Hawke's Bay Regional LiDAR 2020

Dataset Report

March 2023

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HAWKES BAY REGIONAL COUNCIL

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(06) 835 9200
0800 108 838
Private Bag 6006 Napier 4142
159 Dalton Street . Napier 4110

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Hawke's Bay Regional LiDAR 2020

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Prepared By:
Tim Farrier, Team Leader GIS

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Executive summary

Airborne LiDAR contains detailed and accurate elevation measurements of terrain and landscape features and can be used to model and support a wide range of infrastructure, land and environmental management activities.

The Hawke’s Bay Region LiDAR 2020 project is being undertaken as part of the LINZ National Elevation Programme. The project encompasses the areas of Hawke’s Bay Regional Council (HBRC) that overlap with Wairoa District Council (WDC), Hastings District Council (HDC), Napier City Council (NCC) and Central Hawke’s Bay District Council (CHBDC) administration boundaries.

This report provides an overview of the project and describes the datasets that were contracted to be supplied to Council.

1 Overview

Airborne LiDAR contains detailed and accurate elevation measurements of terrain and landscape features and can be used to model and support a wide range of infrastructure, land and environmental management activities.

The Hawke's Bay Region LiDAR 2020 project is being undertaken as part of the LINZ National Elevation Programme. The project encompasses the areas of Hawke's Bay Regional Council (HBRC) that overlap with Wairoa District Council (WDC), Hastings District Council (HDC), Napier City Council (NCC) and Central Hawke's Bay District Council (CHBDC) administration boundaries.

The project is funded by Hawke's Bay Regional Council, Wairoa District Council, Hastings District Council, Napier City Council, Central Hawke's Bay District Council and MBIE Provincial Growth Fund-LiDAR programme.

The work is being completed under contract between Hawke's Bay Regional Council and iXblue Pty Ltd (During February 2022 underwent a Change of Control, joining the Ocean Infinity Group). The project extent (~13,750 sq km) is shown below.

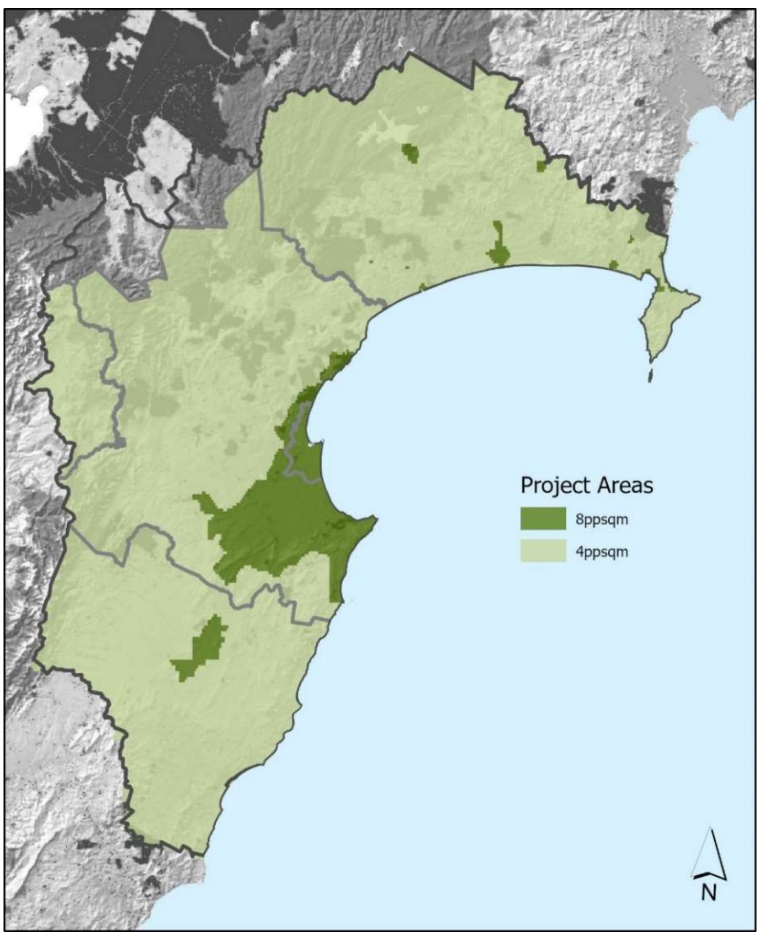


Figure 1 Project extent and base pulse density specification (pulses per sq metre – ppsqm)

Projects undertaken as part of the Provincial Growth Fund-LiDAR programme are required to utilise the PGF Version: New Zealand National Aerial LiDAR Base Specification (LINZ 2020). This is a detailed specification that sets out specific requirements for minimum LiDAR pulse densities, datum and coordinate reference system requirements, positional accuracy validation and product specifications. The PGF specification requires a minimum LiDAR pulse density of 2 ppsqm. The Hawke's Bay Councils elected take advantage of recent improvements in LiDAR data collection efficiencies and requested 8 ppsqm over some communities and 4 ppsqm over the balance of the Region.

2 Dataset Products

Table 1 listed the three primary products in this dataset. Details pertaining to each of the products are provided further on, as well as in the PGF Version: New Zealand National Aerial LiDAR Base Specification (Project Specification).

Product (Product Code)	Description
Classified Point Cloud (CL2)	LiDAR point cloud dataset classified to PGF Version: New Zealand National Aerial LiDAR Base Specification standard CL2
Digital Elevation Model (DEM)	1m grid cell raster digital elevation model with hydro-flattening of large waterbodies.
Digital Surface Model (DSM)	1m grid cell raster digital surface model

Table 1: Primary Products

These products are all tiled into NZTopo50 1:1,000 map tiles. They are all in New Zealand Transverse Mercator 2000 map project (EPSG:2913) and with NZVD2016 normal-orthometric heights (EPSG:7839).

