



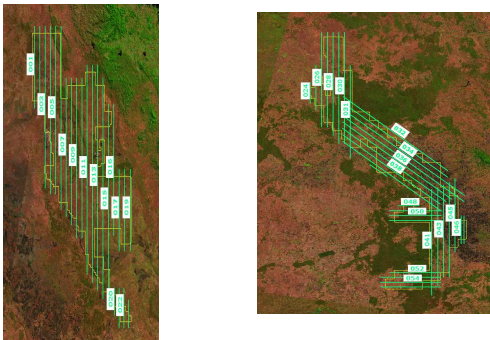
Record ID	Record
Metadata Filename	22440401 Arrow Energy Gas Fields
Metadata Language	English
Metadata Character Set	ASCII
Metadata Point of Contact	<div>s.73 Irrelevant information</div> Fugro Spatial Solutions Pty Ltd Level 1, Brandl Street, Eight Mile Plains Qld 4113 Telephone:3 Irrelevant informat <div>s.73 Irrelevant information</div>
Metadata Date Stamp	16 November 2012
Dataset Title and Graphic Overview	<div>MGA55 Area</div> <div>MGA56 Area</div>
Dataset Reference Date	Nov-12



Dataset Description Abstract	Arrow Energy LiDAR derived products
Dataset Language	English
Dataset Character Set	ASCII and binary
Dataset Topic Category	ModelKeyPoints,. Vegetation, DEM and Contours
Geographic Location Description	Queensland, Australia
Geographic Bounding Box	MGA55 WEST LONGITUDE=147° 48' 12.4318" E NORTH LATITUDE= 21° 03' 09.8450" S EAST LONGITUDE=148° 47' 21.7982" E SOUTH LATITUDE= 22° 56' 22.2815" S MGA56 WEST LONGITUDE=149° 51' 10.6505" E NORTH LATITUDE= 25° 38' 10.6859" S EAST LONGITUDE=151° 28' 32.3475" E SOUTH LATITUDE= 28° 12' 21.3936" S
Acquisition Start Date	16 th June 2012
Acquisition End Date	29 th July 2012
Sensor Type Name	Leica ALS50-2
Sensor/Lens serial ID	SN087
Flying Height (AGL)	2500m
INS / IMU Used	IPAS10
Number of Runs	MGA55 159 MGA56 198
Swath Width	1892m
Flight Direction	Non-Cardinal
Side Overlap (%)	20
Output Data Format	1m DEM, Model key points and Vegetation in ASCII XYZ Contours in ESRI Shape file formats
Horizontal Datum	GDA94
Vertical Datum	AHD as defined by AUSGeoid09 v1.
Map Projection	MGA Zone 55 South and MGA Zone 56 South
Number of control points	No Control Was used on this project
Spatial Accuracy (Hz) meters	0.29m @ 67 % CI
Spatial Accuracy (Vt) meters	0.12m @ 67 % CI
Surface Type	Various
Average Point Separation	Target spacing 1 pt/m ²
Laser Return Types	All Returns
Data Thinning	None
Laser Footprint Size (meters)	0.60
Data Tile size (km 2)	3km ²



Processing / Derivation Lineage	<p>Ground Classifications Fugro Spatial Solutions Pty Ltd aim is to select those points that are part of a clean ground surface, which might not be 100% of the ground hits. This results in a cleaner dataset, without compromising on terrain detail and accuracy. Ground filtering algorithms, tailored for this project, data type and terrain type, are applied to the full dataset. The ground filtered dataset is then visually checked by an operator, and incorrectly classified data is corrected or the ground filtering algorithm is adjusted and then visually checked. For the verification of the ground classifications, intensity imagery is used as a backdrop image.</p> <p>Bare Earth DEM A 1m gridded DEM has been generated from the lidar ground surface. The method of deriving the height for each grid point is by triangulation between the three nearest lidar ground points.</p> <p>Vegetation points Any lidar return, not classified as ground or recognised as a built structure, is part of this dataset.</p> <p>Model Keypoints A resampled ground dataset, consisting of only those points that actually contribute to the shape of the terrain (+/- 15cm), with a minimum point density of 1 point every 20m.</p> <p>Contours From the model keypoints, triangles are built. At 1m intervals in height, points or interpolated points on triangle edges with the same height are connected using smoothed curved lines. The lines for each height interval are then merged to become the final contours.</p> <p>Note: Returns on water have not been removed from the (classified) point clouds. Gridded datasets have been interpolated across voids (up to 500m in diameter) caused by either no-return due to water bodies, or removal of buildings, vegetation or other above ground features. Contour datasets are interpolated across voids, and contours across water bodies have not been removed or clipped. Above ground datasets only start at 30cm above the classified ground surface, to avoid low grasses/system noise to become part of this above ground dataset. The tiled data has been cut into 3km tiles, where the file name prefix corresponds with the Lower Left coordinate of the block.</p>
Limitations of Data	This data has not been field tested for completeness or accuracy.
Conditions of Supply	<ol style="list-style-type: none"> 1. This Metadata file is always to be stored with the unaltered data contained in this volume. 2. Any supplied data is to be used only for the purpose for which it was commissioned and in accordance with the terms of engagement. 3. Use of any supplied data for purposes other than those stated is entirely at the risk of the Client.

Metadata Summary		Arrow Energy ADS Metadata
Record ID	Northern Area	Southern Area
Metadata Filename	North Area	South Area
Metadata Language	English	English
Metadata Character Set	ASCII (uft8)	ASCII (uft8)
Metadata File Parent Identifier	English	English
Metadata Point of Contact	s.73 Irrelevant information	
Metadata Date Stamp	19/11/2012	19/11/2012
Dataset Title	North Area	South Area
Dataset Reference Date	Nov-12	Nov-12
Dataset Description Abstract	Aerial Photography, Orthoimagery	Aerial Photography, Orthoimagery
Dataset Language	English	English
Dataset Character Set	High Quality Orthoimagery - No DEM or Mapping Required	High Quality Orthoimagery - No DEM or Mapping Required
Dataset Topic Category	Orthoimagery	Orthoimagery
Geographic Location Description	QLD	QLD
Geographic Bounding Box		
Acquisition Start Date	5/07/2012	5/07/2012
Acquisition End Date	29/07/2012	5/08/2012
Sensor Type Name	ads80	ads80
Sensor/Lens serial ID	1315	1319
Sensor Focal Length (mm)	62.7	62.7
Nominal Flying Height (m AGL)	5600	5800
INS / IMU Used	DGPS only	DGPS only
Number of Runs	23	32
Swath Width (m)	7200	7200
Number of Frames	N/A	n/a
Flight Direction	n-s	non cardinal
Normal Ground Sample Distance	0.6	0.6
Forward Overlap (%)	60%	60%
Side Overlap (%)	25%	25%
Output Pixel size (cm)	60	60
Output Data Format	ecw tiff	ecw tiff
Horizontal Datum	MGA	MGA
Vertical Datum	AHD	AHD
Map Projection	Map Grid of Australia, Zone 55	Map Grid of Australia, Zone 56
Data Thinning	n/a	n/a
Surface Type	Lidar DEM	Lidar DEM
Spatial Accuracy (Hz) (m)	0.60	0.60
Spatial Accuracy (Vt) (m)	0.84	0.84
Data Tile size (km ²)	3	3
Number of control points	None	None
Description of Geodetic Validation Process' used and Residual Results	Raw imagery was evaluated using Leica's FPES and Xpro software with the estimated accuracy of 3 pixels.	Raw imagery was evaluated using Leica's FPES and Xpro software with the estimated accuracy of 3 pixels.
Description of Aerotriangulation Validation Process' used and Residual Results	RMS-X: 0.686 RMS-Y: 0.805 RMS-Z: 0.282	RMS-X: 0.447 RMS-Y: 0.401 RMS-Z: 0.292
Description of Rectification Process' used	Leica's Xpro software was used to rectify geocoded raw L0 ADS imagery to orthorectified L2 imagery using a Fugro captured Lidar DEM.	Leica's Xpro software was used to rectify geocoded raw L0 ADS imagery to orthorectified L2 imagery using a Fugro captured Lidar DEM.
Description of Mosaicing and Colour Balancing Process' used	Inpho's Orthovista was used to mosaic and colour balance the imagery. Adobe Photoshop was used to edit and batch enhance the final output. ER Mapper was used to generate the final output deliverables.	Inpho's Orthovista was used to mosaic and colour balance the imagery. Adobe Photoshop was used to edit and batch enhance the final output. ER Mapper was used to generate the final output deliverables.
Limitations of Data	The spatial accuracy of the data is limited to the shape boundary and the accuracy specified above.	The spatial accuracy of the data is limited to the shape boundary and the accuracy specified above.
Processing / Derivation Lineage	n/a	n/a
Data Graphic overview		
Conditions of Supply	1. This Metadata file is always to be stored with the unaltered data contained in this volume. 2. Any supplied data is to be used only for the purpose for which it was commissioned and in accordance with the terms of engagement. 3. Use of any supplied data for purposes other than those stated is entirely at the risk of the Client.	1. This Metadata file is always to be stored with the unaltered data contained in this volume. 2. Any supplied data is to be used only for the purpose for which it was commissioned and in accordance with the terms of engagement. 3. Use of any supplied data for purposes other than those stated is entirely at the risk of the Client.



CLOUGH AMEC JV

SURAT BASIN HI-DEF LIDAR & IMAGERY

VOLUME 24066A02NOB

Summary

Project

AAM Pty Ltd were given the project by Clough Amec JV that will deliver Ortho-Imagery and High Definition LiDAR data over the Bowen Basin.

The AOI is approximately of 4960km² and delivery was divided into 5 priority areas

Data

Each priority area was divided in LiDAR products of :-

- LiDAR Intensity Imagery – ECW mosaic @ 25cm GSD
- Shaded Relief Imagery – ECW mosaic @ 25cm GSD
- DEM Imagery – ECW mosaic @ 25cm GSD, ESRI FGDB
- Contours (1m) – ESRI FGDB
- LAZ data – 500m tiles
- LiDAR Max Height Imagery – ECW mosaic @ 25cm GSD
- LiDAR Above Ground Imagery – ECW mosaic @ 25cm GSD

Imagery was provided as 10cm GSD RGB Ortho-rectified in ECW/TIFF Format.

Note all supplied by Web server delivery with HDD supplied for Imagery, DEM, Contours and LAZ data

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4. Validation Plot.....	8

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RTI Act 2009

1. DATA INSTALLATION

Data formats : Listed above
Number & type of media : Web Delivery & HDD
Data formatted on : 11.05.2015
Disk volume : 24066A02NOB
AAM Account Manager
AAM Project Manager

s.73 Irrelevant information

README FILE

This document (Readme_24066A02NOB.PDF) is provided as an Acrobat file in this volume. To open the file, double click on the PDF file to activate Acrobat Reader Software.

Adobe Acrobat Reader may be downloaded from:

<http://www.adobe.com/products/acrobat/readstep2.html>

LOADING NOTES

Data may be copied using a file copy utility such as Windows Explorer or similar.

REVISION HISTORY

Volumes previously issued under this project include:

Volume	Date	Data Title	Contents
24066A01NOM	08.05.2015	Surat Basin	Ortho Imagery
24066A02NOB	11.05.2015	Surat Basin - LiDAR	LiDAR Deliverables – this volume

2. METADATA

REFERENCE SYSTEMS

	Horizontal	Vertical
Datum	GDA94	AHD
Projection	MGA Zone 55 & 56	N/A
Geoid Model	N/A	Ausgeoid09

SOURCE DATA

Item	Source	Description	Ref No	Date
Primary survey control	AAM	New & Existing Ground control		various
Laser System	AAM	Riegl Q1560	24066A	November, December 2014, January, February 2015
Pulse Rate	AAM	400 kHz	24066A	November, December 2014, January, February 2015
Frequency				
GPS Base Data	CORS	SmartNet Aus CORS Network (WNDN,TARO, DALB,4JON & MILL)	24066A (Wandoan,Taroom,Dalby & Millmerran) Chinchilla	November, December 2014, January, February 2015

LASER DATA CHARACTERISTICS

Characteristic	Description
Device Name	Riegl Q1560
Half Scan Angle	29 degrees
Laser Pulse Rate	800kHz
Laser Scan Frequency	32Hz
Overlap Percentage	60%
Laser Pulse Mode	Single Pulse
Swath Width	700m
Average Point Spacing	16pts/m ²
File Format	ASCII XYZ
Horizontal Datum	GDA94
Vertical Datum	AHD using Ausgeoid09
Map Projection	MGA Zone 55,56
Vertical Accuracy Specification	±0.07m at 68% confidence interval
Horizontal Accuracy Specification	±0.15m at 68% confidence interval

EXPECTED ACCURACY

Project specifications and technical processes were designed to achieve data accuracies as follows:

	Measured Point	Derived Point	Basis of Estimation
Vertical data Horizontal data Test points	0.15m 0.05m	0.07m	Project Design System ($1/5500$ flying height @ 1 sigma) Project Design / Survey methodology used

Notes On Expected Accuracy

- Values shown are at 68% confidence interval, in metres.
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates of measured points refer to discrete point-mode observations.
- Ground definition in vegetated terrain may contain localised areas with systematic errors or outliers which fall outside this accuracy estimate.

DATA VALIDATION

- Ground data across this project has been compared to 419 test points obtained by field survey from previous existing projects with the area of interest and assumed to be error-free. Comparison of the field test points with elevations interpolated from measured data resulted in:

Area	PRIORITY 1 (-0.731m)		PRIORITY 2 (-0.717m)	PRIORITY 3 (-0.793m)	PRIORITY 4 (-0.783m)	PRIORITY 5 (-0.734m)
Site	REF2&REF3_141211_North	REF2&REF3_141211_South	PCP6s&PCP9_141210	PCP7_141210	PCP8_141209	REF1&PCPstand5_141211
No of Points	91	112	6	3	70	137
Average dz	0.013	-0.009	-0.003	-0.019	-0.064	-0.013
Minimum dz	-0.030	-0.282	-0.134	-0.076	-0.095	-0.361
Maximum dz	0.055	0.059	0.162	0.043	0.018	0.064
Average magnitude	0.019	0.022	0.099	0.048	0.066	0.025
Root mean square	0.024	0.052	0.108	0.052	0.067	0.05
Std deviation	0.021	0.051	0.119	0.060	0.020	0.049

USE OF DATA

- Intended use : Planning and conceptual design

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **CLOUGH AMEC JV**.

The data in this volume is provided by AAM Pty Limited (AAM) to **CLOUGH AMEC JV** under the client's Terms of Engagement, which require **CLOUGH AMEC JV** to assume shared ownership with AAM, subject to the following conditions:

1. This file (Readme_24066A02NOB.PDF) is always stored with the unaltered data contained in this volume.
2. The data is not altered in any way without the approval of AAM. The data may be copied from this file to another.
3. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by AAM.

Any breach of these conditions will result in the immediate termination of the license issued by AAM, and **CLOUGH AMEC JV** will indemnify AAM from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

AAM Pty Limited

Level 1 Leichhardt Court,
55 Little Edward Street,
SPRING HILL QLD 4000

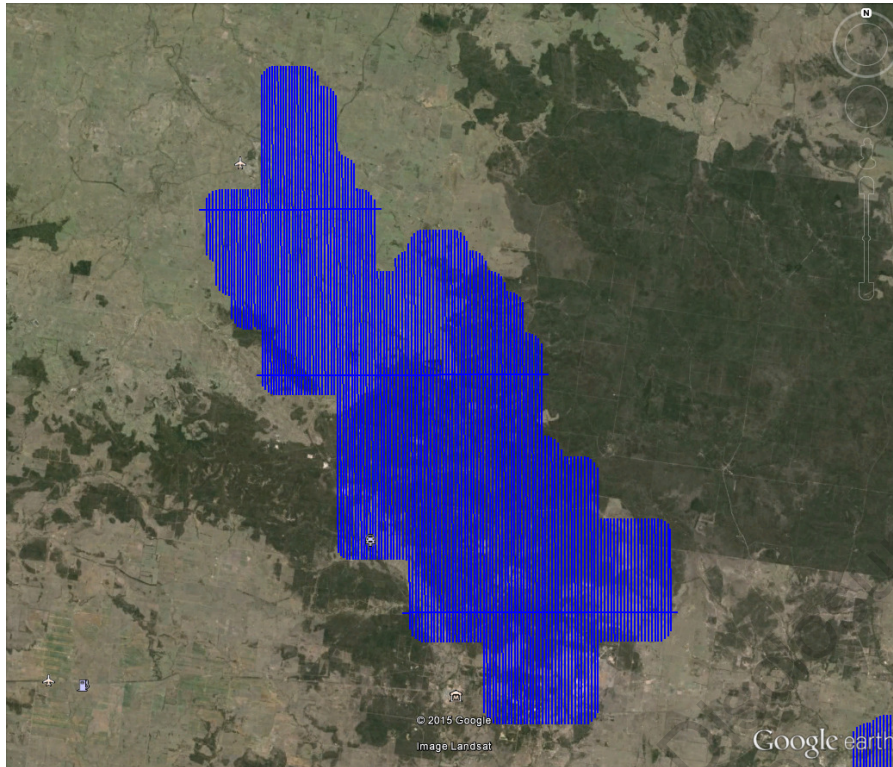
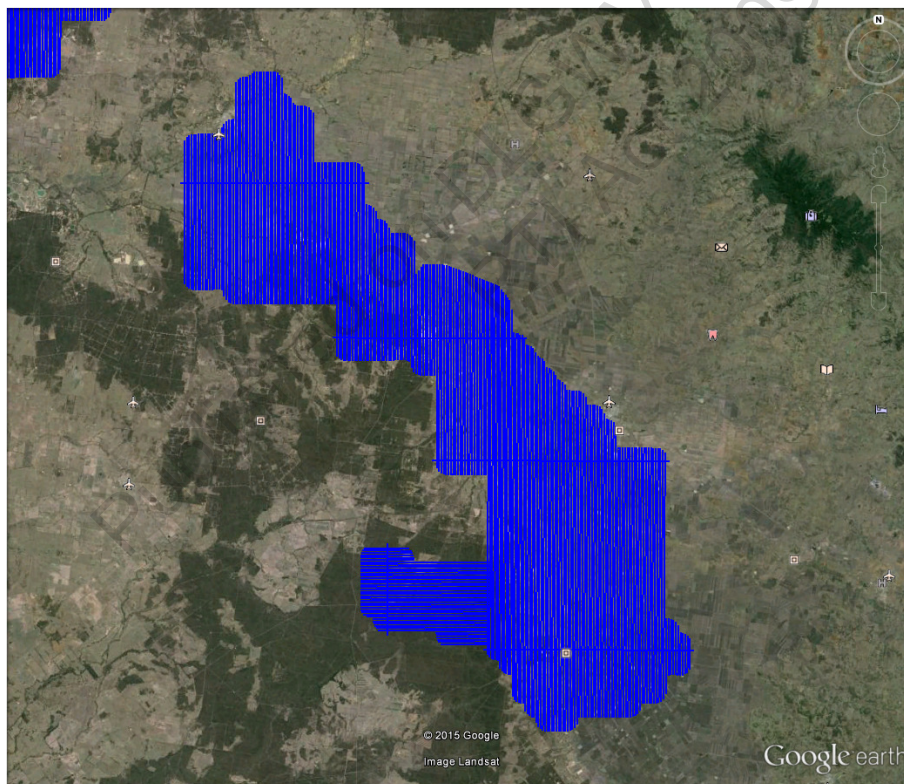
Telephone (07) 3620 3111
Facsimile (07) 3620 3133
Email info@aamgroup.com
Web www.aamgroup.com

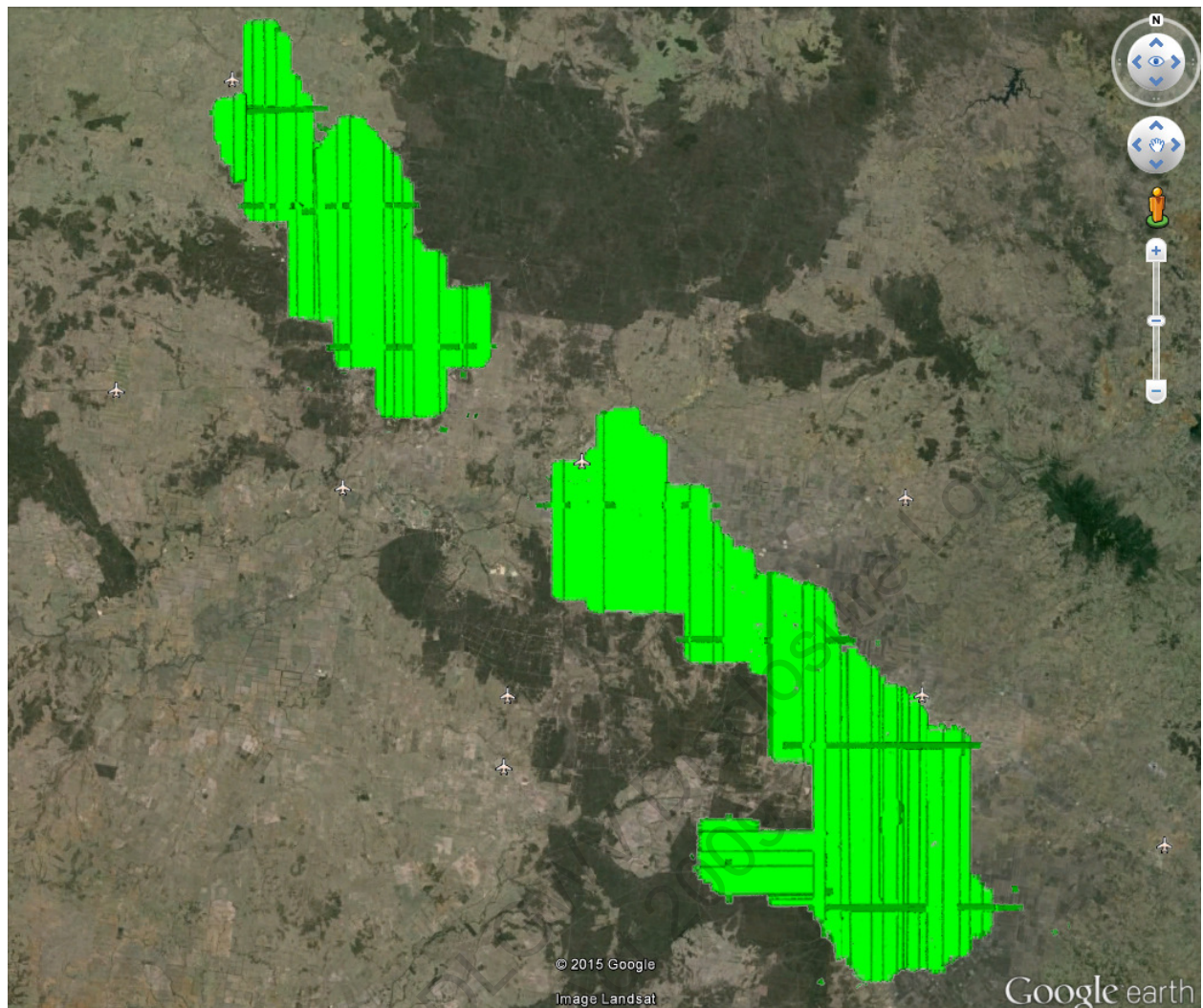
AAM Pty Limited

Suite 2, 33 Waterloo Road,
MACQUARIE PARK NSW 2113

Telephone (02) 8879 1600
Facsimile (02) 8879 1633
Email info@aamgroup.com
Web www.aamgroup.com

4. VALIDATION PLOT





LiDAR

Flightplanning screenshot, Capture completed 12th February 2014 over 40 sorties.



