

The background of the slide features a stylized map with concentric contour lines, some solid and some dashed, representing a topographical surface. A large red rectangular box is centered on the slide, containing the title and author information.

LiDAR in Sport

using airborne LiDAR to
create maps for orienteering

Tyson Hillyard



I am an Orienteer

- Tyson Hillyard
- Orienteering since 1990
 - Past President of Tjuringa Orienteers
 - Past Manager of the Southern Arrows – South Australia's Elite Orienteering Squad
 - President of Wallaringa Orienteers
- Surveyor since 2000
- Father since 2014
- SSSI Remote Sensing and Photogrammetry Rep for South Australia since 2016
- Now Survey Manager at Aerometrex

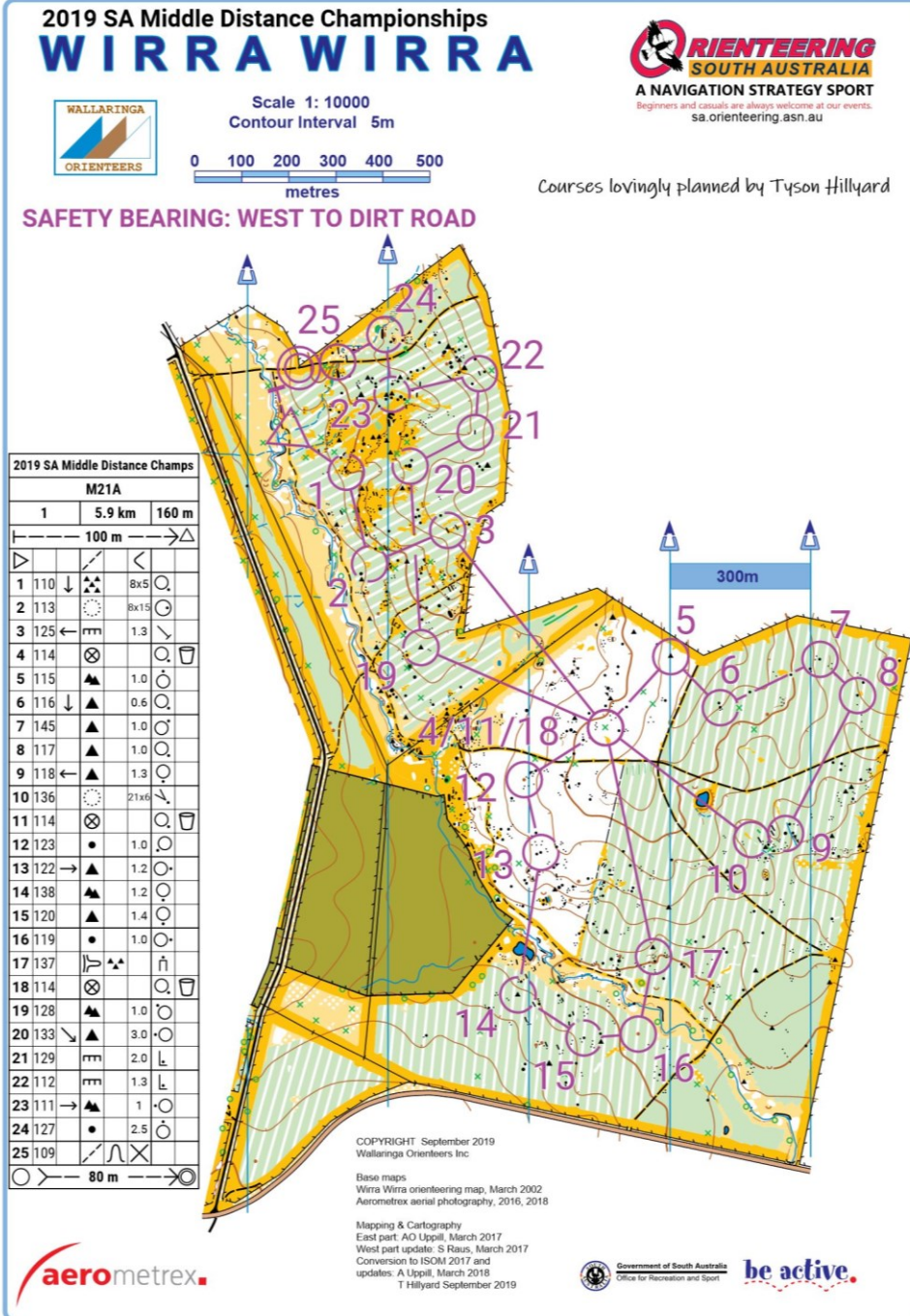
What is Orienteering?

- It's a SPATIAL Sport



What is Orienteering?

- It's a SPATIAL Sport
- Competitors use a detailed topographic map to navigate through a series of checkpoints. The winner is the person who completes the course in the fastest time.



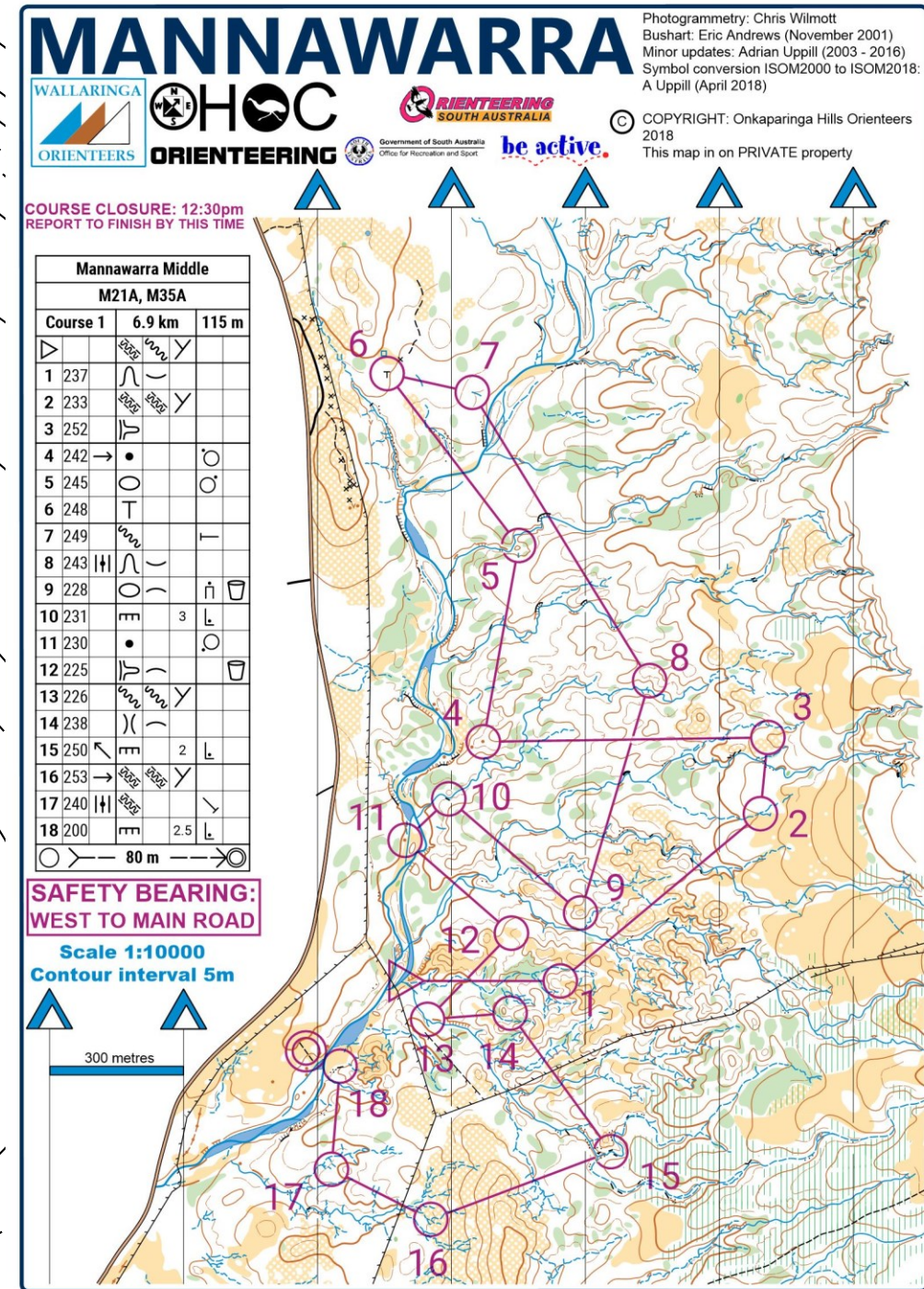
What is Orienteering?