Table 2 listed ancillary products which include product tile layout and records of flight details and ground surveying work.

Product	Description
Flight line data	Record of flight lines flown for data acquisition, which included date and time details for each flight line.
Ground surveying reference marks, control and check points	Ground surveying mark and point locations used for the control and validation of point cloud geopositioning.
Tile layout	NZTopo50 1:1,000 tile layout used for the tiling of the primary products

Table 2: Ancillary Products

These products are all in New Zealand Transverse Mercator 2000 map project (EPSG:2913) and with NZVD2016 normal-orthometric heights (EPSG:7839).

Details on the online access to these products is provided via the Council's Open Data Portal https://hbrcopendata-hbrc.opendata.arcgis.com HBRC intends to create several derived products from the primary products including work programme specific terrain and landcover datasets. Access to these products will also be provided via the Council's Open Data Portal

3 Project Phases

The LiDAR was undertaken by iXblue in four district phases. The survey began with Airborne Data Acquisition. This is where an aircraft mounted wide area LiDAR sensor system (Leica Terrainmapper-LN) is used to collect the raw LiDAR measurements. Ground Surveying runs in parallel with the airborne data acquisition. Ground surveying data is collected to be used to help ensure the fit between the LiDAR point cloud and the survey reference system and validate the absolute geometric accuracy of the point cloud. The next phase of work is the Geopositioning. This involves processing the raw LIDAR measurements and sensor trajectory data to create a set of point clouds for each flight, optimised these and confirm their relative and absolute geometric accuracies against project specifications.

The final phase is Data Processing, this involves the classification of the LiDAR points into the classes prescribed in the Project Specification, the production of the raster datasets, the QA/QC these products and the reporting of results. The Data Processing was completed by Woolpert.

These project phases are detailed in the Beca (2021), iXblue (2020, 2020) and Ocean Infinity (2023) reports. These reports are summarised in the following section.

3.1 Airborne Data Acquisition

iXblue utilised a Lecia TerrainMapper-LN LiDAR sensor system for the data acquisition. The system was mounted in a fix-winged aircraft. A calibration of the sensor system and aircraft installation was undertaken prior to the commence of project data acquisition. The key LiDAR sensor and collection parameters are listed in the Table 3.

Parameter	Variable
Average Pulse Density	8.9 pulses per square metre
Maximum Pulse Spacing: Across Track	0.45 m
Maximum Pulse Spacing Along Track	0.50 m
Average Pulse Spacing	0.34 m
LiDAR Pulse Repetition Rate	1,500,000 Hz
Scanner Pattern	Circular
Nominal Altitude Above Ground Level	1,950 m
Aircraft Ground Speed	Target 145 knots, but not exceeding 163 knots
Field of view	+/-20 degrees
Laser wavelength	1,064 nm
Laser divergence	0.25 mrad
Return Pulses	Programmable up to 15
Intensity digitisation	14 bits

Table 3: 8 ppsqm LiDAR sensor and collection parameters

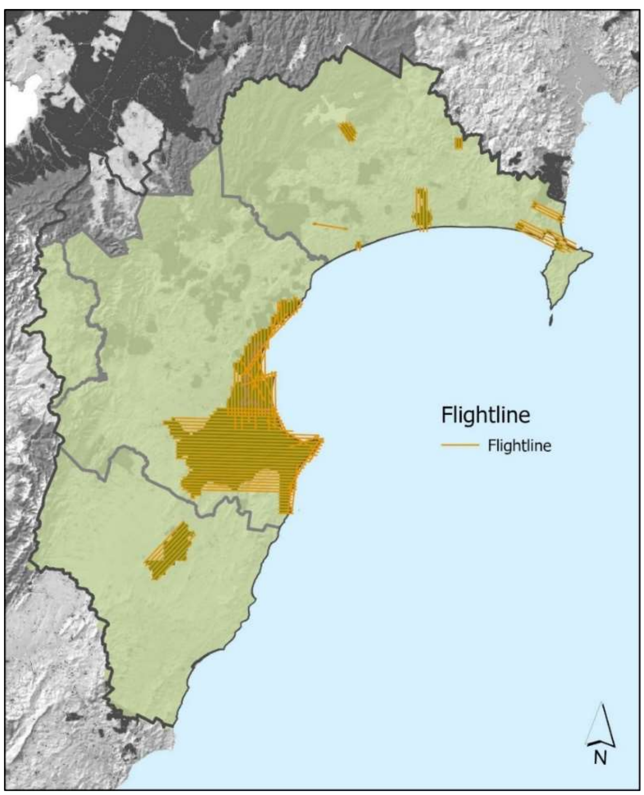


Figure 2 8 ppsqm flightlines

The 8 ppsqm was undertaken over 8 days between 11 November and 6 December 2020. Coastal and tidal areas within Napier City were collected within 1.5 hours either side of low tide. The remainder of the coastal and tidal areas were collected within 3 hours either side of low tide. The flown flight lines are shown in Figure 2. This flightline data is included in the ancillary products, which records date and time information for each flightline.

Parameter	Variable
Average Pulse Density	4.6 pulses per square metre
Maximum Pulse Spacing: Across Track	0.66 m
Maximum Pulse Spacing Along Track	0.66 m
Average Pulse Spacing	0.46 m
LiDAR Pulse Repetition Rate	1,025,000 Hz
Scanner Pattern	Circular
Nominal Altitude Above Ground Level	1,820 m
Aircraft Ground Speed	Target 150 knots, but not exceeding 172 knots
Field of view	+/-20 degrees
Laser wavelength	1,064 nm
Laser divergence	0.25 mrad
Return Pulses	Programmable up to 15
Intensity digitisation	14 bits

Table 4: 4 ppsqm LiDAR sensor and collection parameters

The 4 ppsqm was undertaken over 8 days between 26 November 2020 and 24 January 2021. The coastal and tidal areas were collected within 3 hours either side of low tide. The flown flight lines are shown in Figure 3. This flightline data is included in the ancillary products, which records date and time information for each flightline.

