**USAID/Zambia MCA Threshold Project**

**Ministry of Lands**

**Cadastre Data Management Assessment Report**

**March 2007**

## DATA PAGE

Activity Title and Number:              Zambia MCA Threshold Project
                                        Contract No. AFP-I-00-04-00002-00

Task:                                   Component 1 – Ruling Justly
                                        KRA 1.2 Reducing Opportunities for
                                        Administrative Corruption


Author:                                 Maksym Kalyta – International Land
                                        Systems (ILS), Inc.

Title:                                  Cadastre Data Management
                                        Assessment Report


List of Key Words Contained in Report:
*Ministry of Lands, Survey Department, business process, cadastre, map,
diagram, plan, cadastre index map, training, title registration, survey, parcel,
property*

Abstract:

This report is the result of the on-site assessment of documents and current
procedures used in the Survey Department for cadastre data management.
The report provides an inventory of existing hardware and software in the
Survey Department and a description of available plans and maps used for
cadastre data maintenance.

The purpose of the assessment is to provide recommendations for the
improvement of cadastre data management in the Survey Department and to
develop Cadastre Index Map specifications that will be used for the pilot
project. The index map will serve as a spatial component for the operation of
the Zambia Land Registration System to be implemented under the support of
the ZTP project.

## *1.1.    Executive Summary*

This report presents results of the assessment of the Survey Department conducted by the consultant at the Ministry of Lands in Lusaka, Zambia. This includes:

1. Assessment results for available data, hardware, and software in the Cadastre Section of the Survey Department,
2. Recommendations on the improvement of cadastre data management, including recommended software and hardware upgrades,
3. Procedures, resources and specifications for the implementation of the Cadastre Index Map pilot project, and
4. List of the hardware and software in the Survey Department.

The following recommendations are proposed for the consideration and implementation in the Survey Department to address the most obvious bottlenecks and improve overall cadastre data management:

| Recommendation | Effect |
|---|---|
| Implement parcel information management system | Proper management of cadastre information; better public services; simplified process of the survey results processing and plan examination; level of corruption will be reduced significantly through the better control on land resources management |
| Deploy long-term GIS/IT consultant for the Survey Department support | During this consultancy the ZTP will be able to monitor and supervrise CIM pilot project and also define requirements for the PIMS system. |
| Optimize use of DWG drawings for general plans and survey diagrams | Parcel data can be imported directly into CIM |
| Computerize examination section | Examination procedure will be more accurate and faster |
| Request existing drawings from private companies | Examination procedure will be more accurate and faster; faster compilation of the CIM |
| Redesign workflows for cadastre data management | Faster and more reliable procedures for the cadastre data conversion and management |
| Transfer cadastre index map from CAD to GIS system | Existing data for Lusaka from AutoKA system will be re-used for CIM pilot which in turn will reduce time of CIM compilation |
| Centralize data storage and schedule regular backups | Valuable data can be restored immediately in case of occasional deletion or corruption or in case of hardware/software failure. |
| Limit staff access to the Internet | Working time will not be spent on Internet browsing |
| Conduct GIS training | Refreshing of CIM operators' skills will ensure smoother start of CIM production process |

The Cadastre Index Map (CIM) concept and specifications are presented in the second part of the report. The CIM will provide the sole source of information about land parcels in Zambia. To meet modern international standards, the Cadastre Index Map must contain at least the following data:

| Feature class name | Description |
|---|---|
| Parcels | Main feature class, containing most recent version of parcels that are surveyed and approved. |
| Beacons | Points for parcel beacons or survey stations. |

| Feature class name | Description |
|---|---|
| Parcels History | Feature class to store parcels history. In case parcel shape from "Parcels" feature class is changed for any reason, the old shape should be copied to this historical layer. |
| Beacons History | Feature class to store beacons history. In case beacon point from "Beacons" feature class is changed for any reason, the old point should be copied to this historical layer. |
| Boundaries | Temporary layers to construct boundaries through the coordinate geometry procedures. |
| Approvals | Feature class that must be used to track approved site plans. As soon as new Site (Layout) Plan is submitted to the Survey Department and after it is approved and assigned property numbers, the rough, approximate parcel shape or surveying area should be drawn in this layer to indicate that this area is under surveying now. |
| Sketches | Feature dataset with low-precision boundaries of the areas/parcels covered by sketch plans. Since sketch plans have very low accuracy, it is recommended to have this data separately. |

Once these data are collected for the pilot area according to the recommended specifications, a review workshop should be conducted to evaluate pilot results and elaborate additional requirements and enhance methodology for the CIM, if necessary.

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**ACRONYMS**

| | |
|---|---|
| CIM | Cadastre Index Map |
| COGO | Coordinate Geometry |
| CoT | Certificate of Title |
| DBMS | Database Management System |
| GIS | Geographic Information System |
| GPL | General Plan |
| GPS | Global Positioning System |
| GRZ | Government of the Republic of Zambia |
| ILS | International Land Systems (ILS), Inc. |
| IT | Information Technology |
| LD | Lands Department |
| LIMS | Land Information Management System |
| LO | Lands Officer – Lands Department |
| MOL | The Ministry of Lands |
| PID | Parcel Identifier |
| PIMS | Parcel Information Management System |
| SD | Survey Department |
| SDG | Survey Diagram |
| SG | Surveyor General – Survey Department |
| ZLRS | Zambia Land Registry System |

## 2. Introduction

### 2.1.        Purpose

This document presents results of the assessment of the Survey Department conducted by the consultant at the Ministry of Lands in Lusaka, Zambia. The assessment report outlines findings and recommendations for the improvement of cadastre data management and maintenance at the Survey Department. Furthermore, the report stipulates what actions should be taken and requirements to be met to convert existing analog cadastre data into a digital Cadastre Index Map. The inventory of the existing hardware and software has been created to evaluate the Survey Department's capabilities to start pilot production of the Cadastre Index Map.

### 2.2.        Scope

The document includes:
1.  Assessment results for available data and software in the Cadastre Section of the Survey Department,
2.  Recommendations on the improvement of cadastre data management, including recommended software and hardware upgrades;
3.  Procedures, resources and specifications for the implementation of the Cadastre Index Map pilot project;
4.  List of the hardware and software in the Survey Department, and
5.  Examples of most used documents.

Since the primary focus of this report is creation of the cadastre index map and evaluation of the existing cadastre data and its management, this report does not include a detailed assessment of the Survey Department's sections other than Cadastre Section.

### 2.3.        References

1.  "Business Process Analysis & Reengineering Study" Report by Noel Taylor, ZTP Project, January 2007.
2.  "Guidelines on Real Property Units and Identifiers" Economic Commission for Europe, United Nations, Geneva, 2004.

### 2.4.        Methodology

The methodology adopted in carrying out this consultancy included a number of interlinked activities.

*Assessment:* This includes analysis of existing hardware and software used in the current production line in the Cadastre Section of the Survey Department, assessment of completeness, conditions and availability of various maps and plans, assessment of personnel's computer and GIS skills.

*Interviews/Meetings:* Numerous meetings were held with Survey Department staff to discuss existing processes, constraints, available materials, and current efforts in the creation of the cadastre index map – both in analogue and digital forms.

*Measurements:* Following queries to Land Information Management System, and discussions with staff members, the estimated of number of parcels, plans, and maps was done to foresee efforts required for the Cadastre Index Map creation.

*Design:* Based on availability of different survey and mapping materials and considering current IT/GIS skills of the staff, specification for the pilot cadastre index maps are designed. Among these, recommendations for the improvement of overall business processes for cadastre data management are provided.

# 3. Findings

## 3.1.      Organization structure

The Ministry of Lands consists of four departments, three of which are related to the property registration process.

- Survey Department provides surveying and mapping services, including establishment and maintenance of geodetic network, photogrammetry and cartography productions and preparation of cadastre plans/diagrams.

- Lands and Deeds Department is responsible for title registration process and maintenance of the Deeds Registry.

- Lands Department conducts managements of state lands and their redistribution.
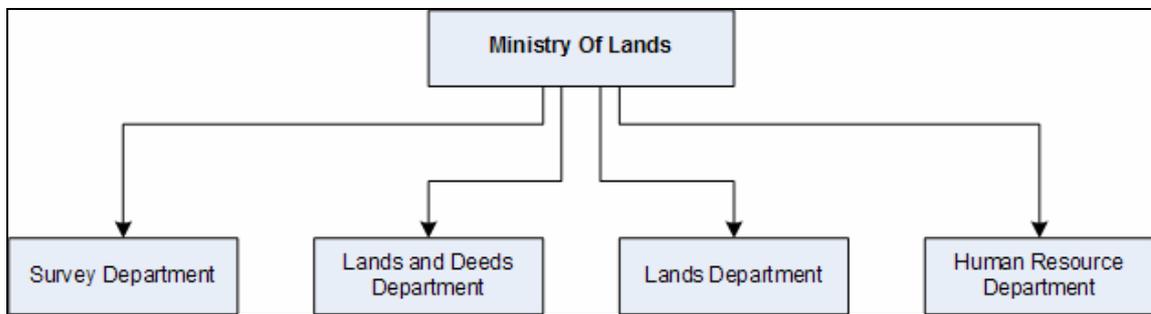


**Figure 1 The Ministry of Lands structure**

In turn, the Survey Department has the following structure (see "*Figure 2 the Survey Department Structure*")
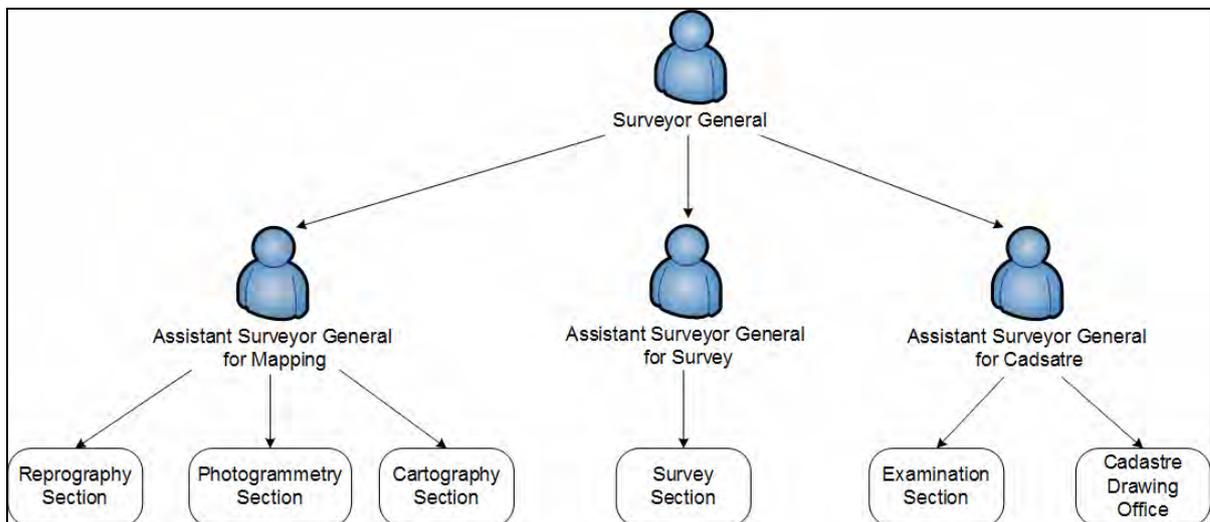


**Figure 2 the Survey Department Structure**

### *3.2.     Cadastre Section*

The Cadastre Section is responsible for the examination and production of different documents that are required for the title registration process. Among these, the following key activities were identified:

1. Examination of cadastre survey results and documents,
2. Preparation of the General Plans and Survey Diagrams for state surveyors[1],
3. Maintenance of Cadastre Series maps, and
4. Storing original copies of General Plans, Sketch Plans, and some other maps.

This section occupies one wing on the ground floor in the MOL building. The main room (*Figure 3 Cadastre Drawing Office*) is used both for production and archiving purposes. Several computers are stationed in the middle of the room and are mainly used for the preparation of the General Plans and Survey diagrams using AutoCAD software.



**Figure 3 Cadastre Drawing Office**

### 3.2.1.  Plans and Documents

The end product of the Cadastre Section, required for the title registration, is the Parcel Diagram. Each Certificate of Title (CoT) has a Parcel Diagram attached, regardless of the existence of a General Plan[2] for the specified area. In case a new CoT is issued and the parcel's shape was not changed, a copy of the old Survey Diagram is prepared.

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[1] *It happens that Cadastre Section drafts General Plans and Survey Diagrams for licensed (private) surveyors if they do not have cartographers.*

[2] *In some other countries with British colonial law, Certificate of Title should contain only reference to the General Plan if such exists and attachment of a separate Survey Diagram is not compulsory.*

Along with Survey Diagrams, there are other documents that are used in the cadastre process. The Table "Cadastre Section Documents" contains a list of key documents of interest.

**Table 1 Cadastre Section Documents**

| Document | Description |
|---|---|
| Site Plan (or *Layout Plan*) | A sketch plan that is used to approve subdivision/development and assign cadastre numbers before actual surveying will take place. The use of the Site Plan is intended to guarantee that non-permitted land allocation will not happen. The site plan is prepared by the local authority.<br>Example: *Figure 17 The Site Plan* |
| Working Plan | A paper plan, created to show how exactly the survey was done by the surveyor. This plan is used to check the surveyor's job before the survey diagram will be approved. The Working Plan shows station positions, directions taken from those stations to parcel points, and outlines of parcel boundaries.<br>Example: *Figure 19 The Working Plan* |
| General Plan | A plan with two or more parcels showing actual parcel boundaries, their lengths and directions. All general plans have list of parcel points with their coordinates. At present, the General Plans are one of the two most reliable sources of parcel boundary information.<br>Example: *Figure 20 The General Plan* |
| Cadastre Series Map | An index map (on transparent film) with parcels' numbers and their boundaries. For populated areas the cadastre map has a scale of 1:5000, for rural areas either 1:50 000 or 1:100 000 scales are used, depending on the province and density of population.<br>Example: *Figure 23 Cadastre Series Map* |
| Sketch Plan | A sketch with several parcels without precise measurements. They are used in cases when geodetic network are unavailable or no qualified surveyor was found in that particular area. Sketch Plans have their own property numbering system, which is unique only within one particular sketch plan. At the time of the assessment there were stored about 10 000 sketch plans in the Cadastre Drawing Office. Most of them are A4 or A3 sized film sheets.<br>Example: *Figure 24 The Sketch Plan* |
| Survey Diagram | A diagram showing the parcel with all related information (parcel number, boundary lengths, area, beacon coordinates) that is inserted into the Certificate of Title. The Parcel Diagram is the second most reliable source of information about parcel boundaries. The reason for that is that for single parcel surveys/subdivisions the General Plan is not created – in such cases Survey Diagrams of the parent parcel might be marked off and new Survey Diagram is created for the child parcel.<br>In turn, Parcel Diagrams, created for parcels from General Plans, do not contain point coordinates and reference to the General Plan is always required.<br>Example: *Figure 21 The Survey Diagram (with coordinates)* |

| Document | Description |
|---|---|
| Chiefdom Maps | Index maps on film outlining boundaries of lands owned by the tribes and managed by their Chiefs. Scale varies.<br>Example: *Figure 22 Chiefdom Lands Map* |
| District Maps | Maps outlining boundaries of districts and tribal lands as well. Scale varies.<br>Example: *N/A* |

The entire process of the survey, after which the Survey Diagram is produced, can be briefly outlined[3] as follows:

1. The Site plan is prepared to show what is planned for development/subdivision in the selected area/parcel.
2. Once the Site Plan is approved by a local authority, it is submitted to the Survey Department and processed (approved and assigned with the parcel number).
3. Survey is conducted.
4. Survey results are processed and all documents/plans are prepared.
5. If surveying was done for a single parcel, then only the Survey Diagram is prepared for the property. If surveying was done for two or more parcels, the General Plan is created and only after separate Survey Diagrams are created for each individual parcel, shown on the General Plan.
6. After approval, Survey Diagrams can be attached to the Certificate of Title.