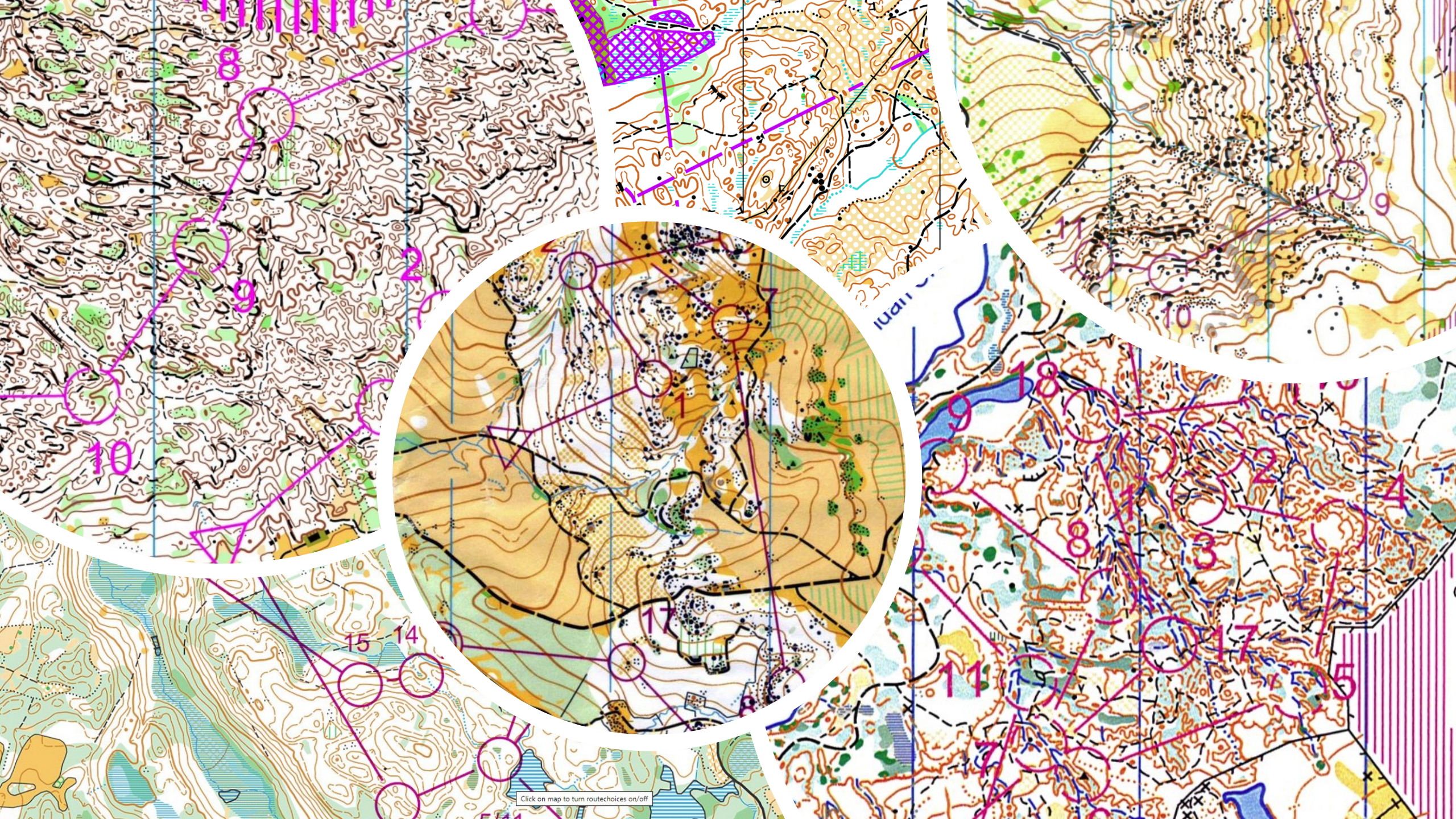
- It's a SPATIAL Sport
- Competitors use a detailed topographic map to navigate a course. The winner is the person who completes the course in the fastest time.
- Caters for athletes from 5 to 100 years old

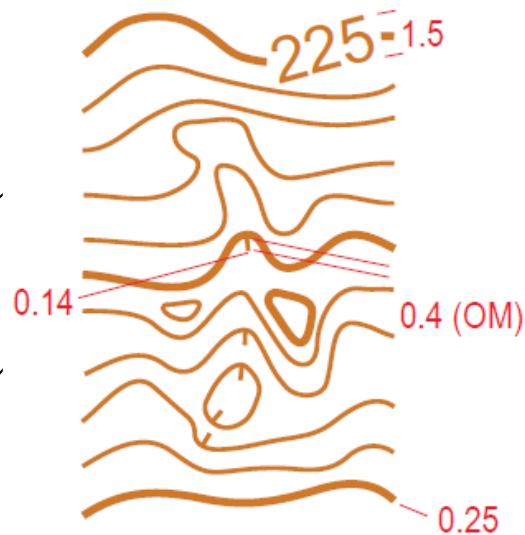


What is Orienteering?

- It's a SPATIAL Sport
- Competitors use a detailed topographic map to navigate a course. The winner is the person who completes the course in the fastest time.
- Caters for athletes from 5 to 100 years old
- Courses are set with varying length, physical and navigation difficulty





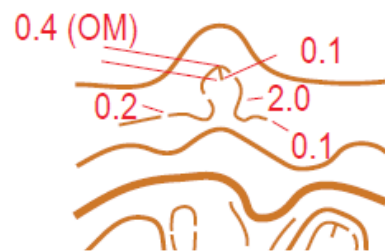


102 Index contour

Every fifth contour line is an index contour. An index contour is a contour line with much detail represented using a single line. The index contour level for the index contour is indicated by a label. An index contour may only be inserted if it is not obscured. It shall be drawn in a sans-serif font. Colour: brown.

103 Form line

Form lines are used to show the shape of the ground. Form lines are complete with ordinates. Only one form line



ISOM 2017

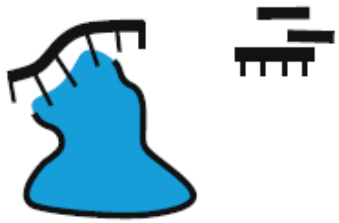
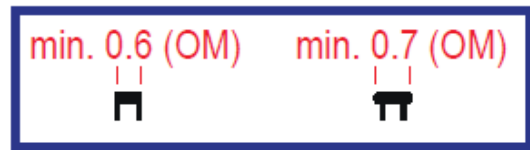
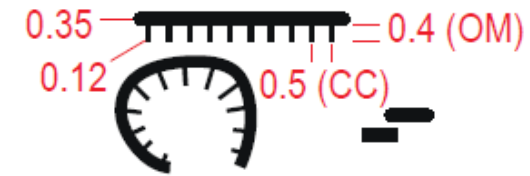
- International Specification for Orienteering Maps

ISOM 2017

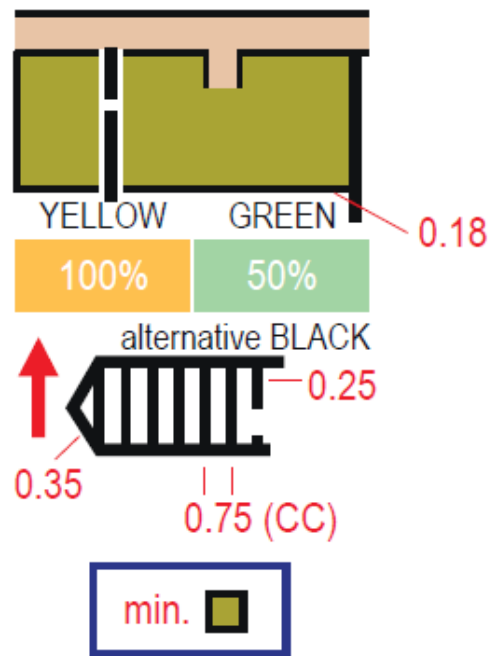
- International Specification for Orienteering Maps
- Other standards for Sprint Orienteering Maps, Mountain Bike Orienteering Maps and Ski Orienteering Maps

201 Impassable

A cliff, quarry or other feature that cannot be passed/climbed or is impassable for the purpose of the competition. For vertical rock faces, the top line may be drawn. The gap between the lines representing the impassable feature shall be clearly expressed. When an impassable feature passes under the contour line, it shall clearly express its position with the contour line. Minimum length: 10 cm. Colour: black.



- International Specification for Orienteering Maps
- Other standards for Sprint Orienteering Maps, Mountain Bike Orienteering Maps and Ski Orienteering Maps
- Defines details on
 - Features to be mapped
 - Colours to be used
 - Standards for Scale
 - Tolerances for size and spacing of symbols
 - Accuracy requirements



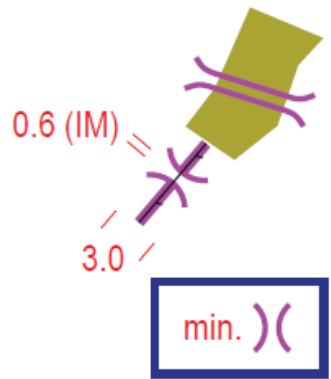
520 Area that

An out-of-bound
or another indu
ways and large
black stripes m
representation

The area shall
Out-of-bound a
line or another
Course plannin
The vertical bla
An out-of-bound
Minimum area:
Colour: yellow

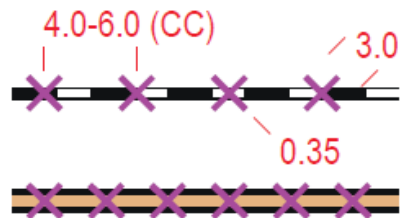
ISOM 2017

- Map does not need to be strictly spatially accurate
But it needs to be spatially interpretable by a
competitor at speed



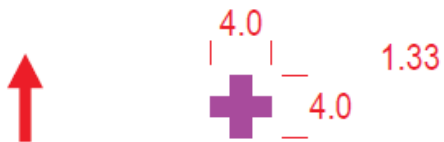
710 Crossing

A crossing point or railway, the boundary is defined to reflect the length. Colour: purple



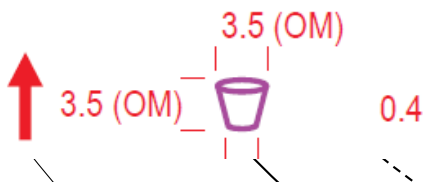
711 Out-of-bounds

A route which is a forbidden route. An out-of-bounds route. Minimum length. Colour: purple