Screenshot of tile layout containing for the supplied Surat Basin LiDAR deliverables



ARROW ENERGY PTY LTD

SUBSIDENCE MONITORING LIDAR AND IMAGERY

VOLUME PRJ37870NOP01

Summary

Project

AAM was engaged by Arrow Energy to undertake a LiDAR and imagery survey over the Surat Gas Project subsidence monitoring area of interest. To this end, LiDAR and imagery data was captured from two fixed wing aircraft in multiple flights between 15/10/2020 and 6/11/2020.

Data

The data in this volume contains:

Lidar

- Classified (ground & non-ground) tiled point cloud in LAS 1.2 format
- 1.0 m tiled DTM in ESRI ASCIIGrid format
- 1.0 m contours in SHP format
- Tile Layout in SHP format
- Area of interest (AOI) SHP format

Control

- Control network report in XLS format

The vertical accuracy for this dataset is 0.05 m RMS.

This dataset is supplied in GDA2020 MGA Zone 56, AHD using Ausgeoid2020.

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1. PROJECT REPORT

Safety: No safety Incidents were reported during the project.

Acquisition: LiDAR data was captured from a fixed wing aircraft via multiple flights between 15/10/2020 and 6/11/2020. Imagery data was acquired from a separate fixed wing aircraft on three flights between 1/11/2020 and 3/11/2020.

Ground Support: Ground survey of control stations, lidar test points and photo targets was undertaken by AAM Pty Ltd. The primary control network was resurveyed via 6 hour static GPS observation and processed using a Final Orbit Auspos solution. The attached control network report (PRJ37870_Lidar_test_Points_Results.xls) includes RTCM, Form 6 and Precise Ephemeris Auspos values. Auspos values were adopted for the primary control network and groups of RTK Lidar test points were surveyed at each site, tied to the primary control network.

Data Processing: Reduction of the ALS data proceeded without any significant problems. Laser strikes were classified into ground and non-ground points using a single algorithm across the project area. Manual checking and editing of the data classification further improved the quality of the terrain model.

Further Processing: A 1m DTM grid was generated from a triangulated model. This method uses the closest triangles and applies weights to the proportionate areas from the grid cell centroid to interpolate the value. It uses known elevation data, it does not make any predictions regarding the surface and accurately depicts existing troughs and peaks in the data and supports irregular point spacing, which suits the nature LiDAR data.

The contours supplied on this volume are designated "ENGINEERING CONTOURS" only. They are compiled from a rigorous triangulation of the supplied data. No cartographic licence has been applied. They are intended to provide a visual representation of the terrain data and are not suitable to be used as a cartographic map.

Data Presentation: The data provided on this volume has been supplied in accordance with a specification agreed with the primary client. Subsequent users experiencing difficulties in handling the data should please contact AAM to arrange a more appropriate data presentation.

Further Issues: There are no further issues to report.

Project Contacts:

Client

s.73 Irrelevant information

s.73 Irrelevant information

Company

Arrow Energy Pty Ltd

AAM Account Manager & Project Manager

s.73 Irrelevant information

s.73 Irrelevant information

AAM Spatial Data Analysts

AAM Brisbane Office

2. DATA INSTALLATION

Data format	: LAS V1.2, ASCII, SHP.
Number & type of media	: AWS cloud links
Number of files on media	: Data files, Readme_PRJ37870NOP01.PDF and metadata
Data formatted on	: 17.12.2020
Disk volume	: PRJ37870NOP01

README FILE

This document (Readme_PRJ37870NOP01.PDF) is provided as an Acrobat file in this volume.

LOADING NOTES

Data may be copied using a file copy utility such as Windows Explorer or similar.

FILE SIZES AND NAMES

The document File_Listing_PRJ37870NOP01.txt provides a list of the files contained in this volume.

3. ADDITIONAL SERVICES AND EXTRA DATA

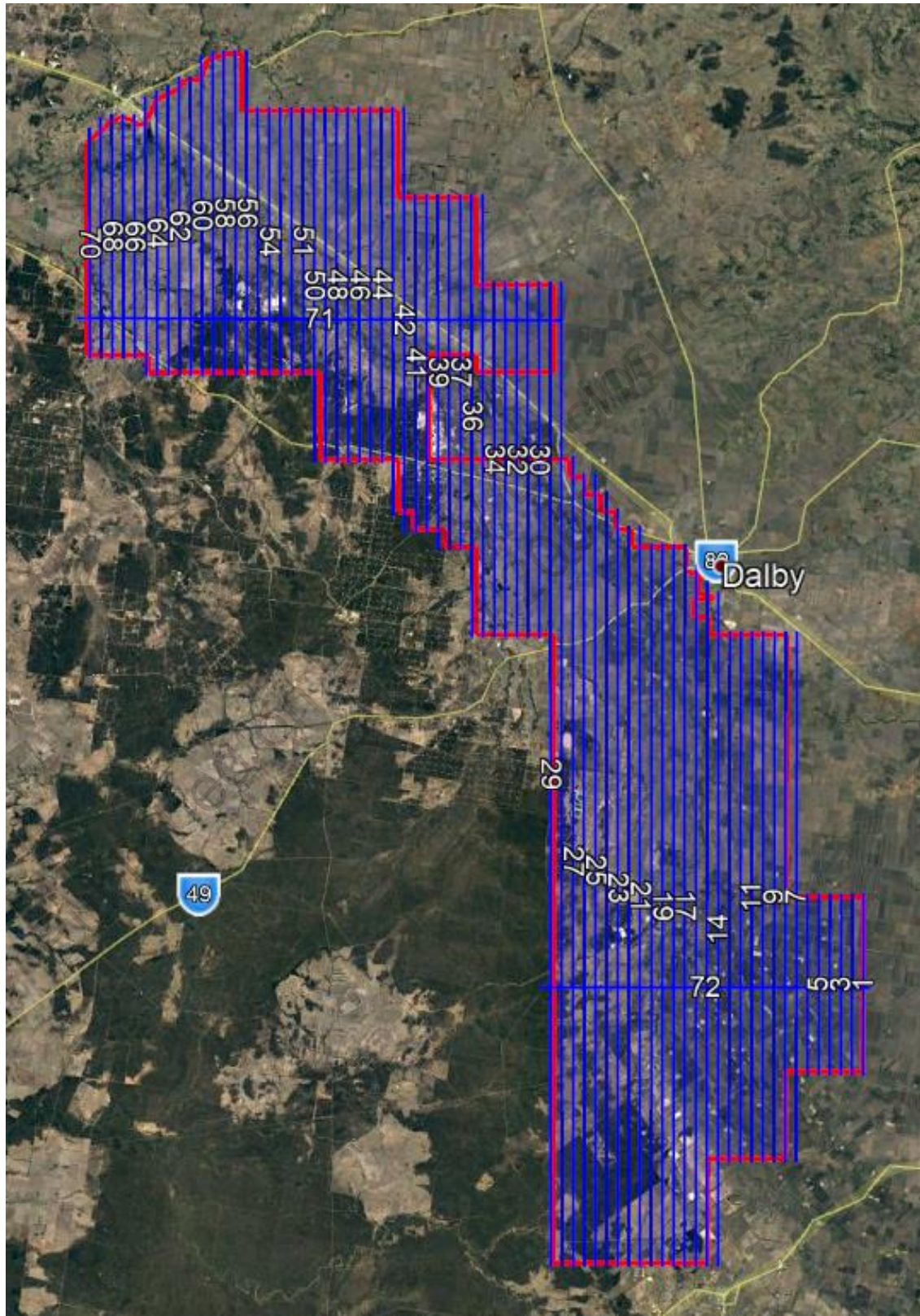
Product Generation

AAM can perform the following additional services on the data contained on this volume if required:

Change horizontal datum	: to AMG other local grid
Alter geoid modeling	: by transforming ALS data to fit orthometric survey heights
Improve data classification	: by tailoring parameters to suit regional variations
Further classification	: assist building identification by further classifying non-ground strikes
Data thinning	: to remove superfluous points not adding to the terrain definition
Data subset	: by dividing the data into different tiles or polygons
Data presentation	: by creating contours, profiles, perspectives, flythroughs, colour-coded height plots etc.
Ground truthing	: by comparing the ALS terrain model with extra independent height data
Data gridding	: to convert the measured spot heights into a regular grid
Extra data	: extra data was collected beyond that supplied on this volume (see below)
Intensity Image	: greyscale image created from laser's intensity returns
Fly – Throughs / 3d Perspectives	Image draping /slope models

Extra Data Captured**COVERAGE Extents**

Laser Data shown in the below image outside the project boundary may be of a lower accuracy. It is not supplied within this volume and no manual classification editing has been undertaken.



4. METADATA

SOURCE DATA

Item	Source	Description	Ref No	Date
Laser System	AAM	Galaxy Prime 424	PRJ37870	15/10 to 6/11/2020
Camera	AAM	A3 Edge - 33	PRJ37870	1/11 to 3/11/2020
Airborne GPS Solution	AAM	RTX	PRJ37870	
Ground control	AAM	RTK GPS	PRJ38780	29/10 to 5/11/2020

*Trimble CenterPoint® RTX™ is a proprietary GPS, GLONASS, BeiDou, and QZSS enabled technology that provides high-accuracy GNSS positioning worldwide without the use of traditional local base stations or a VRS network. By combining real-time data from a global reference station infrastructure with innovative positioning and compression algorithms, Trimble RTX technology computes centimeter-level positions based on satellite orbit and clock information.

METADATA ELEMENTS

Characteristic	Description
Device Name:	Galaxy Prime 424
Half Scan Angle:	25 degrees
Laser Pulse Rate:	450 kHz
Laser Scan Frequency:	40 Hz
Laser Pulse Mode:	Automatic
Imagery:	NA
Laser Footprint Size:	0.4m
File Format:	ESRI ASCII, Shape, LAS V1.2
Contour Interval:	1.0m
DTM GSD:	1.0m
Horizontal Datum:	GDA2020
Vertical Datum:	AHD using Ausgeoid2020
Map Projection:	MGA Zone 56
Vertical Accuracy:	±0.05m Standard Error (68% confidence level or 1 sigma)

REFERENCE SYSTEMS

	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 50	N/A
Geoid Model	N/A	Ausgeoid2020

5. ACCURACY

PROJECT DESIGN ACCURACY

Project specifications and technical processes were designed to achieve data accuracies as follows:

	Measured Point	Derived Point	Basis of Estimation
Vertical data		0.05m	Project Design
Horizontal data	0.20m		System specifications ($1/5500$ flying height)

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in meters.
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modelling refer to the terrain definition on clear ground. Ground definition in vegetated terrain may contain localized areas with systematic errors or outliers which fall outside this accuracy estimate.
- Laser strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

LIMITATIONS OF DATA

- The definition of the ground under trees may be less accurate.

DATA VALIDATION**Lidar Data**

LiDAR Ground data in this volume has been compared to new test points obtained by field survey and assumed to be error-free. The test points used for the comparison were located on open clear ground within each area (test points not on open clear ground were removed). The test points were distributed in twenty groups across the mapping area. Comparison of the field test points with elevations interpolated from measured data before adjustment resulted in:

Ref Point Site	Mean Difference (m)	RMS (m)	StDeviation (m)
1	0.055	0.059	0.021
2	Not Used		
3	0.075	0.076	0.019
4	0.139	0.140	0.018
5	0.132	0.133	0.019
6	0.087	0.091	0.026
7	0.065	0.066	0.014
8	0.079	0.082	0.020
9	0.067	0.068	0.014
10	0.134	0.134	0.015
11	0.110	0.112	0.024
12	0.090	0.090	0.010
13	Not Used		
14	0.060	0.063	0.017
15	0.069	0.070	0.009
16	0.097	0.100	0.025
17	0.092	0.093	0.015
18	Not Used		
19	0.019	0.024	0.014
20	0.044	0.049	0.020
21	-0.006	0.018	0.017
22	0.089	0.090	0.013
23	0.030	0.034	0.017

The mean difference of 0.07m has been removed from the data. Final accuracy estimates after removing the mean offset yielded:

Ref Point Site	Mean Difference (m)	RMS (m)	StDeviation (m)
1	-0.011	0.019	0.016
2	Not Used		
3	0.005	0.017	0.016
4	0.076	0.077	0.014
5	0.061	0.064	0.018
6	0.018	0.030	0.025
7	-0.008	0.012	0.009
8	0.008	0.019	0.017
9	-0.003	0.013	0.012
10	0.062	0.063	0.014
11	0.041	0.047	0.023
12	0.020	0.022	0.010
13	Not Used		
14	-0.010	0.018	0.015
15	0.000	0.007	0.007
16	0.027	0.035	0.023
17	0.019	0.021	0.010
18	Not Used		
19	-0.053	0.054	0.009
20	-0.026	0.030	0.015
21	-0.076	0.077	0.017
22	0.018	0.022	0.012
23	-0.039	0.042	0.014

An area-wide comparison of all 2733 test point elevations yielded the following overall accuracy:

Average dz	+0.008m
Minimum dz	-0.040m
Maximum dz	+0.056m
Average magnitude	0.021m
Root mean square	0.025m
Std deviation	0.024m

6. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **ARROW ENERGY PTY LTD**.

The data in this volume is provided by AAM Pty Limited (AAM) to **ARROW ENERGY PTY LTD** under the client's Terms of Engagement, which require **ARROW ENERGY PTY LTD** to assume beneficial ownership, subject to the following conditions:

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Any breach of these conditions will result in the immediate termination of the license issued by AAM, and **ARROW ENERGY PTY LTD** will indemnify AAM from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

AAM Pty Limited

Level 3, 1002 Hay St.
PERTH WA 6000
Telephone (08) 9228 6800
Facsimile (08) 9228 6806
Email info@aamgroup.com
Web www.aamgroup.com

7. VALIDATION PLOT

Lidar Overview (Colour Elevation Image)



ARROW ENERGY PTY LTD

SUBSIDENCE MONITORING SURVEY SPRING 2021

VOLUME: PRJ40275_02

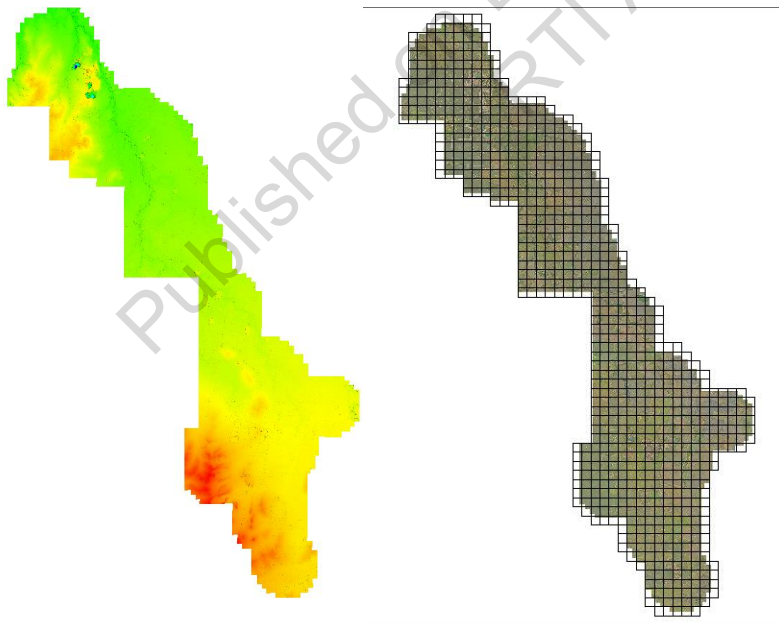
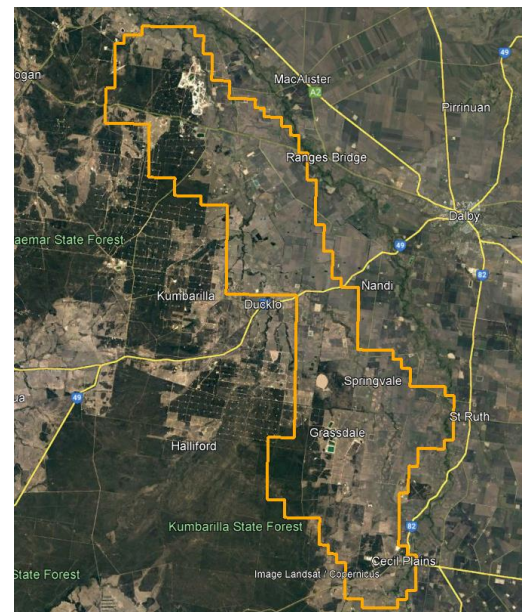
PROJECT SUMMARY

The SUBSIDENCE MONITORING SURVEY SPRING 2021 Project was a combined Ground and Airborne Survey that was carried out in Spring 2021 with the aim of monitoring potential subsidence over the Surat Gas project. In dispatch Volume PRJ40275_01 Tiff imagery was not supplied. This is supplied in addition under this volume although all documentation is still included for both supplies.

Aerial capture occurred on 15th and 20th November plus 16, 20 and 22nd December 2021 over an 829 km² site in Queensland. The Aerial LiDAR survey was planned to achieve +/- 5cm vertical accuracy with an emitted density of 10ppsm or better with classification to ICSM level 2. RGB Imagery products with a GSD of 10cm were generated from simultaneously captured imagery with a planned accuracy of better than 2Px (RMS)

Land survey occurred on 1 -3rd and 17 – 18th November 2021.

The data in this volume contains Land based survey as well as Airborne LiDAR and Imagery based on the GDA2020 datum, MGA Zone 56 projection with AHD obtained via the Ausgeoid2020 geoid model.



DATA SUMMARY

This volume includes the following data in MGA56 (GDA2020) and AHD (Via Ausgoid09):

- 828 x 1km² tiles of ICSM L2 Classified Ground only Point Cloud data in LAS v1.2 format
- 828 x 1km² tiles of ICSM L2 Classified Non-Ground only Point Cloud data in LAS v1.2 format
- 828 x 1km² tiles of 1m cell size DTM Grids in XYZ ASCII format
- 828 TIFF tiles
- 1 x 10cm GSD RGB Orthophoto Mosaic in ECW format
- Land survey results and PSM pictures
- Area of interest polygon in Shapefile and KMZ format
- 1km Lidar Tile layout in Shapefile format
- File listing in .txt format
- Readme*.pdf file: This document in PDF format

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PROJECT REPORT

Safety: No safety Incidents were reported during the project.

Acquisition: Aerial capture occurred on 15 th and 20th November plus 16, 20 and 22nd December 2021 over an 829 km2 site in Queensland.

