Component A

CADASTRAL LEASE DIAGRAMS FOR RESETTLEMENT FARMS IN NAMIBIA

'Digital orthophotos as an alternative to the current field surveying technique'

Frikkie J Louw

Mini-dissertation (LIMT890) submitted in partial fulfilment of the academic requirements for the degree of Master of Environment and Development (Land Information Management), in the Centre for Environment and Development, School of Applied Environmental Sciences, University of KwaZulu-Natal.

Pietermaritzburg, 2004

ABSTRACT:

The Ministry of Lands, Resettlement and Rehabilitation of Namibia is responsible for all land issues. The resettlement of landless farmers, of the previous disadvantaged groups, is one of the issues. The Agricultural (Commercial) Land Reform Act (Act 6 of 1995) applies to the commercial land parts of the country. Under this act the government of Namibia has the first option on the purchase of commercial farms when these are offered for sale.

These purchased farms will then be used to resettle the landless farmers from the communal areas. These applicants may obtain a long-term lease over the purchased commercial farms.

Long-term leases are legally required to be registered in the Deeds Office. A cadastral lease diagram is required for registration.

The government, through the Ministry of Lands, Resettlement and Rehabilitation, has bought approximately 130 farms for resettlement purposes. On June 2003 approximately 13 of these resettlement farms were surveyed and cadastral lease diagrams prepared for registration in the Deeds Office.

The author argues that many factors have affected the slow progress of the resettlement in Namibia including the time required for the preparation of the cadastral lease diagram.

The current field survey techniques, Total Stations or/and GPS, are very reliable, but are slow. The use of digital orthophotos has been shown to shorten the time to prepare the cadastral lease diagrams.

The Author further argues that because digital orthophotos are available at the Surveyor-General's Office means, there are no cost implications. The cost of the cadastral lease diagrams by using digital orthophotos is only a third of the cost of using the current field survey techniques.

Replacing current survey techniques with digital orthophotos or including the use of digital orthophotos, as a surveying technique would require the revision of the Land Survey Act (Act 33 of 1993) and the Survey Regulations, under section 5 of the said Land Survey Act - Government Notice No. 58 of 2002.

Disclaimer:

This is to certify that this study comprises only my original work except where due acknowledgement is made in the text.

Frikkie J Louw

Dr Dennis Rugege
(Co – Supervisor)

ACKNOWLEDGEMENTS

Dr. Hein van Gills – Primary Supervisor, ITC – Netherlands for his guidance, support and assistance.

Dr. Dennis Rugege – Secondary Supervisor, University of KwaZulu-Natal for his support and assistance.

Dr. Tjama Tjivikua – The Rector, Dr Gert Günzel – the Vice-Rector, Dr Willem Jankowitz – The Dean of School for Natural Resources and Tourism, Mr Joe Lewis – the Head of Department of Land Management and Mr Vence Uisso (Ex-HOD), of the Polytechnic of Namibia for the opportunity to study and their support and assistance.

Mr. Chris Paresi and Mr. Eric Holland of ITC, for the opportunity to study and their support.

The Surveyor-General of Namibia, Dr Karim Owolabi and staff members of the Surveyor-General's Office for their technical support.

Soraja, Rose-Anne, Lené and Jonty Louw – My Family, for all their support, love, care, understanding and believe in me.

Koos and The late Lenie Louw – My Parents, for being there for me.

The late Rosa Mouton – My Mother-in-Law, for being there for me.

The late Gunther Reuter (Ex-Surveyor-General of Namibia) and the late Piet Visser (Ex-Deputy Surveyor-General of Namibia) for their trust and believe in me.

Finally to My Farther and My Lord, and His Son, Jesus Christ and the Holy Spirit, for the privilege given to me.

'Alle Eer kom die Here toe'

Table of Contents

List of Abbreviations

DO	Deeds Office
DRR	Directorate of Resettlement and Rehabilitation
FIG	The International Federation of Surveyors
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectare
HTML	Hypertext Mark-up Language
MLRR	Ministry of Land, Resettlement and Rehabilitation
N$	Namibian Dollars – Currency
PTO	Permission To Occupy
SG	Surveyor-General of Namibia
SGO	Surveyor-General's Office in Namibia
UNCHS	The United Nations Centre for Human Settlements
WWW	World Wide Web
www-question	*what* right, *who* holds them and *where* can these rights be exercised

List of Tables

List of Figures

Glossary of Terms

adjudication, the determination of rights to land.

chief, the person recognised under the Traditional Authorities Act (Act 25 of 2000) as the chief of his or her traditional community.

communal area, related to a traditional community under the Traditional Authorities Act, meaning the area comprising the communal land inherited by members of that community.

disadvantaged groups, refers to people who were socially, economically and/or educationally disadvantaged by past discriminatory laws and/or practices under the Traditional Authorities Act.

lease, a contract whereby land is let to or hired by a person other than the owner for a specified period of time on payment of an agreed sum of money.

Minister, means the Minister of Lands, Resettlement and Rehabilitation.

sporadic adjudication, the determination of rights to land here and there, now and then.

systematic adjudication, the determination of rights to land on a regular and systematic basis, for example within all of one area at one time.

Traditional Authority, means a Traditional Authority of whose traditional leaders had been recognised under the Traditional Authorities Act, 2000.

traditional community, means a traditional community as defined in the Traditional Authorities Act, 2000.

1. Introduction

1.1 Problem analysis and description

1.1.1 Background

1.1.1.1 General

Land is a word with many different meanings; it suggests different things to different people, depending on their outlook and their interests. To the economist it is a resource with which to achieve economic production and development, where to a lawyer it is a volume of space from the centre of the earth to the infinite sky with many rights attached. To many people land is the space for human activity as reflected in many forms of land use. For the Professional Land Surveyor, land is a three dimensional unit, YXZ.

The Ad Hoc Group of Experts on Cadastral Surveying and Land Information (1985) defined land as being an area of the surface of the earth together with the water, soil, rocks, minerals and hydrocarbons beneath or upon it and in the air above. This definition embraces all things, which are related to a fixed area or point of the surface, including the areas covered by water, including the sea.

Land is the basic source of material welfare in one way or the other, so the need for the acquisition of land rights is very important. The different types of land rights are as follows:

- Full Ownership
- Lease
- Permission to Occupy (PTO)
- Servitude

- ❖ Sectional Title
- ❖ Surface rights
- ❖ Under ground rights

1.1.1.1.1 Full Ownership

Ownership is the most important relationship between a person and land; it gives the owner the greatest rights over land including the right:

- ❖ To use it to its full potential and take whatever is produced from or on it;
- ❖ To destroy, sell it or dispose of it;
- ❖ To raise money on the security of it - a loan (as collateral);
- ❖ To exclude its use by others, like preventing trespassing;
- ❖ To possess or recover possession if deprived of the land.

1.1.1.1.2 Lease

A lease of land is a contract whereby land is let to or hired by a person other than the owner for a specified period of time on payment of an agreed sum of money. A "short-term lease", a lease of less than ten years, is not entitled to be registered. A lease for ten years or more is a "long-term lease" and must be registered with the Registrar of Deeds, in terms of the Deeds Registries Act (Act 47 of 1937) in Windhoek and the Registrar of Deeds, in terms of the Registration of Deeds in Rehoboth Act (Act 93 of 1976) in Rehoboth.

1.1.1.1.3 Permission To Occupy (PTO)

During the apartheid era, a non-white person could not own land. Large tracts of land were held in trust by the state, and occupied by "Traditional Communities" of the non-white people. The state would issue a letter (PTO), sometimes with a plan

attached, authorizing a juridical person to utilize that land under specific conditions. These PTO's were never submitted to the Deeds Registry, but were kept by the "Chief or the Traditional Authority" that had control over the specific "Traditional Community". After independence the Government embarked on land reform, including resettlement, surveying and leasing commercial farms.

1.1.1.1.4 Servitude

Servitude is a right held by one person over the property of another person. Some examples include air and light servitudes, a right of way servitude, a pipeline servitude, an overhead power line servitude etc. There are two types of servitudes:

- Praedial Servitude is a servitude which operates in favour of the owner of a piece of land and which cannot be separated from that land.
  e.g. A right of way over one property, in favour of another property.

- Personal Servitude is a servitude in favour of a natural or juridical person, like NAMPOWER, not owning land, but having rights over it.
  e.g. an overhead power line of NAMPOWER.

1.1.1.1.5 Sectional Title

Sectional title refers to a section of a building that is bounded by four walls, a floor and a ceiling as in the case of a flat; defined as a unit. A unit owner has exclusive rights to his or her unit, but is jointly responsible for the remainder of the property - common property.

1.1.1.1.6 Surface Rights

Surface rights refer to the rights associated with the surface of the land, which may include the use of the surface of land, like trappers and other commercial and non-commercial users for timber rights.

1.1.1.1.7 Underground Rights

The rights to ownership of everything beneath the physical surface of the land, like water, minerals, gas, oil and so forth that lie beneath the surface of the land. The rights to all minerals under the ground are separate from the surface rights.

Figure 1.1 below shows the range of some rights over land.

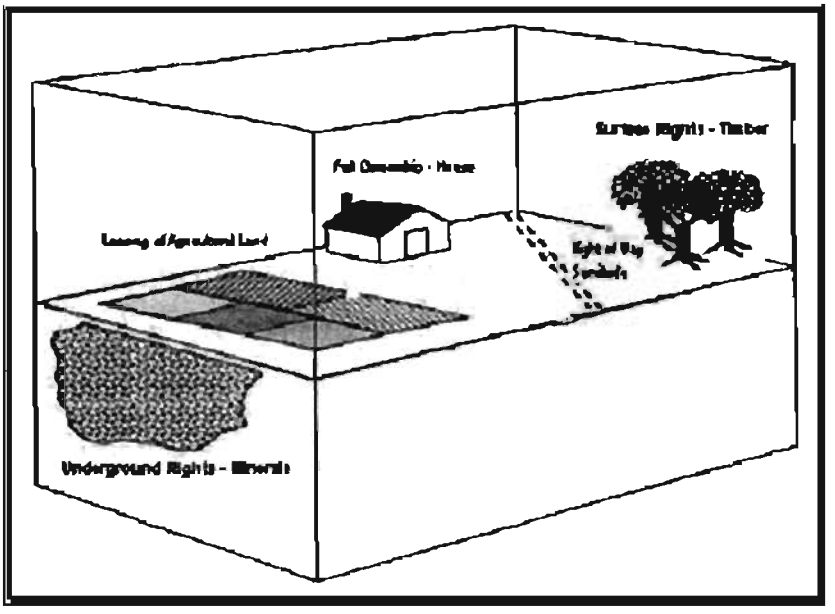


Figure 1.1 – A cadastral parcel and some rights over land. (Dale and McLaughlin 1999 and edited)

According to Larsson (1991), already in the Bible we read that the prophet Jeremiah had been involved with the acquisition of land:

'I bought the field from my cousin Hanamel of Anathot and paid him the price: seventeen silver shekels. I drew up the deed and sealed it, called in witnesses and weighted out the money on the scales. I then took the sealed deed of purchase and its open copy in accordance with the requirements of the law and handed over the deed of purchase to Baruch. (Jer. 32:9)'

The registration of rights requires a document (diagram) that graphically represents the area.

According to Dickson (1990), the Fixed Period State Grant system was created in the late 1960s to guard against alienation of land in perpetuity to non-citizen companies and individuals. It was observed that the need for having lease rights is increasing, because of different factors like the availability of suitable land, availability of financing, etc.

The governments of several countries in Southern Africa have decided that they want to keep some control over the land, for a variety of reasons. Private ownership of land in these countries is restricted and long-term leases are used. The registration of these leases creates a secure tenancy for the lessee and makes it possible for profitable investments in the land.

1.1.1.2 Namibia

Since independence in 1990, the Namibian government has argued that the redistribution of land in the former German and South African colony is critical to its emergence as an independent nation.

The Ministry of Lands, Resettlement and Rehabilitation (MLRR), is one of the new ministries created after Namibia gained its independence. The ministry is responsible for all land issues. The following directorates are part of the ministry, namely:

- ❖ The Directorate of Survey and Mapping (Surveyor-General's Office - SGO)
- ❖ The Directorate of Deeds (Deeds Office - DO)
- ❖ Directorate of Valuation and Estate Management
- ❖ Directorate of Resettlement and Rehabilitations – DRR
- ❖ Directorate of Planning, Research, Training and Information Services

The MLRR implemented a program for the resettlement of landless farmers from the previous disadvantaged groups. For the purpose of this study the term 'disadvantaged groups' refers to Namibian citizens who have been socially, economically and/or educationally disadvantaged by past discriminatory laws and/or practices.

From 1995 onwards the MLRR implemented the Agricultural (Commercial) Land Reform Act (Act 6 of 1995), which applies to the commercial land parts of the country. Under this act the government of Namibia has the first option on the purchasing of commercial farms when these are offered for sale. In case the government should not be interested, a certificate of waiver is issued.

After the purchase of commercial farms, the landless farmers from the communal areas may apply for long-term leases over these farms. Long-term leases are to be registered in the DO; therefore cadastral lease diagrams are required.

The government, through the MLRR has bought approximately 130 commercial farms for resettlement purposes. The staff of the SGO or private Professional Land Surveyors appointed by the Surveyor-General (SG), by using the traditional methods or Global Positioning System (GPS) surveyed approximately 13 of these farms into lease areas, as on June 2003.

1.1.2 Relevant questions

There are many factors, which have affected the slow progress of the resettlement of the landless farmers in Namibia, including the time required for the surveying of the lease areas and for the preparation of the cadastral lease diagrams. When focusing on this factor the following questions can be asked:

- Can the use of digital orthophotos as an alternative method of surveying the lease areas speed up the process?
- Is the use of digital orthophotos as an alternative survey method in the survey regulations and legislation?
- Is there a need to change the survey regulations and legislation and what is the procedure, in order to allow the use of digital orthophotos?
- What is the availability of digital orthophotos in Namibia?
- When were the digital orthophotos created?
- At what scale are the aerial photographs that were used to create the digital orthophotos?
- How was the ground control done?
- What is the quality of the aerial photographs and digital orthophotos?

1.2 Objectives

1.2.1 Main objective

The main objective is to compare the use of digital orthophotos with the current field surveying techniques for the surveying of the lease areas and the preparation of the cadastral lease diagrams over the resettlement farms.

1.2.2 Specific objectives

- Look at the availability of the data of a farm or farms surveyed by the current field surveying techniques
- Look at the availability of the digital orthophotos for the same farm or farms
- Determine the quality of the digital orthophotos
- Determine the date when the aerial photographs were taken
- Compare the accuracies of the areas of the cadastral lease diagrams prepared, between the use of the digital orthophotos technique and the current field surveying technique, using Total Station and/or GPS
- Compare the time spent using each technique
- Compare the actual costs of the two methods
- Look into the Legislation – The Land Survey Act and The Survey Regulations

1.3 Hypothesis

The use of digital orthophotos as an alternative surveying technique for preparing cadastral lease diagrams over the resettlement farms, is more cost and time effective, and if applied can speed up the resettlement process.

2. Literature Review

The present Namibian system of land registration is impossible unless each registered unit of land is surveyed and represented on a diagram or general plan. Cadastral lease diagrams are the documents that are needed for the registration of the lease rights over the resettlement farms in Namibia, therefore there is a need for an intense literature study to define cadastral surveying and some relevant terms that form part of or fall under the subject of cadastral surveying.

The extent of the land units as quoted in the registration documents of the long-term leases is obtained from the cadastral lease diagrams. It is thus apparent that registration of these long-term leases over the resettlement farms originates in the survey of these leases to be registered.

The case studies of Palestine and Fiji were studied to compare with the situation in Namibia.

2.1 Cadastral Surveying

Cadastral surveying can be defined as the determination, demarcation, surveying/measuring and mapping of property boundaries.

The term *cadastral* comes from Latin term *Cadastre* referring to a registry of lands. So cadastral surveying is to do with determining and defining land ownership and boundaries.

According to Larsson (1991), cadastral surveying operations essentially include the determination of the boundaries on the ground, the survey of the boundaries, and the demarcation of the boundaries. He further states that boundaries are the

main object of cadastral surveying. He also states that adjudication is an important aspect of boundary determination.

I.P Williamson (1981) states that cadastral surveying in some countries refers to the collection of all information, which relates to an individual land parcel although in the majority of the cases the main component of a cadastral survey is the survey of the boundaries of the individual parcels of land.

The definition of cadastral surveying by Dale and McLaughlin (1999) is that it describes the gathering and recording of data about parcels of land.

Cadastral surveying in Namibia can be defined as the survey or measuring and demarcation of land for the purpose of defining parcels of land for the registration of land rights in a land register, an example being leasing of the resettlement farms.

Cadastral surveying in Namibia is exclusively undertaken by the professional land surveyors or under their supervision, according to the Land Survey Act (Act 33 of 1993).

2.1.1 Determination of Boundaries

'In legal terms, a boundary is an imaginary line that divides two adjoining estates while in common language the term denotes the physical objects by reference to which this line of division is described' (Dale and McLaughlin 1999).

A boundary can be defined as either the physical objects marking the limits of a property or an imaginary line or surface marking the division between two legal properties.

The determination of boundaries or location of boundaries depend on the type of boundaries involved for the specific property, namely:

- ❖ Fixed boundaries (specific)
- ❖ General boundaries
- ❖ Numerical boundaries

2.1.1.1 Fixed boundaries (Specific)

In the colonial settlement era, the most economical way of defining the boundary of a property was to mark the corner points and suppose that boundaries between adjoining properties ran in straight lines. This method is still used in most other ex-colonial countries.

In Namibia most boundaries are defined by the position of corner beacons, which may vary from 12mm diameter iron pegs in urban areas, to planted stones, planted wine or beer bottles, etc on farms. The "lawful" position of a beacon (that is, the position a court will settle on) is the position where the beacon was originally placed. Where that position is requires a search for evidence by a land surveyor, in which he must use physical evidence of possible beacons, numerical evidence from original and earlier surveys, and the experience of people in the area. The Namibian system like the South African system relies largely on the professional land surveyor for the establishment of the position of boundaries, but requires him to apply judgement based on a variety of evidence, rather than on merely technical expertise (Jackson and Chilufya 2002).

According to Dale and McLaughlin (1999) boundaries may be fixed or specific, in which case the precise line of the boundary can be determined.

Dale and McLaughlin (1999) distinguish three categories of fixed or specific boundaries namely:

I. Defined on the ground prior to development and identified – for example, in documents of sale;

II. Identified after development – for example when the line of the boundary is agreed on between neighbours at the time of adjudication;

III. Defined by surveys to specified standards.

Each of these categories reflects that the precise position of a boundary has been determined.

2.1.1.2 General boundaries

Dale and McLaughlin (1999) defined general boundaries as being only the approximate line(s) of the boundary; the precise details can be established only by further investigation.

A general boundary can be defined as a boundary without terminal bend points, whose position is defined by its physical and acknowledged position on the ground. An example where general boundaries are used is in Britain. A general boundary might move with time, for instance if a boundary wall is removed and rebuilt at a somewhat different place.

In a general boundary system, the position of a boundary on the ground takes precedence over its position on the cadastral map.

Dale and McLaughlin (1999) also distinguish three categories of general boundaries namely:

I. The ownership of the boundary feature is not established, so that the boundary may be on one side of a hedge or the other or down the middle;

II. The boundary is the indeterminate edge of a natural feature such as a forest; and

III. The position of any boundary is regarded as approximate so that the register may be kept free from boundary disputes.

Each of these categories of general boundaries reflects that the precise line of the boundary has not been adjudicated on the ground.

2.1.1.3 Numerical boundaries

Numerical boundaries are defined in terms of the map positions or co-ordinates, of corner beacons. The map takes precedence over evidence on the ground.

A numerical boundary is a kind of fixed boundary: the boundary does not move with usage. When the co-ordinate reference system shifts in a readjustment of the control system, numerical boundaries cannot be expected to shift as well. The boundaries are taken to lie along straight lines between corner beacons.

The definition of numerical boundary positions is a purely technical question, to be solved by a surveyor. In some European states numerical boundaries are still used, like in Holland (Jackson and Chilufya 2002).

Namibia like South Africa uses the fixed boundary system, because the whole survey system in Namibia is based on the South African system, the reason being that for years Namibia was under the governance of South Africa.

2.1.2 Adjudication

Adjudication – *'is the process whereby existing rights in a particular parcel of land are finally and authoritatively ascertained. It is a prerequisite to registration of title and to land consolidation arid redistribution - the process does not alter existing rights or create new ones'* (Dale and McLaughlin 1999).

According to Dale and McLaughlin (1999), *'Adjudication is the first step in the registration of title to land and encompasses procedures for determining what rights exist on the ground'.*

The International Federation of Surveyors (FIG)(1994) defines adjudication as being the process of final and authoritative determination of the existing rights and claims of people to land. FIG (1994) describes adjudication as being a standard procedure prior to the recording of these rights and claims in a registration system. FIG (1994) also states that adjudication is a standard procedure prior to the operation of a land consolidation scheme. The process of adjudication should simply reveal what rights already exist, by whom they are held and what restrictions or limitations there are on these rights.

The United Nations Centre for Human Settlements (UNCHS)(1990) describes adjudication as being the process whereby existing rights to parcels of land are finally and authoritatively ascertained. Adjudication is the first stage in the introduction of registration of title to land in areas already settled but where the ownership of the land is officially unknown. It is also a pre-requisite for land consolidation and redistribution to ensure that each existing owner is treated equitably.

Haldrup (1996) defines adjudication as being the resolution of a dispute by the application of pre-existing rules. He further refers to the *'www-questions'*: *what* right, *who* holds them and *where* can these rights be exercised?

Larsson (1991) states that Adjudication is an essential prerequisite for disposition of state land, consolidation of land and registration of land.

Adjudication means that the boundaries between any two parcels of land must be agreed upon between the adjoining parties. The long-term leases over the resettlement farms in Namibia are rights to be registered, so adjudication forms an important part of the planning of these leases.

Larsson (1991) states that the adjudication process could be sporadically or systematically applied.

2.1.2.1 Sporadic Adjudication

Sporadic adjudication is random, unpredictable with regard to location and timing, available to deal with one land parcel at one time and initiated by an application from the landholder (Larsson 1991).

According to UNCHS (1990), sporadic adjudication means that it occurs whenever or wherever there is a demand or other reason to determine the precise ownership of an individual parcel of land.

Davuth and Suon (2001) state that whenever and wherever there is a demand to or other reason to determine the precise ownership of an individual parcel of land then the process of sporadic adjudication is executed. They also claim that the sporadic method is much cheaper in the short run because in principle those who need a title pay for it.

UNCHS (1990), recommended that sporadic adjudication be used selectively to encourage specific categories of land ownership and it is claimed that it is cheaper in the short term because adjudication of the rights to many parcels of land can be

deferred. It also permits the cost of the whole operation to be passed directly to the beneficiaries who can be charged an appropriate fee for having their land registered.

2.1.2.2 Systematic Adjudication

Davuth and Suon (2001) describe systematic land adjudication as being a system where all land is adjudicated, area-by-area, parcel-by-parcel. They argue that it would be cheaper in the long run per parcel and that the method enables all expected benefits of land registration to be met. In terms of individuals' rights, they claim that it is safer than sporadic adjudication as it is executed with maximum publicity.

UNCHS (1990) sees the systematic approach as a methodical and orderly sequence wherein, area-by-area, all parcels of land are brought on to the register. Its use in Kenya and Malawi, where large areas of unrecorded land have been brought on to the registers, is given as an example of successful implementation. It is also claimed that systematic adjudication is in the long term less expensive because of economies of scale; that it is safer because it gives maximum publicity to the determination of who owns what within an area; and that it is more certain because investigations take place on the ground with direct evidence from owners of adjoining properties.

Larsson (1991) states that there are many advantages to systematic adjudication like it being more cost effective, multipurpose in its use, etc.

UNCHS (1990) states that in voluntary adjudication, the decision to have one's land adjudicated and registered is that of the landowner. Sporadic adjudication can be applied voluntarily, as it is a completely voluntary process based on the immediate need only, whereas the systematic approach must be compulsory since

it is necessary to summon everyone who claims to own land within a designated area to give evidence.

A statement from Sir David Gill's Geodetic Report cited in Jackson and Chilufya (2002)

> *'Early in the year 1897 I had an opportunity of discussing with Earl Grey, who was then Administrator of Rhodesia, the desirability of systematic survey as a first essential to a sound system of land tenure in a new country, and I endeavoured to prove to him the impossibility of surveying a country or of granting indisputable titles to land by surveys made in a patchwork way'*

2.1.3 Demarcation

Demarcation is aimed at defining the parcel of land on the ground and securing evidence for the re-establishment of the boundary if it disappears (FIG 1994).

In simple terms demarcation comprises the delimitation of boundaries and the emplacement of boundary markers (beacons or monuments).

According to Larsson (1991), demarcation includes both legal and technical aspects, but can basically be done in two ways, by:

I. Fixing the exact position of the boundaries on the ground in the presence of the parties' concerned. Boundary disputes can be referred to court or a surveyor determines the boundary. After fixing the positions of the boundaries, they are marked with iron pegs, pipes, stones, concrete beacons, etc, when topographical features such as fences and hedges are not regarded as offering sufficient demarcation. The establishing of new boundaries is usually determined this way.

II. Recognising the boundaries on the ground. When necessary, they may be surveyed or photogrammetrically identified, but they are neither legally fixed nor permanently demarcated if the parties involved do not request it. When large areas have to be mapped, this method is cheaper especially where the boundaries are visible on aerial photos.

2.1.4 Surveying

Surveying in simple terms means the recording of the position of the boundaries and other elements associated with each parcel of land.

The traditional definition of surveying is:
The art of making measurements of the relative positions of natural and man-made features on the earth's surface, and the presentation of this information either graphically or numerically (Survey Manual Version January 2000).

2.1.4.1 History

Egypt was probably the first place where early man took steps to become a food producer rather than a food gatherer. Until man had taken his first step in advancing from a nomadic to a more settled existence, he had no need for land measurement, nor did he have a need to record his claim to ownership of individual pieces of land. It is highly probable therefore, that Egypt saw the first use of surveying.

Evidence from the contents of tombs indicates that there was indeed a form of public land registration and that the land courts would entertain no claim if the land were not registered. There is also evidence that a simple but effective system of surveying was used to set out the boundaries of individual plots of arable land. Even more importantly, surveying was needed to recover the beacons and boundaries of these individual plots after they had been inundated during the

annual flooding of the Nile. The corner beacons of the plots were set out or recovered by measuring from permanent markers above the flood line.

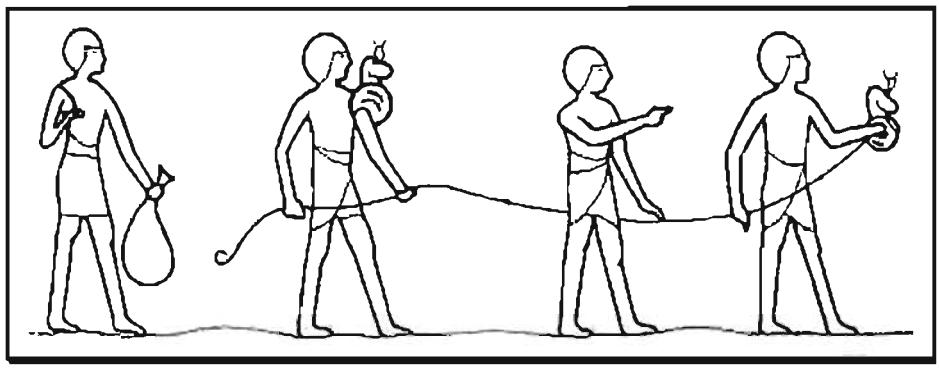


Figure 2.1 – Egyptian surveyors at work (Larsson 1991)

The first land surveyor arrived in the Cape in 1657, five years after Jan van Riebeeck had established the first European settlement at the southern tip of Africa. The first cadastral survey was done to survey a piece of land, on the banks of the Liesbeeck River, in order to transfer this land to a released servant of the Dutch East India Company. Apart from the river, which conveniently formed one boundary, poles were erected to demarcate the other boundaries, which were straight lines.

Graphical surveys were to persist for two centuries using natural features as boundaries, until 1857, when the use of theodolites and the recording of numerical data on diagrams were made compulsory. In 1927, the Land Survey Act, Act 9 of 1927 was put in place to guide and regulate the surveying of any piece of land.

2.1.4.2 Surveying Techniques

'In many countries, the techniques that must be used in cadastral surveying are prescribed in the law and regulations that specify the standards that are to be achieved and the techniques that must be used to deliver them' (Dale and McLaughlin 1999).

The surveying of property boundaries has been traditionally restricted to very few techniques by Survey Laws and Survey Regulations. There are always specific regulations regarding training and experience for land surveyors wishing to carry out cadastral surveys because they have a professional responsibility to society.

Dale and McLaughlin (1999) state that there are two broad categories of surveying techniques or methods, namely the field survey technique (ground survey method) and the photogrammetric survey technique (aerial photography method).

2.1.4.2.1 Field Survey Technique

Field survey is the technique normally used for undertaking cadastral surveys.

The cheap and simple method is to use plane tables or tapes and optical squares. The plane table method was used extensively for cadastral surveying in several European countries during the nineteenth century (Larsson 1991) and also in India and Bhutan in Asia and areas of Buganda in Uganda (Brook 1994).

The tapes and optical squares method, named the orthogonal method by Larsson (1991) was used until recently (twentieth century) for cadastral surveying purposes in urbanized areas in Europe.

Less use is made of the more sophisticated methods like polar and traversing with the use of electronic distance measuring equipment or "Total Stations", which usually give higher accuracies. As the reliability of electronic distance measuring equipment or "Total Stations" increases, coupled with the price decrease their use will certainly increase.

The use of GPS is being introduced more and more and promises to give high accuracy at a relatively low cost in the future (FIG 1994). GPS, more specifically

Real Time Kinematic for cadastral surveying, is becoming more popular due to its speed. Post-processing is used more for the establishment and densification of control points.

Appendices 1 to 4 illustrate the different methods of field surveying technique.

2.1.4.2.2 Photogrammetric Survey Technique

Photogrammetry - *The art, science and technology of obtaining reliable information about physical objects and the environment, through processes of recording, measuring, and interpreting images on photographs* (Survey Manual Version January 2000).

Cadastral surveying can also be undertaken by using aerial photography. Today high accuracies can be obtained using analytical photogrammetric methods. GPS can also be used to reduce the costs of establishing ground control.

Other types of maps or images such as orthophotos or enlarged photographs prints can be used to reduce costs in special areas, especially if a systematic approach is used. Satellite images can today be used effectively only in areas with very large estates and in open terrain and on scales smaller than 1:25 000, whereas most cadastral maps need to have larger scales (1:500 to 1:10 000) depending on the size of the parcels of land.

Aerial photographs can be a valuable aid to property planning but are subject to geometric distortion. As a result of this distortion aerial photographs are not true to any one scale. Geometric distortion of the aerial photograph makes it impossible to get a reasonable fit when applying true to scale information onto an aerial photograph.

There are several types of aerial photographs as listed below (Survey Manual Version January 2000):

- *Aerial Photographic Enlargement* - is nothing more than a "blown-up" photograph. Neither tilt nor relief displacement are removed for these photographs. Because of this, one will not be able to make accurate measurements from the photograph or from maps made from it. These photographs are helpful for making inventories of parcels of land and locating structures.

- *Rectified Aerial Photograph* - is one in which distortions caused by tilt displacement have been removed. The rectification process is accomplished by projecting the photograph image onto a flat surface, which is tilted to eliminate the original tip and tilt of the aircraft. The objective is to project the image back to its correct shape and scale. Although relief displacement is not removed from rectified photographs, this type of photography provides acceptable accuracy for assessment mapping in areas of relatively flat terrain.

- *Orthophoto* - look a lot like the other two types of aerial photographs. However these have the accuracy of a map drawn from ground survey information because tilt and relief displacement have been eliminated. Measurements of a land surveyor on the ground should "fit", when plotted on a true-to-scale orthophoto. Distances and area calculations on an orthophoto are usually extremely accurate, and property lines will correspond closely to physical features.

- *Digital Orthophoto* - is an orthophoto scanned or created in a digital format. These have the same accuracy as orthophoto sheets, but can be viewed and manipulated on the computer, with the capability to

zoom in or out. This also provides one with a method of laying property lines or any other data over the photograph.

When a new cadastral survey of a large area needs to be carried out quickly, aerial photography would be the best practical method (because one can cover a bigger area), unless there is a need for a lot of extra groundwork (Survey Manual Version January 2000).

The use of rectified aerial photographs, orthophotos or digital orthophotos has potential to be more accurate than normal aerial photographs.

2.1.4.3 Mapping (Cadastral Mapping)

Mapping is the construction on paper of a model of the real world from the measurements taken in the field.

A cadastral map is a plan showing the relative position or positions and boundaries of surveyed parcel or parcels of land. Cadastral maps are prepared for subdivisions and other cadastral measures; like cadastral lease diagrams for long-term leases.

Cadastral maps further document and clarify the recorded social transactions that create land ownership. One can also think of the map as providing an address. Alternatively one can think of the textual records as attributes of parcels of land of the map (Jackson and Chilufya 2002).

When we speak of a cadastral map, we usually mean a thematic map that shows parcels of land. The following figures illustrate cadastral maps in different countries.

