SKYTEM HELICOPTER EM SURVEY:

WAIRARAPA 3D AQUIFER MAPPPING

AEM SURVEY, RUAMĀHANGA VALLEY

WAIRARAPA, NZ

Report for

GREATER WELLINGTON

REGIONAL COUNCIL

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SUMMARY

A SkyTEM312 airborne electromagnetic (AEM) survey was flown between the 28th January to 02nd March 2023. The survey area lies within the Ruamāhanga river catchment in the Wairarapa, New Zealand.

This survey area comprises two contiguous irregularly shaped blocks. The "Main Block" extends approximately 44km NNE from the coast at Lake Ferry in the south-west to Greytown in the centre of the survey area and is composed of 200 and 400m spaced flight-lines with a nominal bearing of 130/310°. The "Masterton Block" extends approximately 36km NNE from Greytown to north of Masterton in the north-west and is composed of 200m spaced flightlines with a nominal bearing of 30/210°.

There are also 5 orthogonal (40/220°) tie-lines spaced 2500m apart that run for most of the length of the Main Block. On the Masterton Block, there are 2 closely spaced kinked tie-lines (41/221° & 60/240°) running sub-parallel to the production flight-lines, and an additional two kinked tie-lines running approximately orthogonal (120/300°) to the production flight-lines.

Due to the widespread infrastructure and the large number of roads and dwellings, many small areas had to be omitted from the survey. The total distance surveyed, including repeat lines, was ~5,679 line-kilometres.

Projected grid coordinates have been supplied in NZGD2000 Transverse Mercator.

The SkyTEM survey was flown as part of a contract, awarded to Greater Wellington Regional Council (GWRC) by the Provincial Growth Fund (PGF), to undertake an Airborne Electromagnetic (AEM) Survey to deliver data that will contribute to an improved knowledge and understanding of the Wairarapa's critical groundwater systems.

The aim of the survey is to map the electrical resistivity structure of the Ruamāhanga Valley aquifers. Data from the survey will be used as a basis for further initiatives that enhance the understanding of the groundwater resource, and to develop and refine groundwater and hydrogeological models.

This report lists the SkyTEM system information and specifications relevant for this survey, and describes the processing carried out on the data. A list of the deliverables has also been provided, along with explanatory tables.

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1. SURVEY SPECIFICATIONS

1.1 General

Table 1 lists general survey information.

Table 1 General survey information

SkyTEM Job Number	NZ_10088
Survey Company	SkyTEM Australia Pty Ltd
Block	Wairarapa
Reporting Period	28th January to 02nd March 2023
Client	GWRC
Client Project Number or Project Name	Ruamāhanga Airborne Electromagnetic Survey
Terrain Clearance	45 – 60 m (nominal)
Line Kilometres	Production: 5,660.2 km; Repeat lines: 18.5 km;
Line Direction	Main Block: ~130-310° (~SE-NW); Masterton Block: ~30-210° (~SSW-NNE); Main Block Tie Lines: ~40-220° (~SW-NE); Masterton Block "Sub-Parallel" Tie Lines: ~41-221° & ~60-240° (~SE-NW); Masterton Block "Orthogonal" Tie lines: ~120-300°
Line Spacing	Main Block: 200m & 400m Masterton Block: 200m Main Block Tie Lines: 2500m Masterton Block "Sub-Parallel" Tie lines: 300m (SW segment) & 200m (NE segment); Masterton Block "Orthogonal" Tie lines: 3000m;
Datasets Acquired	Time-domain EM & Magnetics
EM System	SkyTEM312 (Interleaved Low Moment and High Moment)
Helicopter Company	Heli A1
Helicopter Type	AS350 B3
Helicopter Registration	ZK-ILT
Navigation	Real Time DGPS. Base GPS data was recorded as a backup.
Coordinate System	NZGD2000 / TM

1.2 Flight Path

This survey area comprises two contiguous irregularly shaped blocks. The "Main Block" extends approximately 44km NNE from the coast at Lake Ferry in the south-west to Greytown in the centre of the survey area and is comprised of 200 and 400m spaced flight-lines with a nominal bearing of 130/310°. The "Masterton Block" extends approximately 36km NNE from Greytown to Kopauranga on the Opaki-Kaiporoa in the north-west and is comprised of 200m spaced flightlines with a nominal bearing of 30/210°.

There are also 5 orthogonal (40/220°) tie-lines spaced 2500m apart that run for most of the length of the Main Block. On the Masterton Block, there are 2 closely spaced kinked tie-lines (41/221° & 60/240°) running sub-parallel to the production flight-lines, and an additional two kinked tie-lines running approximately orthogonal (120/300°) to the production flight-lines.

There were several small towns within the planned survey area, including Masterton, Martinborough, Carterton and Greytown. These larger built-up zones were omitted from the survey acquisition, along with many other smaller zones with dwellings, roads or other infrastructure scattered throughout both survey blocks. The total distance surveyed, including repeat lines, was ~5,679 line-kilometres.

Figure 1 shows the production lines and repeat lines as they were flown.