Ground Support: (Land survey) : AAM sent their Land Survey Team to undertake the control surveys for this project on 01-03 and 17-18th November 2021.

Resurvey of previous control mark for previous test sites within or close to the current AOI. Of the previously surveyed test sites, 4 sites (PM183307, PM183521, PM39211 & PM73029) were resurveyed by a long period (6 – 12 hours) of static GNSS observation. This data was then used to obtain a Final Orbit AusPos result via the Geoscience Australia online AusPos processing facility. The new coordinates were compared to the previously surveyed coordinates and the differences calculated and applied to the previously surveyed test site points. Those adjusted test site point coordinates were used as the new test site for LiDAR. The spreadsheet below shows the coordinates and comparisons. Note that published coordinates are also shown, but these were not used in the data processing.

Auspos Values December 2021 (Final Orbit)				Auspos Values November 2020 (Final Orbit)				Form 6 Values for PM's				Differences between Auspos December 2021 and Form 6 Values			Differences between Auspos November 2020 Auspos December 2021			Comments
Station	Easting	Northing	AHD Height	Station	Easting	Northing	AHD Height	PM	Easting	Northing	AHD Height	AE	AN	AH	AE	AN	AH	
Note: mark accuracy is variable, refer to Form 6's																		
PM183307	321769.251	6969727.723	345.780	PM183307	321769.247	6969727.718	345.781	PM183307	321769.244	6969727.755	345.761	0.007	-0.032	0.019	0.004	0.005	-0.001	AAM mark + test site
PM183521	309848.658	6983453.288	334.318	PM183521	309848.661	6983453.295	334.285	PM183521	309848.670	6983453.312	334.347	-0.012	-0.024	-0.029	-0.003	-0.007	0.033	AAM mark + test site
PM39211	320822.187	6953348.389	360.046	PM39211	320822.193	6953348.381	360.035	PM39211	320822.188	6953348.373	360.038	-0.001	0.016	0.008	-0.006	0.008	0.011	AAM mark + test site
PM73029	298486.140	7001636.396	325.093	PM73029	298486.136	7001636.394	325.127	PM73029	298486.145	7001636.417	325.190	-0.005	-0.021	-0.097	0.004	0.002	-0.034	AAM mark + test site

Survey of new control marks and test sites provided by Arrow within or close to the current AOI. As part of this epoch of survey, Arrow Energy provided a list of other existing PSM's to be surveyed. A subset of 4 of those marks (PM188408, PM191534, PM1991535 & 202604) were close to or within the AOI, so these were not only surveyed via static GNSS and a result via AusPos, but a GNSS base + rover was used to collect an array of test site points on a suitable surface nearby. These were also used in the processing

Survey of new control marks provided by Arrow beyond the current AOI. Of the list of mark provided by Arrow, the marks that did not require adjacent test site point to be collected were only surveyed by static GNSS, with a final coordinate again provided via AusPos. PSM 191534 needed a site induction prior to obtaining access.

s.73 Irrelevant information

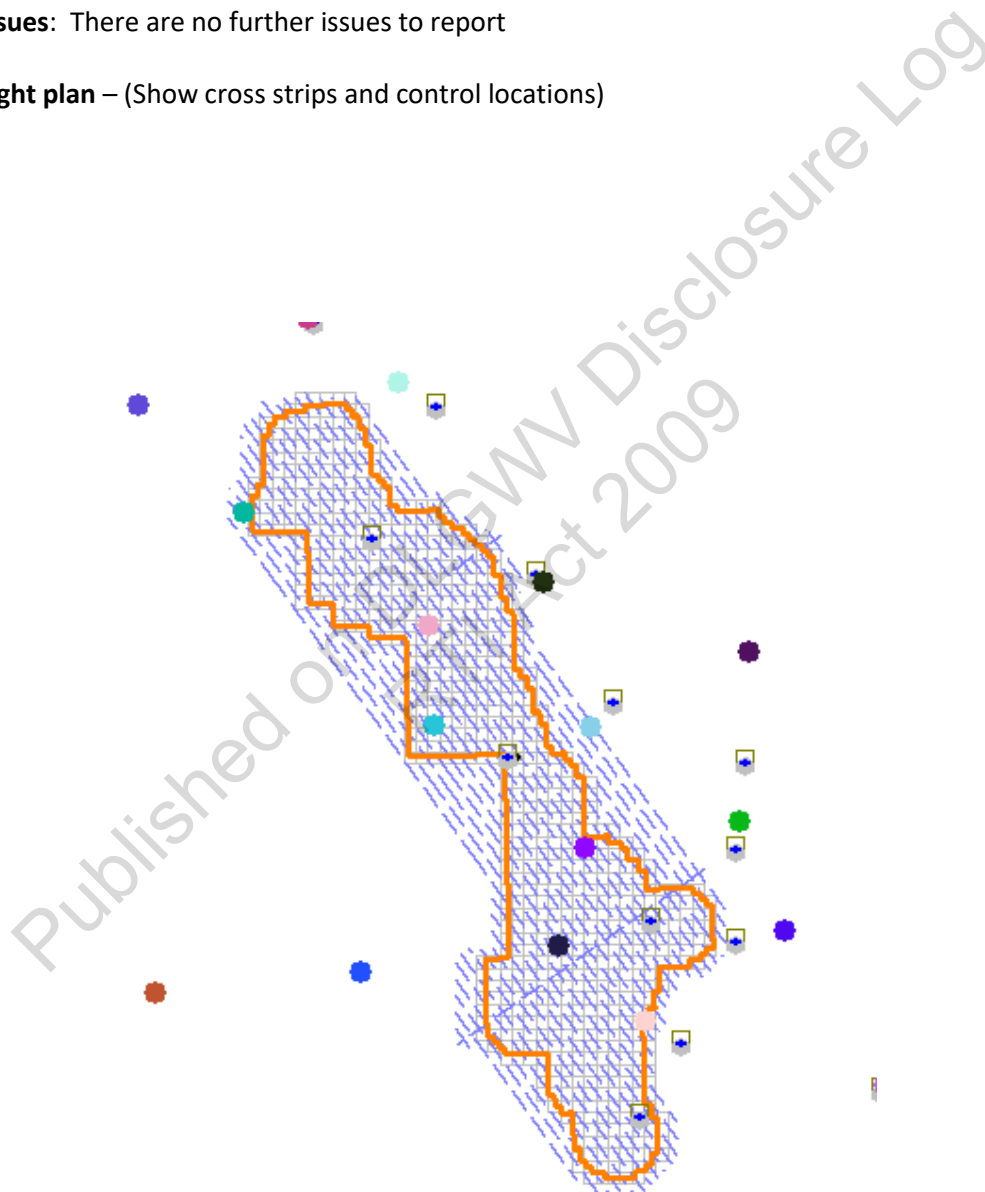
Data Processing: Reduction of the ALS data proceeded without any significant problems. Laser strikes were classified into ground and non-ground points using a single algorithm across the project area. Manual checking and editing of the data classification further improved the quality of the terrain model.

Further Processing: A 1m DTM grid was generated from a triangulated model using Ground classified points. This method uses the closest triangles and applies weights to the proportionate areas from the grid cell centroid to interpolate the value. It uses known elevation data, it does not make any predictions regarding the surface and accurately depicts existing troughs and peaks in the data and supports irregular point spacing, which suits the nature LiDAR data.

Data Presentation: The data provided on this volume has been supplied in accordance with a specification agreed with the primary client. Subsequent users experiencing difficulties in handling the data should please contact AAM to arrange a more appropriate data presentation.

Further Issues: There are no further issues to report

Overall flight plan – (Show cross strips and control locations)



1. DATA INFORMATION

Data supply: AAM AWS S3 (Links via e-mail)
 Number of files: 3,426 including 1 x file_listing.txt and README.PDF – Vol PRJ40275_01
 3,314 including 1 x file_listing.txt and README.PDF - Vol PRJ40275_02
 Data formatted on: 15.03.2022
 README Document: This file

Previous Project Deliveries	Date	Title	Contents
PRJ40275_01	21.02.2022	Subsidence Monitoring Survey Spring 2021	Lidar products and ECW imagery and survey report
PRJ40275_02	15.03.2022	Subsidence Monitoring Survey Spring 2021	TIFF ortho tiles- This delivery

File Details this Delivery	Contents
01_Ground_LAS\288000_7002000.las	Ground only LAS V1.2
02_Non-Ground_LAS\288000_7002000.las	Non-Ground only LAS V1.2
03_DTM_ASCII\ 288000_7002000.asc/prj	1m cell DTM ASCII Ungen fmt
Arrow_Energy_November_2021_10cm_MGA56_GDA2020.ecw/ers	10cm RGB Ortho mosaic
288000_7002000.tiff/tfw/ers/tab	10cm RGB TIFF Ortho tiles
PRJ40275_02_Lidar_Test_Points_Results_GDA2020.xls	Field survey results
SCR039211.pdf	Form 6 PSM survey results
IMG_9992.jpg	Survey mark photos
PRJ40257_Arrow_2021_AOI_MGA56_GDA2020.sha	Area of interest polygon
PRJ40275_02_Tile_Layout_GDA2020_MGA56.sha	Tile layout shape file
PRJ40275_02_File_Listing.txt	Listing of files delivered in this volume
Readme_PRJ40275_02*.pdf	This file in pdf format

2. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	AAM	Optech Galaxy 473	FL016090	15.11.21
			FL016121	20.11.21
			FL016353	16.12.21
			FL016398	20.12.21
			FL016414	22.12.21
Imagery	AAM	Phase One P1-002	Matches LiDAR dates	
Trajectory	AAM	RTX	Matches LiDAR dates	
Survey control	AAM	Static GPS /RTK (PRJ37870 & 40275)	PRJ40275	01.11.2021
			PRJ40275	02.11.2021
			PRJ40275	03.11.2021
			PRJ40275	17.11.2021
			PRJ40275	18.11.2021
Test points	AAM	Static GPS /RTK	PRJ40275	As above
Imagery control	AAM	Static GPS /RTK	PRJ40275	As above

LiDAR Characteristics	Description
Format	LAS 1.2
Emitted Density	4 ppm ²
Model Key Point Thinning	N/A
Tile size	1000m x 1000m
ICSM Classification	Level 3. Ground Correction (99% CL)

Number	Point Class	Description	ICSM	CI %
1	Default	Unclassified	2	98
2	Ground	Ground	2	98

Reference: <https://www.icsm.gov.au/>

Ortho Characteristics	Description
Format	ECW (Volume PRJ40275_01_ & TIFF (Volume PRJ40275_02)
Ground Sample Distance	10cm
Terrain Model	Gridded DEM from LiDAR
Sample Type	8-bit Integer x 3
Image Bands	RGB
Orientation/AT	Block Adjustment

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	Ausgeoid2020
Reference Point	See AUSPOS reports	See AUSPOS reports
Survey Control	PM183307 321769.251e 6969727.723n	345.780 RL AHD
	PM183521 309848.658e 6983453.288n	334.318 RL AHD
	PM39211 320822.187e 6953348.389n	360.046 RL AHD
	PM73029 298486.140e 7001636.396n	325.093 RL AHD
Note	All survey control obtained with 6hr+ AUSPOS	

Note: On 11-10-2017, Australia formally changed its official reference datum from GDA94 to GDA2020, and its map grid from MGA94 to MGA2020. MGA2020 coordinates are approximately 1.7m different from MGA94.



This data is GDA2020-compliant

GDA2020 compliant spatial data is information which has been measured with direct reference to the 2020 datum

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Ground control	0.05m		Survey methodology used
Lidar Test points	0.05m		Survey methodology used
Lidar (Horizontal)	0.10m		Project design
Lidar (Vertical)	0.05m		Project design
Derived DTM		0.07m	Methodology used
Ortho Pixels	0.2m		Project design

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Limitations of Data

- Features obscured by foliage or shadow may not appear.
- The definition of the ground under trees or shadow may be less accurate.
- Underground services have not been mapped.
- The rectified images in this volume were obtained by applying an orthophoto projection where corrections were applied for height displacement tips and tilts using a LiDAR sourced DTM.

Data Validation – LiDAR Data

- Ground data in this volume has been compared to 980 test points (152 classed outliers) obtained by field survey and assumed to be error-free. The test points were distributed in 8 groups across the mapping area and located on clear ground. Comparison of the test points with elevations interpolated from measured data resulted in:

Mean difference: -0.119m
 Av.Standard Error (RMS): 0.023m

This mean elevation difference (-0.119m) has been removed from the data supplied in this volume

Site	dZ	RMS	SD	Calc	Post dZ	Post RMS	Post SD
<i>Average</i>	<i>0.119</i>			<i>0.000</i>	<i>0.001</i>		
Test_Site_01(PM191534)_Grassdale Feedlot	0.112	0.112	0.009	-0.007	-0.007	0.012	0.009
Test_Site_02(PM191535)_Cnr of Springvale Rd and Nandi Rd	0.136	0.136	0.013	0.017	0.017	0.021	0.013
Test_Site_03(PM202604)_Ducklo School Rd	0.080	0.080	0.006	-0.039	-0.039	0.040	0.006
Test_Site_04(PM188408)_Dalby Kogan Rd	0.140	0.141	0.017	0.021	0.021	0.027	0.017
Test_Site_PM39211_November 2020	0.108	0.110	0.018	-0.011	-0.007	0.022	0.021
Test_Site_PM73029_November 2020	0.109	0.111	0.018	-0.010	-0.010	0.021	0.018
Test_Site_PM183307_November 2020	0.147	0.147	0.009	0.028	0.028	0.029	0.009
Test_Site_PM183521_November 2020	0.120	0.121	0.014	0.001	0.001	0.014	0.014

- Data classification has been manually checked and edited against any available imagery.

Data Validation – Orthophoto Image

- The Orthophoto has been compared to 11 test points obtained by field survey and assumed to be error-free. The test points were distributed across 80% of the orthophoto area. Comparison of the orthophoto with the test points resulted in a horizontal standard error (RMS) for the orthophoto of 0.075 m or <1 pixel

PointName	Type	Easting	Northing	Height	dX	dY
Point01	XYOnly	295435.640	7009571.193	320.478	0.085	-0.016
Point02	XYOnly	291529.260	7003879.057	361.050	-0.058	-0.052
Point03	XYOnly	303826.618	6986724.247	330.734	-0.045	-0.054
Point04	XYOnly	311253.616	6987066.507	334.484	-0.098	-0.030
Point05	XYOnly	317777.379	6951202.821	363.826	-0.016	0.020
Point06	XYOnly	325105.905	6971082.198	345.364	-0.086	-0.004
Point07	XYOnly	310928.678	6971075.888	344.859	-0.007	0.037
Point08	XYOnly	301428.014	6998532.582	323.738	-0.056	0.048
Point09	XYOnly	316651.159	6964945.858	349.939	0.052	-0.029
GCP03	XYOnly	304365.960	6996529.091	328.199	-0.028	-0.093
GCP06	XYOnly	305022.288	6997620.334	328.883	0.073	0.009

Data Validation – Field Survey Data

- This data has not been tested for accuracy by an independent, more accurate method. Data was compiled in a process that regularly yields the accuracy estimates reported above

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **ARROW ENERGY PTY LTD**.

The data in this volume is provided by AAM Pty Limited (AAM) to **ARROW ENERGY PTY LTD** under the client's Terms of Engagement, which require **ARROW ENERGY PTY LTD** to assume beneficial ownership, subject to the following conditions:

This file (README_PRJ40275_02.PDF) is always stored with the unaltered data contained in this volume.

1. The data is not altered in any way without the approval of AAM. The data may be copied from this file to another.
2. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by AAM.

Any breach of these conditions will result in the immediate termination of the license issued by AAM, and **ARROW ENERGY PTY LTD** will indemnify AAM from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

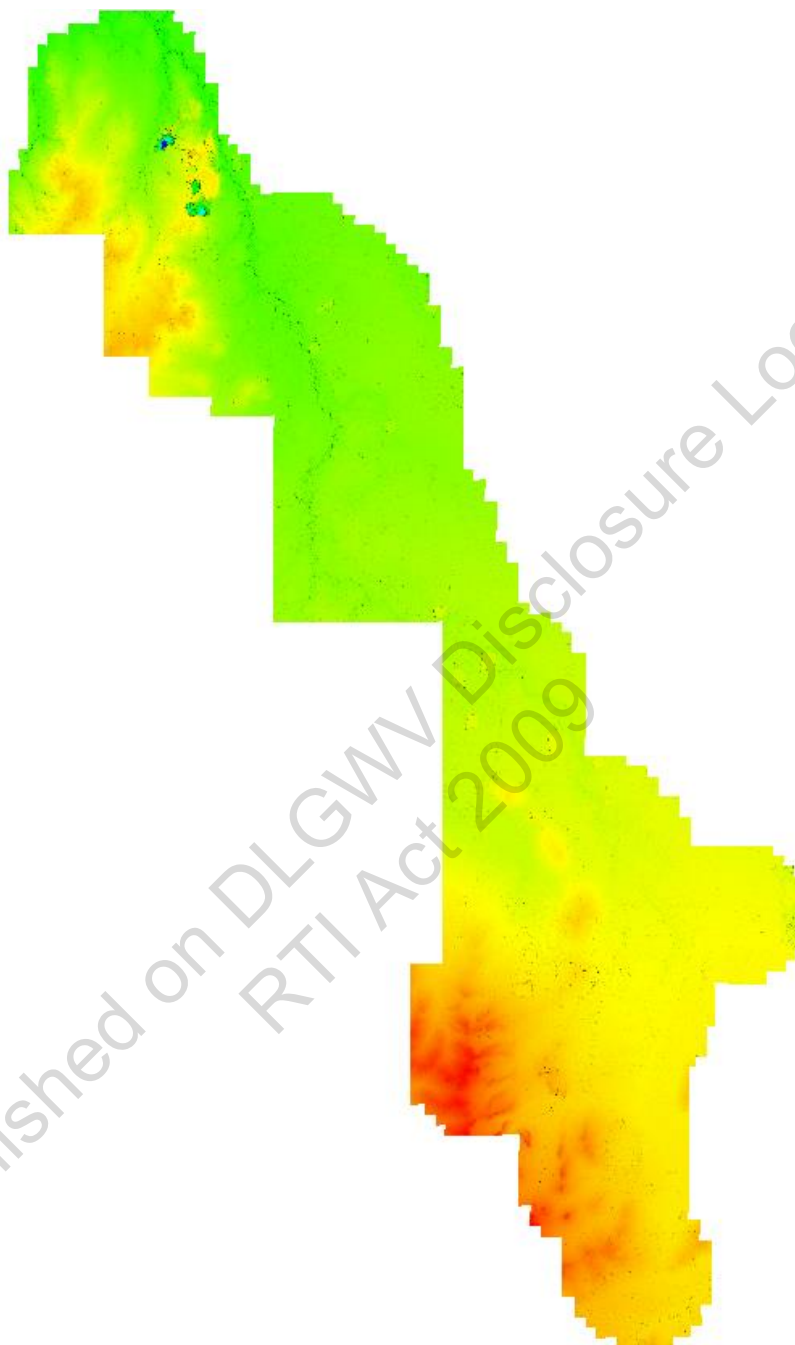
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4. VALIDATION

Ortho tiles



Lidar



ARROW ENERGY PTY LTD

SUBSIDENCE MONITORING SURVEY 2022

VOLUME: PRJ41646_01-05

PROJECT SUMMARY

The SUBSIDENCE MONITORING SURVEY 2022 Project was a combined Ground and Airborne Survey that was carried out in 2022 over an area of ~4643 km² with the aim of monitoring potential subsidence over the Surat Gas project.

Aerial capture occurred on 13th June and 7th August 2022. The Aerial LiDAR survey was planned to achieve +/- 5cm vertical accuracy with an emitted density of 10ppsm or better to attain ground return of +4ppsm with classification to ICSM level 2. RGB Imagery products with a GSD of 10cm were generated from simultaneously captured imagery with a planned accuracy of better than 2Px (RMS)

Geodetic Land survey occurred between 5th and 24th September 2022 based on high end GPS observations

The data in this volume comprises areas notes as A, B, C, D supplied under volume PRJ41646_01-05 and this readme refers to all 5 areas. The data comprises Land based high end geodetic survey as well as Airborne LiDAR and Imagery based on the GDA2020 datum, MGA Zone 56 projection with AHD obtained via the Ausgeoid2020 geoid model.



DATA SUMMARY

This volume includes the following data in MGA54 (GDA2020) and AHD (Via Ausgoid2020):

- 5,100 x 1km² tiles of ICSM L2 Classified Ground only Point Cloud data in LAS v1.2 format
- 5,100 x 1km² tiles of ICSM L2 Classified Non-Ground only Point Cloud data in LAS v1.2 format
- 5,100 x 1km² tiles of 1m cell size DTM Grids in XYZ ASCII format
- 5,099 x 1km² tiles of 10cm RGB Orthophoto tiles in TIFF format
- 5 x 10cm GSD RGB Orthophoto Mosaic in ECW format
- Land survey results and PSM pictures
 - 01_PSMS_State_Survey_Marks 51 x listings in pdf
 - 02_Photos : 457 terrestrial photos
 - 03_AusPos_Final 33 Geoscience Australia submissions
 - 04_Coordinate_List 1 x test site locations (KMZ) : 1 x XLSX coordinate list
- Area of interest polygon in Shapefile and KMZ format
- 5 x 1km Lidar Tile layout in Shapefile format
- File listing in .txt format
- Readme*.pdf file: This document in PDF format

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1. PROJECT REPORT

Safety: No safety Incidents were reported during the project.

