

The Impact of geodetic datum modernisation on cadastral mapping and graticular boundaries in PNG

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CHANGING A GEODETIC DATUM OR COORDINATE SYSTEM

MUST NOT

**CHANGE A LAND BOUNDARY
“ON THE GROUND”**

**CADASTRAL PRINCIPLE –
CARDINAL RULE “101”**

The Corollary:

**“Fixed” Boundary Markers
on the ground will have
different coordinates
in different geodetic datums and
coordinate systems**

“Fixed”
boundary
corner
(e.g. OCP)
different
coordinates
in different
datums and
even different
transformation
methods!

AGD66/AMG66 Zone 56
E 406**284.01** N 9503**393.71**
(From PSM connection – Original Survey)

PNG94/PNGMG94 Zone 56
E 406**405.91** N 9503**550.56**
(Using PNG Mainland
transformation EPSG: 6937)
Transformation accuracy +/- 1 m

PNG94/PNGMG94 Zone 56
E 406**405.62** N 9503**550.79**
(by tie from nearest
1st order **PNG94** control)

PNG2020/PNGMG2020 Zone 56
E 406**405.92** N 9503**549.50**
(by tie from nearest
1st order **PNG2020** control)



Photo: Kuamin Aiso

Global kinematic (dynamic) geodetic reference frames and epochs!

Global coordinates
change continuously due
to plate tectonics
(and earthquakes)

**But boundary does not
change on the ground!**

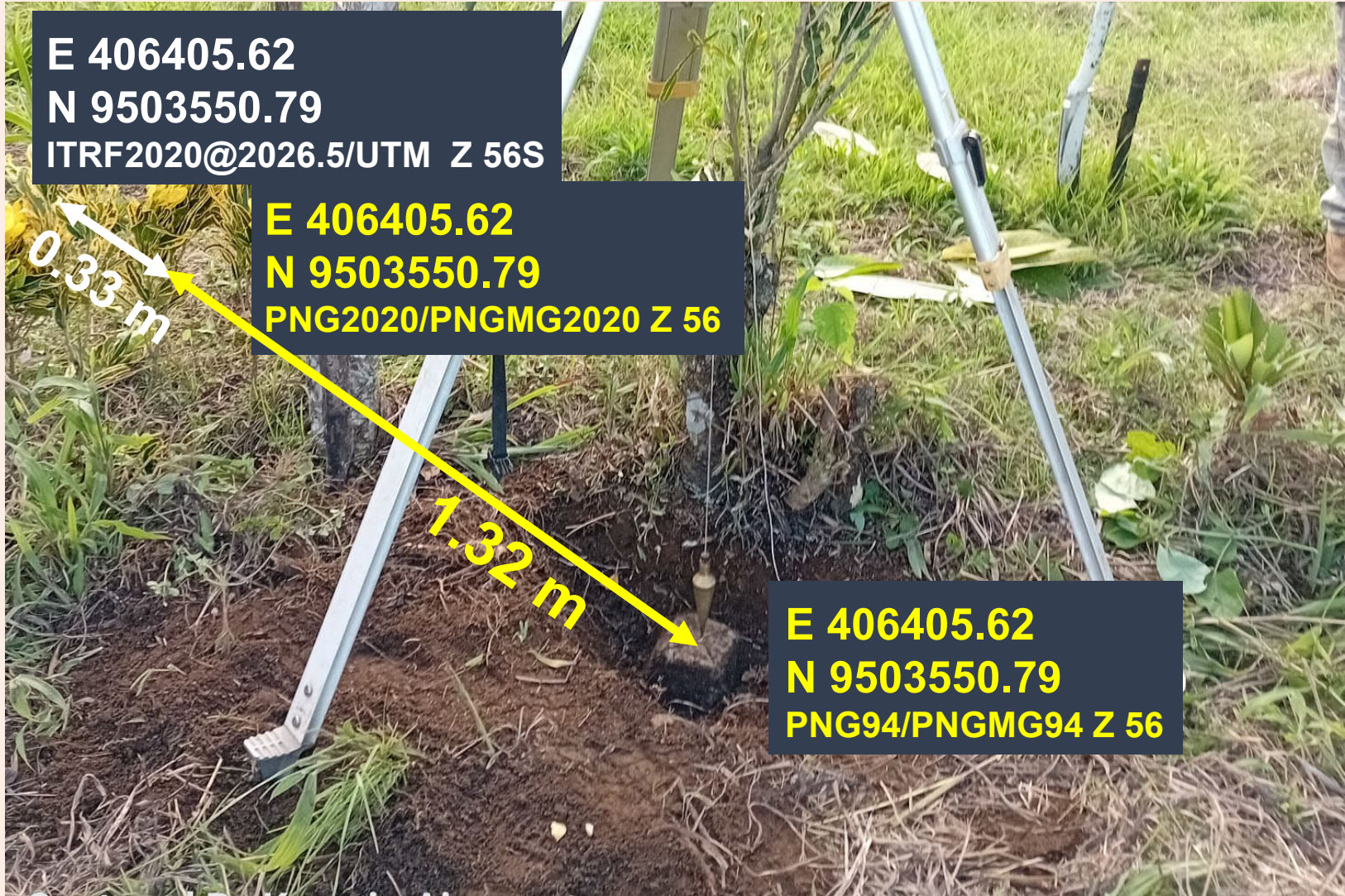


Photo: Kuamin Aiso

Cadastral mapping systems PNG

Fourmil Milinch Hamil

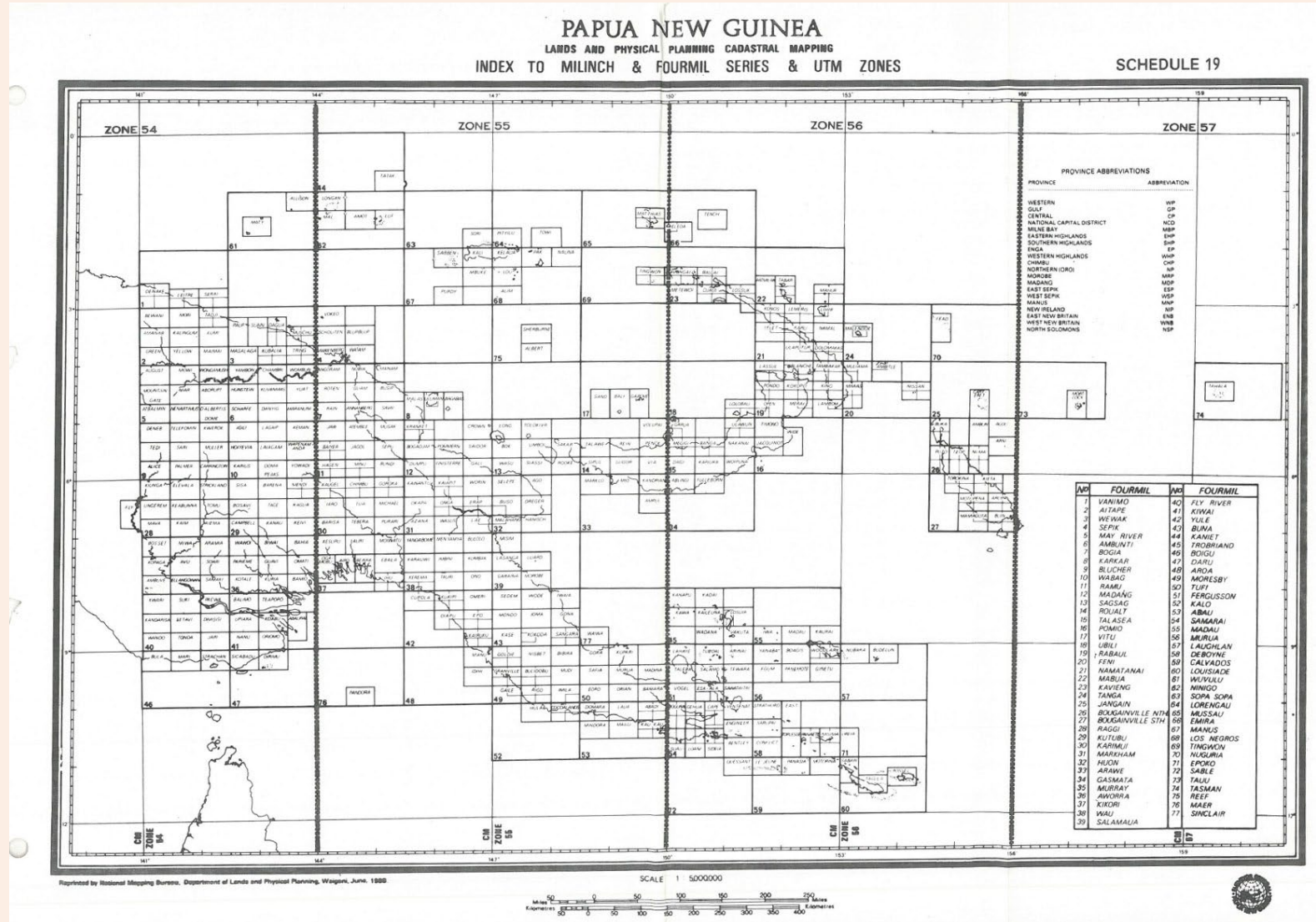
Cadastral Mapping System

Introduced during the colonial
period (1940s - 1950s)

