear in mind is that the plan must show right angle distances from all features to the boundary.

The most accurate method is to set points on the boundaries of the parcel at right angles to the features to be located and measure the direct distance. When this method is not possible we can use the same method from a parallel offset line.

Using this system all ties are easily plotted by the drafting staff, and with measurements of the dimensions of the features to be shown, plus ties from other boundaries, the accuracy of the work is easily checked.

Where these two options are denied us we revert to the use of angle and distance to a specific corner or feature from two known points in the basic survey fabric. This system involves calculations by the office staff to determine the actual ties to be shown on the plan.

Where a building or other structure must be shown and the minimum distance is to the arc of a circle, it is then mandatory to determine the angle and distance, from two known points in the survey fabric, to enable the calculation to be done to join the feature to the centre of the circle.

In many Municipalities it is also a requirement that the rear yard distance be shown on the plan to ensure conformity with the By-Law, and it is preferable to measure this distance directly.

**Commentary**

The location of physical structures must be done in such a manner as to guarantee their positional accuracy.

To satisfy the requirement of the Zoning By-Law we must measure from the most outer face of any structure to the limit of the parcel and at right angles thereto.

However, where the outer face of the structure is some type of siding, (brick, stucco, asbestos, cedar shingle, aluminum etc.) which might be replaced or surfaced over by successive owners, and as the necessity will arise to use the front, side and rear ties to re-establish certain limits from the survey data you record, it is a wise precaution to also measure to the actual foundation, which rarely changes over the years. An alternative is to note how far the siding overhangs the foundation.

To check the validity of the actual dimensions of structures (and to provide the area of them when required) it is necessary to measure all outside dimensions and then perform the basic field check to ensure the total distance of the front of the structure agrees with the back and that the side distances of the structure are also in agreement.

To ensure the positional accuracy of any corner of a structure it really is a necessity to measure to that corner from two points on your survey fabric that have been checked as to their position.

When measuring to fences we can only be as accurate as their natural definition. The estimated centre line of a snake rail fence will be much less accurate than the measurement to the face of a steel or wood post on which the wire fencing is attached.

Problems can arise in the definition of Car-Ports, and if enclosed by some type of sheathing they can be treated as part of the main building.

As with the siding which overhangs the foundation, it is a wise move to indicate all roof overhangs and upper storey projections.

Naming the various structures, and parts thereof, on our plans has brought rather snide remarks from architects and engineers. If you cannot tell a porch from a veranda, a stoop from an atrium, or a maple from a beech, then starting right now you had better ask your O.L.S. for the correct answers, and please do not call all trees "Tree" - specify what type and what size.

Brick buildings are rare compared to Brick Sided buildings, and the term "Wood Shed" leaves us all in doubt.

House numbers, or municipal street addresses must be noted when available, and if the building houses more than one unit then indicate the number applicable on the appropriate door location in your field notes.

**Conclusion**

The essential factor in the production of a Surveyor's Real Property Report is to complete the Plan of Survey and then to superimpose on it all the required topographic data that would be seen from a birds-eye view, naming all the features correctly.

**ADDITIONAL READING**


| | |
|---|---|
| Standards for Surveys | O.L.S. Manual |
| Guidelines for Surveys | O.L.S. Manual |
| The Survey and the Real Estate Transaction | L. Petzold, O.L.S. |

A.O.L.S. Bulletin

# SKETCHES

**REMINDER**

Please note the following section from the Standards for Surveys.

Part D, S.8

> "Other plans prepared for retail leases, land severance applications, accidents, and similar purposes and not prepared in accordance with these Standards, must be entitled using the word 'Sketch'."

The Association has had brought to its attention, through the Comprehensive Reviews and through insurance and complaints procedures, several instances in the last year of "Plans of Survey" that should in fact have been entitled 'Sketches'. This has, in several instances, left the surveyor liable as the plan was construed as reflecting a survey.

DOCUMENTS THAT ARE NOT "SURVEYS", MUST NOT HAVE THE APPEARANCE OF A PLAN OF SURVEY and it must be very clear on the face of the document that it is not a plan of survey.

The Guidelines for Sketches, Part B of the Guidelines for Surveys, should be followed when preparing this type of document.

Please ensure that your drafting personnel are familiar with these Guidelines.

L. Petzold, O.L.S.
Executive Director

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. What is meant by the term, "limited-use plan"?

2. An S.R.P.R. is accepted as correct for what period of time?

3. An S.R.P.R. can be amended to produce what kind of sketches?

4. If an S.R.P.R. is amended to produce a sketch, what must be clearly understood on the document?

5. Who uses an S.R.P.R? Why do they use it?

6. In many cases, the O.L.S. will be required to certify _____ and _____.

7. How do you determine what field method to use?

8. What methods could you use?

9 Why would you show the rear year distance on a plan?

10. Why is it best to measure the foundation of the building?

11. How would you check the actual dimensions of various structures?

12. Why should you note the type of tree(s) in your field notes?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 7 FIELD NOTES

### Introduction

Field notes are the most important part of the survey. They are the written record of what was actually done, seen, and heard during the progress of the field work.

For many reasons all field notes must be:-

- CLEAR
- CONCISE
- CAPABLE OF NO MISUNDERSTANDING.

To be of use they must also be:-

- HONEST
- SELF-CHECKING
- SELF-EXPLANATORY.

Field notes must be able to stand by themselves as the complete documentation of the field survey.

Your field notes are used by many people after you have created them, such as:--

- The O.L.S. who must check the validity of the work, and make decisions based on the information provided,

- The drafting/calculating staff to create the plan of survey,

- Other surveyors who may need to use your information to extend the survey fabric you have established,

- The courts to follow the methods you used, the evidence found and monuments set, when the results of any survey are involved in litigation, and,

- Where the monumentation and other evidence shown in your field notes have been destroyed, then your field notes will be used as evidence to replace those monuments in exactly the same location that you found or left them.