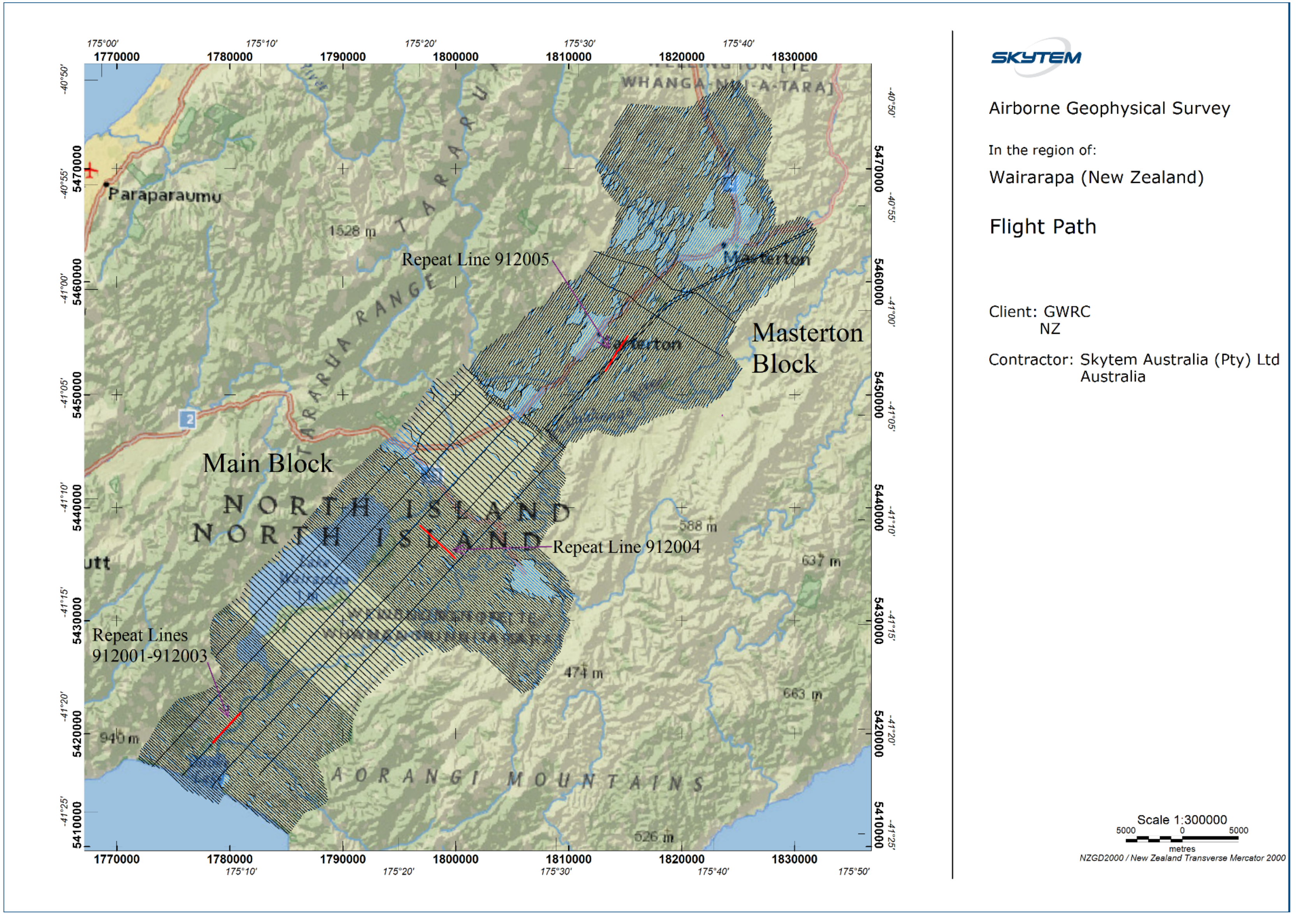


Figure 1 SkyTEM flight path map showing the planned lines (blue), production lines (black) and repeat lines (red))

1.3 Logistics

The survey was flown from a number of different bases throughout the survey area such that ferry times could be optimised. No environmental or safety issues were reported.

1.4 Personnel

A list of the personnel for the survey is provided in Table 2.

Table 2 Survey personnel

Field	
Crew Chief	Brett Rees
Field Manager	Adrian Elsner, Greg Berry, Brett Rees and Wade Markow
Pilots	Alex Mudford, Davin Mudford, Bryan Patterson
Office	
Data Processing	SkyTEM Australia
Reporting	SkyTEM Australia (Geoffrey Peters) gpe@skytem.com

2. ACQUISITION SYSTEM INSTRUMENTS AND PARAMETERS

2.1 Physical Configuration

The geometry of the system used during acquisition is represented in Figure 2. The XYZ coordinates of the instruments relative to the centre of the transmitter loop are provided in Table 3.

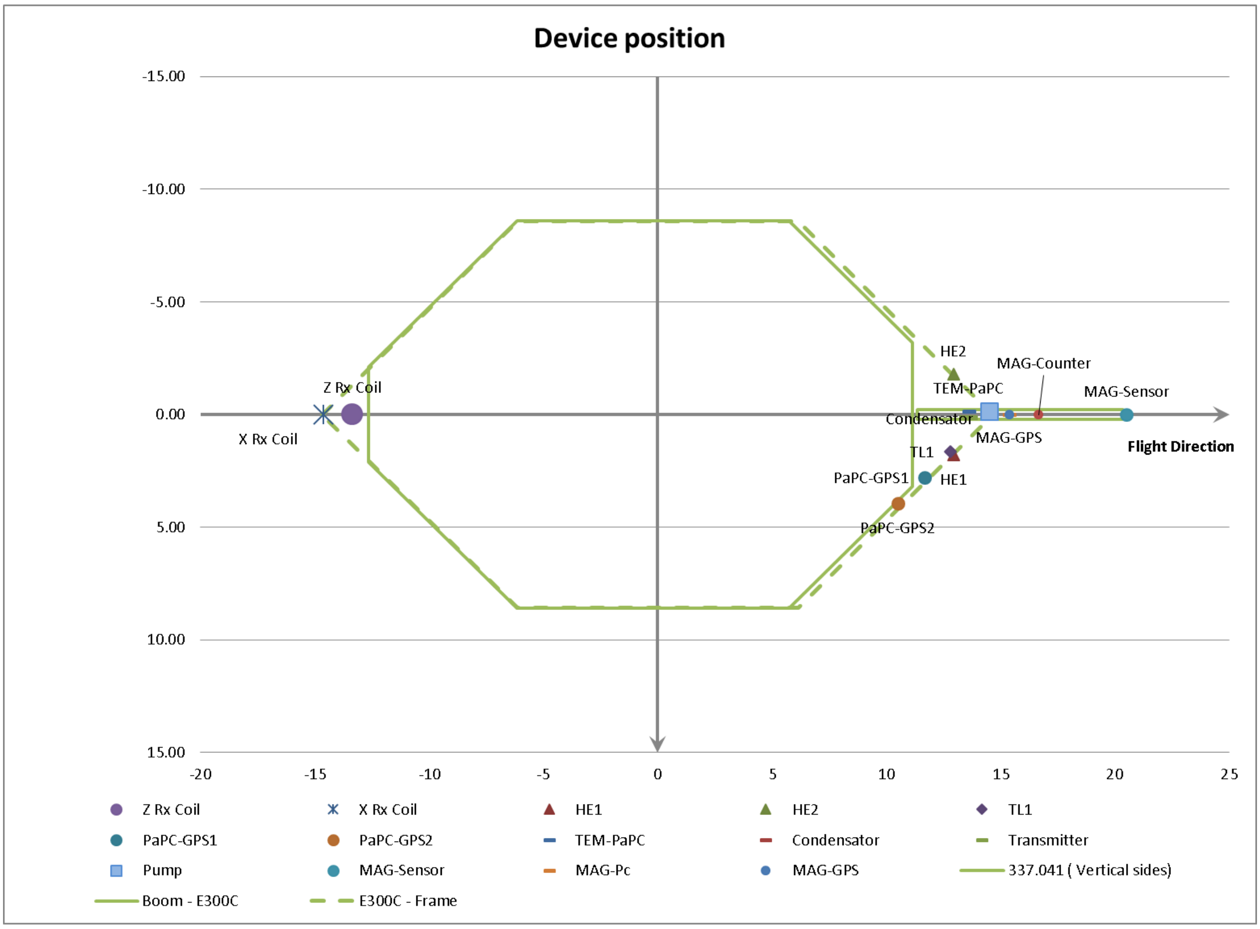


Figure 2 Schematic of the SkyTEM312 System

Table 3 Relative positions of system instruments.

ITEM	DESCRIPTION	SkyTEM312		
		X(m)	Y(m)	Z(m)
Z-coil	EM Z-axis sensor	-13.39	0.00	-2.00
X-coil	EM X-axis sensor	-14.65	0.00	-0.00
TL1/TL2	Tiltmeter 1 & 2 (measures tilts from horizontal with respect to both X and Y axes)	12.79	1.64	-0.12
HE1	Laser Altimeter 1	12.94	1.79	-0.12
HE2	Laser Altimeter 2	12.94	-1.79	-0.12
PaPC-GPS1	GPS 1 Antenna (Standard)	11.68	2.79	-0.16
PaPC-GPS2	GPS 2 Antenna (RTK DGPS)	10.51	3.95	-0.16

The Z-axis is positive below the Tx loop wire. Positive X and Y-axes are in the flight direction and to the starboard side respectively, forming a right-handed coordinate system.

2.2 Transmitter Parameters

Summary of the transmitter specifications are provided in Table 4 and Table 5 with details of the transmitter waveforms for the different moment configurations given in Table 6 and Table 7, and Figure 3 and Figure 4.