Used for land administration

Graticule of land divisions over
PNG

Implicitly tied to a geodetic
datum at the time of creation



Fourmil (e.g. 3 – Wewak)
four miles to an inch or 1:253,440
(1:250,000 after metrication)
1°30' longitude & 1° latitude

Milinch (e.g. Kubalia)
one mile to an inch or 1:63,360
(1:50,000 after metrication)
30' longitude & 20' latitude
(sometimes divided into quadrants as shown)

Hamil (conceptual illustration)
half mile to an inch or 1:31,680
(1:25,000 after metrication)
7.5' longitude & 5' latitude





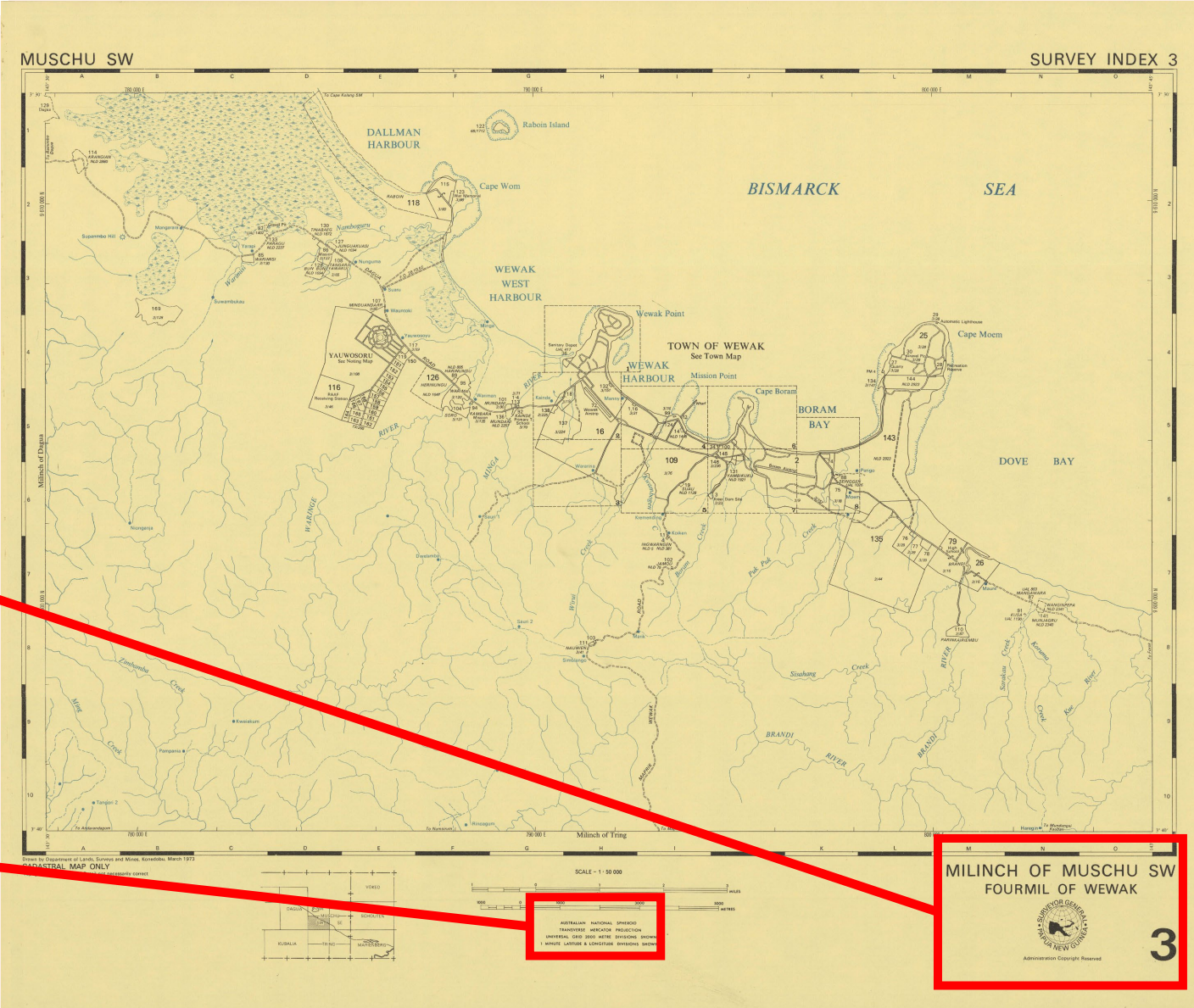
Example of a Milinch Cadastral Map (Muschu SW)

MILINCH OF MUSCHU SW
FOURMIL OF WEWAK



Administration Copyright Reserved

3



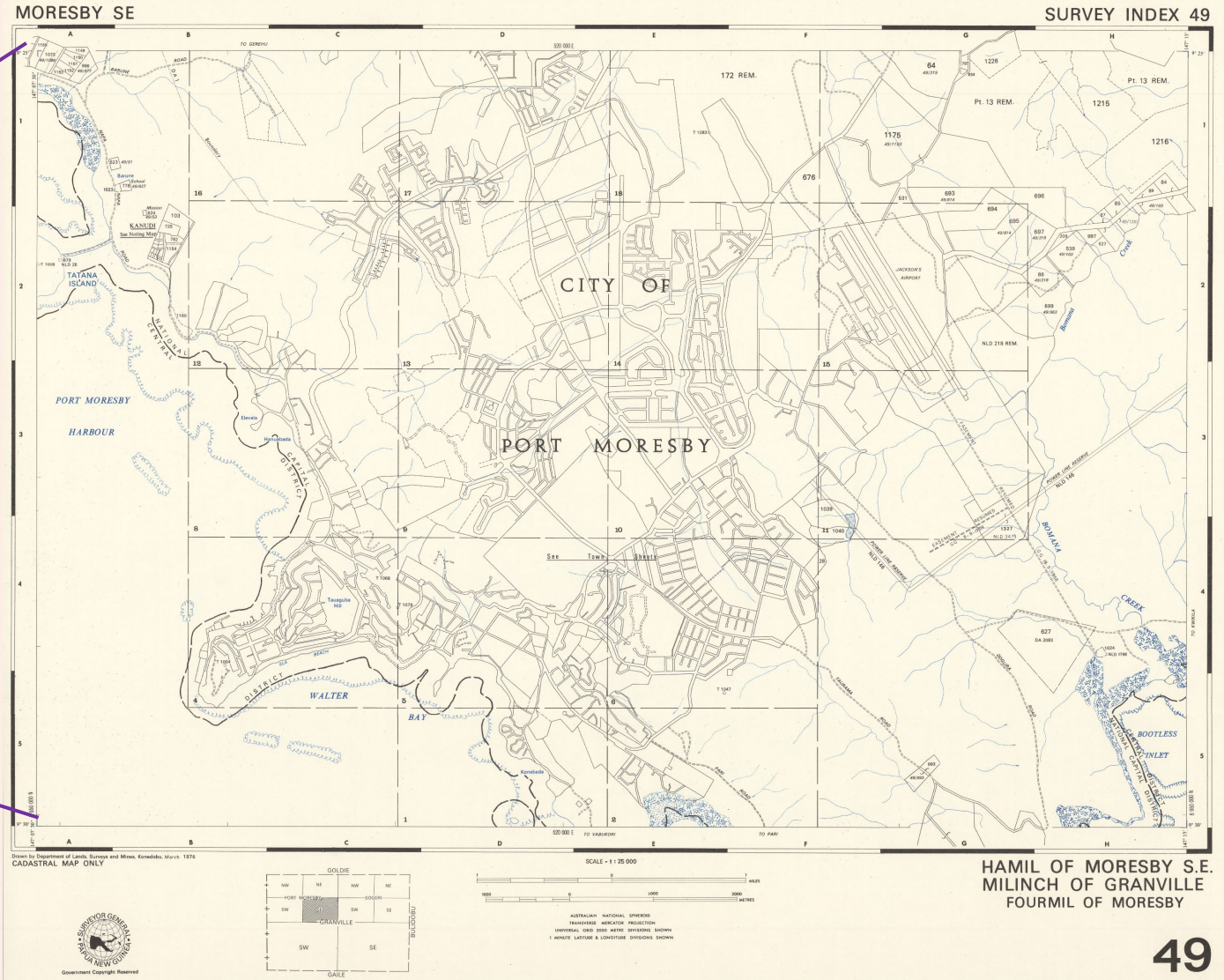
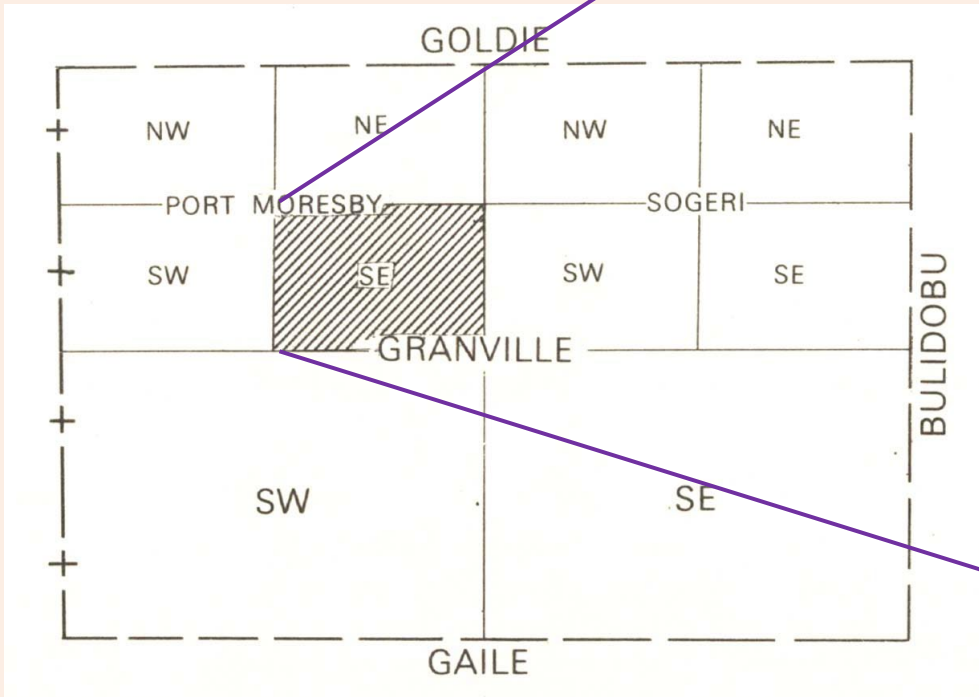
AUSTRALIAN NATIONAL SPHEROID
TRANSVERSE MERCATOR PROJECTION
UNIVERSAL GRID 2000 METRE DIVISIONS SHOWN
1 MINUTE LATITUDE & LONGITUDE DIVISIONS SHOWN