Acquisition: Aerial capture occurred on 13th June and 7th August 2022. It must be stated that this was an incredibly wet year with great difficulties posed by post Covid shortages too.

Control Mark Survey : Field survey was preformed by 2 teams between 5th September and 24th September 2022.

A total of 33 existing PM's were surveyed. This was done by logging a long period (6-12 hours) of static GNSS observations with a geodetic-standard GNSS receiver (Leica GS15's). That data was then submitted to the Geosciences Australia AusPos online processing facility to obtain a Final Orbit AusPos result.

Of those 33 PM's, 24 were marks surveyed in previous years. The 2022 coordinates for each mark were compared with the 2021 (24 marks) and 2020 (2 marks) results and tabulated in the supplied spreadsheet.

Of those 33 marks, 9 were marks surveyed for the first time this year.

A further 10 existing PM's were not surveyed this year for a variety of reasons listed in the spreadsheet, ranging from being in private property, access impeded by flooding, or even the mark simply being destroyed. Where possible, another mark was surveyed in its place (included in the count of 33 marks above) and this is noted in the spreadsheet.

Auspos Values September 2022 (Final Orbit)				Comments
Station	Easting	Northing	AHD Height	
PM183307	321769.258	6969727.735	345.766	Repeat Survey. Test site 07
PM73029	298486.135	7001636.4	325.095	Repeat Survey. Test site 05
PM188408	287679.577	7003985.395	330.984	Repeat Survey. Test site 14
PM191535	316096.276	6976019.729	339.794	Repeat Survey.
PM202604	303611.484	6986188.608	330.846	Repeat Survey. Test site 13
PM64763	327823.402	6943292.497	362.381	Repeat Survey. Test site 19
PM86265	270175.094	7031919.744	306.868	Repeat Survey.
PM122644	266595.604	7024490.947	321.926	Repeat Survey.
PM129706	330126.903	6992285.272	344.17	Repeat Survey.
PM153126	239930.005	7058971.664	331.117	Repeat Survey. Test site 03
PM176255	211123.882	7066091.102	348.024	Repeat Survey. Test site 01
PM177503	228493.044	7047798.382	360.922	Repeat Survey.
PM178881	280270.157	6963908.649	414.892	Repeat Survey.
PM183990	278911.487	7012826.109	370.394	Repeat Survey.
PM185996	297361.457	6965636.516	347.833	Repeat Survey. On Flood plain
PM189217	211179.399	7082191.2	368.215	Repeat Survey. Test site 02
PM196371	268459.803	7042380.075	302.971	Repeat Survey.
PM196380	219383.448	7056804.386	305.024	Repeat Survey. Test site 20
PM199039	316545.971	6986040.829	335.534	Repeat Survey.
PM202601	329007.092	6978137.874	342.655	Repeat Survey.
PM202608	293092.078	7020059.296	315.869	Repeat Survey. Test Site 15
PM202750	300630.134	7014794.279	321.525	Repeat Survey.
PM202762	284250.41	7026257.688	317.509	Repeat Survey.
PM207425	341095.091	6956194.158	361.317	Repeat Survey. Test site 18

PM8249	303855.715	7012525.444	324.588	Newly Surveyed. Test site 06
PM42336	328745.898	6919439.286	394.26	Newly Surveyed. Test site 17
PM46544	329609.115	6982979.177	341.932	Newly Surveyed. Test site 08
PM46547	328768.56	6968007.893	346.732	Newly Surveyed. Test site 09
PM64635	280512.183	7028882.672	317.875	Newly Surveyed. Test site 11
PM89350	266661.272	7038653.992	317.056	Newly Surveyed. Test site 12
PM148210	312228.261	6998565.818	327.472	Newly Surveyed. Test site 16
PM183988	265251.446	7017086.068	314.8	Newly Surveyed. Test site 10
PM207044	257851.777	7046081.608	325.223	Newly Surveyed. Test site 04

Some marks were not surveyed in 2020

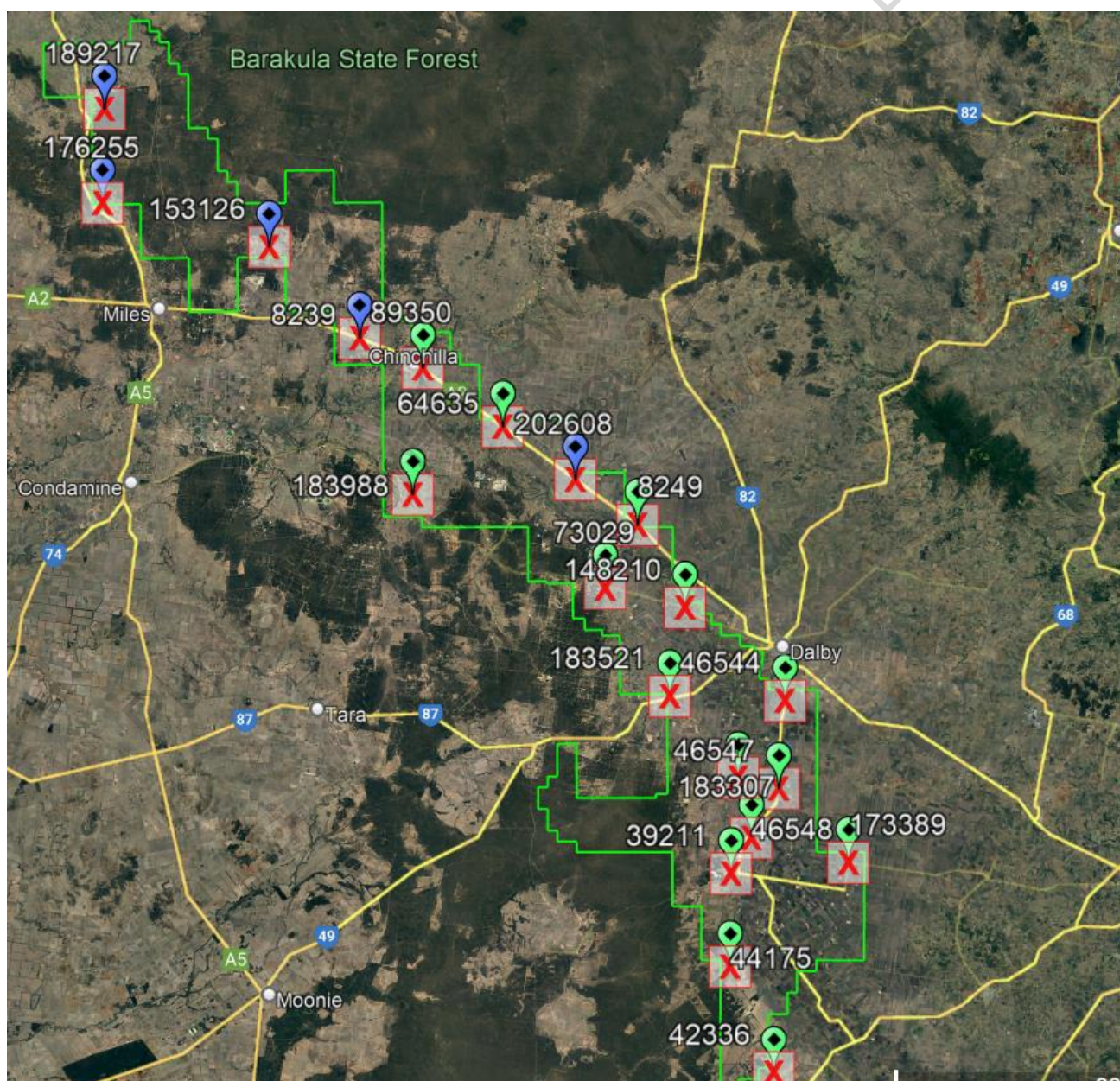
Marks Not Surveyed				
PM202986				Removed from survey as on private property.
PM202602				Private property, access refused by owner.
PM173469				Unable to access due to floodwater. Water over 0.9m. Only one road of access.
PM67790				Mark removed. Spoke to neighbour who confirmed farmer did earthworks.
PM167521				No access to mark. Abandoned private property with new gas line in progress.
PM204535				On Private Property. Unable to be accessed. Replaced with 129706.
PM202605				Mark flooded under 1 ft of water. Unable to drain to see mark. Replaced with
PM191534				Mark on Grassdale feedlot. Was unable to get access from them. replaced with
PM39211				Not on KMZ list to complete this year.
PM183521				Not on KMZ list to complete this year.

LiDAR Test Site Survey

At 20 of the above 33 marks, a LiDAR test site was also surveyed. These were comprised of an array of 50-100 points on a suitable nearby surface using a GNSS base+rover with the base set up directly over the PM. These test sites were used in the processing of the aerial data, either to shift the aerial data or as a check on adjusted aerial data to bring the LiDAR onto the same datum as the new 2022 survey datum.

The 9 newly-surveyed marks all had test site data collected at them. The other 11 test sites were collected from the group of 24 previously surveyed marks.

Land Access Issue : There were no land access issues although it must be stated that AAM did not attempt to visit any sites on private land.



ARROW ENERGY PTY LTD

Data Processing: Reduction of the ALS data proceeded without any significant problems. Laser strikes were classified into ground and non-ground points using a single algorithm across the project area. Manual checking and editing of the data classification further improved the quality of the terrain model.

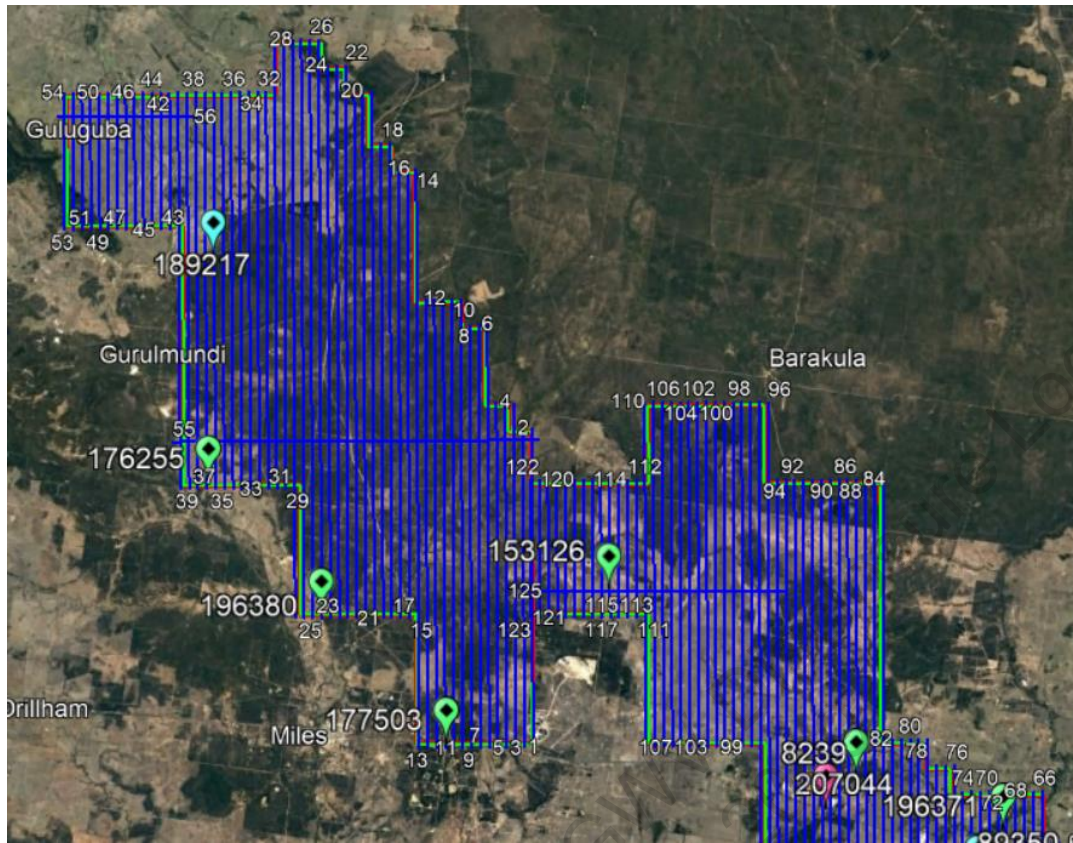
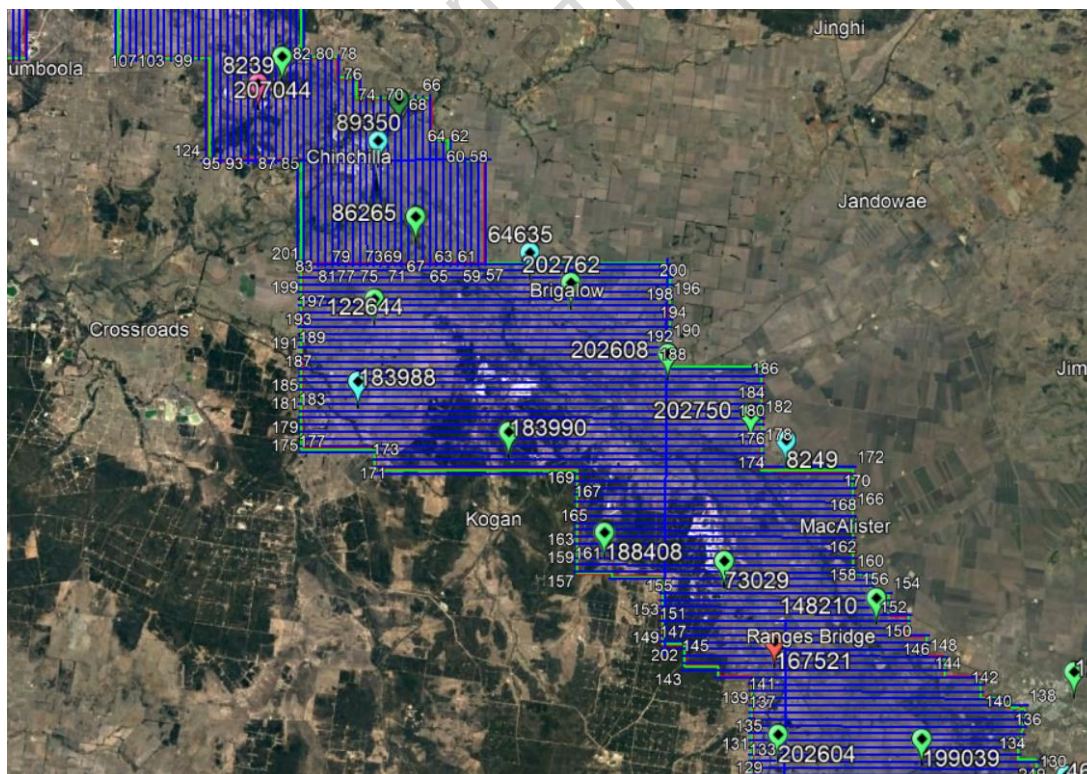
Further Processing: A 1m DTM grid was generated from a triangulated model using Ground classified points. This method uses the closest triangles and applies weights to the proportionate areas from the grid cell centroid to interpolate the value. It uses known elevation data, it does not make any predictions regarding the surface and accurately depicts existing troughs and peaks in the data and supports irregular point spacing, which suits the nature LiDAR data.

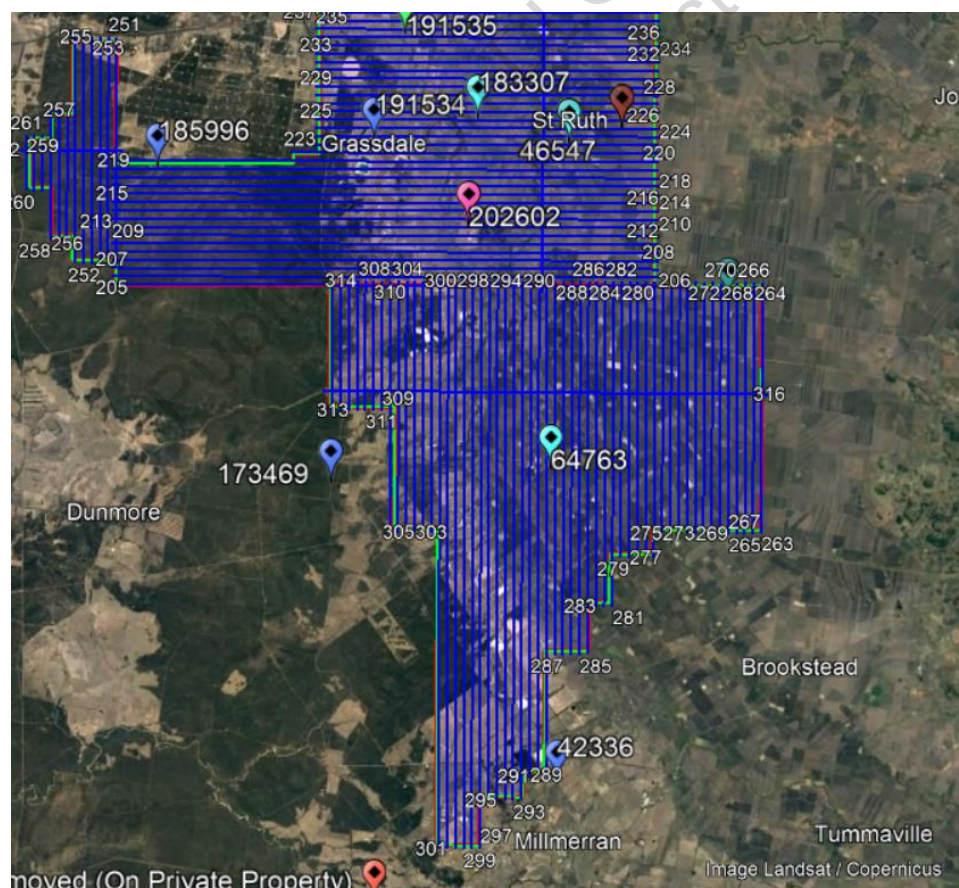
Data Presentation: The data provided on this volume has been supplied in accordance with a specification agreed with the primary client. Subsequent users experiencing difficulties in handling the data should please contact AAM to arrange a more appropriate data presentation.

Further Issues: There are no further issues to report

Published on DLGWV Disclosure Log
RTI Act 2009

Overall flight plan – (Show cross strips and control locations)





Data Docum

DATA INFORMATION

Data supply: AAM AWS S3 (Links via e-mail)
 Number of files: 41,419 including file_listing.txt and README.PDF
 Data formatted on: 26.11.2022
 README Document: This file

Deliveries	Date	Title	Contents
PRJ41646_01	25.11.2022	SUBSIDENCE MONITORING SURVEY 2022	Survey lidar and ortho imagery – This delivery

File Details this Delivery	Contents
01_Classified_Ground_Tiles_LAS\288000_7002000.las	Ground only LAS V1.2
02_Classified_Non-Ground_Tiles_LAS\288000_7002000.las	Non-Ground only LAS V1.2
03_DTM_Tiles_ESRI_ASCII\ 288000_7002000.asc/prj	1m cell DTM ASCII Ungen fmt
04_10cmGSD_RGB_Ortho_Tiles_TIFF\200000_7084000.tif.tfw/ers/tab/tfw	10cm RGB Ortho tiles
05_10cmGSD_RGB_Ortho_Mosaic_ECW\Arrow_Energy_Area_A_10cm_GDA2020_MGA56.ecw/ers/eww/tab	10 RGB Ortho mosaic
06_Land_Survey	Documents and photos
07_AOI_SHP	Area of interest and block definitions
08_Tile_Layout_SHP\PRJ41646_AOI-A_Tile_Layout_GDA2020_MGA56.shp/shx/dbf/prj	Tile layout shape file
09_Readme_PDF\Readme_PRJ41646_01-05*.pdf	This file in pdf format
10_File_Listing_TXT\PRJ41646_*File_Listing.txt	Listing of files delivered in this volume

2. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	AAM	Optech Galaxy 473	FL017495	13.06.2022
			FL017521	16.06.2022
			FL017625	28.06.2022
			FL017656	07.07.2022
			FL017677	07.07.2022
			FL017648	09.07.2022
			FL017691	10.07.2022
			FL017699	11.07.2022
			FL017706	12.07.2022
			FL017709	13.07.2022
			FL017717	14.07.2022
			FL017715	14.07.2022
			FL017733	15.07.2022
			FL017734	16.07.2022
			FL017747	17.07.2022
			FL017750	18.07.2022
			FL017755	19.07.2022
			FL017757	19.07.2022
			FL017767	24.07.2022
			FL017781	24.07.2022
			FL017786	25.07.2022
			FL017797	27.07.2022
			FL017800	27.07.2022
			FL017806	28.07.2022
			FL017807	29.07.2022
			FL017813	29.07.2022
			FL017816	29.07.2022
			FL017822	30.07.2022
			FL017863	04.08.2022
			FL017879	07.08.2022

ARROW ENERGY PTY LTD

Imagery	AAM	Phase One P1-002	Matches LiDAR dates	
Trajectory	AAM	RTX	Matches LiDAR dates	
Survey control	AAM	Static GPS /RTK (PRJ37870 & 40275)	PRJ41646	This survey
Test points	AAM	Static GPS /RTK	PRJ41646	This survey
Imagery control	AAM	Static GPS /RTK	PRJ41646	This survey

LiDAR Characteristics	Description
Format	LAS 1.2
Emitted Density	4 ppm ²
Model Key Point Thinning	N/A
Tile size	1000m x 1000m
ICSM Classification	Level 2. Ground Correction (98% CL)

Number	Point Class	Description	ICSM	CI %
1	Default	Unclassified	2	98
2	Ground	Ground	2	98

Reference: <https://www.icsm.gov.au/>

Ortho Characteristics	Description
Format	ECW
Ground Sample Distance	10cm
Terrain Model	Gridded DEM from LiDAR / Autocorrelation
Sample Type	8-bit Integer x 3
Image Bands	RGB
Orientation/AT	Block Adjustment

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	Ausgeoid2020
Reference Point	See AUSPOS reports	See AUSPOS reports
Survey Control	PM183307 321769.251e 6969727.723n	345.780 RL AHD
	PM183521 309848.658e 6983453.288n	334.318 RL AHD
	PM39211 320822.187e 6953348.389n	360.046 RL AHD
	PM73029 298486.140e 7001636.396n	325.093 RL AHD
Note	All AUSPOS computed control via enhance ephemeris after 6hr+ Obs Window	

Note: On 11-10-2017, Australia formally changed its official reference datum from GDA94 to GDA2020, and its map grid from MGA94 to MGA2020. MGA2020 coordinates are approximately 1.7m different from MGA94.