Table 4 Summary of transmitter specifications

TRANSMITTER SPECIFICATIONS	
Tx ID = 1628	**SkyTEM312**
Transmitter (Tx) Loop Area	342.0 m^2
Transmitter Moments	LM + HM
Number of Transmitter Loop Turns	2 turns (LM) 12 turns (HM)
Nominal Peak Current	5.96 A (LM) 110.8 A (HM)
Peak Moment	~4,077 Am^2 (LM) ~454,723 Am^2 (HM)
Nominal Tx/Rx Frame Height	~40 m – 60 m

Table 5 Transmitter waveform specifications

TRANSMITTER WAVEFORM	
Base Frequency	275 Hz (LM) 25 Hz (HM)
Tx Duty Cycle	44% (LM) 25% (HM)
Tx Waveforms	Linear rise, linear ramp-off, Bipolar (LM) Pseudo-rectangular, linear ramp-off. Bipolar (HM)
Tx ON-Time	0.8 ms (LM) 5.0 ms (HM)
Tx OFF-Time	1.018 ms (LM) 15.0 ms (HM)

Table 6 Detailed SkyTEM312 LM transmitter waveform

Time[s]	Amplitude
-8.0000E-04	0.0000E+00
-7.4090E-04	9.8115E-02
-6.1632E-04	2.6628E-01
-3.7888E-04	5.3923E-01
0.0000E+00	1.0000E+00
4.5200E-07	9.9597E-01
1.1240E-06	9.4437E-01
1.6120E-06	8.7872E-01
2.6040E-06	7.1944E-01
3.0520E-06	6.3610E-01
4.6520E-06	3.8834E-01
5.9320E-06	2.2990E-01
6.8920E-06	1.4407E-01
8.2200E-06	6.4686E-02
9.3720E-06	2.5463E-02
1.1196E-05	-3.0833E-05
1.3044E-05	0.0000E+00

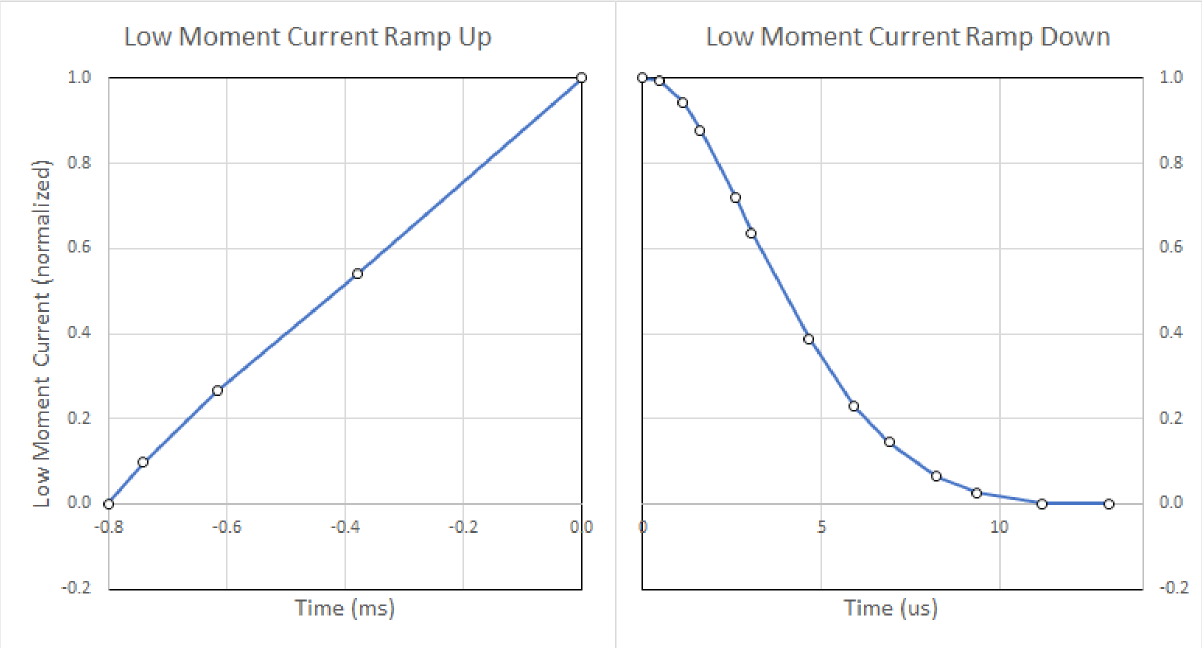


Figure 3 SkyTEM312 LM transmitter waveform

Table 7 Detailed SkyTEM312 HM transmitter waveform

Time [s]	Amplitude
-5.0000E-03	0.0000E+00
-4.9900E-03	2.5303E-02
-4.9042E-03	3.5239E-01
-4.8353E-03	5.9834E-01
-4.7841E-03	7.6441E-01
-4.7242E-03	9.4001E-01
-4.7068E-03	9.7037E-01
-2.6276E-03	9.7557E-01
0.0000E+00	1.0000E+00
3.2660E-06	9.9287E-01
4.5122E-05	8.6091E-01
1.1038E-04	6.4680E-01
1.8450E-04	3.9331E-01
2.9235E-04	1.5001E-02
2.9805E-04	0.0000E+00

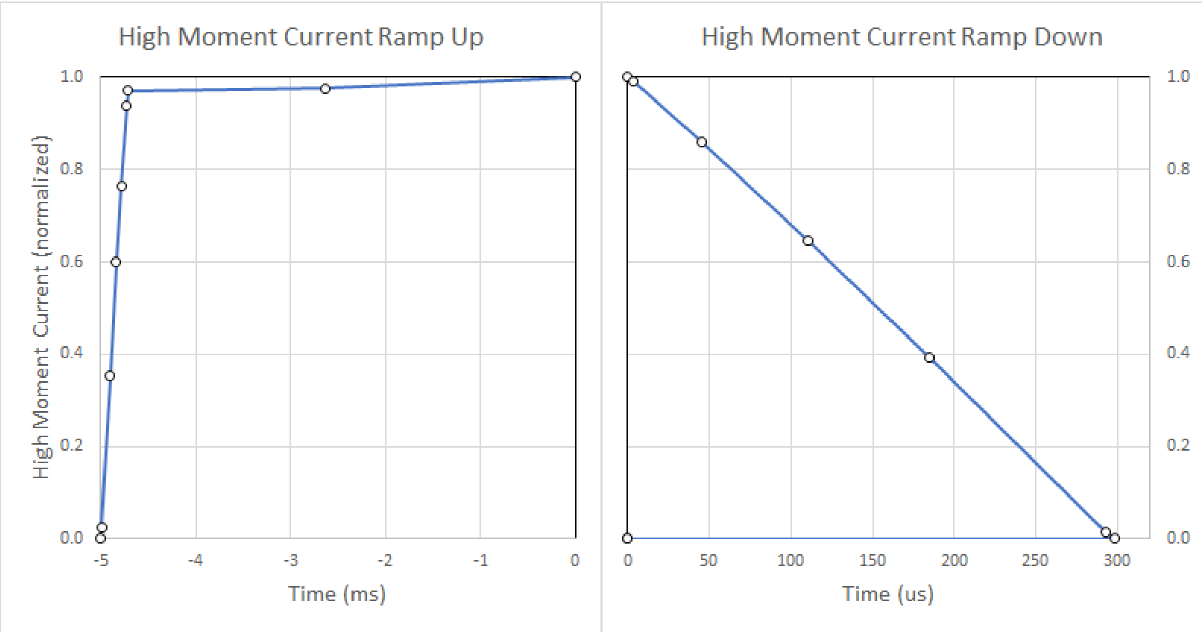


Figure 4 SkyTEM312 HM transmitter waveform

2.3 Receiver Specifications

A summary of the receiver specifications is provided in Table 8. The locations of the X-component and Z-component receiver coils are provided in Table 3.