MILINCH OF MUSCHU SW
FOURMIL OF WEWAK

Administration Copyright Reserved

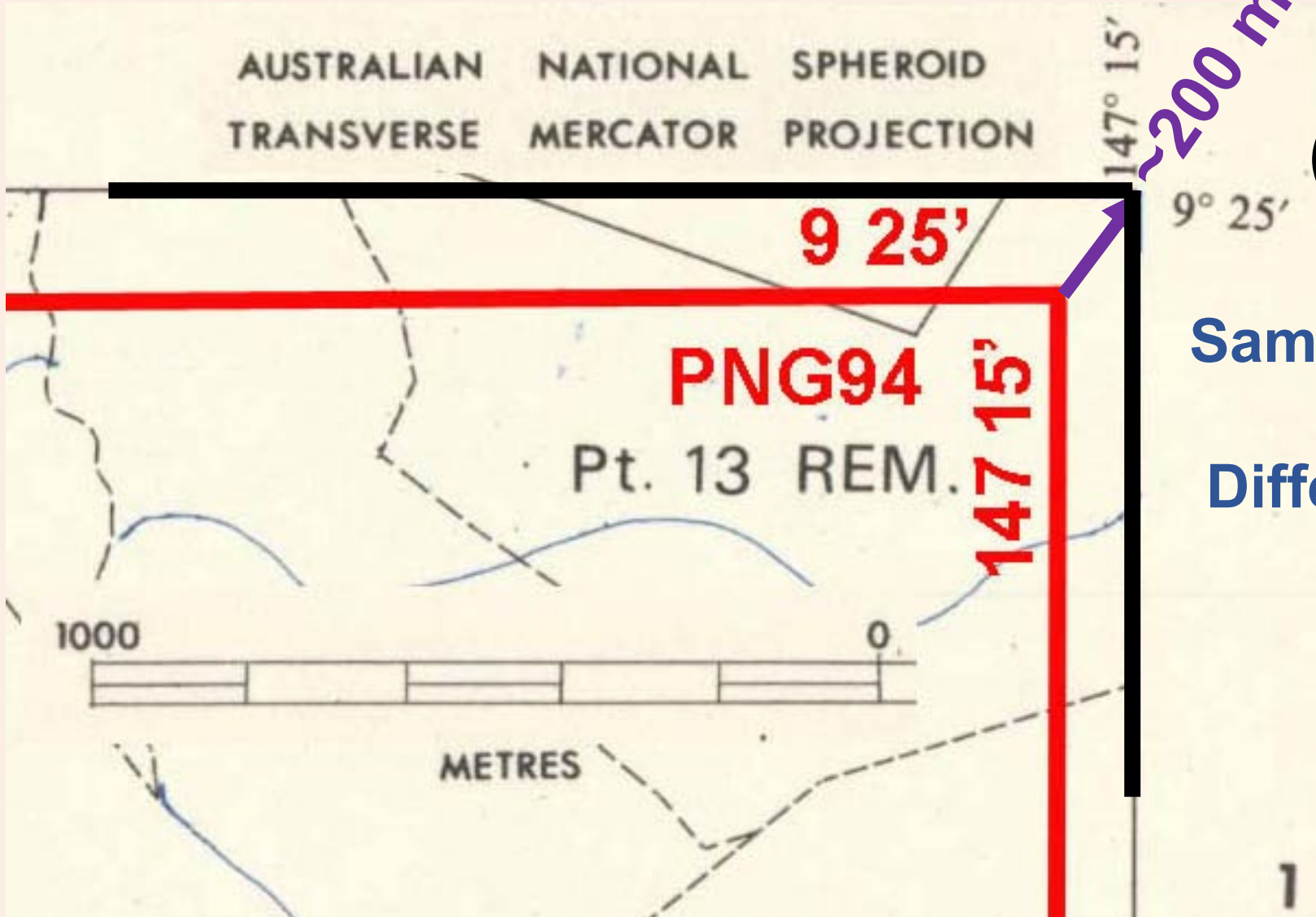
3

Example of a Hamil Cadastral Map (Moresby S.E.)





How do changes in geodetic datums affect Cadastral Mapping in PNG?