This data is GDA2020-compliant

GDA2020 compliant spatial data is information which has been measured with direct reference to the 2020 datum

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Ground control	0.05m		Survey methodology used
Lidar Test points	0.05m		Survey methodology used
Lidar (Horizontal)	0.10m		Project design
Lidar (Vertical)	0.05m		Project design
Derived DTM		0.07m	Methodology used
Ortho Pixels	0.2m		Project design

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Limitations of Data

- Features obscured by foliage or shadow may not appear.
- The definition of the ground under trees or shadow may be less accurate.
- Underground services have not been mapped.
- The rectified images in this volume were obtained by applying an orthophoto projection where corrections were applied for height displacement tips and tilts using a LiDAR sourced DTM.
- 2022 was an intensely wet season which brought moisture and turbulence. This disrupted capture continuity consistent LiDAR point density and accuracy to a minor degree.

Data Validation – LiDAR Data

Ground data in this volume has been compared to 19 test sites with each having approx. 100 points obtained by field survey and assumed to be error-free. The test points were distributed in 19 groups across the mapping area and located on clear ground. Adjustment occurred in 3 blocks dependent on the status of processing at the time with a shift in the order of 10cm found and applied. Results were good.

Comparison of the test points with elevations interpolated from measured data resulted in:

AOI_A-B

Site	dZ	RMS	SD	Calc	Post dZ	Post RMS	Post SD
<i>Average</i>	<i>0.099</i>			<i>0.000</i>	<i>0.001</i>		
Test_Site_01(PM176255)	0.082	0.096	0.051	-0.017	-0.016	0.053	0.051
Test_Site_02(PM189217)	0.125	0.127	0.024	0.026	0.027	0.036	0.024
Test_Site_03(PM153126)	0.109	0.109	0.008	0.010	0.011	0.014	0.008
Test_Site_04(PM207044)	0.096	0.098	0.018	-0.003	-0.002	0.018	0.018
Test_Site_11(PM64635)	0.102	0.102	0.013	0.003	0.004	0.013	0.013
Test_Site_12(PM89350)	0.080	0.081	0.014	-0.019	-0.018	0.023	0.014
Test_Site_20(PM196380)	0.101	0.103	0.020	0.002	0.003	0.020	0.020

AOI_C

Site	dZ	RMS	SD	Calc	Post dZ	Post RMS	Post SD
<i>Average</i>	<i>0.101</i>			<i>0.000</i>	<i>0.003</i>		
Test_Site_05(PM73029)	0.104	0.105	0.013	0.003	0.006	0.014	0.013
Test_Site_06(PM8249)	0.129	0.130	0.009	0.028	0.031	0.033	0.009
Test_Site_10(PM183988)	0.087	0.088	0.011	-0.014	-0.011	0.015	0.011
Test_Site_11(PM64635)	0.084	0.086	0.015	-0.017	-0.014	0.020	0.015
Test_Site_13(PM202604)	0.093	0.094	0.008	-0.008	-0.005	0.009	0.008
Test_Site_14(PM188408)	0.130	0.133	0.026	0.029	0.032	0.041	0.026
Test_Site_15(PM202608)	0.093	0.094	0.008	-0.008	-0.005	0.009	0.008
Test_Site_16(PM148210)	0.089	0.089	0.007	-0.012	-0.009	0.011	0.007

AOI_D-E

Site	dZ	RMS	SD	Calc	Post dZ	Post RMS	Post SD
<i>Average</i>	<i>0.093</i>			<i>0.000</i>	<i>-0.005</i>		
Test_Site_07(PM183307)	0.094	0.095	0.013	0.001	-0.004	0.013	0.013
Test_Site_08(PM46544)	0.097	0.097	0.007	0.004	-0.001	0.007	0.007
Test_Site_09(PM46547)	0.097	0.098	0.007	0.004	-0.001	0.007	0.007
Test_Site_18(PM207425)	0.100	0.102	0.015	0.007	0.002	0.015	0.015
Test_Site_19(PM64763)	0.076	0.077	0.016	-0.017	-0.022	0.027	0.016

- Data classification has been manually checked and edited against any available imagery.

Data Validation – Orthophoto Image

- The Orthophoto has been compared to 11 test points obtained by field survey and assumed to be error-free. The test points were distributed across 80% of the orthophoto area. Comparison of the orthophoto with the test points resulted in a horizontal standard error (RMS) of better than 2 pixels (0.2m)

Blocks A & B

Required Accuracy (RMS)	0.200m (2pixels)
RMS_X	0.039m
RMS_Y	0.071m
RMS_Positional_XY	0.081m
Number of Points	10
Type of GCP	From pre existing Oct2020 Imagery

Block C

Required Accuracy (RMS)	0.200m (2pixels)
RMS_X	0.071m
RMS_Y	0.062m
RMS_Positional_XY	0.094m
Number of Points	20
Type of GCP	From pre existing Oct2020 Imagery

Block D

Required Accuracy (RMS)	0.200m (2pixels)
RMS_X	0.089m
RMS_Y	0.057m
RMS_Positional_XY	0.106m
Number of Points	8
Type of GCP	From pre existing Oct2020 Imagery

Block E

Required Accuracy (RMS)	0.200m (2pixels)
RMS_X	0.054m
RMS_Y	0.071m
RMS_Positional_XY	0.089m
Number of Points	14
Type of GCP	From pre existing Oct2020 Imagery

Data Validation – Field Survey Data

- This data has not been tested for accuracy by an independent, more accurate method. Data was compiled in a process that regularly yields the accuracy estimates reported above

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **ARROW ENERGY PTY LTD**.

The data in this volume is provided by AAM Pty Limited (AAM) to **ARROW ENERGY PTY LTD** under the client's Terms of Engagement, which require **ARROW ENERGY PTY LTD** to assume beneficial ownership, subject to the following conditions:

This file (README_PRJ41646_01-05.PDF) is always stored with the unaltered data contained in this volume.

1. The data is not altered in any way without the approval of AAM. The data may be copied from this file to another.
2. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by AAM.

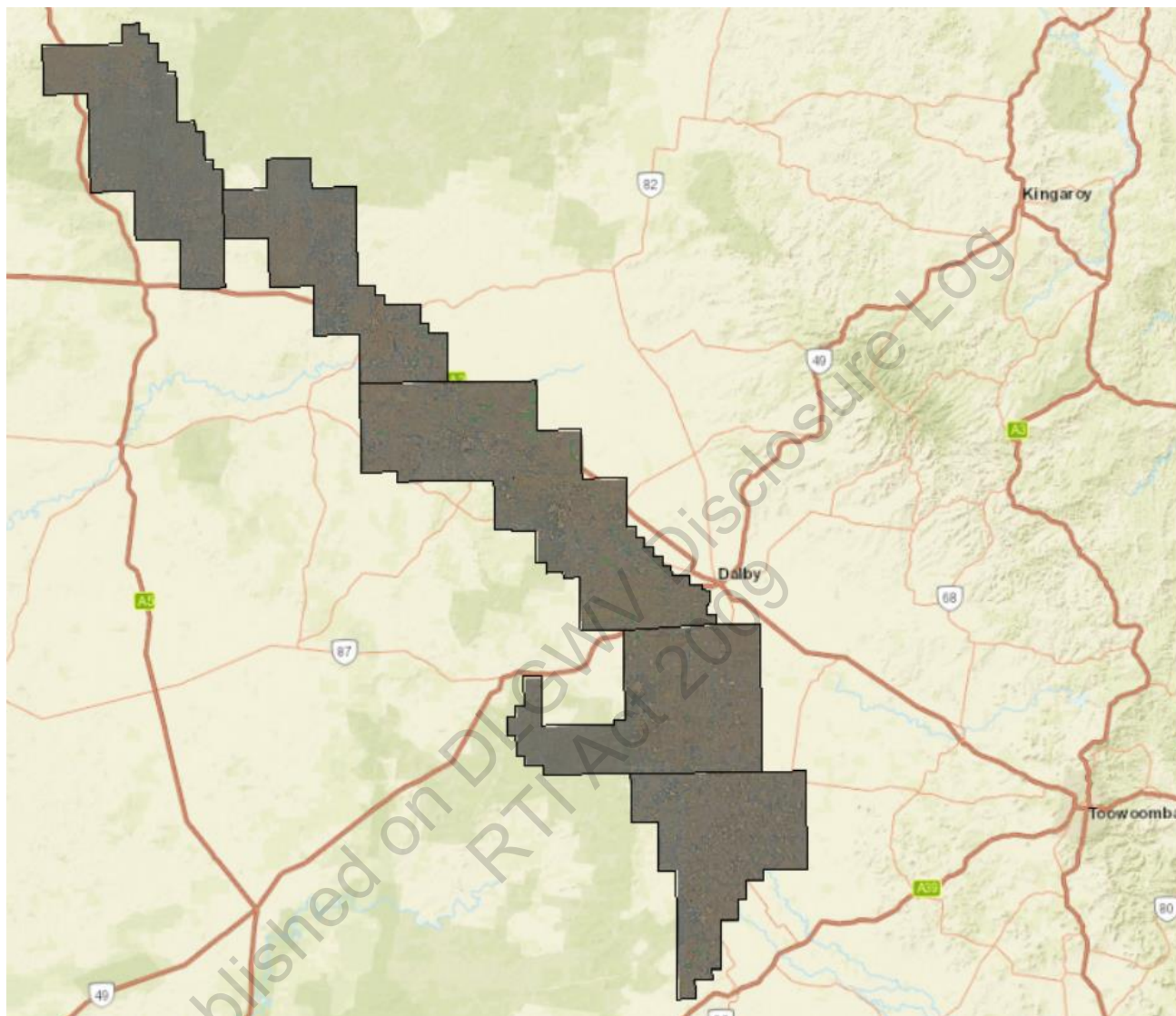
Any breach of these conditions will result in the immediate termination of the license issued by AAM, and **ARROW ENERGY PTY LTD** will indemnify AAM from all resulting liabilities.

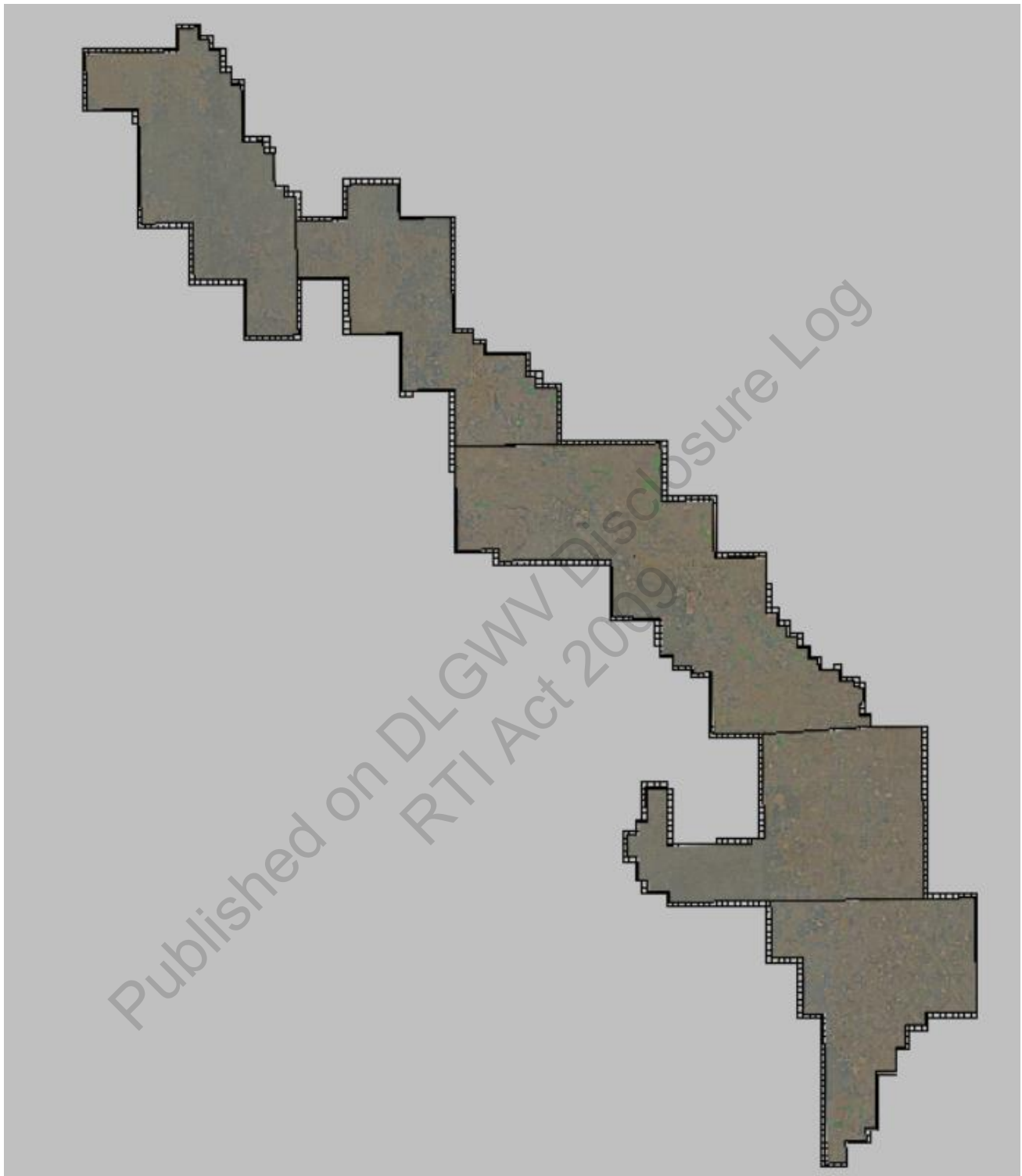
Any problems associated with the information in the data files contained in this volume should be reported to:

AAM Pty Limited
Suite 3, Level 23
6-10 O'Connell Street,
SYDNEY NSW 2000
AUSTRALIA
Telephone: +61 2 8879 1600
Facsimile: +61 2 8879 1633
info@aamgroup.com
www.aamgroup.com

4. VALIDATION

Ortho mosaic





Lidar - DTM



ARROW ENERGY PTY LTD

SUBSIDENCE MONITORING SURVEY 2022

VOLUME: PRJ41646_07 – Additional Data Processing

PROJECT SUMMARY

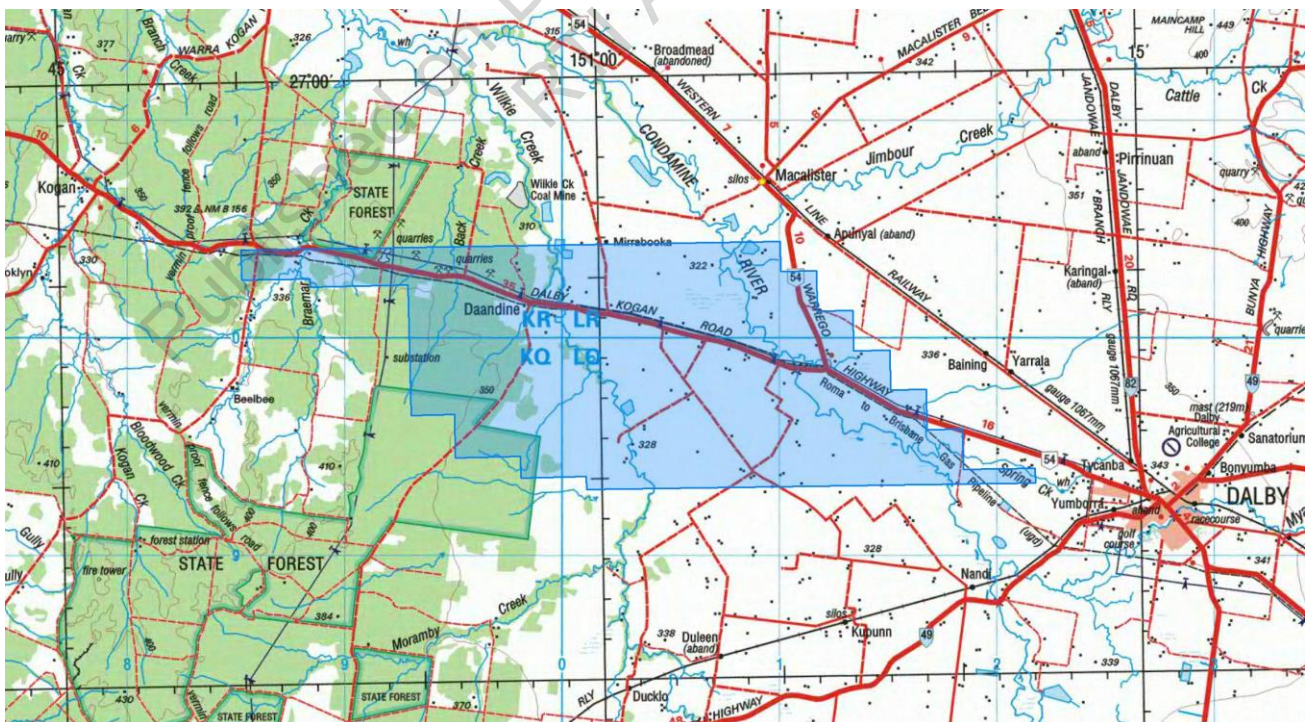
The SUBSIDENCE MONITORING SURVEY 2022 Project was a combined Ground and Airborne Survey that was carried out in 2022 over an area of ~4643 km² with the aim of monitoring potential subsidence over the Surat Gas project.

Aerial capture of the data in this volume occurred on the 14th and 19th of July 2022. The Aerial LiDAR survey was planned to achieve +/- 5cm vertical accuracy with an emitted density of 10ppsm or better to attain ground return of +4ppsm with classification to ICSM level 2.

Geodetic Land survey occurred between 5th and 24th September 2022 based on high end GPS observations.

The data in this volume comprises Additional Data Processing of Airborne LiDAR data and is based on the GDA2020 datum, MGA Zone 56 projection with AHD obtained via the Ausgeoid2020 geoid model.

Extent of the data supplied is shown by the blue polygon on the map below.



DATA SUMMARY

This volume includes the following data in MGA56 (GDA2020) and AHD (Via Ausgoid2020):

- 293 x 1km² tiles of ICSM L2 Classified Ground only Point Cloud data in LAS v1.2 format.
- 293 x 1km² tiles of ICSM L2 Classified Non-Ground Point Cloud data in LAS v1.2 format.
- 293 x 1km² tiles of 1m cell size DTM Grid in XYZ ASCII format.
- 293 x 1km² tiles of 1m interval Contours in ESRI SHP file format.
- Area of interest polygon in ESRI SHP file format.
- 1 x 1km Lidar Tile layout in ESRI SHP file format.
- File list in .txt format.
- Readme_PRJ41646_07.pdf: This document in PDF format.

Published on DLGWV Disclosure Log
RTI Act 2009

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RTI Act 2009

1. PROJECT REPORT

Safety: No safety Incidents were reported during the project.

Acquisition: Aerial capture occurred on the 14th and 19th of July 2022. It was an incredibly wet year with standing water present during data capture.

Data Processing: Reduction of the ALS data proceeded without any significant problems. Laser strikes were classified into ground and non-ground points using a single algorithm across the project area. Manual checking and editing of the data classification further improved the quality of the terrain model.