Table 8 Summary of receiver specifications

RECEIVER (Rx) SPECIFICATIONS	
Rx ID Z = 13232; Rx ID X = PAPC0047/2669;	**SkyTEM312**
EM Sensors	dB/dt coils
Rx coil effective area	325 m^2 (Z) 115.5 m^2 (X)
Low pass cut-off frequency for Rx coils	203.6 kHz (Z) 348.3 kHz (X)
Low pass cut-off frequency for Rx electronics	300 kHz
Front gate	0.00 µs (LM) 370.00 µs (HM)
Earliest gate centre time Measured / recommended use	4.415 µs (LM) Gate 4 (with System Response Inversion) 436.415 µs (HM) Gate 16
Latest gate centre time	861.415 µs (LM) Gate 26 13187.415 µs (HM) Gate 38

2.4 EM Channel Times

Table 9 and Table 10 list the SkyTEM channel times for LM and HM respectively. Both low moment (LM) and high moment (HM) were used for the survey. Times are measured from the start of current switch-off, i.e. from the top of the current ramp. Note that a calibration correction shift has been applied to the gate times. Refer to the Calibration Section in this document on page 18.

Table 9 Detailed SkyTEM312 LM channel times. All gate times are relative to the start of the transmitter current ramp down.

LM Gate Number	Gate Width (μs)	Gate Open (μs)	Gate Centre (μs)	Gate Close (μs)
4	1.57	3.63	4.415	5.2
5	1.57	5.63	6.415	7.2
6	1.57	7.63	8.415	9.2
7	1.57	9.63	10.415	11.2
8	2.57	11.63	12.915	14.2
9	3.57	14.63	16.415	18.2
10	4.57	18.63	20.915	23.2
11	5.57	23.63	26.415	29.2
12	7.57	29.63	33.415	37.2
13	9.57	37.63	42.415	47.2
14	12.57	47.63	53.915	60.2
15	15.57	60.63	68.415	76.2
16	19.57	76.63	86.415	96.2
17	24.57	96.63	108.915	121.2
18	30.57	121.63	136.915	152.2
19	50.57	152.63	177.915	203.2
20	50.57	203.63	228.915	254.2
21	50.57	254.63	279.915	305.2
22	100.57	305.63	355.915	406.2
23	100.57	406.63	456.915	507.2
24	100.57	507.63	557.915	608.2
25	151.57	608.63	684.415	760.2
26	201.57	760.63	861.415	962.2

Table 10 SkyTEM312 HM gate times. All gate times are relative to the start of the transmitter current ramp down.

HM Gate Number	Gate Width (us)	Gate Open (us)	Gate Centre (us)	Gate Close (us)
16	19.57	426.63	436.415	446.20
17	24.57	446.63	458.915	471.20
18	30.57	471.63	486.915	502.20
19	50.57	502.63	527.915	553.20
20	50.57	553.63	578.915	604.20
21	50.57	604.63	629.915	655.20
22	100.57	655.63	705.915	756.20
23	100.57	756.63	806.915	857.20
24	100.57	857.63	907.915	958.20
25	151.57	958.63	1034.415	1110.20
26	201.57	1110.63	1211.415	1312.20
27	252.57	1312.63	1438.915	1565.20

HM Gate Number	Gate Width (us)	Gate Open (us)	Gate Centre (us)	Gate Close (us)
28	353.57	1565.63	1742.415	1919.20
29	403.57	1919.63	2121.415	2323.20
30	504.57	2323.63	2575.915	2828.20
31	707.57	2828.63	3182.415	3536.20
32	807.57	3536.63	3940.415	4344.20
33	1009.57	4344.63	4849.415	5354.20
34	1211.57	5354.63	5960.415	6566.20
35	1415.57	6566.63	7274.415	7982.20
36	1819.57	7982.63	8892.415	9802.20
37	2019.57	9802.63	10812.415	11822.20
38	2729.57	11822.63	13187.415	14552.20

2.5 Interleaving of Transmitter Moments

All data were acquired using interleaved low and high moment transmitter modes, consisting of 110 low moment positive and negative pulse pairs at 275 Hz, and 30 high moment pulse pairs at 25Hz, which repeats every 1.6 seconds.

2.6 Sign Convention of the Data

EM data

The vertical (Z) component electromagnetic data is referenced such that when measured over a purely conductive (non-polarizable) one-dimensional earth it is positive. Early-time Z-component negatives are sometimes observed in very resistive areas due to the transmitter bias if it has not been completely removed from the measured data. Late time Z-component negatives are occasionally observed due to induced polarization effects.

The horizontal inline (X) component electromagnetic data is positive in the flight direction: The X-component response measured over a purely conductive (non-polarisable) one-dimensional earth is typically negative. However, X-component data is strongly affected by frame tilt, which can introduce a large contribution from the much-stronger Z-component response and significantly distort the measured X-component response. The only rigorous way to account for this effect in the data is to explicitly include the transmitter loop tilts in the X and Y directions in the forward/inverse modelling algorithm used to interpret the data.

Tiltmeter data

Angle X (measured by both TL1 and TL2) is positive when the nose of the transmitter loop frame is pitched up, i.e. over level ground, Angle X is positive when the nose of the frame is further from the ground than the base of the tail rudder.

Angle Y (measured by both TL1 and TL2) is positive when the starboard (right) side of the transmitter loop frame is tilted down i.e. over level ground, Angle Y is positive when the starboard side of the frame is closer to the ground than the port side.

2.7 GPS Navigation System

Two Novatel OEMV GPS receivers were employed for the survey.

The TERRASTAR High Precision real time differential correction service was used to provide a real time input to GP2 for the primary navigation system.

As a backup, both GP1 and GP2 recorded information, for which differentially-corrected positions could be obtained via post-processing if required, in conjunction with data from a ground base station recorded at 1 second intervals.

2.8 Magnetometer System

Airborne Magnetometer	
Geometrics G822A	Caesium Vapour magnetometer sensor, mounted on the front of the Tx loop frame. (Figure 2)
Kroum VS KMAG4	Counter Sample interval 50 Hz. (Down sampled in processing)
Base Magnetometer	
GEM Systems GSM 19	Proton precession, sample interval 1 Hz
Typical noise level	0.5 nT

2.9 Magnetometer Base Station

The table below shows the location of the magnetic base station.

Table 11 The location for the base station magnetometer.

Location	Date	Easting NZGD2000	Northing NZGD2000	Constant
122 Hikunui Rd	29-Jan to 19-Feb 2023	1800112	5434813	55560nT
74 Dakins Rd	20-Feb to 03-Mar 2023	1821523	5453954	55401nT

The base station magnetometer data were transferred into a base station Geosoft GDB database daily for further processing.

3. CALIBRATION

3.1 Reference Site Calibrations

SkyTEM equipment has been calibrated at the National Danish Reference Site (GeoFysikSamarbejdet, Aarhus University, 2012).

Calibration factors and time shift are given below. These factors have been applied to the delivered EM data, and therefore the data do not need to be scaled or the window times do not need to be shifted prior to modelling/inversion.

LM:
Factor 0.94
Time shift -1.8 µs

HM:
Factor 0.94
Time shift -1.8 µs

3.2 High Level Lines

The following table lists the line and flight numbers that were flown during the survey. Processed EM data for the high-level flights are included in the final EM dataset.

Table 12 High level lines flown for the survey

Line nr	Flight
913001	20230218.01

3.3 Repeat Lines

Five repeat lines of approximately 3km length were flown during the survey. The line numbers, coordinates and flight details are listed in Table 13. Comparisons of the repeat line and production line LCI models are shown in Appendix D.