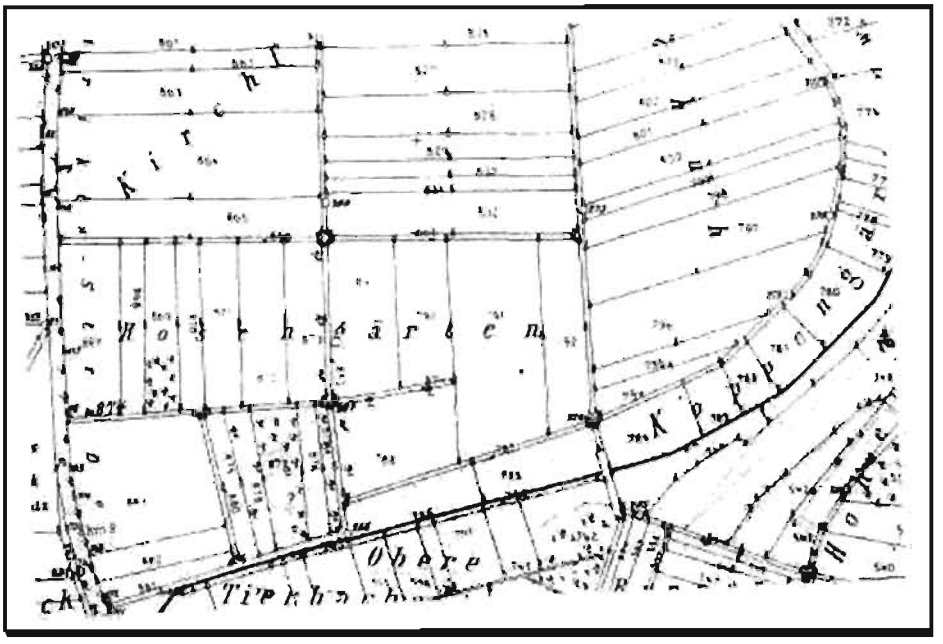


Figure 2.2: An extract from a German cadastral map (Larsson 1991)

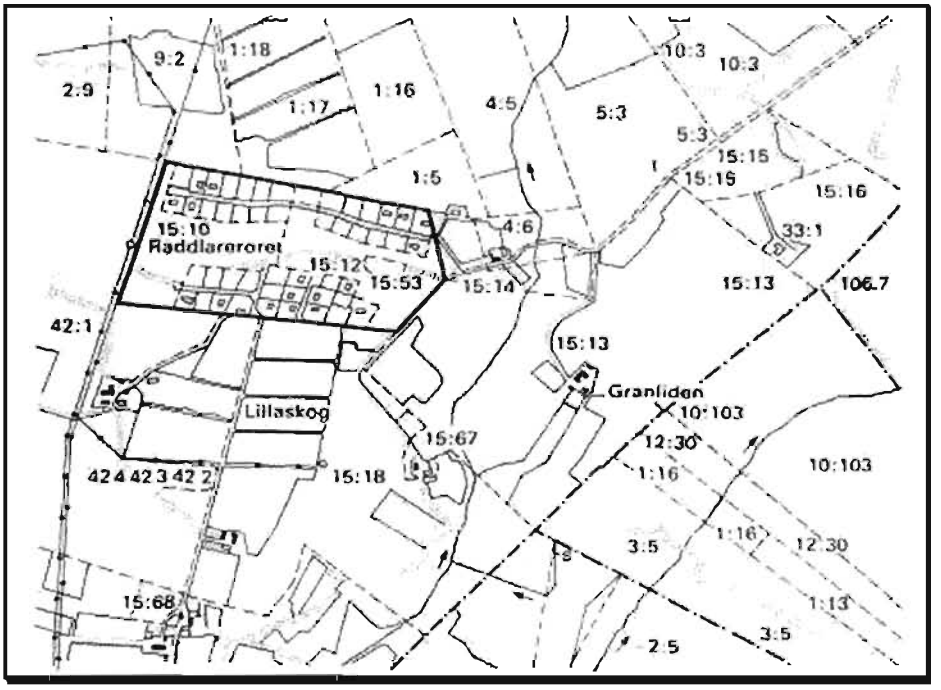


Figure2.3: An extract from a Swedish cadastral map (Larsson 1991)

Figure 2.4: A Dutch cadastral map from 1700 (From Kain and Baigent (1992) cited in Jackson and Chilufya 2002)

A cadastral map like the example above would be difficult to revise and could not easily form part of a countrywide administrative system.

The main types of cadastral maps in Namibia and South Africa (Department of Land Affairs) are the following:

I. The Survey Diagram.

This is the oldest cadastral map. It is a geometrical figure containing numerical and verbal representations of a piece of land, line, feature or area forming the basis for registration of a real right. The survey diagram is the fundamental registerable document prepared by a professional land surveyor for approval at the SGO.

The most common types are the following:

- Subdivisional Diagrams

- ❖ Consolidation Diagram
- ❖ Servitude Diagram
- ❖ Substitutional Diagrams
- ❖ Lease Diagram (Cadastral Lease Diagram)

The lease diagram (cadastral lease diagram) is the one that is important in this study. A lease diagrams is required for the registration of long-term leases over portions of specific properties (farms or erven).

II. The General Plan.

It is a plan representing the relative positions and dimensions of two or more pieces of land together with the same essential information in respect of each land parcel, as required on a diagram.

III. The Sectional Title Plan.

It is a plan showing portions of buildings (sections) that can be separately owned as well as the positioning of these buildings in relation to the land.

IV. The Working Plan.

It is a plan drawn and signed by a professional land surveyor, and it accompanies and forms part of survey records that are submitted to the SG for approval. A working plan shows exactly what the land surveyor had done in the field, indicates existing and newly placed beacons, the property designation, boundaries, servitudes, roads, surrounding properties and rivers.

V. The Noting Plan or Compilation Sheet.

It is purely a cadastral map at various scales showing all land parcels and administrative boundaries, like local authorities, regions, registration division, etc. It shows the relationship of every piece of land to those adjoining it and additional other surveyed real rights such as servitudes and

leases are also included in this map. Noting Plans or Compilation Sheets are internationally called *Index sheets.*

Appendices 5 to 7 illustrate some examples of some of the types of cadastral maps in Namibia and/or South Africa.

2.1.4.4 Legislation – Land Survey Act and Survey Regulations

The Land Survey Act, Act 9 of 1927 put cadastral surveying in Namibia in the position it is today: it is one of the best and most reliable systems anywhere in the world of defining the boundaries of properties, and the positions of rights affecting those properties. That the Act of 1927 was a well thought-out document, based on sound experience, is evident as it was used with only minor amendments to it for sixty years until it was replaced by a new, but substantially similar, Land Survey Act, Act 33 of 1993.

The individual professional land surveyor's field and office records were after 1927 examined and, after approval, were stored in the SGO as evidence for any future boundary relocation. According to the land Survey Act all surveys had to be connected to the national control survey system, as this was extended across the country.

Namibia for years used and relied on the legislation of South Africa, because South Africa was its custodian. The Land Survey Act, Act 9 of 1927 was in operation until 22 December 1993, when the new Land Survey Act, Act 33 was promulgated.

The survey regulations of South Africa were still in operation until 15 April 2002, when the new Survey Regulations for Namibia were gazetted, these regulations being substantially similar to the old survey regulations.

In October 1992 the Chief Surveyor General of South Africa, Mr. D. J. Grundlingh revised a set of *'Random Notes on Land Survey Practice and Procedure in the Republic of South Africa'*, by T de Smit - 1955 *(See Appendices 8 and 9)*. There will be further discussion on these notes under the results.

2.2 Case Studies – Use of Digital Orthophotos

In order to learn more about the usage of orthophotos and digital orthophotos, two situations are reviewed, namely:

- Palestine – Using Digital Orthophotos to Support Land Registration – Authors: Kari Mikkonen and Ian Corker
- The Cadastral Survey Requirements of Developing Countries in the Pacific Region With Particular Reference to Fiji – Author: I. P. Williamson

In Palestine the land involved was 7 000 hectares in the Gaza strip, where ownership has never been registered.

In Fiji the land involved was 45 000 acres bought by the Government in 1973. Tenant farmers on lots between 6 to 25 acres occupy the land.

2.2.1 Palestine – Using Digital Orthophotos to Support Land Registration

According to Mikkonen and Corker (2000), the reason for looking into the use of digital orthophotos was to help the Palestinian Authority to improve land administration in Palestine and especially to carry out the new registration of large areas, altogether 7000 hectares, in the Gaza strip, occupied by Bedouins.

The registration was very much out of date, in some cases the latest registrations dated back to 1920's and 1930's, when Palestine was still under British control.

Since the concept of individual land ownership was difficult for the Bedouins to understand, these areas were never registered.

Palestine uses the general boundary route, because the exact lines of the boundaries were never determined.

The British Military Survey had established the geodetic control network, in the early 1920's. The network is a very unreliable one, because most of the original points were destroyed, either deliberately or accidentally. According to Mikkonen and Corker (2000), only one original control point was found in the Gaza strip. In the project Mikkonen and Corker and the British Consulate joined forces and it was agreed to re-establish and improve the geodetic network.

The Finnish project purchased a kit of 4 Leica geodetic GPS receivers for the Ministry of Housing. The British Consulate funded the mission of a GPS survey team from Ordnance Survey International. The survey was conducted in the spring of 1999. The current geodetic network has excellent internal accuracy (in XY) and is firmly tied to international reference stations. Surveyors in the Ministry of Housing were given intensive on-the-job training and they are today able to densify the network and conduct GPS field surveys on their own.

Most of the cadastral maps are from 1920's and 1930's. The maps available in Palestine are most often copies of copies (of copies), because the original maps are held by Israel.

The use of aerial photography in Palestinian territories was very much restricted, because of the political situation, and only Israeli companies were allowed to fly. The aerial photographs are reviewed by the Israeli military and plans for aerial photography need to be accepted by the Israeli military.

During their project Mikkonen and Corker faced also other practical problems when preparing for aerial photography like:

- There had to be an agreement that the aerial photography will take place on a certain day
- It had to be arranged that signals be laid on the ground on the preceding days.
- Some of the signals or part thereof were almost immediately stolen or destroyed by the local Palestinians.
- The Israeli company flew the photography one day earlier than was agreed because the Israeli military had supposedly announced it would "close the sky" on the scheduled flight day. Since the planned amount of signals on the ground were not placed, and therefore because of missed photogrammetric reference and tie points they had to do quite a lot of extra work to identify sharp natural features clearly visible on the orthophotos and have them surveyed afterwards.

According to Mikkonen and Corker (2000), the surveyor had a resistance to accept orthophotos as a sufficient accurate, scientific and practical cadastral survey technique. It does not feel right for the surveyors to obtain accurate results without taking survey instruments to the field.

The field surveyors using total stations had to re-survey the parcels' boundaries to check the accuracy of the digitized parcel boundaries. The Palestinian GIS operator produced his data and map in less than two hours, whereas it took two days for the team of two surveyors and their assistants to produce their map. The maps matched perfectly.

The conclusion was that there are basically two techniques for surveying or capturing parcel boundaries, namely: Land based survey and Data capture from orthophotos.

- Land based surveys.

  According to Mikkonen and Corker (2000), when large areas need to be surveyed the land based survey method using total stations is an expensive and slow survey method. They further state that the method is popular because it is well understood and considered accurate. In fact in many cases land based survey can be quite inaccurate.

  The surveyors capture the corner points of beacons in the field and assume that the boundary between the points is a straight line. In the case of general boundaries, the boundaries are quite often not at all straight. In Gaza the even boundaries that first appear straight (edge of road, hedge, fence, ditch) on closer inspection often bend or curve. Heads-up digitising from orthophoto images often captures the actual boundaries more accurately than the field survey that only captures individual points with good precision.

- Data capture from orthophotos.

  For large areas aerial photogrammetry and data capture from orthophotos is a quick and economic solution. Purchase of orthophotos in the beginning will cost a lot, but is a good investment that in the long run will pay back. The digital orthophotos are useful for other organizations as well, so there is a good chance for sharing costs.

This project under the leadership of Mikkonen and Corker with its good results has convinced the surveyors and there is now a big demand for new orthophotos, to support survey on other areas in Palestine.

2.2.2 The Cadastral Survey Requirements of Developing Countries in the Pacific Region with Particular Reference to Fiji

According to Williamson (1981) the project consisted of surveying approximately 45 000 acres of land previously owned by the Colonial Sugar Refining Company and bought by the Government of Fiji in 1973.

The project adopted the procedure of adjudicating the boundaries by consulting the tenant farmers of a specific area, mark and survey the lots, roads, drainage easement and railway reserves and then prepare plans of the survey.

The three main functions for the survey were the following:

- The first function of the survey was to facilitate the issue of registered leases for all the lots; to give the tenant farmers increased security of tenure and a mortgage-able interest in the land.

- The second function of the survey was that it would define and mark physically on the ground all boundaries within the survey area and hence assist in resolving any existing or future boundary disputes.

- The third function of the survey is that it provides an inventory of all the land that is surveyed with details of the registered tenants.

If cadastral surveys in developing countries were carried out according to the sophisticated procedures established (though these, in fact, are only partly carried out) in the developed countries, the consequence would be great expense and slow progress. The contribution of such a cadastral survey to the development of the country would therefore be small, and probably very inefficient with regarded to cost.

'The precision of a cadastral survey should not be more than necessary, for the fulfilment of practical requirements. The system, the method of production, and the legal basis should be adapted to local circumstances both social and physical.' Williamson (1981)

The use of orthophotos for the combined use of general and fixed boundaries for the lease areas is suggested. According to Williamson (1981) Fiji has received orthophoto coverage over the past years over most of the agricultural land, especially the area for leases. The orthophotos were produced from scratch so the survey control could have been increased, which would have been of great help in the future.

According to Williamson (1981) the most immediate benefit of the use of orthophotos is the cost savings. Initial investigations have indicated that by using an orthophoto approach, the costs for survey could be significantly less than the current ground survey techniques.

A secondary benefit is to the tenant farmers but is in fact of prime importance to the nation, because there is the possibility of creating a multi- purpose cadastre by using this approach. The orthophotos with the cadastral overlay could be used for a multitude of other uses, for example in rural areas where the project is located the maps may be used for valuation and assessment, land use planning, utilities and services, census information, agricultural planning administration, transportation studies, preparation of land inventories and drainage and irrigation facilities, as well as the major uses of registration of title and boundary definition.

Williamson (1981) concluded with the following statement; *'Many survey systems in developing countries should be reviewed to assess whether they are meeting the economic and social demands presently placed on them.'*

3. Research and Research Results

3.1 Lease Areas over Resettlement Farms in Namibia

3.1.1 Case Study Area

The farms that have been surveyed by the SGO or Private Land Surveyors were submitted to the SGO for approval; so all the surveyed information is thus available at the SGO.

The farm Nautabis No. 268, situated in Registration Division " K", in the Khomas Region in Namibia, was chosen as the study area. The farm Nautabis is 100 kilometres southeast of Windhoek, with the following approximate geographical co-ordinates:

Latitude	23° 03' 38"	South
Longitude	17° 56' 27"	East

See *figure 3.1* on the next page for the location of the farm.

The farm was chosen because the survey was carried out with the combination of GPS and Total Station. Furthermore due to the fact that this is only a Mini-dissertation and also because of time constraints, only one farm was used for research purposes.

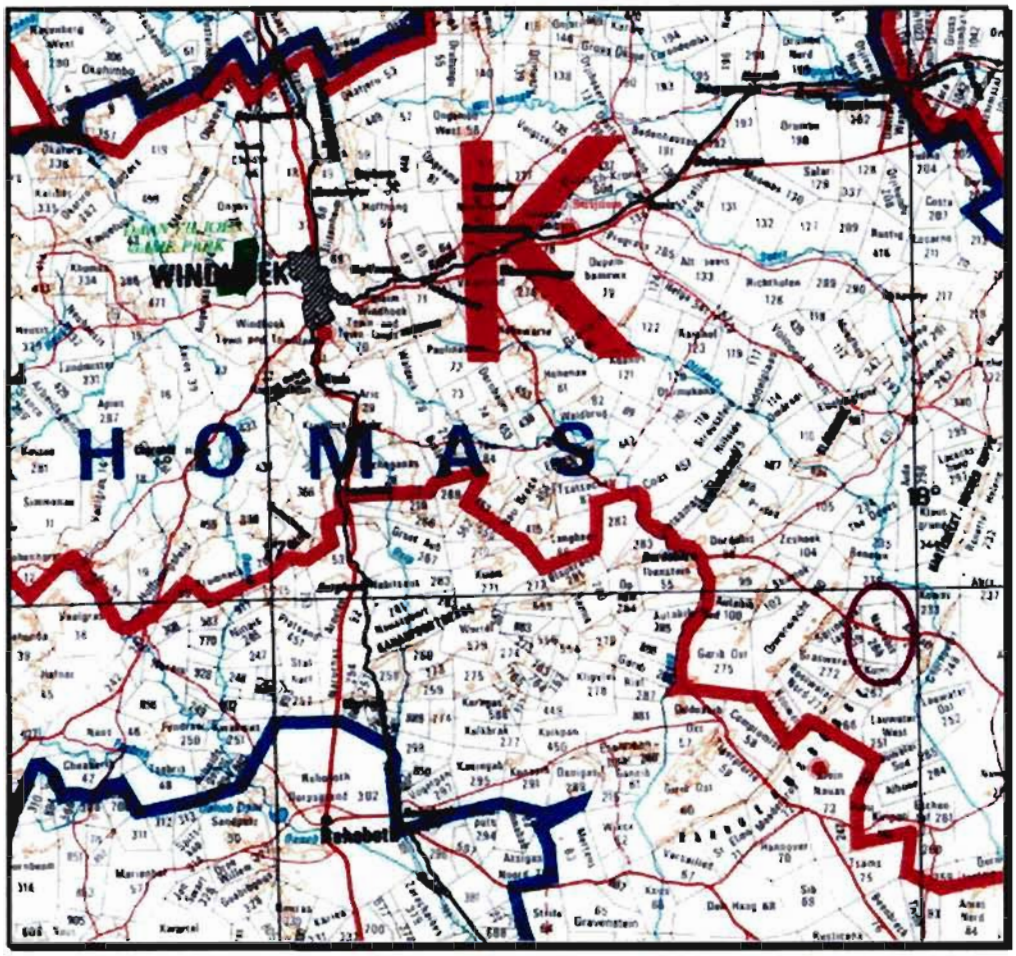


Figure 3.1: Part of the 1: 1 000 000 Wall Map of Namibia showing the Location of the farm Nautabis No 268 (Purple Ellipsoid)

3.1.2 Methodology

3.1.2.1 Planning of Lease Areas

The land-use planners under the Directorate of Resettlement and Rehabilitation (DRR), of MLRR get the information of the original boundaries of the farms bought for resettlement purpose from the SGO. In more than 90% of the cases the outside boundaries (the parameter survey) of these farms are already surveyed. Together with this information and the use of topographical maps of a scale of 1:50 000, they do their planning for the lease areas, see *figure 3.2,* a scanned part of the farm Nautabis on a topographical map (2317 BB – Nautabis).

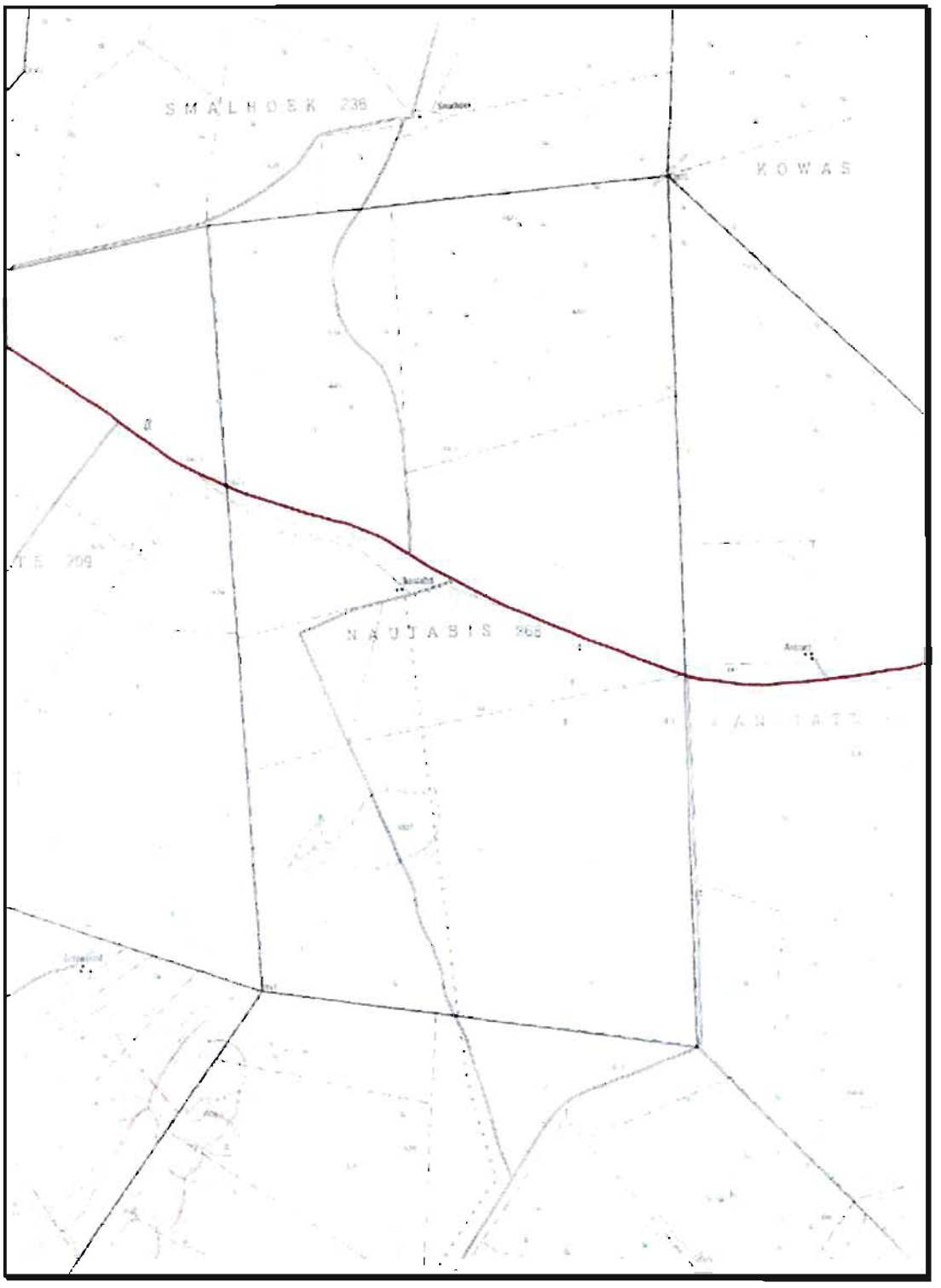


Figure 3.2: Scanned part of a 1: 50 000 topographical map of the farm Nautabis No 268

They further do site visits to verify some of the information like boreholes, reservoirs, farmhouses, and existing internal fences and gather other useful information on the topographical maps, by using a hand-held GPS.

After the proposed layouts have been drawn, they are presented to Director of the DRR, who will present the plans to the Minister of MLRR for approval. The farm Nautabis No 268 was planned into three lease areas.

After the approval from the Minister, the SG will receive instructions to survey the lease areas and prepare cadastral lease diagrams over these resettlement farms. The SG can appoint a private professional land surveyor, if the SGO is not in the position to carry out the surveying of the long-term leases. The flow diagram *(figure 3.3)* on the next page illustrates the planning process up to the instruction to the SG to survey the lease areas over a resettlement farm, like the farm Nautabis.

Figure 3.4 shows the layout plan approved by the Minister. The approved plan shows that the lease area boundaries are planned on existing fences. The usage of these existing fences means that there will be no cost involved to separate the different lease areas from each other, so less or no money will be spent by the resettled landless farmers to erect new fences.

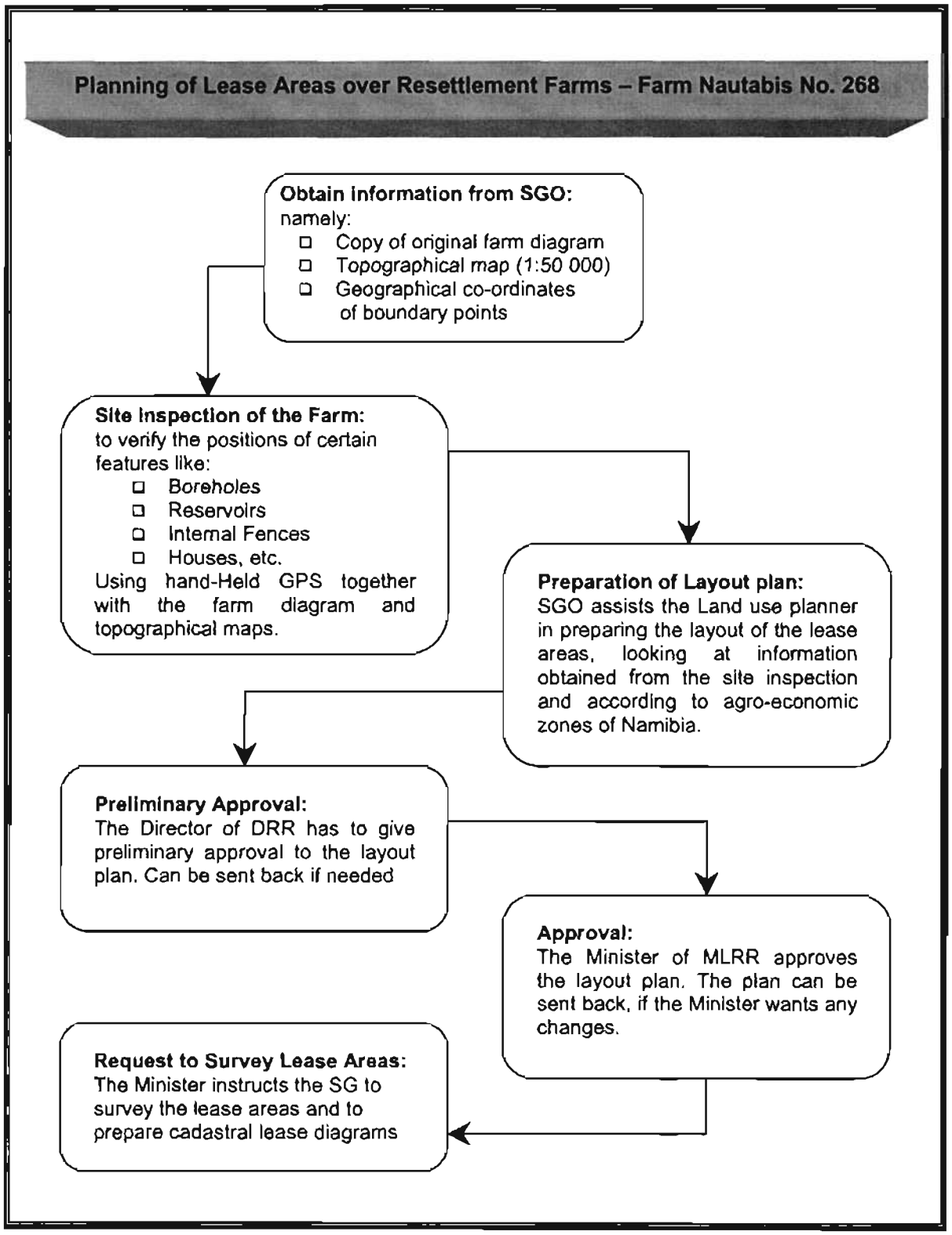


Figure 3.3: Planning of Lease Areas over the farm Nautabis No 268

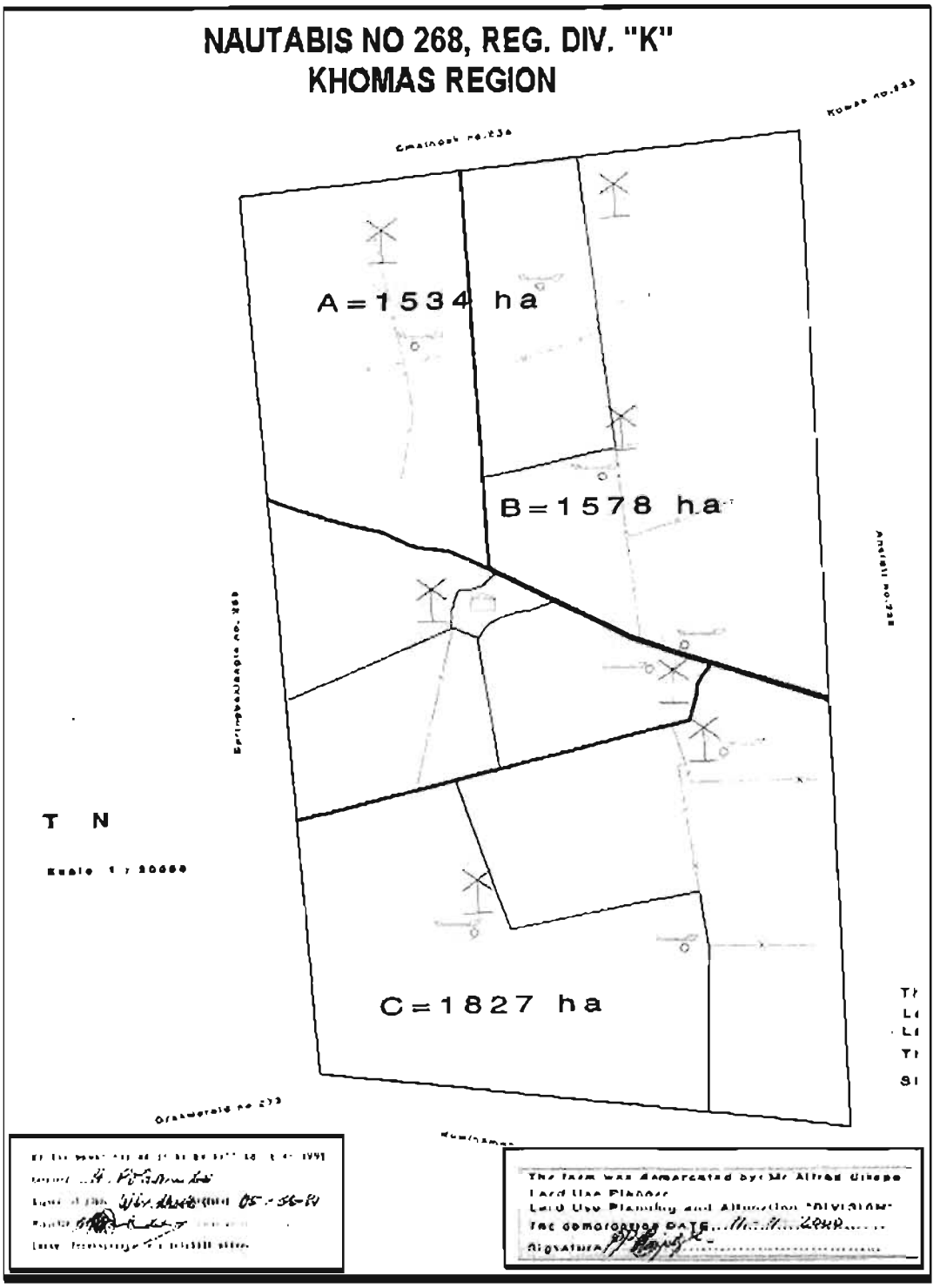


Figure 3.4: Approved Lay-out of the farm Nautabis No 268

3.1.2.2 Surveying of Lease Areas

The SGO and/or the private professional land surveyors are responsible for survey these lease areas and for preparing the cadastral lease diagrams that are needed for registration of the long-term leases, before the resettling of the landless farmers can take place. This means that cadastral surveying needs to be carried out.

The outside boundaries (the perimeter survey) of most of the commercial farms are already surveyed by the current surveying techniques, like the using of theodolites, Total Station and electronical distance measuring or nowadays by GPS. All the surveys of the commercial farms have been connected to the national control network, as specified by the Land Survey Act (1993) and the Survey Regulations.

3.1.2.2.1 Surveying of Lease Areas over the Farm Nautabis No 268

The survey of the farm Nautabis No 268 was contracted to a private professional land surveyor. The survey was done in March 2003, with the combination of the use of GPS and a Total Station. According to the survey report *(figure 3.5)* of the professional land surveyor, he obtained very good results. His comparison sketch, *figure 3.6* also proved that the survey was of good standards. He found three of the original farm beacons and replaced the other one at the intersections of the fences. The triangulation *(figure 3.7)* and the working plan *(figure 3.8)* show how the survey was carried out.

SURVEY REPORT

SURVEY OF THREE LEASE AREAS OVER THE FARM NAUTABIS 268
REGISTRATION DIVISION K

1. Assistants: One field assistant was used.

2. Purpose of Survey was to establish three lease areas on the whole of the land As this is now State Land and a State Survey, no statutory consents are required.

3. Special Requirements:
i) The whole farm had to be surveyed into lease areas.

4. Beacons.

4.1. Beacon ANNABF was easily found. A proper stone cairn exists and I did not want to dismantle the whole cairn to see the peg inside. I lifted a few stones and found part of a wooden signal inside the middle of the cairn. This position was accepted for the beacon.

4.2. Beacon 3269F was easily found fenced of, but a 12mm iron peg was found inside the stone cairn instead of a bottle in an earth heap.

4.3. At 3263F the neat diamond shape fenced off corner was broken, the stone cairn was broken down and the farmer had placed a 75mm pipe game fence post on the intersection of the fences. I was quite annoyed at this because the beacon was practically destroyed. Fortunately the fence post fell exactly on the intersection of the fences and the position looked credible.

