

Digital Twin, Smart Cities and Smart Land Information

FIG Commission 7 Annual Meeting 2019

'Sharing Experiences of Surveyors

AUSTRALIA

Ian Harper





Background IAN HARPER - Bachelor of Surveying University of New South Wales - Sydney 1977

Professional Roles

Graduate Surveyor - UK and Libya 1979

Cadastral & Mining surveys - 5 years

**Registered Surveyor and founding Director in a Survey, Planning
and Environmental Consultancy** - 20 years

Involved in Land Title Development Project Management

Company grew to 35 staff

Survey & Cadastral Database Consultant – 14 years

Involved in creation and management of cadastral databases for
government jurisdictions and infrastructure projects across
Australia and overseas

Specialises in introducing digital processes and automation to
land titling systems, connecting survey and mapping title
documents to modern database systems

My Survey Experience - LIBYA 1979



My Survey Experience - LIBYA 1979



TORRENS TITLE

Developed in South Australia in the 1850's

The State maintains a register of titles and guarantees title.

The register records ownership and all rights, restrictions and responsibilities related to that land.

The State guarantees title but does not guarantee spatial definition. Modern measurement may provide a more accurate distance between boundary monuments.

TORRENS TITLE

Survey plans noted on title provide 'Metes and Bounds' spatial identification that includes:

- Dimensions of Title (Metes)
- Adjoining Titles (Bounds)
- Measurements to survey Marks placed and found (monuments) during the survey
- Measurements to monuments

Most modern (post 1980) plans show field measurements/traverses to geodetic coordinated control points.

Modern Spatially enabled NSW Survey Plan

STATION	RADIUS	ARC	BEARING	CHORD	DISTANCE
1	8.0	14.138	145°37'42"	12.75	
2	13.5	3.445	157°56'32"	3.406	
3	13.5	14.415	145°30'22"	13.74	
4	13.5	14.57	207°20'58"	13.87	
5	13.5	22.815	288°15'10"	20.98	
6	18.0	3.065	328°48'25"	3.025	
7	18.0	11.82	331°38'10"	11.845	
8	24.0	17.7	325°27'40"	20.84	
9	24.0	(5.7)	287°23'52"	5.885 (SAS)	

COOR	BEARING	FROM	DISTANCE
A	218°59'50"	DH & W	4.866
B	100°39'52"	GP PD	0.45
C	188°54'50"	DH & W PD	6.32
D	163°15'20"	DH & W	5.24
E	100°37'40"	DH & W	3.74
F	100°37'40"	DH & W	11.24
G	100°37'40"	DH & W	3.72
H	100°37'40"	DH & W	11.11
I	100°37'40"	DH & W	3.835
J	100°37'40"	DH & W	3.875
K	100°37'40"	DH & W	20.95
L	191°05'20"	DH & W	3.775
M	212°14'10"	SSM168718	17.58

- SCHEDULE OF EASEMENTS**
- ① EASEMENT TO DRAIN SEWER VARYING WIDTH
 - ② EASEMENT TO DRAIN WATER 3 WIDE
 - ③ EASEMENT FOR PADMOUNT SUBSTATION 4.2 WIDE

Reference/recovery Marks - 15+

Survey measurements to coordinated control points.

List of geodetic coordinates

MARK	EASTING	NORTHING	CLASS	ORDER	ORIGIN
SSM95389	741702.907	6390219.578	C	3	SCMS
SSM959155	741818.030	6390136.348	C	3	SCMS
SSM960157	741722.983	6390103.395	C	3	SCMS
SSM141516	741487.288	6390325.35	C	3	SCMS
SSM150662	741587.845	6390241.527			TRAV
SSM150663	741673.688	6390213.311			TRAV
SSM158718	741506.895	6390330.294			TRAV

PM - CONNECTIONS

SSM95158 - SSM141516	329°07'20"	230.338 BY VE
	329°07'18"	230.344 MGA GROUND
SSM141516 - SSM95389	111°00'52"	284.819 BY VE
	111°00'52"	284.826 MGA GROUND

Registered
8.3.2011
DP1162126 P

TORRENS TITLE

Monument over Measurement.