Table 13 Repeat line coordinates

Repeat Line ID	Flight	East (line start)	North (line start)	East (line end)	North (line end)	Coincident Production line segment
912001	20230204.01	1780932.25	5421757.24	1778523.40	5419257.09	9900201
912002	20230207.01	1780930.07	5421813.89	1778530.50	5419215.82	9900201
912003	20230208.01	1780931.07	5421836.22	1778493.79	5419227.96	9900201
912004	20230220.01	1796854.59	5438405.18	1799936.96	5435546.21	106901
912005	20230302.02	1813250.17	5452114.47	1815220.55	5455195.28	205501

4. POWER LINE NOISE INTENSITY

The PLNI monitor values are derived from a frequency analysis of the raw Z-component EM data. For every low moment EM data block (110 pulse pairs) a PLNI value is obtained by Fourier transformation of the measured values of the latest low moment gate. The Fourier transformation is evaluated at the local power transmission frequency (50 Hz) yielding the amplitude spectral density of the power line noise.

CAUTION - When evaluating the PLNI values one should be aware of the following factors that may give rise to anomalous PLNI patterns unrelated to the actual power line noise level:

- Noise sources, other than power line noise, may contribute to the total noise spectral density in the data at the power transmission frequency. When power line noise is present it tends to dominate all such other noise sources.

- The PLNI values are not corrected for flying height or frame angles, which means that adjacent lines crossing the same power line may not exhibit the same values of PLNI.

5. DATA PROCESSING

5.1 GPS Positions and Coordinates

Only the TerraStar HP differentially corrected GPS, GP2 position information were used for the survey. The data were recorded in the WGS84 datum.

The GPS positions were then translated to the centre of the frame based on the instrument x, y and z positions given in Table 3.

The corrected positions were transformed to the NZGD2000 datum, Transverse Mercator Projection.

5.2 Laser Altimeter Data

The height processing involves manual and automated routines using a combination of the SkyTEM in-house software SkyLab and Geosoft Oasis Montaj.

The processing involves the following steps:

Keeping the 5 largest of the 30 values acquired per second, and discarding the remainder to correct for the canopy effect (treetop filter);

3 sec running box-car filter (smoothing filter);

Tilt correction, using the inclinometer data, to account for the altimeter not pointing vertically downward;

Averaging of the tilt corrected values from the two laser altimeters;

A 3 sec low pass filter is then applied to the final result.

5.3 Digital Terrain Model

A digital elevation model (DTM) was derived by subtracting the processed laser altimeter (height above ground) data from the GPS altitude (height above the GRS80 ellipsoid) data to yield the height of the ground above the GRS80 ellipsoid. Then the ellipsoid-geoid separation (N-value) was subtracted to yield the elevation of the ground above the New Zealand Quasi-geoid 2016 (NZVD2016). (LINZS25009,2016).

$\text{Elevation}_{\text{NZVD2016}} = \text{GPS\_Height}_{\text{GRS80}} - \text{Laser\_Altimeter} - \text{N\_Value}$

The subtracted N-values were interpolated from the NZGeoid2016, (LINZ, 2016) grid values obtained via the Land Information New Zealand website:

www.linz.govt.nz

Grids and images of Digital terrain model for the block are included in the digital data delivery.

5.4 Electromagnetic Data

Raw (binary) SkyTEM data have been processed using SkyTEM proprietary software.

Prior to processing a primary field correction (PFC) was applied to the early LM moment gates (1 to 14) to remove the effects of residual currents that occur due to magnetic coupling between the receiver coils and the transmitter loop. PFC is performed by collecting Low Moment data whilst flying the system, so the LM response is clear of any influence from the ground. The primary magnetic field coupling between the receiver coils and the transmitter loop is continuously hardware-monitored at a high ground clearance, providing a separate value for the magnetic field coupling during each transient sounding. These data are used for raw data correction in a separate post-processing step. The primary field compensation technique has proven stable and has routinely yielded a reduction of the primary field influence in very early time gates by a factor exceeding 17dB.

Following PFC on the Low Moment data the data are normalized in respect to the effective Rx coil area, Tx coil area, number of turns and current giving the units [pV/(m4*A)].

The EM data is filtered adaptively based on the signal-to-noise ratio. The applied EM filtering method is based on iterative weighted spline fitting routines, which operate in positive/negative symmetric transform spaces. The data weighting scheme relies on an extensive noise evaluation performed on the individual gate values of the raw data decays. Optimised sets of averaging filters are used for each measured moment and type of receiver coil in a stepwise averaging process. This allows for optimal suppression of motion induced noise as well as cultural noise components, while keeping track of the resulting data uncertainty.

5.5 Magnetic Data

Final processing of the magnetic data involved the application of conventional corrections to compensate for diurnal variation, International Geomagnetic Reference Field (IGRF) removal, and heading effects prior to gridding. Processing of magnetic data was implemented in Geosoft's Oasis Montaj software. The steps involved follow, with the details provided thereafter:

- Pre-processing of static (1 Hz) magnetic data acquired at the magnetic base stations
- Pre-processing of airborne magnetic data
- Standard corrections to compensate the diurnal variation.
- IGRF correction
- Micro-levelling

Pre-processing

Pre-processing of the airborne magnetic data involved automatic de-spiking and resampling of data to 5 Hz and translation of the position to the center of the transmitter frame in SkyLab. The data were then low-pass filtered using a filter of 3.0 s width.

The data were manually edited to remove some of the larger spikes due to infrastructure, but many smaller spikes remain in the data.

Correction for the diurnal variation was made using the digitally recorded ground base station magnetometer data. The ground base station data were first manually de-spiked then low-pass filtered with a filter width of 10 s. The pre-processed base station data, which represent short term temporal magnetic field variations, were merged with the airborne magnetic data using the date and UTC time as the synchronization channels.

These base station data were then subtracted from the airborne magnetometer readings. Then a constant value as shown in Table 11 was added back into the result. The resultant delivered data field from this step is the Total Magnetic Intensity (TMI).

IGRF correction

Geosoft Oasis Montaj was used for applying the IGRF corrections to the magnetic data. The IGRF is a long-wavelength regional magnetic field calculated from permanent observatory data collected around the world. The IGRF is updated and determined by an international committee of geophysicists every 5 years. Secular variations in the Earth's magnetic field are incorporated into the determination of the IGRF. The IGRF correction was applied prior to levelling. The applied corrections were calculated using the following IGRF model parameters:

- IGRF model year: IGRF 13th generation
- https://www.ngdc.noaa.gov/IAGA/vmod/igrf.html

- Date: variable according to date channel in database
- Position: variable according to GPS longitude and latitude
- Elevation: variable according to GPS Altitude of frame (NZVD2016)

The IGRF data were subtracted from the TMI data and a constant of 55577nT (average IGRF for survey area) was then added back in to produce the TMI IGRF channel. These data were then gridded to produce the TMI IGRF grid which is in turn the input grid for the micro-leveling.

Micro-levelling

Geosoft Oasis Montaj was used to micro-level the gridded diurnal and IGRF corrected TMI data via grid based FFT filtering. A high pass Butterworth filter and a directional cosine filter were used to produce an "error grid" which essentially defines the line-parallel corrugation in the orientation of the flight lines. Due to the different survey line directions, this was carried out for both the Main Block and the Masteron Block.

The "error grid" was subtracted from the TMI IGRF grid (see IGRF correction above) to produce the final "TMI IGRF MLEV" grid. This grid was then sampled back into the database to produce the TMI_MLEV_IGRF channel.

Figure 5 shows a colour-shaded image of the TMI IGRF MLEV grid. The difference in flight-line orientation between the main block and the Masterton Block produces a distinctive boundary between the blocks. The boundary is exaggerated by the shading of the grid.