Further Processing: A 1m DTM grid was generated from a triangulated model using Ground classified points. This method uses the closest triangles and applies weights to the proportionate areas from the grid cell centroid to interpolate the value. It uses known elevation data, it does not make any predictions regarding the surface and accurately depicts existing troughs and peaks in the data and supports irregular point spacing, which suits the nature LiDAR data. 1m interval Contours were generated from the ground classified point cloud data.

Data Presentation: The data provided on this volume has been supplied in accordance with a specification agreed with the primary client. Subsequent users experiencing difficulties in handling the data should please contact AAM to arrange a more appropriate data presentation.

Further Issues: There are no further issues to report.

Flight plan:



2. DATA INFORMATION

Data supply: AAM AWS S3 (Links via e-mail)
 Number of files: 2354, viz. 586 LAS 1.2 files, 586 ESRI ASCII files, 1180 ESRI SHP files,
 1 txt format file list and Readme_PRJ41646_07.PDF
 Data formatted on: 11.07.2023
 README Document: Readme_PRJ41646_07 (this file)

Deliveries	Date	Title	Contents
PRJ41646_01-06	25.11.2022	SUBSIDENCE MONITORING SURVEY 2022	Survey, LiDAR data and ortho imagery
PRJ41646_07	11.07.2023	SUBSIDENCE MONITORING SURVEY 2022 Additional Data Processing	LiDAR data – This delivery

File Details this Delivery	Contents
01_Ground_LAS\285000_7002000_v2.las	Ground only LAS V1.2
02_Non_Ground_LAS\285000_7002000_v2.las	Non-Ground only LAS V1.2
03_DTM_EsriAscii\285000_7002000_v2.asc/prj	1m cell DTM ESRI ASCII format
04_TileLayout_SHP\PRJ41646_07_Tile_Layout_GDA2020_MGA56.shp	Tile layout shape file
05_Contour_SHP_1m\ 285000_7002000_v2.shp	1m interval Contours
06_AOI_Polygon\PRJ41646_07_AOI_Polygon_GDA2020_MGA56.shp	Area of interest shape file
07_Readme_PDF\Readme_PRJ41646_07.pdf	This file in pdf format
08_File_List_TXT\PRJ41646_07_File_List.txt	List of files delivered in this volume

3. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	AAM	Optech Galaxy 473	FL017714	14.07.2022
			FL017715	14.07.2022
			FL017755	19.07.2022
Trajectory	AAM	RTX	FL017714	14.07.2022
			FL017715	14.07.2022
			FL017755	19.07.2022
Survey control	AAM	Static GPS /RTK (PRJ37870 & 40275)	PRJ41646	This survey
Test points	AAM	Static GPS /RTK	PRJ41646	This survey

LiDAR Characteristics	Description
Format	LAS 1.2
Emitted Density	4 ppm ²
Model Key Point Thinning	N/A
Tile size	1000m x 1000m
ICSM Classification	Level 2. Ground Correction (98% CL)

Number	Point Class	Description	ICSM	CI %
1	Default	Unclassified	2	98
2	Ground	Ground	2	98

Reference: <https://www.icsm.gov.au/>

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	Ausgeoid2020
Survey Control	PM183307 321769.251e 6969727.723n	345.780 RL AHD
	PM183521 309848.658e 6983453.288n	334.318 RL AHD
	PM39211 320822.187e 6953348.389n	360.046 RL AHD
	PM73029 298486.140e 7001636.396n	325.093 RL AHD

Note: On 11-10-2017, Australia formally changed its official reference datum from GDA94 to GDA2020, and its map grid from MGA94 to MGA2020. MGA2020 coordinates are approximately 1.7m different from MGA94.



This data is GDA2020-compliant.

GDA2020 compliant spatial data is information which has been measured with direct reference to the 2020 datum

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Lidar Test points	0.05m		Survey methodology used
Lidar (Horizontal)	0.10m		Project design
Lidar (Vertical)	0.05m		Project design
Derived DTM		0.07m	Methodology used

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Limitations of Data

- Features obscured by foliage or shadow may not appear.
- The definition of the ground under trees or shadow may be less accurate.
- Underground services have not been mapped.
- The rectified images in this volume were obtained by applying an orthophoto projection where corrections were applied for height displacement tips and tilts using a LiDAR sourced DTM.
- 2022 was an intensely wet season which brought moisture and turbulence. This disrupted capture continuity consistent LiDAR point density and accuracy to a minor degree.

Data Validation – LiDAR Data

Ground data in this volume has been compared to 8 test sites with each having approx. 100 points obtained by field survey and assumed to be error-free. The test points were distributed in 8 groups across the mapping area and located on clear ground. A shift in the order of 10cm was applied.

Comparison of the test points with elevations interpolated from measured data resulted in:

Site	dZ	RMS	SD	Calc	Post dZ	Post RMS	Post SD
<i>Average</i>	<i>0.101</i>			<i>0.000</i>	<i>0.003</i>		
Test_Site_05(PM73029)	0.104	0.105	0.013	0.003	0.006	0.014	0.013
Test_Site_06(PM8249)	0.129	0.130	0.009	0.028	0.031	0.033	0.009
Test_Site_10(PM183988)	0.087	0.088	0.011	-0.014	-0.011	0.015	0.011
Test_Site_11(PM64635)	0.084	0.086	0.015	-0.017	-0.014	0.020	0.015
Test_Site_13(PM202604)	0.093	0.094	0.008	-0.008	-0.005	0.009	0.008
Test_Site_14(PM188408)	0.130	0.133	0.026	0.029	0.032	0.041	0.026
Test_Site_15(PM202608)	0.093	0.094	0.008	-0.008	-0.005	0.009	0.008
Test_Site_16(PM148210)	0.089	0.089	0.007	-0.012	-0.009	0.011	0.007

- Data classification has been manually checked and edited against any available imagery.

4. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **ARROW ENERGY PTY LTD**.

The data in this volume is provided by AAM Pty Limited (AAM) to **ARROW ENERGY PTY LTD** under the client's Terms of Engagement, which require **ARROW ENERGY PTY LTD** to assume beneficial ownership, subject to the following conditions:

1. This file (Readme_PRJ41646_07.PDF) is always stored with the unaltered data contained in this volume.
2. The data is not altered in any way without the approval of AAM. The data may be copied from this file to another.
3. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by AAM.

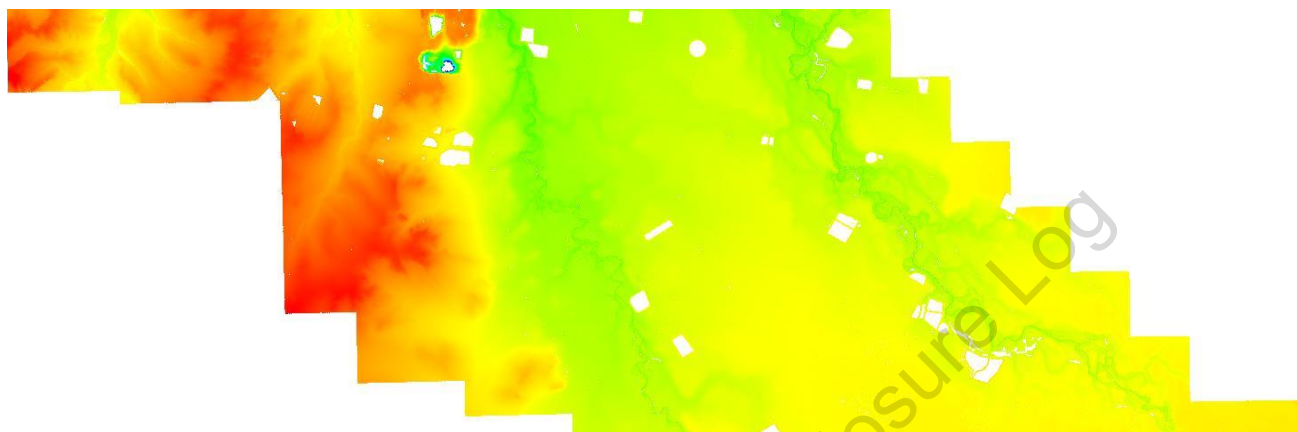
Any breach of these conditions will result in the immediate termination of the license issued by AAM, and **ARROW ENERGY PTY LTD** will indemnify AAM from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

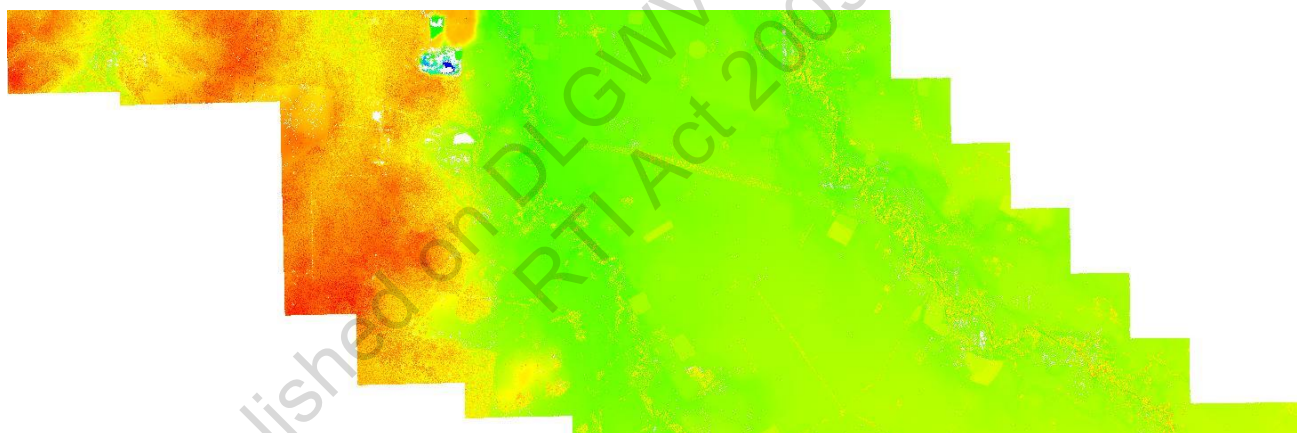
AAM Pty Limited
Suite 3, Level 23
6-10 O'Connell Street,
SYDNEY NSW 2000
AUSTRALIA
Telephone: +61 2 8879 1600
Facsimile: +61 2 8879 1633
info@aamgroup.com
www.aamgroup.com

5. VALIDATION

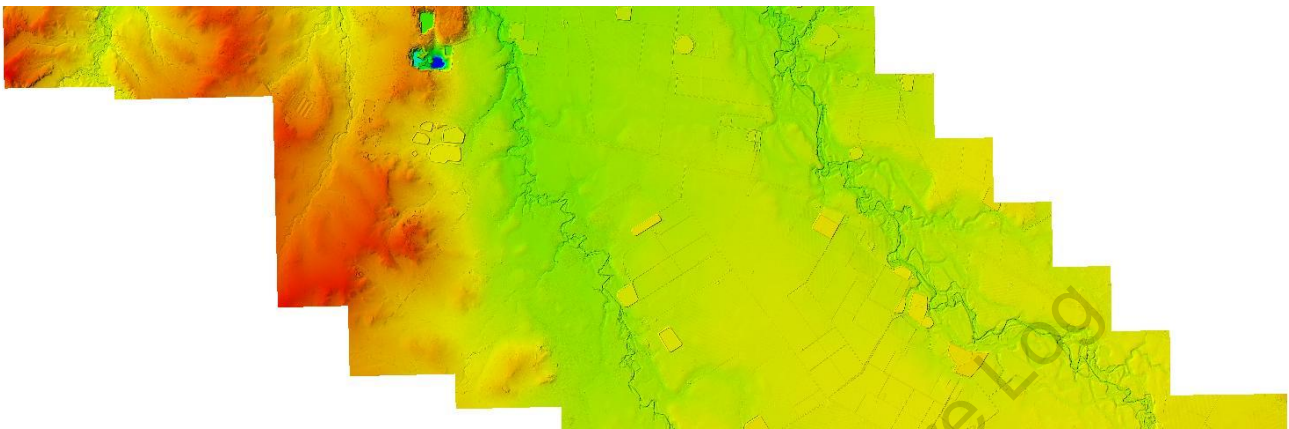
Classified Ground only Point Cloud data in LAS v1.2 format



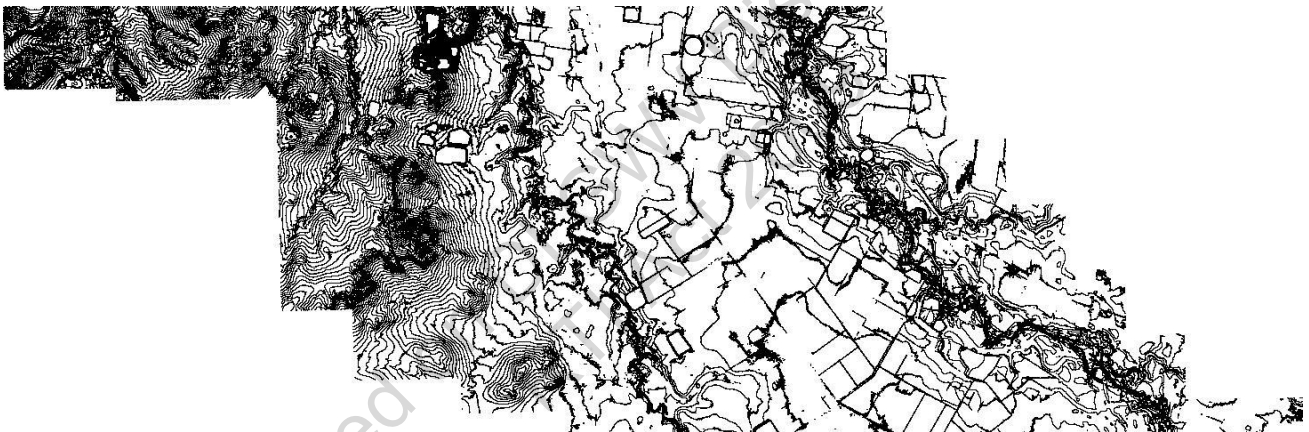
Classified Non-Ground Point Cloud data in LAS v1.2 format



1m cell size DTM Grid in XYZ ASCII format



1m interval Contours in ESRI SHP file format



Arrow Energy Pty Ltd

Arrow Energy LiDAR - October 2023

VOLUME: PRJ43590_01

PROJECT SUMMARY

The Arrow Energy LiDAR, October 2023 is an Airborne LiDAR and Aerial Photography Survey that was carried out between the 7th and the 24th of October 2023.

The project covered an area of 3,281 km² as illustrated by the blue polygon in Figure 1 below.

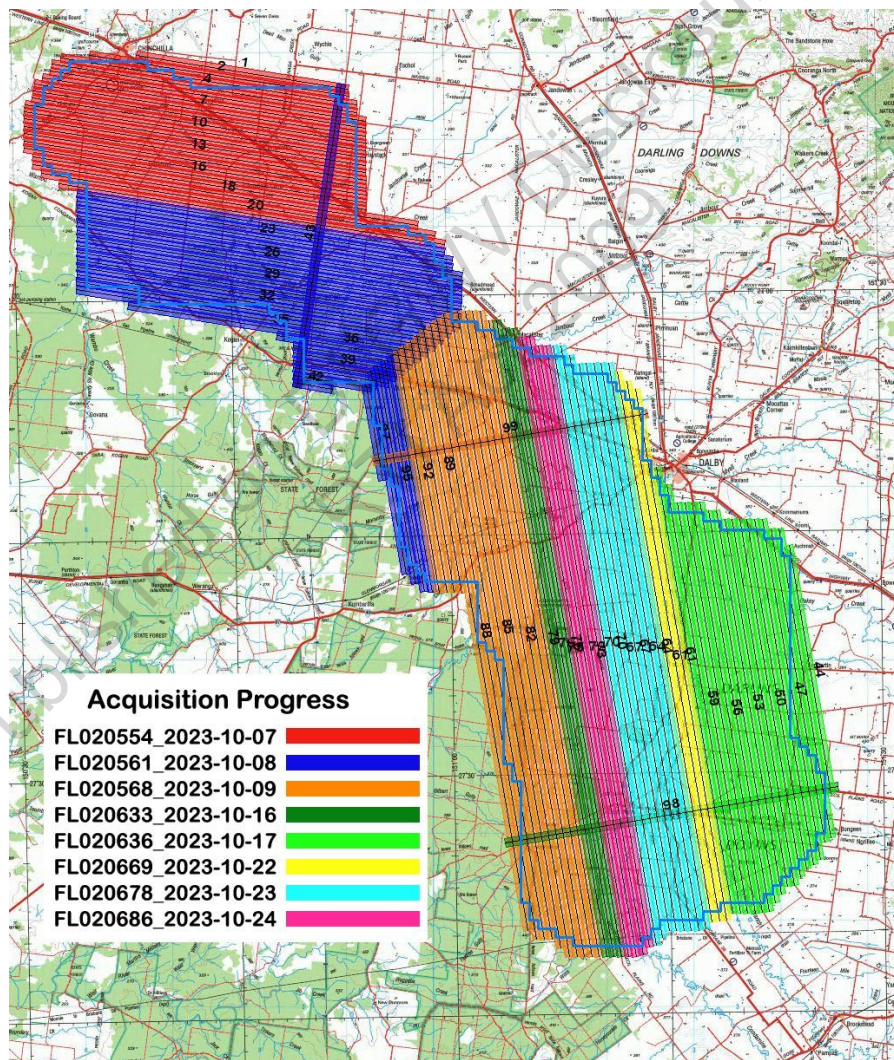


Figure 1

DATA SUMMARY

This volume includes the following data referenced to GDA2020 MGA56 AHD (AusGeoid2020) Datum.

Data:

- 3281, 1 km² tiles of classified point cloud, LAS v1.4 format (.las) - orthometric heights.
- 3281, 1 km² tiles of classified point cloud LAS v1.4 format (.las) - ellipsoidal heights.
- 3281, 1 km² tiles of 1m resolution DTM, ASCII XYZ format (.xyz) - orthometric heights.
- 3281, 1 km² tiles of 1m resolution DTM, GeoTIFF format (.tif) - orthometric heights.
- 3281, 1km² tiles of 0.25m interval contours, ESRI Shapefile format (.shp) - orthometric heights
- 3281, 1km² tiles of LiDAR intensity image, ECW format (.ecw) - 1m pixel size.
- 3281, 1km² tiles of 16cm resolution imagery, GeoTIFF format (.tif).
- 1, Mosaic imagery, ECW format (.ecw).
- 1, Tile index, ESRI Shapefile (polygon) format (.shp).
- 1, Flight trajectories, ESRI Shapefile (polyline) format (.shp).
- 1, Hydro-flattening, ESRI Shapefile (polygon) format (.shp).
- 1, Control and check point locations, ESRI Shapefile (point) format (.shp).
- 1, Point density plot for all returns, IMG format (.img).
- 2, Check point comparison tables, Microsoft Excel spreadsheet read-only format (.xlsx).
- 1, Laser scanning equipment calibration report, PDF format (.pdf).
- 1, List of all files supplied in text format (.txt).
- 1, Project report, PDF format (.pdf) – this file project_report-PRJ43590_01.pdf

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Published on DLGWV Disclosure Log
RTI Act 2009

1. DATA INFORMATION

Data supply: 1, 4 Tb USB external hard disk drives

Number of files: 52,523, viz. 6,562 LAS v1.4 files, 3,281 ASCII XYZ files, 3,281 GeoTIFF files, 13,140 ESRI SHP files, 19,689 GeoReference files, 3,282 ECW files, 3,281 TIFF files, 2 IMG files, 2 PDF files, 2 XLXS files, 1 TXT file

Data formatted on: 31.12.2023

Project Report: project_report-PRJ43590_01.pdf (this file)

Data is provided in files with the following file naming convention

DELIVERABLE	FOLDER NAME	FILE NAME AND TYPE
LAS classified	pointcloud_las_tiles	SW_EEEEEE_NNNNNNNN_1k_class_AHD.las
Las Ellipsoid	pointcloud_las_ellipsoid_tiles	SW_EEEEEE_NNNNNNNN_1k_class_Ellipsoid.las
DTM 1m GeoTIFF	dtm_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.tif
DTM 1m ASCII	dtm_asciiXYZ_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.xyz
Contours	contours_shp_tiles	SW_EEEEEE_NNNNNNNN_1k_25cm_contour.shp
ECW Tile Intensity	intensity_image_ecw_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_Intensity_Image.ecw
16cm Imagery	Image_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_10cm_Image.tif
16cm Imagery ECW	Image_ecw_mosaic	10cm_Mosaic_Image.ecw
Flight Trajectories	metadata/flightlines	flightlines-{archive_name}.shp
Quality Assurance	metadata/quality_assurance	project_report-{archive_name}.pdf
		ground_control_points-{archive_name}.shp
		checkpoint_results-{archive_name}.xlsx
System Calibration	metadata/system_calibration	sensor_calibration-{Sensor_Name}-{Serial_Number}-{YYYYMMDD}.pdf
Tile Indexes	metadata/tile_index	tile_index-{archive_name}-{product_name}.shp

2. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	Woolpert	Optech Galaxy Prime - 436	FL020554	07.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020561	08.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020568	09.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020633	16.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020636	17.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 422	FL020669	22.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 422	FL020678	23.10.2023
LiDAR	Woolpert	Optech Galaxy Prime – 422	FL020686	24.10.2023
Imagery	Woolpert	Phase One 158	FL020554	07.10.2023
Imagery	Woolpert	Phase One 158	FL020561	08.10.2023
Imagery	Woolpert	Phase One 158	FL020568	09.10.2023
Imagery	Woolpert	Phase One 158	FL020633	16.10.2023
Imagery	Woolpert	Phase One 158	FL020636	17.10.2023
Imagery	Woolpert	Phase One 099	FL020669	22.10.2023
Imagery	Woolpert	Phase One 099	FL020678	23.10.2023
Imagery	Woolpert	Phase One 099	FL020686	24.10.2023
Trajectory	Woolpert	RTX	FL020554	07.10.2023
Trajectory	Woolpert	RTX	FL020561	08.10.2023
Trajectory	Woolpert	RTX	FL020568	09.10.2023
Trajectory	Woolpert	RTX	FL020633	16.10.2023
Trajectory	Woolpert	RTX	FL020636	17.10.2023
Trajectory	Woolpert	RTX	FL020669	22.10.2023
Trajectory	Woolpert	RTX	FL020678	23.10.2023
Trajectory	Woolpert	RTX	FL020686	24.10.2023
Imagery control	Woolpert	RTK GPS	PRJ43590	17.11.2023
LiDAR reference points	Woolpert	RTK GPS	PRJ43590	17.11.2023

LiDAR Characteristics	Description
Formats	LAS 1.4, ASCII XYZ, GeoTIFF and ESRI SHP
Emitted Density	4 points per m ²
Tile size	1000 m x 1000 m
ICSM Classification	Level 3. Ground surface improvement

Reference: <https://www.icsm.gov.au/>

Number	Point Class	Description	ICSM	CI %
0	Default	Created, never classified	1	95
1	Unclassified	Unclassified	1	95
2	Ground	Ground	3	99
3	Low vegetation	0 - 0.3m above ground	2	98
4	Medium vegetation	0.3 - 2.0m above ground	2	98
5	High vegetation	> 2.0m above ground	2	98
6	Buildings, structures	Buildings, houses, sheds, silos etc.	3	99
7	Low Noise	Spurious low point returns (unusable)	1	95
9	Water	Any point in water	3	99
17	Bridge	Any bridge or permanent jetty	3	99
18	High Noise	Spurious high point returns (unusable)	1	95

Ortho Characteristics	Description
Format	ECW and TIFF
Ground Sample Distance	16cm
Terrain Model	Gridded DEM from LiDAR
Tile size	Mosaics and 1000 m x 1000 m
Sample Type	8-bit Integer
Image Bands	RGB
Orientation/AT	Direct georeferencing

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	AusGeoid2020

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Field Control Points	0.03m		Methodology used
LiDAR data (Horizontal)	0.30m		Deductive estimate
LiDAR data (Vertical)	0.05m		Project design
Derived DTM		0.10m	Methodology used
Orthophoto Pixels	0.32m		Project design

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground October be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Data Validation – LiDAR Data

Vertical Validation

- Ground data in has been compared to 17 arrays of LiDAR Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
PRJ43590_Ref-01	65	-0.063	0.016	0.065
PRJ43590_Ref-02	68	-0.084	0.007	0.084
PRJ43590_Ref-03	48	-0.078	0.005	0.079
PRJ43590_Ref-04	47	0.025	0.013	0.028
PRJ43590_Ref-05	54	-0.044	0.007	0.044
PRJ43590_Ref-06	52	-0.131	0.046	0.139
PRJ43590_Ref-07	51	-0.110	0.006	0.110
PRJ43590_Ref-08	62	-0.059	0.012	0.060
PRJ43590_Ref-09	55	-0.049	0.016	0.052
PRJ43590_Ref-10	52	-0.048	0.005	0.048
PRJ43590_Ref-12	54	-0.089	0.006	0.089
PRJ43590_Ref-13	61	-0.048	0.006	0.048
PRJ43590_Ref-14	69	-0.051	0.008	0.051
PRJ43590_Ref-15	50	-0.008	0.004	0.009
PRJ43590_Ref-16	51	-0.051	0.011	0.052
PRJ43590_Ref-18	72	-0.080	0.004	0.081
PRJ43590_Ref-19	66	-0.053	0.011	0.054

The mean elevation difference of - 0.060 m has been removed from the data supplied in this volume which resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
PRJ43590_Ref-01	65	-0.003	0.016	0.016
PRJ43590_Ref-02	68	-0.024	0.007	0.025
PRJ43590_Ref-03	48	-0.018	0.005	0.019
PRJ43590_Ref-04	47	0.085	0.013	0.086
PRJ43590_Ref-05	54	0.016	0.007	0.018
PRJ43590_Ref-06	52	-0.028	0.083	0.087
PRJ43590_Ref-07	51	-0.050	0.006	0.050
PRJ43590_Ref-08	62	0.001	0.012	0.012
PRJ43590_Ref-09	55	0.011	0.016	0.019
PRJ43590_Ref-10	52	0.012	0.005	0.013
PRJ43590_Ref-12	54	-0.029	0.006	0.030
PRJ43590_Ref-13	61	0.012	0.006	0.013
PRJ43590_Ref-14	69	0.009	0.008	0.013
PRJ43590_Ref-15	50	0.052	0.004	0.052
PRJ43590_Ref-16	51	0.009	0.011	0.015
PRJ43590_Ref-18	72	-0.020	0.004	0.021
PRJ43590_Ref-19	66	0.007	0.011	0.013

- Data classification has been manually checked and edited against any available imagery.

Horizontal Validation

- Ground data in has been compared to 51 Horizontal Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.364	-0.155
Maximum	0.327	0.375
Mean	-0.018	0.008
Standard Deviation	0.130	0.110
Root Mean Square Error	0.130	0.109

Data Validation – Orthophoto Image

- The Orthophotography has been compared to 40 photo control points obtained by field survey and assumed to be error-free. Comparison of the orthophoto with the control points resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.160	-0.217
Maximum	0.141	0.183
Mean	0.000	0.002
Standard Deviation	0.075	0.087
Root Mean Square Error	0.075	0.086

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **Arrow Energy Pty Ltd**.

The data in this volume is provided by Woolpert Australia Pty Limited (Woolpert) to **Arrow Energy Pty Ltd** under the client's Terms of Engagement, which allow **Arrow Energy Pty Ltd** to assume beneficial ownership, subject to the following conditions:

1. This file (project_report-PRJ43590_01.PDF) is always stored with the unaltered data contained in this volume.
2. The data is not altered in any way without the approval of Woolpert. The data October be copied from this file to another.
3. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by Woolpert.

Any breach of these conditions will result in the immediate termination of the license issued by Woolpert, and **Arrow Energy Pty Ltd** will indemnify Woolpert from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

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Facsimile: +61 2 8879 1633
asiapacific@woolpert.com
www.woolpert.com

4. VALIDATION

LiDAR Ground Point Cloud data (Coloured by elevation)

DTM



0.25m Contours



Orthophoto Mosaic



Arrow Energy Pty Ltd

Arrow Energy LiDAR - May 2023

VOLUME: PRJ43588_01

PROJECT SUMMARY

The Arrow Energy LiDAR, May 2023 is an Airborne LiDAR and Aerial Photography Survey that was carried out between the 30th of May and the 26th of June 2023.

The project covered an area of 3,281 km² as illustrated by the blue polygon in Figure 1 below.

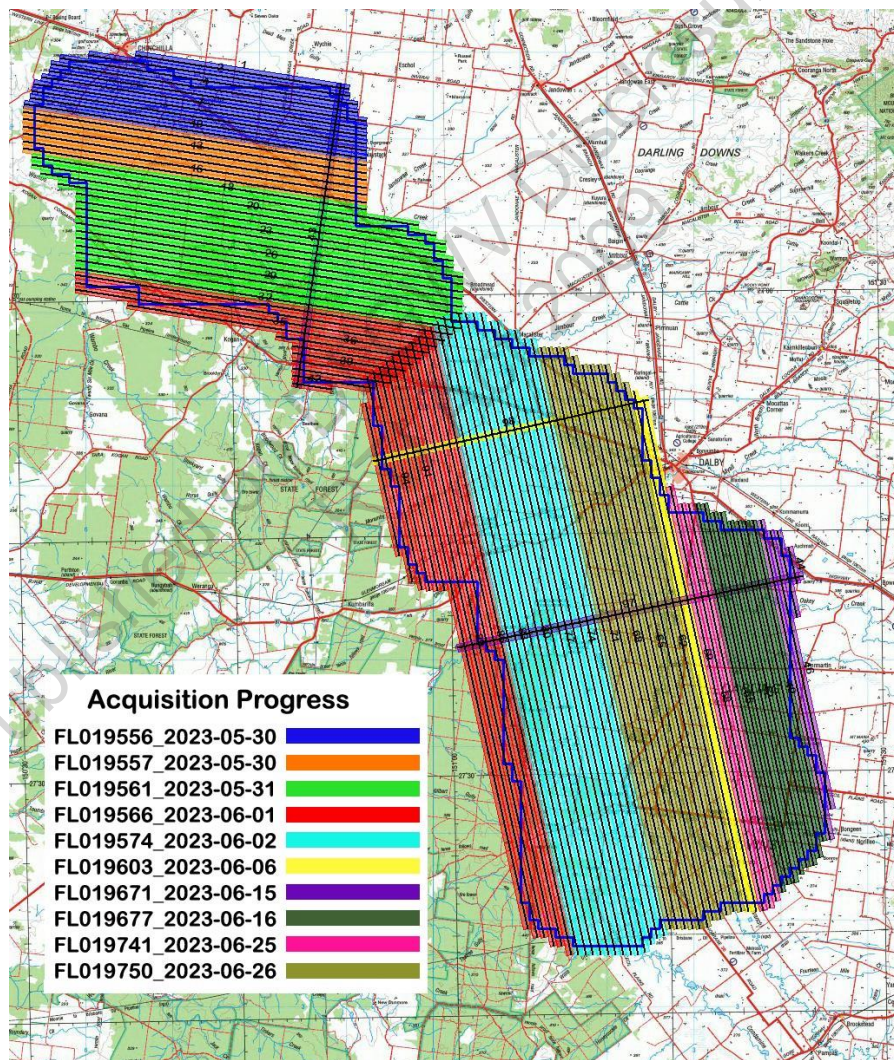


Figure 1

DATA SUMMARY

This volume includes the following data referenced to GDA2020 MGA56 AHD (AusGeoid2020) Datum.

Data:

- 3281, 1 km² tiles of classified point cloud, LAS v1.4 format (.las) - orthometric heights.
- 3281, 1 km² tiles of classified point cloud LAS v1.4 format (.las) - ellipsoidal heights.
- 3281, 1 km² tiles of 1m resolution DTM, ASCII XYZ format (.xyz) - orthometric heights.
- 3281, 1 km² tiles of 1m resolution DTM, GeoTIFF format (.tif) - orthometric heights.
- 3281, 1km² tiles of 0.25m interval contours, ESRI Shapefile format (.shp) - orthometric heights
- 3281, 1km² tiles of LiDAR intensity image, ECW format (.ecw) - 1m pixel size.
- 3281, 1km² tiles of 16cm resolution imagery, GeoTIFF format (.tif).
- 1, Mosaic imagery, ECW format (.ecw).
- 1, Tile index, ESRI Shapefile (polygon) format (.shp).
- 1, Flight trajectories, ESRI Shapefile (polyline) format (.shp).
- 1, Hydro-flattening, ESRI Shapefile (polygon) format (.shp).
- 1, Control and check point locations, ESRI Shapefile (point) format (.shp).
- 1, Point density plot for all returns, IMG format (.img).
- 2, Check point comparison tables, Microsoft Excel spreadsheet read-only format (.xlsx).
- 1, Laser scanning equipment calibration report, PDF format (.pdf).
- 1, List of all files supplied in text format (.txt).
- 1, Project report, PDF format (.pdf) – this file project_report-PRJ43588_01.pdf

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Published on DLGWV Disclosure Log
RTI Act 2009

1. DATA INFORMATION

Data supply: 2, 2 Tb USB external hard disk drives

Number of files: 52,523, viz. 6,562 LAS v1.4 files, 3,281 ASCII XYZ files, 3,281 GeoTIFF files, 13,140 ESRI SHP files, 19,689 GeoReference files, 3,282 ECW files, 3,281 TIFF files, 2 IMG files, 2 PDF files, 2 XLXS files, 1 TXT file

Data formatted on: 06.09.2023

Project Report: project_report-PRJ43588_01.pdf (this file)

Data is provided in files with the following file naming convention

DELIVERABLE	FOLDER NAME	FILE NAME AND TYPE
LAS classified	pointcloud_las_tiles	SW_EEEEEE_NNNNNNNN_1k_class_AHD.las
Las Ellipsoid	pointcloud_las_ellipsoid_tiles	SW_EEEEEE_NNNNNNNN_1k_class_Ellipsoid.las
DTM 1m GeoTIFF	dtm_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.tif
DTM 1m ASCII	dtm_asciiXYZ_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.xyz
Contours	contours_shp_tiles	SW_EEEEEE_NNNNNNNN_1k_25cm_contour.shp
ECW Tile Intensity	intensity_image_ecw_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_Intensity_Image.ecw
16cm Imagery	Image_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_10cm_Image.tif
16cm Imagery ECW	Image_ecw_mosaic	10cm_Mosaic_Image.ecw
Flight Trajectories	metadata/flightlines	flightlines-{archive_name}.shp
Quality Assurance	metadata/quality_assurance	project_report-{archive_name}.pdf
		ground_control_points-{archive_name}.shp
		checkpoint_results-{archive_name}.xlsx
System Calibration	metadata/system_calibration	sensor_calibration-{Sensor_Name}-{Serial_Number}-{YYYYMMDD}.pdf
Tile Indexes	metadata/tile_index	tile_index-{archive_name}-{product_name}.shp

2. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019556	30.05.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019557	30.05.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019561	31.05.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019566	01.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019574	02.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019603	06.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019671	15.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019677	16.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019741	25.06.2023
LiDAR	Woolpert	Optech Galaxy Prime - 422	FL019750	26.06.2023
Imagery	Woolpert	Phase One 099	FL019556	30.05.2023
Imagery	Woolpert	Phase One 099	FL019557	30.05.2023
Imagery	Woolpert	Phase One 099	FL019561	31.05.2023
Imagery	Woolpert	Phase One 099	FL019566	01.06.2023
Imagery	Woolpert	Phase One 099	FL019574	02.06.2023
Imagery	Woolpert	Phase One 099	FL019603	06.06.2023
Imagery	Woolpert	Phase One 099	FL019671	15.06.2023
Imagery	Woolpert	Phase One 099	FL019677	16.06.2023
Imagery	Woolpert	Phase One 099	FL019741	25.06.2023
Imagery	Woolpert	Phase One 099	FL019750	26.06.2023
Trajectory	Woolpert	RTX	FL019556	30.05.2023
Trajectory	Woolpert	RTX	FL019557	30.05.2023
Trajectory	Woolpert	RTX	FL019561	31.05.2023
Trajectory	Woolpert	RTX	FL019566	01.06.2023
Trajectory	Woolpert	RTX	FL019574	02.06.2023
Trajectory	Woolpert	RTX	FL019603	06.06.2023
Trajectory	Woolpert	RTX	FL019671	15.06.2023
Trajectory	Woolpert	RTX	FL019677	16.06.2023
Trajectory	Woolpert	RTX	FL019741	25.06.2023
Trajectory	Woolpert	RTX	FL019750	26.06.2023
Imagery control	Woolpert	RTK GPS	PRJ43588	17.07.2023
LiDAR reference points	Woolpert	RTK GPS	PRJ43588	17.07.2023

LiDAR Characteristics	Description
Formats	LAS 1.4, ASCII XYZ, GeoTIFF and ESRI SHP
Emitted Density	4 points per m ²
Tile size	1000 m x 1000 m
ICSM Classification	Level 3. Ground surface improvement

Reference: <https://www.icsm.gov.au/>

Number	Point Class	Description	ICSM	CI %
0	Default	Created, never classified	1	95
1	Unclassified	Unclassified	1	95
2	Ground	Ground	3	99
3	Low vegetation	0 - 0.3m above ground	2	98
4	Medium vegetation	0.3 - 2.0m above ground	2	98
5	High vegetation	> 2.0m above ground	2	98
6	Buildings, structures	Buildings, houses, sheds, silos etc.	3	99
7	Low Noise	Spurious low point returns (unusable)	1	95
9	Water	Any point in water	3	99
17	Bridge	Any bridge or permanent jetty	3	99
18	High Noise	Spurious high point returns (unusable)	1	95

Ortho Characteristics	Description
Format	ECW and TIFF
Ground Sample Distance	16cm
Terrain Model	Gridded DEM from LiDAR
Tile size	Mosaics and 1000 m x 1000 m
Sample Type	8-bit Integer
Image Bands	RGB
Orientation/AT	Direct georeferencing

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	AusGeoid2020

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Field Control Points	0.03m		Methodology used
LiDAR data (Horizontal)	0.30m		Deductive estimate
LiDAR data (Vertical)	0.05m		Project design
Derived DTM		0.10m	Methodology used
Orthophoto Pixels	0.32m		Project design

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Data Validation – LiDAR Data

Vertical Validation

- Ground data in has been compared to 17 arrays of LiDAR Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
REF_001	70	-0.077	0.013	0.078
REF_002	41	-0.061	0.010	0.062
REF_003	62	-0.089	0.009	0.090
REF_004	60	-0.005	0.012	0.013
REF_005	62	-0.024	0.010	0.026
REF_006	68	-0.070	0.010	0.071
REF_007	69	-0.086	0.011	0.086
REF_008	69	-0.097	0.010	0.097
REF_009	60	-0.075	0.012	0.076
REF_010	70	-0.088	0.010	0.088
REF_012	71	-0.084	0.008	0.084
REF_013	75	-0.087	0.010	0.087
REF_014	66	-0.093	0.015	0.095
REF_015	98	-0.117	0.007	0.117
REF_016	72	-0.088	0.010	0.089
REF_018	66	-0.075	0.008	0.075
REF_019	93	-0.110	0.023	0.112

The mean elevation difference of - 0.078 m has been removed from the data supplied in this volume which resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
REF_001	70	0.001	0.013	0.013
REF_002	41	0.017	0.010	0.020
REF_003	62	-0.011	0.009	0.014
REF_004	60	0.073	0.012	0.074
REF_005	62	0.054	0.010	0.055
REF_006	68	0.008	0.010	0.013
REF_007	69	-0.008	0.011	0.014
REF_008	69	-0.019	0.010	0.021
REF_009	60	0.003	0.012	0.013
REF_010	70	-0.010	0.010	0.014
REF_012	71	-0.006	0.008	0.010
REF_013	75	-0.009	0.010	0.013
REF_014	66	-0.015	0.015	0.021
REF_015	98	-0.039	0.007	0.040
REF_016	72	-0.010	0.010	0.014
REF_018	66	0.003	0.008	0.009
REF_019	93	-0.032	0.023	0.039

- Data classification has been manually checked and edited against any available imagery.

Horizontal Validation

- Ground data in has been compared to 27 Horizontal Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.339	-0.442
Maximum	0.259	0.238
Mean	0.002	-0.073
Standard Deviation	0.132	0.136
Root Mean Square Error	0.129	0.153

Data Validation – Orthophoto Image

- The Orthophotography has been compared to 40 photo control points obtained by field survey and assumed to be error-free. Comparison of the orthophoto with the control points resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.094	-0.166
Maximum	0.208	0.077
Mean	0.049	-0.054
Standard Deviation	0.072	0.052
Root Mean Square Error	0.087	0.074

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **Arrow Energy Pty Ltd**.

The data in this volume is provided by Woolpert Australia Pty Limited (Woolpert) to **Arrow Energy Pty Ltd** under the client's Terms of Engagement, which allow **Arrow Energy Pty Ltd** to assume beneficial ownership, subject to the following conditions:

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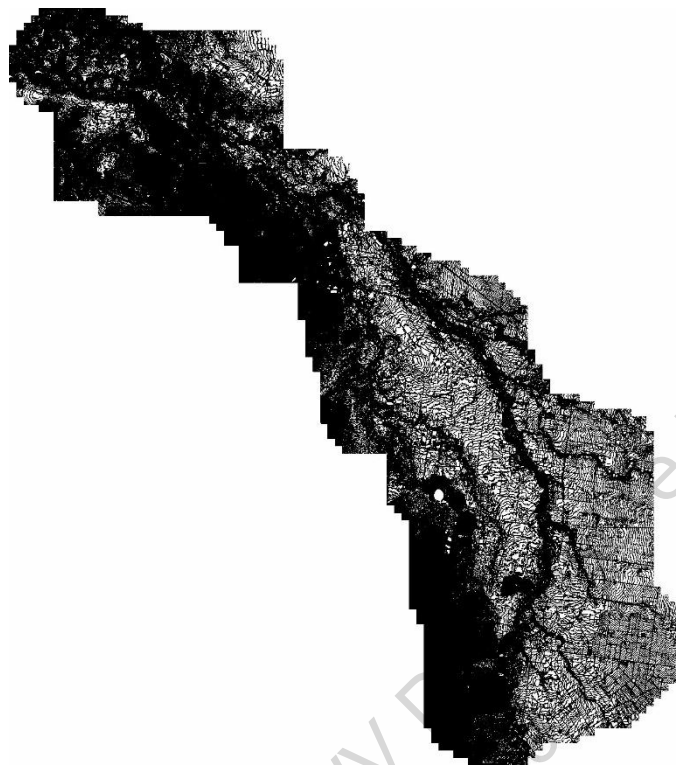
4. VALIDATION

LiDAR Ground Point Cloud data (Coloured by elevation)



DTM

0.25m Contours



Orthophoto Mosaic



Arrow Energy Pty Ltd

Arrow Energy LiDAR - August 2023

VOLUME: PRJ43589_01

PROJECT SUMMARY

The Arrow Energy LiDAR, August 2023 is an Airborne LiDAR and Aerial Photography Survey that was carried out between the 30th of July and the 14th of August 2023.