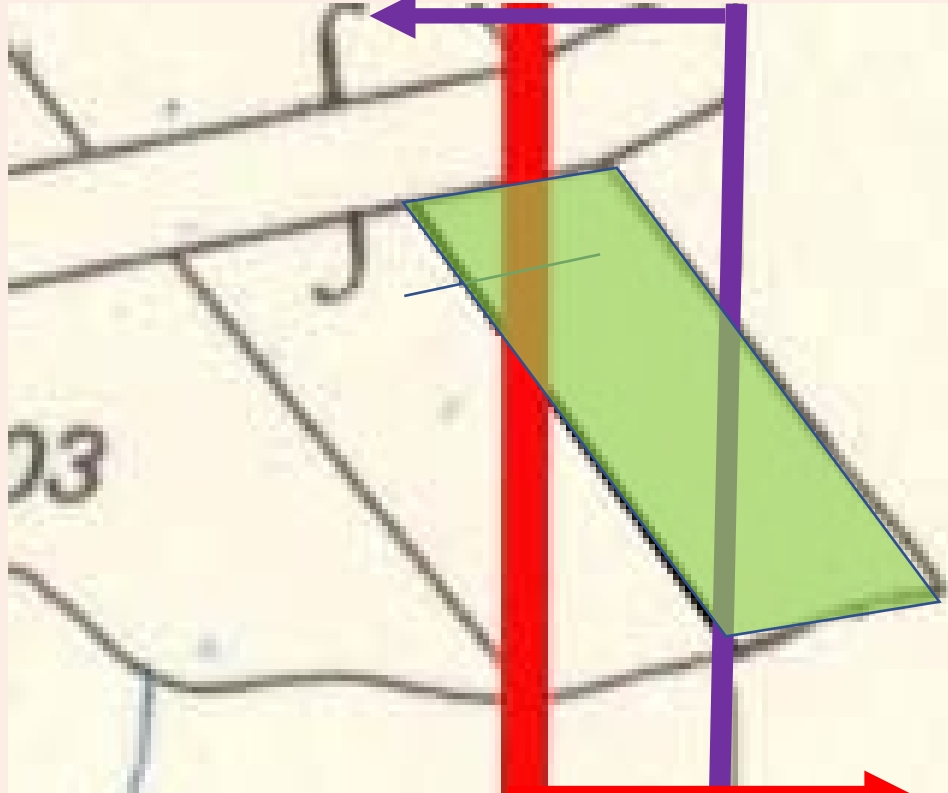


**AGD66
(original)**

**Same Coordinates
BUT
Different location
on the
GROUND**

~200 metres

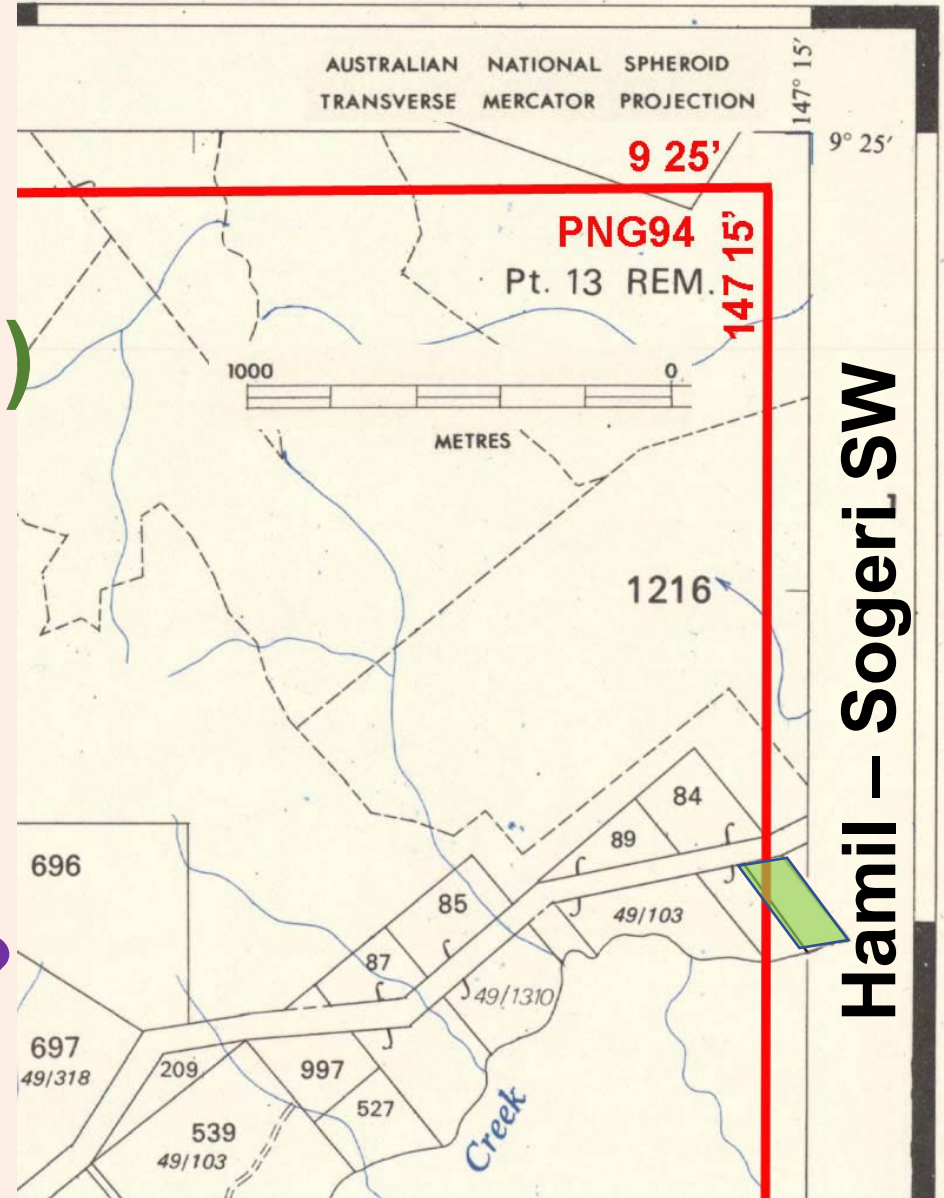
**AGD66
Hamil of Moresby SE**



**Subject
parcel
(in green)**

**Which
Hamil
with
datum
change?**

**PNG94
Hamil of Sogeri SW**



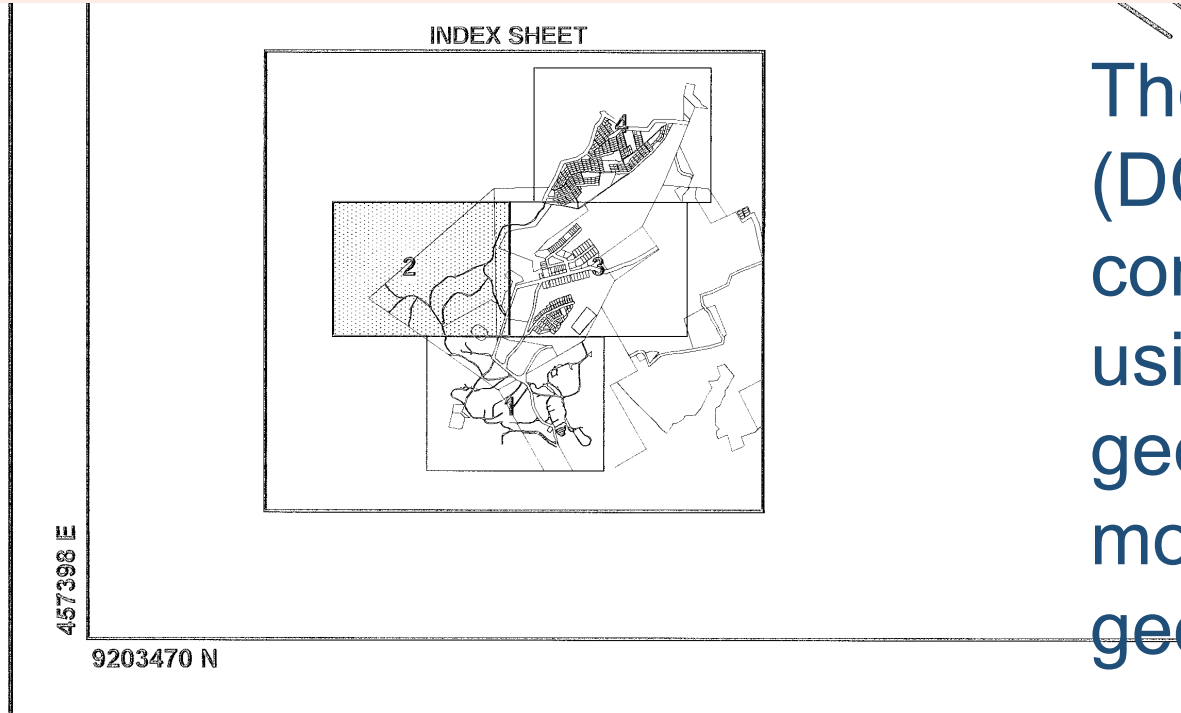
Following Cadastral principle “101” (land boundaries – and title - are fixed to the ground)

By extension, assignment of an allotment, portion, survey plan, lease, title etc. to a Fourmil/Milinch/Hamil is permanent, regardless of change of geodetic datum.

Therefore: AGD66 Fourmil/Milinch/Hamil corners need to be transformed to PNG94, PNG2020 or other future datum using a robust transformation (precision of better than 1 m – plotting scale).

This allows for precise integration of cadastral mapping, cadastral surveys, DCDB within GIS and SDI with the newer geodetic datums.

Town Cadastral Noting Sheets



Produced from the DCDB by the National Mapping Bureau Waigani, February 2002.

Co-ordinates shown on this plan are UTM PNG94 Zone 55

Sheet 2 of 4



The PNG Digital Cadastral Database (DCDB) defined in PNG94 was largely completed between 1997 and 2003 using static GPS observations on urban geodetic control (PSM) and cadastral monuments (commenced by the geodetic section as part of the ACLMP).

Most Town Cadastral Noting Sheets are in PNG94.

Transformation to PNG2020 is possible



Pauline Kaluwin – PNGUoT Final Year GIS student Final Year Project:

Transform Fourmil corners (and boundaries) from AGD66 (Fourmil datum for PNG mainland, New Britain, New Ireland) and WGS72 (Fourmil datum for offshore islands) to PNG94 and also PNG2020 if the new datum is gazetted this year and a transformation model completed.

The transformation will be validated using GNSS observations to realise PNG94 and PNG2020 on existing AGD66 and WGS72 coordinated geodetic monuments in each Fourmil or region.



Implications of geodetic datum changes on PNG Exploration and Mining Tenement Boundaries

The geographical description and demarcation of mining tenement boundaries (notably Exploration Licence (EL) boundaries) in Papua New Guinea is governed by the PNG *Mining Act* 1992 (as amended) and the PNG *Mining Regulation* 1992 (as amended).