**Narrative**

That Field Notes must be CLEAR refers to the requirement that any reader can easily and clearly see and understand where the final boundaries are, and how they were created. These final boundaries can be enhanced in your field notes by shading these boundaries with a yellow marker, thereby drawing to the users immediate attention, the actual boundaries themselves, distinct from all other lines in the field notes.

That Field Notes must be CONCISE refers to the neatness and integrity of all written documentation in the use of both letter and figure sizes in a scale comparative to the space available. This does NOT mean that the written record is so small that a magnifying glass must be used to decipher the data.

Field notes must be CAPABLE of NO MISUNDERSTANDING means that all dimensions have limiting arrowheads, all offset lines are well defined and labelled, traverse lines are labelled as such, evidence for the creation of each boundary is clearly shown, all monuments are fully identified, geographic, underlying and adjacent data is clearly shown and all letters and figures are unmistakeable.

When abbreviations are used they must be referred to a well known and standard format.

Field Notes must be HONEST in that you must record exactly what was done, exactly what was measured and exactly what was seen. There must be no guessing in this scheme of things.

That Field Notes must be SELF-CHECKING means that the positional accuracy of all points noted must be verified by more than one measurement. A closed traverse along offset lines and/or traverse lines will check the validity of the closed traverse data but will not guarantee the accuracy of other data tied into that traverse, or any data set from it unless we take special precautions to guarantee the integrity of that data. One of the methods we can use, which takes very little time is to read the angle to the data, double the angle and then close the horizon by reading the opposing angle, and, at the same time measure the distance in both metric and imperial.

That Field Notes must be SELF-EXPLANATORY means setting out the information in such a manner and with such clarity that questions about the work are rarely needed.

**Commentary**

All of the field notes made for the various types of surveys should be compiled in a logical format which will lead any reader, through the progress of the work in the same manner as the actual field work was completed. To this end the notes should follow a factual and comprehensive format in easy to follow steps, such as:-

PAGE 1 of the field notes to be used as a "Cover Sheet" to note:-

a. Date(s) of the work and composition of the field party;

b. Project Number or Reference File designation'

c. Statement of what work has been authorized (copy of work order);

d. List of research material used during the survey'

e. A report of the survey in general terms stating the actual evidence used in setting each boundary. This report can be carried over to the reverse side of the page or onto other pages numbered 1.A, 1.B etc.

There are many reasons for this approach to the creation of good field notes. It forcefully "Paints the Picture" for anyone about to use the notes. It gives an accurate statement of what the notes contain which can be very useful when research is being done many years later. It allows the Party Chief to review the methods used and check the accuracy of the assessment of the evidence.

PAGE 2 of the field notes (and more if necessary) should show the basic survey framework and evidence used to establish the boundaries. It is here that all offset lines, traverse lines, station numbers, angles and distances between stations, and geographic identities are shown.

PAGE 3 to ? will show in more detail the work carried out during the progress of the survey.

This basic format is ideal for most small surveys and can be easily expanded for more complex and larger surveys.

In large surveys it is always an advantage, especially for subsequent users, to create an index of blocks of pages which cover specific geographic areas. This index should follow immediately after the Report of Survey. In this system it may be wise to defer final page numbering until the work in completed, or to use a field numbering system and a final "office added" page number when the project is complete.

**Conclusion**

The creation of field notes is not to be taken lightly, and constant on-the-job training on different types of surveys is necessary to obtain a true knowledge of how they must be done.

Field Notes that are "messy", incomplete, difficult to read, and without the required checks, lead to frustration, anger and wasted time spent attempting to decipher what was actually done in the field. This often leads to return trips to the site to verify data, or, to incorrect decisions and information being shown on the plan which may result in a costly law suit.

More than anything else, poorly constructed and confusing field notes convey to the user that the field party did not really know what they were doing and that their work cannot be trusted.

Last, when all the field notes are completed and you turn your back on the site you should be able to state with full conviction that no-one, ever, can prove your work incorrect.

**ADDITIONAL READING**

Seminar I - Land Survey Party Chiefs Precis:
The Collection and recording of evidence. ISTO

C.L.S. LOGO

COVER SHEET
FOR
FIELD NOTES OF SURVEY
OF

LOT 61 CON. — MUNICIPALITY MIDDLETON
BLOCK — PLAN 307 COUNTY HALDIMAND-NORFOLK

FIELD PARTY W.G. Mates C. Ferrie J. Weston

TYPE OF SURVEY B.L.S.