712 First aid

The location of a first aid point. Colour: purple



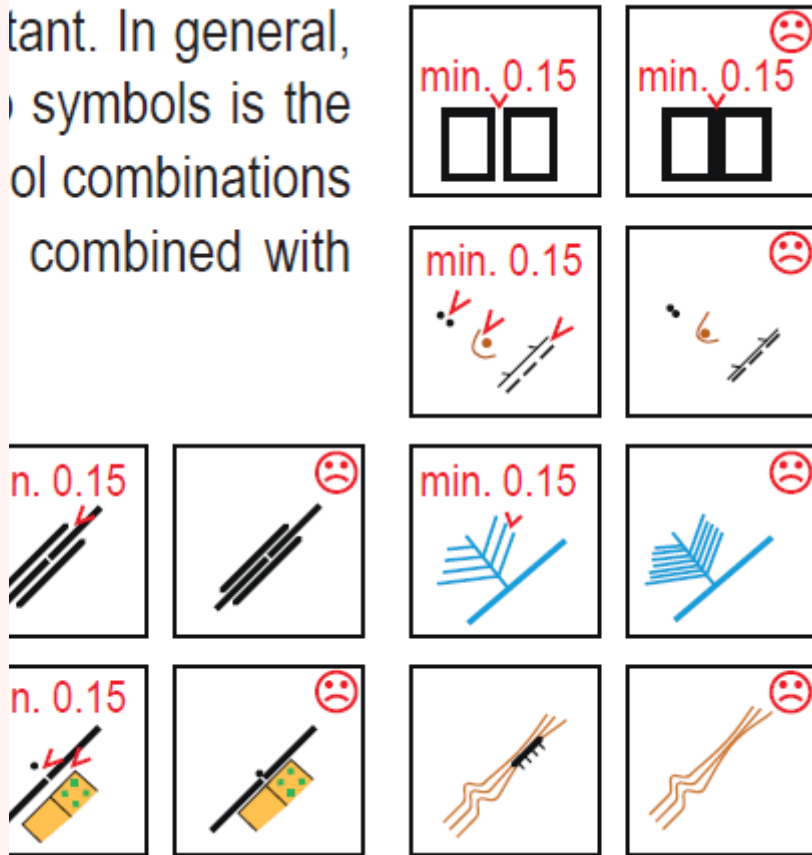
713 Refreshment

The location of a refreshment point. Colour: purple

ISOM 2017

- Map does not need to be strictly spatially accurate
But it needs to be spatially interpretable by a competitor at speed
- Advances being made in colour definition to make the sport fairer for those with colour vision deficiencies

stant. In general,
symbols is the
ol combinations
combined with

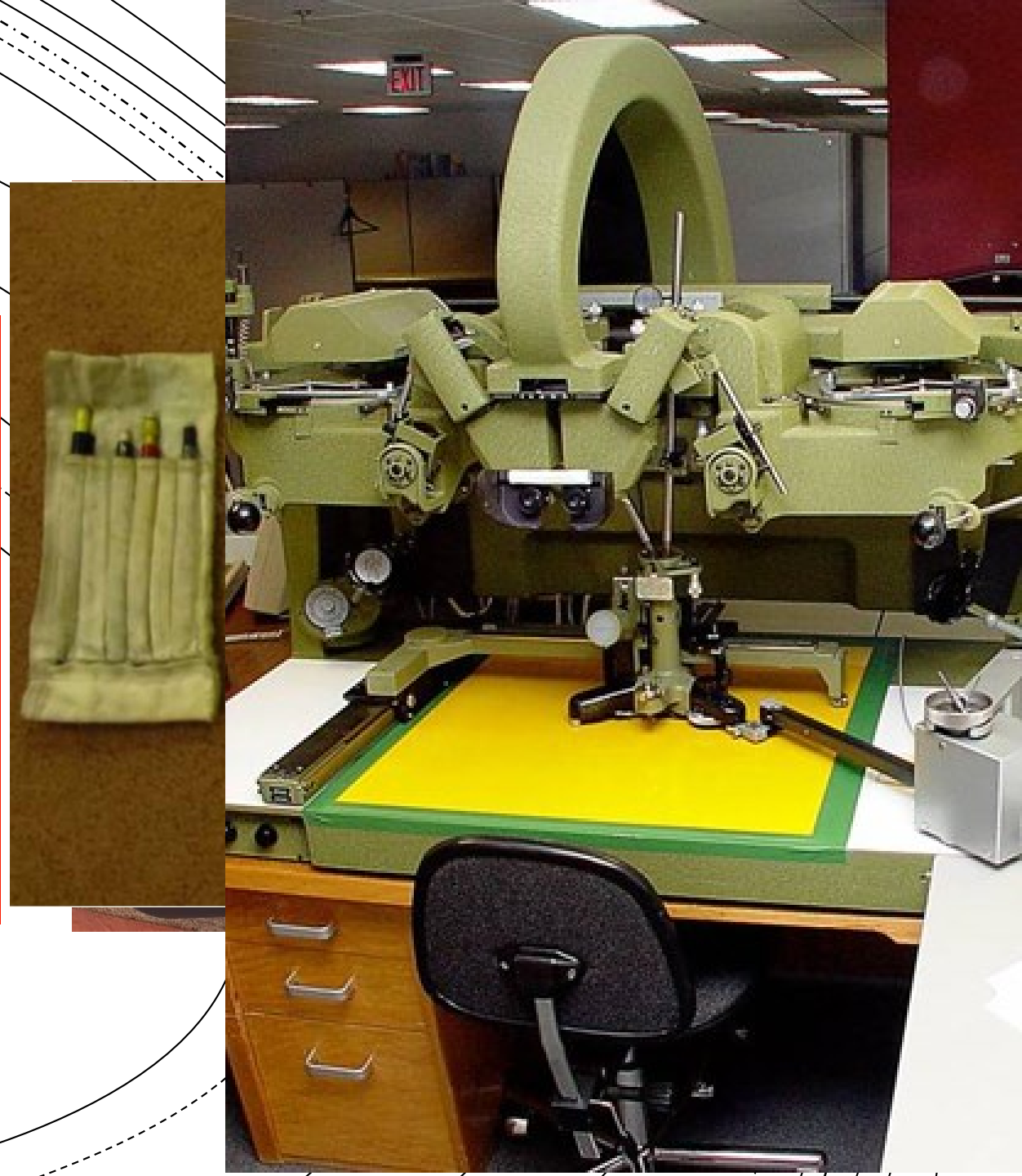


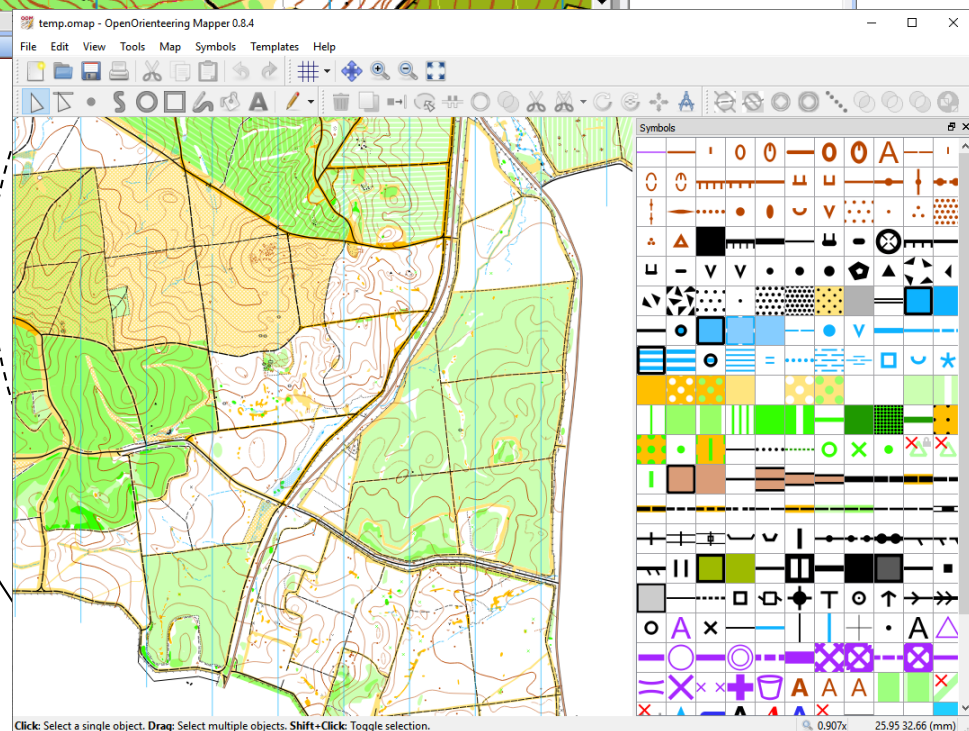
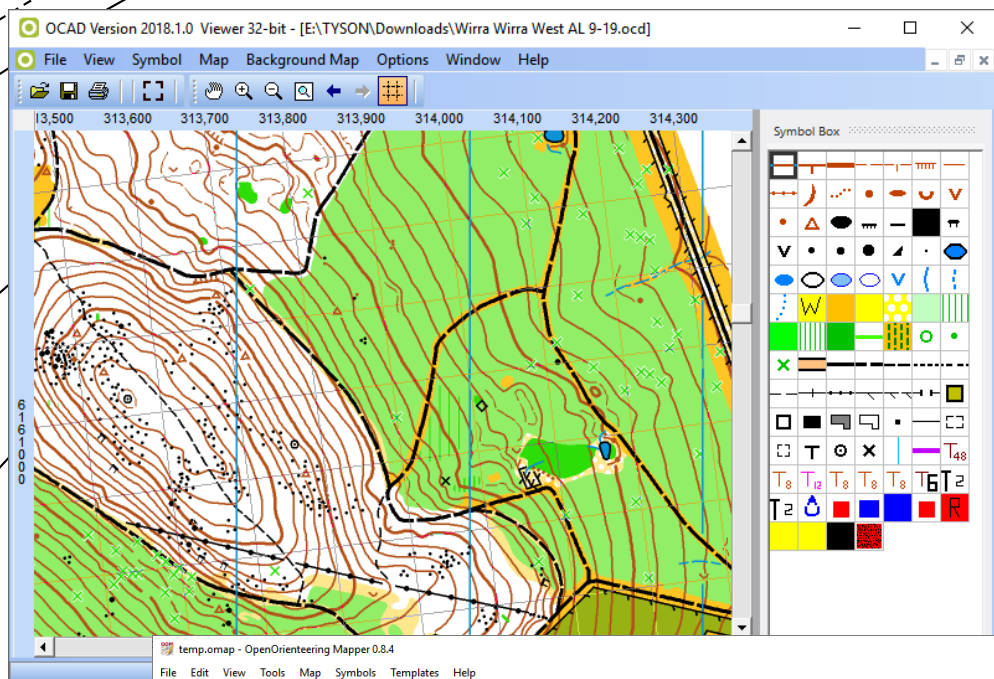
ISOM 2017