4.4. At 3235P the diamond shape fenced corner was still intact but no beacon could be found inside, so I placed as 20mm iron peg exactly at the intersection point of the fences.

5. My survey was done with a Trimble 4000 base station and 4400 Rover. It was quite difficult to connect to a nearby trig beacon as the nearest was 9,6km away. So I accepted a preliminary position for Annab and calibrated my survey on that. I then visited the four land beacons and re calibrated my survey on them. Results were acceptable. However, it was decided to accept the original Lo 22/17 values of Annaberg after being transformed from Lo 22/19 from SR E 10/73 and the Lo 22/17 value of 3263 from diagram A35/55 (SR. E 12/1955)
To prove my Lo position of the farm, a resection was done at AB1, close to ANNABF. More than three trig beacons could be seen, but only 3 could be successfully identified. All other three farm beacons of Nautabis 268 were also observed.
A difference of 0,11 and 0,14 was found on Annabf, which proves my position. It was impossible to sight an arc at 3269F and 3235P
Having accepted previous values of ANNAB and 3263, I decided to do another Helmert transformation to check the scale enlargement of my D.C. file.
For the expenment I threw in AB1 as well as my calculated values of 3235P and 3269F from page 101. The results on page 109 were, to my mind, satisfactory. Differences from the DC file conversion to my new transformations were small.
The new transformation values on page 109 were accepted for diagram purposes.
Seeing that it would be very difficult to do a resection at 3263F, I deem it unnecessary to visit the beacon again.

6. LS1 was 0.03 off line and was recalculated on line for the purpose of the diagram. LS12 lies 4 metres away from the existing fence. Having checked everything I am convinced that the fence is not quite straight.
Beacons along line LS2 - LS9 were placed on the southern side of the road next to the existing road reserve fence.

7. Calculations were done in Trimble geomatics office and Compuplot.

Signed Date: 27 March 2003

Professional Land Surveyor

Figure 3.5: Survey Report

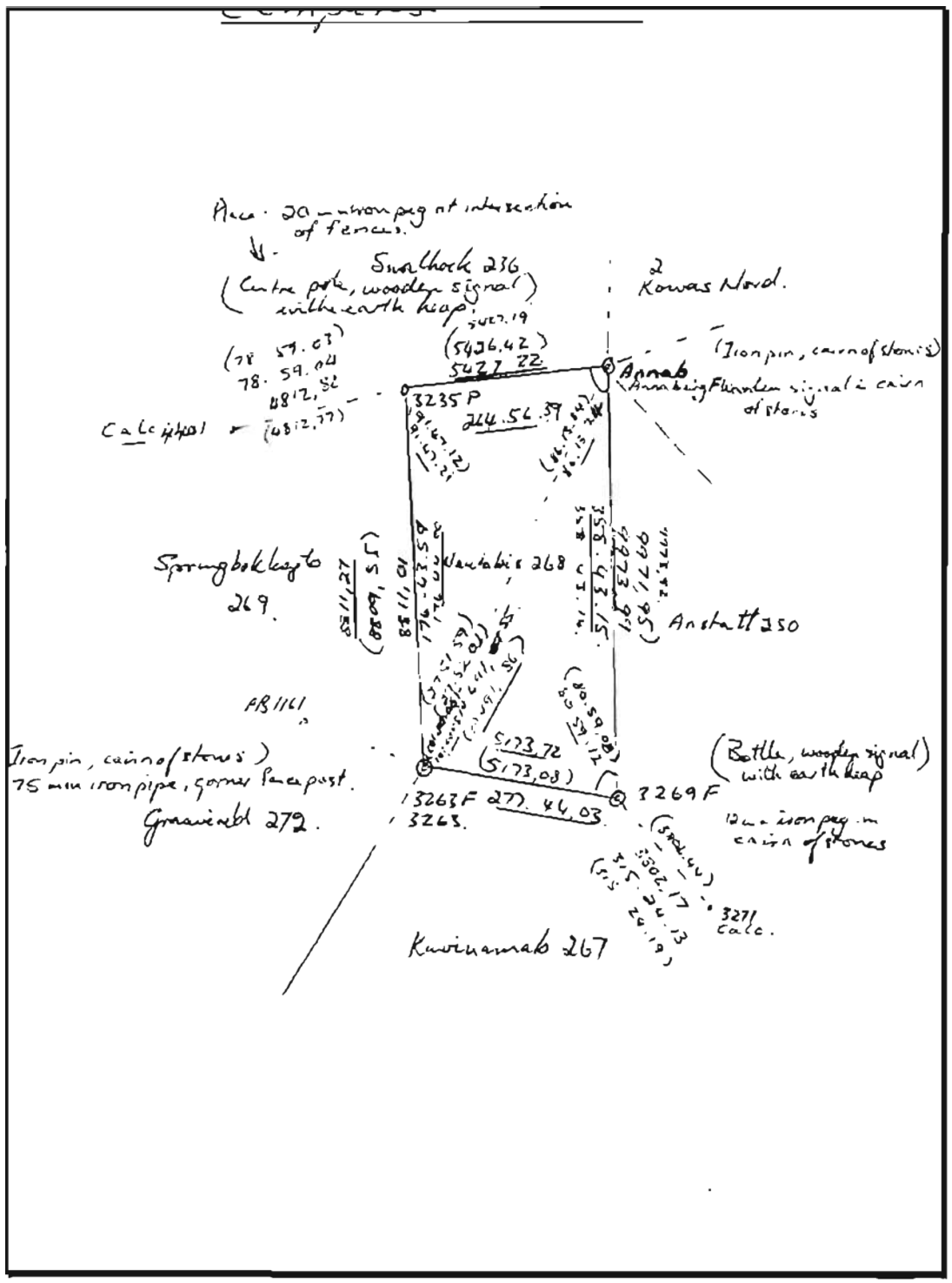


Figure 3.6: Comparison Sketch

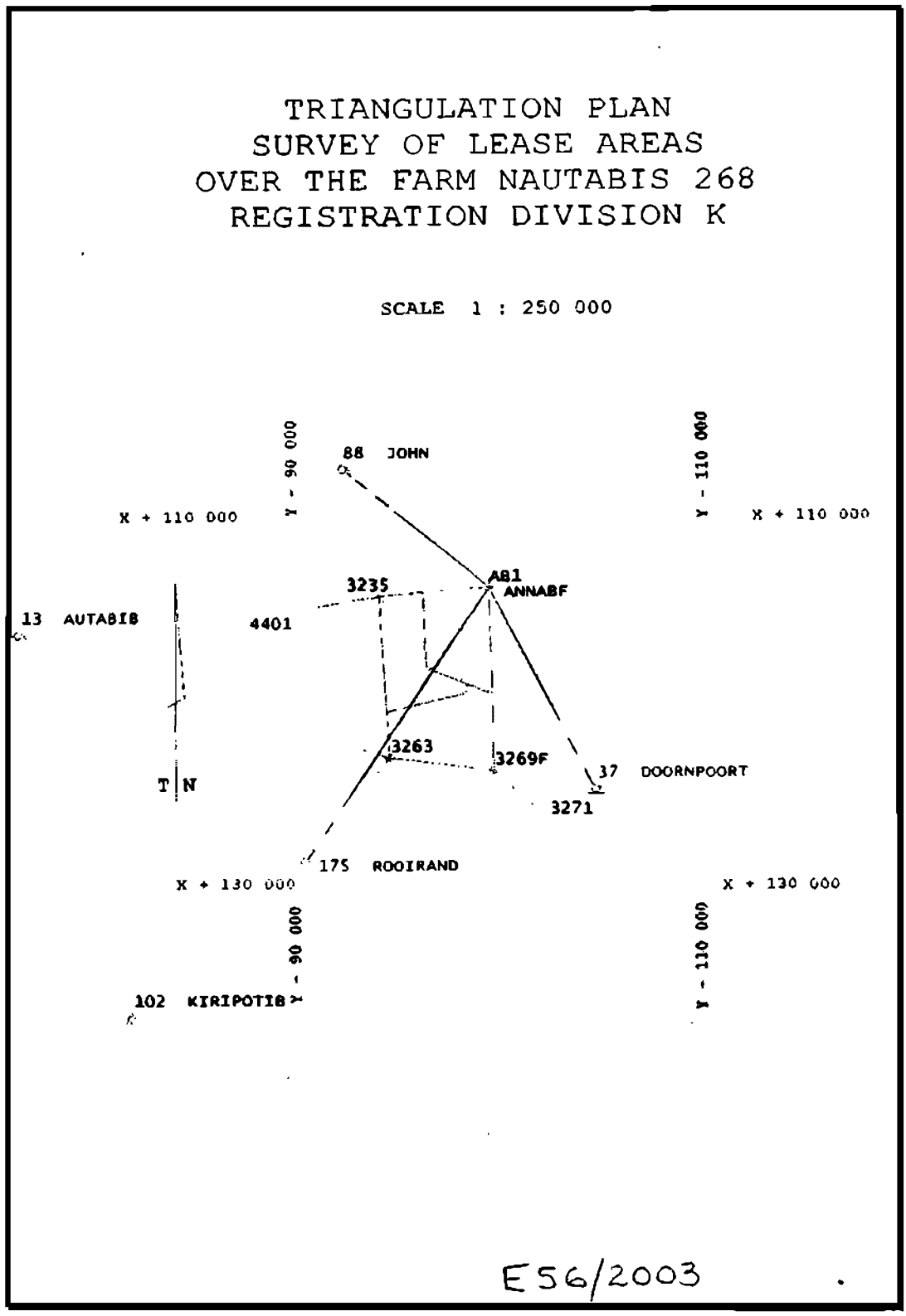


Figure 3.7: Triangulation Plan

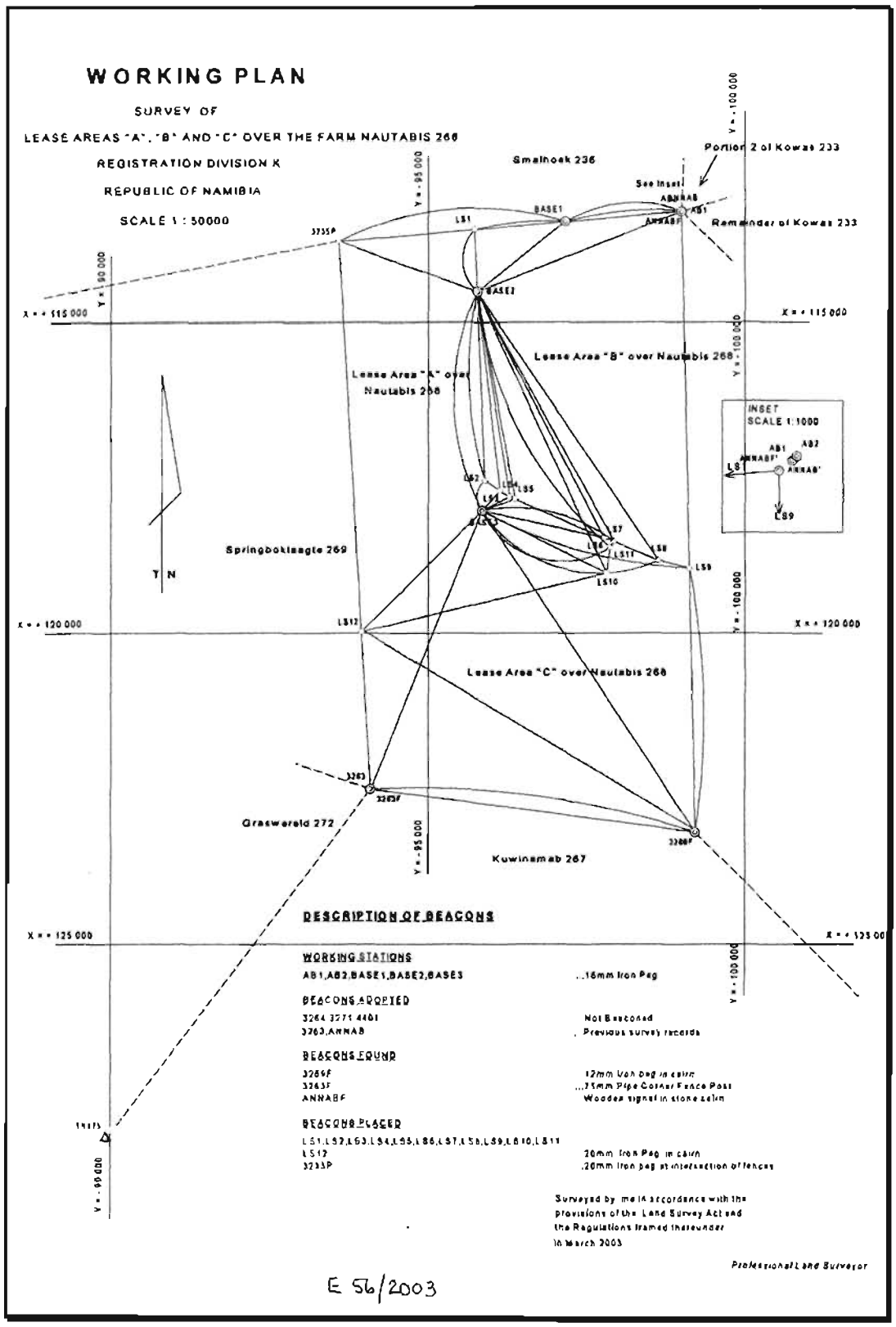
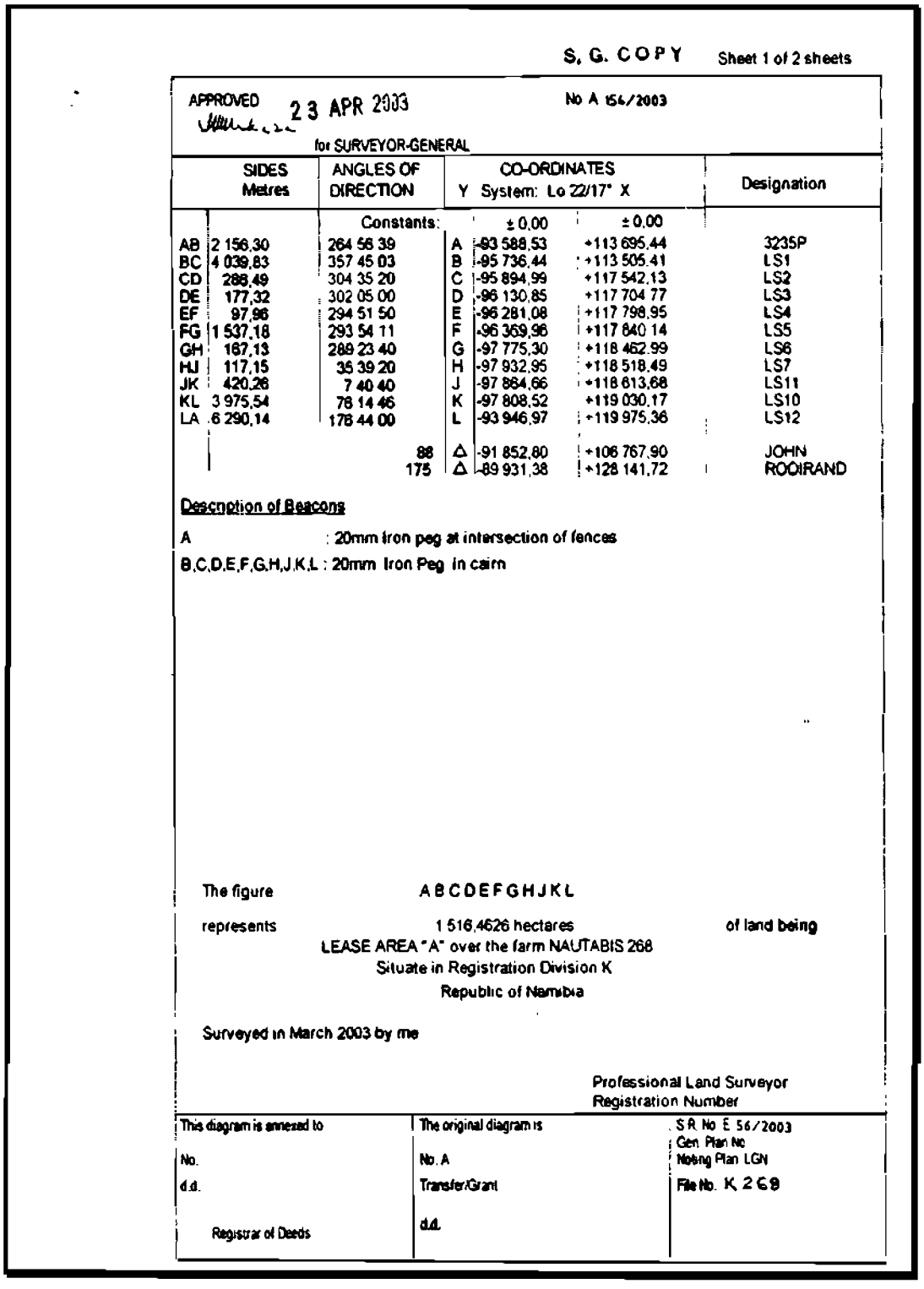


Figure 3.8: Woking Plan

From a personal interview with the professional land surveyor, it was found that the time spent to finalise everything, including the fieldwork and the office work was 10 working days. He further admitted that basically all the boundaries of the lease areas were along existing fences except for a short line between lease area A and lease area C. *Figures 3.9, 3.10, 3.11 and 3.12* represent the cadastral lease diagrams as surveyed.



S. G. COPY Sheet 1 of 2 sheets

APPROVED 23 APR 2003 No A 154/2003

for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants:		± 0,00	± 0,00	
AB	2 156,30	264 56 39	A	-93 588,53	+113 695,44	3235P
BC	4 039,83	357 45 03	B	-95 736,44	+113 505,41	LS1
CD	288,49	304 35 20	C	-95 894,99	+117 542,13	LS2
DE	177,32	302 05 00	D	-96 130,85	+117 704 77	LS3
EF	97,96	294 51 50	E	-96 281,08	+117 798,95	LS4
FG	1 537,18	293 54 11	F	-96 369,96	+117 840 14	LS5
GH	167,13	289 23 40	G	-97 775,30	+118 462,99	LS6
HJ	117,15	35 39 20	H	-97 932,95	+118 518,49	LS7
JK	420,26	7 40 40	J	-97 864,66	+118 613,68	LS11
KL	3 975,54	78 14 46	K	-97 808,52	+119 030,17	LS10
LA	6 290,14	178 44 00	L	-93 946,97	+119 975,36	LS12
		88	Δ	-91 852,80	+106 767,90	JOHN
		175	Δ	-89 931,38	+128 141,72	ROOIRAND

Description of Beacons

A : 20mm Iron peg at intersection of fences

B,C,D,E,F,G,H,J,K,L : 20mm Iron Peg in cairn

The figure A B C D E F G H J K L

represents 1 516,4626 hectares of land being

LEASE AREA "A" over the farm NAUTABIS 268

Situate in Registration Division K

Republic of Namibia

Surveyed in March 2003 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S.R. No E 56/2003
No.	No. A	Gen. Plan No.
d.d.	Transfer/Grant	Mining Plan LGN
Registrar of Deeds	d.d.	File No. K 2 6 9

Figure 3.9: Cadastral lease diagram for lease area A (Sheet 1) over the farm Nautabis No 268

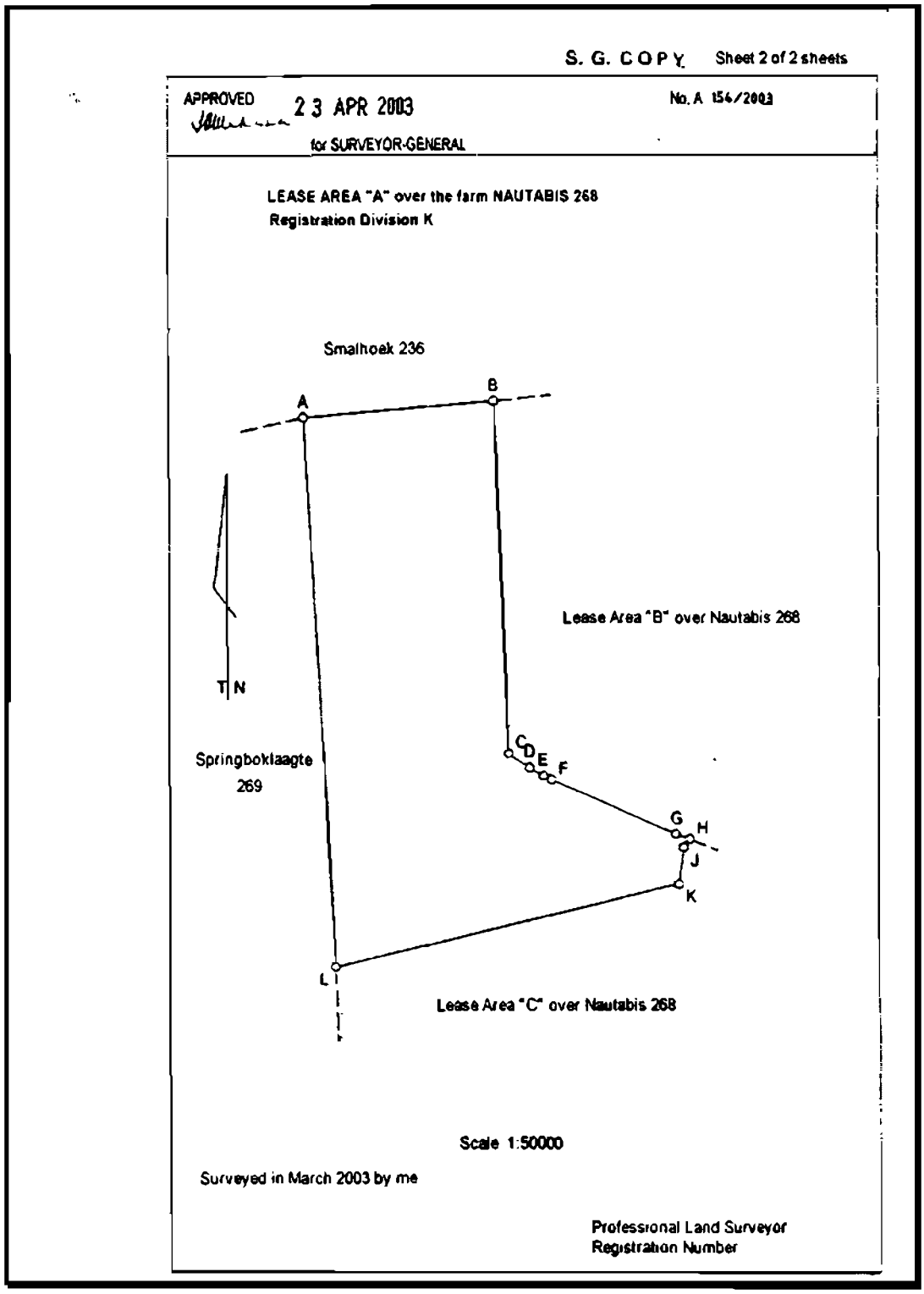


Figure 3.10: Cadastral lease diagram for lease area A (Sheet 2) over the farm Nautabis No 268

S. G. COPY

APPROVED 23 APR 2003 No. A 155/2003

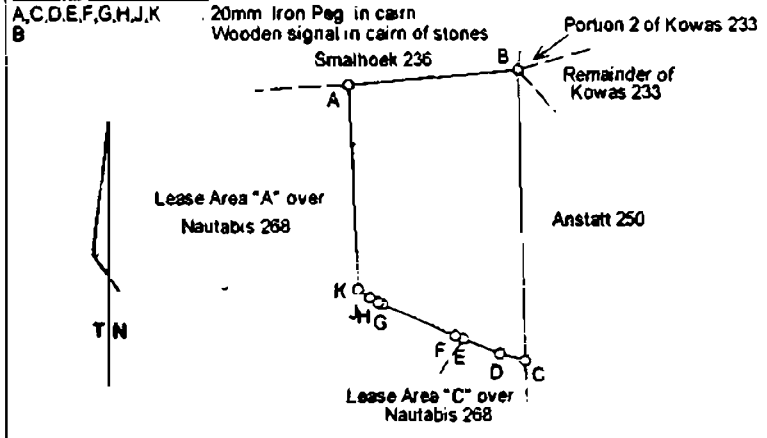
for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System. Lo 22/17° X		Designation
		Constants:		± 0,00	± 0,00	
AB	3 270,93	264 56 39	A	-95 736,44	+113 505,41	LS1
BC	5 738,05	358 43 15	B	-98 994,64	+113 217,16	ANNAB
CD	506,81	104 33 00	C	-99 122,73	+118 953,78	LS9
DE	784,04	113 46 20	D	-98 632,17	+118 826,46	LS8
EF	167,13	109 23 40	E	-97 932,95	+118 518,49	LS7
FG	1 537,18	113 54 11	F	-97 775,30	+118 462,99	LS6
GH	97,96	114 51 50	G	-96 369,96	+117 840,14	LS5
HJ	177,32	122 05 00	H	-96 281,08	+117 798,95	LS4
JK	286,49	124 35 20	J	-96 130,85	+117 704,77	LS3
KA	4 039,83	177 45 03	K	-95 894,99	+117 542,13	LS2
		88	Δ	-91 852,80	+106 767,90	JOHN
		175	Δ	-89 931,38	+128 141,72	ROOIRAND

Description of Beacons

A,C,D,E,F,G,H,J,K 20mm Iron Peg in cairn

B Wooden signal in cairn of stones



Scale 1:100000

The figure A B C D E F G H J K

represents 1 602,1588 hectares of land being

LEASE AREA "B" over the farm NAUTABIS 268

Situate in Registration Division K

Republic of Namibia

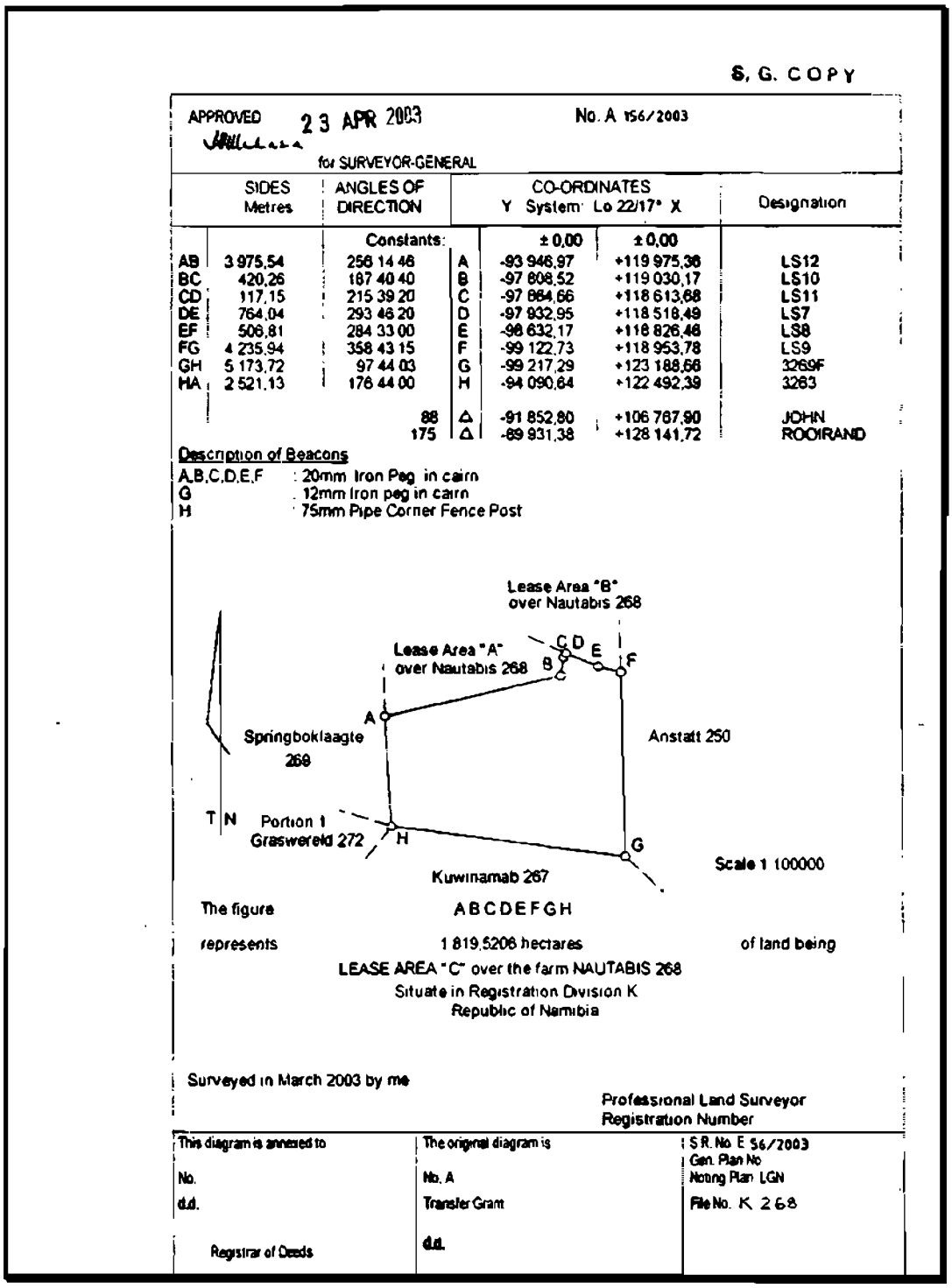
Surveyed in March 2003 by me

Professional Land Surveyor

Registration Number

This diagram is annexed to	The original diagram is	S.R No E 56/2003
No.	No A	Gen. Plan No.
d.d	Transfer/Grant	Noting Plan LGN
Registrar of Deeds	d.d.	File No K 268

Figure 3.11: Cadastral lease diagram for lease area B over the farm Nautabis No 268



S. G. COPY

APPROVED 23 APR 2003 No. A 156/2003

for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System Lo 22/17° X		Designation
		Constants:		± 0,00	± 0,00	
AB	3 975,54	256 14 46	A	-93 946,97	+119 975,36	LS12
BC	420,26	187 40 40	B	-97 808,52	+119 030,17	LS10
CD	117,15	215 39 20	C	-97 864,66	+118 613,68	LS11
DE	764,04	293 46 20	D	-97 932,95	+118 518,49	LS7
EF	506,81	284 33 00	E	-98 632,17	+118 826,46	LS8
FG	4 235,94	358 43 15	F	-99 122,73	+118 953,78	LS9
GH	5 173,72	97 44 03	G	-99 217,29	+123 188,66	3269F
HA	2 521,13	176 44 00	H	-94 090,64	+122 492,39	3263
		88	Δ	-91 852,80	+106 767,90	JOHN
		175	Δ	-89 931,38	+128 141,72	ROOIRAND

Description of Beacons

A,B,C,D,E,F : 20mm Iron Peg in cairn
G : 12mm Iron peg in cairn
H : 75mm Pipe Corner Fence Post

The figure ABCDEFGH

represents 1 819,5206 hectares of land being

LEASE AREA "C" over the farm NAUTABIS 268

Situate in Registration Division K

Republic of Namibia

Surveyed in March 2003 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S.R. No. E 56/2003
No.	No. A	Gen. Plan No
d.d.	Transfer Gram	Noting Plan LGN
Registrar of Deeds	d.d.	File No. K 268

Figure 3.12: Cadastral lease diagram for lease area C over the farm Nautabis No 268

The flow diagram *(figure 3.13)* on the next page illustrates the surveying procedures that were followed by the contracted professional land surveyor to survey and prepare the cadastral lease diagram for the lease areas over the farm Nautabis No 268.