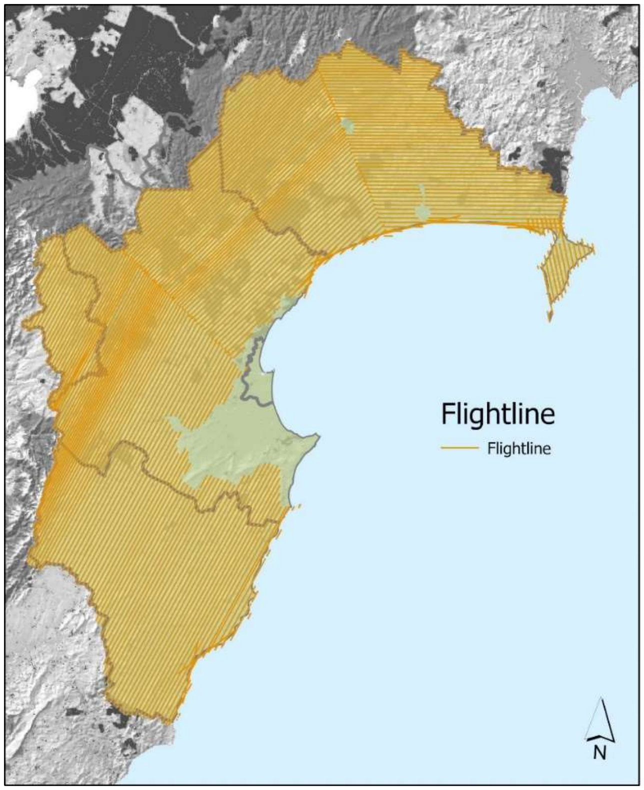


Figure 3 4 ppsqm flightlines

The Project Specification has several criteria that the data needs to satisfy with regard to coverage, density of returns, multiple return characteristics, return intensity value range, acceptable data voids and collection conditions. In addition, iXblue set several quality criteria with regard to the sensor trajectory data and the processing of the Global Navigation Satellite System (GNSS) and Inertial Measurement Sensor (INS) that data needed to satisfy so as correct point cloud creation and geopositioning could be undertaken.

Flight and quality check records are detailed in iXblue (2020) Hawkes Bay Regional Council LiDAR Data Capture Services - Collect Report.

3.2 Ground Surveying

Ground surveying data is used as control to aid the geopositioning of the point cloud to the project datum and coordinate reference system (control) and validate the absolute geometric accuracy of this data. Beca (Engineers and Consultants) undertook the ground surveying.
A total of 247 locations were surveyed. 125 of the locations were surveyed as Control points and 123 were surveyed for check site geometric accuracy validation.

The number of locations and surveying requirements for the check site surveying are set out in the Project Specification. The points needed to be surveyed distribution across the project area and to better than +/- 5cm (95%) vertical and horizontal accuracy relative to 4th Order or better LINZ geodetic marks. The distribution of the marks is shown in Figure 3. Locations were selected in publicly accessible open ground areas where it was judged that the area would be unlikely to be disturbed for the duration of the Airborne Data Acquisition.

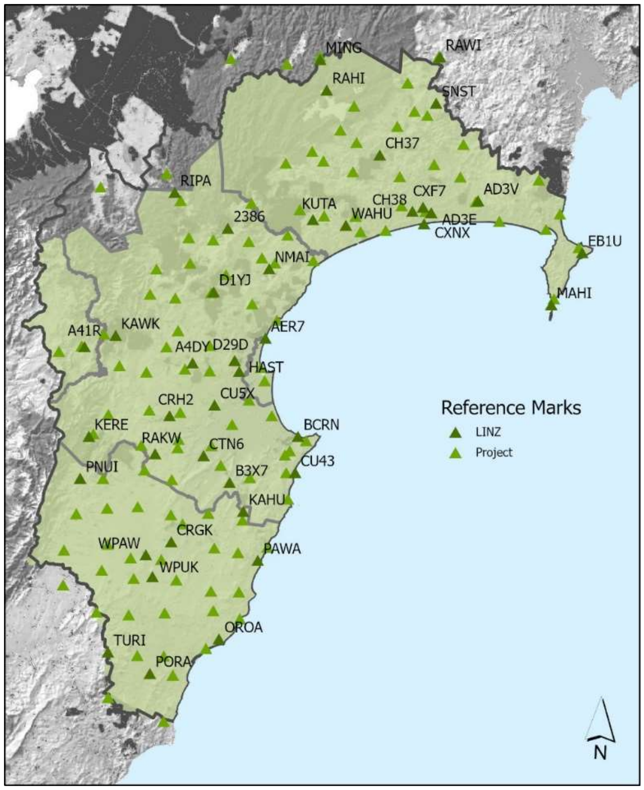


Figure 4 LINZ and Project survey reference marks

The surveying work is reported in detail in Beca (2021). A combination of Smartfix, Faster Static and RTK GNSS surveying methodologies were used for the surveying. Where LINZ geodetic marks weren't available within the vicinity of survey locations project reference marks were surveyed. The field data was collected on 44 dates between 2 March and 5 November 2020. The reference mark, control and check points are included in the dataset as ancillary products.

3.3 Geopositioning

The geopositioning phase of the project is where the raw LIDAR sensor measurements and sensor trajectory data is processed into a set of point clouds for each flightline. Lecia Geosystems HxMap software was used for this and subsequent flightline optimisation. This involves refining the LiDAR sensor calibration through comparison and adjustment of fore and aft viewed points within a flightline as well as between overlapping flightlines.