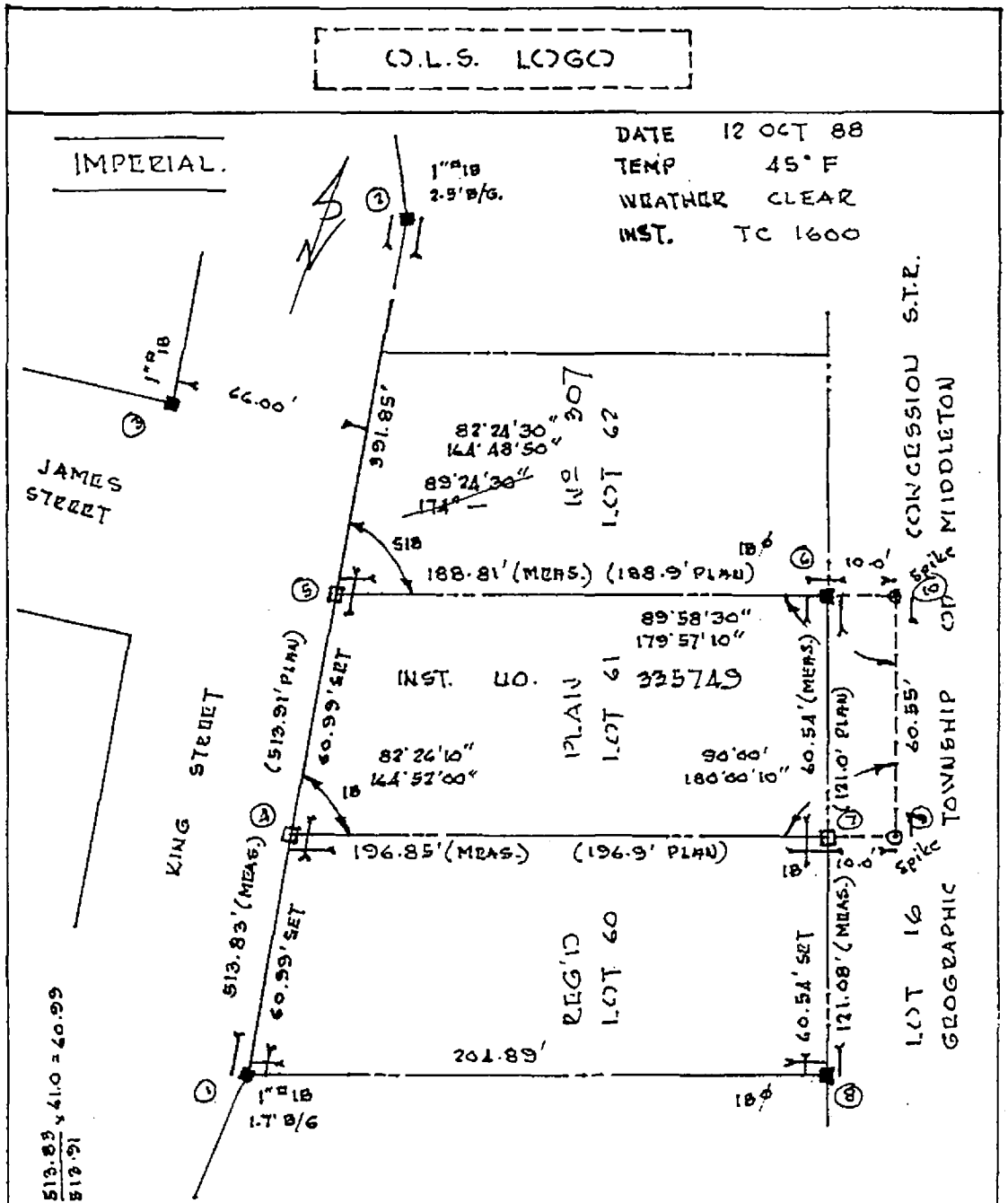
DOCUMENTARY DATA Print of R.P. # 307
Print M.T.C. P-2218-50
Search notes dated 11 Oct 88

REPORT

1. No documentary data for owner to east in search notes.
2. Accepted monuments on east side of King St as original with plan and, there being no other evidence on this line, proportioned lot frontages.
3. Accepted I.B.'s at N.E. LOT 61 and S.E. LOT 60 and proportioned between them for S.E. LOT 61.
4. None of the monuments found have numbers on them.
5. Owner of Lot 61 says the C.L.F. was erected 2 years ago.



