ESRI Cadastral Editor
A Field and Office Tool for Surveyors

Presentation by

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GEODATA AUSTRALIA

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MAPASIA GIS CONFERENCE
AUGUST 2008
Plenary Speakers

‘Cadastre is the core of SDI’

(Prof Ian Williamson-Dept of Geomatics, University of Melbourne)

‘Accuracy is a future issue technology must address and only RIGOROUS TOOLS ENSURE FIDELITY’

(Kaushik Chakraborty-Vice President-Asia Pacific, Leica Geosystems - Geospatial Imaging, India)

‘Redundancy is a key factor in automation’

(Alexander Wiechert - Business Director, Microsoft Photogrammetry, Managing Director, Vexcel Imaging GmbH, Austria)

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CONTENTS

1. Historical Survey Processes
2. The Cadastral Editor Process
3. Cadastral Editor - A Tool for Surveyors
    1. Office
    2. Field
    3. Cadastral Database Management
4. Case Studies

1. HISTORICAL SURVEY PROCESSES

Surveyors make measurements between points in the field.

Record the measurements between the points as lines.

Use the lines to define shapes or entities in a spatial database

More commonly known as a SURVEY PLAN

SURVEY DATA MODELLING

Surveyors build a cadastral database in their survey coordinate geometry using:

1. Existing survey plans – adjust many plans to compensate for:
   - Different azimuths
   - Measurement systems
   - Geodetic reference frames

2. Survey field data
   - Comparisons with plan dimensions and measurements between monuments/occupations on the ground

SURVEY BOUNDARY DEFINITION

Inconsistencies usually exist between statutory and measured information , particularly in areas of old survey plans. The surveyor then makes an intuitive spatial decision based on:

1. Integrity of the existing survey information
   - Age of the survey
   - Quality of survey information (compiled?)
2. Monuments or other information found on site
   - Survey Marks
   - Fences
3. Professional Skill
   - Experience

SURVEY DATA MODELLING

Technology has now provided survey software with powerful functionality for computations, storage and interoperability.

But the spatial decision making is still a

Manual process

2. THE ‘CADASTRAL EDITOR’ PROCESS

A process first conceived in Australia 20 years ago by Dr Michael Elfick to apply survey accuracy to GIS cadastral databases.

Released as CADASTRAL EDITOR - the cadastral management engine of Survey Analyst by ESRI in 2007.

THE ‘CADASTRAL EDITOR’ PROCESS

- Survey Process with survey and GIS outcomes

- Developed for the management of a survey database with cadastral outcomes

- Automates the decision making process of determining the spatial location of boundaries based on survey rules

THE ‘CADASTRAL EDITOR’ PROCESS

New technology that provides surveyors with a higher level of survey data management.

Creates a survey database that retains original survey measurements but also holds all the cadastral intelligence required for a Land Administration System.

CADASTRAL FABRIC – The most accurate representation of the legal cadastre as it exists in the real world

THE ‘CADASTRAL EDITOR’ PROCESS

Future outcomes for surveyors

Electronic survey databases

Value added product

SURVEY DATA MODEL (SDM) PROCESSES

1. DATA ENTRY
   - I. Manual data entry
     - Highest rigour in outcomes
   - II. Importing electronic survey data
     - Efficient access to survey accurate databases
   - III. Migrating existing cadastral database
     - Quick way to build large database but spatially poor

2. PARCEL JOINING

3. ADJUSTMENT

MANUAL DATA ENTRY

Survey plans are currently used by surveyors to define the legal cadastre.

They identify legal and cadastral attributes (Parcel number, plan number, areas, dimensions, easement locations etc.) and they reflect the previous surveyor's decision on the location of title boundaries on the ground.

They also show extra survey information to support their decision and provide the registering authority with the evidence to guarantee that title.