The LiDAR project datum and coordinate reference system are:

- New Zealand Geodetic Datum 2000 (NZGD200 EPSG:4176)
- New Zealand Transverse Mercator 2000 map project (NZTM2000 EPSG:2913)
- NZVD2016 normal-orthometric heights (NZVD2016 EPSG:7839).

The GNSS/INS trajectory processing and point clouds processing computations need to be performed in a rigorous mathematical reference frame. International Terrestrial Reference Frame (IRTF 2014) at epoch 2020.18 was used as the initial datum for this processing. A custom deformation gird was then used to transform the data into the project datum based on NZGD2000 (20180701). The New Zealand QuasiGeoid (NZVD2016) was incorporated into the grid to also reduce the LiDAR elevations to NZVD2016.

Once the inter flightline optimisation is complete the LiDAR is compared with the ground surveyed control points. For the 8 ppsqm areas the control point analysis was performed in 3 blocks: Napier City and Hastings District Towns, Central Hawkes Bay District Towns and Wairoa Towns. The 4 ppsqm area was processed as an independent block. This means that on the edges between the 8 and 4 ppsqm extents that some residual positioning differences will be present in the dataset.

The analysis is detailed in iXblue (2021) Hawkes Bay Regional Council LiDAR Data Capture Services - LiDAR Geopositioning QAQC Report Urban Areas and iXblue (2021) Hawkes Bay Regional Council LiDAR Data Capture Services - LiDAR Geopositioning QAQC Report Rural Areas. The key statistics are provided in Table 4.

	Napier/Hastings (8 ppsqm)	**Central Hawkes Bay (8 ppsqm)**	**Wairoa (8 ppsqm)**	**Rural (4 ppsqm)**
Number of points	35	5	22	80
Minimum dz	-0.112 m	-0.041 m	-0.047 m	-0.136 m
Maximum dz	0.113 m	0.058 m	0.059 m	0.183 m
RMS	0.044 m	0.039 m	0.028 m	0.076 m
Std Deviation	0.045 m	0.043 m	0.029 m	0.076 m

Table 5: Control point (vertical)-LiDAR surface difference statistics

The Project Specification requires that the internal geometric quality of the LiDAR point cloud satisfies the smooth surface repeatability and swath overlap consistency criteria in Table 5.

Criteria	Threshold
Smooth surface repeatability (intraswath, maximum)	≤ 6cm
Swath overlap consistency (interswath, root mean squared difference in z direction (RMSDz))	≤ 8cm
Swath overlap consistency (interswath, maximum)	≤ 16cm

Table 6: Swath relative vertical accuracy requirements

The smooth surface repeatability was calculated from sampled areas that were in flat open areas identified using Google Earth imagery. The relative smoothness of the LiDAR points was assessed and RMSDz values computed. A similar method was used to check the swath overlap consistency, but in this case, locations were selected within areas of flight line overlap and the height difference between surfaces created from each flight line were computed and summarised.

This analysis was also performed in 4 blocks: Napier City and Hastings District Towns, Central Hawkes Bay District Towns and Wairoa Towns and Rural, and is summarised in Table 6.

	Napier/Hastings (8 ppsqm)	Central Hawkes Bay (8 ppsqm)	Wairoa (8 ppsqm)	Rural (4 ppsqm)
Smooth surface repeatability (intraswath, RMSDz)	0.023 m	0.024 m	0.047 m	0.020 m
Swath overlap consistency (interswath, (RMSDz)	0.021 m	0.021 m	0.021 m	0.013 m
Swath overlap consistency (interswath, 95% confidence)	0.041 m	0.041 m	0.041 m	0.026 m

Table 7: Swath relative vertical accuracy statistics

The Project Specification also requires the local vertical accuracy to be check at a specified number of locations based on the size of the project. For the Hawke's Bay Region project required number of locations is 123 non-vegetated vertical accuracy assessment sites. Horizontal accuracy checks are also required and approximately 50% of the locations had additional features surveyed for this purpose.
The Project Specification required non-vegetated vertical accuracy at 95% confidence interval is ≤ 20cm and required horizontal accuracy at 95% confidence interval is ≤ 100cm.

The approach that was followed to collect the ground surveying data used for the checks has been described earlier. For the 8 ppsqm blocks that made up this dataset the assessments were performed in 3 blocks. The 4 ppsqm assessment was performed as a single block. Difference values were computed between ground surveyed points and TIN surfaces created from the point cloud data. The summary statistics are provided in Table 7.

	Napier/Hastings (8 ppsqm)	Central Hawkes Bay (8 ppsqm)	Wairoa (8 ppsqm)	Rural (4 ppsqm)
Number of points/locations	160/19	16/2	50/6	911/109
Average dz	-0.021 m	-0.031 m	-0.007 m	0.017 m
Minimum dz	-0.149 m	-0.066 m	-0.041 m	-0.148 m
Maximum dz	0.073 m	0.006 m	0.038 m	0.158 m
RMSE	0.051 m	0.036 m	0.020 m	0.058 m
95% dz	0.10 m	0.039 m	0.039 m	0.114 m

Table 8: Non-vegetated vertical accuracy check LiDAR surface difference statistics

A proprietary method, that utilises the intensity values in the point cloud was used to measure easting and northing differences between ground surveyed feature locations and the point cloud model. With its lower pulse density, a qualitative assessment of the 4 ppsqm was made where features on LiDAR intensity images were compared with ground surveyed feature locations. All differences were observed to be well within 100cm. The summary statistics are provided in Table 8.

	Napier/Hastings (8 ppsqm)	Central Hawkes Bay (8 ppsqm)	Wairoa (8 ppsqm)	Rural (4 ppsqm)
Number of points	72	6	16	46
95% den vector	0.44 m	0.12 m	0.24 m	NA

Table 9: Non-vegetated positional accuracy Check LiDAR feature difference statistics

These difference statistics show that the dataset meets the Project Specifications. Given the relatively small sample size of the ground surveying point to the extent of the LiDAR dataset users of the data need to be mindful that all LiDAR measurements contain errors, as does the geodetic reference system marks. LiDAR provides a model of the environment, but it isn't an absolute datum. Model accuracy will vary depending on the ground cover, local slope and vegetation canopy structure.