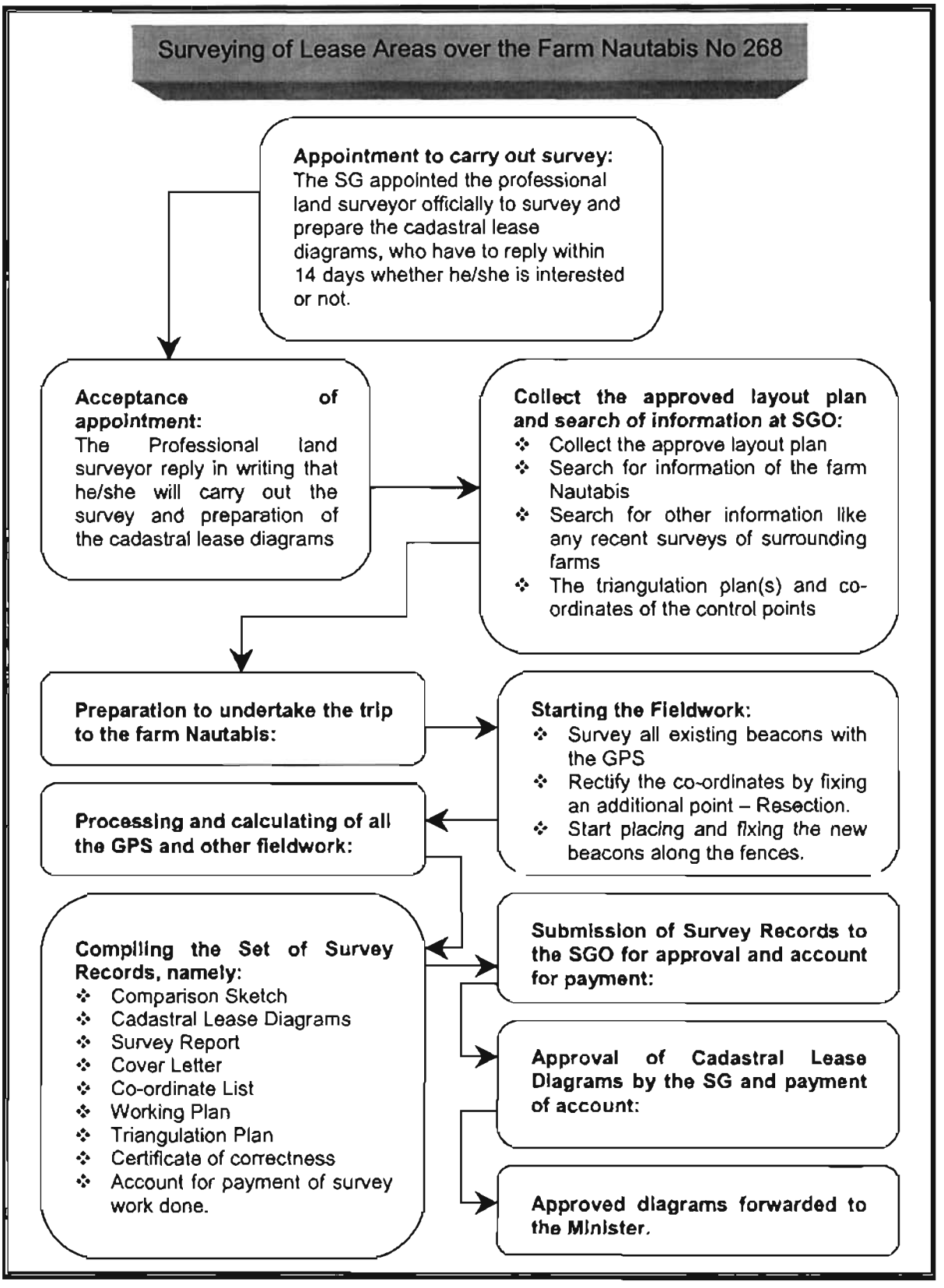


Figure 3.13: Survey procedure of lease areas over the farm Nautabis No 268

3.1.2.3 Use of Digital Orthophotos to prepare Cadastral Lease Diagrams over the Farm Nautabis No 268

The Digital orthophotos of the area of the Farm Nautabis, and the original survey diagram and surrounding information of the Farm Nautabis were obtained from the SGO, which was created in 2003.

The aerial photography was done in 1998, on a scale of 1:80 000. The aerial photographs were originally done for the updating of the 1:50 000 topographical maps of the country. These aerial photographs were then used by a consultant to create the digital orthophotos.

The consultant responsible for the creation of these orthophotos had the expertise with the software used, like Arc View. The consultant further has qualified cartographers and geographers, but not one qualified land surveyors or survey technician, only experienced people that work for surveying firms before. The consultant made use of a private land surveyor to do their ground control surveys.

Each orthophoto is created from four aerial photographs, with a side overlap of 20% and a strip overlap of 40%. The resolution of the orthophotos is 2 metres on the ground, according to the consultant.

The orthophotos were already geo-referenced, which means it made it easier to use. The Geomedia software (a similar GIS software to Arc View) was used to determine the boundaries of the lease areas along the fences on the orthophotos, represented by *figure 3.14 and figure 3.15* on the next page. On the orthophoto all boundaries were identified along the internal fences and the outside boundaries were also identified clearly.

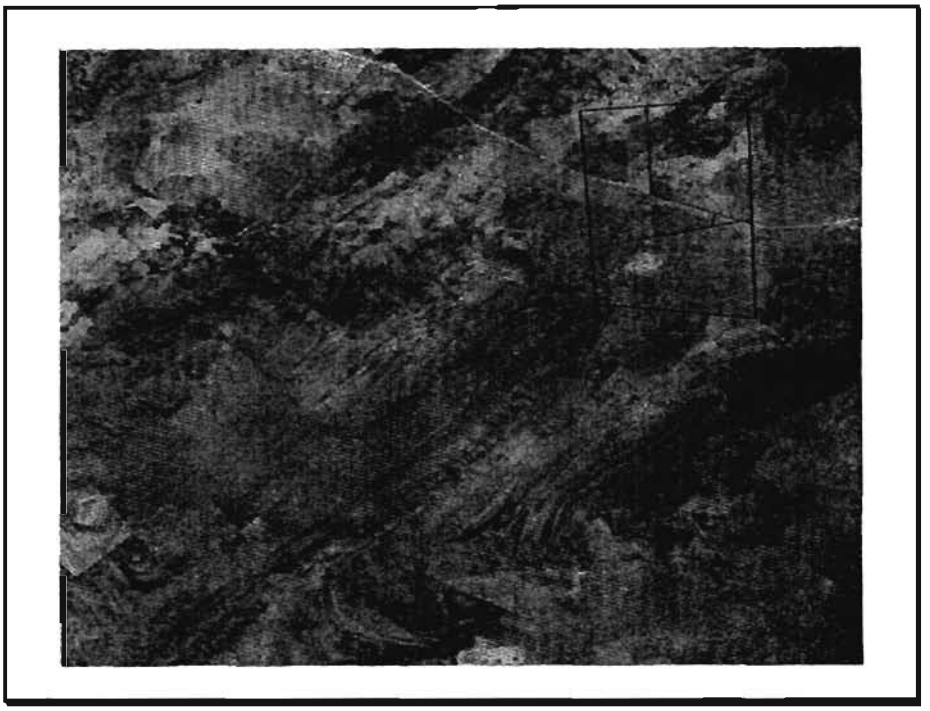


Figure 3.14: The whole orthophoto of the farm Nautabis 268

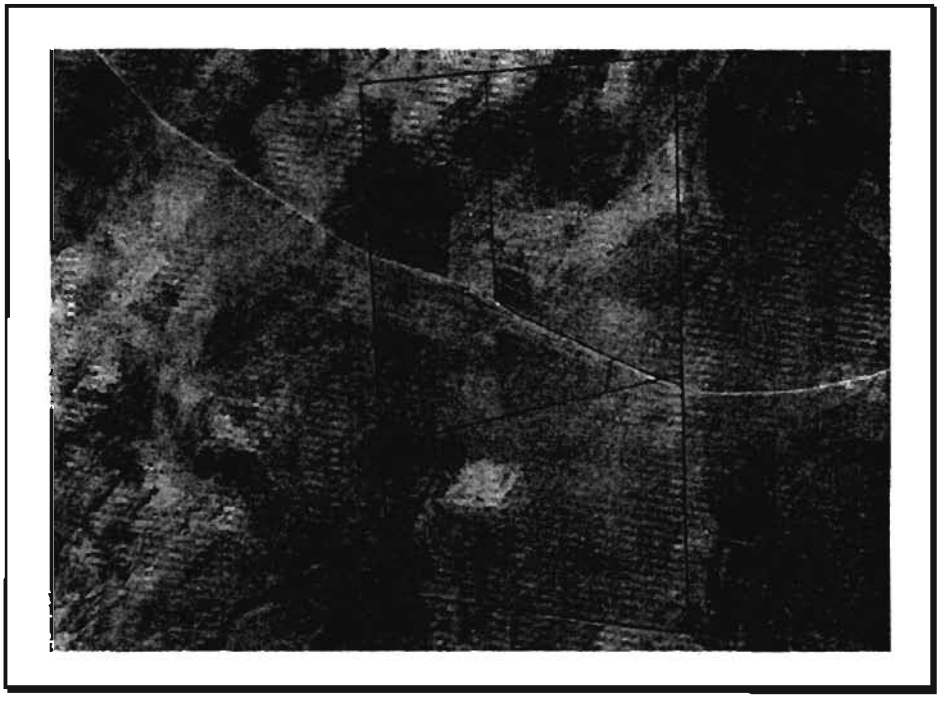
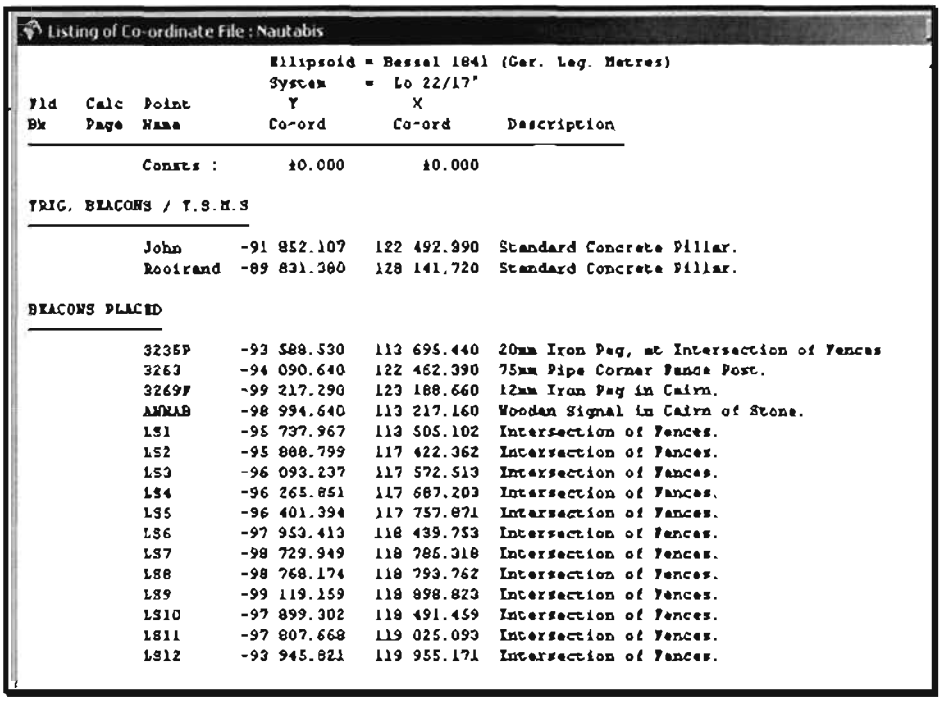


Figure 3.15: Zoomed in orthophoto of the farm Nautabis 268

The co-ordinates of the points as identified on the orthophotos were digitised (measured) on screen, *see figure 3.16* below.



Listing of Co-ordinate File : Nautabis

Ellipsoid = Bessel 1841 (Cer. Leg. Metres)
System = Lo 22/17°

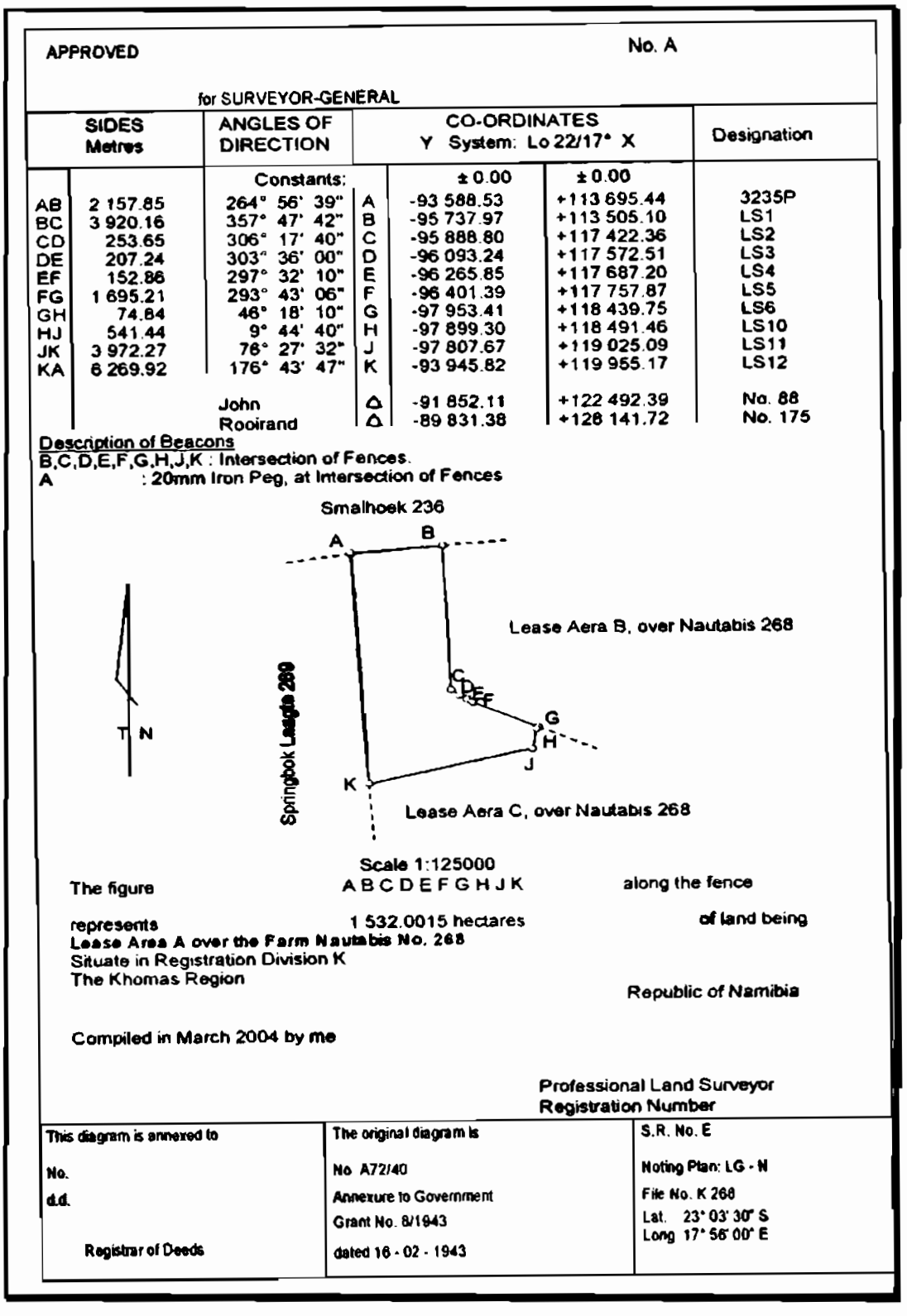
Fld Bk	Calc Page	Point Name	Y Co-ord	X Co-ord	Description
		Consts :	10.000	10.000	
TRIG. BEACONS / T.S.M.S					
		John	-91 852.107	122 492.390	Standard Concrete Pillar.
		Rooirand	-89 831.380	128 141.720	Standard Concrete Pillar.
BEACONS PLACED					
		3235P	-93 588.530	113 695.440	20mm Iron Peg, at Intersection of Fences
		3263	-94 090.640	122 462.390	75mm Pipe Corner Fence Post.
		3269F	-99 217.290	123 188.660	12mm Iron Peg in Cairn.
		ANKAB	-98 994.640	113 217.160	Wooden Signal in Cairn of Stone.
		LS1	-95 737.967	113 505.102	Intersection of Fences.
		LS2	-95 888.799	117 422.362	Intersection of Fences.
		LS3	-96 093.237	117 572.513	Intersection of Fences.
		LS4	-96 265.851	117 687.203	Intersection of Fences.
		LS5	-96 401.394	117 757.871	Intersection of Fences.
		LS6	-97 953.413	118 439.753	Intersection of Fences.
		LS7	-98 729.949	118 785.318	Intersection of Fences.
		LS8	-98 768.174	118 793.762	Intersection of Fences.
		LS9	-99 119.159	118 898.823	Intersection of Fences.
		LS10	-97 899.302	118 491.459	Intersection of Fences.
		LS11	-97 807.668	119 025.093	Intersection of Fences.
		LS12	-93 945.821	119 955.171	Intersection of Fences.

Figure 3.16: Digitised co-ordinates of the farm Nautabis 268

These co-ordinates were used to prepare diagrams for each lease area. *Figures 3.17, 3.18* and *3.19* show the cadastral lease diagrams prepared for the lease areas over the farm Nautabis using the software SURPAC. The preparation of these lease area diagrams takes more or less the same time as the preparing of the diagrams, surveyed by the land surveyor.

The whole process was done within two days.

The flow diagram *(figure 3.20)* on the page 56 illustrates the whole procedure that was followed to determine the co-ordinates and the prepared cadastral lease diagrams for the lease areas over the farm Nautabis No 268, using the orthophotos.



APPROVED

No. A

for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants:		± 0.00	± 0.00	
AB	2 157.85	264° 56' 39"	A	-93 588.53	+113 695.44	3235P
BC	3 920.16	357° 47' 42"	B	-95 737.97	+113 505.10	LS1
CD	253.65	306° 17' 40"	C	-95 888.80	+117 422.36	LS2
DE	207.24	303° 36' 00"	D	-96 093.24	+117 572.51	LS3
EF	152.86	297° 32' 10"	E	-96 265.85	+117 687.20	LS4
FG	1 695.21	293° 43' 06"	F	-96 401.39	+117 757.87	LS5
GH	74.84	46° 18' 10"	G	-97 953.41	+118 439.75	LS6
HJ	541.44	9° 44' 40"	H	-97 899.30	+118 491.46	LS10
JK	3 972.27	76° 27' 32"	J	-97 807.67	+119 025.09	LS11
KA	6 269.92	176° 43' 47"	K	-93 945.82	+119 955.17	LS12
		John Rooirand	Δ	-91 852.11	+122 492.39	No. 88
			Δ	-89 831.38	+128 141.72	No. 175

Description of Beacons

B,C,D,E,F,G,H,J,K : Intersection of Fences.

A : 20mm Iron Peg, at Intersection of Fences

Scale 1:125000

The figure A B C D E F G H J K along the fence

represents 1 532.0015 hectares of land being

Lease Area A over the Farm Nautabis No. 268

Situate in Registration Division K

The Khomas Region

Republic of Namibia

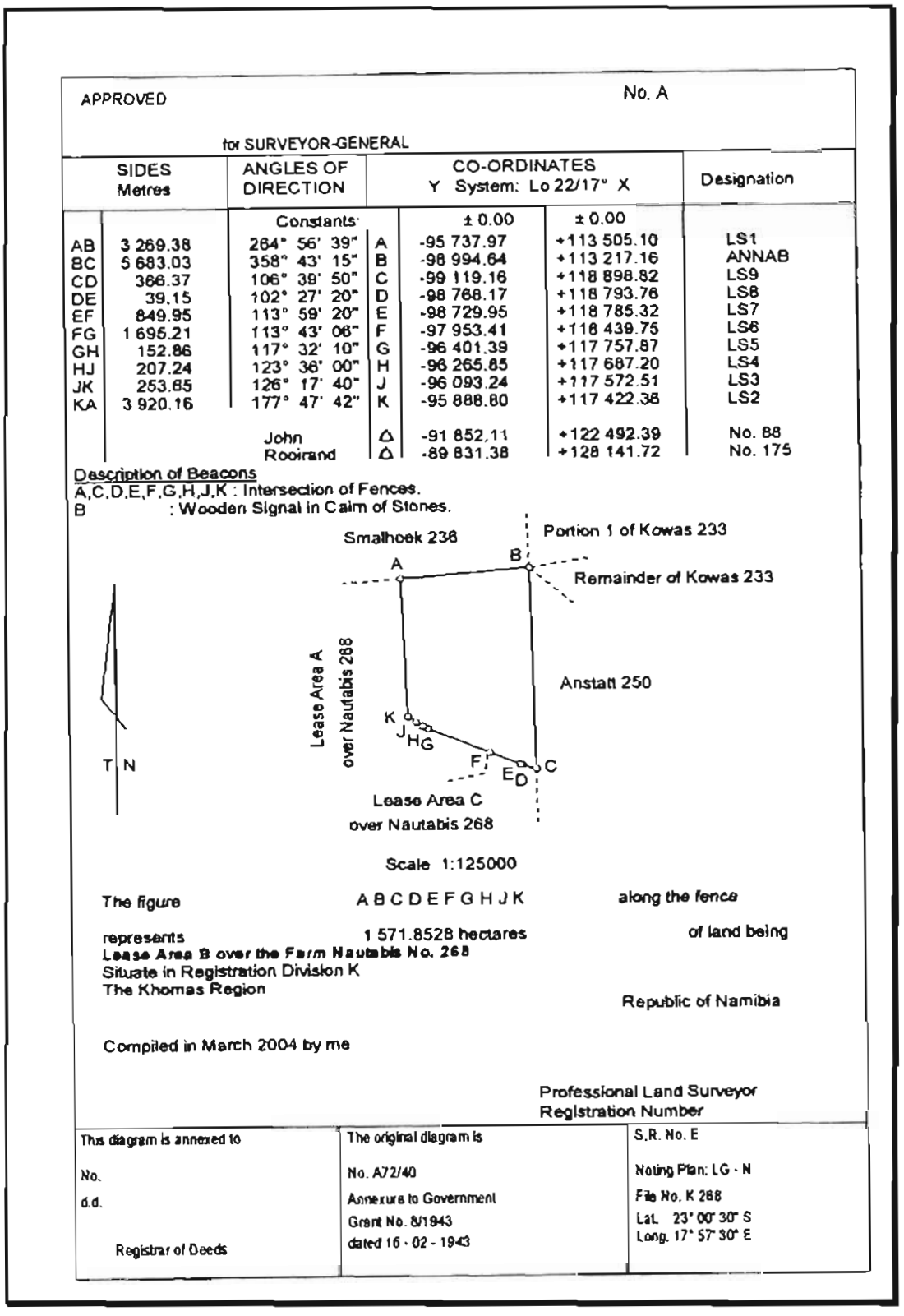
Compiled in March 2004 by me

Professional Land Surveyor

Registration Number

This diagram is annexed to	The original diagram is	S.R. No. E
No.	No. A72/40	Noting Plan: LG - N
d.d.	Annexure to Government Grant No. 8/1943	File No. K 268
Registrar of Deeds	dated 16 - 02 - 1943	Lat. 23° 03' 30" S Long 17° 56' 00" E

Figure 3.17: Cadastral lease diagram for lease area A over the farm Nautabis No 268 (Orthophoto)



APPROVED

No. A

for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants		± 0.00	± 0.00	
AB	3 269.38	264° 56' 39"	A	-95 737.97	+113 505.10	LS1
BC	5 683.03	358° 43' 15"	B	-98 994.64	+113 217.16	ANNAB
CD	366.37	106° 39' 50"	C	-99 119.16	+118 898.82	LS9
DE	39.15	102° 27' 20"	D	-98 768.17	+118 793.76	LS8
EF	849.95	113° 59' 20"	E	-98 729.95	+118 785.32	LS7
FG	1 695.21	113° 43' 06"	F	-97 953.41	+116 439.75	LS6
GH	152.86	117° 32' 10"	G	-96 401.39	+117 757.87	LS5
HJ	207.24	123° 38' 00"	H	-96 265.85	+117 687.20	LS4
JK	253.85	126° 17' 40"	J	-96 093.24	+117 572.51	LS3
KA	3 920.16	177° 47' 42"	K	-95 888.80	+117 422.38	LS2
		John Rooirand	Δ	-91 852.11	+122 492.39	No. 88
			Δ	-89 831.38	+128 141.72	No. 175

Description of Beacons
A,C,D,E,F,G,H,J,K : Intersection of Fences.
B : Wooden Signal in Cairn of Stones.

Scale 1:125000

The figure A B C D E F G H J K along the fence

represents 1 571.8528 hectares of land being

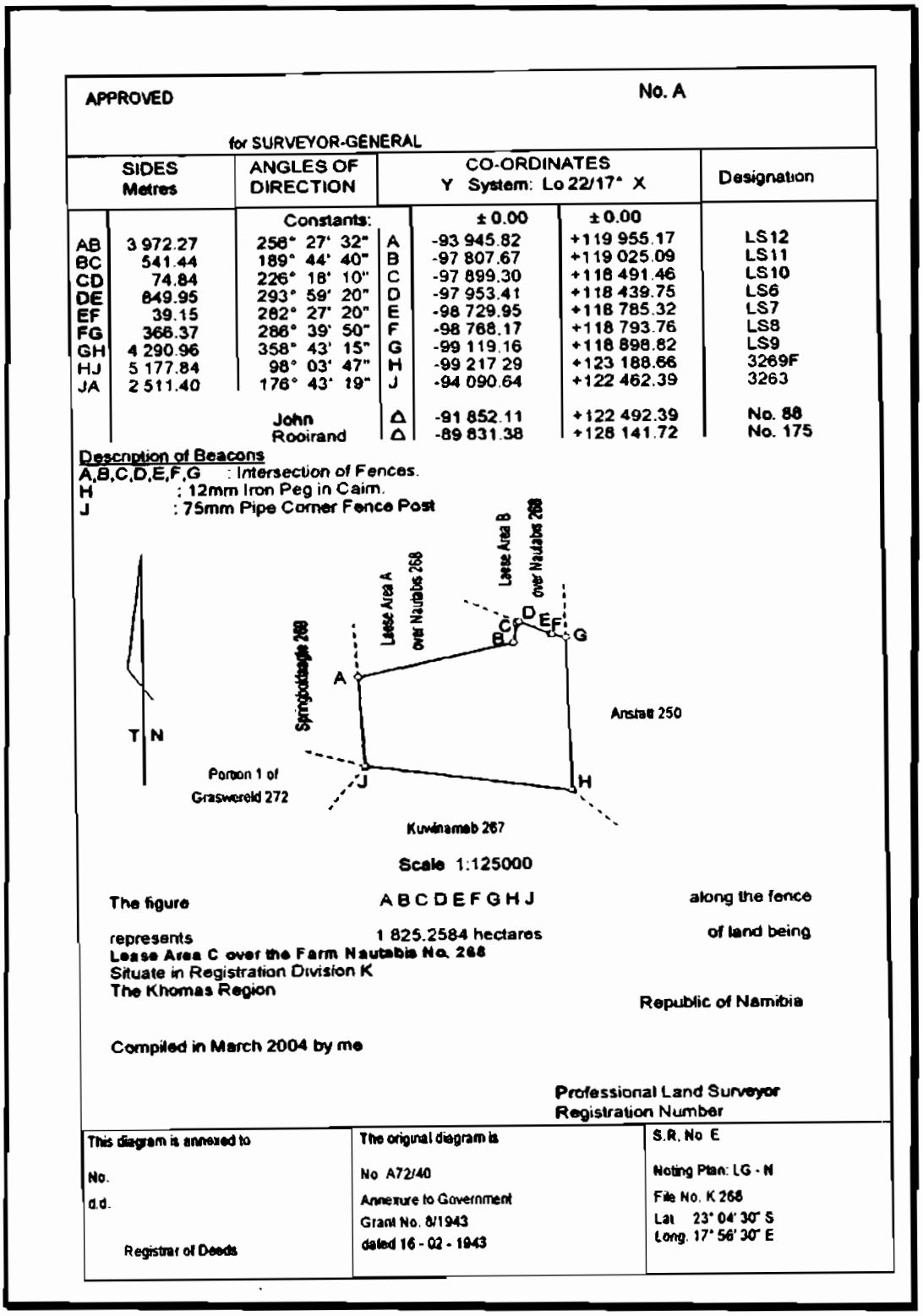
Lease Area B over the Farm Nautabis No. 268
Situate in Registration Division K
The Khomas Region
Republic of Namibia

Compiled in March 2004 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S.R. No. E
No.	No. A72/40	Noting Plan: LG - N
d.d.	Annexure to Government Grant No. 8/1943 dated 16 - 02 - 1943	File No. K 268
Registrar of Deeds		Lat. 23° 00' 30" S Long. 17° 57' 30" E

Figure 3.18: Cadastral lease diagram for lease area B over the farm Nautabis No 268 (Orthophoto)



APPROVED

No. A

for SURVEYOR-GENERAL

SIDES Metres		ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants:		± 0.00	± 0.00	
AB	3 972.27	258° 27' 32"	A	-93 945.82	+119 955.17	LS12
BC	541.44	189° 44' 40"	B	-97 807.67	+119 025.09	LS11
CD	74.84	226° 18' 10"	C	-97 899.30	+118 491.46	LS10
DE	849.95	293° 59' 20"	D	-97 953.41	+118 439.75	LS6
EF	39.15	282° 27' 20"	E	-98 729.95	+118 785.32	LS7
FG	366.37	286° 39' 50"	F	-98 768.17	+118 793.76	LS8
GH	4 290.96	358° 43' 15"	G	-99 119.16	+118 898.82	LS9
HJ	5 177.84	98° 03' 47"	H	-99 217 29	+123 188.66	3269F
JA	2 511.40	176° 43' 19"	J	-94 090.64	+122 462.39	3263
		John Rooirand	Δ	-91 852.11	+122 492.39	No. 88
			Δ	-89 831.38	+128 141.72	No. 175

Description of Beacons
A,B,C,D,E,F,G : Intersection of Fences.
H : 12mm Iron Peg in Cairn.
J : 75mm Pipe Corner Fence Post

Scale 1:125000

The figure A B C D E F G H J along the fence

represents 1 825.2584 hectares of land being

Lease Area C over the Farm Nautabis No. 268
Situate in Registration Division K
The Khomas Region

Republic of Namibia

Compiled in March 2004 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S.R. No E
No.	No A72/40	Noting Plan: LG - N
d.d.	Annexure to Government Grant No. 8/1943	File No. K 268
Registrar of Deeds	dated 16 - 02 - 1943	Lat 23° 04' 30" S Long. 17° 56' 30" E

Figure 3.19: Cadastral lease diagram for lease area C over the farm Nautabis No 268 (Orthophoto)

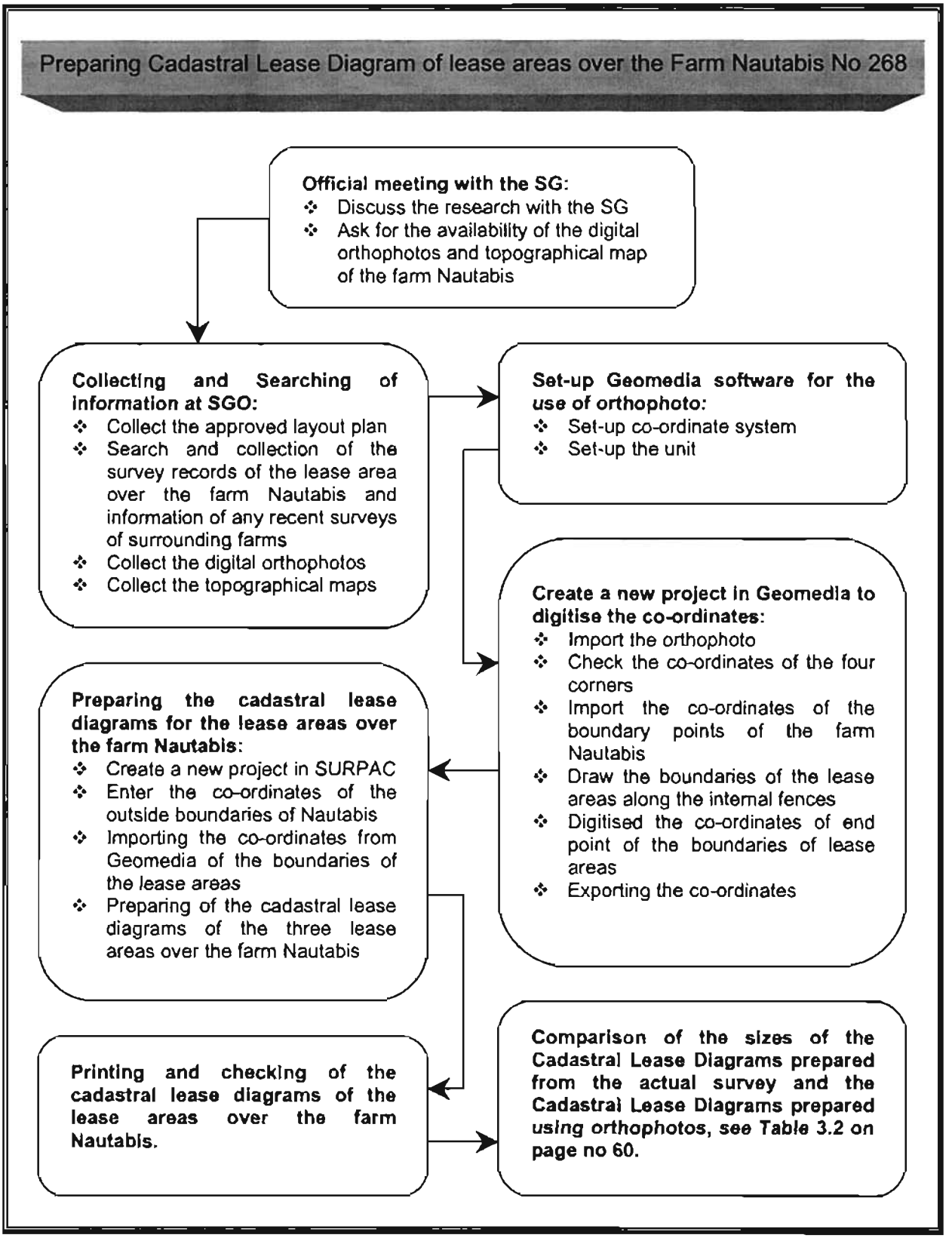


Figure 3.20: Procedure of using orthophotos for preparing the cadastral lease areas over the farm Nautabis No 268

3.1.3 Results

3.1.3.1 Cost and Time of the two methods

The fact that the orthophotos are already available means that there will be no cost involved for the creation of them. The software that is needed to digitise the co-ordinates is also already available at the SGO and some of the private professional land surveyors also have this kind of software (namely Arc View or Geomedia or Micro-Station, etc).

The software for the compiling of the Lease area diagrams, like SURPAC, ReMap, Caddy, MCad, etc is also available.