PROJECT NO. 88-821



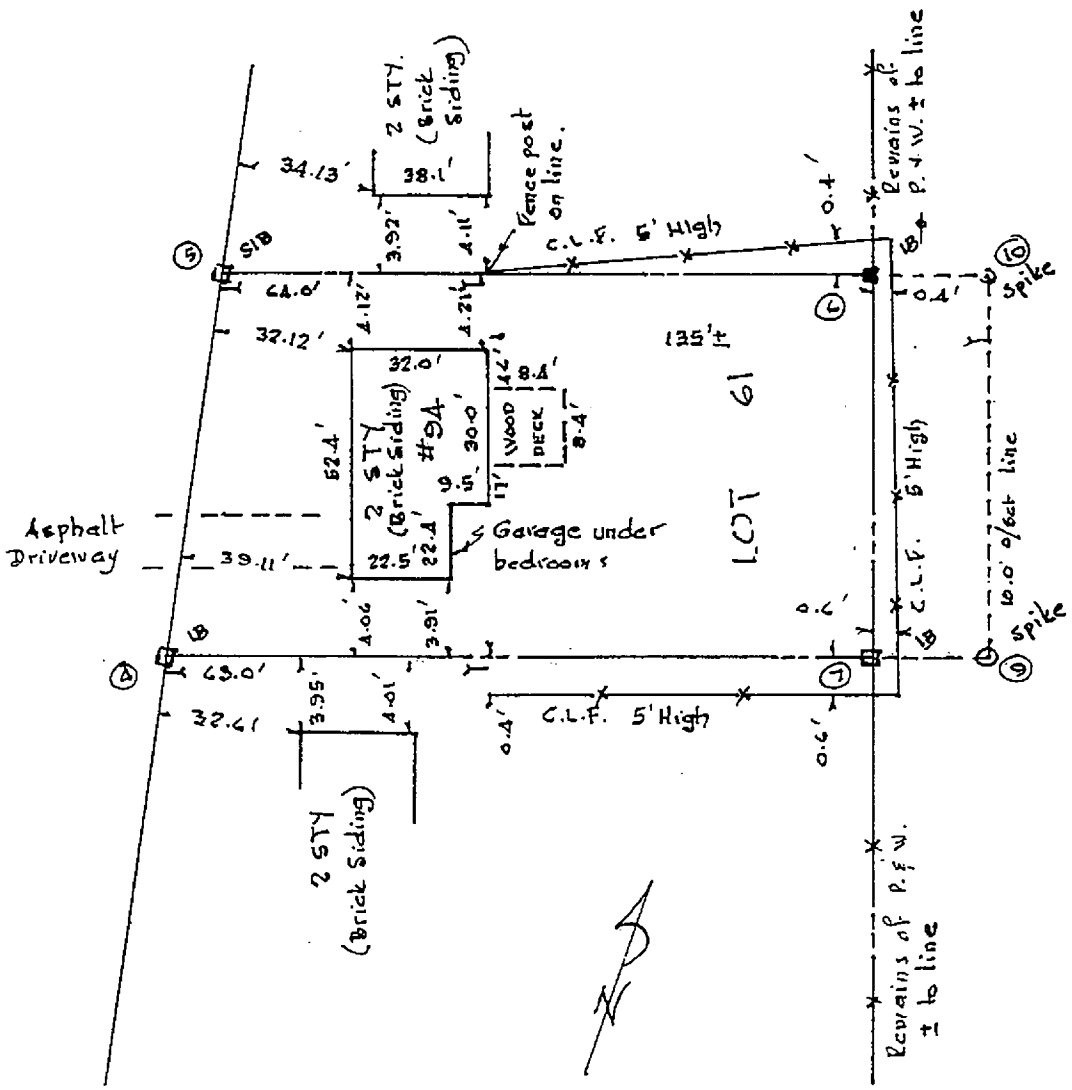

PAGE 2 OF 3 PAGES. PROJECT NO. 88-821

O.L.S. LOGO

IMPERIAL

DATE 12 OCT 1988
TEMP 45°F
WEATHER CLEAR
INST. TC 1600

NOTE: - All ties are to first course of brick siding




PAGE 3 OF 3 PAGES

PROJECT NO. 88-821

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. List three things all field note must be?

2. To be of use, what also must field notes be?

3. Besides your survey office, who else might use your field notes?

4. Describe something you can do to make your field notes clear to another reader?

5. How do you determine what abbreviations to use?

6. What do understand by the term, "Self-Checking"?

7. Why should field notes be compiled in a logical manner?

8. What information might appear on the cover sheet of your field notes (five items)?

9. Why would you (or your Party Chief) want the best possible field notes?

10. What does the author recommend for field notes for larger surveys?

11. How do you know, according to the author, when your field notes are complete?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 8 FIELD CALCULATIONS

### Introduction

Today's state-of-the-art reasonably priced, hand-held, programmable calculators now on the market, have brought the capability to solve *all* but the more complex calculations into the hands of the field staff. Coupled with the capability of on-board computerised data that can be generated and held in memory by the "Total Station" we can have the field staff virtually replacing the calculator-functions done by the office staff - or can we?

Few hand-held systems produce hard copy of the entry data, and the answers produced. The entry data and other self generating data of the "Total Station" can only be checked by down-loading the Data Collector information into a mini-computer and this is rarely done in the field.

Are we really that much further ahead of the surveyor of only twenty years ago who found a shady spot in the bush on a warm day and did the required calculations using his table of five-place logarithms? At least he was forced to keep a hard copy of the work just to keep track of all the numbers used.

Hard copy diagrams explaining what you did, showing the data used, and the answers are inseparable from your field notes because someone else must always check what you have done to verify the input, and the answers. We work with masses of numerical data and it is so very easy to be in error that it is mandatory that all calculations be checked by someone other than the originator.

If you are a mathematical analyst you will quickly realize that 95% of survey calculations can be broken down to the solution of right-angled triangles. If we remember (or have it written down in our field book) the relationships between Tangent, Cosine and Sine it is simple to solve these right-angles, and, as you all will remember from school the solution to Pythagoras Theorem, given any two sides in a right-angled triangle you can solve for the missing side.

When we run into the problem of an odd-shaped triangle we can bring into play the Sine Formulae if we know any three quantities of the triangle, one of which must be an angle.

Almost all of our field calculations are based on these simple and easily used formulae.

(Curve problems are a little different but remembering only three basic formulae we can solve even these problems with very little difficulty.)

Whether we realize it or not we actually use a lot of Co-ordinate Geometry in our work. Any time we create co-ordinates or solve the distance between two sets of co-ordinates, we are using the basic mathematics of Co-ordinate Geometry.

With two sets of co-ordinates we determine the difference in Northing and the difference in Easting then use the tangent formulae to determine the angular measurement and the cosine formulae to determine the distance. On our hand-held calculators this is done by converting the rectangular distances to polar. It is so easy.

With a traverse line of many courses we use the same system to solve a direction and distance between the beginning and end of that traverse.

Most hand-held programmable calculators will accept and retain in continuous memory a basic programme to solve a "Missing Course Programme." All we must do is feed the required data of Bearing and Distance for each leg of the traverse and then ask for the total sum of the entries for the Missing Course required. In actual practice the calculator works internally on AZIMUTHS and distances so we must know how to enter the data in the correct format.

Some of us have a little difficulty with Bearings and Azimuths, and relating them to the actual work we are doing. An AZIMUTH is the direction of a line measured by the right-handed angle clockwise from NORTH.

A Bearing uses this same principle but defines the angular displacement from NORTH or SOUTH by quadrants,

i.e. AZIMUTH of 30 is the BEARING N30 E.

AZIMUTH of 115 is the BEARING S65 E or N65 W.

AZIMUTH of 220 is the BEARING S40 W or N40 E.

AZIMUTH of 333 is the BEARING N270 W.