3.4 Data Processing

The data processing phase of the project is where the points in the LiDAR cloud are classified into classes that describe the sort of landscape and LiDAR dataset feature that the point represents. This is the final data processing phase of a LiDAR project and so it is also where the Project Specified deliverable dataset products are created.

The point cloud specification has been undertaken in accord with the Project Specification. The focus of this specification is on the classification of ground points and the creation of raster digital elevation and digital surface models (DEM and DSM).

Points have been classified into the classes list in Table 9. These classes are based on the *LAS Specification Version 1.4 – R13 (2013)*.

Code	Description
1	Processed, but unclassified
2	Ground
3	Low Vegetation <2m
4	Medium Vegetation
5	High Vegetation >8m
6	Building
7	Low noise
9	Water
17	Bridge deck
18	High noise

Table 10: Point Cloud Classes

The Project Specification focuses on the quality of the ground classification, and it specifies that the work is to be done to Classification Level 2 *ICSM (2011)* standard. The benchmark in this standard is that within any 1km x 1km area, no more than two percent of the ground classified points should have demonstrable errors. The correct classification of noise, water and bridge points have a direct impact on the quality of the raster digital elevation and surface models. The classification accuracy of the other classes is not of so much concern. Users of the data need to take this into consideration and depending on the end use and goal it may be necessary to undertake additional classification work.

The classification was achieved using a mix of automatic classification algorithms and manual classification. This work and the classification quality and consistency checks performed on the dataset are described in *iXblue (2021) Hawkes Bay Regional Council LiDAR Data Capture Services – LiDAR Processing Report – Urban Areas A, C & D and Ocean Infinity (2023) Hawkes Bay Regional Council LiDAR Data Capture Services – LiDAR Processing Report Complete Rural Area A, B, C.*

LiDAR is a line-of-sight measurement technology which means that returns will only be observed if there is an uninterrupted path from the sensor to the ground. In vegetated areas the proportion of emitted pulses that as registered as returns from the ground will vary significantly and in areas with dense canopy the number of returns may be limited.

Returns will also only be observed where enough energy is reflected from the ground for the sensor to detect and register the point. The 1,064nm wavelength of laser light absorbed by water as well as some of the common composite roof materials used in new hosing. This means that void areas in the point cloud can be observed at locations of water and some housing areas.

The Project Specification has additional requirements with regard to the identification and classification of overlap points (that is points within the dataset where the area is covered by points collected in more than a single flight line), and they LAS v1.2 overlap flag is used for this purpose.

The Project Specification requires the creation of Hydro-flattened DEM with the incorporation of hydro-flattening features into DEM where islands are 5,000 sq m or larger, ponds and lakes are 10,000 sq m or larger and rivers are ≥30m nominal width. These features are used in the creation of the DEM to reduce the presence of artifacts in the DEM where the point cloud points alone aren't sufficient to model the landscape. For work where the data is to be used for detailed hydrological modelling hydro-enforcement and enhancement may be required. As the 8 ppsqm and 4 ppsqm blocks were georeferenced independently some residual positioning differences are present on the edges between these blocks. Regard should be made for this when working across these areas.

The raster DEM and DSM have grid cell size of 1m. The DEM depicts the bare-earth elevation, devoid of vegetation and structures. For this project the DEM was created using linear interpolation of a TIN created from the Ground class points and hydro-flattening features. The DSM is an elevation model that depicts the highest surface, including buildings, vegetation, towers, and other features. For this project the DSM was created using points of return type, first, first of many and only and excluding Noise and Water class points. The maximum value binning method was applied and where gaps existed in the model these cells were populated with hydro-flattened DEM cell values.

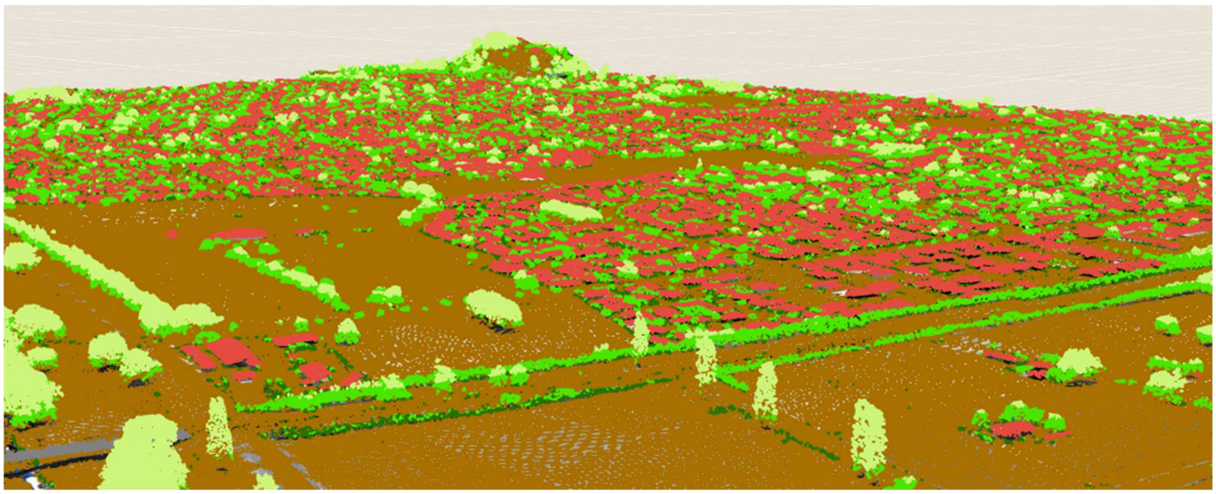
The Project Specification has numerous specific requirements regarding how data such as GPS times are recorded within the point cloud, how the data is tiled and formatted, how intensity values are scaled (16 bit), how georeferencing details are recorded in OGS WKT format, how flight line details are recorded for each point and how the primary products are named.