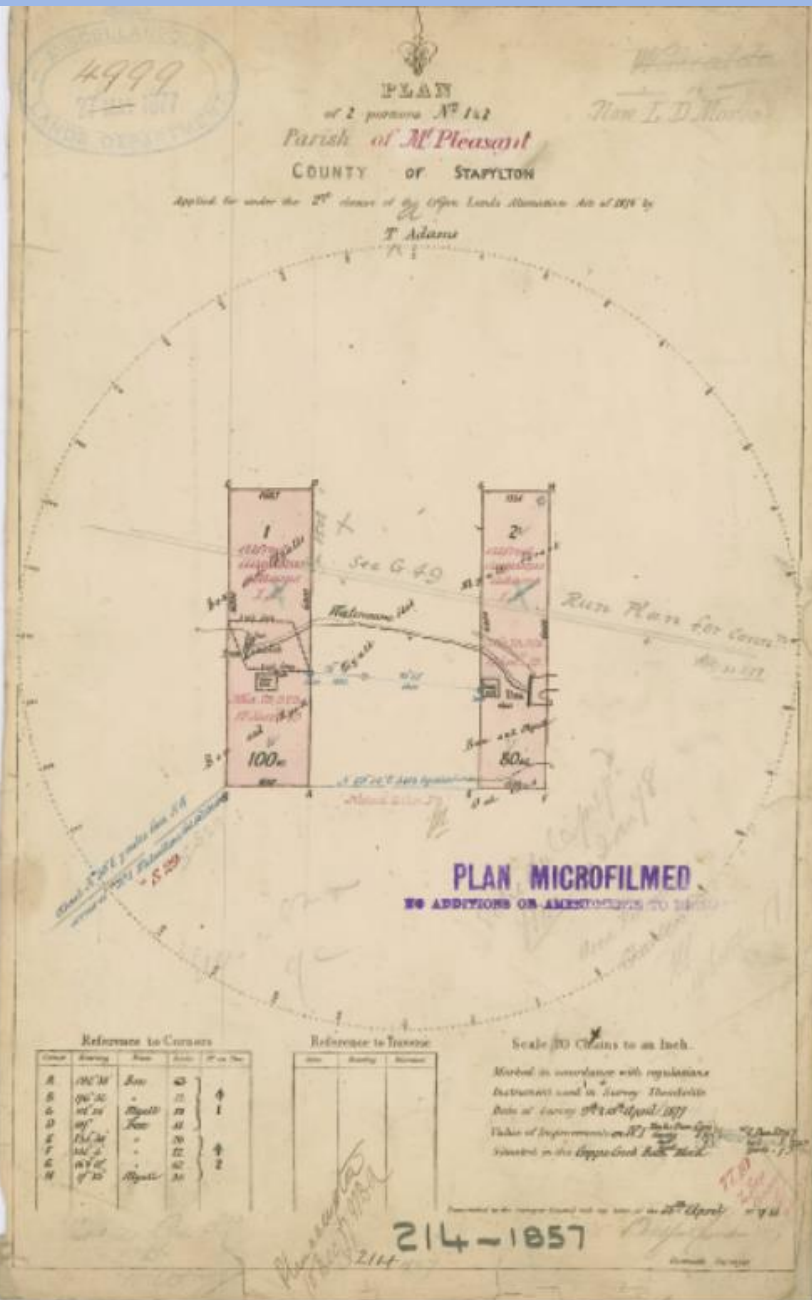
The legal responsibility of the surveyor is to identify where the original surveyor placed the survey marks in survey creating the Title.

TORRENS TITLE – Monument over Measurement.

Survey marks (corner pegs or reference marks) have a higher weighting over survey plan measurements in determining boundary locations.

Reference Marks are the secret survey data that allows surveyors to relocate historical surveys.