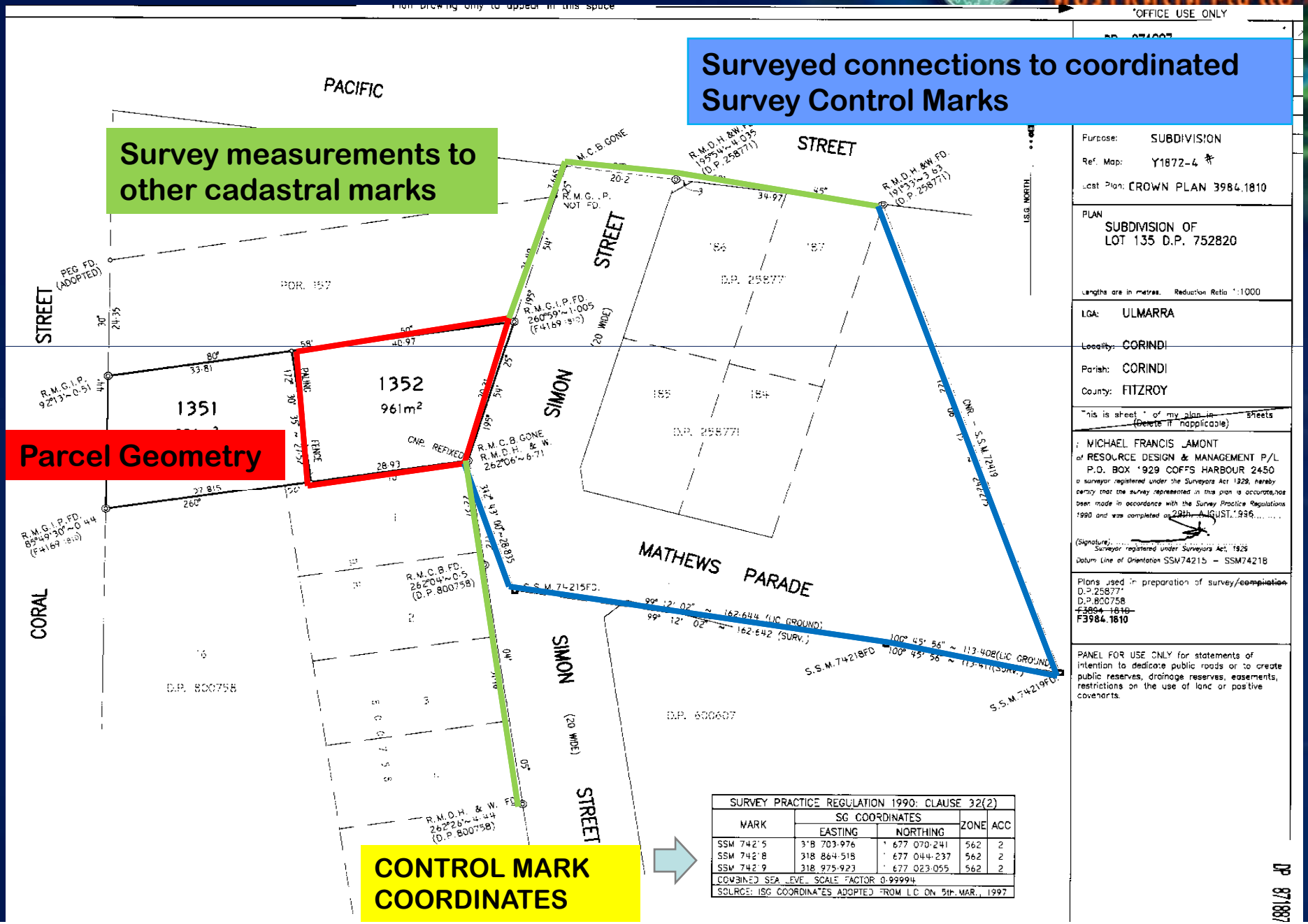
MANUAL DATA ENTRY

GEODATA AUSTRALIA Pty Ltd

Surveyed connections to coordinated Survey Control Marks

Survey measurements to other cadastral marks

Parcel Geometry



CONTROL MARK COORDINATES

SURVEY PRACTICE REGULATION 1990: CLAUSE 32(2)

MARK	SG COORDINATES EASTING	SG COORDINATES NORTHING	ZONE	ACC
SSM 74215	318 703·976	6 677 070·241	562	2
SSM 74218	318 864·518	6 677 044·237	562	2
SSM 74219	318 975·923	6 677 023·055	562	2

COMBINED SEA LEVEL SCALE FACTOR 0·99994
SOURCE: ISG COORDINATES ADOPTED FROM LIC ON 5th MAR., 1997

'OFFICE USE ONLY

Purpose: SUBDIVISION
Ref. Map: Y1872-4
Last Plan: CROWN PLAN 3984.1810

PLAN
SUBDIVISION OF
LOT 135 D.P. 752820

Lengths are in metres. Reduction Ratio 1:1000

L.G.A: ULMARRA
Locality: CORINDI
Parish: CORINDI
County: FITZROY

This is sheet 1 of my plan ... sheets (Delete if inapplicable)

I, MICHAEL FRANCIS LAMONT of RESOURCE DESIGN & MANAGEMENT P/L P.O. BOX 1929 COFFS HARBOUR 2450 a surveyor registered under the Surveyors Act 1929, hereby certify that the survey represented in this plan is accurate, has been made in accordance with the Survey Practice Regulations 1990 and was completed on 28th AUGUST, 1996

(Signature) ... Surveyor registered under Surveyors Act, 1929

Datum Line of Orientation SSM74215 – SSM74218

Plans used in preparation of survey/~~compilation~~
D.P.258771
D.P.800758
~~F3894.1810~~
F3984.1810

PANEL FOR USE ONLY for statements of intention to dedicate public roads or to create public reserves, drainage reserves, easements, restrictions on the use of land or positive covenants.