The current hourly rate for a professional land surveyor is N$395-00, according to the official surveying tariffs (Government Gazette No 2778, dated 2 August 2002). This is already out dated and is normally revised every year. The cost of preparing cadastral diagrams is N$ 207-00 per diagram.

The cost for the long-term leases surveyed will be approximately N$ 7 000-00 per lease for the surveying only, for three leases of an approximate size between 1500 ha and 2000 ha.

The travelling cost was N$ 4-30 per kilometre and then a further N$ 276-00 per hour for the travelling time, to and from the farm. If no accommodation is provided, a further N$ 450-00 for the land surveyor and N$ 350-00 for every assistant per day will be charged.

The time for the whole survey process compare to the use of the digital orthophotos was five times longer. The whole field survey process was 10 days and the use of orthophotos was 2 days.

Table 3.1 show the cost comparison between the two techniques.

Cost Comparison					
Item or Document	**Actual Field Survey**	**Amount**	**Use of Orthophoto**	**Amount**	**Difference**
Searching for information	2 Hours	N$790.00	5 Hours	N$1,975.00	N$1,185.00
Topographical Map	1 Map	N$25.00	1 Map	N$25.00	
Orthophotos				N$0.00	
Travelling				N$0.00	
Kilometres	200 km	N$860.00		N$0.00	-N$860.00
Time	2 Hours	N$552.00		N$0.00	-N$552.00
Accommodation	5 Nights	N$4,000.00		N$0.00	-N$4,000.00
Survey fees per lease area	3 leases	N$21,000.00		N$0.00	-N$21,000.00
Geo-Media					
Importing		N$0.00	5 Hours	N$1,975.00	N$1,975.00
Digitising		N$0.00	3 Hours	N$1,185.00	N$1,185.00
Diagrams					
Basic	3 Diagrams	N$621.00	3 Diagrams	N$621.00	N$0.00
Hourly Rate	3 Hours	N$1,185.00	3 Hours	N$1,185.00	N$0.00
Total		N$29,033.00		N$6,966.00	**-N$22,067.00**

Table 3.1: Cost comparison between the two techniques.

The actual survey cost is thus approximately four times what the cost would have been if the orthophotos had been used to prepare the cadastral lease diagrams.

3.1.3.2 Accuracies between the two techniques

According to the survey regulations the survey of these long-term leases falls under Class C. The allowable error for Class C = 3 A meters,

where $A = 0.012 + \frac{0.082S}{3S + 1000} + \frac{0.15S}{100\,000}$

S = approximately 5400 metres and 8800 metres.

Therefore the Class C allowable error is approximately from 0.114m to 0.154m and the difference obtained by the professional land surveyor was 0.110m and 0.140m.

The use of the orthophotos for compiling of the lease areas shows that the differences of the sizes of these areas were very close to those found in the surveyed areas and also the planned areas. Looking at the size of the lease areas will show a clear comparison between the two techniques. Table 3.2 shows the comparison of the size of these lease areas.

Comparison of the sizes of the leases areas

Lease Area	Planned Size Ha	Surveyed Size Ha	Orthophoto Size Ha	% Difference Planned and Surveyed	% Difference Planned and Orthophoto	% Difference Surveyed and Orthophoto
A	1534.0000	1516.4626	1532.0015	-1.143	-0.130	1.025
B	1578.0000	1602.1588	1571.8528	1.531	-0.390	-1.892
C	1827.0000	1819.5206	1825.2584	-0.409	-0.095	0.315

Table 3.2: Size comparison of lease areas between the two techniques

The orthophotos areas of all three lease areas are closer to the planned areas than the surveyed areas are.

3.1.4 Materials

3.1.4.1 Legislation – Land Survey Act and Survey Regulations

3.1.3.1.1 The Land Survey Act

The land Survey Act, Act 33 of 1993, was promulgated to regulate the survey of land in Namibia and to provide for all matters incidental thereto (Government Gazette No 770, dated 22 December 1993).

The Land Survey Act (1993) stipulates only professional land surveyors registered with the Professional Land Surveyors', Technical Surveyors' and Survey Technicians' Council, are allowed to sign and are responsible for signing all the diagrams, plans and any other documents forming part of the survey records submitted to the SGO for approval. According to the Professional Land Surveyors', Technical Surveyors' and Survey Technicians' Act, Act 32 of 1993 (Government Gazette No 769, dated 21 December 1993) there are five different categories of survey practitioners according to their qualifications *(see appendix 10)* namely:

- *A professional land surveyor*
- *An apprentice land surveyor*
- *An apprentice survey technician or technical surveyor*
- *A survey technician*
- *A technical surveyor*

Except for the professional land surveyor all these other survey practitioners can do cadastral surveying, but only under the supervision of a professional land surveyor and they cannot sign or counter-sign any of these survey documents.

Some of the headings of some sections of the Act might differ from the South African act, but the meaning is the same, like the following for example:

1. Original survey of land to which title has been issued – South African Act
   Original survey of land – Namibian Act

2. Approval of superseding general plan – South African Act
   Approval of new general plan – Namibia Act

There is actually one part in the South African Act that has been totally left out, namely - Improper conduct of Land Surveyor

The Act makes provision for the establishment of the Survey Regulations Board, which is responsible for the creation of the Survey Regulations to regulate all land surveying issues in Namibia.

3.1.3.1.2 The Survey Regulations

The survey regulations of South Africa were used until 15 April 2002, when the new Survey Regulations were gazetted.

The techniques that may be used in cadastral surveying are not rigidly prescribed, but all work must be adequately done and carefully checked. All recognised techniques have special requirements laid down when surveys are undertaken. In Namibia Total Station and/or GPS are used for most cadastral surveys.

The following regulations and/or sub-regulations are useful to look at if one compares the use of orthophotos with the current field survey techniques.

The survey regulations clearly determine how a survey has to be conducted. The following regulation (4) is very important for the surveying of any piece of land (Government Gazette No 2723, dated 15 April 2002).

- *All surveys have to be based on the national control survey system as this was extended across the country, unless the SG gives exemption*

- *When the survey is conducted by GPS, sufficient GPS vectors shall be measured to determine the relationship between the GPS reference datum and the national control survey reference datum, by connecting to at least three trigonometrical stations or reference marks, within the boundaries of the land under survey and the whole survey shall fall within the perimeters of the trigonometrical stations or reference marks*

- *A land surveyor can use the co-ordinate value of any survey station or beacon previously determined in relation with the national control network, if he/she has verified the physical position*

In regulation 9, the accuracies with which surveys must be carried out, are prescribed. There are three classes of survey, each with its specified accuracy limit:

- Class A - Surveys for the determination of the positions of reference marks in urban surveys,
- Class B - Surveys of new townships, subdivision of erven within an existing township, replacement of beacons within an existing township and for mining titles in respect of precious stones and minerals,
- Class C – All other surveys not included in classes A and B, like farm surveys and surveys for mining titles in respect of base minerals.

Class A = A meters;
Class B = 1,5 A meters;
and Class C = 3 A meters, where $A = 0.012 + \frac{0.082S}{3S + 1000} + \frac{0.15S}{100\,000}$

where S = the distance between the known point and unknown point.

A very important sub-regulation under the accuracies is that the SG may also determine the standard of accuracy of any survey operation not specified in the regulations.

In regulation 12, the use of photogrammetric methods is allowed for the determination of curvilinear boundaries, as long as the annotation of that specific boundary on an aerial photograph has been done in the field.

Further more in regulation 16 certain cases are mentioned when no beacons need to be placed, one is that the SG may waive the requirement to erect a beacon or beacons, when he/she determines the erection of the beacon will serve no useful purpose.

3.1.3.1.3 Random Notes on Land Survey Practice and Procedure in the Republic of South Africa

In 1955 the Survey Board of South Africa published notes on Land Surveying in South Africa, which were prepared by a former Surveyor – General and the Chairman of the Survey Board, M. T. de Smit. These notes were revised on a regular basis, in January 1963, October 1972 and February 1979.

In October 1992 the notes were revised again, so the notes were expanded to make provision for all further amendments to the Land Survey Acts and the Survey

Regulations and survey methods, by the Chief Surveyor-General, Mr D. J. Grundlingh.

The requirements for the use of GPS equipment in cadastral surveying has been added to the new notes now. These notes explain the following:

- The full procedure for the field operations
- The relationship to the National Control Network
- The software to be used and the processing of the field observed data
- The compilation of the survey records - what should be in the survey records
- The information that needs to be given on the equipment and software

Some of the most important issues in these notes are the following:

- Single point determination is not allowable
- A minimum of two single or dual frequency receivers must be used
- The base lines must not be longer than the average length between secondary triangulation points
- The base lines used to determine or fix a point needs to have at least 4 satellites available
- The connection to the national control network, need to have at least 3 stations of the national control network
- Base lines need to be surveyed in such a way that there is always a loop closure between the baselines
- Areas under survey need to fall within the parameters of the survey, to make sure no extrapolation occurs
- The information of the software, the manufacturer's name, the model of the receivers must be provided
- The name of the processing software and the version must be given
- The details of the transforming parameters must be provided

The determination of Cadastral boundaries (curvilinear and rectilinear boundaries) using photogrammetric methods has been revised. These notes explain the following when using photogrammetric methods.

- The compilation of the survey records – what should be in the survey records
- The specifications for aerial photography
- Guidelines on ground control
- Annotation
- Specifications for the accuracy

These notes are very useful in South Africa, but they were never utilised or adopted or reframed to be part of the Land Survey Act and/or Survey Regulations in Namibia.

These notes are already outdated because of development. The lack of information on the creation of digital orthophotos and the use of digital orthophotos is a shortcoming in the current notes.

No information or notes could be found on the use of digital orthophotos in South Africa or Namibia.

4. Discussion

The current field surveying techniques used for surveying the lease areas is correct according to the Land Survey Act and the Survey Regulations when it comes to the conventional methods. Personal experience working in the SGO for more than 10 years enables the author to state that when it comes to the use of the GPS all the professional land surveyors are not yet familiar with how to apply the Land Survey Act and the Survey Regulations.

The Survey Regulations clearly states that one has to connect to at least three trigonometrical beacons or reference marks and furthermore that the area of survey must fall fully within the perimeter of these control points. The survey of the farm Nautabis suffers a shortcoming with this. Strictly speaking the SG should not have approved the survey of the lease areas of Nautabis.

The Land Survey Act and the Survey Regulations of Namibia are fully based on the Land Survey Act of South Africa, but when the Namibian legislation was prepared and compiled in 1993, the Notes on Land Survey Practice and Procedure in the Republic of South Africa, revised by the Chief Surveyor General, in October 1992, were overlooked. Namibia has in the past relied on so much legislation from South Africa, that it would be wise to look at what legislation from South Africa could be used in Namibia.

According to Williamson (1983) in Thailand cadastral surveying has two survey procedures, namely first class and second class. The first class surveys are done in the urban areas and where there are sufficient national control points, with theodolites, total station, etc. The second class surveys are done mostly in the rural areas, in which use is made of rectified photomaps. Williamson (1983) further states that Thailand is a country that continuously re-assessed the performance of its cadastral surveying to see if the objectives of the country had been met. The

most important thing about the surveying system in Thailand is, that if the cadastral surveying system is found wanting, it is flexible enough to change direction accordingly.

The question is raised why not look at what and which legislation, laws and other relevant notes can be utilised from South Africa and also other countries.

Williamson (1981) suggests an alternative approach for the issuing of leases in Fiji, namely the use of combined general and fixed boundaries based on orthophoto maps. Williamson (1981) furthers his argument with the following statement: *'Even in Australia and New Zealand, who have some of the most ardent supporters of the "fixed" boundary approach, occupational boundaries are acceptable in law under certain circumstances and the use of general boundaries delineated on large aerial photographs is being seriously considered'.*

The cost of the surveying of the lease areas over the different resettlement farms and the preparation of cadastral lease diagrams is so expensive that the Government can only manage to survey and to prepare a certain number of these cadastral lease diagrams per year. The time for surveying is also much to long, because it is not always that there are professional land surveyors available to carry out the surveying.

For large areas like farms, data capture from orthophotos is a quick and economic method. Although the purchase of digital orthophotos requires a rather high initial investment, it will pay back in the long run. The digital orthophotos are usually used by a lot of other organizations as well, so there is often a good chance of sharing costs. The scale of the aerial photographs can be changed to suite multiple uses, like in creating orthophotos with sub-metre resolution.

The lease areas of the resettlement farms are planned in such a way that existing internal fences can be used as boundaries. Part of the reason for utilising the

existing fences is because the landless farmers who are going to be resettled on these farms are not very rich people because they are previously disadvantaged from the communal areas. If the cadastral lease diagrams are planned and prepared along existing fences there will be no costs for erecting new fences. The use of orthophotos together with the lease area diagrams will help the newly resettled farmers to understand where their boundaries are because they will be along the fences and not between two pegs that are supposed to form a straight line.

Currently only professional land surveyors are allowed to sign and submit survey documents to the SGO for approval and the possibility of giving some of this responsibility to the technical surveyors and survey technicians should also be looked into. At least these survey practitioners are familiar with the current system in Namibia. The other option is to get professional land surveyor from other countries, but then again there is a time constraint because they required to work in the SGO for six weeks and then to write a law exam, before they can practise as professional land surveyors in Namibia. Even if both these options are used the cost will still be higher because the official tariffs are fixed. If any survey practitioner changes less than the official tariff, the Council for Professional Land Surveyors, Technical Surveyors and Survey Technicians can sue them for mis-conduct.

The UN Land Administration Guidelines (UNECE)(1996) as quoted by Dale and McLaughlin (1999) state that the selection of the most appropriate technique for cadastral surveying and mapping depends on a lot of different questions, namely:

1. *What physical boundary features are used to delimit property – for instance if there are fences or hedges and if only the boundary line turning points are monumented or marked?*
2. *Are there any cultural or legal restrictions affecting the choice of boundary delimiter – for instance in some communities physical*

barriers to entry are considered anti-social while some residential areas of modern towns are open planned?

3. *Are the boundary points or lines visible or can be made visible on aerial photographs so that photogrammetrical techniques can be used?*
4. *What is the legal status of maps and plans kept within the land registration system?*
5. *What are the legal requirements for land parcels to be surveyed, what accuracy is laid down and are the field notes of the land surveyor treated as legal evidence;*
6. *What restrictions exist governing the maximum and minimum sizes of land parcels, and whether precise details on road reserve widths, plot frontages, etc. form part of the building development control regulations?*
7. *Who is responsible for quality control and how is such control implemented?*
8. *How is the surveyed data stored and retrieved, either in paper form or using information technology?*
9. *What is the real cost in both money and time of the different techniques of cadastral surveys?*
10. *What educational and training skills are available?*

5. Conclusion

According to Williamson (1981) it is important to review the survey systems in developing countries, to assess if the systems meet the current economic and social demands, like it is done in Fiji. Williamson (1981) further argues that developing countries like Fiji should be encouraged to establish professional standards and techniques that are applicable to them and should not just accept the standards, without carefully considering them, from developed countries.

UNCHS (1990), states that in Uganda the existing land law provides relatively few constraints on the cadastral survey operations, because the Real Property Act requires that surveys be carried out to the satisfaction of the Commissioner of Surveys, thus in theory giving great flexibility to the survey profession in Uganda.

The SG, the Survey Regulations Board and Council for Professional Land Surveyors, Technical Surveyors and Survey Technicians of Namibia need to look at the legislation and try to keep up with the development of technology. They must carefully look at ways of incorporating the beneficial changes that South Africa has put in place, but must not just accept them.

When aerial photographs of an area are being taken for any departmental purpose, it is sound practice to examine the possible needs of all departments for photographs of the area and to consider whether it is cost effective to take the photographs, once and for all, on the largest scale required for any or all possible purposes. The SG must look at this option for the decreasing of the scale of the aerial photography, the resolution and the quality of the orthophotos and digital orthophotos and then to use the digital orthophotos for the creation of cadastral lease diagrams.

For large areas that need to be surveyed, land-based surveys using total stations is an expensive and slow survey method. However, the method is popular

because it is well understood and considered accurate. In fact, in many cases land-based surveys can be quite inaccurate. In the field, the surveyors typically capture (precisely) corner points of a parcel of land and assume that the boundary between the points is a straight line. General boundaries are quite often not at all straight.

The use of digital orthophotos may assist in speeding up the resettling process if it can be used to prepare the cadastral lease diagrams. The Taxpayers will also benefit, because of the method's cost effectiveness.

According to Dale and McLaughlin (1999), in many less developed countries the choice of the technique of cadastral surveying is constrained in part by the law and in part by finance since the required modern technology needs to be either donated or else paid for from the very limited amount of hard currency available. However the primary importance is the end product and not the technology needed to achieve it, and sometimes simple and inexpensive techniques are just effective as the more expensive and sophisticated methods.

The availability of new technology and some resources like digital orthophotos, in Namibia can also be effective, if there is provision under the laws, for their usage. The Author argues that Survey Regulations should not restrain the options to best achieve goals; the cadastral surveying system should be made to be more dynamic. It should not be necessary to wait for changes in the laws and regulations before new techniques like the use of digital orthophotos can be tried and if acceptable adopted. The accuracies should be related to the end-product, so this will provide more flexibility, to allow the professional land surveyor and / or any other survey practitioners to use their discretion on which survey technique is going to be used: for instance the field survey or photogrammetric survey technique.

Finally the author argues for the desirability to have flexibility in the cadastral surveying system in order to allow for cheaper graphical determination of boundaries, by using digital orthophotos.

The land surveyors must adapt their knowledge and practical abilities to be of assistance to the land reform system. The land surveyors will still be responsible for the cadastral lease diagrams, and furthermore they will have more time for other survey work. We do not want to see the land surveying profession as show in figure 5.1, below.

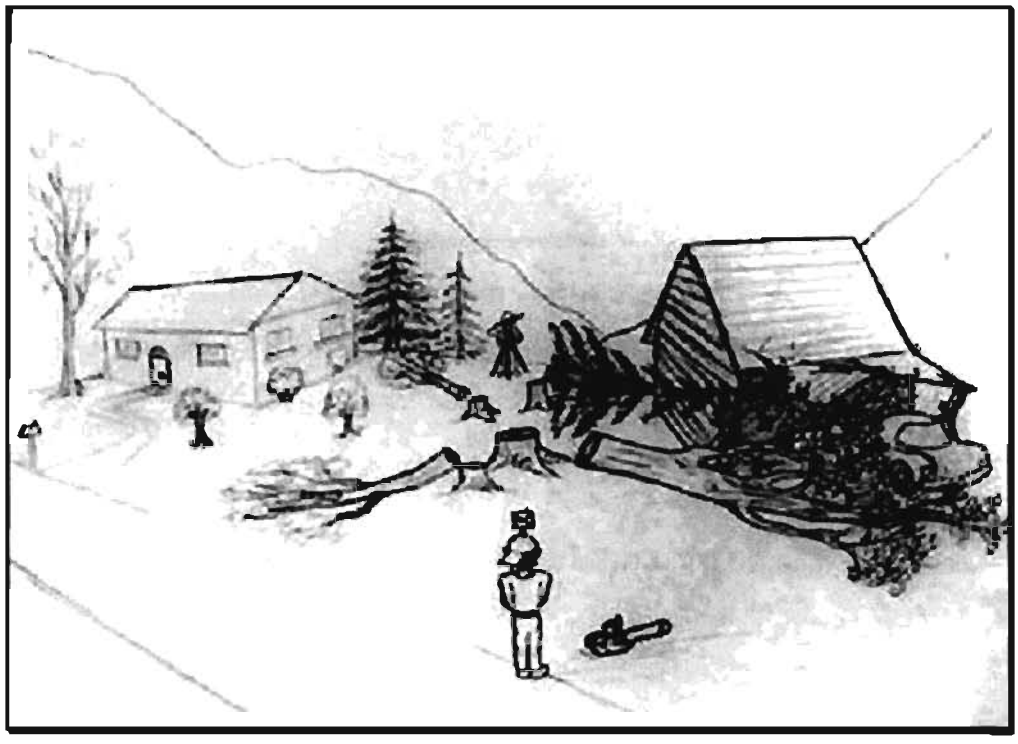


Figure 5.1 – Land Surveyor will not change, even if he has to destroy everything.

Land reform is a new concept in many spheres. It caught the Professional Land Surveyors off guard and they waited to be asked for advice before realising that the people involved were not going to ask their advice. The land surveyors perform

a task poorly understood by many of the planners and the public, and it has become necessary for the Survey Profession to step in and market itself.

Land reform is here to stay and as the current saying goes, "Deal with it, it will not disappear".

6. References

Books, articles, papers and Internet:

Birkett, R.W. and Van Dyk, C. (2001): *The Role of the Land Surveyor in the Land Reform Process, proceedings,* Conference of Southern African Surveyors, Cape Town.

Brook, I. (1994): *Control Networks and Cadastral Survey Methods - course notes* - Certificate in Development and Management of Cadastral and Land Information Systems - Swedesurvey, Gävle, Sweden.

Dale, P. and McLaughlin, J. (1999): *Land Administration,* Claredom Press, Oxford.

Davuth, L. and Suon, S. (2001): *Reforming land registration in Cambodia,* Proceedings, New Technology for a New Century International Conference, FIG Working Week 2001, Seoul, Korea 6–11 May 2001, Session 16 - Major Land Administration, Cadastre and Land Titling Projects.

Dickson, W.L. (1990): *Land Tenure and Management in a Developing Country,* NIR, University of Botswana, Working Paper No 54.

Fourie, C. and Van Gysen, H. (1996): *Land management and local level registries,* South African Journal of Surveying and Mapping, Vol.23, Part 6, 353-359.

Groot, R. and McLaughlin, J. (2000): *Geospatial Data Infrastructure,* Claredom Press, Oxford.

Haldrup, N. O. (1996): Adjudication – *A way of coping with incomplete information in developing countries,* Survey Review, Vol. 33, No. 262, October 1996.

International Federation of Surveyors (FIG)(1994): *FIG Statement on the Cadastre, adopted by Commission 7.* South African Journal of Surveying and Mapping, Vol. 22, Part 6, December 1994, pp.415-426.

Jackson, J. and Chilufya, M. (2002): *Geomatics for Land Management, course notes* - University of Natal, Durban.

Larsson, G. (1991): *Land Registration and Cadastral System,* Longman Scientific & Technical, UK Limited.

Mikkonen, K. and Corker, I. (2000): *Using Digital Orthophotos to Support Land Registration* - Was presented at the ESRI User Conference in San Diego in June 2000.

Schoeman, P. C. (2003): *Spatial Description of Leased Rural State Land Inconsistent with the Cadastre* – Mini-dissertation, University of Natal, Pietermaritzburg

Simpson, S. R. (1976): *Land Law and Registration,* Cambridge University Press, London.

Survey Manual –Version 2000:
http://www.state.nj.ua/transportation/eng/documents/survey/.

The Ad Hoc Group of Experts (1985): *Cadastral Surveying and Land Information.*

The Department of Land Affairs: *The Chief Surveyor General of South Africa –* http://www.csg.org.za.cadsurv/htm.

United Nations Centre for Human Settlements (UNCHS)(Habitat) (1990): *Guidelines for the Improvement of Land Registration and Land Information Systems in Developing Countries* (with special reference to English- speaking countries in Eastern, Central and Southern Africa), Nairobi.

Williamson, I. P. (1981): *The Cadastral Survey Requirements of Developing Countries in the Pacific Region. With Particular Reference to FIJI,* Paper presented at 23rd Australian Survey Congress, Sydney, Australia.

Williamson, I. P. (1983): *The Cadastral Survey Techniques in Developing Countries, with Particular Reference to Thailand,* The Australian Surveyor, Vol.31, No.7, 496-512.

Statutes:

Namibia: *Agricultural (Commercial) Land Reform Act, Act 6 of 1996 - Government Gazette No 1040, dated 3 March 1995.*

Namibia: *Communal Land Reform Act, Act 5 of 2002 - Government Gazette No 2787, dated 12 August 2002.*

Namibia: *Land Survey Act, No 33 of 1993 – Government Gazette No 770, dated 22 December 1993.*

Namibia: *Professional Land Surveyors', Technical Surveyors' and Survey Technicians' Act, No 32 of 1993 – Government Gazette No 769, dated 21 December 1993.*

Namibia: *Survey Tariffs – Government Gazette No 2778, dated 2 August 2002.*

Namibia: *Regulations relating to the manner in which land surveys shall be conducted according to the Land Survey Act - Government Gazette No 2723, dated 15 April 2002.*

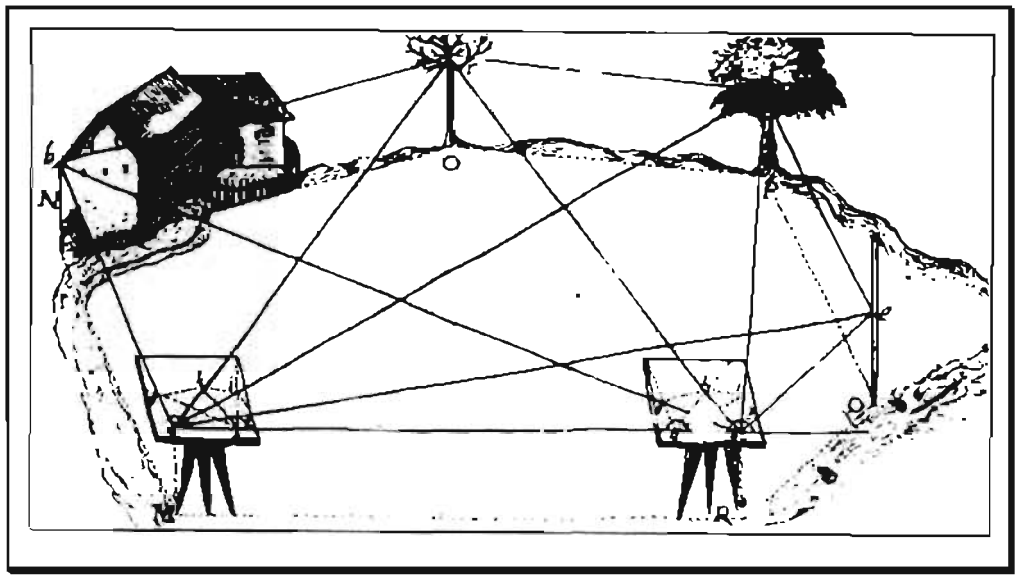
South Africa: *Random Notes on Land Survey Practice and Procedure in the Republic of South Africa – See Appendix 11 for Front Page.*

Personal Communications and Assistance:

Name	Title/Organisation	Place
Dr Karim Owolabi	Surveyor-General	Windhoek, Namibia
Claus Düvel	Land Surveyor	Windhoek, Namibia
Wynand Dreyer	Land Surveyor	Windhoek, Namibia
Late Piet Visser	Land Surveyor	Windhoek, Namibia
Louis le Hané	Technical Surveyor	Windhoek, Namibia
Chris Paresi	ITC	Windhoek, Namibia
Johann van Rensburg	Geo-Business Solutions	Windhoek, Namibia
Sue Davis	Proof Reader	Hilton, KwaZulu-Natal
Dennis Rugege	University of KwaZulu-Natal	Pietermaritsburg, KwaZulu-Natal

7. Appendices

Appendix 1

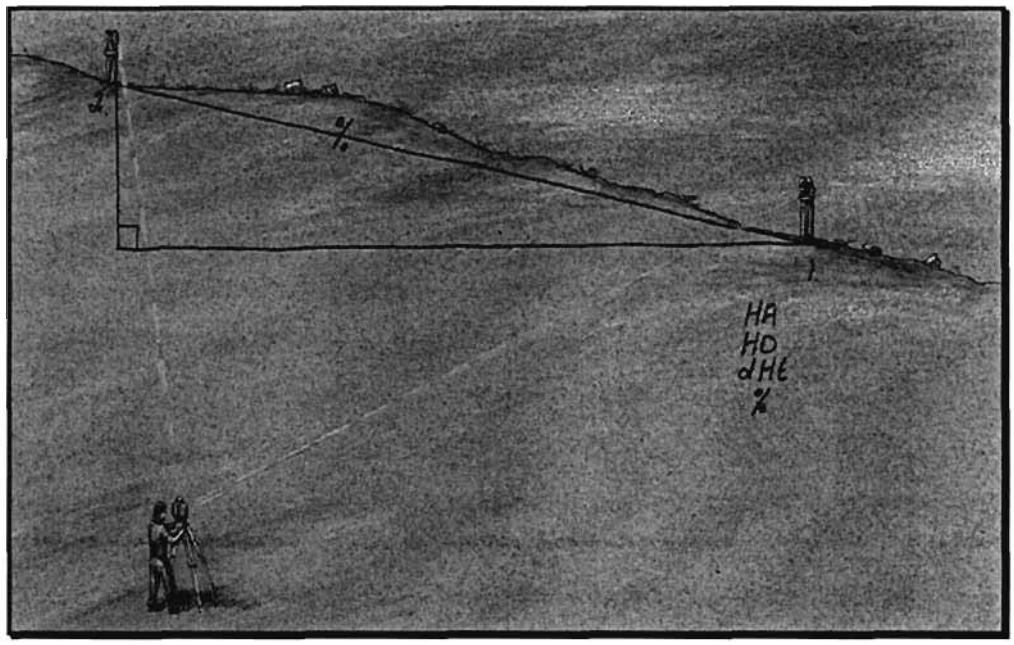


Plane table – Zubler 1601. (From Larsson –1991)

Appendix 2

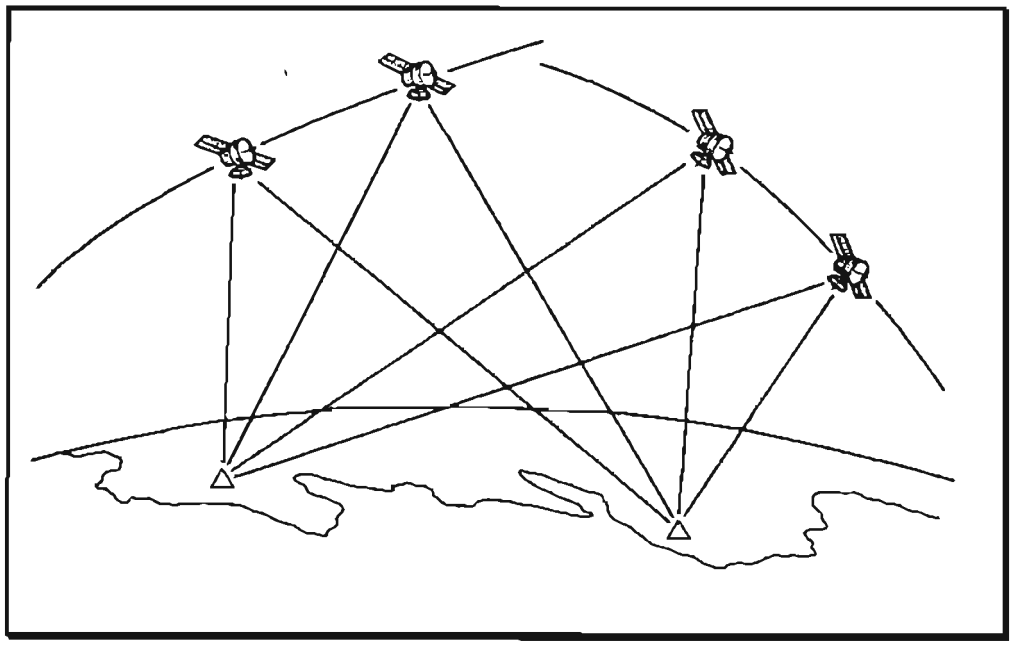
Orthogonal measuring in the sixteenth century: The square / optical square (From Larsson –1991)

Appendix 3



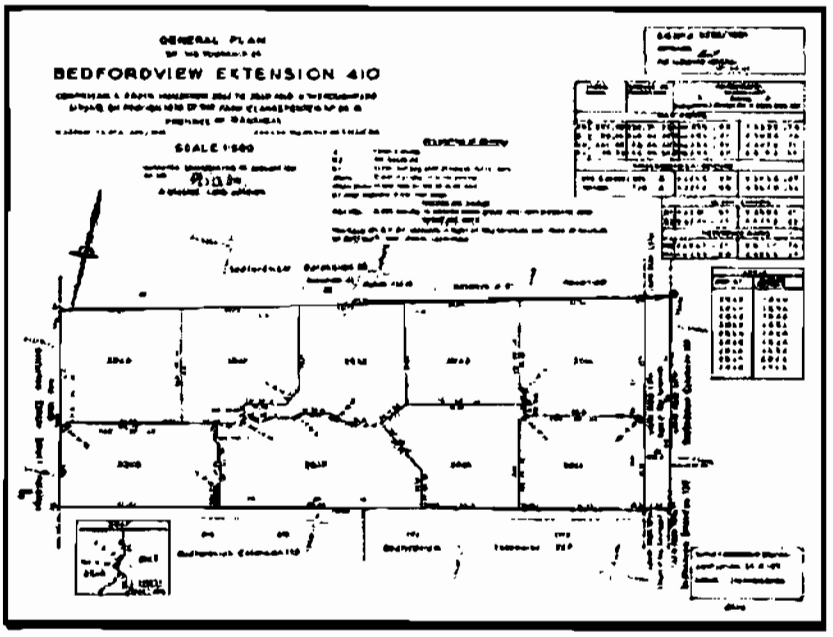
Modern technology: Total Station. (From Geodimeter pamphlet.)