We very rarely start our traverse lines from a true South to North direction, but use Reference bearings from previous surveys. To run bearings throughout the traverse we must begin with the Reference Bearing and by adding, or subtracting, the angles read at each station we end up with the AZIMUTH or BEARING of each course, depending upon which system you prefer to use.

**Commentary**

The basic calculations needed during field operations involve the setting of a monument behind a tree, determining the length of a property line from the measurements along a parallel offset line or a traverse line, proportioning of lot corners between substantiated evidence, etc. They all appear to be simple and uncomplicated problems. However, irrespective of how simple they appear, as with any work using numbers, they can be subject to error. Diagram the problem in your field notes, solve the problem, and set out the answers. Get someone else to check the information you began with and your mathematics.

Once you have used these answers to set specific points, or the monumentation required, find some method to check the data you have set to prove it is indeed correct, as in your calculations. Many surveys have gone to the dogs because of the lack of this final check of the work.

The concept that must be remembered is that no matter how perfect your field offsets and traverse lines are done, it is the monuments you leave in the ground which are the proof of your work. It is the work done on the ground which is the testament to your ability. The calculations only lead to the correctness of setting the true limits. The O.L.S. will need to check what you have done to validate the work and your easy-to-follow diagrams and calculations, which are part of your field notes, is the only method available. The setting of the monuments correctly are your responsibility.

**Conclusion**

Basic field calculations are part of your responsibilities as a trained and skilled member of a Field Party.

The solving of right-angled and obtuse-angled triangles must become second nature to you.

The understanding of Bearings and Azimuth come from just a little practice.

The use of the programmable calculator to solve Missing Course computations may take time, but should be learned. Solving curve problems in the field is a necessary part of all field work and can come easily to you with practice.

To be perfectly correct in the solution of such problems means accuracy in the use of figures and understanding of the principles of the mathematics involved.

PRACTICE can make PERFECTION.

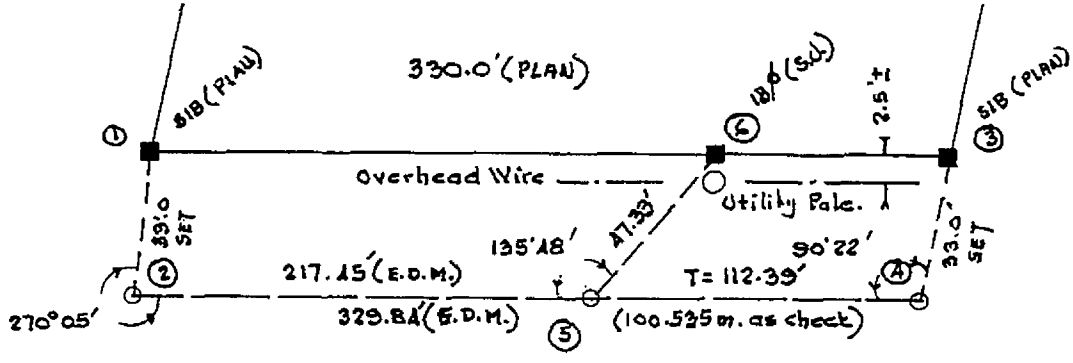
**ADDITIONAL READING**

Instructions in Mathematical Calculations - MTO Right of Way Branch

(This precis is a little dated but contains all you need.).