Presently, the Cadastre Section prepares Survey Diagrams using unlicensed copies of Autodesk AutoCAD 2002 (or AutoCAD 2004) software. AutoCAD is used to create drawings for state surveyors – most of the private surveyors submit General Plans and Parcel Diagrams in paper form (some of the companies can use other software for GPL or SDG creation, but in any case they submit only paper versions of plans/diagrams). Also there are cases when the Cadastre Section provides services for the private surveyors and creates drawings for them in AutoCAD but this does not happen often.

The process of plan/diagram preparation is quite simple: using a list of coordinates from a paper source provided by the Surveyor, the Operator creates points by entering X and Y coordinates in the specified coordinate system and then connects points to form the parcel(s). When all required objects are placed (grid marks, text labels etc.) on the drawing, the Survey Diagram is printed and submitted for approval/examination. A similar procedure applies to the creation of General Plan.

> The current policy does not require storing of DWG files after Survey Diagrams are approved and attached to the CoT.   The same applies to the General Plans, created in AutoCAD in Cadastre Section. In other words, as soon as the hard drive runs out of space, "*unnecessary" georeferenced* drawings with survey diagrams and plans are deleted.

All these drawing files with General Plans and Survey Diagrams are temporarily stored on local drives or shared network drives without a strict organization policy.

After the General Plan and/or the Survey Diagram(s) are created, they are submitted to the Examination Section for verification. In fact, the examination officers will check every computation on the plan using old programmed calculators.

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[3] *For details please see "Business Process Analysis & Reengineering Study" ZTP Report by Noel Taylor.*
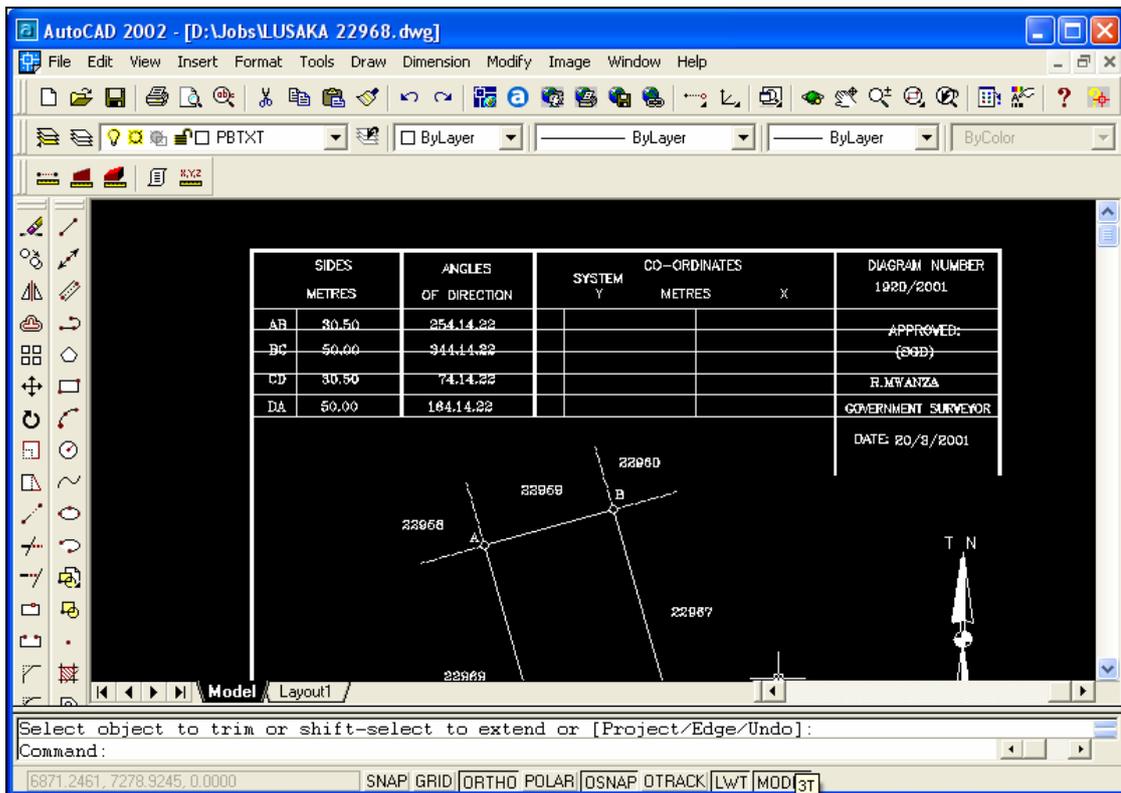
**Figure 4 Preparation of Survey Diagram in AutoCAD software**
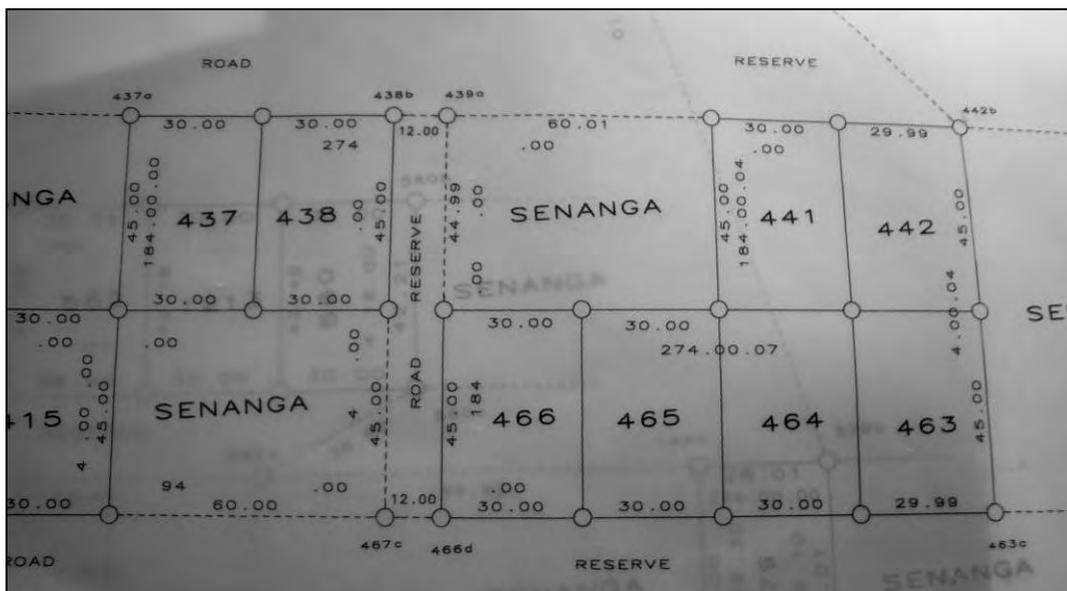

**Figure 5  Part of General Plan**

In other words, if one looks at Figure 5  Part of General Plan, the examination officer checks every computation – for example, since coordinates for points 466d and 463c are known, the examination officer will start with point 466d and using programmed functions in the calculator will calculate a traverse to the point 463c. In case the calculated and shown coordinate for the point 463c has a bigger difference than allowed, the survey results will be rejected. Similar verifications are done for the *entire* drawing. During the interview the examination officer has shown one drawing with approximately fifty parcels and according to his words it will take him up to 2-3 weeks to check the entire drawing and survey notes.

> As one can see, during the examination procedure the officer actually receives a list of all coordinates in digital form but these are used in the calculator and not

the computer. However, should the surveying software be used for examination purposes, the received list of coordinates can be afterwards used for the import into GIS software to facilitate creation of the Cadastre Index Map.

Ideally, after survey results are approved, the cadastre index map should be updated with new parcel shapes. However, in reality the analogue Cadastre Series map is updated with new parcel outlines only in case the scale allows showing new parcel(s) in such a way that it will be possible to read the information. In practice, current cadastre Registry Map Sheets can be outdated especially in areas with rapid or extensive development. The other reason for that is that at some point it is not possible to draw new parcels on top of the parent. And, finally, a third reason is the huge backlog of survey plans pending approval.

### 3.2.2.  IT infrastructure

The Cadastre Section has heterogeneous sets of hardware and software that is used for plan preparation and verification. These is no single software platform used for the production line and often selection of the software is made based on availability of pirate copies. The current use of AutoCAD 2004 is one example of such selection – it was the initiative of the staff to select this software to speed up the process of GPL/SDG preparation and increase the quality of these documents.
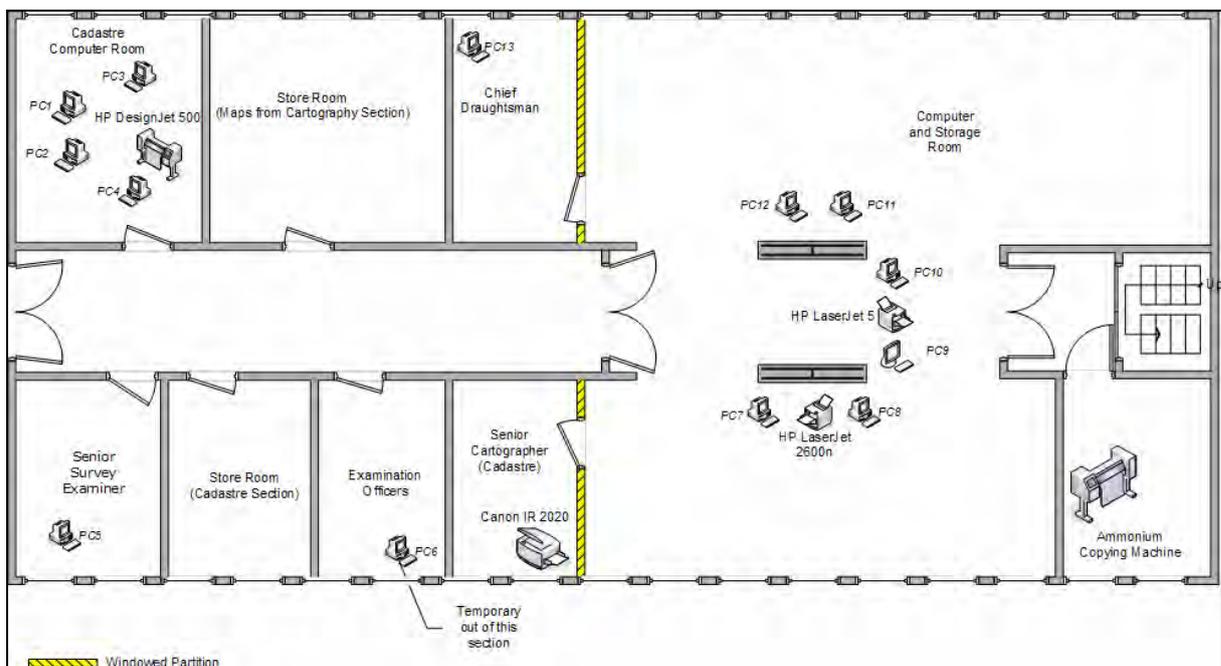


**Figure 6 Cadastre Drawing Office layout**

Currently, the Cadastre Section uses the following software:

| # | Name | Purpose | Use | License |
|---|------|---------|-----|---------|
| 1. | Autodesk AutoCAD 2000/2002/2004 | Preparation of General Plans and Survey Diagrams | Daily | Not licensed |
| 2. | AutoKA PC | Checking of survey results, maintenance of cadastre index map for Lusaka. | Daily | 1 dongle |
| 3. | LIMS | Checking parcel status to find if it was further subdivided/resurveyed | Daily | Licensed |
| 4. | MapSource (Garmin | Import data from handheld | Rare | Free |

| # | Name | Purpose | Use | License |
|---|------|---------|-----|---------|
|   | GPS software) | GPS |   |   |
| 5. | MS Office XP | Office documents management (preparation, reading, printing etc.) | Sometimes | Not licensed |
| 6. | Trimble Geomatics Office | Import/process data from GPS/total stations | Rare | Not licensed |
| 7. | Leica GEO Office 1.1 | Import/process data from GPS/total stations | Rare | 1 license |

Most of the software used in the section is unlicensed and thus no proper support or documentation is available. Below is list of all computers in Cadastre Section with relevant software installed. For a detailed list of hardware configuration please see next section.

**Table 2  List of hardware in Cadastre Section**

| # | Computer | Software Installed | Comments |
|---|----------|--------------------|----------|
| 1. | PC1 | N/A | Old, not used |
| 2. | PC2 | N/A | Old, not used |
| 3. | PC3 | Autodesk AutoCAD 2000<br>AutoKA | |
| 4. | PC4 | Autodesk AutoCAD 2000<br>AutoKA PC<br>LIMS<br>MapSource (Garmin GPS software)<br>ArcView 3.x<br>MS Office XP | Connected to Lands network |
| 5. | PC5 | Autodesk AutoCAD 2004<br>AutoKA PC<br>Trimble Geomatics Office<br>LIMS<br>Leica GEO Office 1.1<br>ArcGIS 9.x (not used)<br>OpenOffice | |
| 6. | PC6 | LIMS? | Temporarily taken to the Cartography section |
| 7. | PC7 | Autodesk AutoCAD 2002<br>MS Office XP | |
| 8. | PC8 | Autodesk AutoCAD 2002<br>MS Office XP<br>ArcGIS 9.2 (not used)<br>ArcView 3.2 (not used) | |
| 9. | PC9 | Autodesk AutoCAD 2002 | |
| 10. | PC10 | Autodesk AutoCAD 2002<br>ArcView 3.2<br>MS Office XP | |
| 11. | PC11 | Autodesk AutoCAD 2002<br>ArcView 3.2<br>MS Office XP<br>Leica Geo Office 1.1<br>Bernese GPS Software 5.0 | |
| 12. | PC12 | Autodesk AutoCAD 2002 | Connected to Lands network |

| # | Computer | Software Installed | Comments |
|---|----------|-------------------|----------|
|   |          | LIMS <br> MS Office XP |  |
| 13. | PC13 | Autodesk AutoCAD 2002 <br> LIMS |  |

## 3.3.      Survey Department Hardware and software

During the detailed assessment of the entire Survey Department the following hardware equipment and software packages were identified.

**Table 3 List of official software licenses in Survey Department**

| Name | Licenses | Comments |
|------|----------|----------|
| AutoKA APC 2.x | 5 |  |
| Windows 2000 Server | 1 + 25 CAL |  |
| Windows 2000 Professional | 2 |  |
| MS Exchange 2000 | 1+5 CAL |  |
| MS SQL 2000 | 1+5 CAL |  |
| NetObjects | 1 |  |
| ArcGIS 8.3 Desktop (ArcInfo) | 1 | Floating License |
| ArcInfo 8.2 Workstation | 1 | Floating License |
| ArcInfo 4 Workstation | 1 |  |
| Microsoft Office XP Standard | 1 |  |
| Mcirosoft Project Standard | 1 |  |
| Microsoft Publisher | 1 |  |
| Data Analyzer | 1 |  |
| Microsoft Picture IT- Photo Standard | 1 |  |
| Microsoft Picture IT -Digital Image Pro | 1 |  |
| Leica Geo Office | 4 |  |

Along with this software a number of unlicensed copies of Autodesk AutoCAD, and Microsoft office software were found.