DP 871887

MANUAL DATA ENTRY

The extra survey information in the database adjustment provides more expansive accurate data and redundancies for checking.

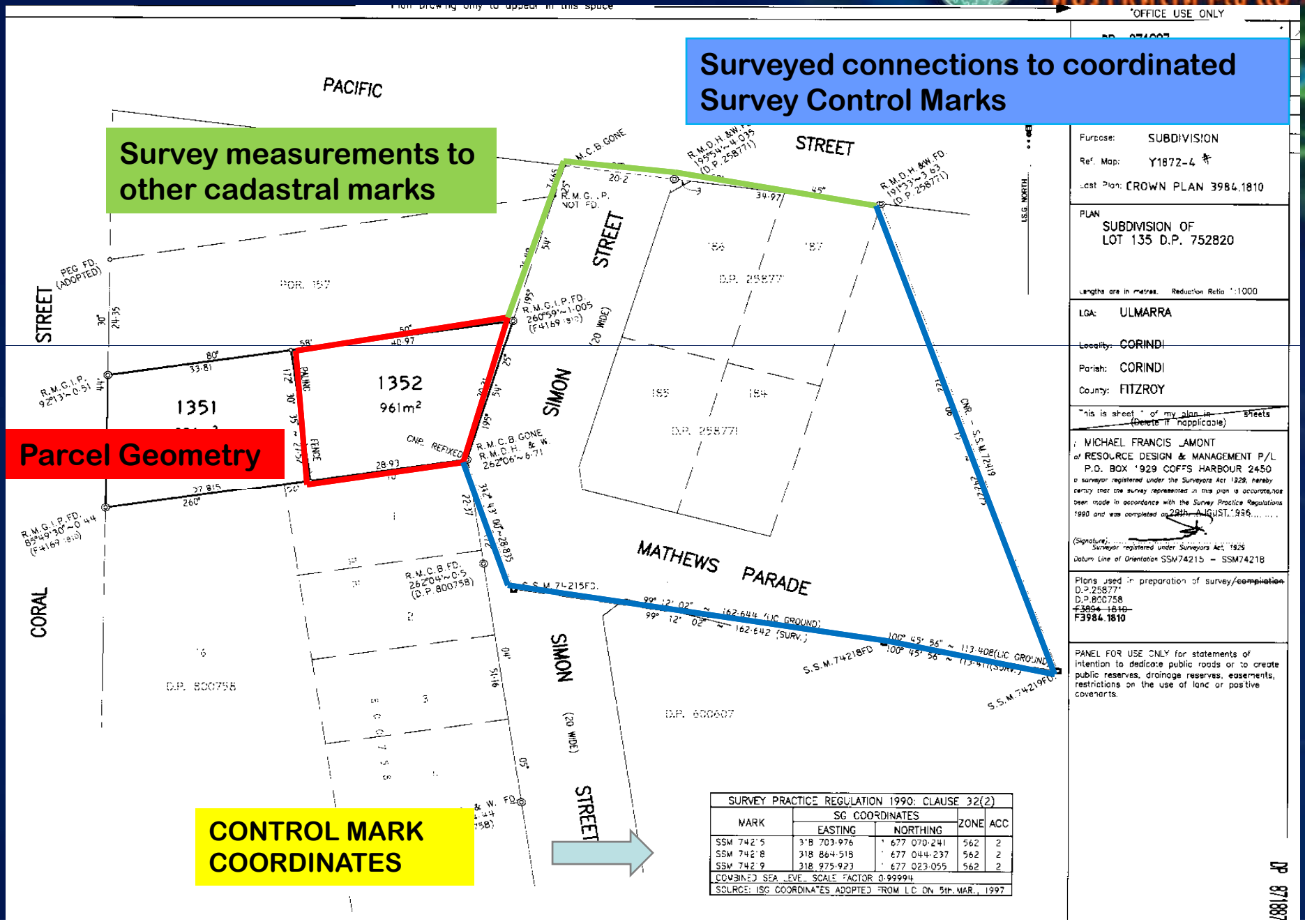
Parcel miscloses are reported as the first stage of checking