The datasets were checked for compliance by iXblue and Woolpert before delivery as well as by LINZ. Some further details on the dataset products follow.

4 Primary Products

The primary products are all tiled into NZTopo50 1:1,000 map tiles. The file naming convention follows the Product Specification naming convention [Product]_[Sheet]_[Year]_[Scale]_[Tile].[Ext] for example CL2_BJ39_2020_1000_1738.las
Specific product format details follow.

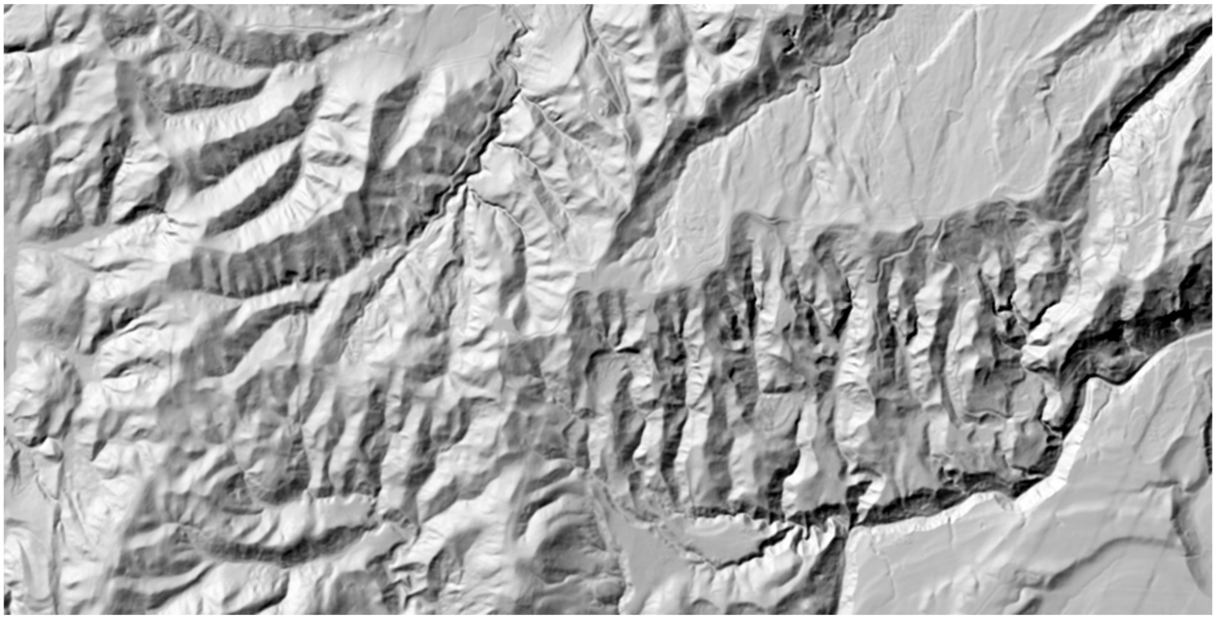
4.1 Classified Point Cloud



Parameter	Value/Usage
Product Code	CL2
File Format	LAS 1.4 Point Data Record Format 6
GPS Time Type	Adjusted GPS Time
Intensity values	Normalised to 16-bit (0-65,536)
Flags	Withheld and Overage Flags Utilised for noise and overlap points
Point Source ID	Populated with unique flightline ID
File Source ID	Set to Zero

Table 11: Classified Point Cloud product parameters

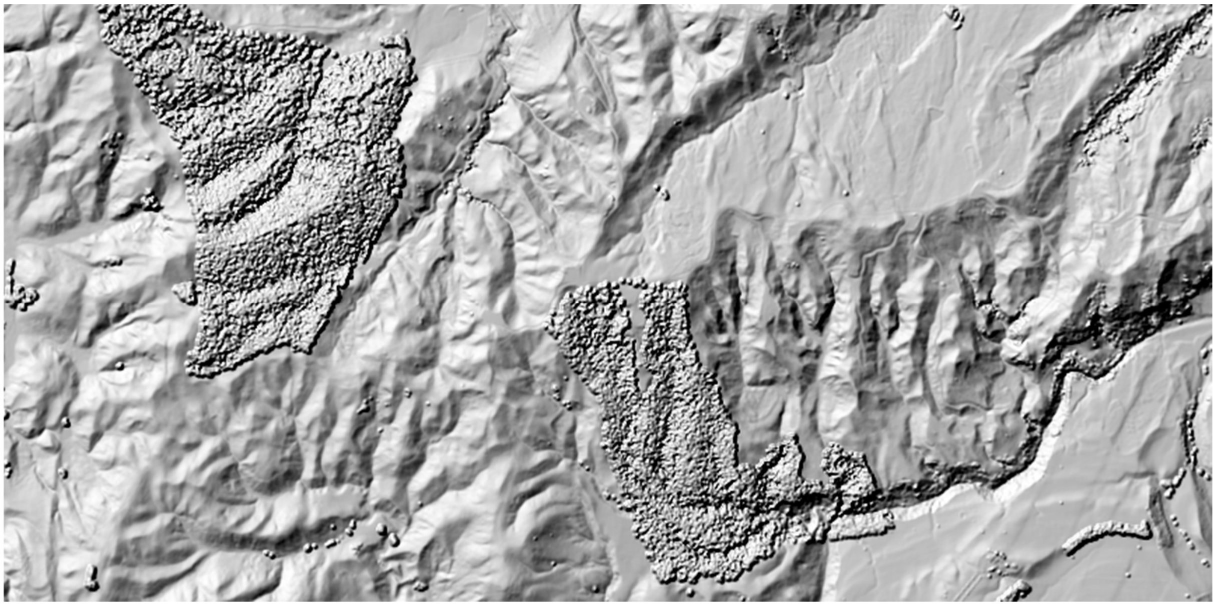
4.2 Digital Elevation Model (DEM)