# DIAGRAMS TO EXPLAIN THE TEXT.

## 1. RIGHT-ANGLE TRIANGLES.




47.33 sin 44°12' = 33.00' ∴ ⑥ is on line between ① and ③

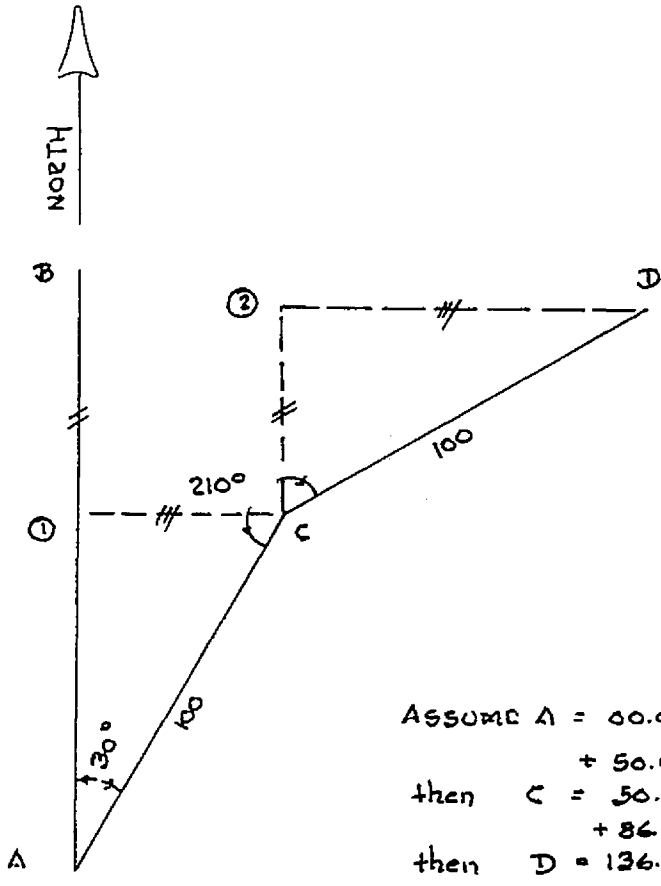
Distance ① to ⑥

33 tan 0°05' = − 0.05
217.45
33 tan 45°18' = + 33.93
251.33

Distance ⑥ to ③

33 tan 45°18' = − 33.93
112.39
33 tan 0°22' = + 0.21
78.67

## 2. CO-ORDINATES.




100 sin 60° = 86.60
cos 50.00

100 sin 30° = 50.00
cos 86.60

Assume A = 00.00 East and 00.00 North

+ 50.00 + 86.60

then C = 50.00 East and 86.60 North of A

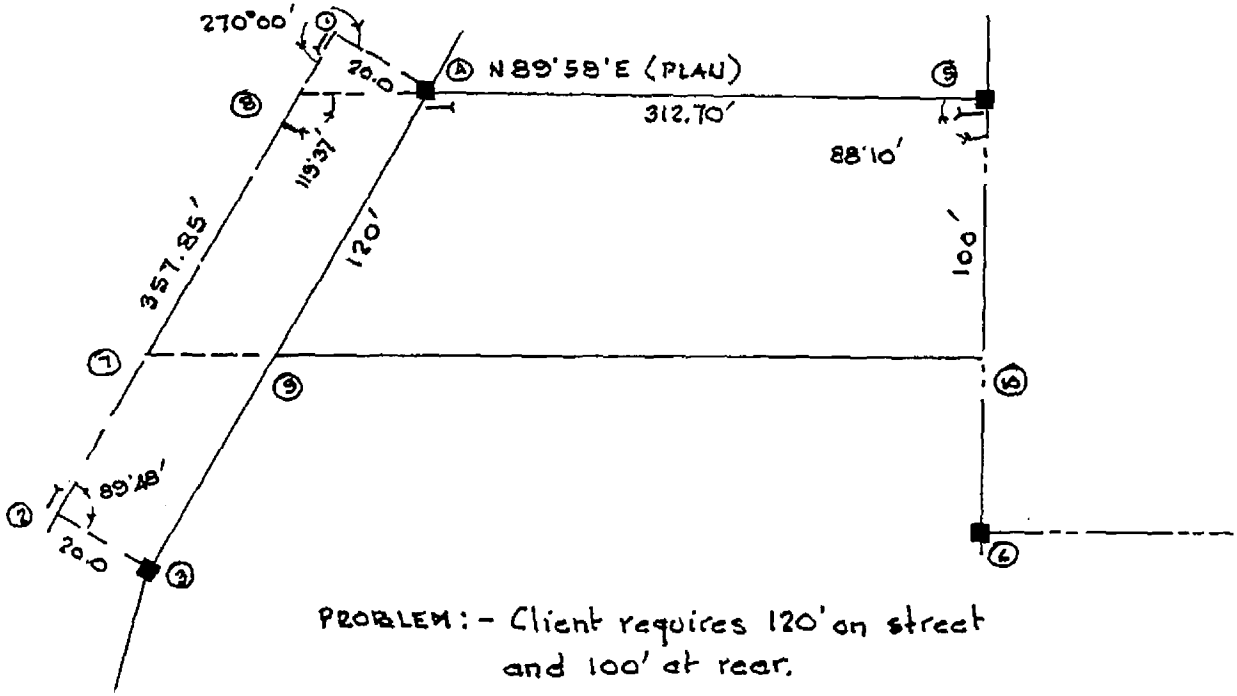
+ 86.60 + 50.00

then D = 136.60 East and 136.60 North of A

then by tangent formulae :-

A to D = 193.18 at 45° from line A to B

3. Field Problem.




PROBLEM:- Client requires 120' on street and 100' at rear.

SOLUTION.

STEP 1. Solve data for line ⑨ to ⑩ using missing coorse programme.

U 29°35'E 120'
U 89°58'E 312.70'
S 01°48'W 100'
} U 89°17'15"E 368.83'

STEP 2. Solve for angle 8.$\hat{7}$.10; distance 1-8, 8-7, and 7-9.

U 29°35'00"E
U 89°17'15"E
59°42'15"

20 tan 29°37' = 11.37 — (1 to 8)

120
− 11.37 (20 tan 29°37')
+ 11.69 (20 tan 30°17'45")
120.32 — (8 to 7)

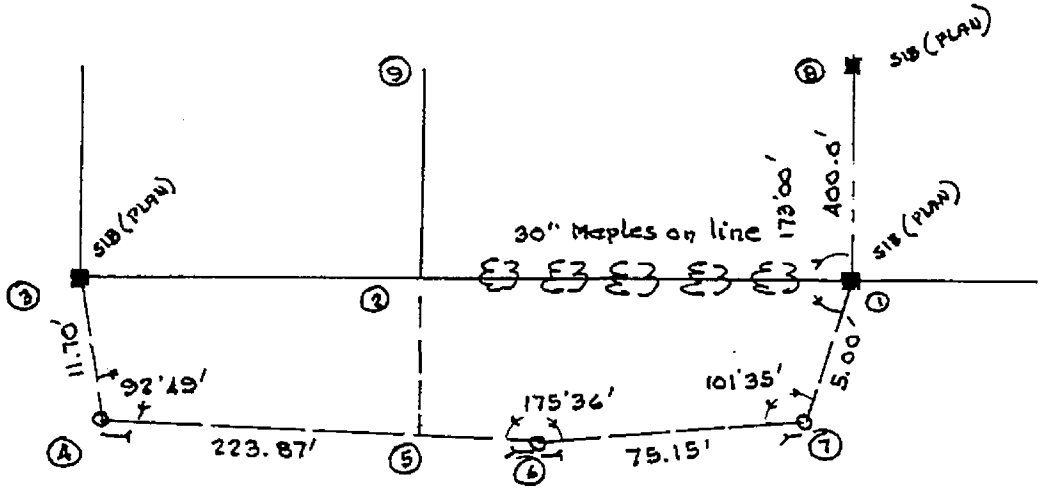
20 sec 30°17'45" = 23.16 (7-9)

L.S.F.P.