**Table 4 List of current peripherals in the Survey Department**

| # | Device | Type | Current Location | Room | Max size | Color | Comments |
|---|--------|------|------------------|------|----------|-------|----------|
| 1. | HP LaserJet 2100 | Printer | Cartographic Drawing Office | 151 | A4 | N |  |
| 2. | HP LaserJet 5 | Printer | Cadastral Main Drawing Office | G37 | A4 | N |  |
| 3. | HP DesignJet 455CA | Plotter | Mapping |  | A0 | Y | Out of Use |
| 4. | HP DesignJet 455CA | Plotter | Mapping |  | A0 | Y | Out of Use |
| 5. | HP DesignJet 500ps | Plotter | Cartographic Drawing Office | 151 | A0 | Y |  |
| 6. | HP DesignJet 500ps | Plotter | Photogrammetry Section | G26 | A0 | Y |  |
| 7. | HP DesignJet 500 | Plotter | Cadastral Computer Room | G39 | A1 | Y |  |
| 8. | HP DesignJet 500 | Plotter | Photogrammetry Section | G26 | A1 | Y |  |
| 9. | HP LaserJet 2300 | Printer |  | 149 | A4 | N |  |
| 10. | HP LaserJet 2420 | Printer | Examination Section | G34 | A4 | N |  |
| 11. | HP Color LaserJet 2600n | Printer | Cadastral Main Drawing Office | G37 | A4 | Y |  |
| 12. | HP 1320 | Printer | Cartography Section | 150 | A4 | N |  |
| 13. | HP 1320 | Printer | SG Secretary | 141 | A4 | N |  |

| # | Device | Type | Current Location | Room | Max size | Color | Comments |
|---|--------|------|------------------|------|----------|-------|----------|
| 14. | HP 1320 | Printer | Reprography Section | B14 | A4 | N | |
| 15. | HP 2300 | Printer | Surveyors Room | 148 | A4 | N | |
| 16. | HP 2420 | Printer | SEO | 147 | A4 | N | |
| 17. | HP 1320 | Printer | Surveyor General | 142 | A4 | N | |
| 18. | HP 1100 | Printer | Assistance Surveyor General | 143 | A4 | N | |
| 19. | HP 1100 | Printer | Typing Pool | 136 | A4 | N | |
| 20. | HP 1320 | Printer | Plan Room | 134 | A4 | N | |
| 21. | Canon (IR2020) | Photocopying Machine | Plan Room | 134 | A3 | N | |
| 22. | Canon (IR2020) | Photocopying Machine | Conference Room | 140 | A3 | N | |
| 23. | Canon (IR2020) | Photocopying Machine | Senior Cartographer Room | G37b | A3 | N | |
| 24. | Sharp | Photocopying Machine | Registry | 138 | A3 | N | |
| 25. | Scanner Canon Lide 20 | Scanner | Reprography Section | B14 | A4 | Y | |
| 26. | Scanner HP Scanjet 5590 | Scanner | Reprography Section | B14 | A4 | Y | |
| 27. | Contex Panorama 50 Plus | Wide Format Scanner | Photogrammetry Section | G29 | A0 + | N | |
| 28. | Contex Magnum XL 54 Plus | Wide Format Scanner | Photogrammetry Section | G29 | A0 + | Y | |

There are several digitizing tables that are installed in the Cartography Section but they are not utilized anymore since on-screen digitalization is used for the conversion of the analogue maps into digital form.

**Table 5 List of computers and their configarations in Survey Daparment**

| # | MODEL | BRAND | LOCATION | ROOM # | SECTION | OS | CPU Type | CPU Mhz | RAM (MB) | HDD (GB) | DISPLAY | Comments |
|---|-------|-------|----------|--------|---------|-----|----------|---------|----------|----------|---------|----------|
| 1 | Compaq | Deskpro | AGS Mapping | 144 | Admin | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | CRT | Desktop Not Working |
| 2 | Compaq | Deskpro | AGS SS | 139 | Admin | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | CRT | Desktop Not Working |
| 3 | Fujitsu Siemens | | ASG Mapping | 144 | Admin | Windows XP | | 2200 | 256 | 60 | CRT | |
| 4 | Dell | Optiplex Gn+ | ASG Cadastral | 143 | Admin | Windows 2000 Pro | | | | | CRT | |
| 5 | AST | Bravo MS-TPRO 6200 | Cadastral | G36 | Cadastral | Windows 98 | Pentium Pro | 200 | 32 | 2.5 | CRT | |
| 6 | Compaq | Deskpro | Cadastral | G37 | Cadastral | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | 15" CRT | |
| 7 | Compaq | Deskpro | Cadastral | G39 | Cadastral | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | 15" CRT | |
| 8 | Dell | Optiplex 466L | Cadastral | G39 | Cadastral | | | | | | 15" CRT | Desktop Not Working |
| 9 | Dell | Optiplex 466L | Cadastral | G39 | Cadastral | | | | | | 15" CRT | Desktop Not Working |
| 10 | Fujitsu Siemens | Scenic P300 | Cadastral | G37 | Cadastral | Windows XP | Pentium IV | 2660 | 512 | 40 | 15" CRT | |
| 11 | Fujitsu Siemens | Scenic P300 | Cadastral | G37 | Cadastral | Windows XP | Pentium IV | 2660 | 512 | 40 | 15" CRT | |
| 12 | Dell | Optiplex 170L | Cadastral | G37 | Cadastral | Windows XP | Pentium IV | 3000 | 512 | 74 | 17" TFT | |
| 13 | HP | Brio | Cadastral | G39 | | Windows 2000 Pro | Pentium II | 400 | 32 | 4 | CRT | CD Drive and USB Port not working |
| 14 | HP | Vectra VE | Cadastral | 130 | Plan Room | Windows 98 | Pentium III | 600 | 64 | 8 | CRT | Chief Examiner |
| 15 | HP | HP Compaq | Cadastral | G39 | Cadastral | Windows XP | Pentium IV HT | 3000 | 504 | 74.53 | 17" TFT | |
| 16 | HP Compaq | Dx2000MT | Cadastral | G37 | Cadastral | Windows XP | Pentium IV | 3000 | 504 | 74.52 | 17" CRT | |
| 17 | HP Compaq | Dx2000MT | Cadastral | G37 | Cadastral | Windows XP | Pentium IV | 3200 | 504 | 74.52 | 17" CRT | |
| 18 | DELL | Optiplex GX270 | Cadastral | 130 | | Windows XP | Pentium IV | 2800 | 256 | 37.25 | 17" CRT | |
| 19 | HP Compaq | DX2200MT | Cadastral | 130 | Plan Room (Examination) | Windows XP | Pentium IV | 3000 | 448 | 74.52 | 17" CRT | |
| 20 | AST | Bravo MS-TPRO 6200 | Cartography | 152 | Cartography | Windows 2000 Pro | Pentium Pro | 200 | 32 | 2.5 | CRT | |
| 21 | AST | Bravo MS-TPRO | Cartography | 151 | Cartography | Windows | Pentium Pro | 200 | 32 | 2.5 | CRT | |

| #  | MODEL | BRAND | LOCATION | ROOM # | SECTION | OS | CPU Type | CPU Mhz | RAM (MB) | HDD (GB) | DISPLAY | Comments |
|----|-------|-------|----------|--------|---------|-----|----------|---------|----------|----------|---------|----------|
|    |       | 6200  |          |        |         | 2000 Pro |     |      |      |      |      |      |
| 22 | Compaq | Deskpro | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium III | 800 | 256 | 20 | CRT | |
| 23 | Compaq | Deskpro | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | CRT | |
| 24 | Dell | Optiplex Gx1 | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium II | 400 | 128 | 6 | CRT | |
| 25 | Dell | Optiplex Gxa | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium II | 266 | 64 | 4 | CRT | |
| 26 | Dell | Optiplex Gx1 | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium II | 400 | 128 | 10 | CRT | |
| 27 | Dell | Optiplex Gx1 | Cartography | 151 | Cartography | Windows 2000 Pro | Pentium II | 350 | 64 | 4 | CRT | Desktop Not Working |
| 28 | Dell | Optiplex Gxa | Cartography | 151 | Cartography | Windows 2000 Pro | | | | | CRT | Desktop Not Working |
| 29 | Fujitsu Siemens | Scenic P300 | Cartography | 151 | Cartography | Windows XP | Pentium IV | 2660 | 512 | 40 | CRT | |
| 30 | Fujitsu Siemens | Scenic Edition X1021 | Cartography | 151 | Cartography | Windows XP | Pentium IV | 3060 | 480 | | CRT | |
| 31 | Fujitsu Siemens | Scenic Edition X1021 | Cartography | 151 | Cartography | Windows XP | Pentium IV | | 504 | | CRT | |
| 32 | Fujitsu Siemens | Scenic Edition X1021 | Cartography | 151 | Cartography | Windows XP | Pentium IV | 3060 | | | CRT | Desktop Not Working |
| 33 | Fujitsu Siemens | Scenic Edition X1021 | Cartography | 151 | Cartography | Windows XP | Pentium IV | 130 | 504 | | CRT | |
| 34 | Dell | Optiplex | Cartography | 151 | Cartography | Windows 2000 | Pentium II | 2660 | 616 | 6 | CRT | |
| 35 | Fujitsu Siemens | Scenic P300 | Cartography | 151 | Cartography | Windows XP | Pentium IV | | 480 | 40 | CRT | |
| 36 | Compaq | Deskpro | Cartography | 151 | Cartography | Windows 2000 | Pentium III | 2600 | 528 | 20 | CRT | |
| 37 | Dell | Optiplex GX1 | Cartography | 151 | Cartography | Windows 2000 | Pentium II | 130 | 616 | 6 | CRT | |
| 38 | Compaq | Deskpro | Admin | 136 | Admin | Windows 2000 Pro | Pentium IV | 800 | 64 | 10 | CRT | |
| 39 | Toshiba | | Land Surveyors Office | 148 | | Windows XP | Pentium IV | 2660 | 240 | 40 | CRT | |
| 40 | Toshiba | SPA40  EN | Land Surveyors Office | 149 | | Windows XP | Pentium IV | 1660 | 240 | 40 | CRT | |
| 41 | AST | Power Premium | Photogrammetry | G26 | Photogrammetry | Windows 3.1 | | | | | CRT | |

| # | MODEL | BRAND | LOCATION | ROOM # | SECTION | OS | CPU Type | CPU Mhz | RAM (MB) | HDD (GB) | DISPLAY | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | AST | Bravo MS-TPRO 6200 | Photogrammetry | G26 | Photogrammetry | Windows NT4.0 | Pentium Pro | 200 | 32 | 2.5 | CRT | Desktop Not Working |
| 43 | Compaq | Deskpro | Photogrammetry | G33 | Photogrammetry | Windows 2000 Server | Pentium II | 400 | 128 | 20 | 17" CRT | |
| 44 | Compaq | Deskpro | Photogrammetry | G26 | Photogrammetry | Windows 2000 Pro | Pentium III | 800 | 256 | 20 | 15" CRT | |
| 45 | Compaq | Deskpro | Photogrammetry | G26 | Photogrammetry | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | 15" CRT | |
| 46 | Dell | Optiplex Gx1 | Photogrammetry | G26 | Photogrammetry | | Pentium II | 400 | 128 | 6 | 15" CRT | |
| 47 | Fujitsu Siemens | Scenic P300 | Photogrammetry | G29 | Photogrammetry | Windows XP | Pentium IV | 2660 | 512 | 40 | 17" CRT | |
| 48 | Fujitsu Siemens | Scenic P300 | Photogrammetry | G29 | Photogrammetry | Windows XP | Pentium IV | 2660 | 512 | 40 | 15" CRT | |
| 49 | | | Photogrammetry | | Photogrammetry | | | | | | CRT | |
| 50 | Fujitsu Siemens | Scenic P300 | Reprography | B16a | Reprography | Windows XP | Pentium IV | 2660 | 512 | 40 | 15" CRT | |
| 51 | HP | Dx2000MT | Reprography | B16a | Reprography | WindowsXP | Pentium IV | 3000 | 504 | 74.53 | 17" CRT | |
| 52 | Compaq | Deskpro | Server Room | 150b | Server Room | LINUX Red Hat 7.0 | Pentium III | 800 | 64 | 10 | CRT | |
| 53 | Fujitsu Siemens | Scenic | Server Room | 150b | Server Room | | XEON | | 1000 | | CRT | |
| 54 | Fujitsu Siemens | Scenic | Server Room | 150b | Server Room | Windows 2000 Server | XEON | | 1000 | | CRT | |
| 55 | Compaq | ML 370 | Server Room | 150b | Server Room | Windows 2000 Server | | | | | CRT | |
| 56 | Fujitsu Siemens | | SG | 142 | Admin | Windows XP | Pentium IV | 2200 | 256 | 60 | CRT | |
| 57 | Dell | Optiplex Gn+ | Registry | 138 | Admin | Windows 2000 Pro | At compatible | | 65 | 4 | 15" CRT | |
| 58 | Aopen | Aopen | SG's Secretary | 141 | Admin | Windows 2000 Pro | Pentium | 2800 | 253 | 25 | 17" CRT | |
| 59 | Compaq | Deskpro | Survey Services/ Cadastral | 148 | | Windows 2000 Pro | Pentium III | 800 | 64 | 10 | CRT | |
| 60 | Fujitsu Siemens | Lifebook E8110 | Cartography | 152 | Cartography | Windows X Pro | Intel Centrino Pentium | 997/2000 | 2000 | | 15" TFT | New Laptop |

# 4. Recommendations

This section provides a set of recommendations that should improve the overall process in the Survey Department used to manage cadastre information and provide public services. Some of the current issues can be resolved through simple changes applied to the existing procedures; others will require methodological support especially when dealing with new GIS/cadastre technologies.

## *4.1.        Implement Parcel Information Management System*

| Level | Required |
|---|---|
| Duration | Continuous |
| Effect | Proper management of cadastre information; better public services; simplified process of the survey results processing and plan examination; level of corruption will be reduced significantly through the better control on  land resources management |
| Level of efforts | Identify requirements for the system; customization or existing software and development of new modules will be required |

The general observations from this consultancy shows that even if personnel in the Cadastre Section have good theoretical skills and are willing to provide better services and do more efficient work, in many cases the staff have difficulty with the fulfillment of their tasks because of the outdated and inefficient business processes. Furthermore, the various international projects usually provide only sets of hardware and off-the-shelf software packages as is. However, in reality, such production processes do require the customization of the software before it can be used efficiently to meet Zambian requirements and regulations. Thus, the implementation of the spatial *parcel information management system* (PIMS) is required to guarantee that all relevant business processes are automated and changes to the spatial information are reflected on CIM in time. The automation of daily routines will also contribute to the reduction of the plan examination backlogs.

The PIMS system should be provided as standalone module that will be closely integrated with the ZLRS system. Ideally, the PIMS system can be built on top of an ESRI software platform that will be used for the CIM pilot and should provide following functions:

- Using the preconfigured workflow, the PIMS will trace the status of each plan examination event and ensure that no information/documents will be lost or unreasonable delayed;
- Provide tools for spatial data management and maintenance of CIM, including creation of new parcels and conducting spatial analysis for the land administration purposes;
- Provide tools/methodology to generate parcel diagrams directly from CIM database. In other words the PIMS should be able to generate parcel diagrams according to current MOL requirements so that the Survey Department can discontinue use of the pirate copies of the Autodesk software;
- Provide functions and tools to plan new survey jobs; compute survey results and import them directly into CIM database. In such a case the significant amount of time required for the conversion of the analogue records will be saved and personnel can focus on provision of better services.
- Provide functions to assign and manage parcel numbers to ensure their uniqueness and easy to use.