Parameter	Value/Usage
Product Code	DEM
File Format	GeoTIFF
Data type	32-bit float
Nodata value	-9999
Grid cell size	1m

Table 4: DEM product parameters

4.3 Digital Surface Model (DSM)



Parameter	Value/Usage
Product Code	DSM
File Format	GeoTIFF
Data type	32-bit float
Nodata value	-9999
Grid cell size	1m

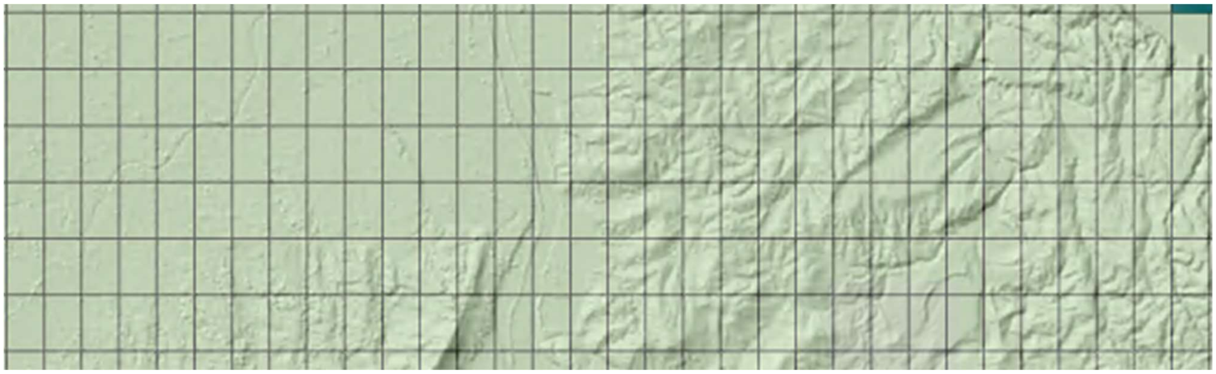
Table 5: DSM product parameters

5 Ancillary Products

The ancillary geospatial layers include flight line and tile layout data as well as ground surveying datasets. These datasets are contained in a ESRI File Geodatabase format, and available on the HBRC Open Data Portal https://hbrcopendata-hbrc.opendata.arcgis.com

5.1 Tile Layout

This layer shows the map tiles used for the product creation and naming.

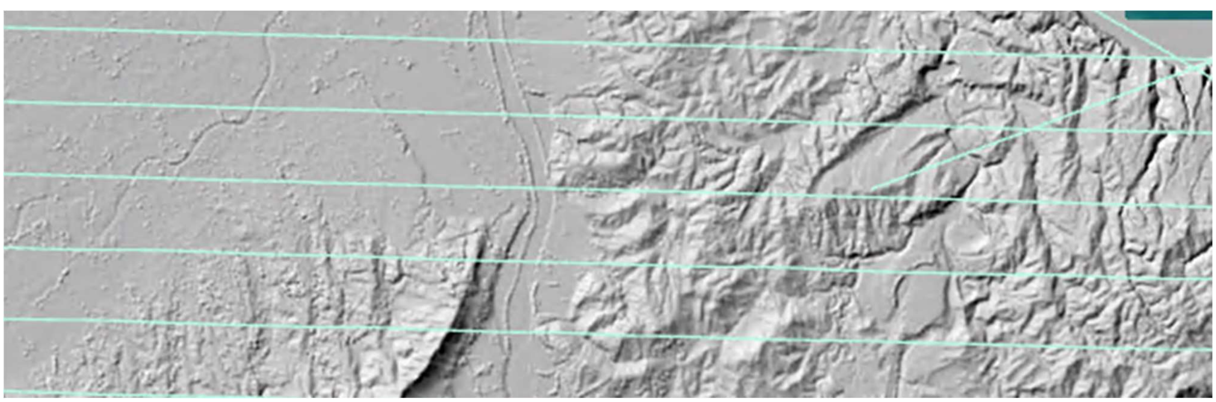


Parameter	Value/Usage
Geometry Type	Polygon
TileIndentifier	Unique Identifier for map tile
NominalPulseDensity	Project Specification Pulse Density [4,8]
LowerLeftEasting	NZTM easting coordinate for lower left corner of tile
LowerLeftNorthing	NZTM northing coordinate for lower left corner of tile

Table 6: Tile Layout geometry type and attribute details

5.2 Flightlines

This layer shows the actual tracks that the aircraft flew when collecting data.