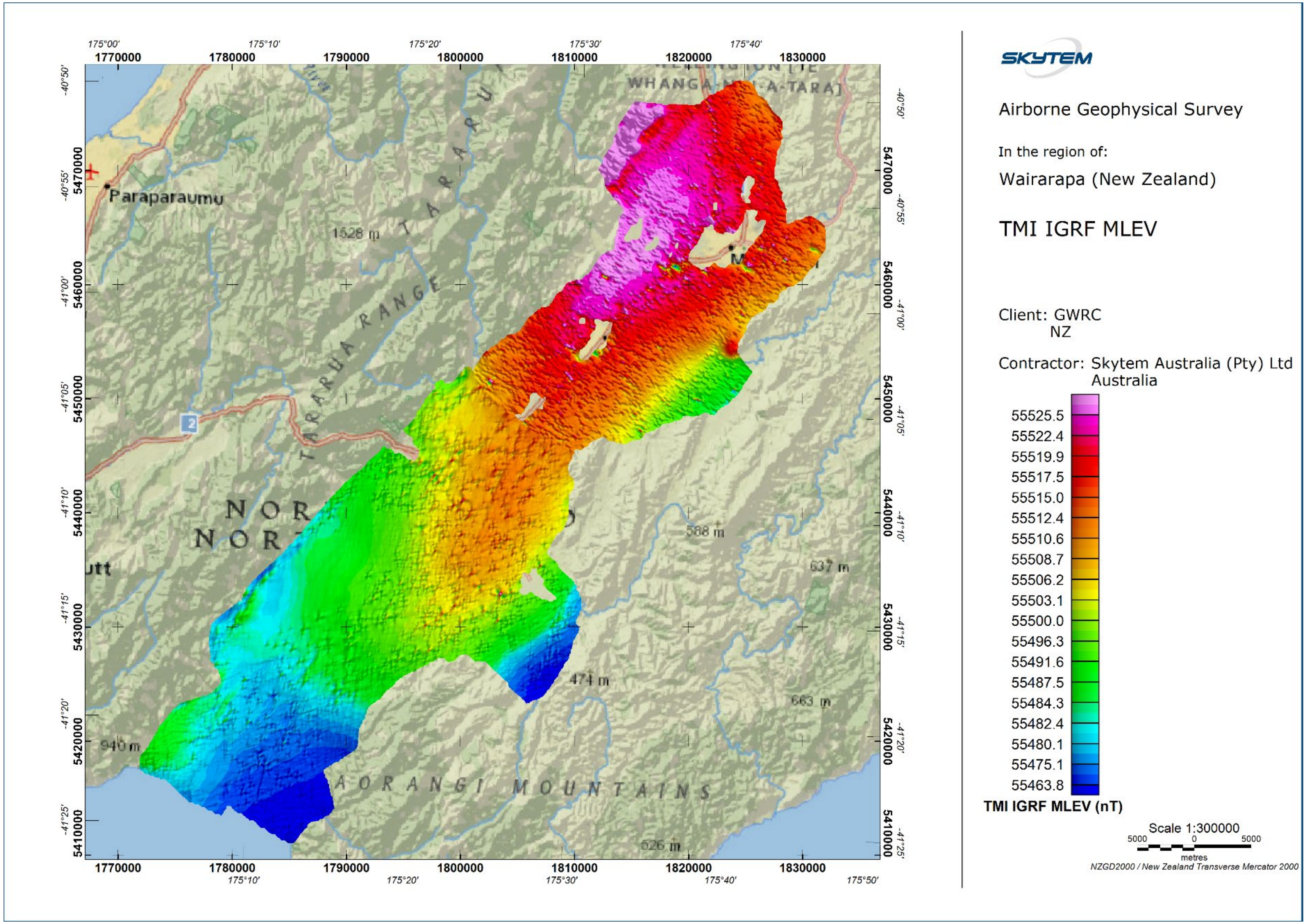


Figure 5 Image of TMI_MLEV_IGRF.

6. INVERSION OF THE SkyTEM DATA

In this section, the particulars of modelling and inversion of SkyTEM data from this Project will be described.

6.1 Outline

The SkyTEM data have been processed and inverted using spatially constrained inversion (SCI) in Aarhus Workbench, a unique software package initially developed at Aarhus University, Denmark. In this SCI algorithm a group of time-domain EM (TEM) soundings are inverted simultaneously using 1-D models. Each sounding yields a separate layered model, but the models are constrained laterally. See Figure 6.

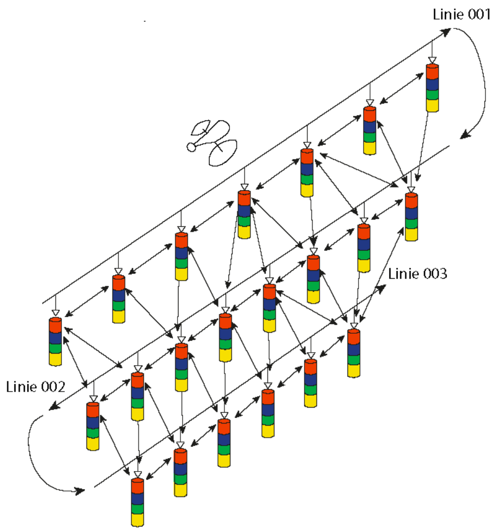


Figure 6 Schematic presentation of the SCI setup (figure from hgg.au.dk).

Constraints connect not only soundings located along the flight line, but also those across them.

The result of the SCI inversion is a quasi-3D model that varies smoothly along and across the profiles. The SCI inversion is capable of simultaneously inverting the interleaved HM and LM measurements, yielding a conductivity model that combines the very good shallow depth resolution offered by the low moment data and the larger depth of investigation from the high moment data.

The five repeat lines were inverted via the standard Workbench LCI, which forgoes the line-to-line lateral constraint of the SCI, whilst retaining the along line lateral constraint. Essentially, the LCI treats each line individually and without constraints imposed from any of the other lines, which provides a more vigorous assessment of the consistency of the co-located repeat line data.

6.2 Input data and noise

The input data to the inversion were LM gates 9 to 26 and HM gates 16 to 38 of the Z-component. LM ramp-down gates were not included in the provided SCI, but have been provided with the EM data along with SR2 files describing the system response such that system response convolution inversions can be carried out in Workbench.

Both LM and HM moments are combined in a single inversion to increase the depth resolution. Automatic filtering of the EM data through sign, slope and relative uncertainty routines was carried out in Workbench. This has removed most of the couplings (e.g. due to power lines) and zones of low signal to noise ratio in the data (e.g. over very resistive ground).

Additional manual masking of portions of data thought to contain coupling effects was not a requirement of the project, and as such, cultural effects in the EM data could still be manifested in the inversion results and final conductivity database.

6.3 Model parameterization and initial model

The SCI code is run in multi-layer, smooth-model mode in which the layer thicknesses are fixed, and the data are inverted only for conductivity.

For this survey a 30 layer model was used. In the model the thickness of the first layer is set to 2 m and the depth to the top of the deepest layer boundary is 500 m.

While computing the layer thicknesses, the first and last layer boundary scales the model thicknesses automatically using a log distribution. The deepest layer (30) is an infinitely thick half-space. Thicknesses and depths to the top of each layer for the current project are given in Table 14 below.

The initial model resistivity structure was a homogenous half-space model with an auto calculated starting resistivity. This resistivity is the mean of the apparent resistivities calculated for each sounding.