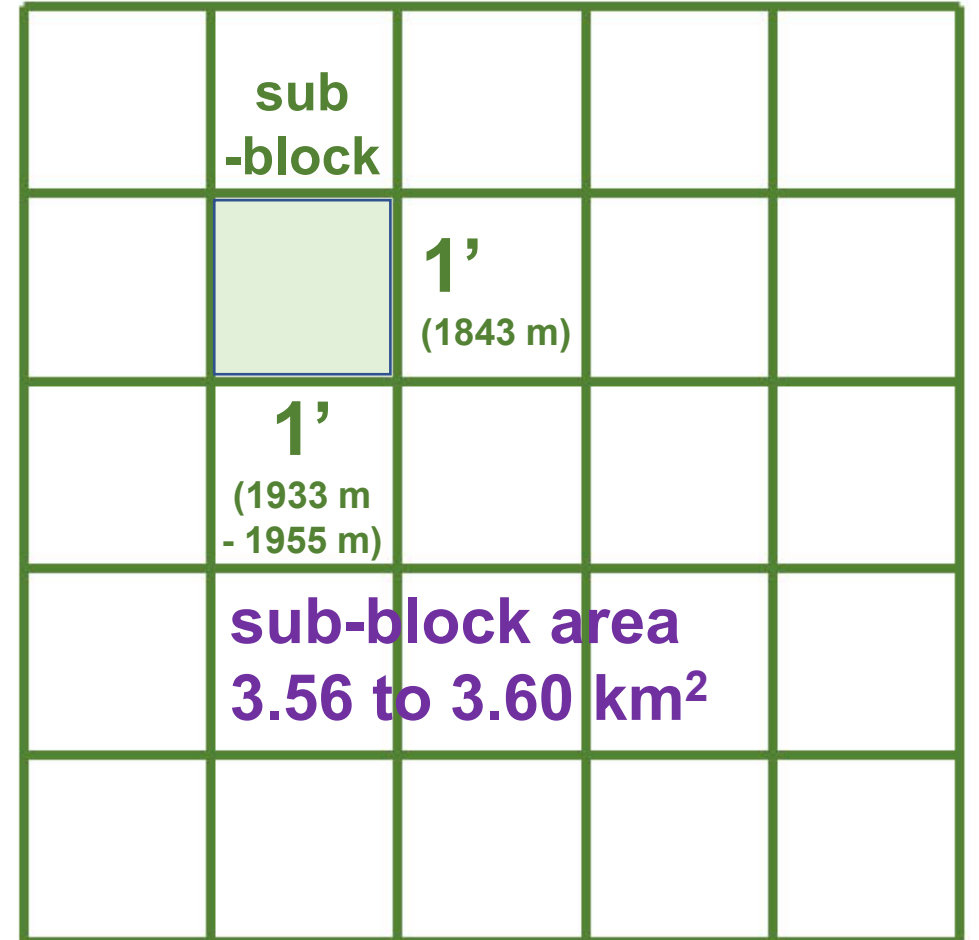
Exploration Licence (EL) boundaries in PNG

Exploration Licence (EL) boundaries are described by geographical coordinates (latitude and longitude).

Graticular blocks of 5 minutes of latitude and longitude each divided into 25 one-minute **sub-blocks** are used for the legal cadastral description of EL boundaries.

EL boundaries are not usually surveyed or marked on the ground (Unlike ML or SML for mining leases).

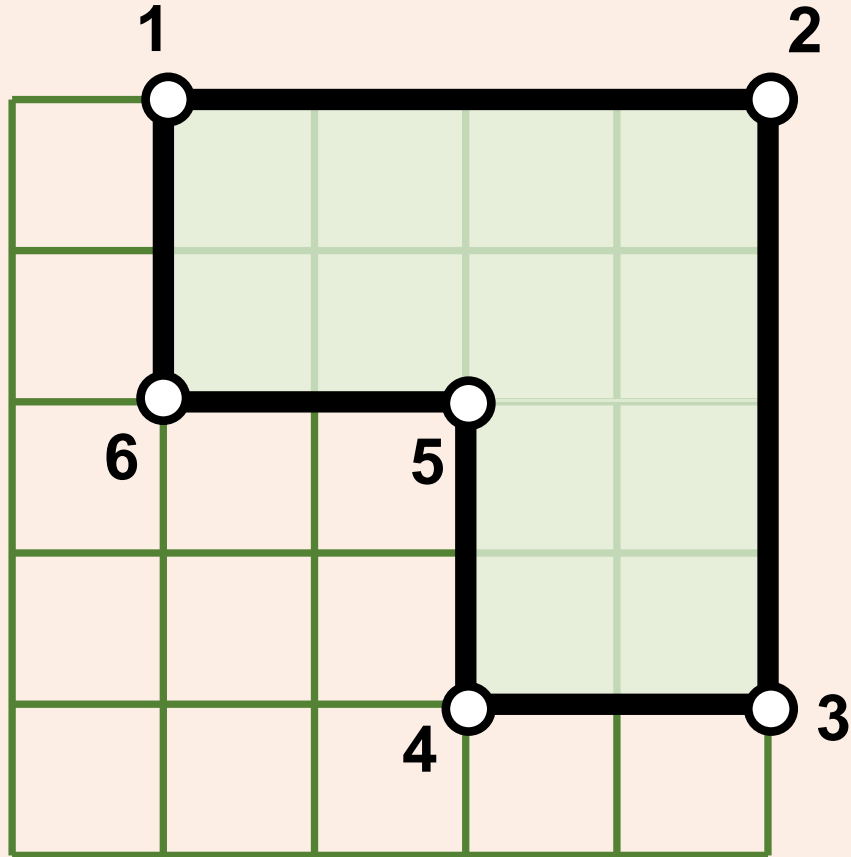
Coordinates take precedence over any sketch plans, marked up imagery, maps or GIS visualisation.



Example of an EL (fictitious)

registered
1991

datum
AGD66
(national datum at
the time)



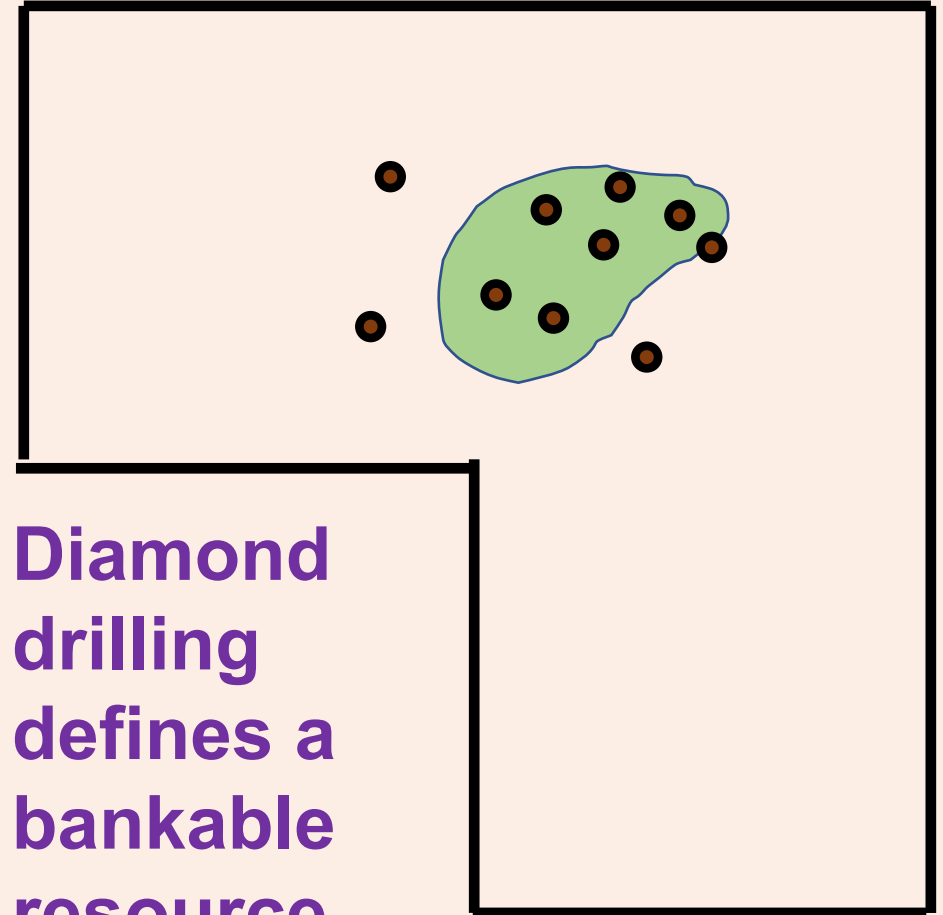
EL 99999

| | | |
|---|----------|------------|
| 1 | S 7° 15' | E 142° 06' |
| 2 | S 7° 15' | E 142° 10' |
| 3 | S 7° 19' | E 142° 10' |
| 4 | S 7° 19' | E 142° 08' |
| 5 | S 7° 17' | E 142° 08' |
| 6 | S 7° 17' | E 142° 06' |
| 1 | S 7° 15' | E 142° 06' |