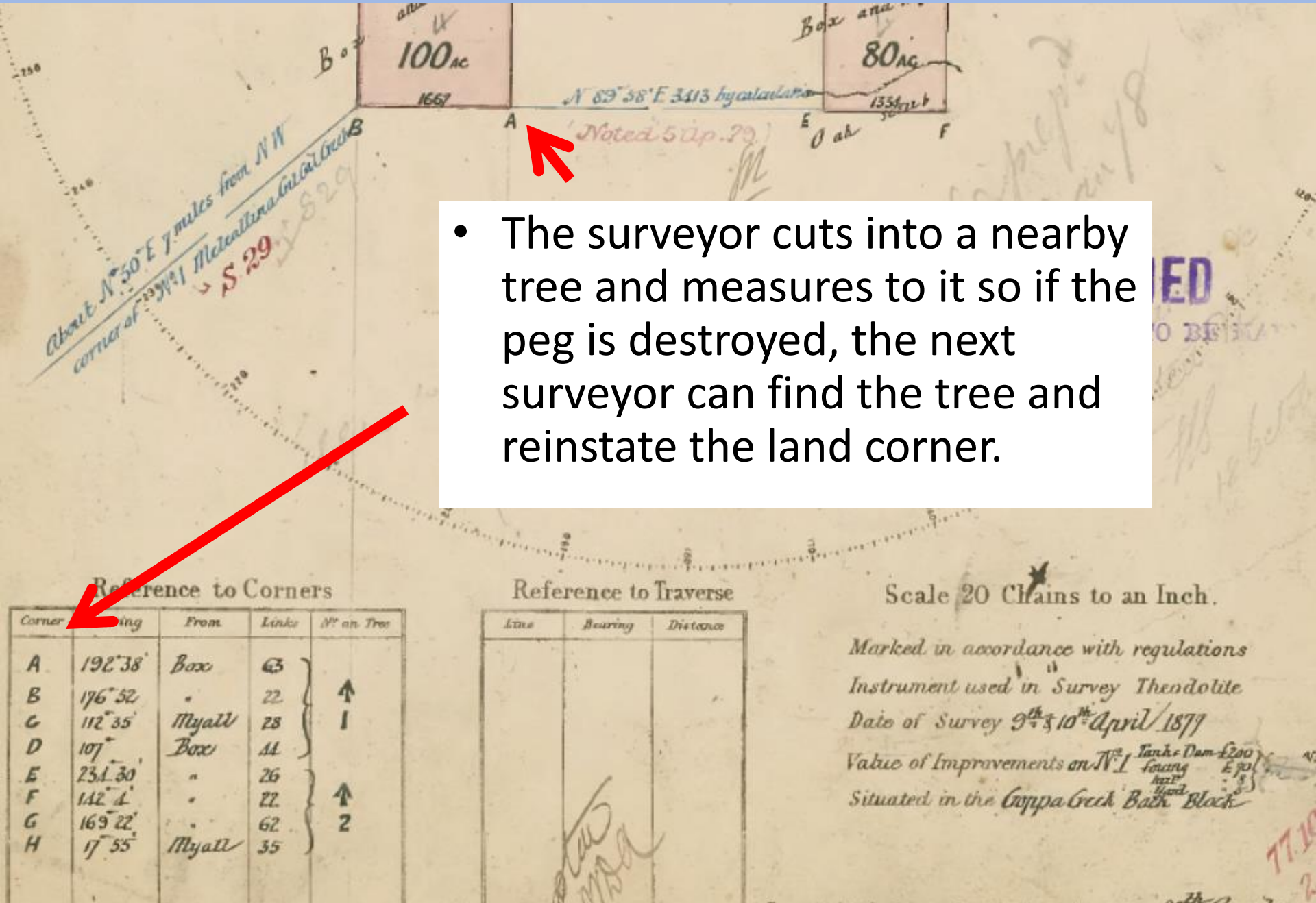
TORRENS TITLE – Survey Plan - 1877



2 lots defined by survey to provide record of spatial extents of land granted / purchased from the government who owns all surrounding land.

