USES & APPLICATIONS OF AIRBORNE LIDAR BATHYMETRY

Overview of Fugro’s Hydrographic Surveying Services

**Fugro:**
- 10,500 employees
- 60 countries
- ~200 offices
- 55 years exploring the earth

Two divisions within Fugro:
- Marine
- Land

**Local Presence – Global Reach**

Fugro’s Asia-Pacific regional office is based in **Singapore** with local offices in **Perth**, **Adelaide** and **New Plymouth**, providing Hydrographic Survey Services in the region and sourcing specialist Hydrographic Survey Services from operating companies world-wide including:
- Australasia
- Europe and the Middle East
- Americas
Fugro’s Hydrography services include:

- Acoustic (MBES/SBES/SSS/SBP) Surveys
- **Airborne LiDAR Bathymetry (ALB) Surveys**
- Capable of multi-sensor operations
- Inclusive of MetOcean and Positioning
- Deliverables include data for nautical charts (SOLAS) and UNCLOS EEZ
- IHO Special Order, 1a, 1b and 2 capable
- Bathymetry, Backscatter/reflectance, water column data

Current / Previous Clients:

- Australian Hydrographic Office / Royal Australian Navy
- Land Information New Zealand (LINZ)
- United Kingdom Hydrographic Office (UKHO / Maritime and Coastguard Authority (MCA))
- SHOM (French Hydrographic Service)
- Geological Survey of Ireland (GSI)
- NOAA (USA)
- Canadian Hydrographic Service
- Norwegian Hydrographic Service
- Finnish Transport Authority
- Swedish Hydrographic Service
- Qatar Ministry of Municipality and Environment
Current / Previous Clients for CZM projects:

- WA dept. of Transport and Planning / Landgate (Case study discuss in this presentation)
- Victoria Department of Sustainability and Environment
  - Whole VIC coastline surveyed with ALB
- Port Hedland Port Authority
  - Port development
- Port of Melbourne Corporation
  - Channel deepening project
  - 2x ALB survey for change detection, pre and post dredging/channel deepening
- Dubai Municipality
  - 2x ALB survey for change detection over Dubai coastline for CZM
- Geological Survey of Ireland
  - 5x ALB survey campaigns covering 13 bays for CZM
- NSW Office of Environment and Heritage (NSW OEH)
  - 2x ALB survey collections covering multiple areas (2008 and 2011) for CZM
- SHOM (French Hydrographic Service)
  - 2x ALB surveys in 2009 and 20011 in Languedoc-Roussillon for CZM and Change detection, sand monitoring
  - Separate ALB surveys of Martinique, Guadeloupe, Finistère, PACA and French Polynesia (Moorea, Tahiti and Bora Bora)
- Samoan Govt. (MNRE)
  - Whole country to 50m water depth
  - For Climate Change Resiliience and CZM
- New Zealand – Bay of Plenty reginal council
  - 1x ALB survey for CZM
- Many others…

Coastal Zone Management Historical Clients

Uses and application of Airborne LiDAR Bathymetry Technology, QLD Coastal Conference, Airlie Beach, 5 September 2017
What is Airborne LiDAR Bathymetry?

Hydrographic Survey / Shallow Water Mapping tool based on LiDAR technology

Pulses of laser light (532 nm) are used to measure the depth of water and height of features (ie rocks, islands, beach gradients)

Technology was designed principally for **Nautical Charting** applications,

ALB technology is used now in other applications such as:

- **Costal Zone Management**
- Marine Coastal Engineering
- Delineation of Baselines for EEZ/UNCLOS
- Tsunami modeling / inundation mapping
- Pre-Seismic surveys for O&G Industry
Benefits of Airborne LiDAR Bathymetry

Chart NZ 864
(Apolima Strait)

NOTE: Unsurveyed area
North of Salelologa
Harbour, Savai’i Island
Benefits of Airborne LiDAR Bathymetry

Chart NZ 864
(Apolima Strait)

NOTE: Unsurveyed area
North of Salelologa
Harbour, Savai’i Island
Airborne LiDAR Bathymetry - Overview of Technology

- Scanned green beam (532mn), reflects from the sea surface and the seabed, and is detected by the green receiver.

- Reflections from the sea surface are used to create a sea surface model

- Reflections from the seabed, are used to determine the depth of water, relative to the sea surface model or measured from the ellipsoid
Two types of Sensors – Operated Simultaneously

1. **Fugro LADS HD**
   - Depth performance to 80m in best conditions (3 x Secchi disk)
     - 7mj Laser Power
     - 3 kHz Pulse frequency
   - High Data Quality
     - Wide Aperture Receiver
     - Automatic Gain Control - for optimised signal return
   - Efficient data collection
     - Operating heights from 1200 – 3000 feet
     - 2x2 to 3.5x3.5 m spot spacing;
     - Roll and off-track compensation

2. **RIEGL VQ-820-G**
   - Depth performance to 7-10m in best conditions (1 x Secchi disk)
   - High spatial resolution
     - Up to 520 kHz pulse frequency
     - Variable resolution up to ~8 points / m²
Topo/Bathy (Shallow Water) ALB Sensors