Appendix 4



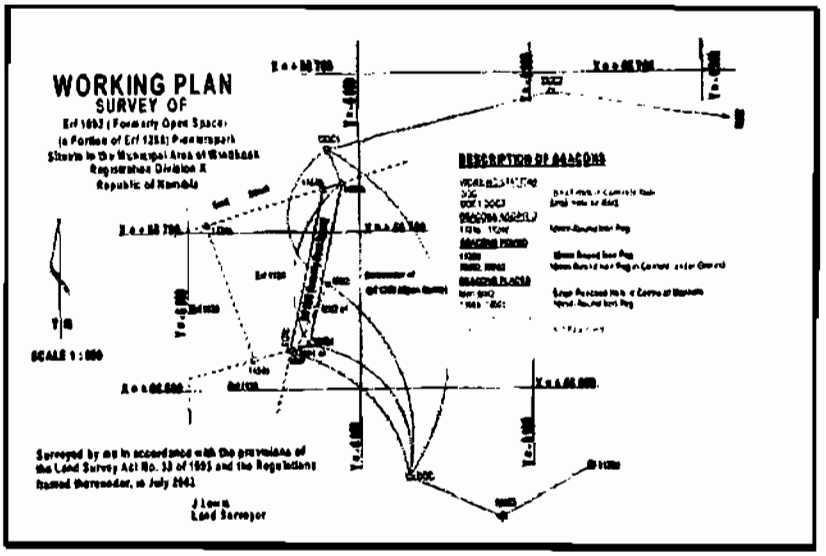
Global Positioning (GPS) surveying. (From Larsson –1991)

Appendix 5

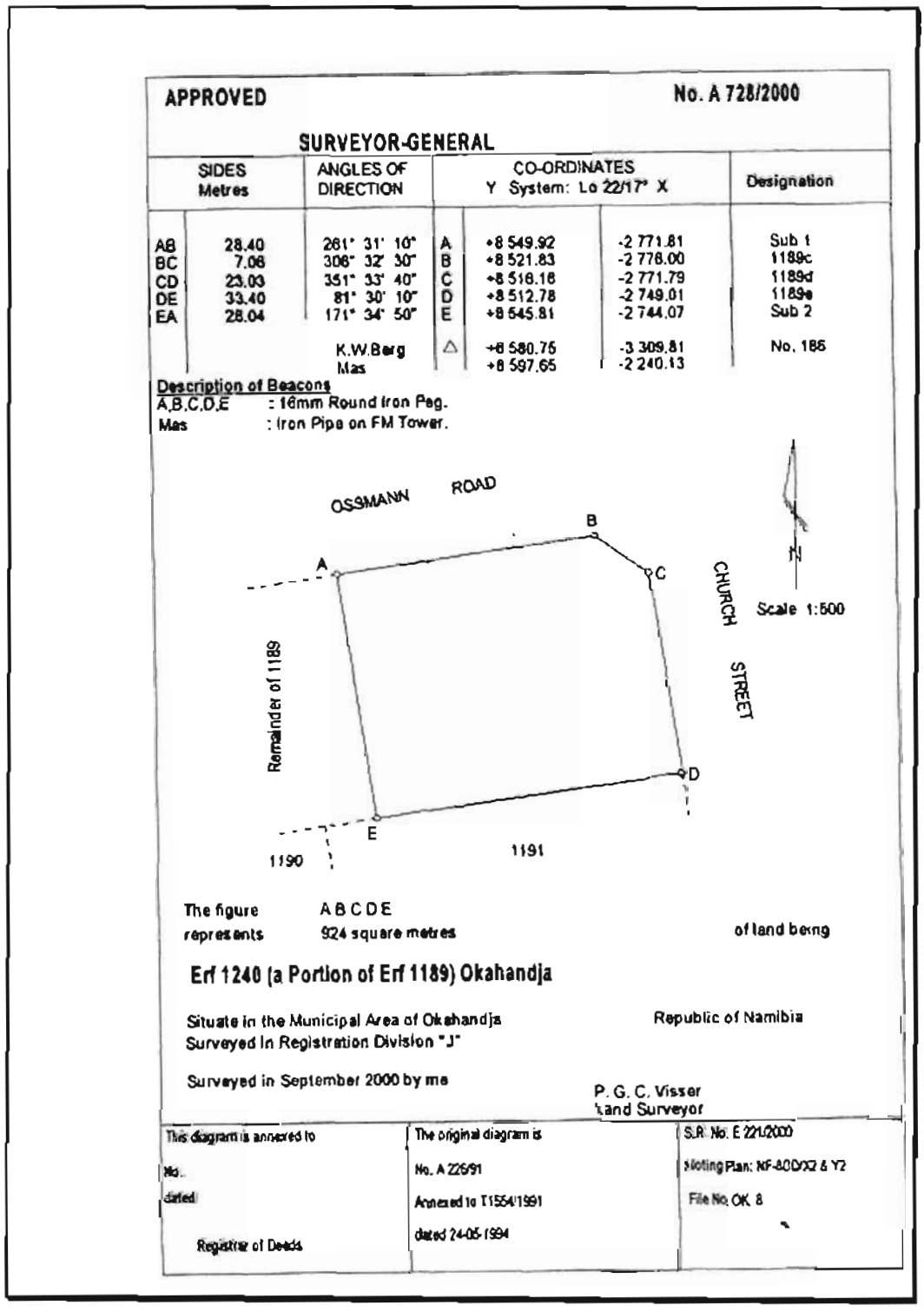


A General Plan

Appendix 6



A Working Plan



APPROVED No. A 728/2000

SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
AB	28.40	261° 31' 10"	A	+8 549.92	-2 771.81	Sub 1
BC	7.08	306° 32' 30"	B	+8 521.83	-2 778.00	1189c
CD	23.03	351° 33' 40"	C	+8 518.18	-2 771.79	1189d
DE	33.40	81° 30' 10"	D	+8 512.78	-2 749.01	1189e
EA	28.04	171° 34' 50"	E	+8 545.81	-2 744.07	Sub 2
		K.W.Berg Mas	△	+8 580.75 +8 597.65	-3 309.81 -2 240.13	No. 186

Description of Beacons
A,B,C,D,E : 16mm Round Iron Peg.
Mas : Iron Pipe on FM Tower.

The figure A B C D E
represents 924 square metres of land being

Erf 1240 (a Portion of Erf 1189) Okahandja

Situate in the Municipal Area of Okahandja Republic of Namibia
Surveyed in Registration Division "J"

Surveyed in September 2000 by me

P. G. C. Visser
Land Surveyor

This diagram is annexed to	The original diagram is	S.R. No. E 221/2000
No.	No. A 226/91	Plotting Plan: NF-33D/X2 & Y2
dated	Annexed to T1554/1991	File No. OK 8
Registrar of Deeds	dated 24-05-1994	

A Diagram

FOREWORD

It was a long felt need over many years that a commonsense explanation of principles and a clarification of matters of procedure in which land surveyors experienced difficulty, and which were not directly set out in detail in the Land Survey Act No 9 of 1927 and the regulations framed thereunder, would benefit newly qualified land surveyors as well as the more experienced land surveyors who seldom come across uncommon phases of survey practice. With that object in view, the Survey Board in 1955 published the notes prepared by T. de Smidt, a former Surveyor-General and Chairman of the Survey Board, and distributed these to all land surveyors for study and use in the future.

For various reasons it is not possible or practicable to standardise methods in the different provinces in all respects, and certain procedures contained in these notes may therefore at the instance of a Surveyor-General require modification to suit local registration requirements or other circumstances. Nevertheless, a study of the valuable material presented herein will undoubtedly assist to surmount difficulties which often lead to the rejection of surveys or to the amendment of diagrams. It is hoped that by the assistance these notes will render, the number of survey records rejected will drop significantly and will reduce the queries raised by land surveyors and examiners alike, to the mutual benefit of all concerned.

The notes were revised in January 1963, October 1972 and February 1979. This present edition has been enlarged and takes into account further amendments to various Acts and Regulations and methods. I trust it will prove of as much benefit as before.

CHIEF SURVEYOR-GENERAL

October 1992

ANNEXURE D

REPUBLIEK VAN SUID AFRIKA — REPUBLIC OF SOUTH AFRICA

HOOFDIREKTORAAT:OPMETINGS EN GRONDINLIGTING
CHIEF DIRECTORATE:SURVEYS AND LAND INFORMATION

CSG CIRCULAR NO 2 OF 1992

TO ALL PROFESSIONAL LAND SURVEYORS

Van der Sterrgebou/Van der Stert Building
Rhodestaan/Rhodes Avenue
Privaatsak/Private Bag X 10
7705 MOWBRAY
Teleloon/Telephone (021) 689-9721
685-4070
Tel. Adres/Address TRIGSURVEY
Teleks/Telex 5-21418
Telefax (021) 689-1351
Navrae/Enquiries
Verwysing/Reference DG 11/1/3

1992.06.02

A. DETERMINATION OF CADASTRAL BOUNDARIES USING PHOTOGRAMMETRIC METHODS

B. REQUIREMENTS FOR THE USE OF GPS EQUIPMENT IN RESPECT OF CADASTRAL SURVEYS

1. Enclosed please find two annexures which have been compiled by the Director of Mapping and the Director of Control Surveys respectively, in which the required procedures are set out when cadastral boundaries are determined by photogrammetric methods, as well as when GPS equipment is used in respect of cadastral surveying.

2. The procedures were compiled with the co-operation of the Surveyors-General and compliance with the requirements will ensure that your survey records can be approved without any unnecessary delays.

3. In terms of the proviso to Regulation 11(1) the Surveyor-General shall determine the standard of accuracy for survey operations not specified in Regulation 11(1). The accuracies which are laid down in the enclosed annexures are applicable until the Survey Regulations Board prescribes the necessary norms.

D J GRUNDLINGH
CHIEF SURVEYOR-GENERAL

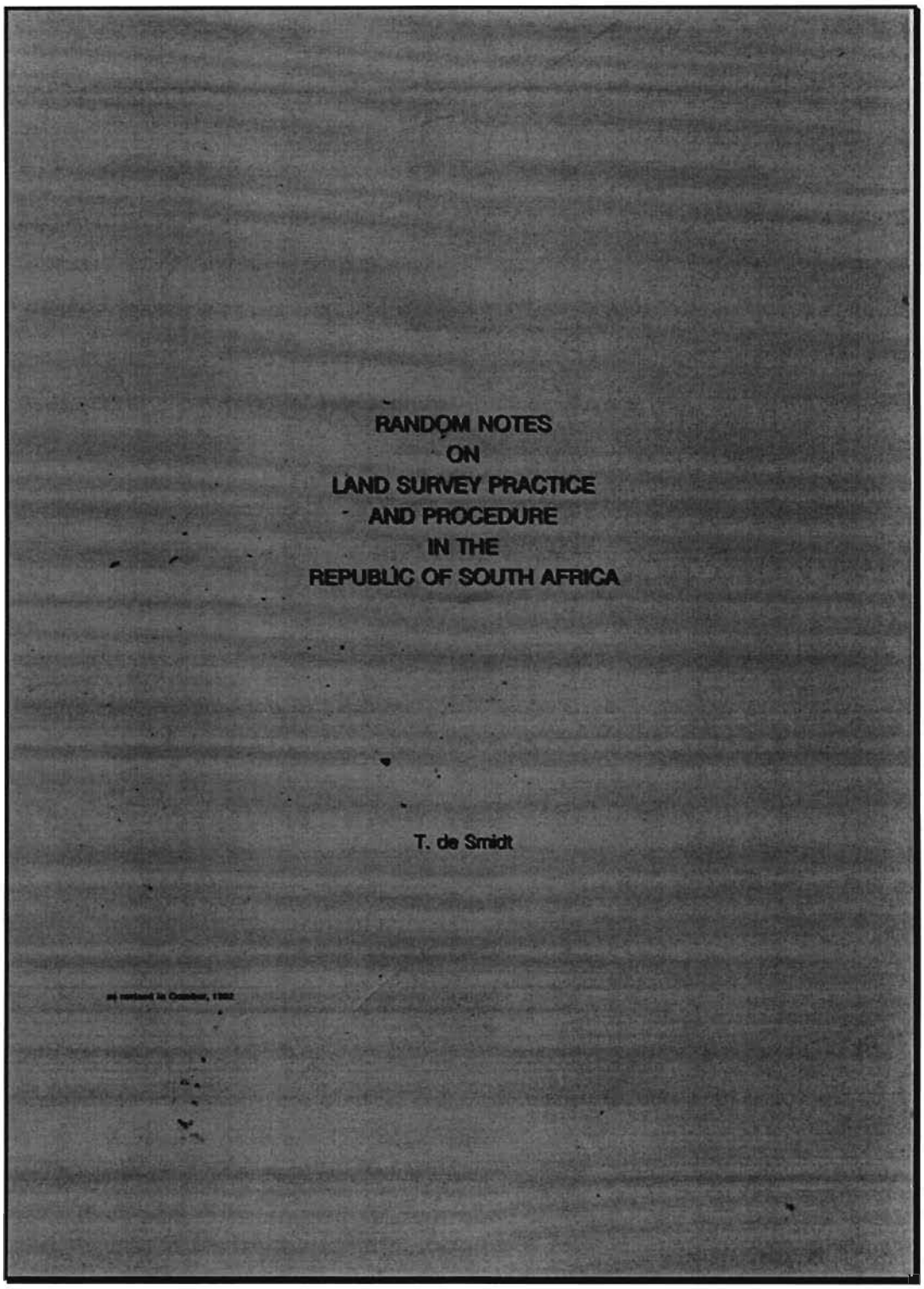
DEPARTEMENT VAN STREEK-EN GRONDSAKE
DEPARTMENT OF REGIONAL AND LAND AFFAIRS

Appendix 10

Categories of Survey Practitioners

- A professional land surveyor: Is a person who holds a degree in land surveying from an accredited university in Namibia or any other university recognized by the Council and must have passed such examination as determined by the council, carried out such trial survey or practical test which in whole or in part may consist of an oral examination set by the council and completed a period of 270 working days under the supervision of a professional land surveyor who has been practicing for at least two years.
- An apprentice land surveyor: Is a person who holds a degree in land surveying from an accredited university in Namibia or any other university recognized by the Council.
- An apprentice survey technician or technical surveyor: Is somebody who plans to study land surveying at an accredited Polytechnic in Namibia or any other Polytechnic or Technikon recognized by the Council.
- A survey technician: Is a person who holds a National Diploma in Land Surveying from an accredited Polytechnic in Namibia or any other Polytechnic or Technikon recognized by the Council.
- A technical surveyor: Is a person who holds a Higher National Diploma in Land Surveying from an accredited Polytechnic in Namibia or any other Polytechnic or Technikon recognized by the Council and also have practical experience of 10 years, including the period of study and training.

Appendix 11



RANDOM NOTES
ON
LAND SURVEY PRACTICE
AND PROCEDURE
IN THE
REPUBLIC OF SOUTH AFRICA

T. de Smidt

as revised in October, 1992

Component B

'Using digital orthophotos instead of the current field surveying technique to survey lease areas'

Frikkie J Louw

The resettlement of landless farmers, of the previous disadvantage groups, from the communal land parts of Namibia, is one of the most important land reform issues in this country. The Agricultural (Commercial) Land Reform Act (Act 6 of 1995) applies to the commercial land parts of the country. Under this act the government of Namibia has the first option on the purchase of commercial farms when these are offered for sale. The government, through the Ministry of Lands, Resettlement and Rehabilitation, has bought approximately 130 farms for resettlement purposes. Approximately 13 of these resettlement farms were surveyed and cadastral lease diagrams prepared for registration in the Deeds Office. This article shows that the current field survey technique, based on the use of theodolites, Total Stations or/and GPS, is very reliable, but is still to slow. The use of digital orthophotos as an alternative technique to the current field surveying technique was identified through literature study of other countries. The use of digital orthophotos has shown to shorten the time to prepare the cadastral lease diagrams. This means saving time will save money.

1. Introduction

1.1 General

Land is a word with many different meanings; it suggests different things to different people, depending on their outlook and their interests. To the economist it is a resource with which to achieve economic production and development, where to a lawyer it is a volume of space from the centre of the earth to the infinite sky with many rights attached. To many people land is the space for human activity as reflected in many forms of land use. For the Professional Land

Surveyor, land is a three dimensional unit, YXZ. The Ad Hoc Group of Experts on Cadastral Surveying and Land Information (1985) defined land as being an area of the surface of the earth together with the water, soil, rocks, minerals and hydrocarbons beneath or upon it and in the air above. This definition embraces all things, which are related to a fixed area or point of the surface, including the areas covered by water, including the sea.

Land is the basic source of material welfare in one way or the other, so the need for the acquisition of land rights is very important. The different types of land rights are as follows:

- Full Ownership
- Lease
- Permission to Occupy (PTO)
- Servitude
- Sectional Title
- Surface rights
- Under ground rights

During the apartheid era, a non-white person could not own land. Large tracts of land were held in trust by the state, and occupied by "Traditional Communities" of the non-white people. The state would issue a letter, sometimes with a plan attached, authorizing a juridical person to utilize that land under specific conditions. These letters were never submitted to the Deeds Registry, but were kept by the "Chief or the Traditional Authority" that had control over the specific "Traditional Community". After independence the Government embarked on land reform and introduced the changing of occupational leases to either full ownership or lease rights.

Full Ownership

Ownership is the most important relationship between a person and land; it gives the owner the greatest rights over land including the right:

- To use it to its full potential and take whatever is produced from or on it;
- To destroy, sell it or dispose of it;
- To raise money on the security of it - a loan (as collateral);
- To exclude its use by others, like preventing trespassing;
- To possess or recover possession if deprived of the land.

Lease

A lease of land is a contract whereby land is let to or hired by a person other than the owner for a specified period of time on payment of an agreed sum of money. A "short-term lease", a lease of less than ten years, is not entitled to be registered. A lease for ten years or more is a "long-term lease" and must be registered with the Registrar of Deeds, in terms of the Deeds Registries Act (Act 47 of 1937) in Windhoek and the Registrar of Deeds, in terms of the Registration of Deeds in Rehoboth Act (Act 93 of 1976) in Rehoboth.

According to Larsson (1991), already in the Bible we read that the prophet Jeremiah had been involved with the acquisition of land:
'I bought the field from my cousin Hanamel of Anathot and paid him the price: seventeen silver shekels. I drew up the deed and sealed it, called in witnesses and weighted out the money on the scales. I then took the sealed deed of purchase and its open copy in accordance with the requirements of the law and handed over the deed of purchase to Baruch. (Jer. 32:9)'

According to Dickson (1990), the Fixed Period State Grant system was created in the late 1960s to guard against alienation of land in perpetuity to non-citizen companies and individuals. It was observed that the need for having lease rights is increasing, because of different factors like the availability of suitable land, availability of financing, etc. The registration of rights requires a document (diagram) that graphically represents the area. The registration of these leases creates a secure tenancy for the lessee and makes it possible for profitable investments in the land.

1.2 Namibia

Since independence in 1990, the Namibian government has argued that the redistribution of land in the former German and South African colony is critical to its emergence as an independent nation.

The Ministry of Lands, Resettlement and Rehabilitation (MLRR), is one of the new ministries created after Namibia gained its independence. The MLRR is responsible for all land issues. The MLRR implemented a program for the resettlement of landless farmers from the previous disadvantaged groups. For the purpose of this study the term 'disadvantaged groups' refers to Namibian citizens who have been socially, economically and/or educationally disadvantaged by past discriminatory laws and/or practices.

From 1995 onwards the MLRR implemented the Agricultural (Commercial) Land Reform Act (Act 6 of 1995), which applies to the commercial land parts of the country. Under this act the government of Namibia has the first option on the purchasing of commercial farms when these are offered for sale. In case the government should not be interested, a certificate of waiver is issued.

After the purchase of commercial farms, the landless farmers from the communal areas may apply for long-term leases over these farms. Long-term leases are to be registered in the Deeds Office; therefore cadastral lease diagrams are required. The government, through the MLRR has bought approximately 130 commercial farms for resettlement purposes. As on June 2003 the staff of the Surveyor-General's Office or private Professional Land Surveyors appointed by the Surveyor-General (SG), by using the traditional methods or Global Positioning System (GPS) surveyed approximately 13 of these farms into lease areas.

1.3 Objectives

There are many factors, which have affected the slow progress of the resettlement of the landless farmers in Namibia, including the time required for the surveying of the lease areas and for the preparation of the cadastral lease diagrams. When focusing on this factor the main objective is to compare the use of digital orthophotos with the current field surveying techniques for the surveying of the lease areas and the preparation of the cadastral lease diagrams over the resettlement farms.

Specific objectives are the following:

- Look at the availability of the data of a farm or farms surveyed by the current field surveying techniques
- Look at the availability of the digital orthophotos for the same farm or farms
- Determine the quality of the digital orthophotos
- Determine the date when the aerial photographs were flow
- Compare the accuracies of the areas of the cadastral lease diagrams prepared, between the use of the digital orthophotos technique and the current field surveying technique, using Total Station and/or GPS
- Compare the time spent using each technique
- Compare the actual costs of the two methods
- Look into the Legislation – The Land Survey Act and The Survey Regulations

1.4 Hypothesis

The use of digital orthophotos as an alternative surveying technique for preparing cadastral lease diagrams over the resettlement farms, is more cost and time effective, and if applied can speed up the resettlement process.

2. Literature Review - Conceptual Framework and Definitions, and Prior Work

The present Namibian system of land registration is impossible unless each registered unit of land is surveyed and represented on a diagram or general plan.

Cadastral lease diagrams are the documents that are needed for the registration of the lease rights over the resettlement farms in Namibia, therefore there is a need for an intense literature study to define cadastral surveying and some relevant terms that form part of or fall under the subject of cadastral surveying. The extent of the land units as quoted in the registration documents of the long-term leases is obtained from the cadastral lease diagrams. It is thus apparent that registration of these long-term leases over the resettlement farms originates in the survey of these leases to be registered.

The case studies of Palestine and Fiji were studied to compare with the situation in Namibia.

2.1 Cadastral Surveying

The term *cadastral* comes from Latin term *Cadastre* referring to a registry of lands. So cadastral surveying is to do with determining and defining land ownership and boundaries.

According to Larsson (1991), cadastral surveying operations essentially include the determination of the boundaries on the ground, the survey of the boundaries, and the demarcation of the boundaries. He further states that boundaries are the main object of cadastral surveying. He also states that adjudication is an important aspect of boundary determination.

I.P Williamson (1981) states that cadastral surveying in some countries refers to the collection of all information, which relates to an individual land parcel

although in the majority of the cases the main component of a cadastral survey is the survey of the boundaries of the individual parcels of land.

Cadastral surveying in Namibia can be defined as the survey or measuring and demarcation of land for the purpose of defining parcels of land for the registration of land rights in a land register, an example being leasing of the resettlement farms. Cadastral surveying in Namibia is exclusively undertaken by the professional land surveyors or under their supervision, according to the Land Survey Act (Act 33 of 1993).

2.2 Determination of Boundaries

'In legal terms, a boundary is an imaginary line that divides two adjoining estates while in common language the term denotes the physical objects by reference to which this line of division is described' (Dale and McLaughlin 1999).

The determination of boundaries or location of boundaries depend on the type of boundaries involved for the specific property, namely:

- Fixed boundaries (specific)
- General boundaries
- Numerical boundaries

Fixed boundaries (Specific)

In the colonial settlement era, the most economical way of defining the boundary of a property was to mark the corner points and suppose that boundaries between adjoining properties ran in straight lines. This method is still used in most other ex-colonial countries.

In Namibia most boundaries are defined by the position of corner beacons, which may vary from 12mm diameter iron pegs in urban areas, to planted stones, planted wine or beer bottles, etc on farms. The "lawful" position of a beacon (that is, the position a court will settle on) is the position where the beacon was

originally placed. Where that position is required a search for evidence by a land surveyor, in which he must use physical evidence of possible beacons, numerical evidence from original and earlier surveys, and the experience of people in the area. The Namibian system like the South African system relies largely on the professional land surveyor for the establishment of the position of boundaries, but requires him to apply judgement based on a variety of evidence, rather than on merely technical expertise (Jackson and Chilufya 2002).

Dale and McLaughlin (1999) distinguish three categories of fixed or specific boundaries namely:

I. Defined on the ground prior to development and identified – for example, in documents of sale;
II. Identified after development – for example when the line of the boundary is agreed on between neighbours at the time of adjudication;
III. Defined by surveys to specified standards.

Each of these categories reflects that the precise position of a boundary has been determined.

General boundaries

A general boundary can be defined as a boundary without terminal bend points, whose position is defined by its physical and acknowledged position on the ground. An example where general boundaries are used is in Britain. A general boundary might move with time, for instance if a boundary wall is removed and rebuilt at a somewhat different place. In a general boundary system, the position of a boundary on the ground takes precedence over its position on the cadastral map.

Dale and McLaughlin (1999) also distinguish three categories of general boundaries namely:

I. The ownership of the boundary feature is not established, so that the boundary may be on one side of a hedge or the other or down the middle;

II. The boundary is the indeterminate edge of a natural feature such as a forest; and
III. The position of any boundary is regarded as approximate so that the register may be kept free from boundary disputes.

Each of these categories of general boundaries reflects that the precise line of the boundary has not been adjudicated on the ground.

Numerical boundaries

Numerical boundaries are defined in terms of the map positions or co-ordinates, of corner beacons. The map takes precedence over evidence on the ground. A numerical boundary is a kind of fixed boundary: the boundary does not move with usage. When the co-ordinate reference system shifts in a readjustment of the control system, numerical boundaries cannot be expected to shift as well. The boundaries are taken to lie along straight lines between corner beacons. The definition of numerical boundary positions is a purely technical question, to be solved by a surveyor. In some European states numerical boundaries are still used, like in Holland (Jackson and Chilufya 2002).

Namibia like South Africa uses the fixed boundary system, because the whole survey system in Namibia is based on the South African system, the reason being that for years Namibia was under the governance of South Africa.

2.3 Adjudication

The International Federation of Surveyors (FIG)(1994) defines adjudication as being the process of final and authoritative determination of the existing rights and claims of people to land. FIG (1994) describes adjudication as being a standard procedure prior to the recording of these rights and claims in a registration system. FIG (1994) also states that adjudication is a standard procedure prior to the operation of a land consolidation scheme. The process of

adjudication should simply reveal what rights already exist, by whom they are held and what restrictions or limitations there are on these rights.

Haldrup (1996) defines adjudication as being the resolution of a dispute by the application of pre-existing rules. He further refers to the *'www-questions'*: *what* right, *who* holds them and *where* can these rights be exercised?

Adjudication means that the boundaries between any two parcels of land must be agreed upon between the adjoining parties. The long-term leases over the resettlement farms in Namibia are rights to be registered, so adjudication forms an important part of the planning of these leases.

Larsson (1991) states that the adjudication process could be sporadic or systematic.

Sporadic Adjudication

Sporadic adjudication is random, unpredictable with regard to location and timing, available to deal with one land parcel at one time and initiated by an application from the landholder (Larsson 1991).

Davuth and Suon (2001) state that whenever and wherever there is a demand to or other reason to determine the precise ownership of an individual parcel of land then the process of sporadic adjudication is executed. They also claim that the sporadic method is much cheaper in the short run because in principle those who need a title pay for it.

Systematic Adjudication

Davuth and Suon (2001) describe systematic land adjudication as being a system where all land is adjudicated, area-by-area, parcel-by-parcel. They argue that it would be cheaper in the long run per parcel and that the method enables all expected benefits of land registration to be met. In terms of individuals' rights,

they claim that it is safer than sporadic adjudication as it is executed with maximum publicity

Larsson (1991) states that there are many advantages to systematic adjudication like it being more cost effective, multipurpose in its use, etc.

2.4 Demarcation

In simple terms demarcation comprises the delimitation of boundaries and the emplacement of boundary markers (beacons or monuments).

According to Larsson (1991), demarcation includes both legal and technical aspects, but can basically be done in two ways, by:

I. Fixing the exact position of the boundaries on the ground in the presence of the parties' concerned. Boundary disputes can be referred to court or a surveyor determines the boundary. After fixing the positions of the boundaries, they are marked with iron pegs, pipes, stones, concrete beacons, etc, when topographical features such as fences and hedges are not regarded as offering sufficient demarcation. The establishing of new boundaries is usually determined this way.

II. Recognising the boundaries on the ground. When necessary, they may be surveyed or photogrammetrically identified, but they are neither legally fixed nor permanently demarcated if the parties involved do not request it. When large areas have to be mapped, this method is cheaper especially where the boundaries are visible on aerial photos.

2.5 Surveying

The traditional definition of surveying is:

The art of making measurements of the relative positions of natural and man-made features on the earth's surface, and the presentation of this information either graphically or numerically. (Survey Manual Version January 2000).

It is highly probable that Egypt saw the first use of surveying. Evidence from the contents of tombs indicates that there was indeed a form of public land registration and that the land courts would entertain no claim if the land were not registered. There is also evidence that a simple but effective system of surveying was used to set out the boundaries of individual plots of arable land. Even more importantly, surveying was needed to recover the beacons and boundaries of these individual plots after they had been inundated during the annual flooding of the Nile. The corner beacons of the plots were set out or recovered by measuring from permanent markers above the flood line.

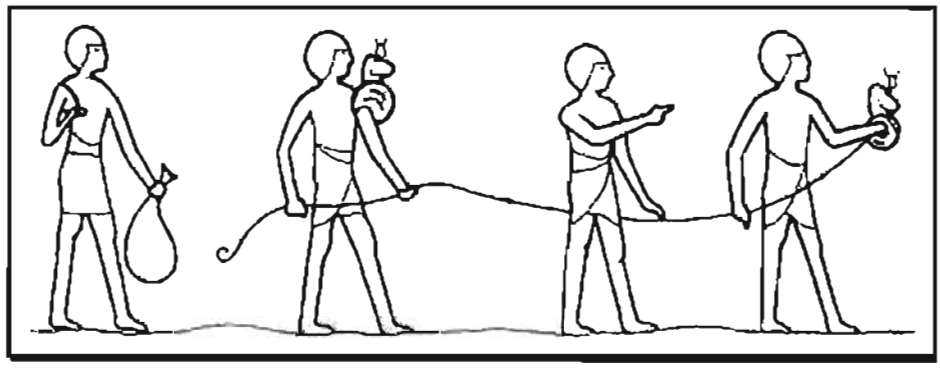


Figure 2.1 – Egyptian surveyors at work (Larsson 1991)

The first land surveyor arrived in the Cape in 1657, five years after Jan van Riebeeck had established the first European settlement at the southern tip of Africa. The first cadastral survey was done to survey a piece of land, on the banks of the Liesbeeck River, in order to transfer this land to a released servant of the Dutch East India Company.

Graphical surveys were to persist for two centuries using natural features as boundaries, until 1857, when the use of theodolites and the recording of

numerical data on diagrams were made compulsory. In 1927, the Land Survey Act, Act 9 of 1927 was put in place to guide and regulate the surveying of any piece of land.

Surveying Techniques

'In many countries, the techniques that must be used in cadastral surveying are prescribed in the law and regulations that specify the standards that are to be achieved and the techniques that must be used to deliver them' (Dale and McLaughlin 1999).

Dale and McLaughlin (1999) state that there are two broad categories of surveying techniques or methods, namely the field survey technique (ground survey method) and the photogrammetric survey technique (aerial photography method).

2.5.1 Field Survey Technique

Field survey is the technique normally used for undertaking cadastral surveys. The cheap and simple method is to use plane tables or tapes and optical squares. The plane table method was used extensively for cadastral surveying in several European countries during the nineteenth century (Larsson 1991) and also in India and Bhutan in Asia and areas of Buganda in Uganda (Brook 1994).

The tapes and optical squares method, named the orthogonal method by Larsson (1991) was used until recently (twentieth century) for cadastral surveying purposes in urbanized areas in Europe.

Less use is made of the more sophisticated methods like polar and traversing with the use of electronic distance measuring equipment or "Total Stations", which usually give higher accuracies. As the reliability of electronic distance measuring equipment or "Total Stations" increases, coupled with the price decrease their use will certainly increase.

The use of GPS is being introduced more and more and promises to give high accuracy at a relatively low cost in the future (FIG 1994). GPS, more specifically Real Time Kinematic for cadastral surveying, is becoming more popular due to its speed. Post-processing is used more for the establishment and densification of control points.

2.5.2 Photogrammetric Survey Technique

Photogrammetry - *The art, science and technology of obtaining reliable information about physical objects and the environment, through processes of recording, measuring, and interpreting images on photographs* (Survey Manual Version January 2000).

Cadastral surveying can also be undertaken by using aerial photography. Today high accuracies can be obtained using analytical photogrammetric methods. GPS can also be used to reduce the costs of establishing ground control. Other types of maps or images such as orthophotos or enlarged photographs prints can be used to reduce costs in special areas, especially if a systematic approach is used. Satellite images can today be used effectively only in areas with very large estates and in open terrain and on scales smaller than 1:25 000, whereas most cadastral maps need to have larger scales (1:500 to 1:10 000) depending on the size of the parcels of land.

Aerial photographs can be a valuable aid to property planning but are subject to geometric distortion. As a result of this distortion aerial photographs are not true to any one scale. Geometric distortion of the aerial photograph makes it impossible to get a reasonable fit when applying true to scale information onto an aerial photograph.

There are several types of aerial photographs as listed below (Survey Manual Version January 2000):

- *Aerial Photographic Enlargement*
- *Rectified Aerial Photograph*
- *Orthophoto*
- *Digital Orthophoto*

For this study there is a need to look more into Orthophoto and Digital Orthophoto.