In order to ensure that such system will be really useful and properly developed, the ZTP should consider the deployment of the short term GIS/IT consultant to identify functional requirements for the PIMS system and agree on them with the Survey Department staff.

### 4.2.      Deploy long-term GIS/IT consultant for the Survey Department support

| Level | Highly Recommended |
|---|---|
| Duration | Temporary, until parcel management system will be designed and/or implemented |
| Effect | During this consultancy the project will be able to monitor and supervise CIM pilot project and also define requirements for the PIMS system. |
| Level of efforts | 2-3 months of the on-site presence will be required |

### 4.3.      Optimize use of DWG drawings for General Plans and Survey Diagrams

| Level | Highly Recommended |
|---|---|
| Duration | Temporary, until alternative approach is implemented |
| Effect | Once implemented, parcel data can be imported directly into GIS software |
| Level of efforts | Change layer organization in AutoCAD drawings; control georeference; store DWG files |

As was discovered during this assessment, currently the Cadastre Drawing Section uses unlicensed copies of Autodesk AutoCAD software to draw General Plans and Survey Diagrams. However, most of the work is related to manual entry of points' coordinates and their further connection by lines to model parcel boundaries. Additional discussions have indicated that drawing files (.DWG) are not stored after the paper copy is approved and can be easily deleted if sufficient storage space is not available. Unfortunately, at later stages operators in Cadastre Computer Room will be forced to repeat the same procedure when they are compiling cadastre index map from paper copies of General Plans – and they will have to do it since original drawings were deleted! The reasons for such omission are the following:

- The use of AutoCAD is quite a new process and seems to have been at the initiative of operators (this initiative is a positive move), thus no detailed instructions were provided by senior management,
- Not all computers were connected into the local network so there was no ability to store files centrally - local drives do not have sufficient free space,
- Since conversion of cadastre index map into digital form was initiated very recently, nobody thought out the fact that individual drawings of General Plans can be used to compile a continuous parcel map.

To reduce redundant steps in workflow and facilitate compilation of the cadastre index map, it is recommended to implement the following rules:

1. All drawings for General Plans and Parcel diagrams should be saved on the server in a special directory so that later on they can be converted into GIS environment.
2. Naming of files should at least include number of plan/diagrams and date of last edit, like GP_595_2006_farm50a_15_Mar_2007.dwg.
3. The operator must collect all points in one layer so that they can be imported later into GIS environment.
4. All drawing should be properly georeferenced.

As an alternative, the Survey Department should consider migration from a CAD to a GIS platform so that they can maintain a single  continuous layer of cadastre parcels using one software package. This will allow for producing parcel diagrams and general plans automatically by extracting points, coordinates, and line directions and distances from the parcel fabric, once it will be properly constructed following the topology rules. As an example, ESRI ArcGIS software can be used to provide such automation, once it is customized and becomes part of the PIMS system.

## *4.4.      Computerize Examination Section*

| Level | Highly Recommended |
|---|---|
| Duration | Permanent |
| Effect | Examination procedure will be more accurate and faster |
| Level of efforts | Install computers into examination section, review examination procedure[4], implement automated tracking of examination process |
| Alternative | Simplify examination procedure |
| Level of efforts for alternative | May require legislative changes |

Two examination officers use old Casio calculators with programmed coordinate geometry functions to check submitted survey results. In fact, they may re-calculate all traverses according to distance/direction values drawn on plans/diagrams. The process is very slow and inefficient since requires high attention from operators. It is also very hard to track the progress of the examination since no software is used for process tracking.
The recommendation will be to discontinue use of those calculator and they should be substituted by modern surveying packages. The selection of the surveying software should be done based on the requirements from Mr. Walter Volkmann, who is preparing recommendations for the improvement of the examination procedure.
Nevertheless, regardless of what type of changes will be proposed by Mr. Volkmann, the computerization of this section must be done so that examination officers can use ArcExplorer software to connect to the CIM database and check information about parcels in the examined area. The ArcExplorer software is free and can be used in the meanwhile for facilitating the examination process after the CIM pilot project thus producinga useful data set for the Lusaka area.
At the same time, the PIMS system that can be implemented later on should provide all required tools and function to automate the examination process.

## *4.5.      Request existing drawings from private companies*

| Level | Optional |
|---|---|
| Duration | Permanent |
| Effect | Examination procedure will be more accurate and faster |
| Level of efforts | Identify companies/surveyor who is using software to prepare general plans. Evaluate their drawings quality and conduct test import into ArcGIS environment. |

In Zambia there are several companies that are using different CAD/GIS software for the preparation of the General Plans. For example, one of the surveyors uses Model Maker, South African software, for several years in his daily routines.
Ideally, if drawings by those companies are done with an acceptable level of quality, they can be requested and directly imported into ArcGIS. To be sure of the feasibility of such a process, it is recommended to contact at least one company and request a couple of drawings for the City of Lusaka. After Quality Assurance is completed, the Survey Department can take a further decision and elaborate procedures for the acceptance of such drawings. They can be both used for the pilot CIM project and, in future, they can be used to facilitate the examination procedure. This means that drawings can be imported into the GIS environment and directions/lines can be extracted from the parcel boundaries so that examination officers will be able to compare printed copy and digital version without using repetitive routines programmed in Casio calculators.

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[4] It will be recommended to simplify and change examination procedure – such recommendation can be found in Mr. Walter Walter's report that will be completed after current report will be submitted.

### 4.6.          Redesign workflows for cadastre data management

| Level | Required |
|---|---|
| Duration | Permanent |
| Effect | Faster and more reliable procedures for the cadastre data conversion and management |
| Level of efforts | Change current business process for CIM production |

To ensure validity of information represented in the CIM, the entire business process for the compilation of the CIM should be improved. Nowadays, tracking of the plan examination flow is not efficient and no one can prove that the plan was actually fully and properly checked. This conclusion derives from the CIM training, when two *approved* plans were used to restore parcel boundaries. On the first plan the wrong constant value for X coordinate was shown: 700 000 instead of 70 000. On the second plan, during the construction of traverse it was found that direction for series of lines, shown on plan, was incorrect and with error equal to about 2-3 minutes. It is not clear why this is possible and why these errors were not identified during examination, especially taking into account that according to current procedures any line and coordinate, represented on a plan, should be checked. Immediate actions must be taken during the CIM pilot to increase data validity and correctness. For details about proposed workflows please see section "CIM Business process".

### 4.7.          Transfer Cadastre Index Map from CAD to GIS system

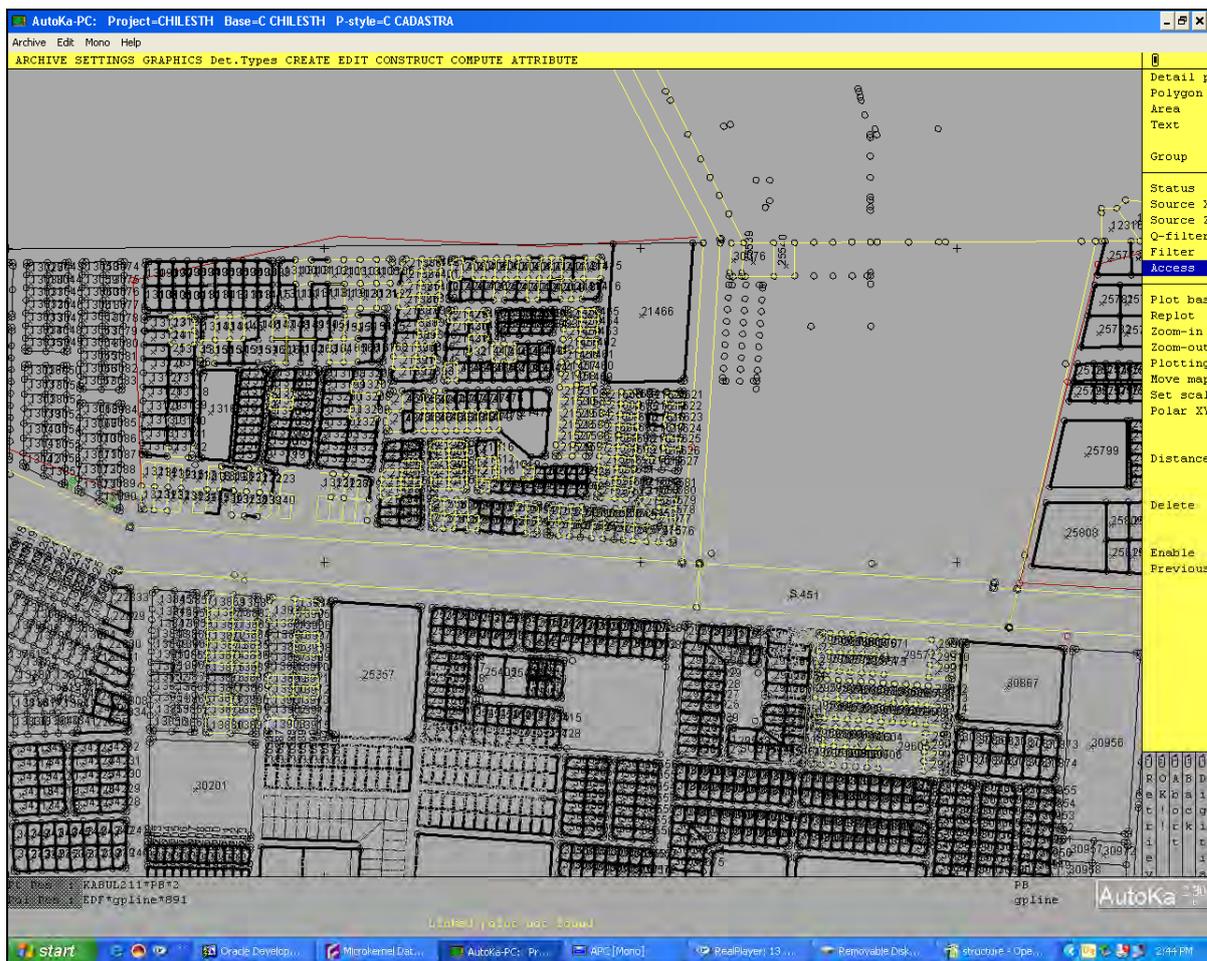| Level | Required |
|---|---|
| Duration | One time process |
| Effect | Existing data for Lusaka from AutoKA system will be re-used for CIM pilot which in turn will speed-up CIM pilot |
| Level of efforts | Perform clean up of data in AutoKA PC. Import data into ArcGIS. Construct polygon features and assign attributes. |

**Figure 7 Cadastre Data in AutoKA PC**

The data for Lusaka city, which are currently maintained in AutoKA PC system, should be migrated to ArcGIS 9.2 geodatabase and used for the CIM compilation. The use of the AutoKA PC software for the CIM production and maintenance should be discontinued because of several reasons. First of all it is recommended for the Chief Examiner Officer (who is maintaining Lusaka index map now) to focus on his direct responsibilities and not to spend time on CIM compilation. Secondly, AutoKA PC software is outdated, does not provide all required functions and proper topology support. Furthermore, this software is not available for purchase anymore and is substituted by ArcCadastre software. According to the Survey Department staff, when they tried to acquire additional licenses of AutoKA PC, they were prompted to purchase ArcCadastre as AutoKA's successor.

Once data from AutoKA PC are migrated to the ArcGIS environment, the additional topology checks should be done to delete obsolete or duplicate boundaries. Later on, this data can be used to construct parcels and assign proper attributes after each parcel will be verified both for special and textual data accuracy. For details on CIM specifications please see section "Feature Classes and Attributes".


## *4.8.* *IT Systems Administration Improvements*

### 4.8.1. Centralize data storage and schedule regular backups

| Level | Required |
|---|---|
| Duration | Permanent |
| Effect | Valuable data can be restored immediately in case of occasional deletion or corruption or in case of hardware/software failure. |

| Level of efforts | New server and software should be acquired. The backup procedures should be thought trough, set up and continuously maintained. |
|---|---|

The IT personnel of the Survey Department should pay more attention to the backup and disaster recovery procedures. It is common that available local disk space is used inefficiently (storing private multimedia files) and thus personnel is complaining about lack of space. However, the data master copies should be located at the server side where they can be easily copied on tapes using scheduled full and/or incremental backups.

### 4.8.2. Limit Staff Access to the Internet

| Level | Highly recommended but optional |
|---|---|
| Duration | Permanent |
| Effect | Working time will not be spent on the Internet browsing |
| Level of efforts | Access to the Internet should be limited for certain working hours. |

During assessment it was often noticed that some personnel uses Internet for private purposes which results in loss of the productivity. It is not common in developed countries that GIS or cadastre operators have access to the Internet since their work requires continuous attention. Thus it is recommended to restrict access to the Internet for the most of the Survey Department's staff and leave it open only for those who really needs it.
However, taking into account that some personnel can use Internet for self training, the access can be provided after 4 p.m. so that each interested person can have some time to browse useful sites to conduct the self-training. Alternatively, some offices leave one computer in a common visible area that staff can access as necessary.

## 4.9.    Conduct GIS Training

| Level | Optional |
|---|---|
| Duration | One time process |
| Effect | Refreshing of CIM operators' skills will ensure smoother start of CIM production process |
| Level of efforts | Training will take about 2-3 days |

The initial training was provided to cadastre technicians to demonstrate methodology and tools that can be used to convert existing analogue data, compile them into the CIM and properly manage this. The training utilized ESRI ArcGIS software as the GIS tool. The personnel demonstrated good theoretical skills in the area of survey principles and land cadastre aspects. However, to ensure that acquired skills will not be forgotten before GIS software is provided, it is recommended to continue self-training using demo versions installed on one of the computers.
At the same time, a refresher course for CIM operators should be done before the CIM project begins its main production cycle. The desired program for such training is provided below.

**ArcGIS Introduction**

- Creating geodatabase, feature classes and feature datasets.
- Defining projections.
- Set and use geodatabase validation rules.
- Importing data from CAD.
- Opening data in ArcMap – define styles and labels
- Associate tables using joins and relates.

**Editing in ArcEditor**

- Create and edit features using a variety of ArcMap editing tools.
- Copy and paste techniques.
- Constructing features using COGO tools

**Topology tools**

- Define topology for feature classes
- Verify topology and fix errors
- Construct features using topology tools

**Advanced techniques**

- Create points by importing data from Excel
- Create, edit, and manage annotation
- Georeference raster data
- Perform spatial adjustments on data in local coordinates system

# 5. Cadastre Index Map Specifications

This section provides recommended specifications for the Cadastre Index Map pilot. The pilot study of Lusaka CIM should verify proposed methodology and specifications and prove them before they will be used for all of Zambia – meaning that based on the pilot's results, the specifications can be further updated to meet Survey Department needs.

The main use of the CIM is not only to provide precise parcel boundaries, but also to indicate that some particular land piece is already owned or used by a person. As opposed to a *parcel* map, where all boundaries are precisely surveyed, in the context of the ZTP project the CIM should and may have parcels restored from various sources and thus with different level of accuracy. However, low accuracy information on parcel boundaries should be stored in separate feature classes so that one layer can be used as 'parcel' map.