- Map does not need to be strictly spatially accurate
But it needs to be spatially interpretable by a competitor at speed
- Advances being made in colour definition to make the sport fairer for those with colour vision deficiencies
- Only mapping specification that is truly global
 - ~~Aviation Charts~~
 - ~~Meteorological Charts~~
 - ~~Nautical Charts~~
 - ~~Geological Charts~~

Mapping the old way

- Basemap usually from Photogrammetry to generate contours, generalized vegetation, linear features, point features. Limited by what can be seen from above
- 100's hours in the field locating, identifying, interpreting and mapping features with basic techniques
- Handheld GPS, single frequency, code only
- Many mappers still mapping on Cartographic Film
- Some lucky enough to have field tablet PCs



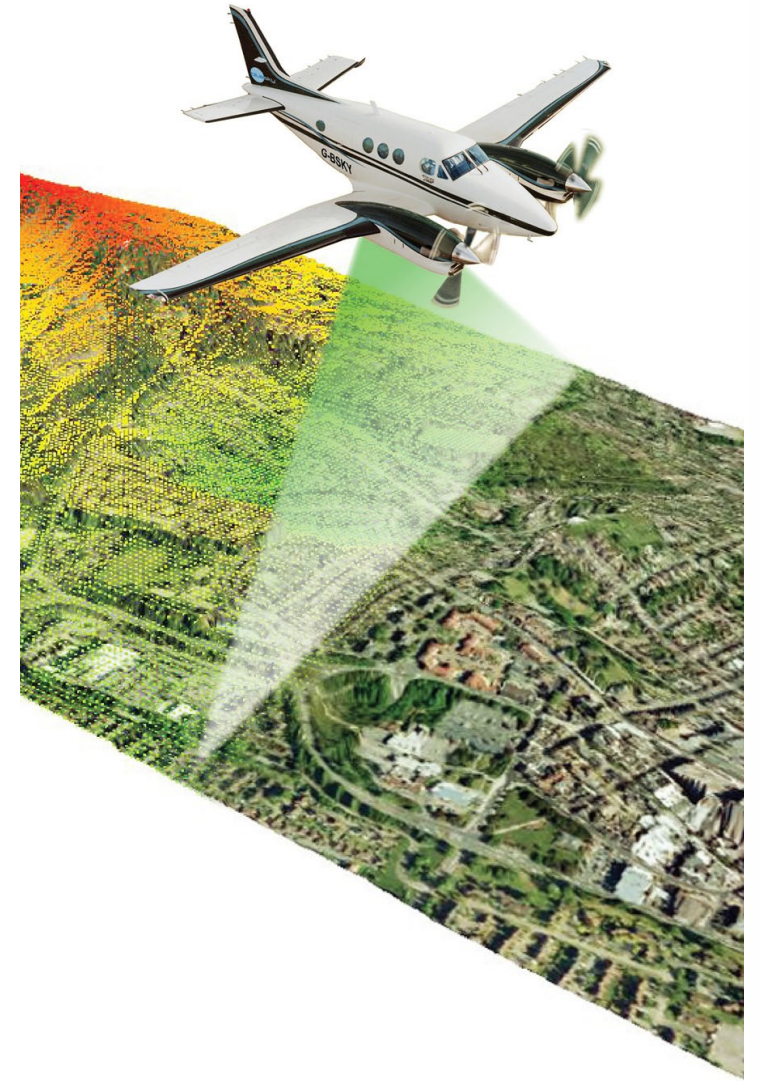


Orienteering Drafting

- Drafted in specialist software
- A lot like a usual CAD drafting package, but more focused on the symbology and feature drawing than precise CAD drafting.
- OCAD - Proprietary
- Open Orienteering Mapper - Open Source

LiDAR Revolution

- Growth in LiDAR use started around 2011
- Governments making datasets “Open”
- Access to greater computing power
- Generation of Contours is primary goal – with greater detail than photogrammetry
- Vegetation
- Cliffs and Boulders
- Other user interpretable features, eg tracks, fences



LiDAR data sources and tools

- Open data sets - ELVIS from ICSM
- Sourcing existing data from landowners / councils
- Contracting specific surveys \$\$\$\$
- Orienteering SA were lucky to get support from ARA in 2018
- QGIS
- Free parts of LAStools – las2txt, LASzip
- Kartapullautin
- OCAD



the smart software
for cartography

Kartapullautin

- Free for non-commercial use
- Generates / extracts:
 - Contours and Formlines
 - Vegetation density estimate
 - Cliffs
- pullauta.ini controls the parameters for terrain and vegetation extraction
- Very simple to use, but difficult to master

```
### Here we calculate points. We can use elevation zones and factors for green. Example
# low|high|roof|factor
# zone1=1|5|99|1 # points 1 to 5 meters will be calculates as one hit if tallest trees
# zone2=5|9|11.0|0.75 # in additon, poitns 5 to 9 meters will be calculated as 0.75 poi
# There can be as many zones as you like
```

```
# low|high|roof|factor
zone1=1.0|2.65|99|1
zone2=2.65|3.4|99|0.1
zone3=3.4|5.5|8|0.2
```

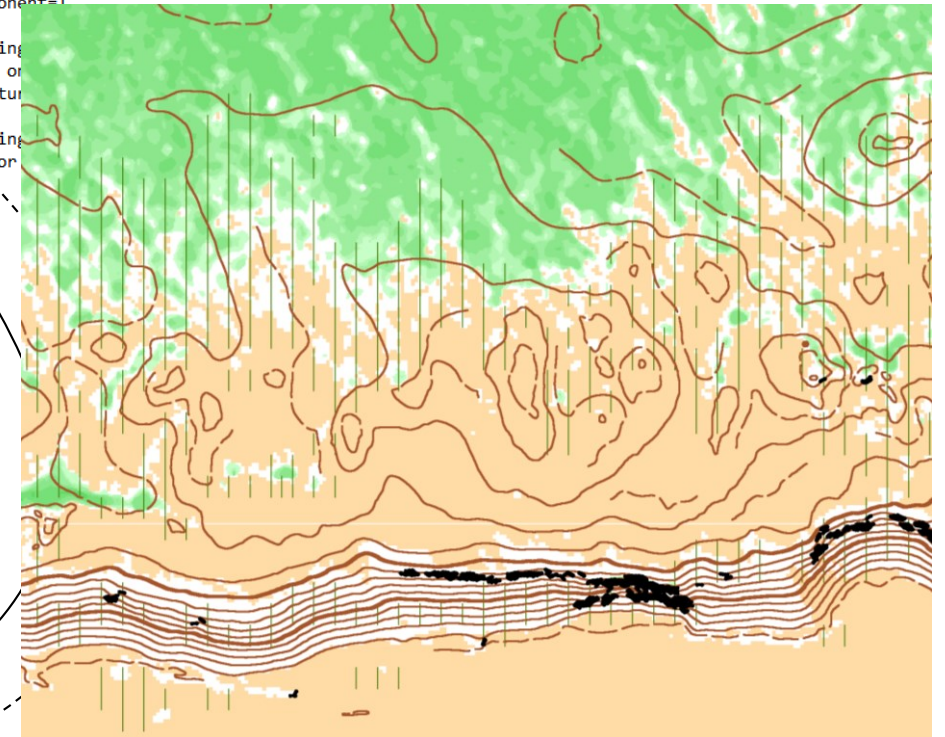
```
## Here we fine how sensitively we get green for different (hight or low) forest types.
# For example tf tall forest with big trees gets too green compared to low forest, we c
# roof low|roof high| greenhits/ground ratio to trigger green factor 1
thresold1=0.20|3|0.1
thresold2=3|4|0.1
thresold3=4|7|0.1
thresold4=7|20|0.1
thresold5=20|99|0.1
```