- *Orthophoto* - look a lot like the other two types of aerial photographs. However these have the accuracy of a map drawn from ground survey information because tilt and relief displacement have been eliminated. Measurements of a land surveyor on the ground should "fit", when plotted on a true-to-scale orthophoto. Distances and area calculations on an orthophoto are usually extremely accurate, and property lines will correspond closely to physical features.

- *Digital Orthophoto* - is an orthophoto scanned or created in a digital format. These have the same accuracy as orthophoto sheets, but can be viewed and manipulated on the computer, with the capability to zoom in or out. This also provides one with a method of laying property lines or any other data over the photograph.

When a new cadastral survey of a large area needs to be carried out quickly, aerial photography would be the best practical method (because one can cover a bigger area), unless there is a need for a lot of extra groundwork (Survey Manual Version January 2000). The use of rectified aerial photographs, orthophotos or digital orthophotos has potential to be more accurate than normal aerial photographs.

2.6 Mapping (Cadastral Mapping)

A cadastral map is a plan showing the relative position or positions and boundaries of surveyed parcel or parcels of land. Cadastral maps are prepared for subdivisions and other cadastral measures; like cadastral lease diagrams for long-term leases.

Cadastral maps further document and clarify the recorded social transactions that create land ownership. One can also think of the map as providing an address. Alternatively one can think of the textual records as attributes of parcels of land of the map (Jackson and Chilufya 2002).

When we speak of a cadastral map, we usually mean a thematic map that shows parcels of land. The following figures illustrate cadastral maps in different countries.

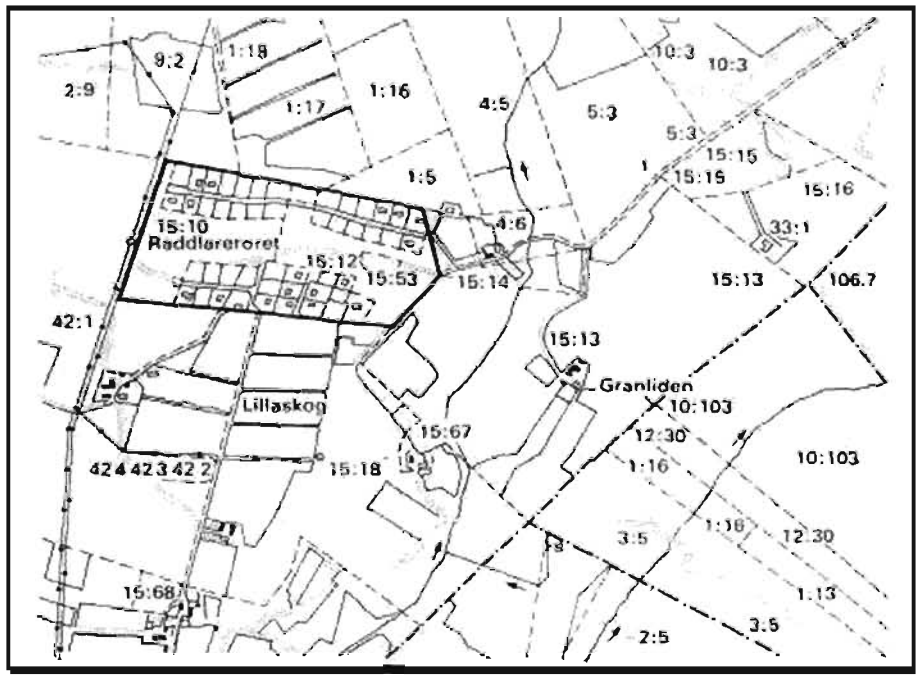


Figure2.2: An extract from a Swedish cadastral map (Larsson 1991)

Figure 2.3: A Dutch cadastral map from 1700 (From Kain and Baigent (1992) cited in Jackson and Chilufya 2002)

The main types of cadastral maps in Namibia and South Africa (Department of Land Affairs) are the following:

I. The Survey Diagram.
II. The General Plan.
III. The Sectional Title Plan.
IV. The Working Plan.
V. The Noting Plan or Compilation Sheet.

The Survey Diagram:

This is the oldest cadastral map. It is a geometrical figure containing numerical and verbal representations of a piece of land, line, feature or area forming the basis for registration of a real right. The survey diagram is the fundamental registerable document prepared by a professional land surveyor for approval at the SGO.

The most common types are the following:

- ❖ Subdivisional Diagrams
- ❖ Consolidation Diagram
- ❖ Servitude Diagram
- ❖ Substitutional Diagrams
- ❖ Lease Diagram (Cadastral Lease Diagram)

The lease diagram (cadastral lease diagram) is the one that is important in this study. A lease diagrams is required for the registration of long-term leases over portions of specific properties (farms or erven).

2.7 Legislation – Land Survey Act and Survey Regulations

The Land Survey Act, Act 9 of 1927 put cadastral surveying in Namibia in the position it is today: it is one of the best and most reliable systems anywhere in the world of defining the boundaries of properties, and the positions of rights affecting those properties. The individual professional land surveyor's field and office records were after 1927 examined and, after approval, were stored in the SGO as evidence for any future boundary relocation. According to the land Survey Act all surveys had to be connected to the national control survey system, as this was extended across the country. That the Act of 1927 was a well thought-out document, based on sound experience, is evident as it was used with only minor amendments to it for sixty years until it was replaced by a new, but substantially similar, Land Survey Act, Act 33 of 1993.

Namibia for years used and relied on the legislation of South Africa, because South Africa was its custodian. The Land Survey Act, Act 9 of 1927 was in operation until 22 December 1993, when the new Land Survey Act, Act 33 was promulgated.

The survey regulations of South Africa were still in operation until 15 April 2002, when the new Survey Regulations for Namibia were gazetted, these regulations being substantially similar to the old survey regulations.

In October 1992 the Chief Surveyor General of South Africa, Mr. D. J. Grundlingh revised a set of *'Random Notes on Land Survey Practice and Procedure in the Republic of South Africa'*, by T de Smit - 1955. There will be further discussion on these notes under the results.

2.8 Case Studies – Use of Digital Orthophotos

In order to learn more about the usage of orthophotos and digital orthophotos, in Namibia there is a need to look at the situation in other developing countries. Two situations are reviewed, namely:

- Palestine – Using Digital Orthophotos to Support Land Registration – Authors: Kari Mikkonen and Ian Corker
- The Cadastral Survey Requirements of Developing Countries in the Pacific Region With Particular Reference to Fiji – Author: I. P. Williamson

2.8.1 Palestine – Using Digital Orthophotos to Support Land Registration

According to Kari Mikkonen and Ian Corker (2000), the reason for looking into the use of digital orthophotos was to help the Palestinian Authority to improve land administration in Palestine and especially to carry out the new registration of large areas, altogether 7000 hectares, in the Gaza strip, occupied by Bedouins.

The registration was very much out of date, in some cases the latest registrations dated back to 1920's and 1930's, when Palestine was still under British control. Since the concept of individual land ownership was difficult for the Bedouins to understand, these areas were never registered.

Palestine uses the general boundary route, because the exact lines of the boundaries were never determined.

The British Military Survey had established the geodetic control network, in the early 1920's. The network is a very unreliable one, because most of the original points were destroyed, either deliberately or accidentally. According to Mikkonen and Corker (2000), only one original control point was found in the Gaza strip. In the project Mikkonen and Corker and the British Consulate joined forces and it was agreed to re-establish and improve the geodetic network. The Finnish project purchased a kit of 4 Leica geodetic GPS receivers for the Ministry of Housing. The British Consulate funded the mission of a GPS survey team from Ordnance Survey International. The survey was conducted in the spring of 1999. The current geodetic network has excellent internal accuracy (in XY) and is firmly tied to international reference stations. Surveyors in the Ministry of Housing were given intensive on-the-job training and they are today able to densify the network and conduct GPS field surveys on their own.

Most of the cadastral maps are from 1920's and 1930's. The maps available in Palestine are most often copies of copies (of copies), because the original maps are held by Israel.

The use of aerial photography in Palestinian territories was very much restricted, because of the political situation, and only Israeli companies were allowed to fly. The aerial photographs are reviewed by the Israeli military and plans for aerial photography need to be accepted by the Israeli military.

According to Mikkonen and Corker (2000), the surveyor had a resistance to accept orthophotos as a sufficient accurate, scientific and practical cadastral survey technique. It does not feel right for the surveyors to obtain accurate results without taking survey instruments to the field. The field surveyors using total stations had to re-survey the parcels' boundaries to check the accuracy of

the digitized parcel boundaries. The Palestinian GIS operator produced his data and map in less than two hours, whereas it took two days for the team of two surveyors and their assistants to produce their map. The maps matched perfectly.

The conclusion was that there are basically two techniques for surveying or capturing parcel boundaries, namely: Land based survey and Data capture from orthophotos.

- Land based surveys:
  According to Mikkonen and Corker (2000), when large areas need to be surveyed the land based survey method using total stations is an expensive and slow survey method.

- Data capture from orthophotos.
  For large areas aerial photogrammetry and data capture from orthophotos is a quick and economic solution. Purchase of orthophotos in the beginning will cost a lot, but is a good investment that in the long run will pay back.

This project under the leadership of Mikkonen and Corker with its good results has convinced the surveyors and there is now a big demand for new orthophotos, to support survey on other areas in Palestine.

2.8.2 The Cadastral Survey Requirements of Developing Countries in the Pacific Region with Particular Reference to Fiji

According to Williamson (1981) the project consisted of surveying approximately 45 000 acres of land previously owned by the Colonial Sugar Refining Company and bought by the Government of Fiji in 1973.

The project adopted the procedure of adjudicating the boundaries by consulting the tenant farmers of a specific area, mark and survey the lots, roads, drainage easement and railway reserves and then prepare plans of the survey.

The three main functions for the survey were the following:

- The first function of the survey was to facilitate the issue of registered leases for all the lots; to give the tenant farmers increased security of tenure and a mortgage-able interest in the land.
- The second function of the survey was that it would define and mark physically on the ground all boundaries within the survey area and hence assist in resolving any existing or future boundary disputes.
- The third function of the survey is that it provides an inventory of all the land that is surveyed with details of the registered tenants.

If cadastral surveys in developing countries were carried out according to the sophisticated procedures established (though these, in fact, are only partly carried out) in the developed countries, the consequence would be great expense and slow progress. The contribution of such a cadastral survey to the development of the country would therefore be small, and probably very inefficient with regard to cost.

'The precision of a cadastral survey should not be more than necessary, for the fulfilment of practical requirements. The system, the method of production, and the legal basis should be adopted to local circumstances both social and physical.' Williamson (1981)

The use of orthophotos for the combined use of general and fixed boundaries for the lease areas is suggested. According to Williamson (1981) Fiji has received orthophoto coverage over the past years over most of the agricultural land, especially the area for leases. The orthophotos were produced from scratch so

the survey control could have been increased, which would have been of great help in the future.

According to Williamson (1981) the most immediate benefit of the use of orthophotos is the cost savings. Initial investigations have indicated that by using an orthophoto approach, the costs for survey could be significantly less than the current ground survey techniques.

A secondary benefit is to the tenant farmers but is in fact of prime importance to the nation, because there is the possibility of creating a multi- purpose cadastre by using this approach. The orthophotos with the cadastral overlay could be used for a multitude of other uses, for example in rural areas where the project is located the maps may be used for valuation and assessment, land use planning, utilities and services, census information, agricultural planning administration, transportation studies, preparation of land inventories and drainage and irrigation facilities, as well as the major uses of registration of title and boundary definition.

Williamson (1981) concluded with the following statement; '*Many survey systems in developing countries should be reviewed to assess whether they are meeting the economic and social demands presently placed on them.*'

3. Research and Research Results

3.1 Lease Areas over Resettlement Farms in Namibia

3.1.1 Case Study Area

The farms that have been surveyed by the SGO or Private Land Surveyors were submitted to the SGO for approval; so all the surveyed information is thus available at the SGO.

The farm Nautabis No. 268, situated in Registration Division " K", in the Khomas Region in Namibia, was chosen as the study area. The farm Nautabis is 100 kilometres southeast of Windhoek, with the following approximate geographical co-ordinates: Latitude 23° 03' 38" South

Longitude 17° 56' 27" East

See *figure 3.1* below for the location of the farm.

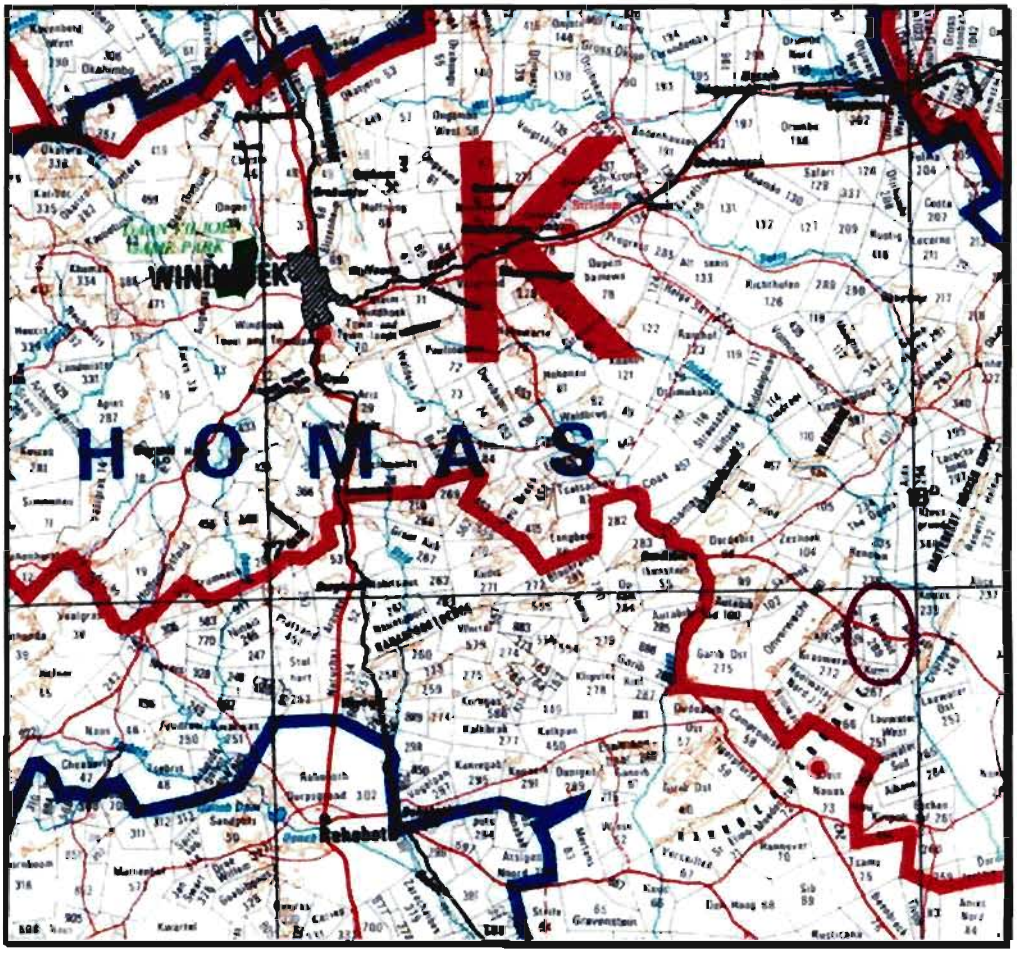


Figure 3.1: Part of the 1: 1 000 000 Wall Map of Namibia showing the Location of the farm Nautabis No 268 (Purple Ellipsoid)

The farm was chosen because the survey was carried out with the combination of GPS and Total Station. Furthermore due to the fact that this is only a Mini-dissertation and also because of time constraints, only one farm was used for research purposes.

3.2 Methodology

3.2.1 Planning of Lease Areas

The land-use planners under the Directorate of Resettlement and Rehabilitation (DRR), of MLRR get the information of the original boundaries of the farms bought for resettlement purpose from the SGO. In more than 90% of the cases the outside boundaries (the parameter survey) of these farms are already surveyed. Together with this information and the use of topographical maps of a scale of 1:50 000, they do their planning for the lease areas.

They further do site visits to verify some of the information like boreholes, reservoirs, farmhouses, and existing internal fences and gather other useful information on the topographical maps, by using a hand-held GPS.

After the approval from the Minister, the SG will receive instructions to survey the lease areas and prepare cadastral lease diagrams over these resettlement farms. *Figure 3.2* shows the layout plan approved by the Minister. The approved plan shows that the lease area boundaries are planned on existing fences. The usage of these existing fences means that there will be no cost involved to separate the different lease areas from each other, so less or no money will be spent by the resettled landless farmers to erect new fences.

The flow diagram *(figure 3.3)* on page 27 illustrates the planning process up to the instruction to the SG to survey the lease areas over a resettlement farm, like the farm Nautabis.

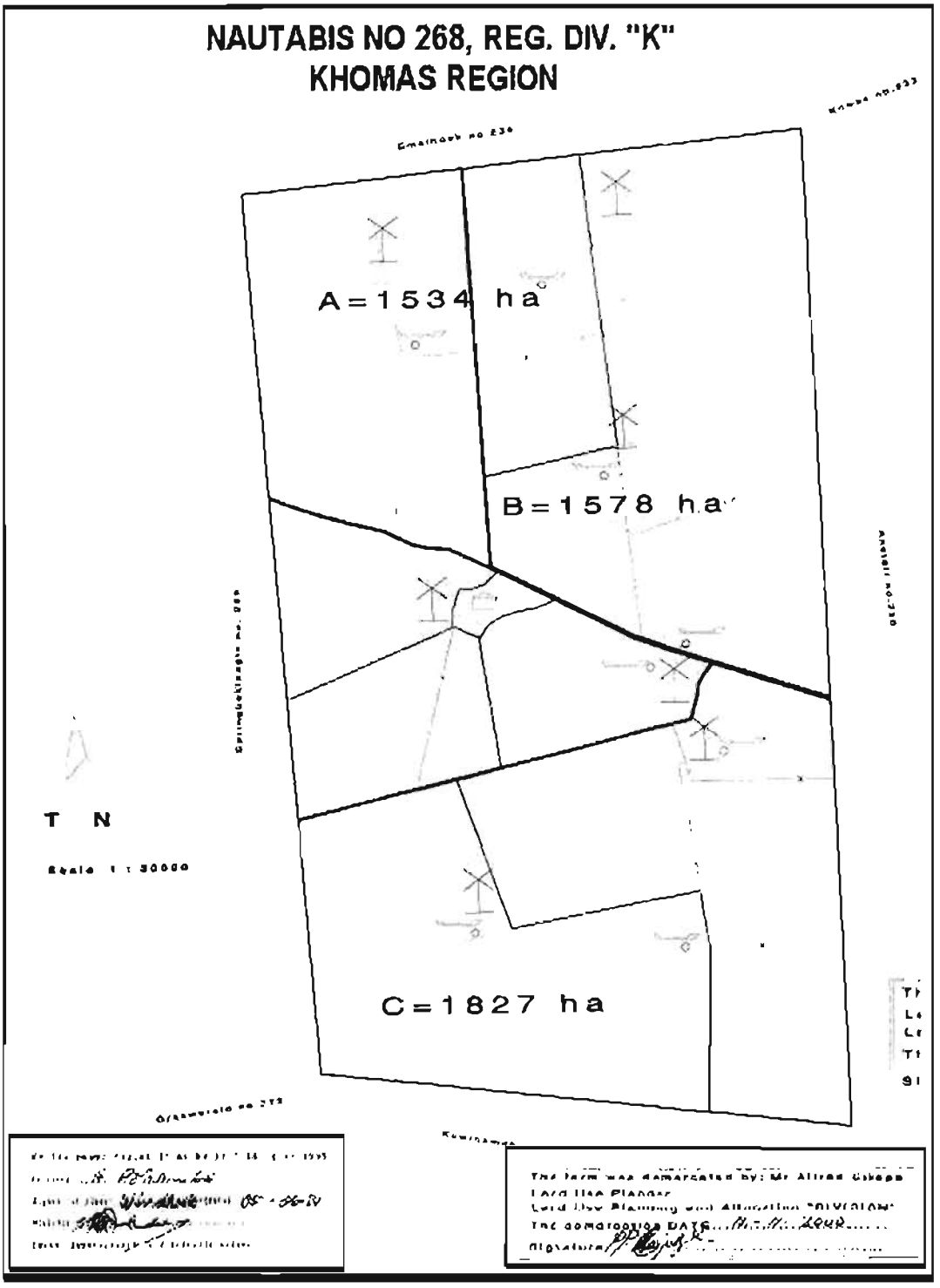


Figure 3.2: Approved Lay-out of the farm Nautabis No 268

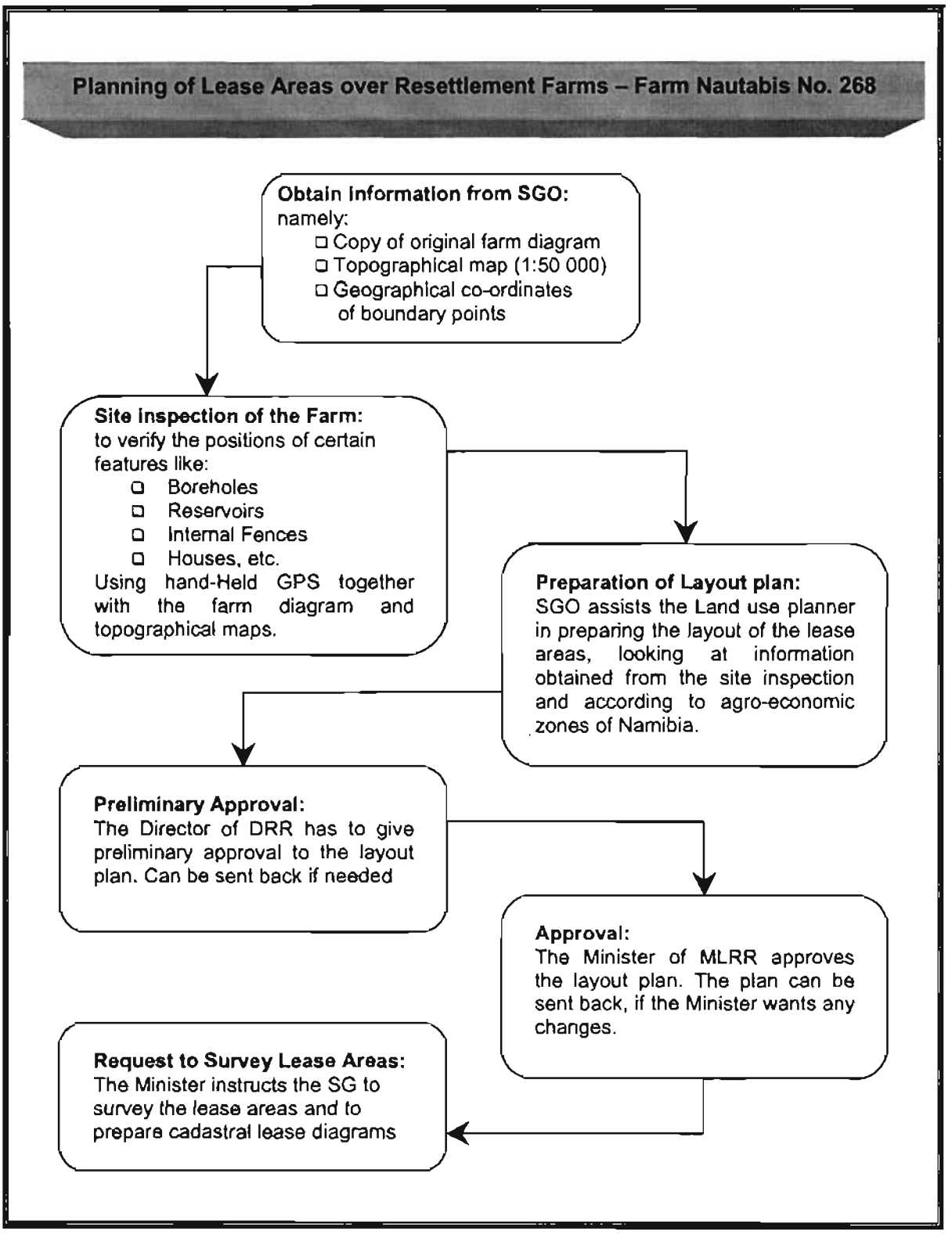


Figure 3.3: Planning of Lease Areas over the farm Nautabis No 268

3.2.2 Surveying of Lease Areas

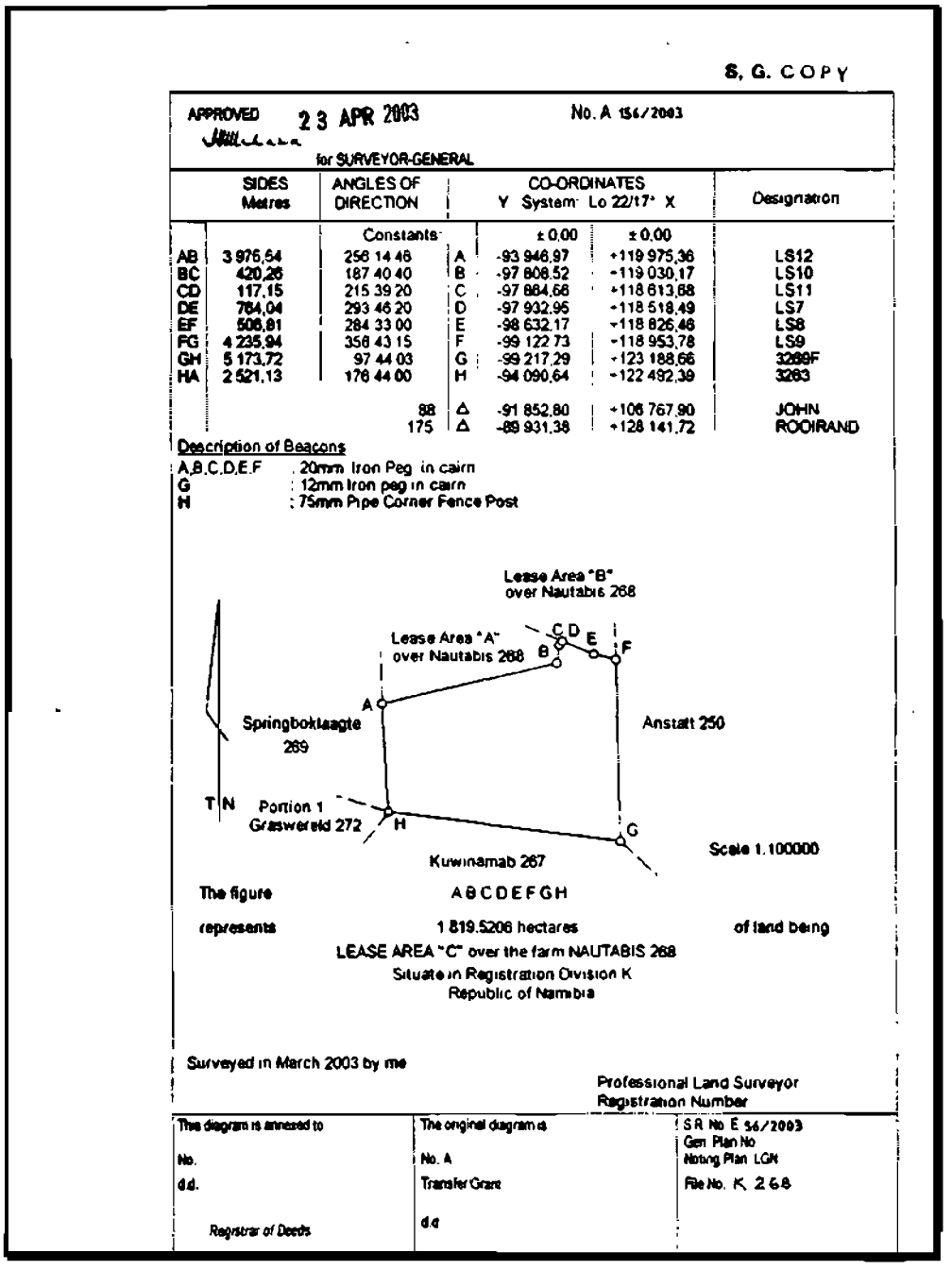
The SGO and/or the private professional land surveyors are responsible for survey of these lease areas and for preparing the cadastral lease diagrams that is needed for registration of the long-term leases, before the resettling of the landless farmers can take place. This means that cadastral surveying needs to be carried out.

The outside boundaries (the perimeter survey) of most of the commercial farms are already surveyed by the current surveying techniques, like the using of theodolites, Total Station and electronical distance measuring or nowadays by GPS. All the surveys of the commercial farms have been connected to the national control network, as specified by the Land Survey Act (1993) and the Survey Regulations.

3.2.2.1 Surveying of Lease Areas over the Farm Nautabis No 268

The survey of the farm Nautabis No 268 was contracted to a private professional land surveyor. The survey was done in March 2003, with the combination of the use of GPS and a Total Station. In the survey report the professional land surveyor claimed that he had obtained very good results and his comparison data also proved that the survey is of good standards. He found three of the original farm beacons and replaced the other one at the intersections of the fences.

From a personal interview with the professional land surveyor, it was found that the time spent to finalise everything, including the fieldwork and the office work was 10 working days. He further admitted that basically all the boundaries of the lease areas were along existing fences except for a short line between lease area A and lease area C. *Figures 3.4* represent the approved cadastral lease diagram of Lease Area C as surveyed.



S. G. COPY

APPROVED 23 APR 2003 No. A 156/2003

for SURVEYOR-GENERAL

	SIDES Metres	ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants:		± 0.00	± 0.00	
AB	3 976,54	256 14 46	A	-93 946,97	+119 975,36	LS12
BC	420,26	187 40 40	B	-97 808,52	+119 030,17	LS10
CD	117,15	215 39 20	C	-97 884,66	+118 613,68	LS11
DE	764,04	293 46 20	D	-97 932,95	+118 518,49	LS7
EF	506,81	284 33 00	E	-98 632,17	+118 826,46	LS8
FG	4 235,94	358 43 15	F	-99 122,73	+118 953,78	LS9
GH	5 173,72	97 44 03	G	-99 217,29	+123 188,66	3269F
HA	2 521,13	176 44 00	H	-94 090,64	+122 492,39	3263
		88	Δ	-91 852,80	+106 767,90	JOHN
		175	Δ	-89 931,38	+128 141,72	ROOIRAND

Description of Beacons

A,B,C,D,E,F : 20mm Iron Peg in cairn
G : 12mm Iron peg in cairn
H : 75mm Pipe Corner Fence Post

The figure A B C D E F G H represents 1 819.5206 hectares of land being

LEASE AREA "C" over the farm NAUTABIS 268
Situate in Registration Division K
Republic of Namibia

Surveyed in March 2003 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S R No E 56/2003
No.	No. A	Gen Plan No
d.d.	Transfer Grant	Mining Plan LGM
		File No. K 2 6 8
Registrar of Deeds	d.d.	

Figure 3.4: Approved Cadastral lease diagram **for Lease Area C over the farm** Nautabis No 268

The flow diagram *(figure 3.5)* on the next page illustrates the surveying procedures that were followed by the contracted professional land surveyor to survey and prepare the cadastral lease diagram for the lease areas over the farm Nautabis No 268.

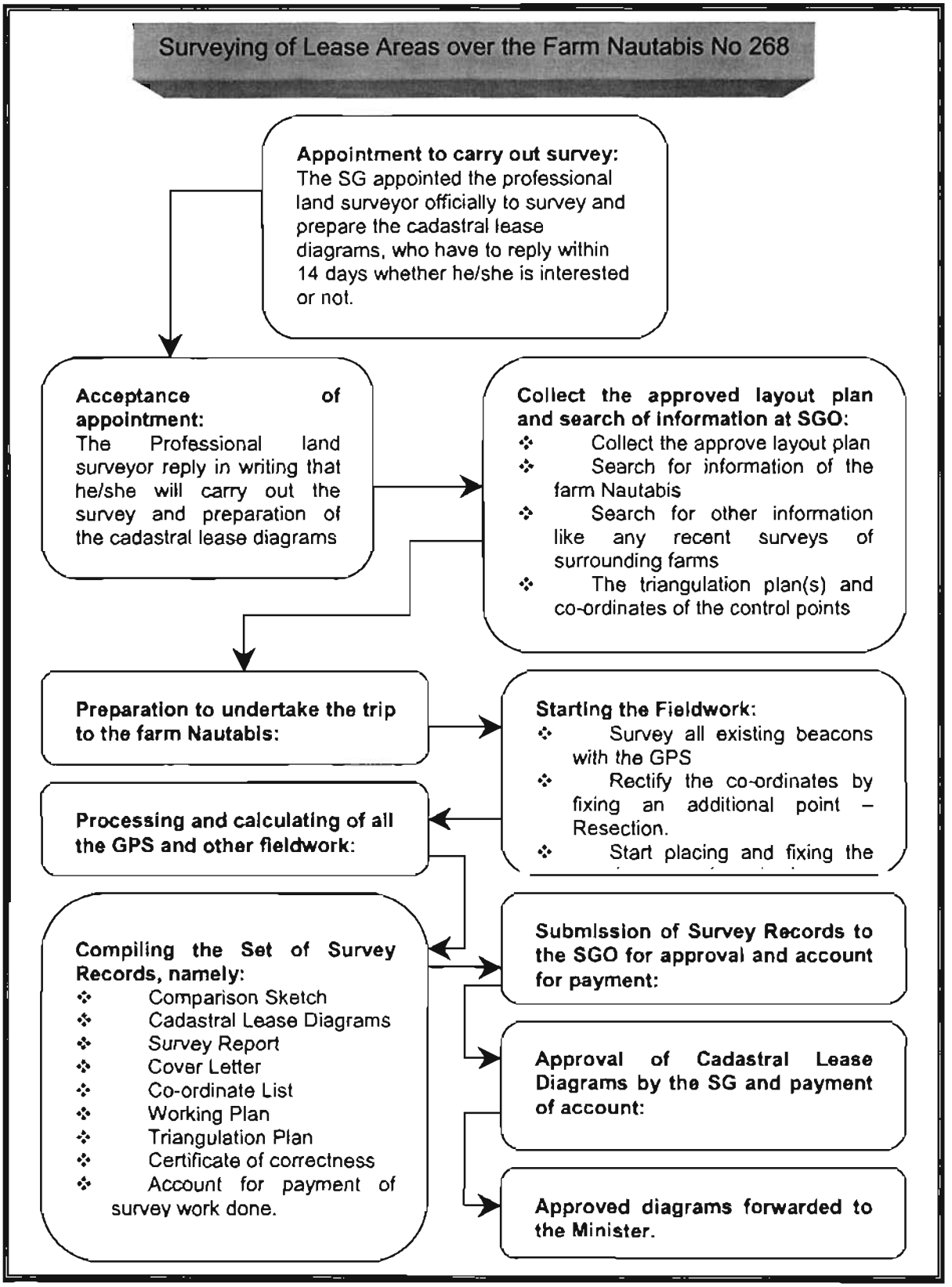


Figure 3.5: Survey procedure of lease areas over the farm Nautabis No 268

3.2.2.2 Use of Digital Orthophotos to prepare Cadastral Lease Diagrams over the Farm Nautabis No 268

The Digital orthophotos of the area of the Farm Nautabis, and the original survey diagram and surrounding information of the Farm Nautabis were obtained from the SGO, which was created in 2003.