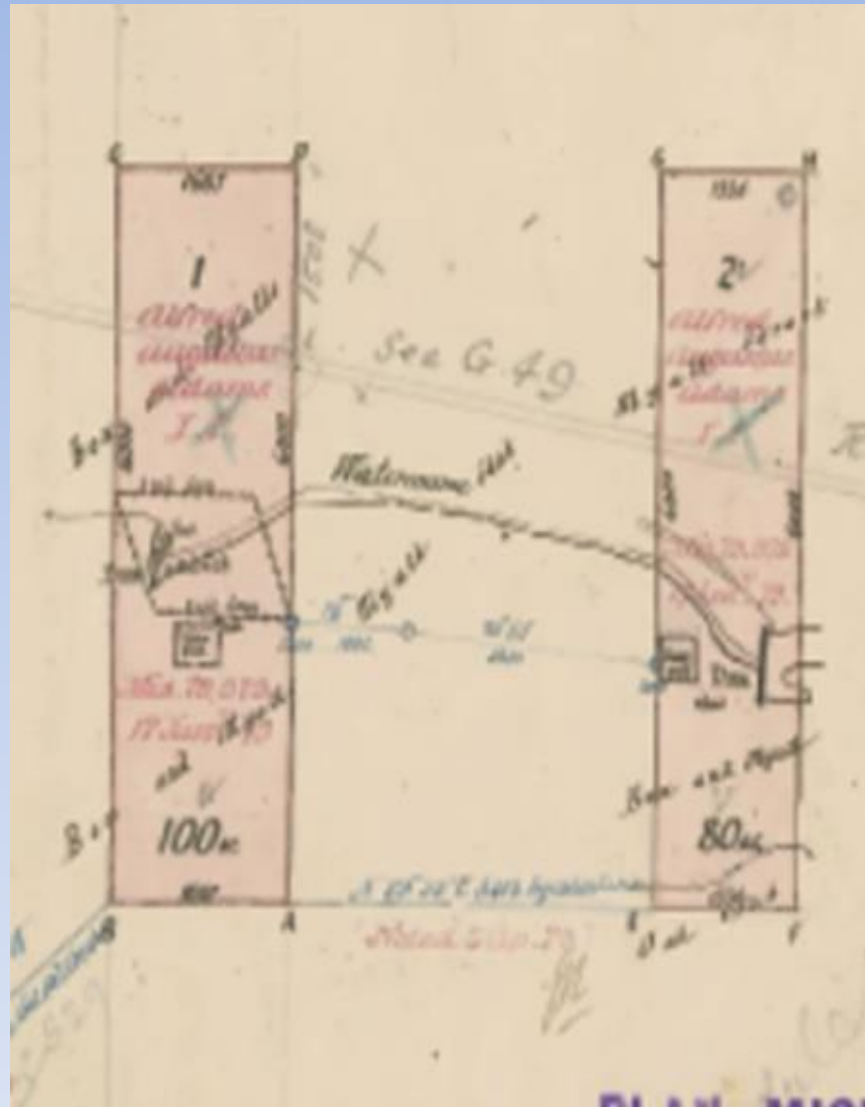
The land corners are marked by wooden survey pegs to monument the corner.

TORRENS TITLE – Survey Plan - 1877



- The surveyor cuts into a nearby tree and measures to it so if the peg is destroyed, the next surveyor can find the tree and reinstate the land corner.

TORRENS TITLE – Survey Plan - 1877



In the early days there may have been no other properties within 10 or 20 miles so the first spatial challenge for the surveyor is to find where the survey was.

So natural and built features were shown on the plan (rivers, creeks, dams, buildings, fences etc) to locate the land and the surveyor could look for pegs or reference trees.

Reference trees



Courtesy of: <http://www.dohertysmith.com.au/blog/survey-reference-trees/>

Survey Reference Marks used to assist surveyors in identifying boundary locations.



Concrete Block and Boundary Peg

geodato AUSTRALIA



Galvanised Iron Pipe Reference Mark

geodato AUSTRALIA



Drill Hole and Wing in Kerb

geodato AUSTRALIA



Permanent Mark

geodato AUSTRALIA

Current Status

Australian states are transitioning from the manual measurement based title systems of the past to the digital location based title systems of the future.

The efficiencies and capacity of technology is the driver.