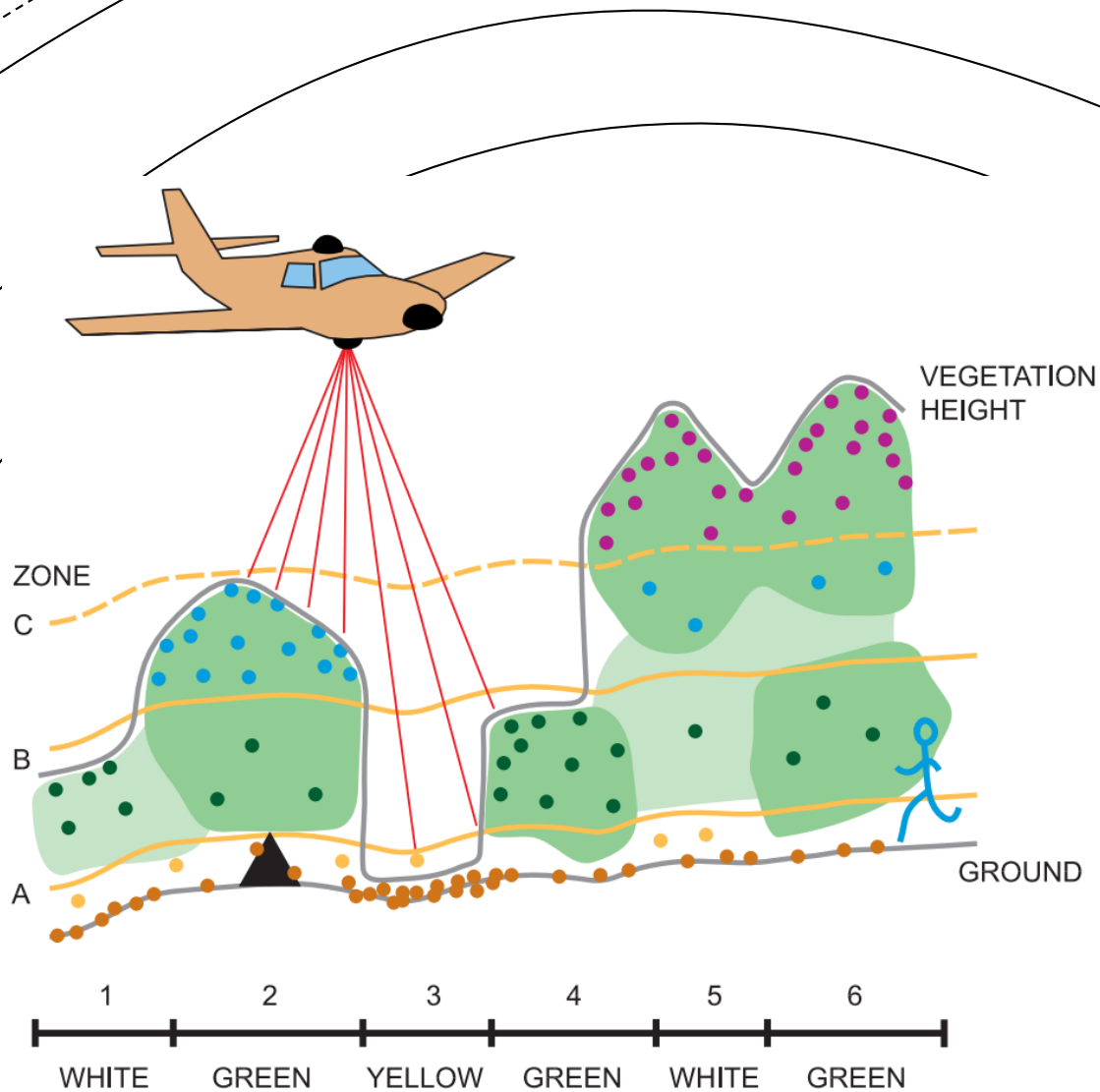
```
## areas where scanning lines overlap we have two or three times bigger point density.
# formula is: * (1-pointvolumefactor * mydensity/averagedensity) ^ pointvolumeexpone
# so pointvolumefactor = 0 gives no balancing/effect
```

```
pointvolumefactor=0.1
pointvolumeexponent=1
```

```
# green weighting
# so these are on
firstandlastreturn
```

```
# green weighting
lastreturnfactor
```





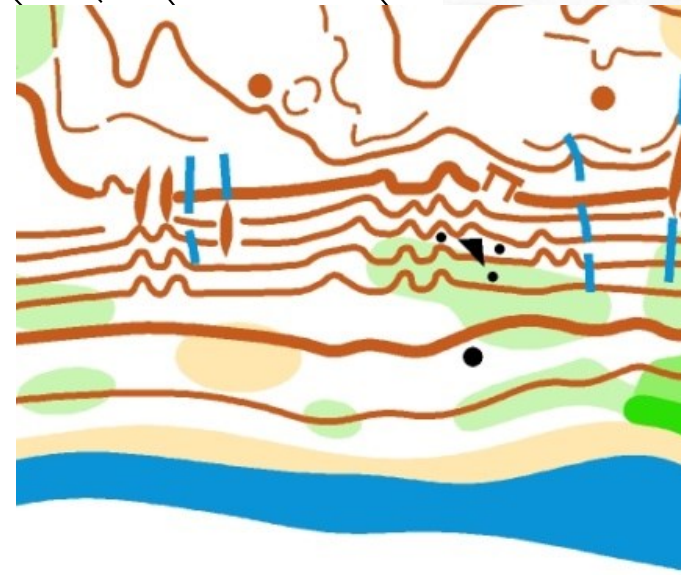
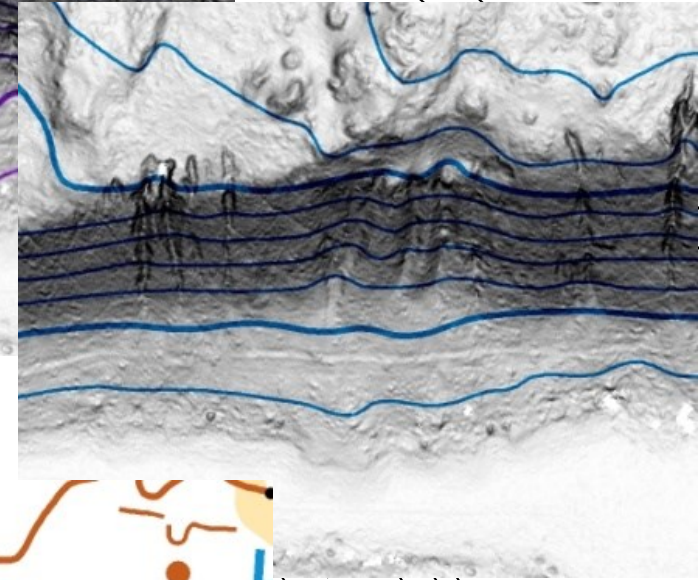
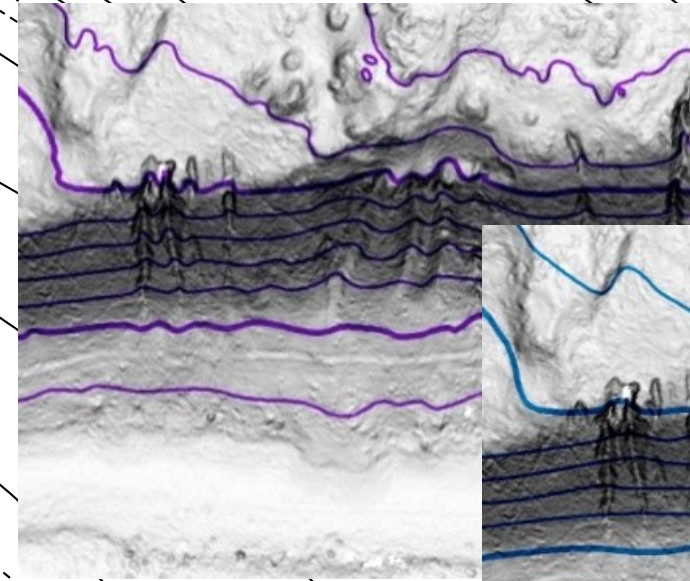
Vegetation Extraction