2. PARCEL JOINING

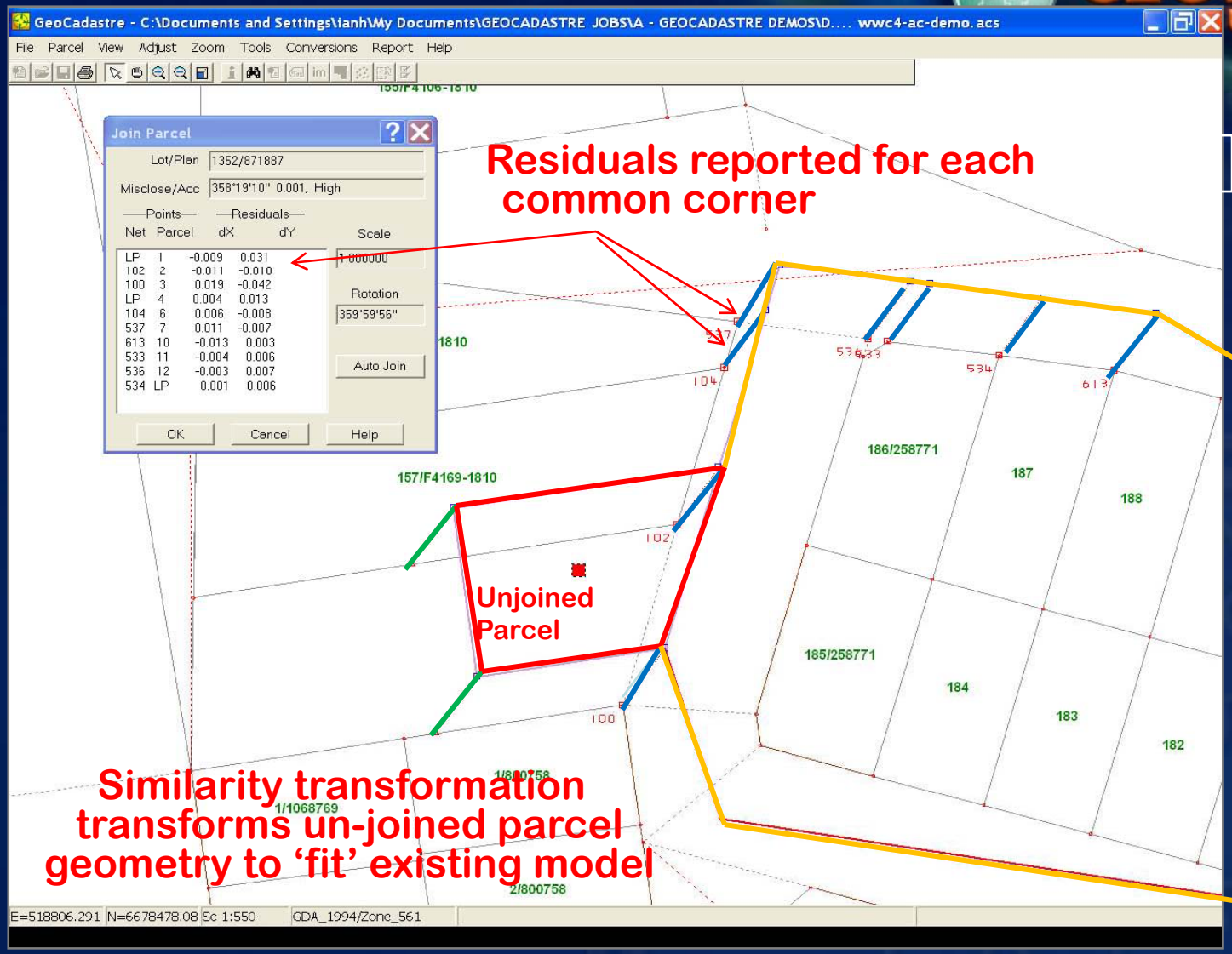
After data entry the parcels are selectively joined to the SDM to force the outcome of a continuous fabric without overlaps or gaps.

MANUAL DATA ENTRY

GEODATA AUSTRALIA Pty Ltd



Parcel Joining



PARCEL JOINING

- This process provides another level of data checking by reporting on the quality of the ‘fit’ of the new survey data into the existing model.
- If a quality Parcel Fabric exists, the parcel joining process becomes a tool for checking the integrity of the survey geometry being added

LPI PLAN CHECKING PILOT

The Land and Property Information (LPI) of the NSW Lands Department is undertaking a pilot study using the SDM process as part of the **EPlan (Electronic processing of digital plans) program.**

One of the aims of the program is to develop a plan information management system incorporating **automated electronic lodgement and examination of survey quality.**

NSW LAND AND PROPERTY INFORMATION (LPI) - EPlan PILOT

BUSINESS GOALS FOR LPI

- SURVEY GEOMETRY – Automation of reporting on the precision of the fit of the parcel geometry and the adjoining survey information into the existing model **reduces manual mathematical plan checking times.**

- STAFF RESOURCES – The process allows **utilisation of less experienced plan checking staff, freeing up senior staff.**

www.lands.nsw.gov.au/land_titles/eplan

The ADJUSTMENT

The date entry and parcel joining stages create a geometry mesh of measurement vectors - no coordinates of any model points have been computed.

The adjustment then fits the nominated control points in the geometry model to the true coordinates of those points and adjusts the measurement vectors to fit and compute the coordinates of the complete cadastre.

This process overcomes consideration of individual measurement grid/ground adjustments as control point coordinates determine all geodetic relationships.