The project covered an area of 3,281 km² as illustrated by the blue polygon in Figure 1 below.

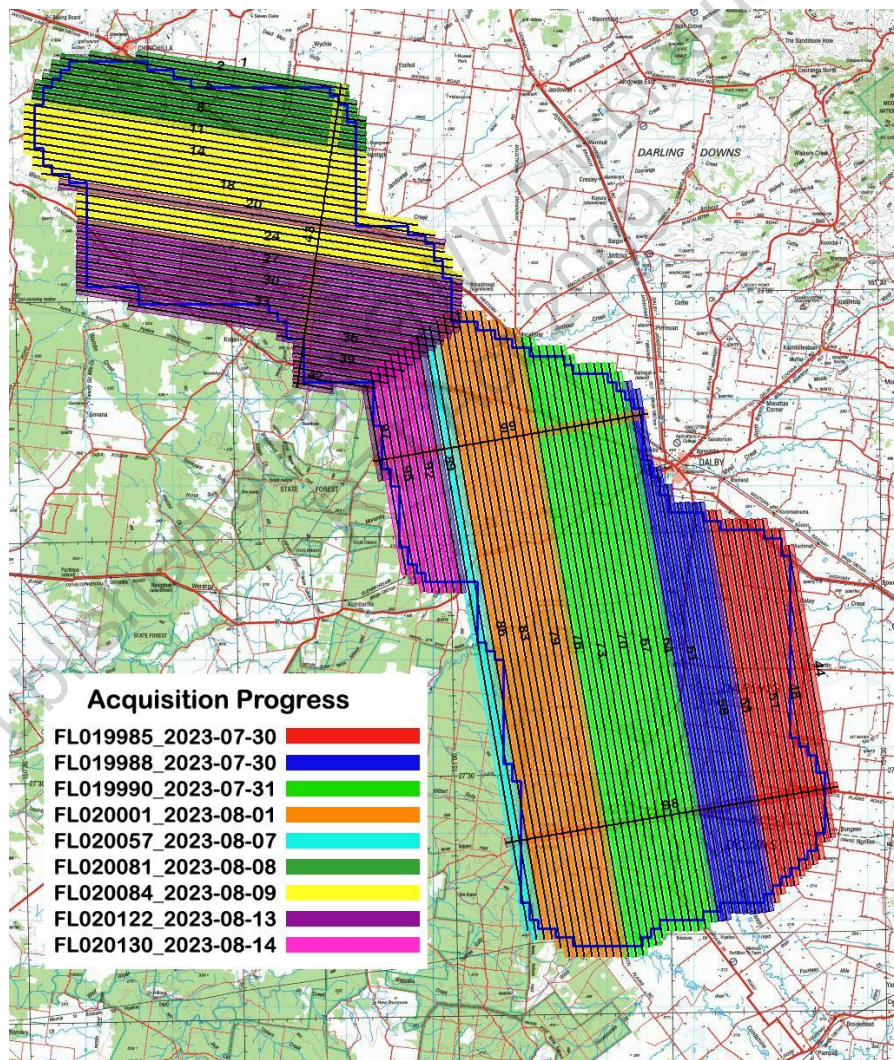


Figure 1

DATA SUMMARY

This volume includes the following data referenced to GDA2020 MGA56 AHD (AusGeoid2020) Datum.

Data:

- 3281, 1 km² tiles of classified point cloud, LAS v1.4 format (.las) - orthometric heights.
- 3281, 1 km² tiles of classified point cloud LAS v1.4 format (.las) - ellipsoidal heights.
- 3281, 1 km² tiles of 1m resolution DTM, ASCII XYZ format (.xyz) - orthometric heights.
- 3281, 1 km² tiles of 1m resolution DTM, GeoTIFF format (.tif) - orthometric heights.
- 3281, 1km² tiles of 0.25m interval contours, ESRI Shapefile format (.shp) - orthometric heights
- 3281, 1km² tiles of LiDAR intensity image, ECW format (.ecw) - 1m pixel size.
- 3281, 1km² tiles of 16cm resolution imagery, GeoTIFF format (.tif).
- 1, Mosaic imagery, ECW format (.ecw).
- 1, Tile index, ESRI Shapefile (polygon) format (.shp).
- 1, Flight trajectories, ESRI Shapefile (polyline) format (.shp).
- 1, Hydro-flattening, ESRI Shapefile (polygon) format (.shp).
- 1, Control and check point locations, ESRI Shapefile (point) format (.shp).
- 1, Point density plot for all returns, IMG format (.img).
- 2, Check point comparison tables, Microsoft Excel spreadsheet read-only format (.xlsx).
- 1, Laser scanning equipment calibration report, PDF format (.pdf).
- 1, List of all files supplied in text format (.txt).
- 1, Project report, PDF format (.pdf) – this file project_report-PRJ43589_01.pdf

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RTI Act 2009

1. DATA INFORMATION

Data supply: 1, 4 Tb USB external hard disk drives

Number of files: 52,523, viz. 6,562 LAS v1.4 files, 3,281 ASCII XYZ files, 3,281 GeoTIFF files, 13,140 ESRI SHP files, 19,689 GeoReference files, 3,282 ECW files, 3,281 TIFF files, 2 IMG files, 2 PDF files, 2 XLXS files, 1 TXT file

Data formatted on: 16.11.2023

Project Report: project_report-PRJ43589_01.pdf (this file)

Data is provided in files with the following file naming convention

DELIVERABLE	FOLDER NAME	FILE NAME AND TYPE
LAS classified	pointcloud_las_tiles	SW_EEEEEE_NNNNNNNN_1k_class_AHD.las
Las Ellipsoid	pointcloud_las_ellipsoid_tiles	SW_EEEEEE_NNNNNNNN_1k_class_Ellipsoid.las
DTM 1m GeoTIFF	dtm_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.tif
DTM 1m ASCII	dtm_asciiXYZ_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_DTM.xyz
Contours	contours_shp_tiles	SW_EEEEEE_NNNNNNNN_1k_25cm_contour.shp
ECW Tile Intensity	intensity_image_ecw_tiles	SW_EEEEEE_NNNNNNNN_1k_1m_Intensity_Image.ecw
16cm Imagery	Image_tif_tiles	SW_EEEEEE_NNNNNNNN_1k_10cm_Image.tif
16cm Imagery ECW	Image_ecw_mosaic	10cm_Mosaic_Image.ecw
Flight Trajectories	metadata/flightlines	flightlines-{archive_name}.shp
Quality Assurance	metadata/quality_assurance	project_report-{archive_name}.pdf
		ground_control_points-{archive_name}.shp
		checkpoint_results-{archive_name}.xlsx
System Calibration	metadata/system_calibration	sensor_calibration-{Sensor_Name}-{Serial_Number}-{YYYYMMDD}.pdf
Tile Indexes	metadata/tile_index	tile_index-{archive_name}-{product_name}.shp

2. METADATA

Source Data	Source	Description	Ref No	Date
LiDAR	Woolpert	Optech Galaxy Prime - 436	FL019985	30.07.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL019988	30.07.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL019990	31.07.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020001	01.08.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020057	07.08.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020081	08.08.2023
LiDAR	Woolpert	Optech Galaxy Prime – 436	FL020084	09.08.2023
LiDAR	Woolpert	Optech Galaxy Prime – 422	FL020122	13.08.2023
LiDAR	Woolpert	Optech Galaxy Prime – 422	FL020130	14.08.2023
Imagery	Woolpert	Phase One 158	FL019985	30.07.2023
Imagery	Woolpert	Phase One 158	FL019988	30.07.2023
Imagery	Woolpert	Phase One 158	FL019990	31.07.2023
Imagery	Woolpert	Phase One 158	FL020001	01.08.2023
Imagery	Woolpert	Phase One 158	FL020057	07.08.2023
Imagery	Woolpert	Phase One 158	FL020081	08.08.2023
Imagery	Woolpert	Phase One 158	FL020084	09.08.2023
Imagery	Woolpert	Phase One 099	FL020122	13.08.2023
Imagery	Woolpert	Phase One 099	FL020130	14.08.2023
Trajectory	Woolpert	RTX	FL019985	30.07.2023
Trajectory	Woolpert	RTX	FL019988	30.07.2023
Trajectory	Woolpert	RTX	FL019990	31.07.2023
Trajectory	Woolpert	RTX	FL020001	01.08.2023
Trajectory	Woolpert	RTX	FL020057	07.08.2023
Trajectory	Woolpert	RTX	FL020081	08.08.2023
Trajectory	Woolpert	RTX	FL020084	09.08.2023
Trajectory	Woolpert	RTX	FL020122	13.08.2023
Trajectory	Woolpert	RTX	FL020130	14.08.2023
Imagery control	Woolpert	RTK GPS	PRJ43589	18.08.2023
LiDAR reference points	Woolpert	RTK GPS	PRJ43589	18.08.2023

LiDAR Characteristics	Description
Formats	LAS 1.4, ASCII XYZ, GeoTIFF and ESRI SHP
Emitted Density	4 points per m ²
Tile size	1000 m x 1000 m
ICSM Classification	Level 3. Ground surface improvement

Reference: <https://www.icsm.gov.au/>

Number	Point Class	Description	ICSM	CI %
0	Default	Created, never classified	1	95
1	Unclassified	Unclassified	1	95
2	Ground	Ground	3	99
3	Low vegetation	0 - 0.3m above ground	2	98
4	Medium vegetation	0.3 - 2.0m above ground	2	98
5	High vegetation	> 2.0m above ground	2	98
6	Buildings, structures	Buildings, houses, sheds, silos etc.	3	99
7	Low Noise	Spurious low point returns (unusable)	1	95
9	Water	Any point in water	3	99
17	Bridge	Any bridge or permanent jetty	3	99
18	High Noise	Spurious high point returns (unusable)	1	95

Ortho Characteristics	Description
Format	ECW and TIFF
Ground Sample Distance	16cm
Terrain Model	Gridded DEM from LiDAR
Tile size	Mosaics and 1000 m x 1000 m
Sample Type	8-bit Integer
Image Bands	RGB
Orientation/AT	Direct georeferencing

Reference Systems	Horizontal	Vertical
Datum	GDA2020	AHD
Projection	MGA Zone 56	N/A
Geoid Model	N/A	AusGeoid2020

Accuracy Specification	Measured Point	Derived Point	Basis of Estimation
Field Control Points	0.03m		Methodology used
LiDAR data (Horizontal)	0.30m		Deductive estimate
LiDAR data (Vertical)	0.05m		Project design
Derived DTM		0.10m	Methodology used
Orthophoto Pixels	0.32m		Project design

Project specifications and technical processes were designed to achieve data accuracies as above.

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling by Lidar or photogrammetry refer to the terrain definition on clear ground.
- LASER strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground August be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

Data Validation – LiDAR Data

Vertical Validation

- Ground data in has been compared to 17 arrays of LiDAR Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
PRJ43588_Site-18	66	-0.112	0.006	0.112
PRJ43589_Site-01	52	-0.111	0.007	0.112
PRJ43589_Site-02	45	-0.120	0.006	0.120
PRJ43589_Site-03	50	-0.113	0.005	0.113
PRJ43589_Site-04	58	-0.016	0.010	0.019
PRJ43589_Site-05	50	-0.096	0.006	0.096
PRJ43589_Site-06	56	-0.109	0.006	0.109
PRJ43589_Site-07	60	-0.068	0.014	0.069
PRJ43589_Site-08	59	-0.121	0.008	0.121
PRJ43589_Site-09	52	-0.104	0.006	0.104
PRJ43589_Site-10	50	-0.063	0.005	0.064
PRJ43589_Site-12	59	-0.114	0.009	0.115
PRJ43589_Site-13	60	-0.076	0.007	0.077
PRJ43589_Site-14	50	-0.130	0.025	0.133
PRJ43589_Site-15	50	-0.103	0.006	0.103
PRJ43589_Site-16	59	-0.104	0.007	0.105
PRJ43589_Site-19	50	-0.102	0.007	0.102

The mean elevation difference of - 0.098 m has been removed from the data supplied in this volume which resulted in:

Ref Point Site	No. of Points	Mean Difference (m)	Std Deviation (m)	RMS (m)
PRJ43588_Site-18	66	-0.014	0.009	0.017
PRJ43589_Site-01	52	-0.013	0.007	0.015
PRJ43589_Site-02	45	-0.022	0.006	0.023
PRJ43589_Site-03	50	-0.015	0.005	0.016
PRJ43589_Site-04	58	0.082	0.010	0.082
PRJ43589_Site-05	50	0.002	0.006	0.006
PRJ43589_Site-06	56	-0.011	0.006	0.012
PRJ43589_Site-07	60	0.030	0.013	0.036
PRJ43589_Site-08	59	-0.023	0.008	0.024
PRJ43589_Site-09	52	-0.006	0.006	0.008
PRJ43589_Site-10	50	0.035	0.005	0.035
PRJ43589_Site-12	59	-0.016	0.009	0.019
PRJ43589_Site-13	60	0.022	0.007	0.023
PRJ43589_Site-14	50	-0.032	0.025	0.041
PRJ43589_Site-15	50	-0.005	0.006	0.007
PRJ43589_Site-16	59	-0.006	0.007	0.010
PRJ43589_Site-19	50	-0.004	0.007	0.008

- Data classification has been manually checked and edited against any available imagery.

Horizontal Validation

- Ground data in has been compared to 38 Horizontal Reference points obtained by field survey and assumed to be error-free. Comparison of the test points with elevations interpolated from measured data resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.230	-0.200
Maximum	0.224	0.285
Mean	-0.006	0.013
Standard Deviation	0.102	0.132
Root Mean Square Error	0.100	0.131

Data Validation – Orthophoto Image

- The Orthophotography has been compared to 50 photo control points obtained by field survey and assumed to be error-free. Comparison of the orthophoto with the control points resulted in:

	ΔE (m)	ΔN (m)
Minimum	-0.126	-0.119
Maximum	0.182	0.142
Mean	0.037	0.008
Standard Deviation	0.081	0.073
Root Mean Square Error	0.088	0.073

3. CONDITIONS OF SUPPLY

The data in this volume has been commissioned by **Arrow Energy Pty Ltd**.

The data in this volume is provided by Woolpert Australia Pty Limited (Woolpert) to **Arrow Energy Pty Ltd** under the client's Terms of Engagement, which allow **Arrow Energy Pty Ltd** to assume beneficial ownership, subject to the following conditions:

1. This file (project_report-PRJ43589_01.PDF) is always stored with the unaltered data contained in this volume.
2. The data is not altered in any way without the approval of Woolpert. The data August be copied from this file to another.
3. The data is not used for purposes beyond that explicitly agreed in the description of the Services provided by Woolpert.

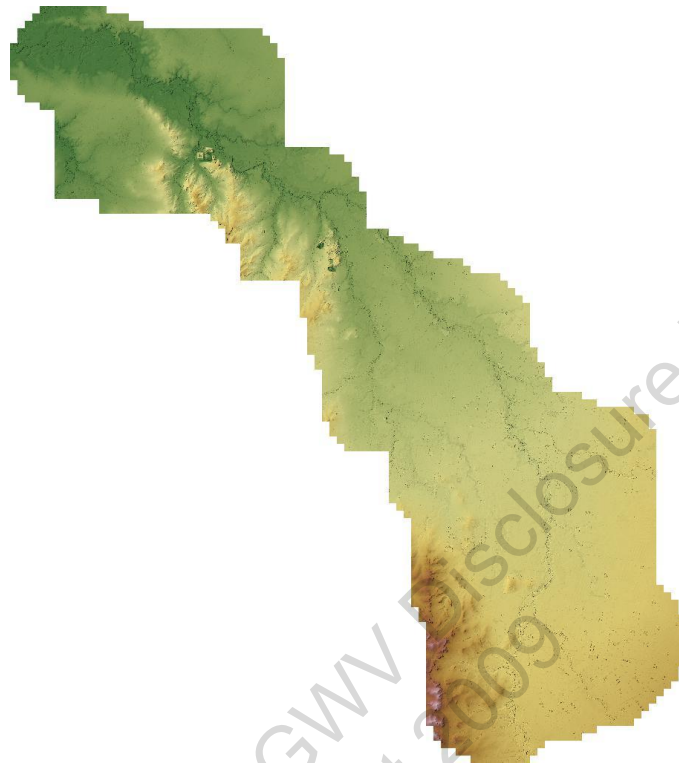
Any breach of these conditions will result in the immediate termination of the license issued by Woolpert, and **Arrow Energy Pty Ltd** will indemnify Woolpert from all resulting liabilities.

Any problems associated with the information in the data files contained in this volume should be reported to:

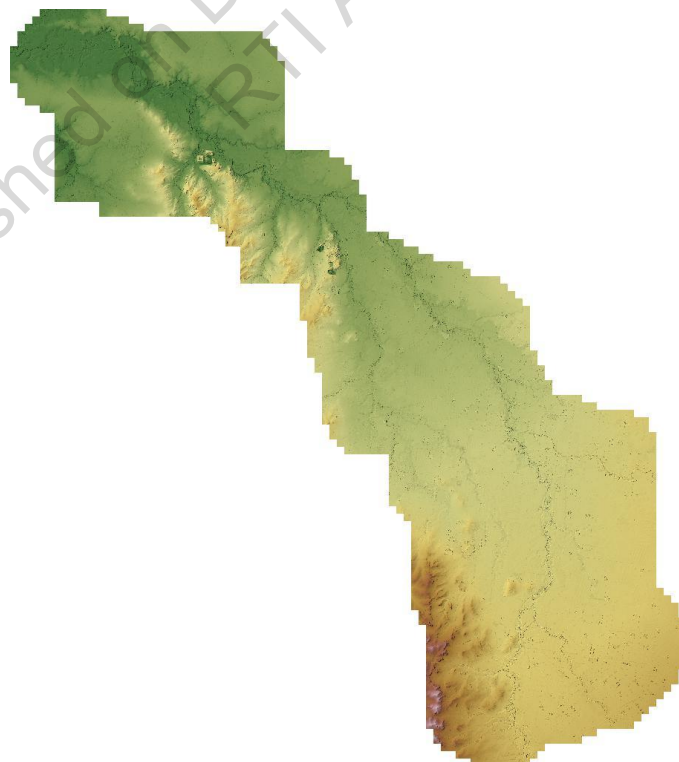
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4. VALIDATION

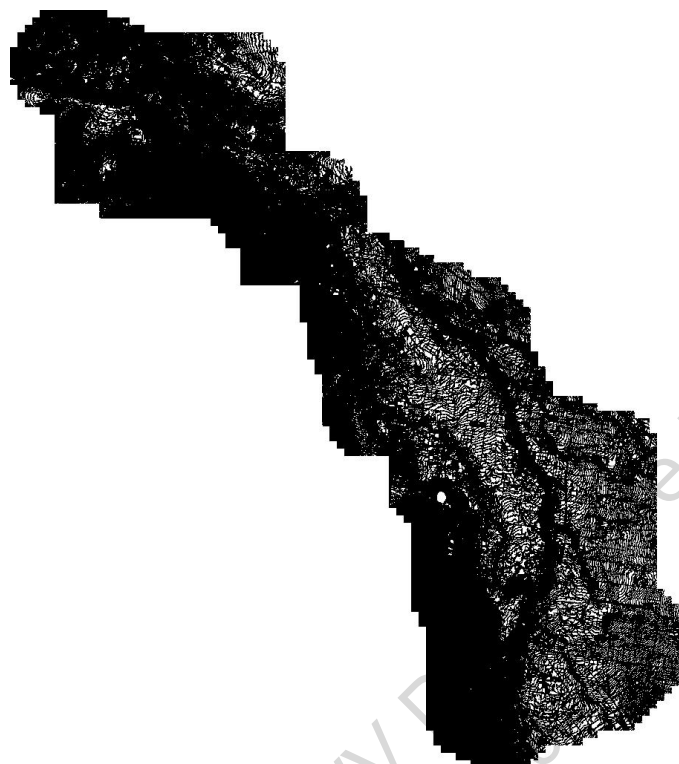
LiDAR Ground Point Cloud data (Coloured by elevation)



DTM



0.25m Contours



Orthophoto Mosaic