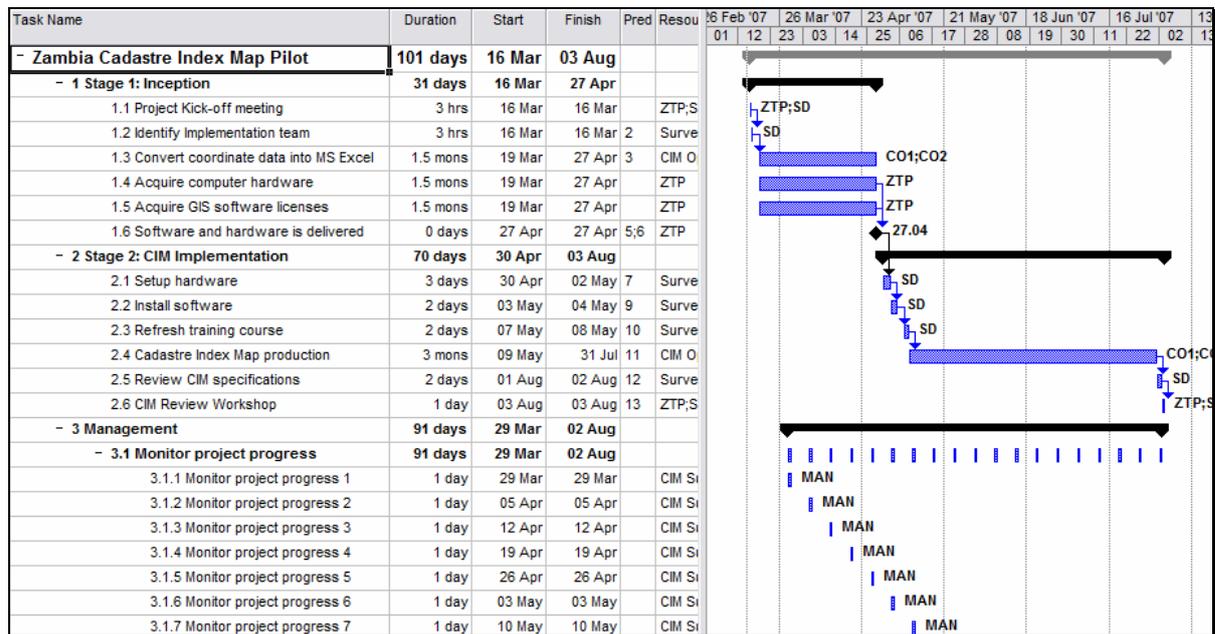## 5.1.    Implementation plan



**Figure 8 CIM implementation plan**

The anticipated duration of the CIM pilot is four months. Because at the time of the report submission the Survey Department did not have proper software licenses and hardware, one to one and a half months will be required to get all GIS software. This period of the project is called the "Inception phase". In any case, since most of the parcels on the Cadastre Index Map will be constructed using points imported from survey records, the Inception phase must be also used to collect coordinates into Microsoft Excel files. This will dramatically accelerate data import once GIS software licenses are acquired.

The actual implementation of the CIM pilot is expected to be three months after the Inception stage. Since the estimated number is parcels in Lusaka city is about 33 000 parcels (with number of General plans, registered in the LIMS, close to 2 400), the implementation team should consist of at least 3 operators who will enter data into the geodatabase, construct parcels and assign attributes.  After three months of production, a review workshop should be conducted to evaluate pilot results and elaborate additional requirements and enhance methodology for the CIM, if necessary.

In parallel to these two key phases, it must be emphasized that comprehensive monitoring activities should be conducted on a weekly basis to ensure smooth implementation of the project and quick resolution of any discovered issues.  Thus, by the end of each week, the project supervisor should present to the Survey Department management staff a progress

report showing current progress and number of parcels entered during the past week, and notify them if any problems were discovered and require resolution.

## 5.2.    CIM General Information

| | |
|---|---|
| The proposed area for the pilot: | City of Lusaka |
| Coordinate System: | Zambia National system Lo29[5] (or UTM 35S) |
| Estimated number of properties: | 33 000+ |
| Project duration: | 3-4 months |
| Number of CIM operators: | 3 editors and 1 supervisor |
| Target platform: | ESRI ArcGIS 9.2 (*as proposed*) |
| Source for graphical data: | Index Map from AutoKA, survey records and various plans/maps |
| Source for textual data: | LIMS, survey records and General Plans/Survey Diagrams |

## 5.3.    Source data

This section outlines what data should be used for the compilation of the CIM pilot. The most important source of parcel boundaries are analogue survey records files, which have lists of all points, shown on plans, and their coordinates. However, even being a good base source for the spatial information, the survey records do not reflect all the changes that can take place with a property after it was initially surveyed – for example, if after the initial survey the parcel was further subdivided, the General Plans are not updated. Thus, consultation with the LIMS system must be done for *each* parcel shown on diagram or plan.

**Table 6 Source data for CIM**

| # | Type | Precision | Comment |
|---|---|---|---|
| 1. | Cadastre Index Map DWG/DXF files (AutoCAD/AutoKA) | Unknown | The current datasets might be converted from AutoKA PC to ArcGIS geodatabase. Practically, these datasets were compiled from survey records. However, since no complete control was done for the compilation of the pilot datasets, it is advised to treat all coordinates as with "Unknown" precision. |
| 2. | Survey records | Varies | As of today the most reliable and complete source of spatial information. The actual precision of the coordinates kept in survey records can vary and it depends on survey methods and equipment that was used during survey. |
| 3. | LIMS | - | LIMS system does not contain spatial information about parcel but has latest attribute information about the parcel. Using the parcel identifier, it is possible to track parcel history to check its most recent status. |
| 4. | General Plans | Varies | In case original survey records are not available |

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[5] Default installation of ArcGIS does not have definition for the projection thus it should be created. Description of the projection, used for the training, can be found in

| # | Type | Precision | Comment |
|---|------|-----------|---------|
| | | | or are lost, a parcel fabric can be constructed from the coordinates and direction/distances that appear on General Plans. Nevertheless, during the training it was discovered that General Plans can contain mistakes, thus accuracy can be different especially after spatial adjustment is done to close traverse. |
| 5. | Survey Diagrams | Varies | In case original survey records are not available or are lost, a parcel fabric can be constructed from the coordinates and direction/distances that appear on "D" Survey diagram. |
| 6. | Sketch Plans | Unknown | Current Sketch plans can be used only to get approximate parcel shape and location of the parcels. Sketch plans can be used only in conjunction with 1:5 000 and 1:50 000 maps since all sketch plans will require georeferencing. |
| 7. | Chiefdom Maps | Unknown | *Optional data.* May not be crucial for Lusaka City pilot if no tribal lands will be identified in selected area. However, it is an important source of information for rural areas. Precision of data is unknown or very low since they are drawn based on 1:250 000 topographic maps. |
| 8. | Map 1:5 000 | 2.5-5 meters | Optional data. To be used to georeference Sketch Plans. In most cases these maps are outdated. |
| 9. | Map 1:50 000 | 25-50 meters | Optional data. To be used to georeference Sketch Plans. Since paper copies of these maps are outdated, it is recommended to use digital (vectorized) version of 1:50 000 map when possible. |
| 10. | High Resolution Satellite Imagery | 1-5 meters | To be used as background and to georeference sketch plans. These data are not available now and should be considered for acquisition. Use of this type of data for areas with large number of conflicts or with rapid land development is highly recommended. |
| 11. | Cadastre Series Map | Lowest | Current analogue copies of Cadastre Series maps should be scanned and georeferenced to be used for reference purposes only. |
| 12. | Drawings from private companies | Varies | This data, if available, can be directly converted into parcel information and can significantly reduce time for CIM compilation. Additional study is required to see how it is possible to acquire digital data from private companies and estimate its accuracy. |

The table above includes all the relevant data currently available at the Survey Department. In case there are any other plans/records that can provide more up-to-date information, these records should be acquired *before* the main cycle of the CIM production will start. For

example, local authorities or state engineering companies can have their own parcel index maps in analogue form and these maps can have most recent parcel index comparing to Cadastre Series map.

## 5.4.        Feature Classes and Attributes

The CIM will consist of the several feature classes stored in an ESRI geodatabase.  In contrast to current CAD based datasets, these are available for Lusaka, Ndola and Kitwe, and much greater attention should be paid to the attribute information about each parcel and validity of the both spatial and textual information. This is required to ensure that after the completion of the Lusaka CIM pilot, collected datasets will be up-to-date in both graphical and attributive parts. Thus, the CIM layers should include not only precisely surveyed and finally approved parcels, but parcels from Site plans and Sketch plans should be digitized as well.

**Table 7  The cadsatre Index Map feature classes**

| # | Name | Type | Description |
|---|------|------|-------------|
| 1. | Parcels | Polygons | Main feature class, containing most recent version of parcels that are surveyed and approved. |
| 2. | Beacons | Points | Points for parcel beacons or survey stations. |
| 3. | Parcels History | Polygons | Feature class to store parcels history. In case parcel shape from "Parcels" feature class is changed for any reason, the old shape should be copied to this historical layer. |
| 4. | Beacons History | Points | Feature class to store beacon history. In case beacon point from "Beacons" feature class is changed for any reason, the old point should be copied to this historic layer. |
| 5. | Boundaries | Lines | Temporary layers to construct boundaries through the coordinate geometry procedures. Later on lines are converted into polygons. The frequency of use of this layer will depend on selected approach on data conversion – in case all point are imported, parcel can be created directly in "Parcels" feature class. Then, if and when necessary, polygons can be converted to the lines and COGO values can be extracted. |
| 6. | Approvals | Polygons | Feature class that must be used to track approved site plans. As soon as new Site (Layout) Plan is submitted to the Survey Department and after it is approved and assigned with property numbers, the rough, approximate parcel shape or surveying area should be drawn in this layer to indicate that this area is under surveying now. |
| 7. | Sketches | Polygons | Feature dataset with low-precision boundaries of the areas/parcels covered by sketch plans. Since sketch plans have very low accuracy, it is recommended to have this data separately. If parcel from this feature class is re-surveyed using accurate methods, in will be deleted in this layer and a new parcel will be created in "Parcel" feature class. |

The proposed set of feature classes is a minimal dataset that should be used for the pilot project and is designed for the urban area of Lusaka city. Although currently Cadastre Series Map in AutoKA PC/AutoCAD formats can have more graphical information, it is highly recommended to start CIM with only these seven feature classes from above to work through

the methodology and procedures. In additional to that, the recommendation to have a lower number of feature classes is derived from the fact that the Cadastre Department has limited number of human resources for this project. In such a situation the lower number of feature classes will allow concentrating attention only on most important information and will allow keeping it updated.

Below is a proposed list of attributes for each feature class. Please note that some fields have coded values. In case proposed codes do not cover the range of all possible attribute values, the Survey Department should extend these lists on its own.

**Table 8  "Parcels" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|-----------|------|----------|-------------|
| 1. | UPID[6] | Text (20) | No | Unique parcel number. This field will be used for new parcel identifier after it will be approved in the course of the ZLRS project. |
| 2. | PID | Text (50) | Yes | Full parcel number according to current algorithms, including administrative unit code. |
| 3. | Type | Text (4) | Yes | Type of the parcel: S – Stand L – Lot F – Farm W – Wayleave If type is unknown, this field is left blank. |
| 4. | DREF | Text (20) | Yes | Number of the most recent Survey Diagram for this parcel. |
| 5. | SRREF | Text (20) | Yes | This  is the reference number to the Survey Records folder and serves as survey "transaction" number. This number coincides with General Plan number. |
| 6. | Survey_Date | Date | Yes | Date when most recent survey of this parcel was finished (taken from Survey Diagram or from General Plan). In case survey records show only months and year, by default last day of the shown month is used as day value. |
| 7. | Create_Date | Date | Yes | Date when this parcel was last created or updated in the "Parcel" feature class. |
| 8. | Survey_Area | Double | Yes | Area of parcel according to survey records |
| 9. | Comment | Text (128) | No | Any comment in free form |

**Table 9  "Beacons" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|-----------|------|----------|-------------|
| 1. | Name | Text (20) | Yes | Name of the point |
| 2. | Point_Origin | Text(4) | Yes | Code indicating how this point was entered in cadastre index map: 0 – Unknown 1 – Direct input (Coordinate for the point was imported from survey records) 2 – Point was created manually (on-screen digitizing) |

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[6] This field will be not used during pilot project

| # | Field Name | Type | Required | Description |
|---|------------|------|----------|-------------|
| | | | | 3 – Point was constructed using COGO tools based on information shown on General Plan/ Survey diagram<br>4 – Point imported from CAD drawing |
| 3. | Survey_type | Text(4) | Yes | Code indicating survey accuracy according to the Survey Act requirements:<br>51 – geodetic accuracy<br>52 – sub 30 centimeters accuracy<br>53 – sub meter accuracy<br>54 – all above sub meter accuracy |
| 4. | Northing | Double | Yes | Original value of Y coordinate according to survey records |
| 5. | Easting | Double | Yes | Original value of X coordinate according to survey records |
| 6. | CSystem | Text (12) | Yes | Name of original coordinate system from survey records |
| 7. | SRREF | Text (12) | Yes | Reference number to the Survey Records file, from which this point was collected. This reference number serves as survey "transaction" number and usually coincides with General Plan number. |
| 8. | Survey_Date | Date | Yes | Date when most recent survey of this point was finished (taken from Survey Diagram or from General Plan). In case survey records show only months and year, by default last day of this month is used as day value. |
| 9. | Create_Date | Date | Yes | Date when this beacon was created or updated in "Beacons" feature class. |
| 10. | Beacon_Desc | Text(128) | No | Textual description of the beacon material in free form |
| 11. | Comment | Text (128) | No | Any comment in free form |

**Table 10  "Parcels_History" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|------------|------|----------|-------------|
| 1. | UPID[7] | Text (20) | No | Unique parcel number. This field will be used for new parcel identifier after it is approved in the scope of the ZLRS project. |
| 2. | PID | Text (50) | Yes | Full parcel number according to current algorithms, including administrative unit code. |
| 3. | Type | Text (4) | Yes | Type of the parcel:<br>S – Stand<br>L – Lot<br>F – Farm<br>W – Wayleave<br>If type is unknown, this field is left blank. |
| 4. | DREF | Text (20) | Yes | Number of the most recent Survey Diagram for this parcel. |

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[7] This field will be not used during pilot project

| # | Field Name | Type | Required | Description |
|---|---|---|---|---|
| 5. | SRREF | Text (20) | Yes | It is reference number to the Survey Records folder and serves as survey "transaction" number. This number coincides with General Plan number. |
| 6. | Survey_Date | Date | Yes | Date when most recent survey of this parcel was finished (taken from Survey Diagram or from General Plan). In case survey records show only months and year, by default last day of the shown month is used as day value. |
| 7. | Create_Date | Date | Yes | Date when this parcel was last created or updated in the "Parcel" feature class. |
| 8. | Survey_Area | Double | Yes | Area of parcel according to survey records |
| 9. | Archive_Date | Date | Yes | Date when this parcel was added to the historical layer (moved out of main feature class). |
| 10. | Comment | Text (128) | No | Any comment in free form |