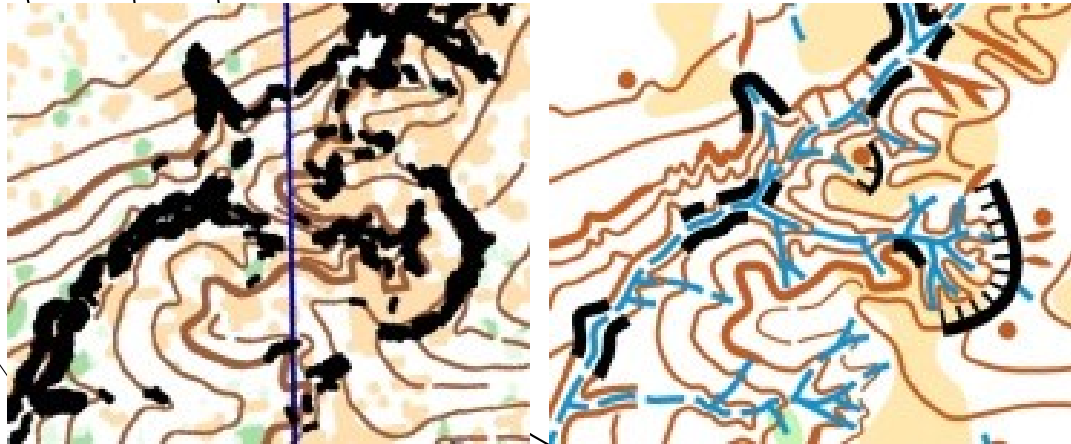
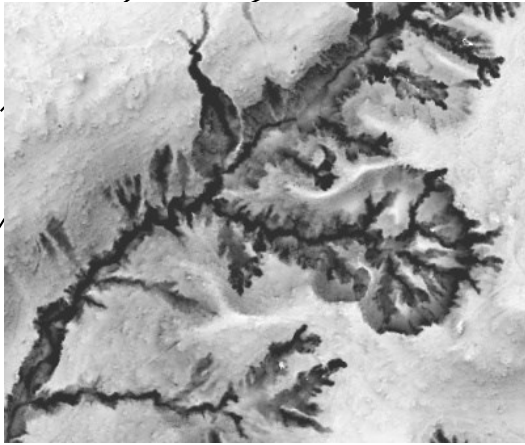
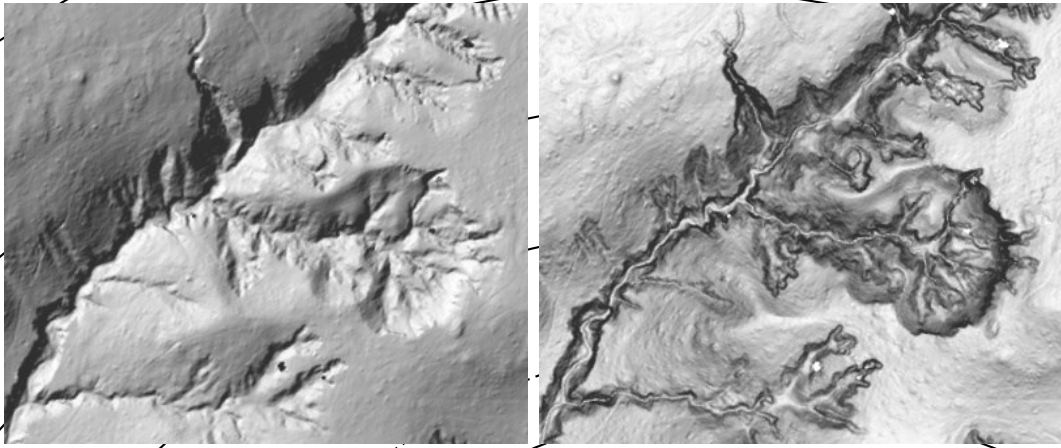
- Vegetation is classified by ease of movement of a competitor

	Open land
	with scattered trees
	Rough open land
	with scattered trees
	Forest: fast run
	Forest: slow run
	Forest: walk
	Forest: impenetrable
	Undergrowth: slow
	Undergrowth: walk

DTM Visualisation

- Contours are main source of topographic shape for the Orienteer
- Steepness, shape, orientation
- Contours are derived 2.5m or 5m
- OCAD
- Kartapullautin
- Field / Mapper interpretation





DTM Visualisation

- LiDAR DTM is rendered to allow better interpretation of terrain features
- Where contours are “over smoothed”
- Hillshading
- Slope
- Sky View Factor

2018 AUSTRALIAN ORIENTEERING CHAMPIONSHIPS SA

Crooked Straight

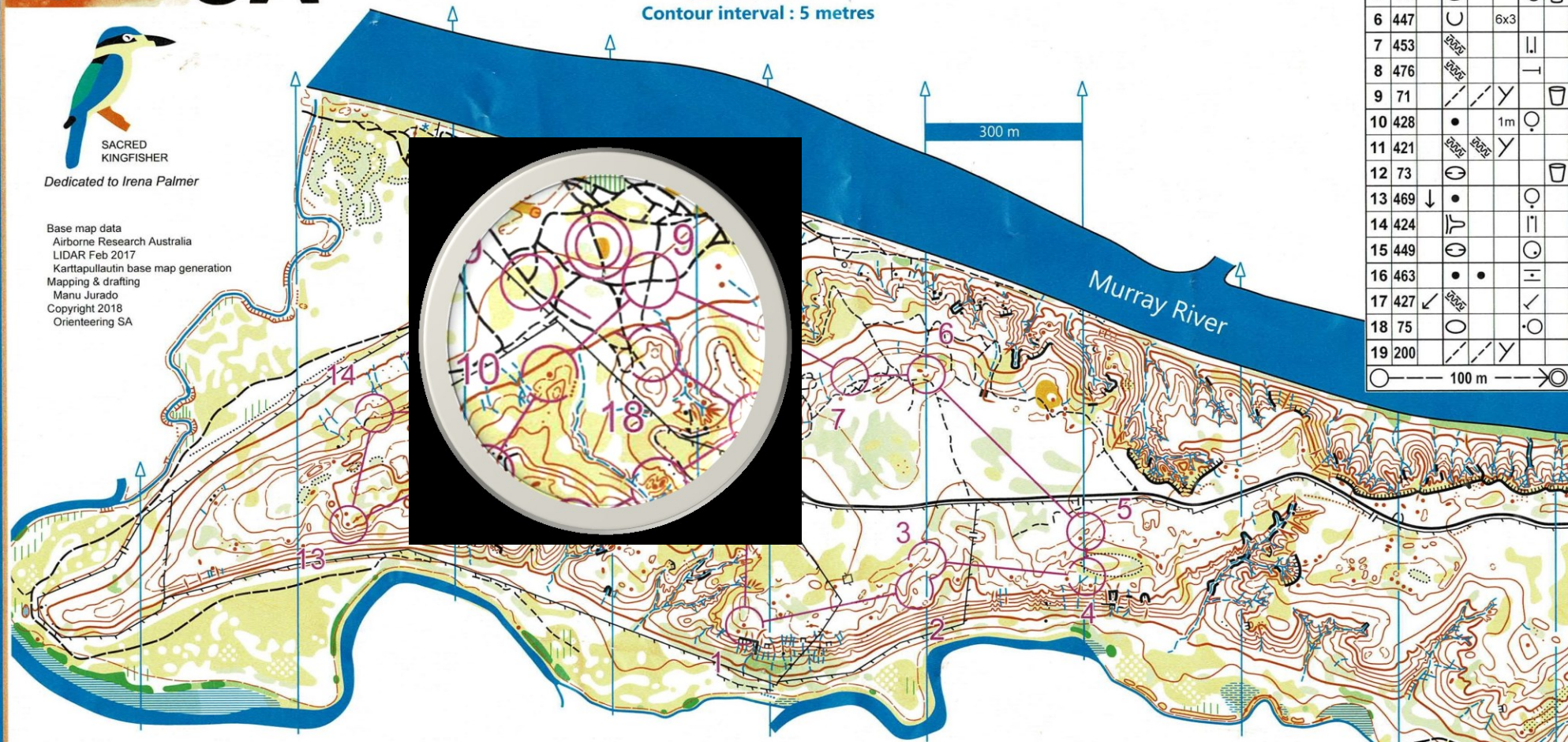
Australian Middle Distance Championships

Scale 1 : 10000
Contour interval : 5 metres

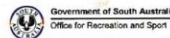


Dedicated to Irena Palmer

Base map data
Airborne Research Australia
LIDAR Feb 2017
Kartapullautin base map generation
Mapping & drafting
Manu Jurado
Copyright 2018
Orienteering SA



Australian MD Champs 2018				
M35A, M40A, W20E				
Course 4	4.2 km	120 m		
1 406	•	1.8m	Q	
2 412	○	2m/3m	○	
3 413	U	6x2		
4 414			↗	
5 74	○	•	○	☐
6 447	U	6x3		
7 453				
8 476				
9 71			Y	☐
10 428	•	1m	○	
11 421			Y	
12 73	○			☐
13 469	↓	•	○	
14 424				
15 449	○		○	
16 463	•			
17 427			✓	
18 75	○	•	○	
19 200			Y	
100 m				



R	R	R

2018 AUSTRALIAN ORIENTEERING CHAMPIONSHIPS SA

Crooked Straight

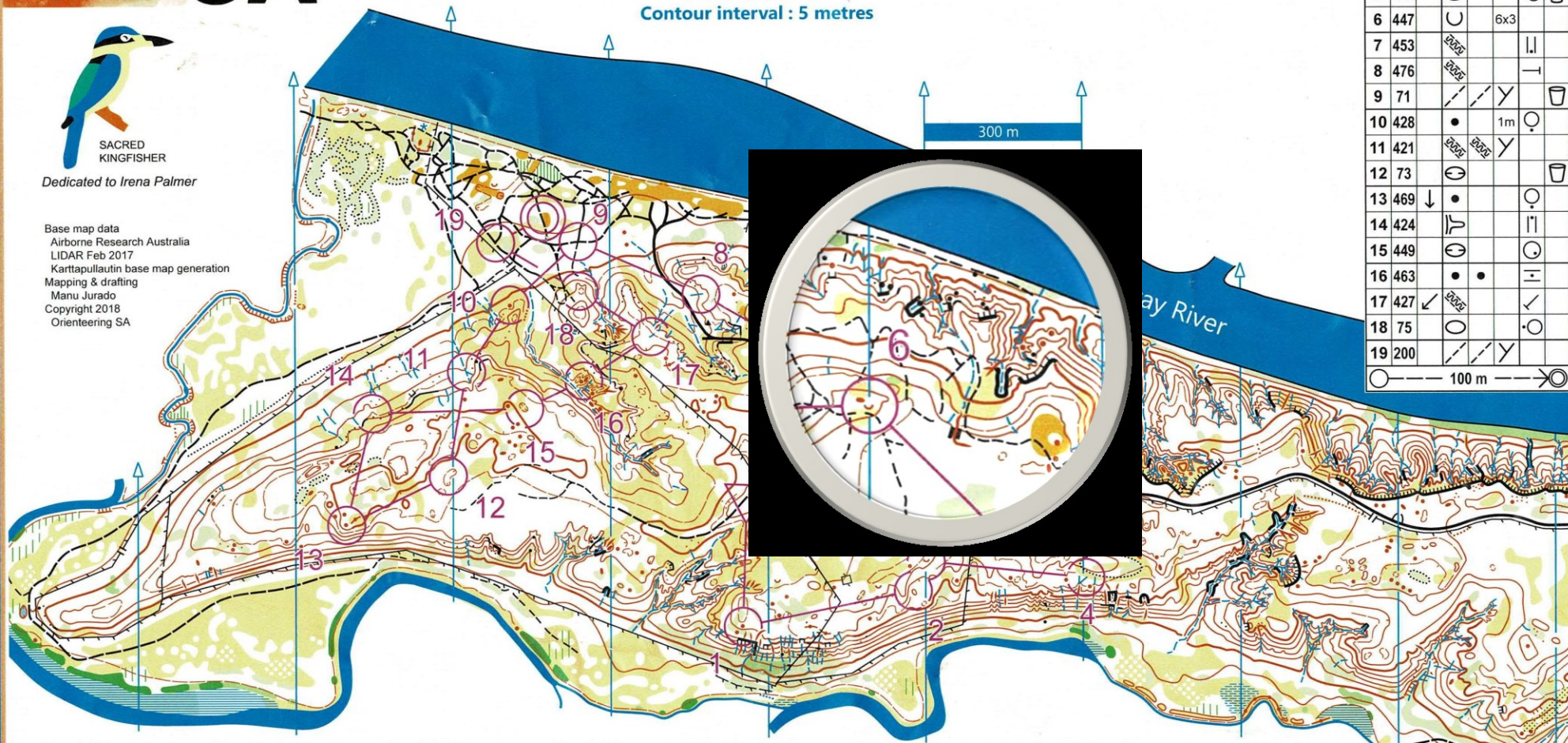
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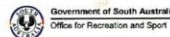