S.P. Nº 8 ADDENDUM 1

## PROBLEMS YOU MUST SOLVE.

1. GIVEN the data shown on the diagram below:—




Determine angle $4\hat{5}9$ so that 5.9 is parallel to 1.8;

Determine distance 4.5 so that 2.1 is 100.0';

Determine distance 5.2.

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. Total Stations and programmable calculators have not replaced the need for hard copy output. True?

2. Who should check your data? Why?

3. All field calculations can be broken down into triangle and _____ problems.

4. What is co-ordinate geometry?

5. On a calculator, how do you determine the angular measurement and distance?

6. What figure must you have before you run bearings throughout the traverse?

7. Azimuth of 170° is what bearing?

8. A bearing of N270°W is what azimuth?

9. Your calculations will not matter if this is not done properly.

10. Why should yo diagram the property if all the data is stored electronically?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 9 TOPOGRAPHIC SURVEYS

### Introduction

One of the many services provided by an O.L.S is the production of up-to-date, site-specific plans which range from a small area showing all physical and man-made features, used by an architect to design an addition to a present home, to the series of plan sheets showing both present and proposed physical features for the design of a golf course or super highway.

The data required to be shown on most of these types of plans includes the topography, the configuration of the parcel, and all data which may affect the use of the land.

It is a requirement for us to always begin with the research to establish ownership of the lands in question and, depending upon the data required by the client, research to disclose any prior work relevant to the client's needs which can be of assistance in what we wish to accomplish.

In all cases we must look at the project through the eyes of our client, and include in our returns those items which will provide the client with a complete information package.

This is the area of surveying where a "Total Station" is the greatest asset you can have, provided always that the required checks are part of the work to ensure your answers are indeed correct.

**Narrative**

Most architects, engineering companies and Governmental Agencies have devised their own set of specifications for different types of Topographic Surveys and include these with the documentation and letter of transmittal sent out authorizing you to carry out the work. These specifications are devised to cover almost every aspect that will affect the work. We must use a lot of common sense in our application of these specifications to what is on the ground.

For instance, where the specifications require a metric plan for a 50 acre parcel at a scale of 1:200 with grid spacing of 10 meters, and it is all solid bush; (?) or, elevations to be accurate to 3mm and it is a ploughed field (?); we should review the specifications and make recommendations with respect to the manner in which the information will be acquired. We must be capable of looking at the overall picture regarding what the client proposes to do with our plan, deciding what will be the best and economic method of attaining the required result, and obtaining the approval of the client to proceed on our recommendation.

Another example is the request from a client who states: "I need some elevations on Lot 12, Plan M-51, right away." We must ask why he needs this work, to what accuracy, on what datum, and on what grid spacing, when he then tells us that he must prepare a drainage plan for deep swales along the sides and back of the lot for the City Engineer to approve his Building Permit Application, then we know we must be prepared to locate any underground plant in the area and provide enough spot elevations both on and adjacent to the site to depict the present drainage system and the elevations and location of buildings and other structures.

When the request for topographic information is for a large area - over 20 acres - it is most probable that economics will suggest the acquisition of a manuscript derived from recent aerial photography, supplanted by your basic field work of vertical and horizontal control, and the acquisition of information not available from the photographs.

**Commentary**

In any topographic survey we must first determine the datum for the proposed work, generally Geodetic but may be City or Local. Find a Bench Mark, having published data, and run a level loop out to the site to establish local Site Bench Marks, and continue the loop back out to a different Bench Mark, as a check for the accuracy of the work. When doing this initial precise levelling always ensure that the Local Site Bench Marks are used as Turning Points in the level loop, and set the Local Site Bench Marks so that they are intervisible and away from any proposed construction.

(Setting spikes in Utility Poles is against the law and using Hydrants can be a rather hazardous method of doing business.)

The next step is to establish a well-anchored base line for your proposed survey framework and also to provide the base for further work, such as construction lay-out at a later date. Should you have plans of the proposed work then the determination of where to set the base line is easy.

When these two basic steps are complete the really difficult task now begins. Gathering the required data of elevations, and their location, of buildings, curbs, manholes, catch basins, utility poles, height of wires on those poles, fences, other spot elevations and the grades and cross-sections of roads, streams, ditches and footpaths takes time and it must be done accurately.

The field notes originated during this phase of the operation must be clear and precise, and even the data collected by using the "Total Station" requires a point-plot set of notes as a direct check of what was done.

The type of field notes you produce of the work can be arranged in many different ways, and all depend upon terrain, density of data to be collected, spacing of cross-sectioning and areas of interest off the site. What is paramount is that old cliche:-

Identify trees and bushes by their size and species and locate the centre of them at about waist level.

Buildings and structures must be identified by size, use, type of siding, type of foundation and height.

Spot elevations well beyond the site to indicate drainage patterns is a necessity.

In all things, put yourself in the client's shoes to identify the reason and need for the required data and you will be able to proceed with confidence and produce the best result.

CLEAR, CONCISE AND CAPABLE OF NO MISUNDERSTANDING.

When all of the necessary data is collected and correctly recorded you have one more task to do.

Tie in the corners of the main features of buildings and other critical structures from points on the survey fabric again but from different points than originally used, and, run a separate level loop from the Local Site Bench Marks to critical points in the survey. Both of these concepts are critical so as to ensure no errors have been introduced into the original work. It only takes a few more minutes and guards against costly mistakes.

**Conclusion**

When setting Local Site Bench Marks try to ensure that at least two of them can be seen from anywhere on the site. This may mean providing up to ten Bench Marks over a 5 acre site - and the reason is obvious, - the saving of time and the ensuring of accuracy at any time you return to the site to accomplish more work.