**Table 11  "Beacons_History" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|---|---|---|---|
| 1. | Name | Text (20) | Yes | Name of the point |
| 2. | Point_Origin | Text(4) | Yes | Code indicating how this point was entered in cadastre index map:<br>0 – Unknown<br>1 – Direct input (Coordinate for the point was imported from survey records<br>2 – Point was created manually (on-screen digitizing)<br>3 – Point was constructed using COGO tools based on information shown on General Plan/ Survey diagram<br>4 – Point imported from CAD drawing |
| 3. | Survey_type | Text(4) | Yes | Code indicating survey accuracy according to the Survey Act requirements:<br>51 – geodetic accuracy<br>52 – sub 30 centimeters accuracy<br>53 – sub meter accuracy<br>54 – all above sub meter accuracy |
| 4. | Northing | Double | Yes | Original value of Y coordinate according to survey records |
| 5. | Easting | Double | Yes | Original value of X coordinate according to survey records |
| 6. | CSystem | Text (12) | Yes | Name of original coordinate system from survey records |
| 7. | SRREF | Text (12) | Yes | Reference number to the Survey Records file, from which this point was collected. This reference number serves as survey "transaction" number and usually coincides with General Plan number. |
| 8. | Survey_Date | Date | Yes | Date when most recent survey of this point |

| # | Field Name | Type | Required | Description |
|---|---|---|---|---|
|  |  |  |  | was finished (taken from Survey Diagram or from General Plan). In case survey records show only months and year, by default last day of this month is used as day value. |
| 9. | Create_Date | Date | Yes | Date when this beacon was created or updated in "Beacons" feature class. |
| 10. | Beacon_Desc | Text(128) | No | Textual description of the beacon material in free form |
| 11. | Archive Date | Date | No | Date when this beacon was archived from "Beacons" feature class to "Beacons_History" to feature class. |
| 12. | Comment | Text (128) | Yes | Any comment in free form |

**Table 12  "Boundaries" feature class attributes**

| # | Name | Type | Required | Description |
|---|---|---|---|---|
| 1. | Direction | Text (12) | No | Line direction. This field can be used to auto populate line direction value when using COGO tool. |
| 2. | Distance | Text (10) | No | Line length. This field can be used to auto populate line length value when using COGO tool. |
| 3. | Type | Shot Integer | Yes | 0 – unknown<br>1 – boundary<br>2 – connection |

**Table 13  "Approvals" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|---|---|---|---|
| 1. | UPID | Text (20) | No | Unique parcel number. This filed will be used for new parcel identifier after it will be approved in the scope of the ZLRS project. *<Creation rules to be discussed>* |
| 2. | PID | Text (50) | Yes | Full parcel number according to current algorithms, including administrative unit code. |
| 3. | Type | Short Integer | Yes | Type of the parcel:<br>S – Stand<br>L – Lot<br>F – Farm<br>W – Wayleave |
| 4. | SPREF | Text (20) | Yes | Number of the Site Plan from which this parcel was created or updated. |
| 5. | App_Number | Text (20) | Yes | Number of the application for approval. |
| 6. | Create_Date | Date | Yes | Date when this parcel was created last time in "Approvals" feature class. |
| 7. | Comment | Text (128) | No | Any comment in free form |

**Table 14  "Sketches" feature class attributes**

| # | Field Name | Type | Required | Description |
|---|---|---|---|---|

| 1. | SPID | Text (50) | Yes | Parcel number from sketch plan. |
|---|---|---|---|---|
| 2. | Type | Short Integer | Yes | Type of the parcel:<br>S – Stand<br>L – Lot<br>F – Farm<br>W – Wayleave |
| 3. | SPREF | Text (20) | Yes | Number of the Sketch Plan from which this parcel was created or updated. |
| 4. | SWREF | Text (20) | Yes | Reference number to the Survey Records for this sketch plan; serves as survey "transaction" number. |
| 5. | Survey_Date | Date | Yes | Date when this parcel was surveyed (taken from Survey records). In case plan shows only months and year, by default last day of this month is used as day value. |
| 6. | Create_Date | Date | Yes | Date when this parcel was created in "Sketches" feature class. |
| 7. | Comment | Text (128) | No | Any comment in free form |

## 5.5.    CIM Business process

### 5.5.1. Operational Environment

The team for CIM pilot will consist of at least three operators and one supervisor. The number of operators is calculated based on assumption that these operators will be full-time dedicated to the project during one month of Inception phase and three  months of Implementation phase. The estimated number of Lusaka parcels is about 33 000 (according to the query to the LIMS databases) as of 14 March, 2007. Thus, in order to construct 33 000 parcels in 3 months the following performance should be archived buy the operators: 33 000 parcels = 11 000 parcels a month * 3 month or 500 parcels * 66 working days. This gives estimates that each operator should do on average 167 parcels a day, which includes:

- Entering data into Excel files (for General Plans) or directly into ArcGIS (for Parcel Diagrams),
- Construction of parcel polygons
- Assigning of attributes and cross verification with LIMS system

Taking into account the fact that one month of Inception phase can be used to conduct initial collection of coordinates into Excel files, the value 167/parcel a day can be reduced to 120-140 parcels a day per operator. Anticipating some delays that may result from lack of experience or due to errors in source data (which will require extra time for analysis and correction), it might be feasible to have in reserve one extra operator for coordinate data entry into Excel files. This will not require extra ArcGIS license and to archive performance and equal skills development operators may do weekly rotation:  first week 3 operators (#1, #2 and #3) do parcel construction in ArcGIS, one (#4) does data entry in MS Excel. Next week operators #2, #3 and #4 do parcel construction and operator #1 does data entry.  Such scheme can be used in case if after Inception Phase there will be still significant number of General Plans (or their survey records with point coordinates) to be converted into MS Excel.
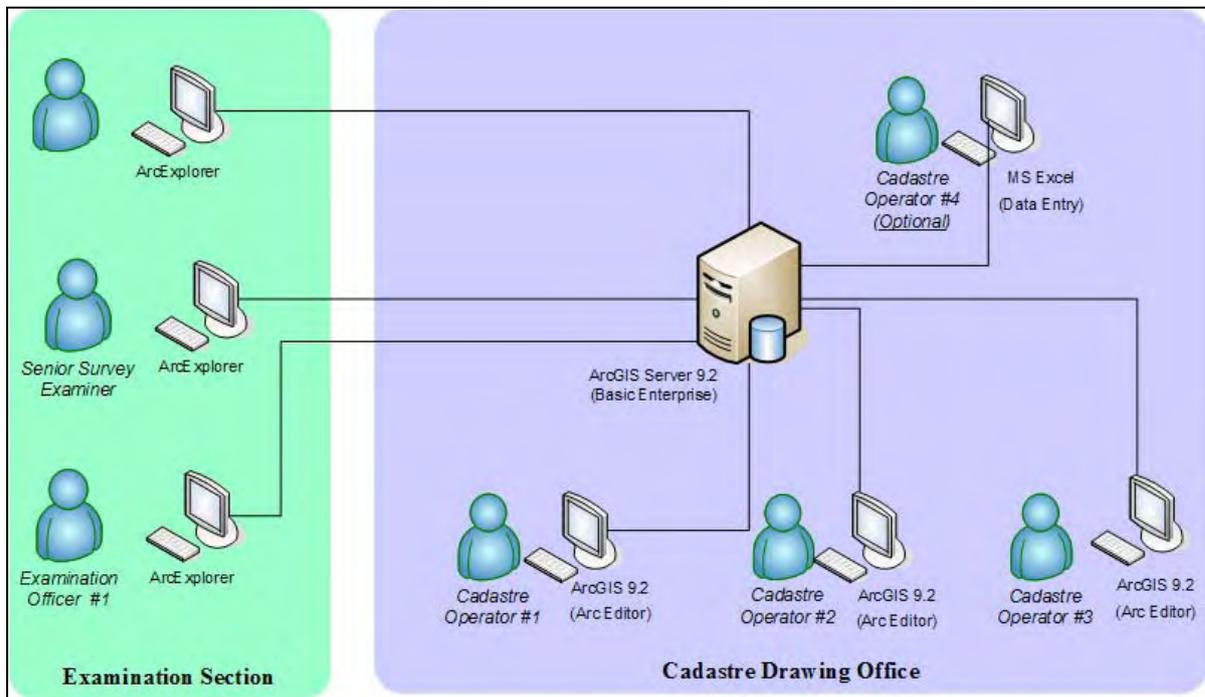
**Figure 9 CIM Operation Environment**

The selected platform for the CIM pilot project is ESRI ArcGIS. The following factors support such a proposal:
- Survey Department already invested in ESRI platform and has several licenses for ESRI software in other departments and provincial offices.
- The personnel have base experience working with ESRI software
- The Cartography Section of Survey Department already uses ESRI ArcGIS and ArcView software packages to maintain digital version of 1:50 000 map for Zambia.

Furthermore, ESRI ArcGIS provides the following functions:

- Build and maintain spatial integrity including topological relationships between geographic features.
- Multi-user editing of data and versioning support
- Import of CAD data
- Coordinate Geometry support
- Full support for cartographic projections, including custom definition of new datums and projections
- Automate quality control by building validation rules directly into your data.
- Create and edit GIS features with visual editing and productivity tools.
- Build and maintain spatial integrity including topological relationships between geographic features.
- Additional extension can be purchased to manage survey data in a geodatabase and display survey measurements and observations on a map (ArcGIS Survey Analyst extension).

The Figure 9 CIM Operation Environment shows proposed IT environment for the CIM pilot.
- One server will be used as database server to host Microsoft SQL Server 2000 and file server to store all raster files.

- At least three workstations will be dedicated to Cadastre Operators. The ESRI ArcGIS 9.2 ArcEditor software will be used as main applications for CIM editing and maintenance.
- Three other computers will be used by examination officers to work with Cadastre Index Map in read-only mode.

To support such an environment it is required to acquire new hardware and software licenses. The Annex "Hardware and Software " provides a list of required software and hardware, including their configurations.

The following should be considered:

- Survey department already has one license for Microsoft SQL Server 2000 which is not currently used. This license will be used to host ArcGIS geodatabase.
- Once new workstations will be acquired, two existing workstations from Cadastre Computer Room should be transferred to Survey Examination Officer.

### 5.5.2.  Prerequisites

The following prerequisites should be met before Cadastre Index Map production will be fully operational:

- At least three operators and one supervisor for the project are identified and dedicated,
- Required software and hardware procured, delivered and installed,
- The Cadastre Index Map feature classes and attributes lists are reviewed by the Survey Department and approved (or updated if necessary),
- The projection and datum for pilot area are approved and defined in ArcGIS,
- The Cadastre Series Map for  pilot area are scanned and georeferenced,
- The AutoKA PC dataset for Lusaka is imported into ArcGIS environment,

### 5.5.3.  Process workflows

#### Preparation of points lists in MS Excel format

The primary process for converting cadastre data into the index map will consist of entering point coordinates on a map and their manual connection to form parcel boundaries.  To facilitate data collection/conversion and avoid repetitious entry of attributes that are similar to all points on the single plan, it is recommended to use Microsoft Excel spreadsheets to initially gather points from survey records and assign common attributes to them. These *intermediate* spreadsheets should be used in first turn for General Plans' survey records, where the number of point is quite large and, in some cases, conversion of coordinates from one system to another may be required. The example template is shown in "Figure 10 Microsoft Excel template for coordinates collection".

**Figure 10  Microsoft Excel template for coordinates collection**

| Column Name | Description |
|---|---|
| Name | Name of the point |
| Point_Origin | Always equal to "1" (means that coordinate for the point was imported from survey records) |
| Survey_type | Code indicating survey accuracy according to the Survey Act requirements:<br>51 – geodetic accuracy<br>52 – sub 30 centimeters accuracy<br>53 – sub meter accuracy<br>54 – all above sub meter accuracy |
| Northing | Original value of Y coordinate according to survey records |
| Easting | Original value of X coordinate according to survey records |
| CSystem | Name of original coordinate system |
| SRREF | Reference number of the Survey Records file, from which this point was collected. |
| Survey_Date | Date when survey of this point was. In case survey records shows only months and year, by default last day of this month is used as day value. |
| Beacon_Desc | Textual description of the beacon material, in free form |
| Create_Date | Date when this beacon was created or updated in "Beacons" feature class. This filed will be populated at the day when this Excel file will be actually imported in ArcGIS. Should be left blank during initial data entry. |

All Excel files should be stored centrally on server and regular daily backups should be set up. The recommended folder structure is very simple and consists of folders named by ten years like 197X, 198X, 199X and 200X etc.

Files should be named using the following template:
<record number>_<creation date>_<name>.xls

<creation date> is date when this file was created, <name> is *optional* short name of the object represented on plan.  In cases where the survey record file has several General Plans, XLS files should have all points in one spreadsheet.
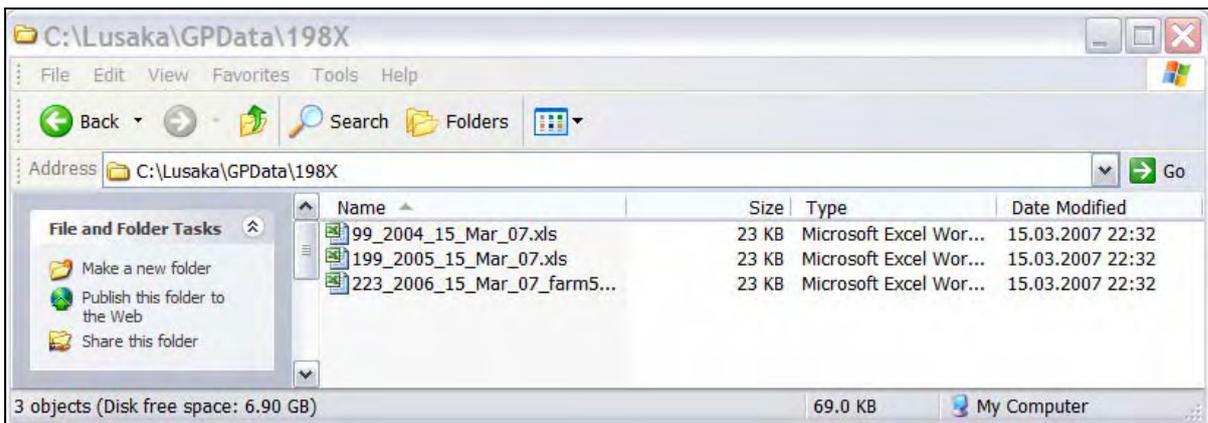
**Figure 11  Storing MS Excel fils with coordinates**

To avoid situations when different operators create duplicate XLS files for the same survey records, the following is recommended:

1.  Pilot area should be virtually divided into several zones according to number of operators. Zone boundaries should coincide with Cadastre Series map boundaries. Each operator will work only within his designated zone.
2.  A tracking spreadsheet should be used for recording all processed survey records. Before creating XLS file for selected survey record, the operator should check spreadsheet to ensure that these records were not already processed by another operator. The tracking file should be stored on the server and accessed by all CIM operators. Based on information from this file, the CIM supervisor can also track project status.


**Figure 12 Tracking spreadsheet for Excel files with point coordinates**

The following columns will be used:

| Column Name | Description |
| --- | --- |
| Plan Number | Number of survey record/plan number |
| Survey date | Date when survey of this point was done. In case survey records show only months and year, by default last day of this month is used as day value. |
| Date Queued | Date when MS Excel file with point coordinates was created |
| Start Date | Date when construction of parcels in ArcGIS will be started |
| Operator | Name of the operator who works with this plan/data |
| Finish Date | Date when construction of parcels in ArcGIS will be finished |

| Column Name | Description |
|---|---|
| Parcels | Number of parcels on plan |

Fields "Start Date" and "Finish Date" will be filled in only when actual parcel construction in ArcGIS will be completed.

### Tracking CIM progress

Once the point data in Excel files are prepared, they can be imported into the ArcGIS environment and parcel polygons can be constructed. However, to ensure that CIM is up-to-date and reflects the same information as the LIMS system, the following steps should be introduced:

1. For each parcel, which will be created in CIM or imported from the existing AutoKA dataset, the CIM operator should consult LIMS system to get the latest attribute information and ensure that parcel was not further subdivided.
2. To ensure that all newly approved survey results are represented on map, the simple Q-Tracking spreadsheet should be used to notify CIM operators that a new Survey Diagram or General Plan was approved and is pending for processing to be converted into CIM. The use of this spreadsheet should be a provisional but mandatory measure before the PIMS system with proper functions and workflows will be implemented.