12 sub-blocks

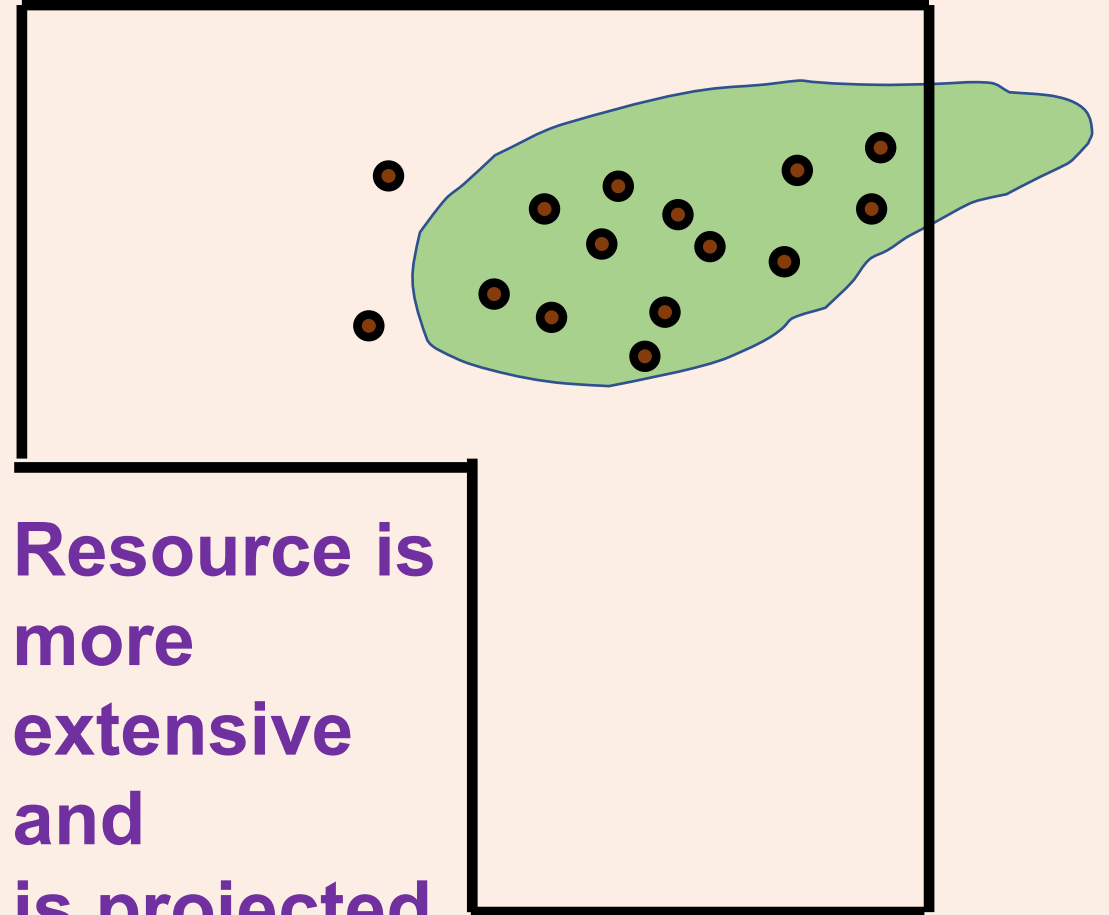
Area 43 sq. km

Exploration Commences - 1992



**Diamond
drilling
defines a
bankable
resource
worthy
of extraction**

Exploration Continues 1993



**Resource is
more
extensive
and
is projected
to extend
outside EL**

PSM 93516

(coordinated in AGD66)

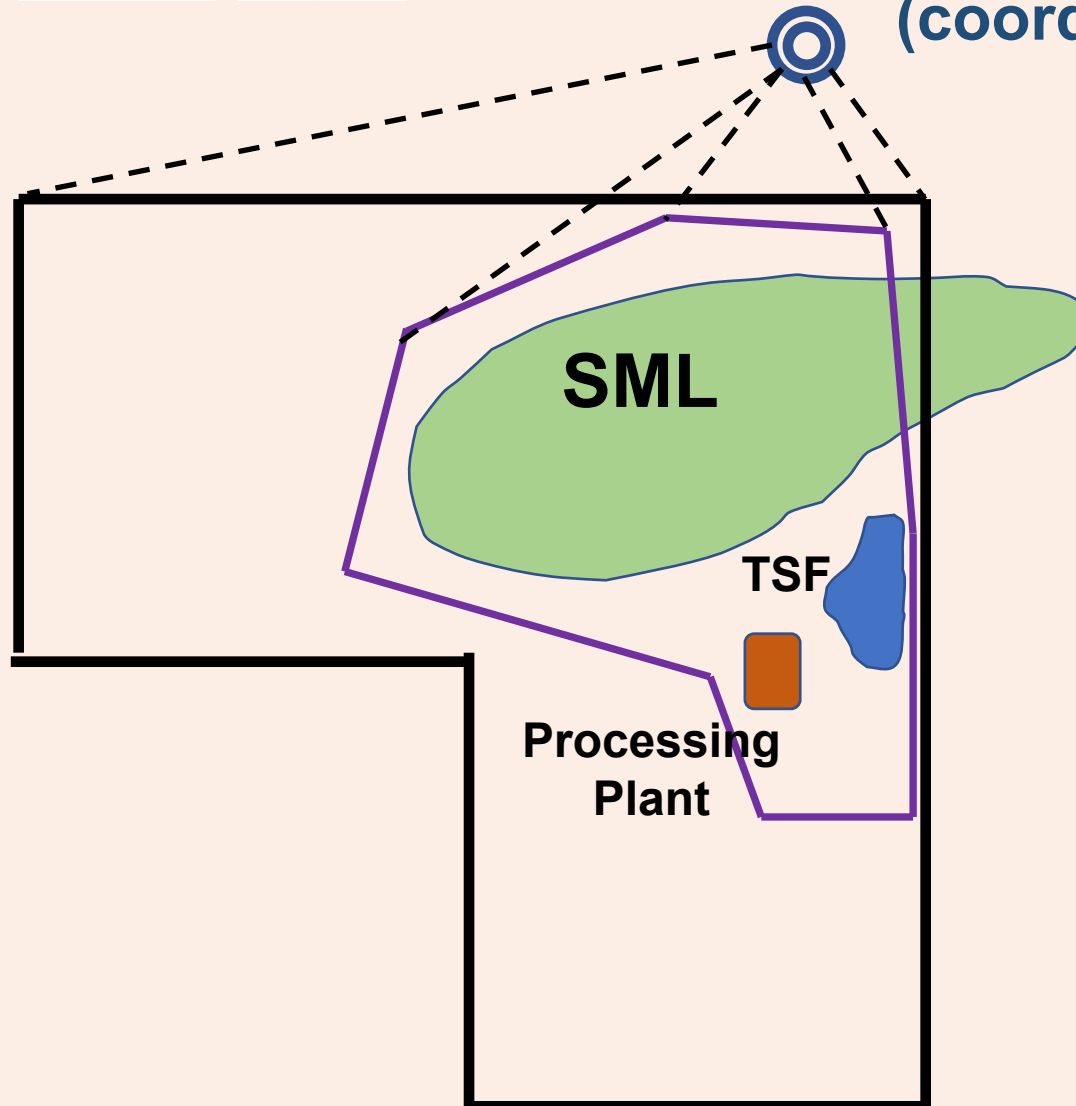
SML surveyed

(connected to
AGD66 geodetic
control and plan
is signed by a
registered surveyor)