Table 14 Conductivity model layer thicknesses for the Block

Layer #	Layer Thickness [m]	Depth to top of layer [m]	Res. Constraints Vert.	Res. Constraints Horz.
1	2	0	2.00	1.1
2	2.3	2	2.00	1.1
3	2.5	4.3	2.00	1.1
4	2.9	6.8	2.00	1.1
5	3.2	9.7	2.00	1.1
6	3.7	12.9	2.00	1.1
7	4.1	16.6	2.00	1.1
8	4.7	20.7	2.00	1.1
9	5.2	25.3	2.00	1.1
10	5.9	30.6	2.00	1.1
11	6.7	36.5	2.00	1.1
12	7.5	43.2	2.00	1.1
13	8.5	50.7	2.00	1.1
14	9.6	59.2	2.00	1.1
15	10.8	68.8	2.00	1.1
16	12.2	79.7	2.00	1.1
17	13.8	91.9	2.00	1.1
18	15.5	105.7	2.00	1.1
19	17.5	121.2	2.00	1.1
20	19.8	138.7	2.00	1.1
21	22.3	158.5	2.00	1.1
22	25.2	180.8	2.00	1.1
23	28.4	206	2.00	1.1
24	32.1	234.4	2.00	1.1
25	36.2	266.5	2.00	1.1
26	40.8	302.6	2.00	1.1
27	46	343.5	2.00	1.1
28	51.9	389.5	2.00	1.1
29	58.6	441.4	2.00	1.1
30	∞	500	2.00	1.1

6.4 Regularization

Smoothness constraints are applied on the variation of resistivity with depth. In addition, lateral constraints are applied between adjacent models. Multi-layer smooth-model inversion is slower to compute but is usually able to provide a very close fit to the observed data.

Constraints are given as factors, i.e. a factor of 1.1 means that the parameter can vary between the starting value divided by 1.1 to the starting value multiplied by 1.1 (Aarhus University, n.d.).

The SCI inversion allows for horizontal and vertical constraints to be set for resistivities. For this survey, the vertical resistivity constraints were set to 2.0. So, for each iteration, the resistivity of the layer above, and below each layer can be between [2 X initialRes], or [0.5 X initialRes].

Horizontal constraints are scaled by distance using a reference distance and power function:

$$C = 1 + \left(C_{opt} - 1\right)\left(\frac{\Delta GPS}{Dist_{ref}}\right)^{n}$$

Where C is the constraint used scaled by distance, C_{opt} is the optimal constraint at a sounding distance of $Dist_{ref}$ and ΔGPS is the actual sounding distance. For this survey, C_{opt} is the horizontal constraint given in Table 17, and $Dist_{ref}$ =25 m. The power law dependency n was set to 1.5. Note that these constraints are not strict, and do not prevent abrupt changes, if fitting of the data requires it.

Inversion for flight altitude is included after the first 5 inversion runs. The constraint on the inverted flight height was set to a standard deviation value of 2.

6.5 Depth of investigation

The depth of investigation (DOI) is determined by performing a sensitivity analysis of the cumulated response of the data to each layer's resistivity from the deepest layer upwards, (Christiansen and Auken, 2012).

6.6 Qualifications on the conductivity model

Geophysical inversion is a non-unique process. This means that many possible conductivity models could possibly explain the data. Several factors contribute to this non-uniqueness, some of which are outlined below.

Data and noise model

The accuracy of conductivity model generated by the inversion is influenced by the noise in the TEM data. This noise is reduced by selective stacking of delay time series and by applying appropriate filters in the receiver system, nevertheless noise is present in the data.

Data insufficiency

For SkyTEM data, the insufficiency lies primarily in the limited delay time range that can be obtained. The earliest obtainable time gate is determined by the turnoff of the Tx current, and the latest useful time gate is determined by the signal to noise ratio. Increasing the Tx moment will give better measurements at late times, and thus improve the depth penetration, but also increase the turnoff time and thus remove early-time gates, thereby making the near-surface resolution poorer. This trade-off is partially solved by transmitting an alternating sequence of (1) a low moment that can be turned off quickly to give good near-surface resolution, and (2) a high moment that will improve the signal-to-noise ratio at late times, thus improving depth penetration.

Inconsistency between 1D modelling and 3D geology

When using 1D modelling in the inversion of SkyTEM data, inconsistency arises where the lateral gradient of conductivity is large, e.g. typically in mining applications. However, also in environmental investigations, inconsistencies can arise, typically where strong near-surface conductors have abrupt boundaries.

Often such inconsistency is indicated by the data residual being high. One should look upon the inversion results with some caution at these locations. 3D effects can also reveal themselves by the so-called 'pant legs', i.e. conductive or resistive structures projecting at an angle of approximately 30 degrees from the horizontal in the inverted resistivity models at the edges of high contrast structures.

6.7 Conductivity Model Sections

The models resulting from the inversion are presented as sections of conductivity - depth intervals and are delivered in digital format.

Model sections

The model sections can be found in the data delivery folder. The main section plots consist of subplots as seen in the figure below. The top plot displays the inverted models, with topography, where the conductivity of the individual layers are colour coded according to the colour scale bar, which is displayed using a logarithmic distribution. The faded zone indicates the estimated depth of investigation.

The measured and inverted flight elevation are shown with a black and blue line, respectively, above the model section.

In each section, the region below the estimate of the DOI, the inverted conductivity is determined predominantly by the regularization, i.e. the conductivity is essentially undetermined.

Underneath the model section plot are two plots of the measured data prior to Workbench filtering (faint grey lines), actual inversion input data after Workbench filtering (coloured dots) together with the response of the inverted models (solid-coloured lines). LM is low moment data and HM is high moment data. Note that the early time negative low moment data is not plotted correctly as the graphing software does not allow for absolute values colour coded by polarity to plotted on the log-y-axis graphs. The bottom plot is the data residual (black line) of the inversions.

Blank sections in the data profile indicate areas where the signal to noise ratio has been too low for any data to be used in the inversion. Essentially the resistivity in those sections can be considered as "Very high" (>1,000 Ωm). Alternatively cultural features have been superimposed on the ground response, which can also lead to data being discarded prior to the inversion.

Residuals

The quality of the fit between the observed data and the predicted data (i.e., the calculated forward model response of the conductivity model resulting from the inversion) can be evaluated by inspecting the residuals. The data residual is calculated by comparing the measured data with the response of the resulting model after inversion.

If the residual is in the vicinity of 1, the misfit between the response of the final model and the data is, on average, equal to the noise. A high residual is due to data that has noise greater than the noise model has taken into account. This can be seen where resistivities are very high and the signal consequently very low.

A high data residual can also be due to the inconsistency between the 1D model assumed in the inversion and the 2D/3D character of the real-world geology. These are found primarily at the edges of sharp lateral conductivity contrasts. Finally, coupling effects due to power lines and other man-made conductors can also be a source of a high residual.

Layer conductivity maps

The conductivity maps can be found in the data delivery folder as well as gridded located images.

These maps show the inverted conductivity for each of the model depth layers. As the thickness of the model layers increases downwards, the maps represent a varying thickness interval. The depth interval is stated on the files and is in metres below the surface. An example can be seen in the figure below.