The ADJUSTMENT

The level of rigour in Cadastral Editor limits its effectiveness to ideally adjusting smaller sections of a cadastral database. (<2000 parcels)

For 1000 parcels there are 5,000 unknowns which require 12,501,500 terms in the normal equations to be solved. This increases by the rate of the square of the number of parcels.

THE ADJUSTMENT – A Survey Process

The adjustment provides the tool for troubleshooting the data for the highest precision in the fabric.

Tolerances are set by the operator to allow the degree of precision being tested.

THE ADJUSTMENT – A Survey Process

SURVEY CONTROL

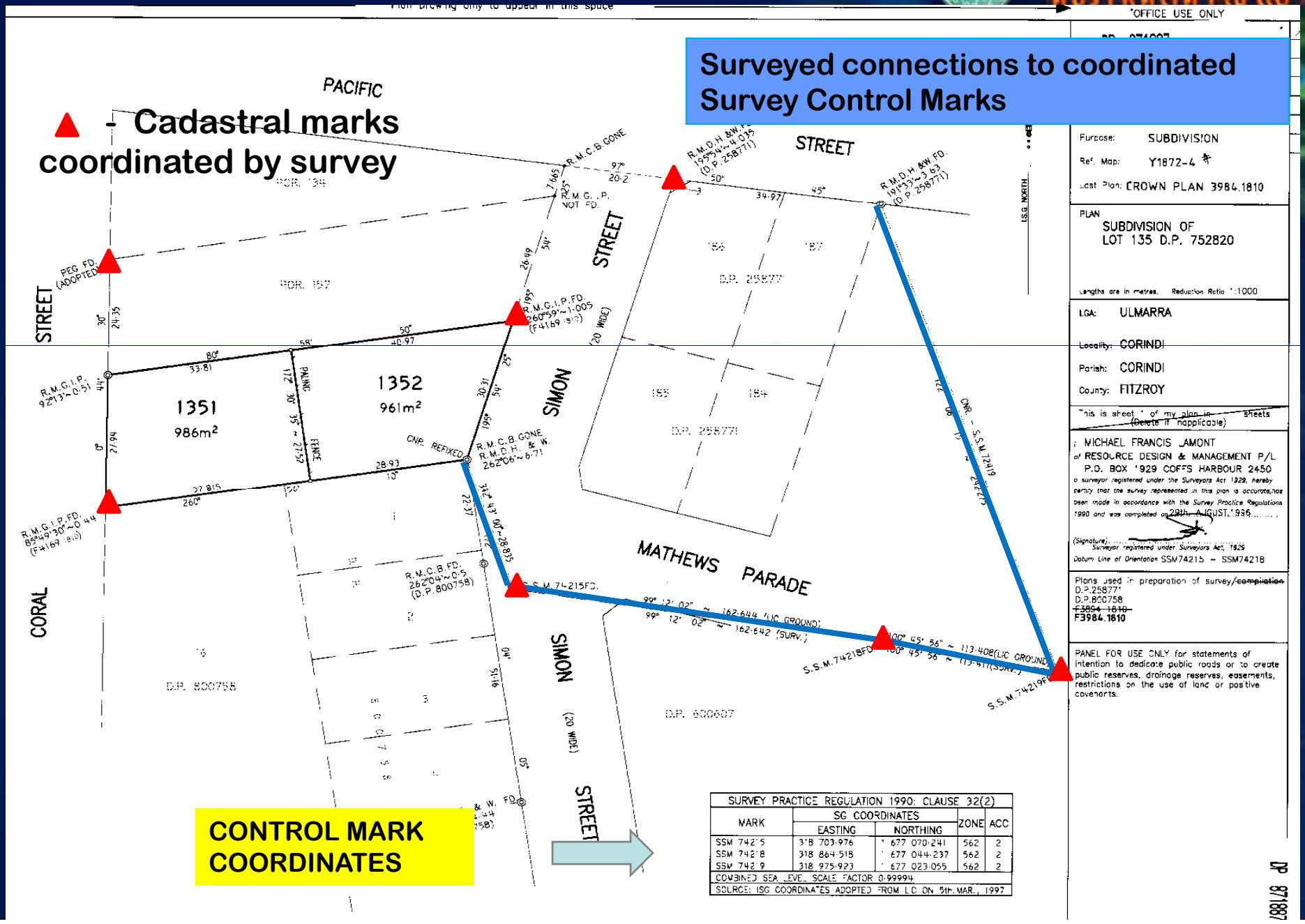
Survey Control throughout a data set can be Geodetic Control connected to the cadastre or any cadastral point with accurate geodetic coordinates.