During the planning of the methods you will use to acquire the necessary data remember that your notes must be clear and easily plotted. Random radial ties require some calculation and therefore are subject to more error than normal.

In the determination of underground plant it is good practice to have the office arrange to have locates done while you are on site. Another good practice is to obtain Engineering As-Built Plans of services and Utilities before going on site.

Remember it is a "No-No" to remove manhole covers and to enter manholes without permission from the utility, and even with that permission you must arrange protection and safety personnel.

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. What could a topographic survey be used for?

2. What data must usually be shown on a plan?

3. List what research you must do for a topographic survey.

4. What general information do you need to know before starting a topographic survey?

5. What may be a better method, according to the author, for larger-sized topographic surveys?

6. What is a datum? List two types.

7. What should you use as a turning point when doing the initial precise levelling?

8. Why should you have a well-anchored base line?

9. What task should you do once all the necessary data is collected and recorded? Why?

10. What criteria should you use when setting local site bench marks.

11. While you are doing the survey in the field, what should the office be doing (have done) for you?

12. List one reason why a spot elevation is required.

13. Why are manholes dangerous?

# LAND SURVEY FIELD PROCEDURES

## CHAPTER 4

## LESSON 10 FIELD REPORTS

### Introduction

The A.O.L.S. Standards for Surveys states that a survey is not final until the Report of Survey is completed and signed by the O.L.S.

This Report of Survey is in reality a letter of transmittal to accompany the Plan of Survey (and the account for the work) indicating the survey was completed in accordance with the applicable Statutes and Regulations and if there are some problem areas with boundaries, extent of title, unregistered easements etc. the Report will make note of these. Such problem areas might be respecting the buildings being in contravention of the Zoning By-Law, fences not in agreement with actual boundaries, plan or deed measurements being different than measured on the ground, or overhead wires crossing the lands under survey where no registered easement exists.

These comments in the Report of Survey are shown on the Plan of Survey but a need always exists to draw attention to them for the benefit of the client and his solicitor to say "Watch Out." If you want clear title to this property then here is a list of items to which you must pay close attention, and deal with in the correct manner.

### Narrative

The Field Report of Survey made by you as part of your field notes is the beginning of the trail of documentation that leads the O.L.S. to the Report of Survey in it's final stage and form. Your Field Report is much more specific as it is a complement to the Field Notes themselves, is technical in nature, and outlines the rationale for decisions made in the field.

When preparing the Field Report of Survey the main concept to bear in mind is that the reader was not physically present on the ground and you must "paint a picture" of your activities so that the report may be easily read and intelligently understood. It is well to keep in mind that someone may be

questioned in a court of law about the specifics of a survey done 20 years previously and required to fully explain exactly what was done, and why. It thus becomes very obvious that the Field Notes must stand as a complete entity of exactly what was done with no reliance whatsoever on supposition, and this is where the Field Report is the definitive answer.

The reason for a Field Report of Survey is therefore to set out at the very beginning of the Field Notes a brief and easily understood summary of items such as:-

- data about the survey too lengthy to put in the notes;
- investigations done, comments by owners, solutions to problem areas, and why specific actions were taken;
- comments regarding inconsistencies found in measurements;
- comments respecting visible and measurable encroachments;

In other words a verbal picture of all you found and did.

**Commentary**

The Field Report of Survey should serve many functions including:-

1. Drawing immediate attention to problem areas;
2. Explaining how each boundary was set;
3. Becomes a permanent record of what was done;
4. Details why specific actions were taken; and;
5. Gives the O.L.S a thumbnail sketch of the work.

But beyond this, it provides the Party Chief an opportunity to review the actions and methods used for consistency with good survey practice, compliance with the Standards, and naturally the completeness and accuracy of all measurements.

The significance of field notes, and the Field Report of the Survey cannot be over-emphasized, as their use in validating the information on the plan of survey is most substantial, as Mr. Izaak deRijcke O.L.S. has well stated:- "...it is the field notes to a plan that distinguishes that plan from a mere map as an exercise in geography."

The Field Report respecting the re-survey of a lot in a recent plan of subdivision may be very brief, such as:-

"Found original plan monumentation to substantiate plan data to within 2cm in distance and 20 seconds in angles."

A complicated boundary survey in a densely populated downtown area of twenty sides may well run up to twenty pages, and for a route survey across a complete geographic township about the same.

**Conclusion**

The requirement for a Field Report of Survey is not a new requirement in our profession. It has its roots in the initial Canadian Land settlement, at which time the Surveyor was an important agent of the State. His instructions described how he was to survey a particular area, and included directions to him to report on the geography and geology of the area. His returns included his method of survey, a report of the survey and reports of the staff used, difficulties encountered and the suitability of the area for farming and industry.

We still use the original notes and reports today in the retracement of those original surveys.

All of the Government surveying services demand a full, explicit and complete Field Report of Survey as an adjunct to the work done.

As has been stated by many judges, lawyers and surveyors - "Field Notes are the most important part of the survey," and as the Field Report explains the notes, and gives valuable information as to how and why the boundaries and monuments were located, it is incumbent upon us to ensure that the Report is clear, precise and unambiguous.

## SELF-STUDY QUESTIONS

Now answer the following questions. Find out how much you know or don't know about this chapter's topic. But no peeking!

1. When is a survey final?

2. Besides the fact that it was done in accordance with applicable Statutes and Regulations - and what other information must appear on the Report of Survey?

3. Why is that information necessary on the Report of Survey?

4. Since the reader of your Field Report of Survey was not present with you at the time, your report must "_____ a _____" of the site.

5. List three general items which must appear in your Field Report of Survey.

6. List three things your report will be used for.

7. How does your preparation of the report help you as a Party Chief?

8 How does the Field Report differ from the Field Notes?