1994

Mine
is developed
1995-1997

Mine starts
operation 1998



Meanwhile:
A new PNG
geodetic datum,
PNG94 is
gazetted in
1996

Existing
surveys and EL
boundaries
remain on
AGD66

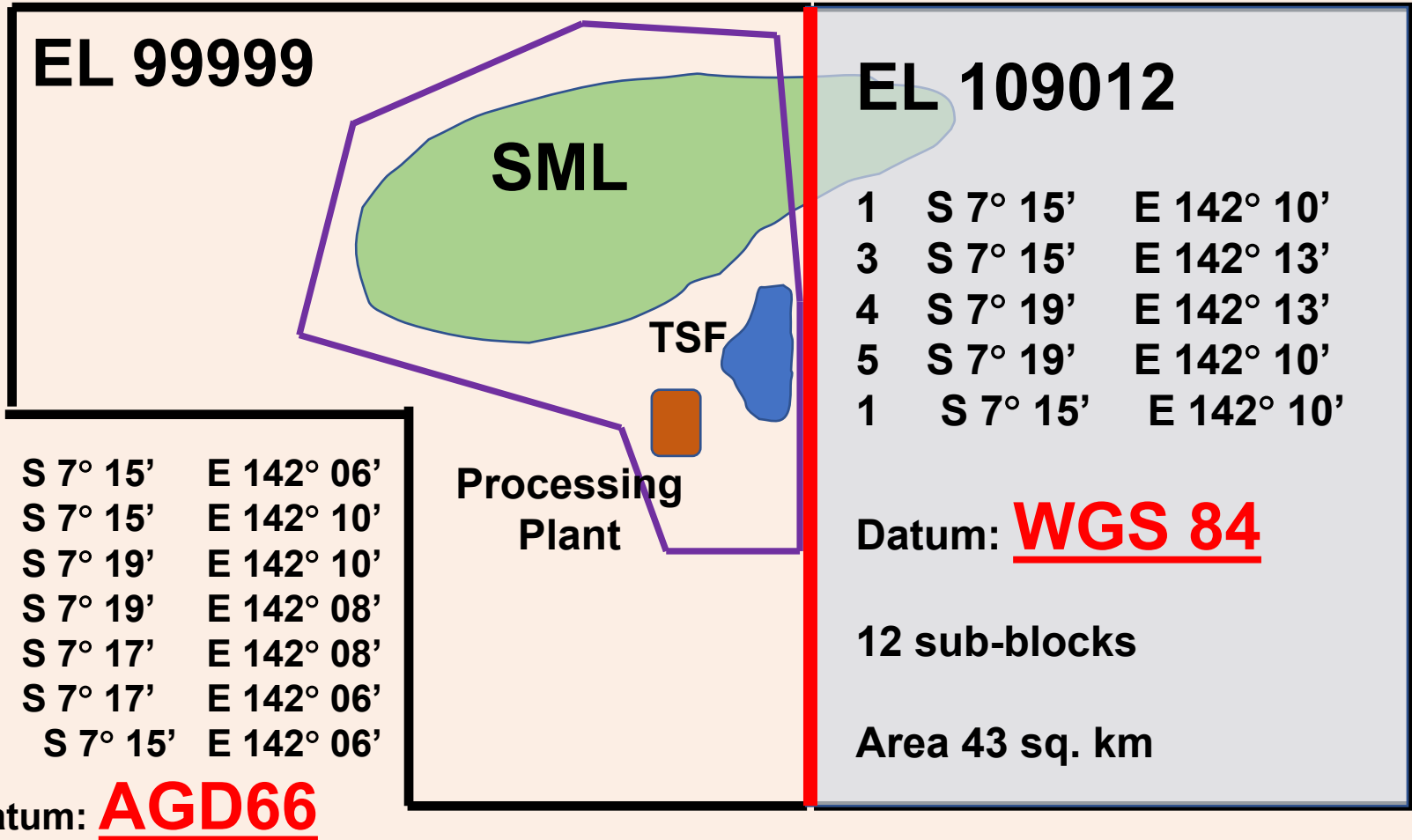
**From 2002 – EL boundaries
can be registered in WGS 84
graticular sub-blocks
(and later in PNG94)**

**WGS 84 is however not a legal geodetic
datum in PNG for cadastral coordination
(it is also a global dynamic datum)**

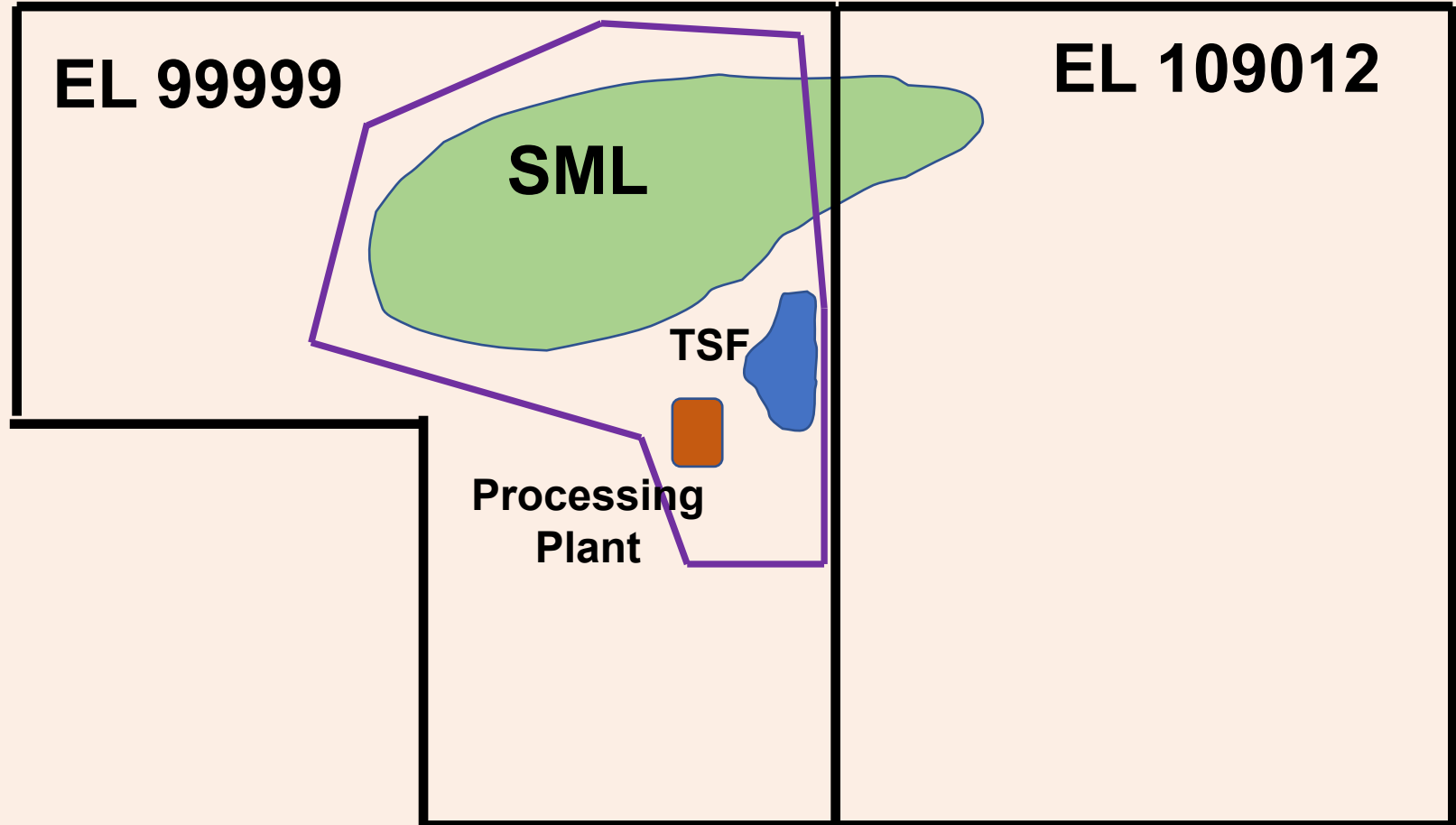
In 2008

A different operator registers EL 109012 abutting the existing EL

But is there a problem with the common EL boundary?