The Q-Tracker should be used for the several types of documents:

1) *Approved documents* (General plans, "D"-type Survey Diagrams and Sketch plans) – first of all, the CIM operator should record in the Q-Tracker all old, existing plans and their data after these plans are processed and converted into CIM. This is required to track CIM pilot progress and staff productivity.
   However, as soon as a new survey job (with General Plan or Survey Diagram) is approved, the examination officers should update Q-tracker and add corresponding record to indicate that *new* plans/diagrams were registered and are pending for conversion.



**Figure 13 GP Q-Tracker for new plans**

2) *Approved Site plans* – as soon as new Site plans are approved, the corresponding spreadsheet should be updated by Plan room staff and then parcel(s) from Site plan should be approximately drawn by CIM operators in "Approvals" feature class. This is required to show on map that something is being surveyed in the specified area.
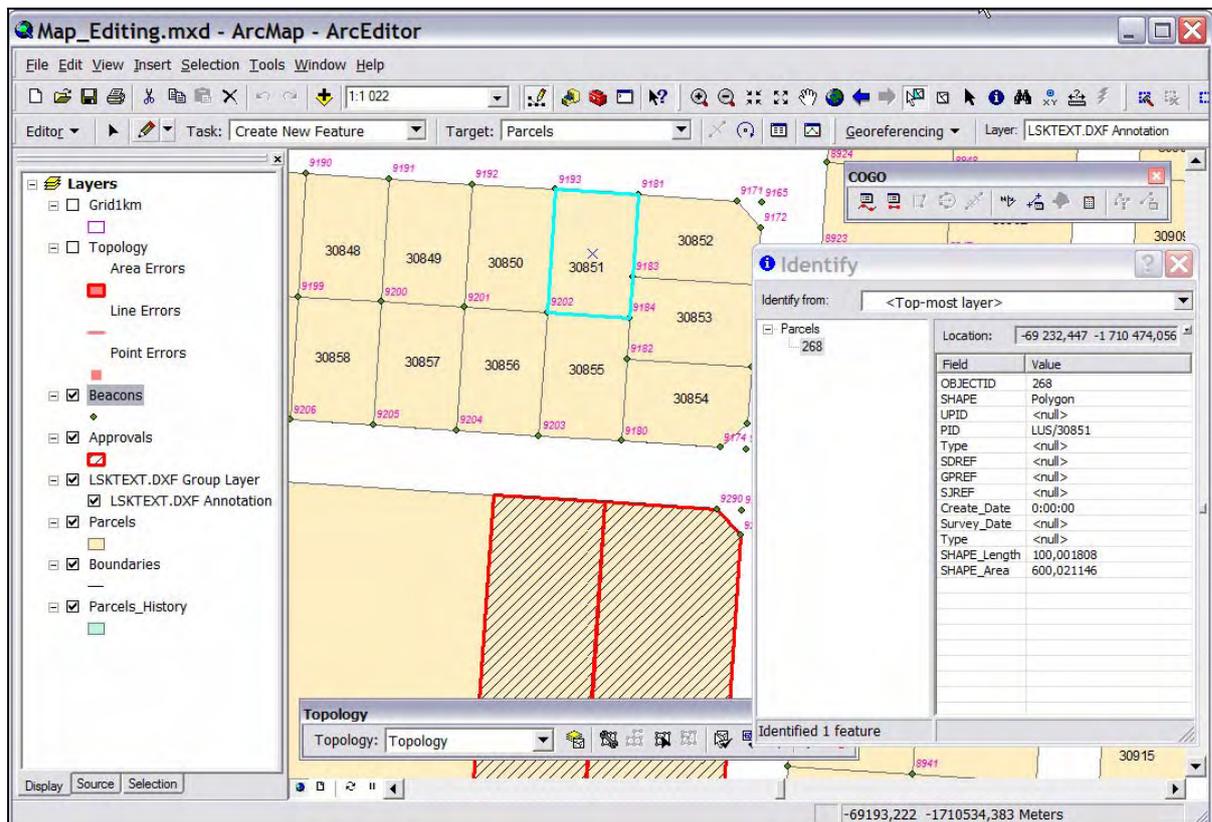
**Figure 14  CIM with "Approvals" feature class**

One more time it is worth to emphasize that use of Q-Tracker spreadsheets is compulsory for all involved personnel and this should be done on regular, at least daily basis. Otherwise by the end of CIM pilot the Survey Department will end up with a complete layer but in some parts with outdated parcels.

**Data conversion**

The two main approaches are identified for the conversion of the General Plans:

Method#1
1. Collect *all* points in Excel files
2. Import points into ArcGIS
3. Construct polygons
4. Check and assign attributes, including consultations with LIMS
5. Construct COGO lines from polygons and verify distances/directions

Method #2
1. Collect *some* point in Excel files or enter manually
2. Import point into ArcGIS
3. Construct boundaries using COGO tools
4. Create polygons using topology tools
5. Check and assign attributes, including consultations with LIMS

The selection of the desired method should be done by the operator but with the following considerations:

1. The method #1 is preferable because it allows collecting all point and attributes from original survey records. Otherwise, since in some cases incorrect information is shown

       on the General Plan, the constructed parcel can have slightly different area or shape if using only COGO procedures.

2. The method #2 is only one alternative in case if original survey records are not available – for example for old colonial General Plans. In such case COGO will be used to construct parcels features.

Regardless the use of one the methods for conversion of the parcels diagrams, it is possible to say that since Survey Diagram contain small parcel with several beacons, it is advised to enter X and Y coordinates directly during ArcGIS Sketch tool in editing session and assign point attributes manually – otherwise use of intermediate spreadsheets with coordinates will slow done conversion process.

## Convert Existing General Plan

### CIM Operator
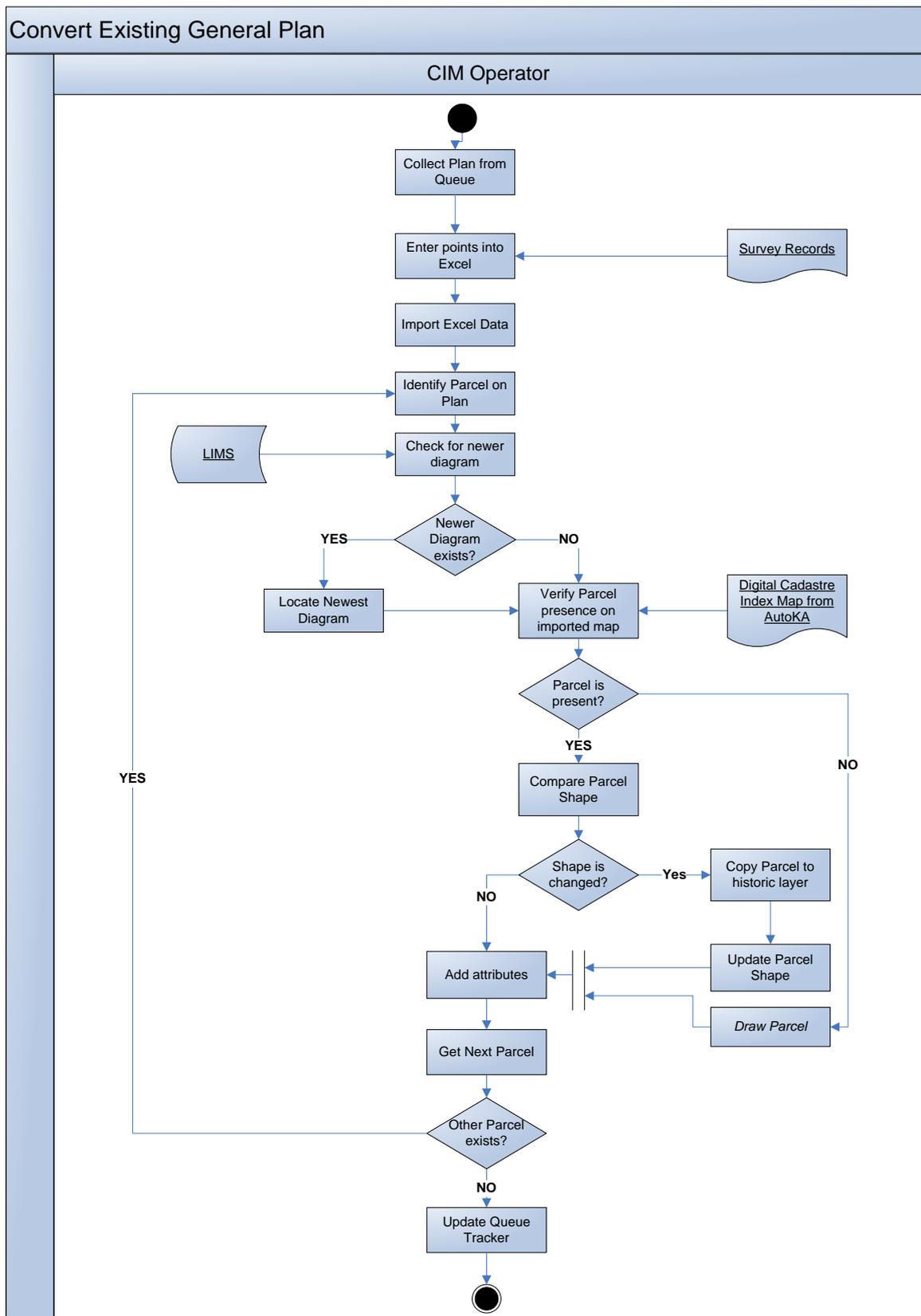


**Figure 15 Outline of General Plan conversion process**

## Convert Existing Survey Diagram (*Single Parcel*)
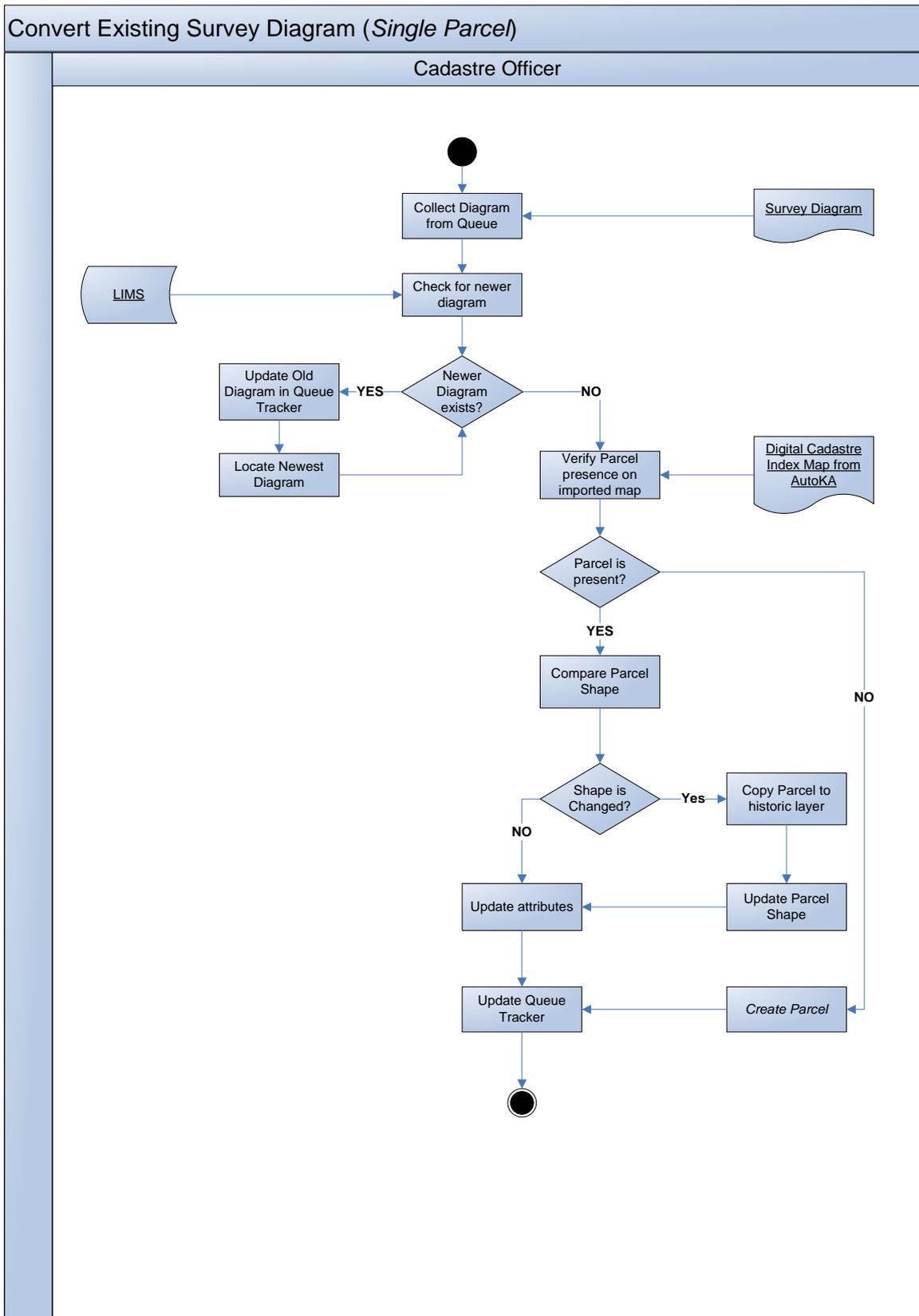
### Cadastre Officer



**Figure 16 Outline of Survey Diagram conversion process**

# 6. Annexes

## *6.1.        Hardware and Software for CIM pilot*

The following is a minimal set of hardware and software required to start the CIM project. Later on some software might be utilized for the implementation of the PIMS system, but additional purchases will be still required. An alternative solution will be to provide these licenses to the Cartography section to strengthen their production line.