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R	R	R
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2018 AUSTRALIAN ORIENTEERING CHAMPIONSHIPS SA

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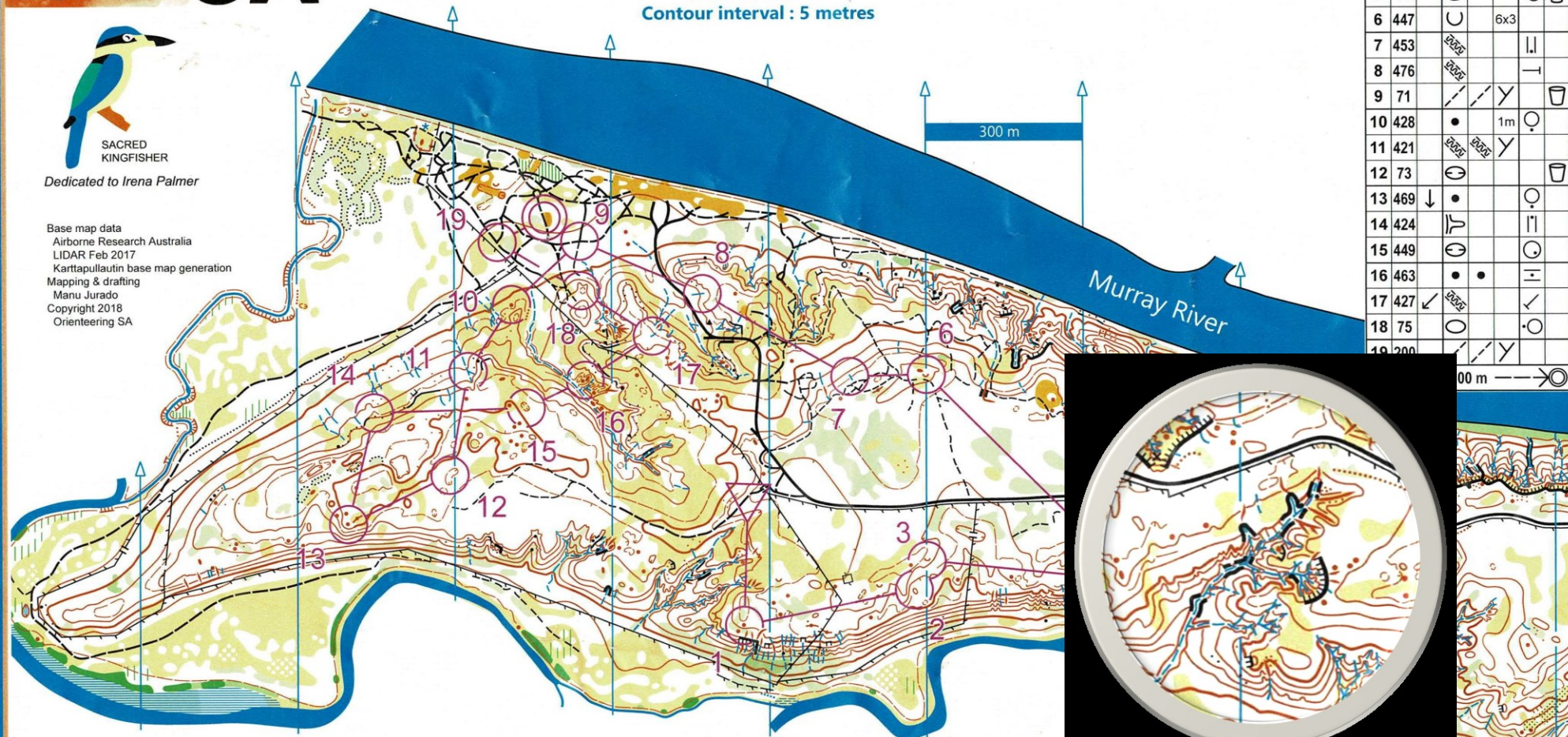
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6 447	U	6x3		
7 453				
8 476				
9 71			Y	○
10 428	•	1m	○	
11 421			Y	
12 73	○			○
13 469	↓		○	
14 424				
15 449	○		○	
16 463	•			
17 427			Y	
18 75	○		•	○
19 200			Y	



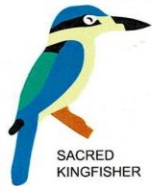
R	R	R

2018 AUSTRALIAN ORIENTEERING CHAMPIONSHIPS SA

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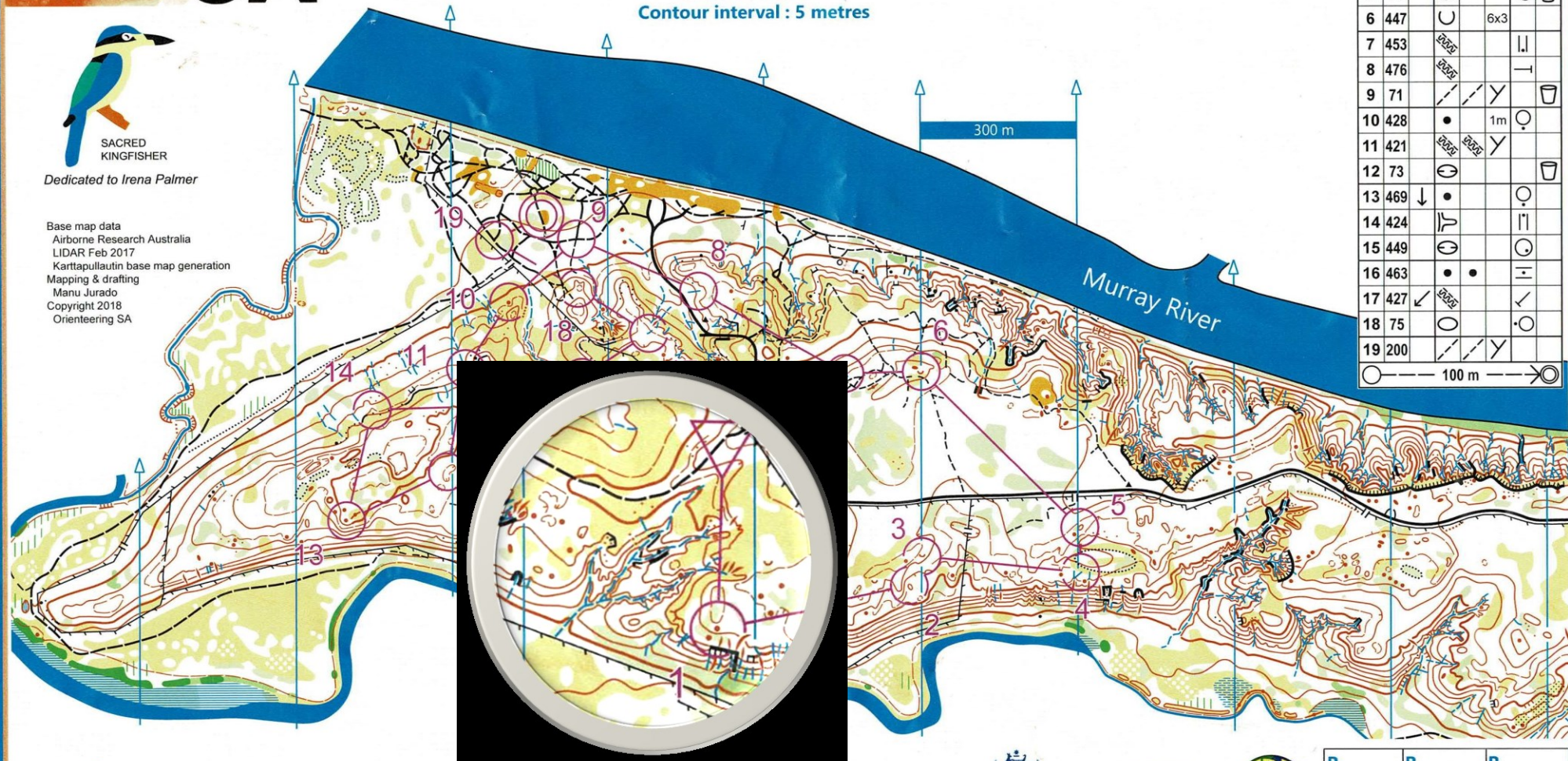
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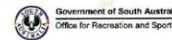