Technology Drivers

- Measurement tools - EDM, GNSS, Scanners, high resolution imagery.
- Computing power.
- Software, Applications, AI, etc

CASE STUDY



Timor Sea

NORTHERN TERRITORY



Northern Territory

Area - 1.3 mill sq kms

Population - 250,000

Total Parcels - 85,000

Australia

WESTERN AUSTRALIA

Brisbane

SO
UST



Digitisation in the Northern Territory (NT)

For over 20 years the NT has been utilising the GeoCadastré application developed by the Geodata Australia team.

The NT has been extracting relevant measurement and other data from all NT survey plans and is now all but complete.

Local surveyors as major stakeholders were engaged in the data capture so they were part of the process and understood how it worked.

The NT the mapping based Cadastral Database is now being replaced by a parcel fabric survey database (SPICAD) built by compiling the machine readable text files of individual survey plans.

Digitisation in the Northern Territory

Total Digital lodgement was made mandatory in 2017. That lodgement is simplified with a mixture of formats:

1. **a digital image of the new survey plan**
2. **A file of machine readable text file.** That content relates only to parcel dimensions and other measurements that can benefit the spatial upgrading of the parcel fabric (SPICAD) or statutory jurisdictional content needed for transactions.
3. **A standard Plan Examination Report** generated by Surveyors.

The NT approach is minimalist compared with other states but scalable if more rigour or cadastral intelligence is required in the future.

Basic heights are also entered and stored as parcel attributes when capturing Strata/Apartment/Condominium survey plans for 3D modelling from the SPICAD survey database.

The Northern Territory Survey Database



Delete Calculate Selection: Zoom To Switch Clear Delete

Type	StatedArea	Accuracy	Shape_Area	OBJECTID_1	Plan	Lot	Floor_lev	Ceiling_He	Floor	Lot_Plan
59	81	2	81.259844	11	UTS2014016	9070	23	2.7	First_Floor	9070_UTS2014016
59	155	2	155.180805	15	UTS2014016	9074	26	2.7	Second_Floor	9074_UTS2014016
59	155	2	155.180805	57	UTS2014016	9116	44	2.7	Eighth_Floor	9116_UTS2014016
59	155	2	155.180805	50	UTS2014016	9109	41	2.7	Seventh_floor	9109_UTS2014016
59	155	2	155.180805	36	UTS2014016	9095	35	2.7	Fifth Floor	9095_UTS2014016

Cadastral Database with 3D Parcel

ion



Inquiry

Labeling



UTS2014105_parcel - 10135

Accuracy	2
Rotation	0.39624
Scale	1.000048
Unclosed	0
MiscloseRa	33084.590956
MiscloseDi	0.00766
MiscloseBe	66.741069
Constructi	0
ShapeStdEr	0.001
ShapeStd_1	0.002
BacksightB	224.633333
Shape_Leng	253.454509
Shape_Area	3072.912361
OBJECTID_1	2
Plan	UTS2014105
Lot	10135
Floor_leve	20
Ceiling_He	3.7
Floor	Basement
Lot_Plan	10135_UTS2014105



The Northern Territory Outcomes

A fully digital survey documentation process for lodgement of new title plans.

Relevant Survey and jurisdictional data in an accessible text data file allowing automation in transactions and a level of automation in spatial analysis.

Database applications for seamless spatial upgrading and transaction updating.

Is Torrens Title still relevant in the digital transition?

YES

Coordinates in Torrens Title?

1. GNSS is another form of measuring between 2 points.
2. Coordinates are the most efficient way to store measurement outcomes in a digital environment

Coordinates in Torrens Title?

In Australia the Northern Territory (NT) and South Australia has legislation in place to allow coordinates to define Land boundaries.

The Legislation allows the Surveyor General to declare that the authoritative cadastral database represents the monumented boundary.

Only 3 areas in the NT have been declared.

Coordinates in Torrens Title?

Australian surveyors have reservations about coordinates but the Torrens system can still apply.

Coordinates reflect a point on the ground. If a surveyor is satisfied that the coordinate does not represent the monument he or she can provide evidence to the Titles Office.

Coordinates are a new type of monument.