MANUAL DATA ENTRY

GEODATA AUSTRALIA Pty Ltd

Surveyed connections to coordinated Survey Control Marks

▲ - **Cadastral marks coordinated by survey**



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DP 871887

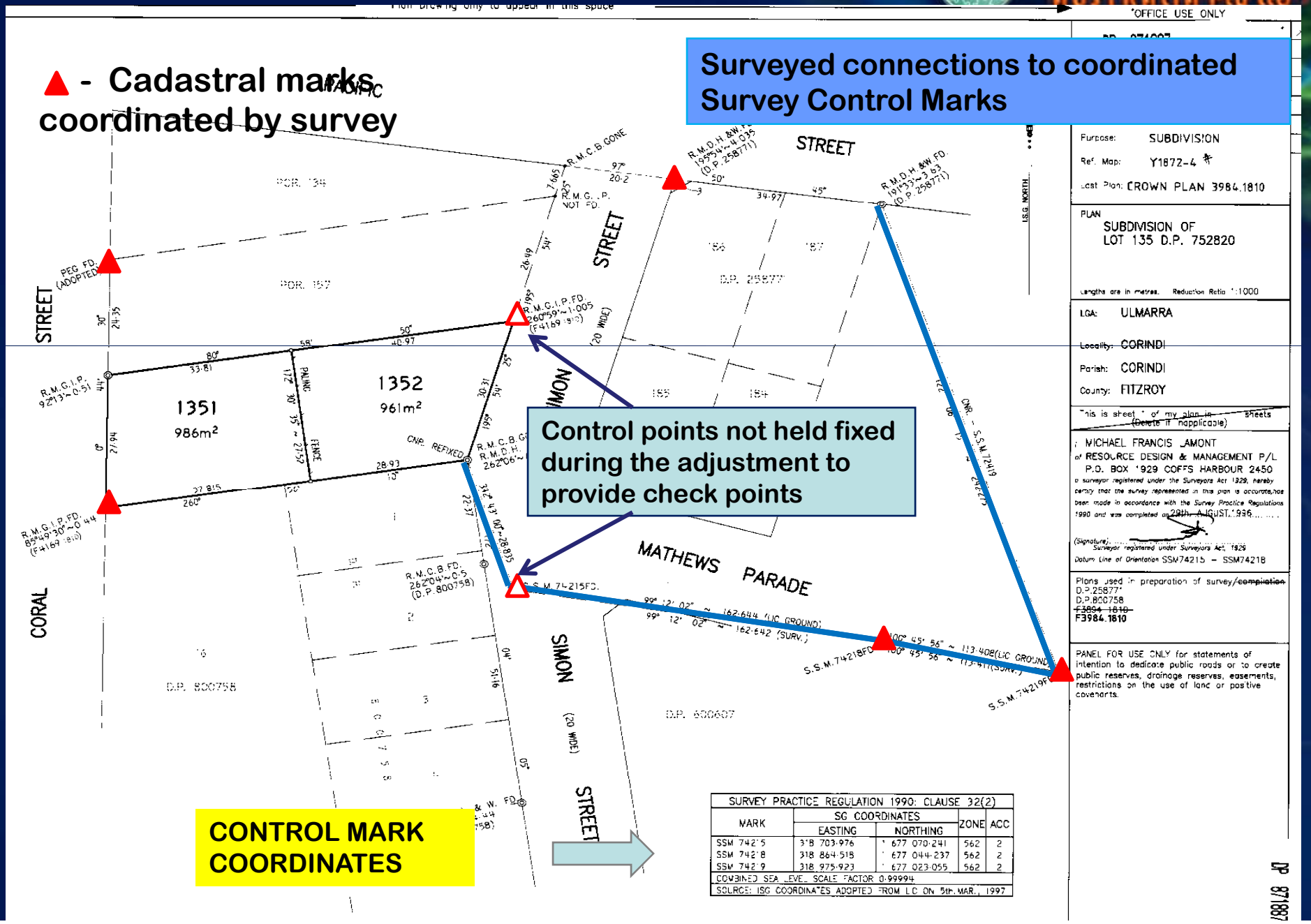
THE ADJUSTMENT – A Survey Process

THE ADJUSTMENT – CONTROL

Control can be held fixed or not held fixed and be adjusted with the model.

When not held fixed the difference between the original fixed coordinates and the new adjusted coordinates provides another test of the spatial quality of the model.

MANUAL DATA ENTRY



THE ADJUSTMENT – A Survey Process

THE ADJUSTMENT REPORT

Highlights major problems in the data by:

1. not allowing the adjustment to proceed
2. identifying the parcel or parcels where the problem is
   - Parcel misclose (drafting error, etc)
   - Incorrect joining.