The aerial photography was done in 1998, on a scale of 1:80 000. The aerial photographs were originally done for the updating of the 1:50 000 topographical maps of the country. These aerial photographs were used by a consultant to create the digital orthophotos. The consultant made use of a private land surveyor to do their ground control surveys.

Each orthophoto is created from four aerial photographs, with a side overlap of 20% and a strip overlap of 40%. The resolution of the orthophotos is 2 metres on the ground, according to the consultant.

The orthophotos were already geo-referenced, which means it made it easier to use. The Geomedia software (a similar GIS software to ArcView) was used to determine the boundaries of the lease areas along the fences on the orthophotos, represented by *figure 3.6* on the next page. On the orthophoto all boundaries were identified along the internal fences and the outside boundaries were also identified clearly.

Figure 3.6: Orthophoto of the farm Nautabis 268

The co-ordinates of the points as identified on the orthophotos were digitised (measured) on screen, *see figure 3.7* below.

Listing of Co-ordinate File : Nautabis

Ellipsoid = Bessel 1841 (Cer. Leg. Metres)
System = Lo 22/17°

Fld Bk	Calc Page	Point Name	Y Co-ord	X Co-ord	Description
		Consts :	40.000	40.000	
TRIC. BEACONS / T.S.M.S					
		John	-91 852.107	122 492.390	Standard Concrete Pillar.
		Roofrand	-89 831.380	128 141.720	Standard Concrete Pillar.
BEACONS PLACED					
		32359	-93 588.530	119 695.440	20mm Iron Peg, at Intersection of Fences
		3263	-94 090.640	122 462.390	76mm Pipe Corner Fence Post.
		32697	-99 217.290	123 188.660	12mm Iron Peg in Cairn.
		ANNAB	-98 994.640	113 217.160	Wooden Signal in Cairn of Stone.
		LS1	-95 737.967	113 505.102	Intersection of Fences.
		LS2	-95 888.799	117 422.362	Intersection of Fences.
		LS3	-96 093.237	117 572.513	Intersection of Fences.
		LS4	-96 265.851	117 687.203	Intersection of Fences.
		LS5	-96 401.394	117 757.871	Intersection of Fences.
		LS6	-97 963.413	118 439.763	Intersection of Fences.
		LS7	-98 729.969	118 785.318	Intersection of Fences.
		LS8	-98 768.174	118 793.762	Intersection of Fences.
		LS9	-99 119.159	118 898.823	Intersection of Fences.
		LS10	-97 899.302	118 491.459	Intersection of Fences.
		LS11	-97 807.668	119 025.093	Intersection of Fences.
		LS12	-93 945.821	119 935.171	Intersection of Fences.

Figure 3.7: Digitised co-ordinates of the farm Nautabis 268

These co-ordinates were used to prepare diagrams for each lease area. *Figure 3.8* show the cadastral lease diagram prepared for Lease Areas C over the farm Nautabis using the software SURPAC. The preparation of these cadastral lease diagrams takes more or less the same as the preparing of the diagrams, surveyed by the land surveyor. The whole process was done within two days.

The flow diagram *(figure 3.9)* on the page 36 illustrates the whole procedure that was followed to determine the co-ordinates and the prepared cadastral lease diagrams for the lease areas over the farm Nautabis No 268, using the orthophotos.

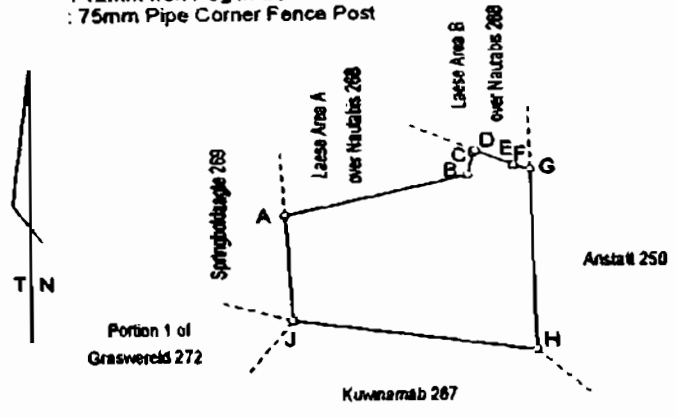
APPROVED

No. A

for SURVEYOR-GENERAL

SIDES Metres		ANGLES OF DIRECTION		CO-ORDINATES Y System: Lo 22/17° X		Designation
		Constants:		± 0.00	± 0.00	
AB	3 972.27	256° 27' 32"	A	-93 945.82	+119 955.17	LS12
BC	541.44	189° 44' 40"	B	-97 807.67	+119 025.09	LS11
CD	74.84	226° 18' 10"	C	-97 899.30	+118 491.46	LS10
DE	849.95	293° 59' 20"	D	-97 953.41	+118 439.75	LS6
EF	39.15	282° 27' 20"	E	-98 729.95	+118 785.32	LS7
FG	366.37	286° 39' 50"	F	-98 768.17	+118 793.76	LS8
GH	4 290.96	358° 43' 15"	G	-99 119.16	+118 898.82	LS9
HJ	5 177.84	98° 03' 47"	H	-99 217.29	+123 188.66	3269F
JA	2 511.40	176° 43' 19"	J	-94 090.64	+122 462.39	3263
		John Rooirand	Δ	-91 852.11	+122 492.39	No. 88
			Δ	-89 831.38	+128 141.72	No. 175

Description of Beacons
A,B,C,D,E,F,G : Intersection of Fences.
H : 12mm Iron Peg in Cairn.
J : 75mm Pipe Corner Fence Post



Scale 1:125000

The figure A B C D E F G H J along the fence

represents 1 825.2584 hectares of land being

Lease Area C over the Farm Nautabis No. 268
Situate in Registration Division K
The Khomas Region

Republic of Namibia

Compiled in March 2004 by me

Professional Land Surveyor
Registration Number

This diagram is annexed to	The original diagram is	S R No E
No.	No. A72/40	Noting Plan. LG - N
d.d.	Annexure to Government Grant No. B/1943 dated 16 - 02 - 1943	File No K 268
Registrar of Deeds		Lat. 23° 04' 30" S Long. 17° 56' 30" E

Figure 3.8: Cadastral lease diagram for Lease Area C over the farm Nautabis No 268 (Orthophoto)

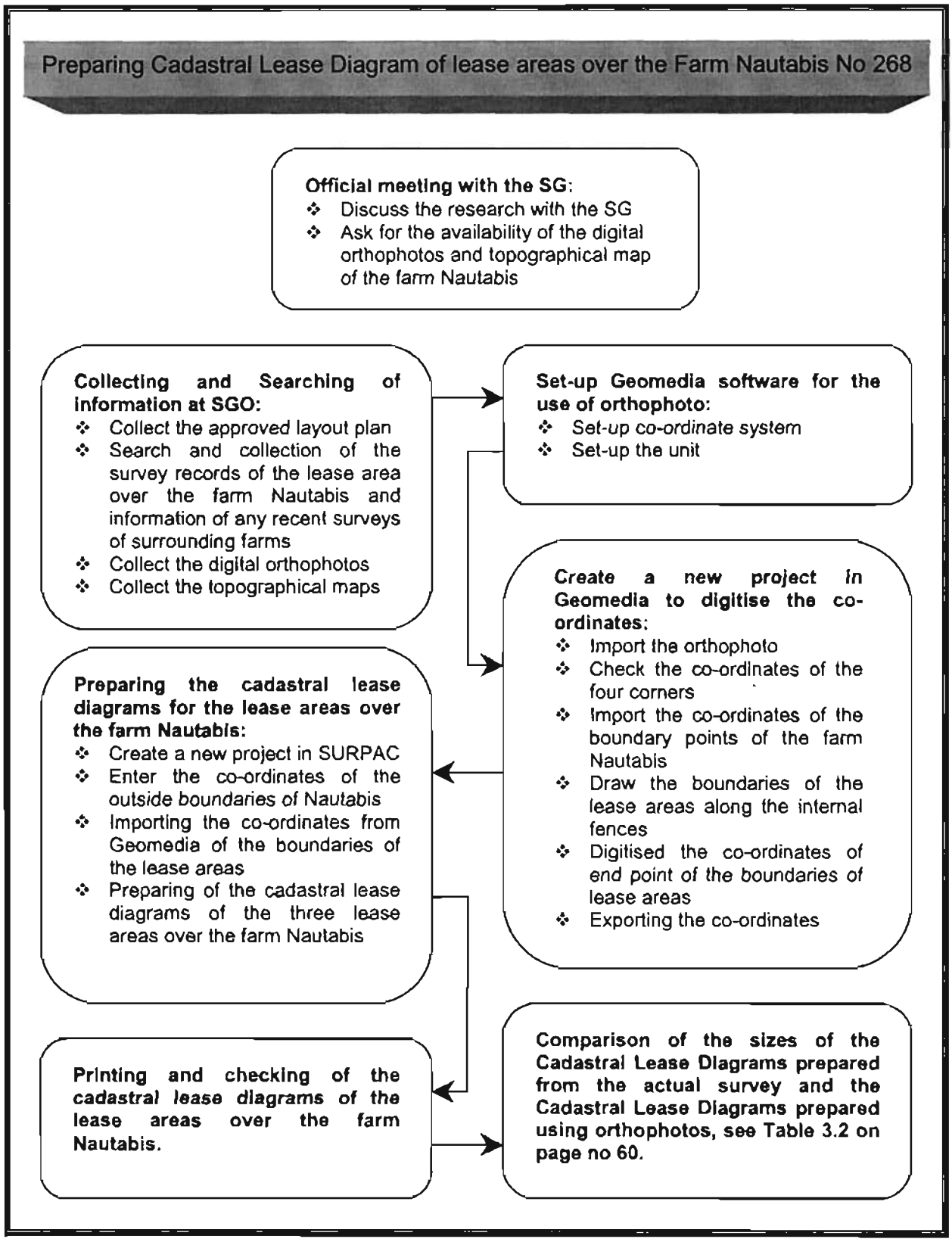


Figure 3.9: Procedure of using orthophotos for preparing the cadastral lease areas over the farm Nautabis No 268

3.3 Results

3.3.1 Cost and Time of the two methods

The fact that the orthophotos are already available means that there will be no cost involved for the creation of them. The software that is needed to digitise the co-ordinates is also already available at the SGO and some of the private professional land surveyors also have this kind of software (namely ArcView or Geomedia or Micro-Station, etc). The software for the compiling of the Lease area diagrams, like SURPAC, ReMap, Caddy, MCad, etc is also available.

The time for the whole survey process compare to the use of the digital orthophotos was five times longer. The whole field survey process was 10 days and the use of orthophotos was 2 days.

Table 3.1 show the cost comparison between the two techniques, according to the official surveying tariffs (Government Gazette No 2778, dated 2 August 2002). This is already out dated and is normally revised every year.

Cost Comparison					
Item or Document	**Actual Field Survey**	**Amount**	**Use of Orthophoto**	**Amount**	**Difference**
Searching	2 Hours	N$790.00	5 Hours	N$1,975.00	N$1,185.00
For information					
Topographical	1 Map	N$25.00	1 Map	N$25.00	
Map					
Orthophotos				N$0.00	
Travelling				N$0.00	
Kilometres	200 km	N$860.00		N$0.00	-N$860.00
Time	2 Hours	N$552.00		N$0.00	-N$552.00
Accommodation	5 Nights	N$4,000.00		N$0.00	-N$4,000.00
Survey fees					
per lease area	3 leases	N$21,000.00		N$0.00	-N$21,000.00
Geo-Media					
Importing		N$0.00	5 Hours	N$1,975.00	N$1,975.00
Digitising		N$0.00	3 Hours	N$1,185.00	N$1,185.00
Diagrams					
Basic	3 Diagrams	N$621.00	3 Diagrams	N$621.00	N$0.00
Hourly Rate	3 Hours	N$1,185.00	3 Hours	N$1,185.00	N$0.00
Total		N$29,033.00		N$6,966.00	**-N$22,067.00**

Table 3.1: Cost comparison between the two techniques.

The actual survey cost is thus approximately four times what the cost would have been if the orthophotos had been used to prepare the cadastral lease diagrams.

3.3.2 Accuracies between the two techniques

According to the survey regulations the survey of these long-term leases falls under Class C. The allowable error for Class C = 3 A meters,

where $A = 0.012 + \frac{0.082S}{3S + 1000} + \frac{0.15S}{100\,000}$

S = approximately 5400 metres and 8800 metres.

Therefore the Class C allowable error is approximately from 0.114m to 0.154m and the difference obtained by the professional land surveyor was 0.110m and 0.140m.

The use of the orthophotos for compiling of the lease areas shows that the differences of the sizes of these areas were very close to those found in the surveyed areas and also the planned areas. Looking at the size of the lease areas will show a clear comparison between the two techniques. Table 3.2 shows the comparison of the size of these lease areas.

Comparison of the sizes of the leases areas

Lease Area	Planned Size Ha	Surveyed Size Ha	Orthophoto Size Ha	% Difference Planned and Surveyed	% Difference Planned and Orthophoto	% Difference Surveyed and Orthophoto
A	1534.0000	1516.4626	1532.0015	-1.143	-0.130	1.025
B	1578.0000	1602.1588	1571.8528	1.531	-0.390	-1.892
C	1827.0000	1819.5206	1825.2584	-0.409	-0.095	0.315

Table 3.2: Size comparison of lease areas between the two techniques

The orthophotos areas of all three lease areas are closer to the planned areas than the surveyed areas are.

3.4 Materials

3.4.1 Legislation – Land Survey Act and Survey Regulations

3.4.1.1 The Land Survey Act

The land Survey Act, Act 33 of 1993, was promulgated to regulate the survey of land in Namibia and to provide for all matters incidental thereto (Government Gazette No 770, dated 22 December 1993). The Land Survey Act (1993) stipulates only professional land surveyors registered with the Professional Land Surveyors', Technical Surveyors' and Survey Technicians' Council, are allowed to sign and are responsible for signing all the diagrams, plans and any other documents forming part of the survey records submitted to the SGO for approval. According to the Professional Land Surveyors', Technical Surveyors' and Survey Technicians' Act, Act 32 of 1993 (Government Gazette No 769, dated 21 December 1993) there are five different categories survey practitioners, namely:

- *A professional land surveyor*
- *An apprentice land surveyor*
- *An apprentice survey technician or technical surveyor*
- *A survey technician*
- *A technical surveyor*

Except for the professional land surveyor all these other survey practitioners can do cadastral surveying, but only under the supervision of a professional land surveyor and they cannot sign or counter-sign any of these survey documents.

Some of the headings of some sections of the Act might differ from the South African act, but the meaning is the same. There are actually some parts in the South African Act that has been totally left out.

The Act makes provision for the establishment of the Survey Regulations Board, which is responsible for the creation of the Survey Regulations to regulate all land surveying issues in Namibia.

3.4.1.2 The Survey Regulations

The survey regulations of South Africa were used until 15 April 2002, when the new Survey Regulations were gazetted.

The techniques that may be used in cadastral surveying are not rigidly prescribed, but all work must be adequately done and carefully checked. All recognised techniques have special requirements laid down when surveys are undertaken. In Namibia Total Station and/or GPS are used for most cadastral surveys.

The following regulations and/or sub-regulations are useful to look at if one compares the use of orthophotos with the current field survey techniques.

The survey regulations clearly determine how a survey has to be conducted. The following regulation (4) is very important for the surveying of any piece of land (Government Gazette No 2723, dated 15 April 2002).

- *All surveys have to be based on the national control survey system as this was extended across the country, unless the SG gives exemption*
- *When the survey is conducted by GPS, sufficient GPS vectors shall be measured to determine the relationship between the GPS reference datum and the national control survey reference datum, by connecting to at least three trigonometrical stations or reference marks, within the boundaries of the land under survey and the whole survey shall fall within the perimeters of the trigonometrical stations or reference marks*

- *A land surveyor can use the co-ordinate value of any survey station or beacon previously determined in relation with the national control network, if he/she has verified the physical position*

In regulation 9, the accuracies with which surveys must be carried out, are prescribed. There are three classes of survey, each with its specified accuracy limit:

- Class A - Surveys for the determination of the positions of reference marks in urban surveys,
- Class B - Surveys of new townships, subdivision of erven within an existing township, replacement of beacons within an existing township and for mining titles in respect of precious stones and minerals,
- Class C – All other surveys not included in classes A and B, like farm surveys and surveys for mining titles in respect of base minerals.

Class A = A meters;

Class B = 1,5 A meters;

and Class C = 3 A meters, where $A = 0.012 + \frac{0.082S}{3S + 1000} + \frac{0.15S}{100}$

000

where S = the distance between the known point and unknown point.

A very important sub-regulation under the accuracies is that the SG may also determine the standard of accuracy of any survey operation not specified in the regulations.

In regulation 12, the use of photogrammetric methods is allowed for the determination of curvilinear boundaries, as long as the annotation of that specific boundary on an aerial photograph has been done in the field.

Further more in regulation 16 certain cases are mentioned when no beacons need to be placed, one is that the SG may waive the requirement to erect a beacon or beacons, when he/she determines the erection of the beacon will serve no useful purpose.

3.4.1.3 Random Notes on Land Survey Practice and Procedure in the Republic of South Africa

In 1955 the Survey Board of South Africa published notes on Land Surveying in South Africa, which were prepared by a former Surveyor – General and the Chairman of the Survey Board, M. T. de Smit. These notes were revised on a regular basis, in January 1963, October 1972 and February 1979. In October 1992 the notes were revised again, so the notes were expanded to make provision for all further amendments to the Land Survey Acts and the Survey Regulations and survey methods, by the Chief Surveyor-General, Mr D. J. Grundlingh.

The requirements for the use of GPS equipment in cadastral surveying has been added to the new notes now. Some of the most important issues in these notes are the following:

- Single point determination is not allowable
- A minimum of two single or dual frequency receivers must be used
- The base lines must not be longer than the average length between secondary triangulation points
- The base lines used to determine or fix a point needs to have at least 4 satellites available
- The connection to the national control network, need to have at least 3 stations of the national control network
- Base lines need to be surveyed in such a way that there is always a loop closure between the baselines

- Areas under survey need to fall within the parameters of the survey, to make sure no extrapolation occurs
- The information of the software, the manufacturer's name, the model of the receivers must be provided
- The name of the processing software and the version must be given
- The details of the transforming parameters must be provided

The determination of Cadastral boundaries (curvilinear and rectilinear boundaries) using photogrammetric methods has been revised. These notes explain the following when using photogrammetric methods.

- The compilation of the survey records – what should be in the survey records
- The specifications for aerial photography
- Guidelines on ground control
- Annotation
- Specifications for the accuracy

These notes are very useful in South Africa, but they were never utilised or adopted or reframed to be part of the Land Survey Act and/or Survey Regulations in Namibia.

These notes are already outdated because of development. The lack of information on the creation of digital orthophotos and the use of digital orthophotos is a shortcoming in the current notes. No information or notes could be found on the use of digital orthophotos in South Africa or Namibia.

4. Discussion

The current field surveying techniques used for surveying the lease areas is correct according to the Land Survey Act and the Survey Regulations when it comes to the conventional methods. Personal experience working in the SGO for more than 10 years enables the author to state that when it comes to the use of the GPS all the professional land surveyors are not yet familiar with how to apply the Land Survey Act and the Survey Regulations. The Survey Regulations clearly states that one has to connect to at least three trigonometrical beacons or reference marks and furthermore that the area of survey must fall fully within the perimeter of these control points. The survey of the farm Nautabis suffers a shortcoming with this. Strictly speaking the SG should not have approved the survey of the lease areas of Nautabis.

The Land Survey Act and the Survey Regulations of Namibia are fully based on the Land Survey Act of South Africa, but when the Namibian legislation was prepared and compiled in 1993, the Notes on Land Survey Practice and Procedure in the Republic of South Africa, revised by the Chief Surveyor General, in October 1992, were overlooked. Namibia has in the past relied on so much legislation from South Africa, that it would be wise to look at what legislation from South Africa could be used in Namibia.

According to Williamson (1983) in Thailand cadastral surveying has two survey procedures, namely first class and second class. The first class surveys are done in the urban areas and where there are sufficient national control points, with theodolites, total station, etc. The second class surveys are done mostly in the rural areas, in which use is made of rectified photomaps. Williamson (1983) further states that Thailand is a country that continuously re-assessed the performance of its cadastral surveying to see if the objectives of the country had been met. The most important thing about the surveying system in Thailand is,

that if the cadastral surveying system is found wanting, it is flexible enough to change direction accordingly.

The question is raised why not look at what and which legislation, laws and other relevant notes can be utilised from South Africa and also other countries.

Williamson (1981) suggests an alternative approach for the issuing of leases in Fiji, namely the use of combined general and fixed boundaries based on orthophoto maps. Williamson (1981) furthers his argument with the following statement: *'Even in Australia and New Zealand, who have some of the most ardent supporters of the "fixed" boundary approach, occupational boundaries are acceptable in law under certain circumstances and the use of general boundaries delineated on large aerial photographs is being seriously considered'.*

The cost of the surveying of the lease areas over the different resettlement farms and the preparation of cadastral lease diagrams is so expensive that the Government can only manage to survey and to prepare a certain number of these cadastral lease diagrams per year. The time for surveying is also much to long, because it is not always that there are professional land surveyors available to carry out the surveying.

For large areas like farms, data capture from orthophotos is a quick and economic method. Although the purchase of digital orthophotos requires a rather high initial investment, it will pay back in the long run. The digital orthophotos are usually used by a lot of other organizations as well, so there is often a good chance of sharing costs. The scale of the aerial photographs can be changed to suite multiple uses, like in creating orthophotos with sub-metre resolution.

The lease areas of the resettlement farms are planned in such a way that existing internal fences can be used as boundaries. Part of the reason for utilising the existing fences is because the landless farmers who are going to be

resettled on these farms are not very rich people because they are previously disadvantaged from the communal areas. If the cadastral lease diagrams are planned and prepared along existing fences there will be no costs for erecting new fences. The use of orthophotos together with the lease area diagrams will help the newly resettled farmers to understand where their boundaries are because they will be along the fences and not between two pegs that are supposed to form a straight line.

The UN Land Administration Guidelines (UNECE)(1996) as quoted by Dale and McLaughlin (1999) state that the selection of the most appropriate technique for cadastral surveying and mapping depends on a lot of different questions, namely:

1. *What physical boundary features are used to delimit property – for instance if there are fences or hedges and if only the boundary line turning points are monumented or marked?*
2. *Are there any cultural or legal restrictions affecting the choice of boundary delimiter – for instance in some communities physical barriers to entry are considered anti-social while some residential areas of modern towns are open planned?*
3. *Are the boundary points or lines visible or can be made visible on aerial photographs so that photogrammetrical techniques can be used?*
4. *What is the legal status of maps and plans kept within the land registration system?*
5. *What are the legal requirements for land parcels to be surveyed, what accuracy is laid down and are the field notes of the land surveyor treated as legal evidence;*
6. *What restrictions exist governing the maximum and minimum sizes of land parcels, and whether precise details on road reserve widths, plot frontages, etc. form part of the building development control regulations?*

7. *Who is responsible for quality control and how is such control implemented?*
8. *How is the surveyed data stored and retrieved, either in paper form or using information technology?*
9. *What is the real cost in both money and time of the different techniques of cadastral surveys?*
10. *What educational and training skills are available?*

5. Conclusion

According to Williamson (1981) it is important to review the survey systems in developing countries, to assess if the systems meet the current economic and social demands, like it is done in Fiji. Williamson further argues that developing countries like Fiji should be encouraged to establish professional standards and techniques that are applicable to them and should not just accept the standards, without carefully considering them, from developed countries.

UNCHS (1990), states that in Uganda the existing land law provides relatively few constraints on the cadastral survey operations, because the Real Property Act requires that surveys be carried out to the satisfaction of the Commissioner of Surveys, thus in theory giving great flexibility to the survey profession in Uganda.

The SG, the Survey Regulations Board and Council for Professional Land Surveyors, Technical Surveyors and Survey Technicians of Namibia need to look at the legislation and try to keep up with the development of technology. They must carefully look at ways of incorporating the beneficial changes that South Africa has put in place, but must not just accept them.

When aerial photographs of an area are being taken for any departmental purpose, it is sound practice to examine the possible needs of all departments for

photographs of the area and to consider whether it is cost effective to take the photographs, once and for all, on the largest scale required for any or all possible purposes. The SG must look at this option for the decreasing of the scale of the aerial photography, the resolution and the quality of the orthophotos and digital orthophotos and then to use the digital orthophotos for the creation of cadastral lease diagrams.

For large areas that need to be surveyed, land-based surveys using total stations is an expensive and slow survey method. However, the method is popular because it is well understood and considered accurate. In fact, in many cases land-based surveys can be quite inaccurate. In the field, the surveyors typically capture (precisely) corner points of a parcel of land and assume that the boundary between the points is a straight line. General boundaries are quite often not at all straight.

The use of digital orthophotos may assist in speeding up the resettling process if it can be used to prepare the cadastral lease diagrams. The Taxpayers will also benefit, because of the method's cost effectiveness.

According to Dale and McLaughlin (1999), in many less developed countries the choice of the technique of cadastral surveying is constrained in part by the law and in part by finance since the required modern technology needs to be either donated or else paid for from the very limited amount of hard currency available. However the primary importance is the end product and not the technology needed to achieve it, and sometimes simple and inexpensive techniques are just effective as the more expensive and sophisticated methods.

The availability of new technology and some resources like digital orthophotos, in Namibia can also be effective, if there is provision under the laws, for their usage. The Author argues that Survey Regulations should not restrain the options to best achieve goals; the cadastral surveying system should be made to be more

dynamic. It should not be necessary to wait for changes in the laws and regulations before new techniques like the use of digital orthophotos can be tried and if acceptable adopted. The accuracies should be related to the end-product, so this will provide more flexibility, to allow the professional land surveyor and / or any other survey practitioners to use their discretion on which survey technique is going to be used: for instance the field survey or photogrammetric survey technique.

Finally the author argues for the desirability to have flexibility in the cadastral surveying system in order to allow for cheaper graphical determination of boundaries, by using digital orthophotos.

The land surveyors must adapt their knowledge and practical abilities to be of assistance to the land reform system. The land surveyors will still be responsible for the cadastral lease diagrams, and furthermore they will have more time for other survey work. We do not want to see the land surveying profession as show in figure 5.1, below.

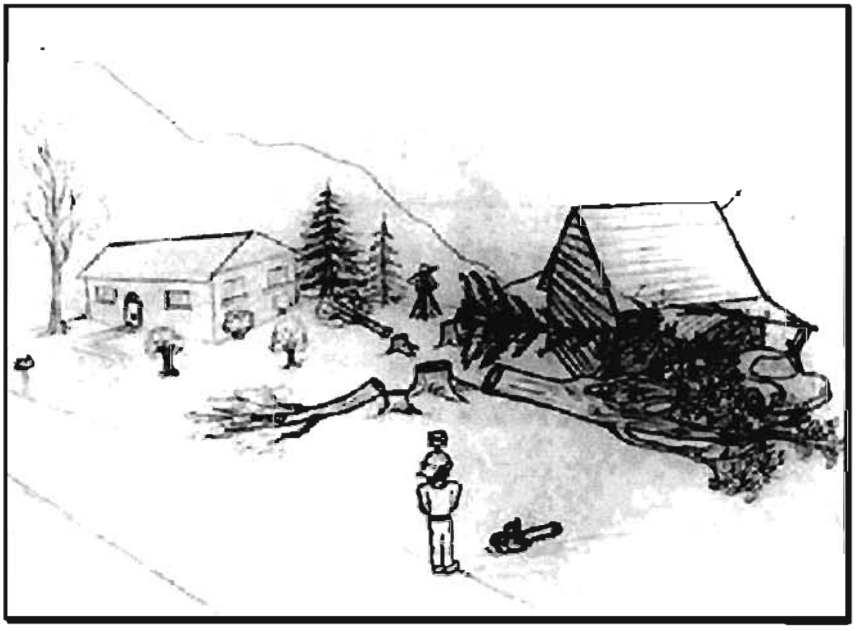


Figure 5.1 – Land Surveyor will not change, even if he has to destroy everything.

Land reform is a new concept in many spheres. It caught the Professional Land Surveyors off guard and they waited to be asked for advice before realising that the people involved were not going to ask their advice. The land surveyors perform a task poorly understood by many of the planners and the public, and it has become necessary for the Survey Profession to step in and market itself. Land reform is here to stay and as the current saying goes, "Deal with it, it will not disappear".

References

Books, articles, papers and Internet:

Birkett, R.W. and Van Dyk, C. (2001): *The Role of the Land Surveyor in the Land Reform Process, proceedings,* Conference of Southern African Surveyors, Cape Town.

Brook, I. (1994): *Control Networks and Cadastral Survey Methods - course notes* - Certificate in Development and Management of Cadastral and Land Information Systems - Swedesurvey, Gävle, Sweden.

Dale, P. and McLaughlin, J. (1999): *Land Administration*, Claredom Press, Oxford.

Davuth, L. and Suon, S. (2001): *Reforming land registration in Cambodia,* Proceedings, New Technology for a New Century International Conference, FIG Working Week 2001, Seoul, Korea 6–11 May 2001, Session 16 - Major Land Administration, Cadastre and Land Titling Projects.

Dickson, W.L. (1990): *Land Tenure and Management in a Developing Country*, NIR, University of Botswana, Working Paper No 54.

Fourie, C. and Van Gysen, H. (1996): *Land management and local level registries,* South African Journal of Surveying and Mapping, Vol.23, Part 6, 353-359.

Groot, R. and McLaughlin, J. (2000): *Geospatial Data Infrastructure*, Claredom Press, Oxford.

Haldrup, N. O. (1996): Adjudication – *A way of coping with incomplete information in developing countries,* Survey Review, Vol. 33, No. 262, October 1996.

International Federation of Surveyors (FIG)(1994): *FIG Statement on the Cadastre, adopted by Commission 7.* South African Journal of Surveying and Mapping, Vol. 22, Part 6, December 1994, pp.415-426.

Jackson, J. and Chilufya, M. (2002): *Geomatics for Land Management, course notes* - University of Natal, Durban.

Larsson, G. (1991): *Land Registration and Cadastral System,* Longman Scientific & Technical, UK Limited.

Mikkonen, K. and Corker, I. (2000): *Using Digital Orthophotos to Support Land Registration* - Was presented at the ESRI User Conference in San Diego in June 2000.

Schoeman, P. C. (2003): *Spatial Description of Leased Rural State Land Inconsistent with the Cadastre* – Mini-dissertation, University of Natal, Pietermaritzburg

Simpson, S. R. (1976): *Land Law and Registration,* Cambridge University Press, London.

Survey Manual –Version 2000:
http://www.state.nj.ua/transportation/eng/documents/survey/.

The Ad Hoc Group of Experts (1985): *Cadastral Surveying and Land Information.*

The Department of Land Affairs: *The Chief Surveyor General of South Africa* – http://www.csg.org.za.cadsurv/htm.

United Nations Centre for Human Settlements (UNCHS)(Habitat) (1990): *Guidelines for the Improvement of Land Registration and Land Information Systems in Developing Countries* (with special reference to English- speaking countries in Eastern, Central and Southern Africa), Nairobi.

Williamson, I. P. (1981): *The Cadastral Survey Requirements of Developing Countries in the Pacific Region. With Particular Reference to FIJI,* Paper presented at 23rd Australian Survey Congress, Sydney, Australia.

Williamson, I. P. (1983): *The Cadastral Survey Techniques in Developing Countries, with Particular Reference to Thailand,* The Australian Surveyor, Vol.31, No.7, 496-512.