Transition from Survey Plan to ePlan with different levels of implementation in different states

Paper Plan



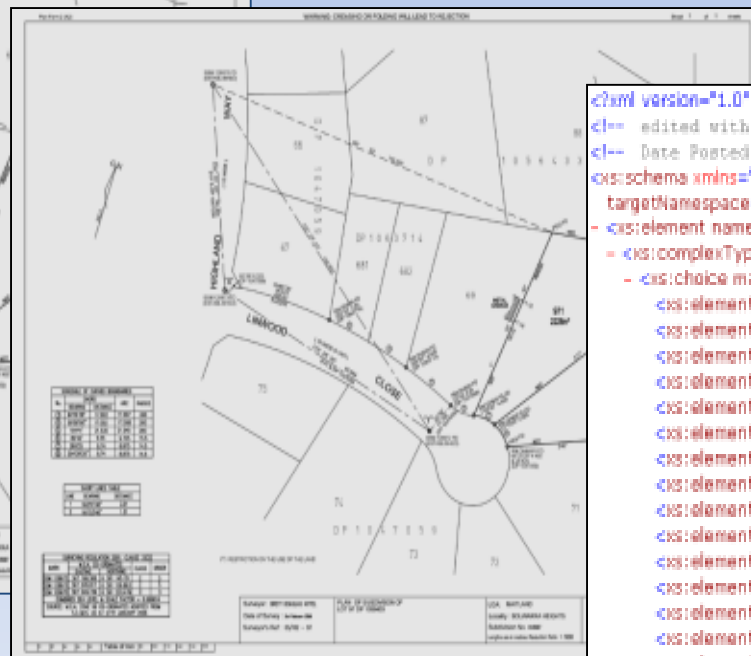
Tiff file



Text File



Image



Digital Image

```
<?xml version="1.0" encoding="utf-8" ?>
<!-- edited with XMLSpy v2008 R2 (http://www.altova.com) by Nathan Crews [Auto] -->
<!-- Date Posted: 7/29/2008 -->
<!-- schema xmlns="http://www.landxml.org/schema/LandXML-1.2" xmlns:x="http://www.landxml.org/schema/LandXML-1.2" version="1.2" -->
<!-- targetNamespace="http://www.landxml.org/schema/LandXML-1.2" -->
<!-- element name="LandXML" -->
<!-- complexType -->
<!-- choice maxOccurs="unbounded" -->
  <!-- element ref="Units" -->
  <!-- element ref="CoordinateSystem" minOccurs="0" -->
  <!-- element ref="Project" minOccurs="0" -->
  <!-- element ref="Application" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Alignments" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="CgPoints" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Amendment" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="GradeModel" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Monuments" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Parcels" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="PlanFeatures" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="PipeNetworks" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Roadways" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Surfaces" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="Survey" minOccurs="0" maxOccurs="unbounded" -->
  <!-- element ref="FeatureDictionary" minOccurs="0" maxOccurs="unbounded" -->
  <!-- any namespace="##other" processContents="skip" minOccurs="0" -->
```

Digital Data File

Observations

The future of Torrens cadastral systems will still be built on the record information captured from the original survey plans.

Current and future surveys will be of high accuracy irrespective of being measurement or position based.

Observations

The nature of Torrens Title and the extreme difference in survey data spatial integrity when historical surveys are involved will continue to challenge the digital transition in Australia.

It is a jigsaw where the pieces do not fit together – not ideal for a digital database and requires a rigorous solution to get the highest spatial outcomes.

Observations

The innovations in the Northern Territory cadastral database have been due to doing what is readily achievable and not trying to pursue complicated outcomes that technology has the capacity for.

Observations

Cadastral applications are now required to manage all types of spatial data (survey traverses, GNSS, imagery location, crowd sourcing, etc)

Smart processes use all the raw measurement data types in the database and the spatial integrity of the data is taken into consideration in the adjustment. (As used in the NT)

With the applications available, states should be rapidly looking at digitisation implementations to capture and retain the integrity of good data moving forward while considering how historical legal records are brought into the system.



Thank you

Ian Harper

harper@geodata.com.au