OFFICE OUTCOMES

THE ADJUSTMENT REPORT

Reports on:

1. Variances between observed and calculated dimensions for every line and identifies possible suspect lines.

2. Every parcel (misclose, rotation etc)

CADASTRAL EDITOR AS A TOOL FOR SURVEYORS

In the past(1):

- **Surveyors go into the field with all the available survey plans.**
- **Locate survey marks/monuments referenced on those plans and use field measurements to determine the spatial validity of those marks so they can base their boundary determinations on them.**

CADASTRAL EDITOR AS A TOOL FOR SURVEYORS

In the past (2):

- **Field measurements often don't agree with plan dimensions – the problem that could be caused by many reasons but often due to problems in existing registered title plans.**
- **If this is the problem, it is difficult to find and field survey is usually extended considerably to resolve it. Often it cannot be resolved until computations are completed back in the office.**

CADASTRAL EDITOR AS A TOOL FOR SURVEYORS - OFFICE

After collecting all survey data surveyors now build an SDM for all jobs (large and small) before any field work.

The process identifies problems in survey plans and field work can be planned more efficiently.

CADASTRAL EDITOR - IN THE FIELD

- Using the SDM in the field allows the surveyor to accurately search for cadastral survey marks.

- When a mark is found, new coordinates are fixed for the mark and the model is readjusted. The increase in the precision of the model allows other marks to be found more easily.

CADASTRAL EDITOR AS A TOOL FOR SURVEYORS

CADASTRAL DATABASE MANAGEMENT

- Historical role undertaken by surveyors
- Recently, managing a cadastral database has generally become a GIS management role because adjusting databases has been a higher level mathematical process.

CADASTRAL DATABASE MANAGEMENT

Cadastral Editor is a tool that allows surveyors to manage a cadastral database.

A MANAGEMENT ROLE FOR SURVEYORS

The Survey Analyst / Cadastral Editor Process:

1. **Holds the extents of a localised set of cadastre fixed (packet).**
2. **Extracts it from the geodatabase**
3. **Update and adjust.**
4. **Returns to the geodatabase**
5. **Records all adjustments to the cadastre to allow cadastre dependent layers to be moved accordingly**

MANAGEMENT ROLES FOR SURVEYORS

SURVEYS AFFECTING THE CADASTRAL FABRIC

1. CADASTRAL SURVEYS

2. GEODETIC CONTROL SURVEYS

MANAGEMENT ROLES FOR SURVEYORS

CADASTRAL SURVEYS

The affect of a cadastral survey updating a cadastral database is localised.

Cadastral Editor adjusts local areas of a cadastral database.

SURVEYS AFFECTING THE CADASTRAL FABRIC

GEODETIC CONTROL SURVEYS

Can be local or affect up to a complete State or national grid

Cadastral Editor does not adjust geodetic survey control coordinates.

Surveyors understand how survey control is adjusted and recognise it is important to source the latest coordinates.

A MANAGEMENT ROLE FOR SURVEYORS

The benefits of the GEODATABASE:

1. **Holds the complete cadastral fabric database ranging from a small project to a State or Federal government database.**
2. **Allows only specified users access to the amend the cadastral fabric. (preferably surveyors)**
3. **Allows one person at a time to amend a specific 'packet' of cadastral data**

CASE STUDIES

NORTHERN TERRITORY – Legislation enacted for survey definition of title by coordinates

RICHMOND LINE UPGRADE – A cadastral fabric completed for a 10 km urban rail corridor

NORTHERN TERRITORY

GPS is now the most efficient means of survey measurement in remote parts of NT.

Large Pastoral Leases are already defined by Latitude & Longitude (ie Geodetic references)

An SDM has been completed in urban areas and is being extended into the remote areas defined by large Pastoral Leases.

Legislation for legal coordinates for Title boundary definition in proclaimed areas enacted in 2004.

NORTHERN TERRITORY

OUTCOMES

Technology has provided the NT a way of moving from a measurement based title definition system to a position based title definition system.

To peg the parcel corners of one 80 km outback pastoral lease boundary:

- Traversing – 3-4 weeks
- GPS - 1 day

NSW TRANSPORT INFRASTRUCTURE DEVELOPMENT CORPORATION

RICHMOND RAIL PROJECT

Upgrade of 10km of an existing single line that serviced areas identified as a major growth centre for Sydney's future.

Undertaken by the NSW Government authority – the Transport Infrastructure Development Corporation (TIDC).

For the planning and design stage, the project needed a survey accurate cadastral model of the route.

It was also preferred for political reasons that this was done initially with a minimum of survey field work.

RICHMOND RAIL PROJECT

The desktop model was created.

2 days GPS field work was undertaken to provide:

- extra survey control in areas of poor survey definition.
- Ground-truthing of the model

The model was taken into the field with GPS and the desktop model coordinates allowed the surveyors to navigate accurately (0.05 – 0.5 meters) to marks on the ground or where buried marks were located.

In many cases the model quickly allowed recognition that survey marks had been destroyed by cables or other works.