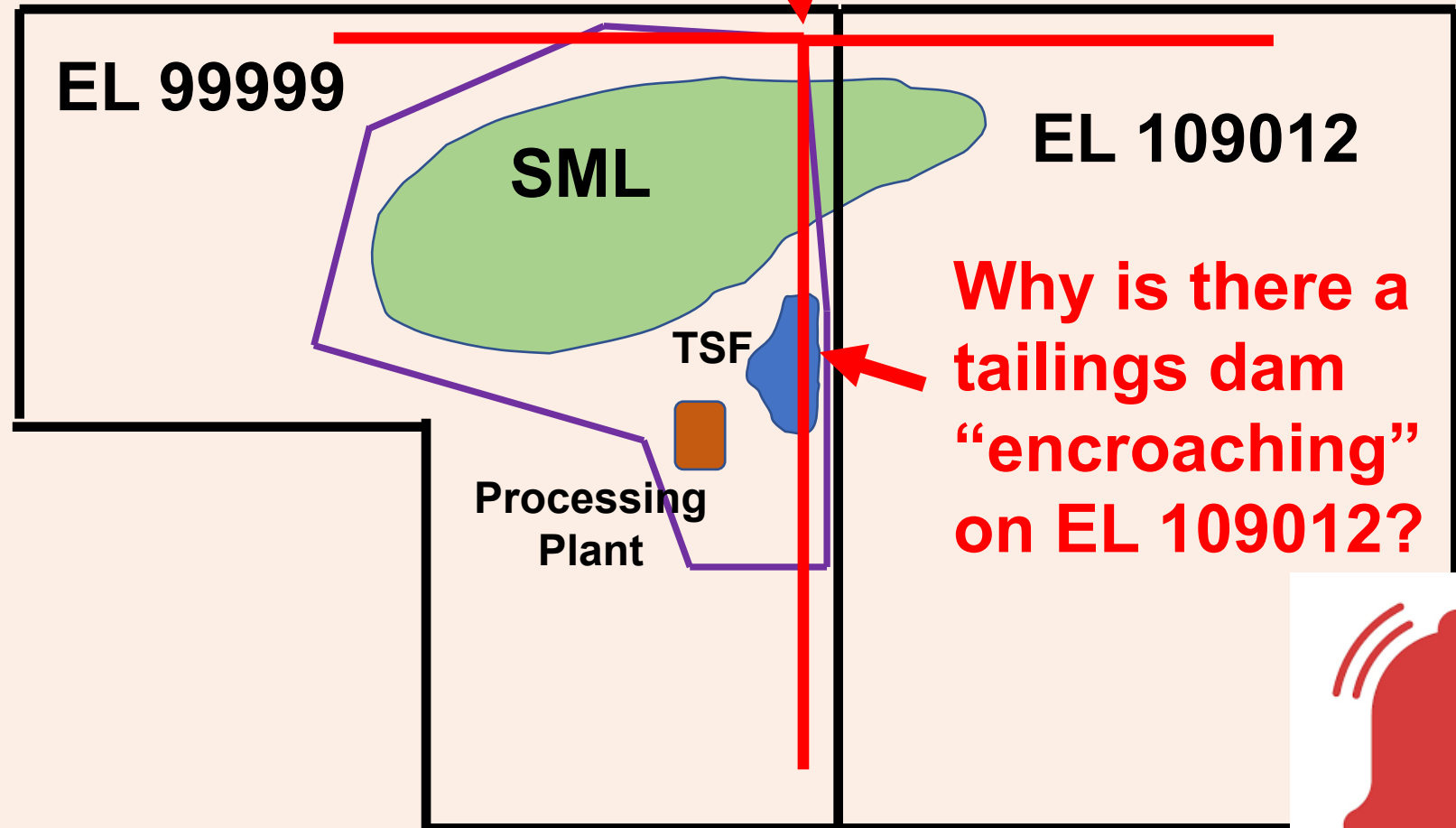
EL 109012
operator
engages a
surveyor
to locate the
boundary
with EL 99999
and to
check the
existing SML
boundary



**Check surveyed
WGS 84 boundary**

**EL 99999 and the
SML appear
to “encroach”
on EL 109012
by almost 120
metres!**

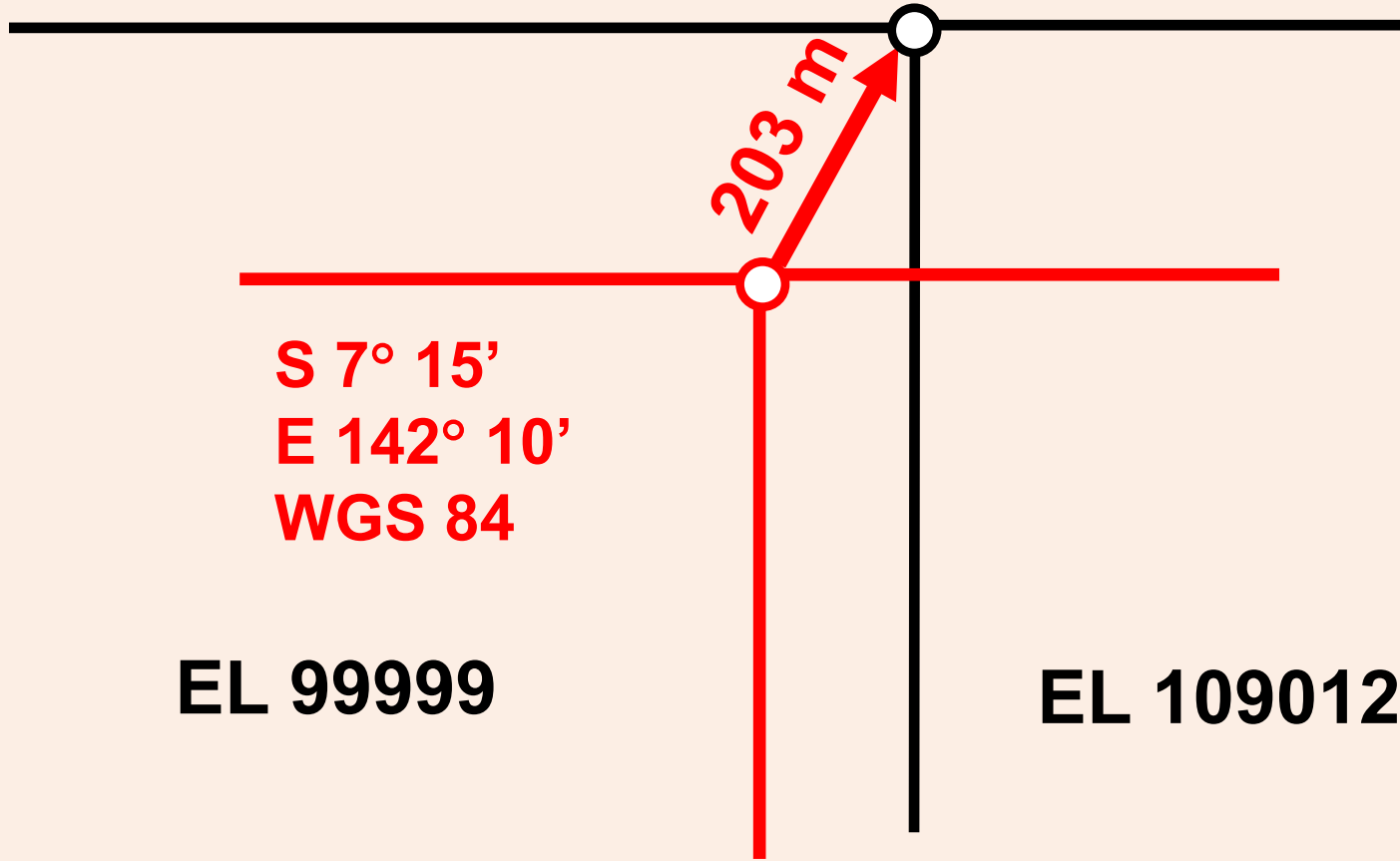
**Geologists with
handheld GPS
(+/- 10 metres)
even notice!**



**Why is there a
tailings dam
“encroaching”
on EL 109012?**



S 7° 15'
E 142° 10'
AGD66



S 7° 15'
E 142° 10'
WGS 84

EL 99999

EL 109012

Same coordinates
but different location
on the ground!

Which coordinates
take priority?

The original AGD66
or the later WGS84?

Cadastral principle
applies. The later
abutting EL **must not
encroach** on existing
EL.

**Cadastral principles, common
law and even common sense**

VS

**Geodetic assumptions,
cartographic and administrative
convenience worded into the**
Mining Act



In most cases changing the EL boundary from AGD66 to WGS84 or PNG94 (thus shifting the boundary on the ground by 200 metres) has had no impact on licensing and exploration operations where the resource is located well within the EL.

There are however, very notable exceptions – hence the need to resolve these following legal and cadastral principles and precedent.

Limitations of the *Mining Act* 1992

1. **Geodetic Datum is not specified (only that the Greenwich Meridian is the longitude origin).** In 1992, the datum in use in PNG was the Australian Geodetic Datum 1966 (AGD66), so by default all EL tenements up until the national datum change will be AGD66 unless explicitly specified in the EL definition for registration.
2. **Section 153**, specifies that **sub-blocks must be one minute of longitude and latitude in dimension** (fitting within 5 minute graticular blocks) originating from the Greenwich Meridian and the Equator (so whole 5 minutes, not minutes, seconds and decimals of a second).

S 153 is for cartographic and administrative convenience only.

Summary of the issues

1. Existing EL defined in AGD66 should be transformed using robust and authorised transformation parameters to PNG94 (and PNG2020).
2. The original location “on the ground” cannot change, particularly if ML and SML have been created within the EL and development has taken place close to the EL boundary.
3. Newer abutting EL need to:
 - a. still be defined in AGD66 to maintain the neat 1’ lat/long requirement in S153 (but issue of infilling blocks later)
 - b. have smaller (or larger) sub-blocks that abut existing AGD66 EL (but administrative issue of sub-block area difference)
 - c. be completely defined by sub-blocks in degrees, minutes, seconds and decimals of a second in PNG94/PNG2020 (contradicts S.153)

Urgent amendments are required to Section 153 of the *Mining Act 1992*

1. specify: The gazetted geodetic datum at the time
2. specify: sub-blocks must be one minute of longitude and latitude by means of transformation from the Australian Geodetic Datum 1966 using transformation parameters authorised by the PNG Surveyor-General.
3. specify: Sub-blocks may be less than one minute in dimension in special cases where abutting sub-blocks are defined in a different geodetic datum, or as a result of geodetic transformation.

Thank you!