1. **Pros:**
   - High Frequency/High resolution/small footprint, smaller units for installation

2. **Cons:**
   - Lower power, Limited depth performance, 1 x Secchi Depth, limited performance in low reflectivity seabed conditions
Deep Water Sensor – Fugro LADS HD

Traditional Bathymetric LiDAR Sensors

1. **Pros:**
   - High power, Greater depth performance, 3 x Secchi Depth capability

2. **Cons:**
   - Low Frequency/lower resolution/larger footprint, Larger units for installation
Multi-sensor operations

- Riegl VQ-820-G data used for Land and Shallow Water (Land to ~7-10m water depth)
- LADS HD data used for Shallow to Deep Water (Shallow Water to Max Depth)

Deep Water to 80m (subject to water clarity)
Shallow Water to -10m
Coastline + Topography

Overlapping Data
Multi-sensor operations – LADS + RIEGL Data
Example of LADS + Riegl data
Example of LADS + Riegl data
Example of LADS + Riegl data
Stakeholders involved:

- The client was funded as part of the Location Information Strategy with multiple stakeholders amounting to $1.75MAUD. The Main stakeholders were:
  - Landgate (Western Australian Land Information Authority)
  - Department of Water (DoW), WA
  - Department of Transport (DoT), WA
  - Department of Planning

- Other stakeholders included:
  - WALIS Marine group
  - Department of Fisheries
  - WA Marine Sciences Institutes
  - Department of Parks & Wildlife –
  - WA Local Government association
  - Others…
Case study – Recent WA Coast & Inland Waters Survey

Scope of Work:

• Area of interest
  • Coastal Area from Perth to Geraldton (~650km of coast). Coverage requirement: from the coast to ~20m contour (~21m AHD)
  • Inland Water
    • Peel Inlet / Harvey Estuary
    • Leschenault Estuary
    • Hardy Inlet
    • Wilson Inlet

• Hydrographic data requirement:
  • Minimum of 5m x 5m grid to IHO1b standard or greater
  • ICSM classification of topo LiDAR data

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<td>Hardy Inlet</td>
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<td>TOTAL</td>
<td>5411 sq km</td>
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The aircraft used was a Cessna 441

The LADS HD system was used which operates at 3kHz to provide deep bathymetric coverage at 3.5m spot spacing.

The REIGL VQ-820-G was operated at 284kHz to provide very high density topographic and shallow bathymetric data at 0.25m spot spacing.
Case study – Recent WA Coast & Inland Waters Survey

Some survey metrics and facts:

- Number of flight conducted: 63x survey flights
- Flight line kilometres flown: 18,015km
- Airport bases: Geraldton and Perth airports
- First flight conducted 1\textsuperscript{st} March 2016
- Last flight conducted 13\textsuperscript{th} May 2016 (12 weeks data collection period)
- Weekly progress report issued weekly to Landgate
- HSE: 0 Incidents / near misses
- Staged delivery of final data and report completed on August 8\textsuperscript{th}. 
Case study – Recent WA Coast & Inland Waters Survey

Results of deliverables:

- Report of survey
- RAW LAS 1.2 and LAS 1.4 ALB point cloud Data
- Final Merged and classified Bathymetric and Topographic Data
- RGB Mosaic
- Reflectivity Mosaic
- Digital seabed model: SHOAL Bias and Mean grid ESRI grids
Abrolhos Island

- Excellent data coverage well beyond 20m Contour to 45m

- Many shallow coral bommies surveyed at very high density

- Total surveyed area – 1,387 sqkm

- Exposed western side produced a lot of persistent white water resulting in some small gaps
Coastal Area

- Excellent data coverage well beyond 25m Contour
- Total surveyed area – 3,542 sqkm
- Minor gaps due to turbidity or persistent white water
Inland Waterways – Peel Inlet & Harvey Estuary

• Excellent data coverage well beyond 5m depth

• Minor gaps due to turbidity
Case study – Recent WA Coast & Inland Waters Survey

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<tr>
<td>Wilson Inlet</td>
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<td>60%</td>
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<td>TOTAL</td>
<td>5411 sq km</td>
<td>5173 sq km (96% avg)</td>
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Case study – Recent WA Coast & Inland Waters Survey

Reflectivity Mosaic

RGB Imagery Mosaic

Digital Surface Model (DSM)
Case study – Recent WA Coast & Inland Waters Survey
Fugro provided an innovative and fit for purpose solution to the WA Government stakeholders to provide a seamless and comprehensive datasets to allow confident decisions and enable modelling of the coastal environment.

Data is being used to
- Update nautical charts
- Model sediments
- Plan oil spill response teams
- Monitor change on the seabed (between epochs of same areas)
- CZM and preliminary design
- Investigate geological features
- Coastal risk management for natural disasters/events

Future services will confirm sediment modelling and allow updates to CZM strategies.
Thankyou

Questions?