TIDC SURVEY DATA MODEL

JOB STATISTICS

10 kms

4000 Parcels

92 Existing coordinated Geodetic Control Points connected to the cadastre

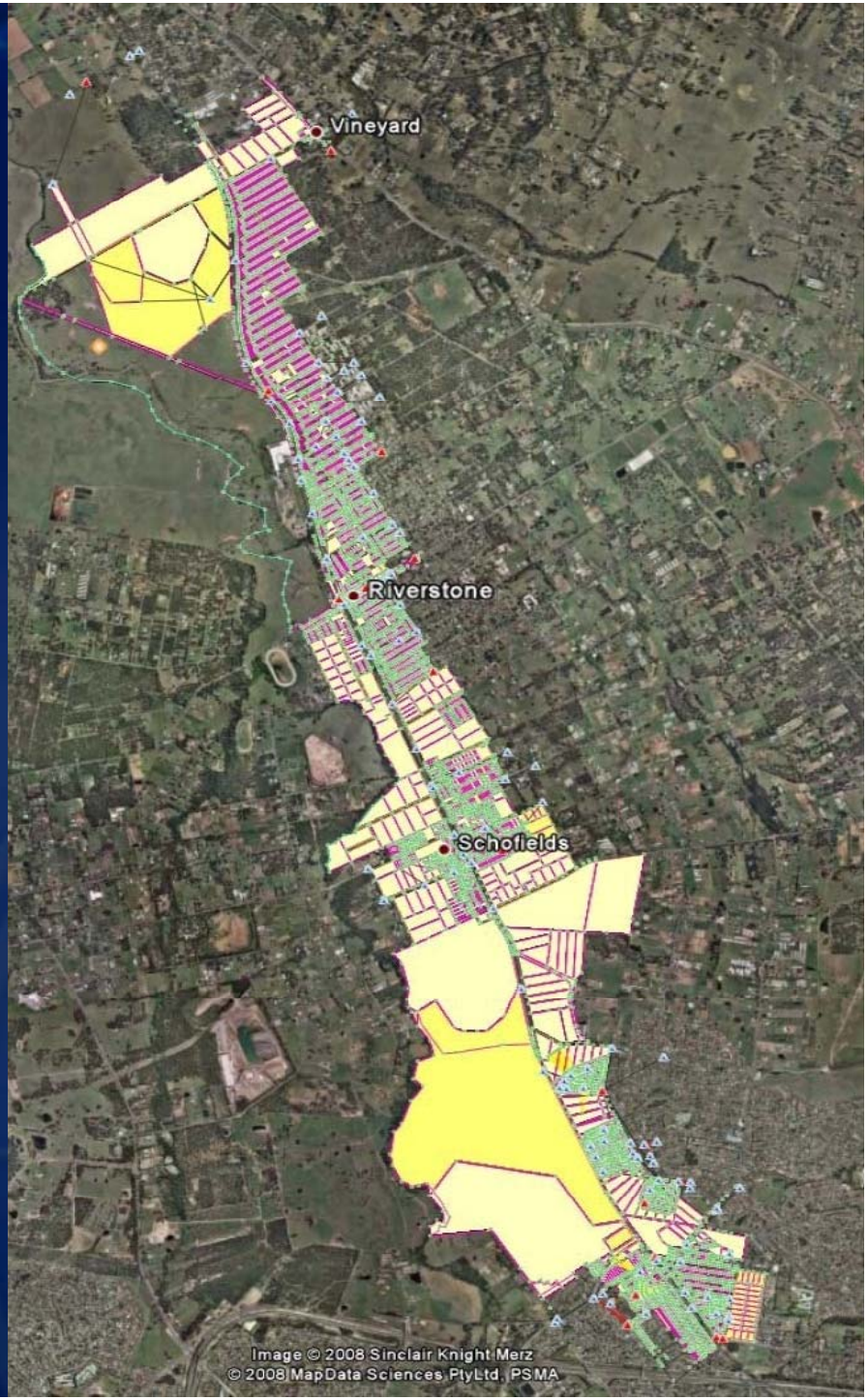
ADJUSTMENT OVERVIEW

16 Control Points held fixed

76 Control Points 'inactive'

REPORT ON INACTIVE CONTROL PT PRECISION

Accuracy Range	No. of Inactive Control Pts	%
0 - 50mm	25	33
50 – 150mm	26	34
150 - 250mm	15	20
>250mm	10	13



RICHMOND RAIL PROJECT

OUTCOMES

The spatial accuracy of the final TIDC model is in the order of 30mm – 100mm in urban areas and 100mm-200mm in rural or areas of older survey plans

The project would have required 4 - 6 weeks field survey to create the cadastral model.

The project now has a survey accurate cadastral database with property attributes to underpin the project GIS database for ongoing design, construction & asset management.

ACKNOWLEDGEMENTS

Dr Michael Elfick,	***Wallalong, NSW, AUSTRALIA***
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Gary West	***Surveyor General – Northern Territory***
Tim Hodson	***ESRI – Redlands, CALIFORNIA***
Christine Leslie	***ESRI – Redlands, CALIFORNIA (CE Tech Seminar UC 2008)***
Craig Sandy	***ESRI Australia - ACT***