**Hardware/Software List**

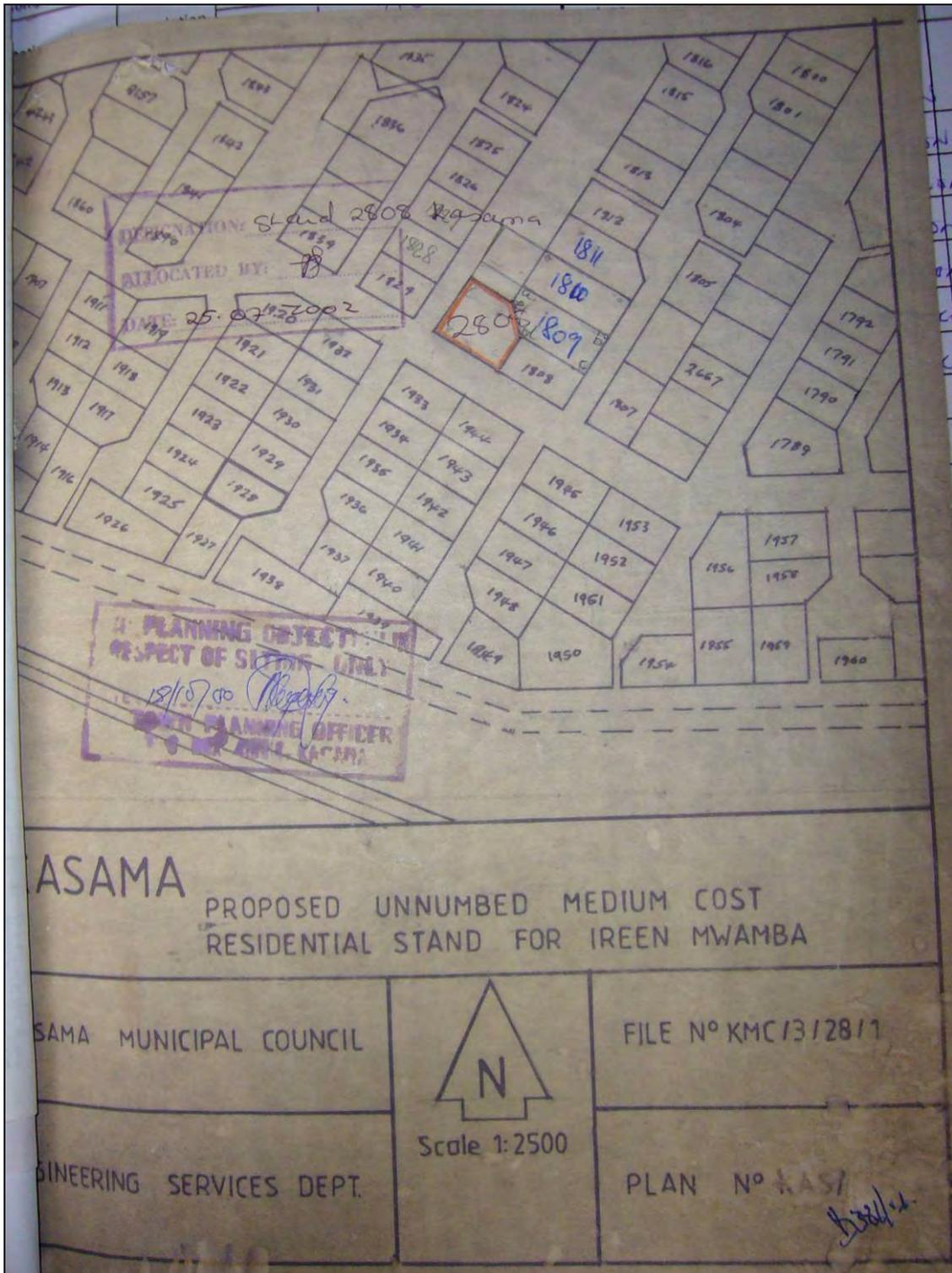| # | Item | Parameters | Item Qty | Comment |
|---|------|------------|----------|---------|
| 1 | Database Rack Server | CPU: 2 x Dual Core Xeon 5130 (2.0 GHz)<br>RAM: 4 x 1GB PC2-5300<br>HDD: 5 x 146.8 Gb SAS 10K ppm Hot pluggable<br>RAID: Smart array controller for RAID-5 support with online spare<br>LAN: 2 x 1 Gbps Ethernet adapter (copper)<br>Video: Integrated on board<br>Media: 1 x DVD-RW drive<br>Power: 2 x Power supply Hot plug<br>Redundant Fan Kit<br>Keyboard, Mouse<br>Monitor: LCD 15" 1024x768, Tco 99<br>Windows 2003 Server Standard Edition + 10 CAL | 1 | DBMS server for cadastre index map and raster data<br><br>3 years international warranty and next day on site support |
| 2 | External tape storage | External DLT 160 SCSI Tape Drive;<br>80 GB native storage capacity<br>160 Gb compressed | 1 | |
| 3 | Tape | DLT 80(160) tape cartridge | 10 | for external tape storage |
| 4 | Rack Mounted UPS | 2200VA<br>USB manageable<br>rack-ready | 1 | |
| 5 | Cadastre Workstation | CPU: 1x Pentium IV 3.2 GHz HT<br>RAM: 2 x 1 Gb non-ECC<br>HDD: 1 x 160 Gb SATA<br>Video 128 RAM PCI-e<br>LAN: 1 x 1 Gbps Ethernet adapter<br>Media: DVD<br>Monitor: LCD 19" 1280x1024, Tco 99<br>Keyboard, Mouse<br>Windows XP Professional | 4 | 3 years international warranty and next day on site support |
| 6 | UPS | UPS, 500VA, 500 Watt, RJ-11/USB, 6 Outlets, Tower | 4 | |
| 7 | Office software | Microsoft Office 2007 Standard | 4 | |
| 8 | Geodetic Software | Bluemarble Geographic Calculator | 1 | single license |
| 8 | Backup Software | VERITAS Back-Up Exec 10 for Windows Server | 1 | |
| 9 | GIS Client Software | ESRI ArcGIS ArcEditor 9.2 | 3 | floating licenses |
| 10 | GIS Client Software | ESRI ArcGIS Publisher | 1 | |
| 11 | GIS Server Software | ESRI ARCGIS Server Basic Enterprise 9.2 for 1-2 CPU | 1 | |

### *6.2.* *Document Examples*



**Figure 17 The Site Plan**

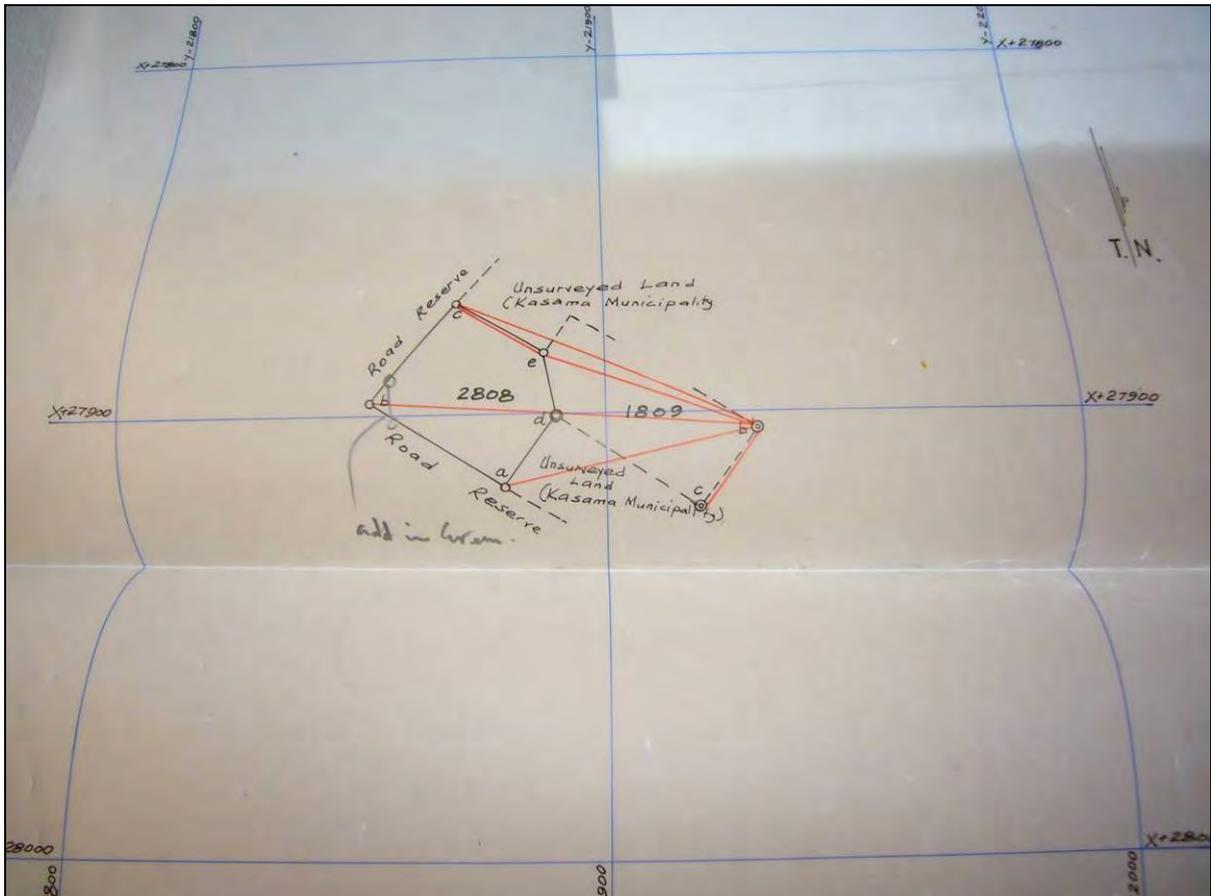**Figure 18 Approved Survey Form with list of coordinates**



**Figure 19 The Working Plan**

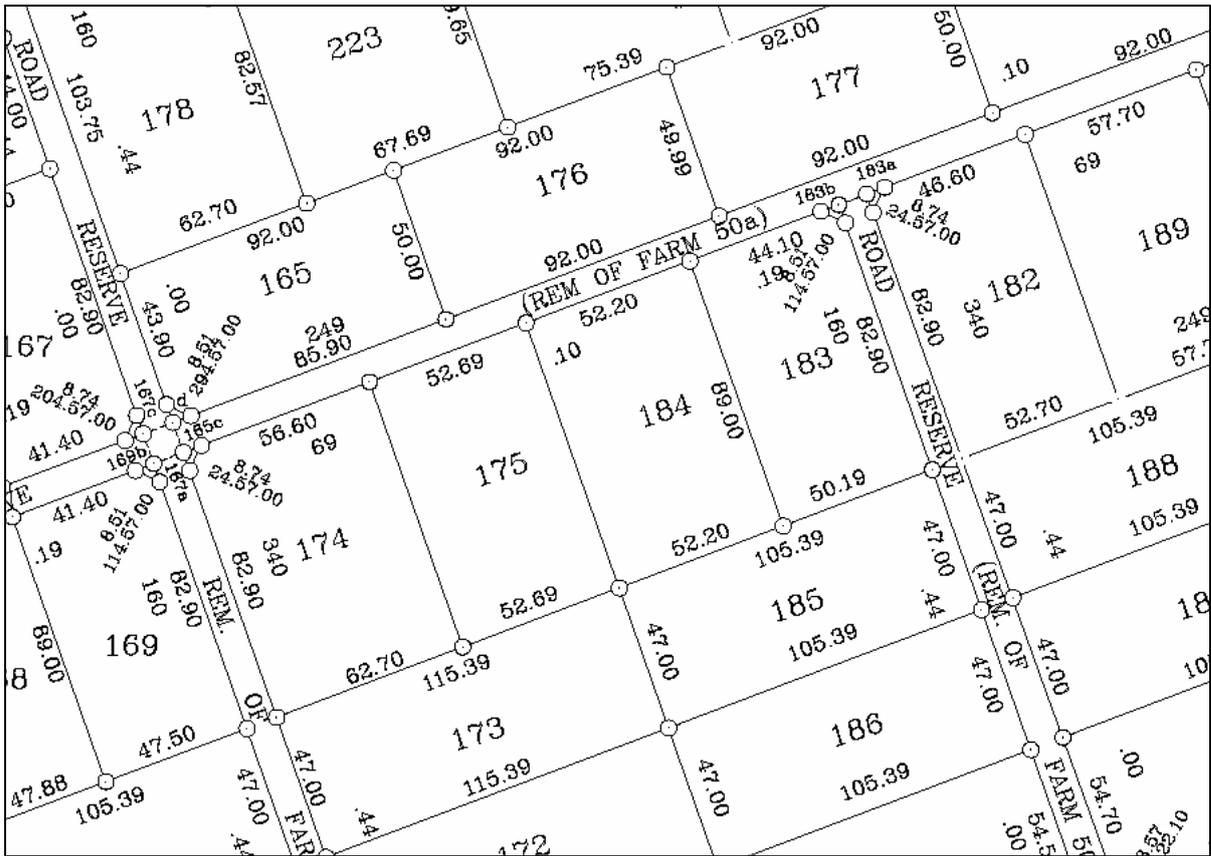**Figure 20 The General Plan (part of)**

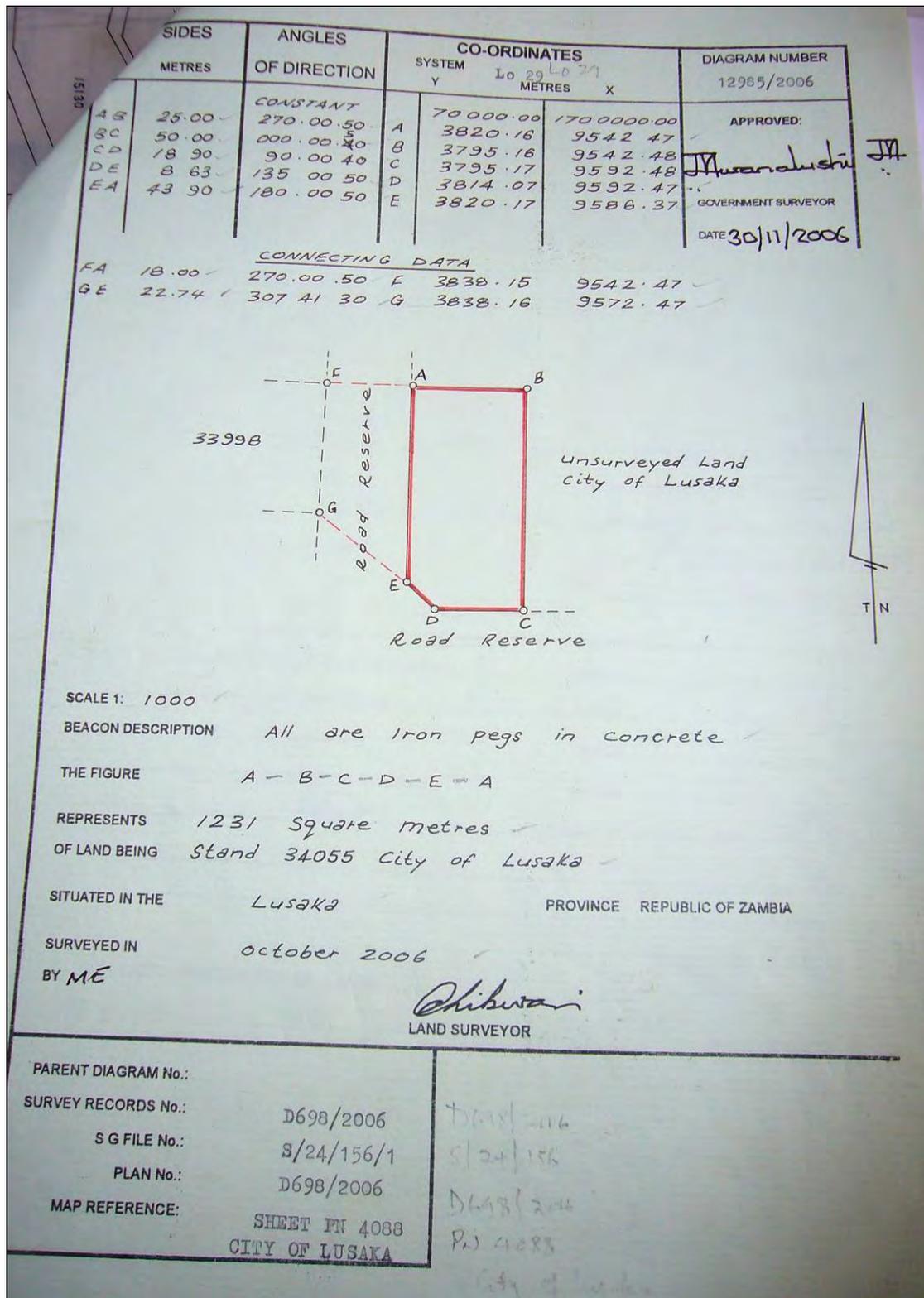**Figure 21 The Survey Diagram (with coordinates)**

**Figure 22 Chiefdom Lands Map**



**Figure 23 Cadastre Series Map**

**Figure 24 The Sketch Plan**