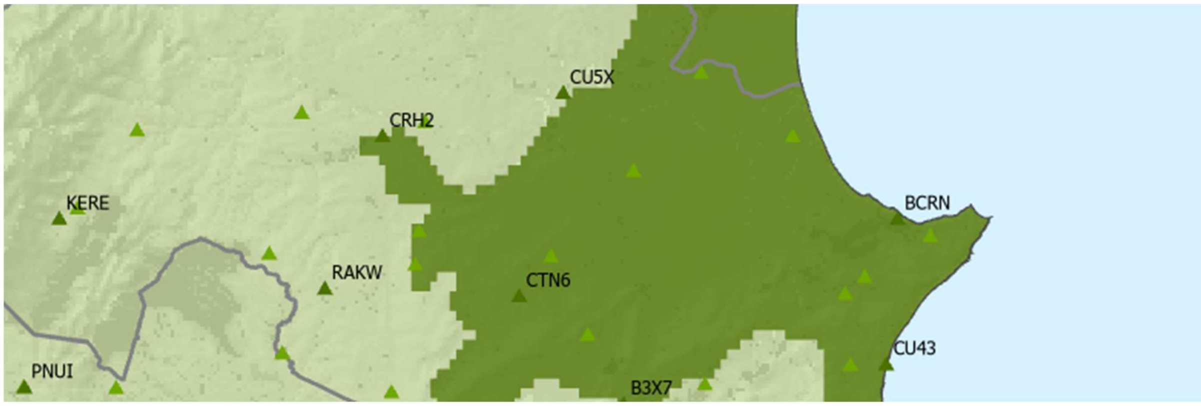


Parameter	Value/Usage
Geometry Type	Line
Flightline	Unique Identifier for each flightline
Local Date	Date of Acquisition
StartNZST	New Zealand Standard Data and Time for when the laser was turned on.
EndNZST	New Zealand Standard Data and Time for when the laser was turned off
StartGPST	GPS Adjustment Time for when the laser was turned on
EndGPST	GPS Adjustment Time for when the laser was turned off
Mission	iXblue flight identifier
Sensor	Serial Number for LiDAR sensor system

Table 7: Flightline geometry type and attribute details

5.3 Ground Surveying Reference Marks

This layer shows the surveying reference marks utilised for the Ground Surveying



Parameter	Value/Usage
Geometry Type	Point
Type	Record showing if the reference mark is from LINZ geodetic database or if it was established for the project [LINZ|Project]
MarkCode	Unique Identifier for mark, LINZ code or Beca code
NZTMEasting	NZTM easting coordinate for the mark
NZTMNorthing	NZTM northing coordinate for the mark
NZVD2016Height	NZVD2016 height for the mark
NZGD2000Height	NZGD2000 ellipsoidal height for the mark
MarkName	LINZ geodetic database details
Description	LINZ geodetic database details
MarkType	LINZ geodetic database details
MarkCondition	LINZ geodetic database details
Order	LINZ geodetic database details

Table 8: Reference Mark geometry type and attribute details

5.4 Ground Surveying Points

This layer shows the Ground Surveying points that were collected for the purpose of controlling and validating the spatial accuracy of the point cloud.

Parameter	Value/Usage
Geometry Type	Point
Point_Id	Unique Identifier for the surveyed point
NZTMEasting	NZTM easting coordinate for the point
NZTMNorthing	NZTM northing coordinate for the point
NZVD2016_Height	NZVD2016 height for the point
CQ_2D	Coordinate Quality easting/northing (position) 1σ standard deviation
CQ_1D	Coordinate Quality z (elevation) 1σ standard deviation
Date	Date of field surveying
Methodology	Surveying Methodology [STATIC|SMARTFIX|RTK]
Reference Mark	Identifier for the reference mark used for surveying of the point
Purpose	Purpose for which the mark was surveyed {Control|CheckVerticalOnly|CheckVerticalAndHorizontal}

Table 9: Ground Surveying Point geometry type and attribute details

6 Data Licensing and Use Constraints

This dataset is licensed for reuse by Hawke's Bay Regional Council under Creative Commons BY INT 4.0 https://creativecommons.org/licenses/by/4.0/. This means that you are free to use, reuse and share the data as long as you attribute the work to HBRC as the original source of the data.

HBRC provides this information in good faith. However, the Council does not warrant the accuracy or completeness of data or warrant that the data is appropriate or suitable for the use to which it may be put by third parties. Any person using the data does so at their own risk. Users should be aware that temporal changes may have occurred since these data were collected and that some parts of these data may no longer represent actual surface conditions. Users should not use these data for critical applications without a full awareness of its limitations.

7 Acknowledgements

The production of this report has been supported by the following people.

Name and title	Organisation
Hellen Simpson GIS Team Leader	Hawkes Bay Regional Council
Stuart Paisley Technical Manager	iXblue Pty Ltd
Technical Leader, Elevation Location Data Analyst	Toitū Te Whenua Land Information New Zealand

8 Document Control

This report will be added to as the coverage of the dataset expands until the full regional coverage is complete.

8.1 Document History

Version	Date	Changes	Status
0.9	4 October 2021	Draft report for circulation to TLA to coincide with availability of WDC, NCC and CHBDC datasets for internal work.	Draft – HBRC Publication No. 5566
1.0	5 November 2021	Updated on finalisation of WDC, NCC, HDC and CHBDC 8 pulse datasets.	HBRC Publication No. 5566
2.0	27 March 2023	Updated to include details for Rural 4 pulse dataset.	HBRC Publication No. 5566

9 Glossary of abbreviations and terms

Abbreviation/Term	Meaning
dEN	Difference in the combined easting and northing direction (position)
dZ	Difference in the z direction (elevation)
GNSS	Global Navigation Satellite System
Hydro-flattening	The process of creating a LiDAR derived DEM in which water surfaces appear as they would in a traditional topographic map
INS	Inertial Navigation Sensor
LiDAR	Light detection and ranging
RMSE	Root mean square error
RMSDz	Root mean square difference in the z-direction (elevation)
Nominal Pulse Density	The density of pulses emitted by the LiDAR sensor per specified unit area
Overlap	Any part of a swath/flightline that also is cover by any part of any other swath/flightline
Pulse	A pulse of laser light emitted from the LiDAR sensor
Point/return	A discrete point measured from the returning pulse to the LiDAR sensor. In vegetated areas there are often multiple points/returns per pulse
Smooth surface repeatability	A measure of variations on a surface model that would expect to be flat and without variation in the real world
Std Deviation	Standard deviation
Swath overlap consistency	A measure of the geometric alignment of two overlapping swaths/flightlines. Overlap consistency is the fundamental measure of the quality of the calibration of the data form each flight
95%	95% confidence interval

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