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6 447	U	6x3		
7 453				
8 476				
9 71		Y	☐	
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13 469	↓	•	○	
14 424				
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16 463	•			
17 427		Y	✓	
18 75	○	•	○	
19 200		Y		
100 m				

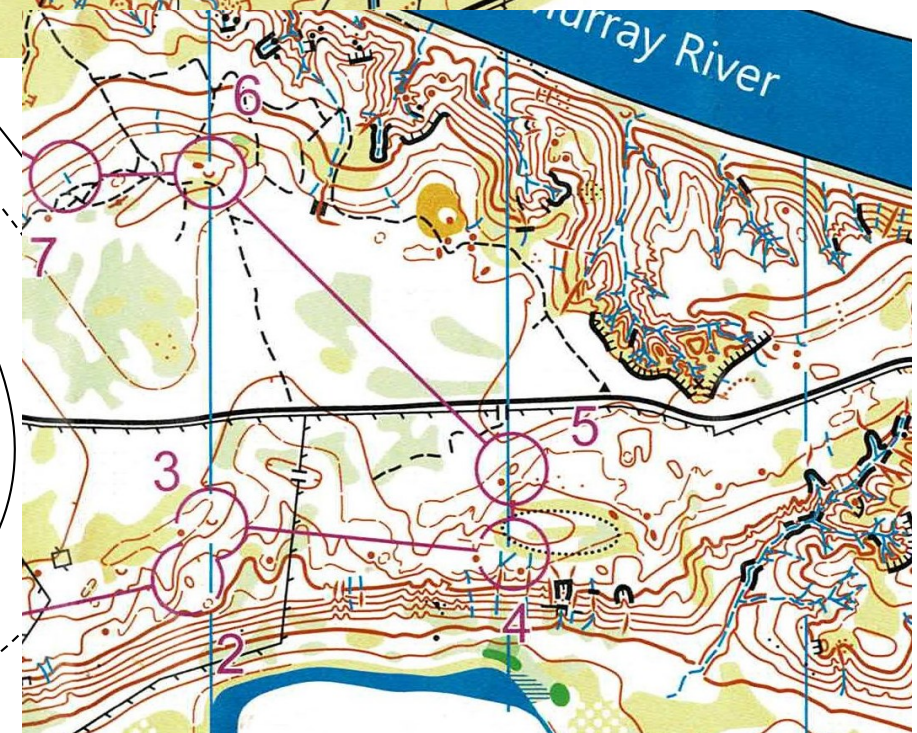
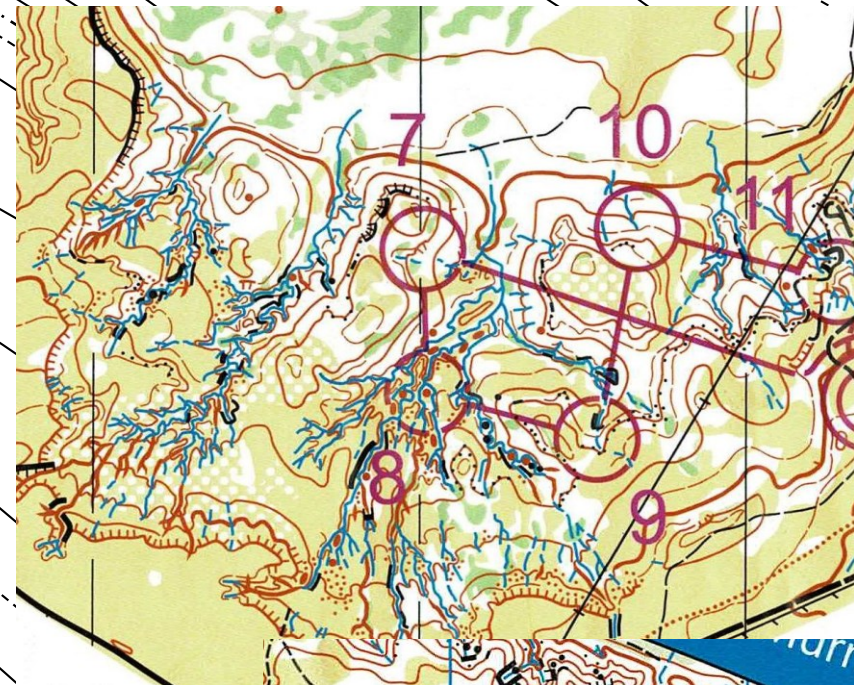


R	R	R

LiDAR and Mapping

Benefits

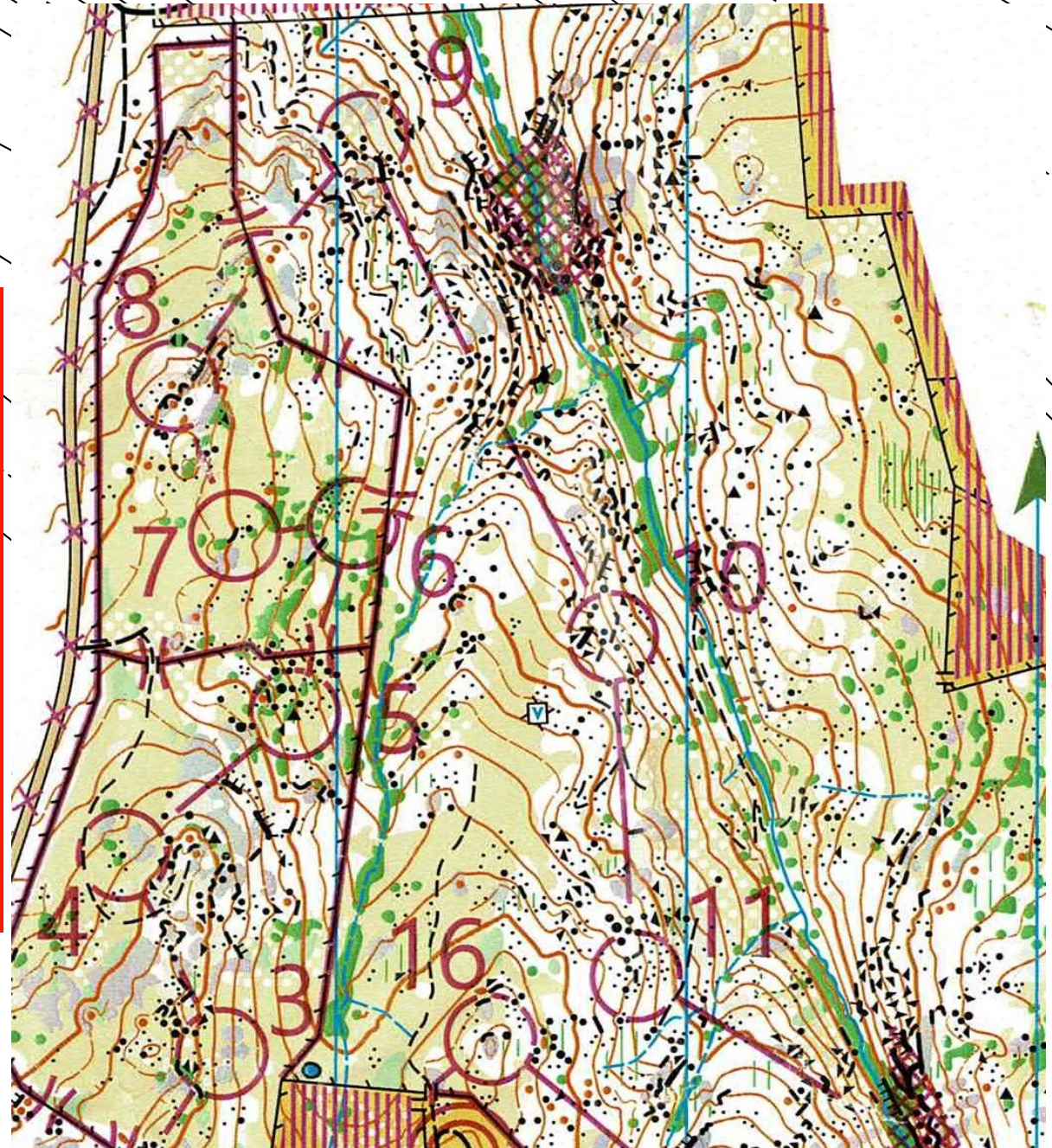
- Reduces fieldwork time considerably
- Decreases the chances that features are missed in fieldwork
- Drastically lowers drafting time



LiDAR and Mapping

Challenges

- Accessing data
- Training mappers in new technology
- Developing partnerships with LiDAR suppliers
- Getting enough people interested in mapping





THANKYOU

- **Orienteering**

- <http://sa.orienteering.asn.au>
- <http://orienteering.asn.au>
- <http://orienteering.sport>

- **Orienteering Maps**

- <http://omaps.worldofo.com>
- <https://orienteering.asn.au/index.php/mapping/>
- <https://orienteering.sport/iof/mapping/>

- **Tyson Hillyard**

- Tyson.hillyard@gmail.com
- <http://www.linkedin.com/in/tyson-hillyard>