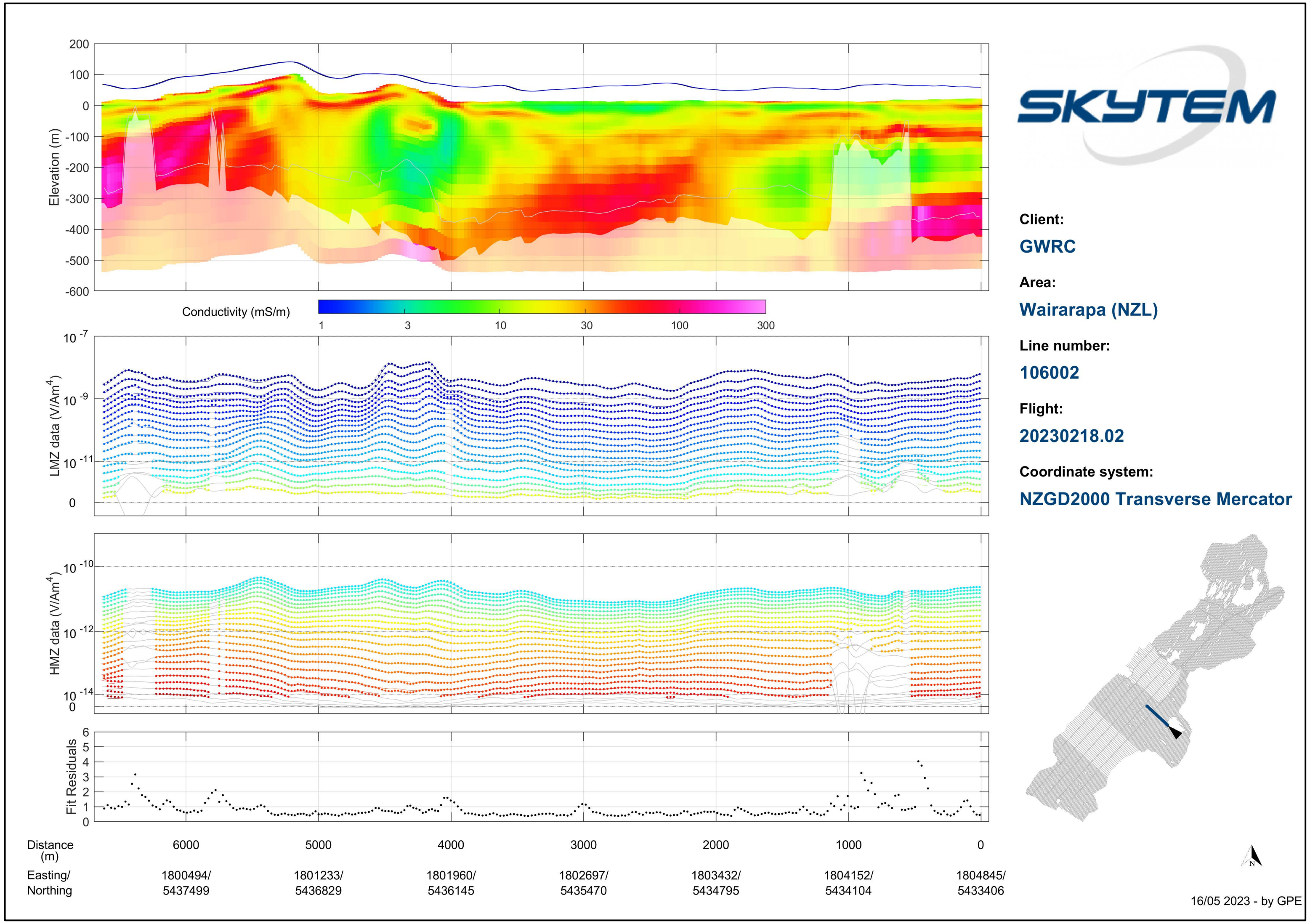


Figure 7 Sample SCI conductivity section

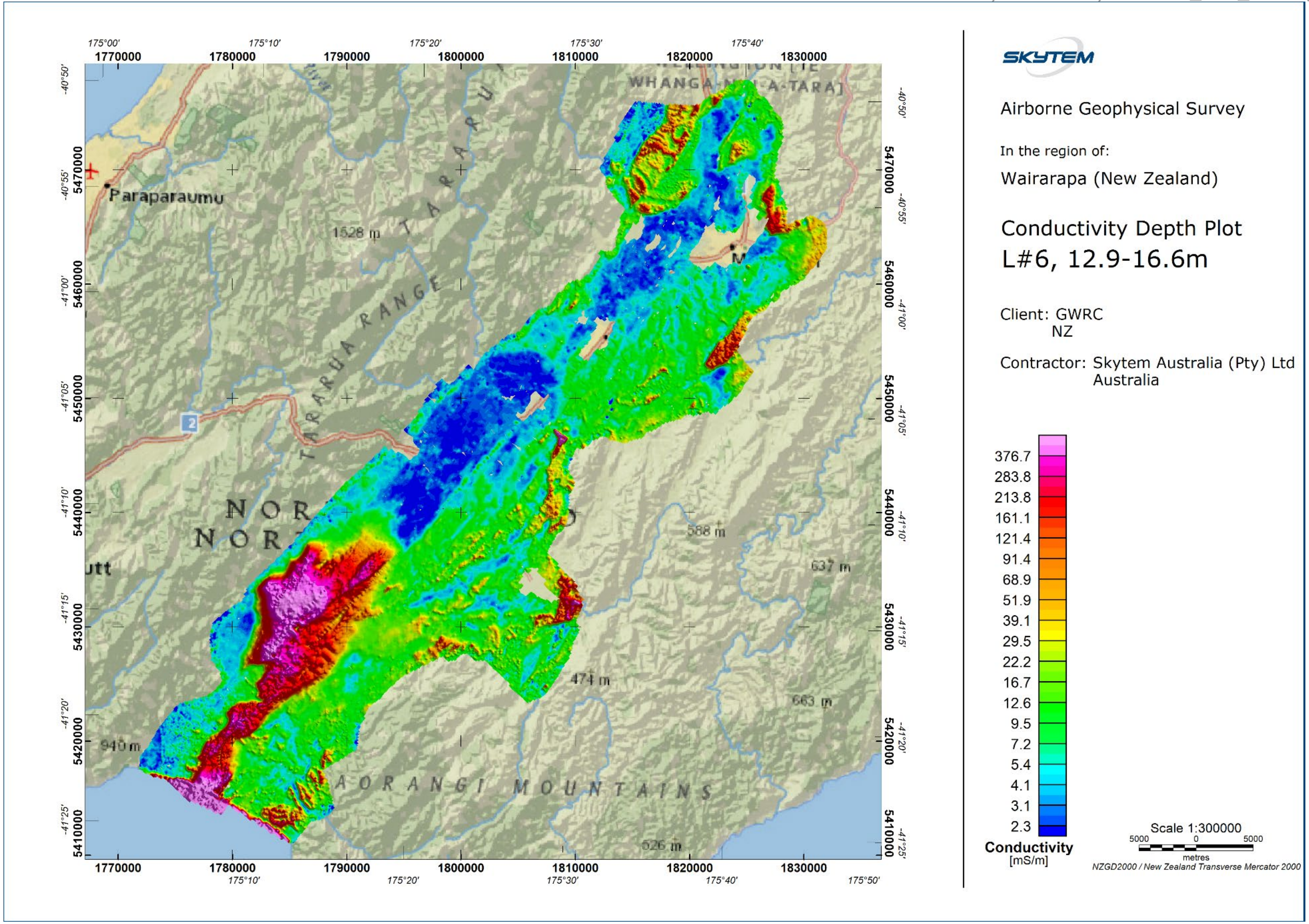


Figure 8 Representative SCI layer conductivity map.

7. DELIVERED REPORT AND DATA

7.1 Report

Acquisition and Processing Report	
Format	PDF
Copies	1 × Electronic copy

7.2 Electromagnetic data – Geosoft Database

Wairarapa_EM_NZGD2000.GDB, Geosoft Database;			
Field	**CHANNEL**	**DESCRIPTION**	**UNITS**
1	Fid	Fiducial Number	s
2	Line	Line number	
3	Flight	Flight number	
4	DateTime	Decimal Days since midnight 31/12/1899	days
5	Date	UTC Date	yyyymmdd
6	Time	UTC Time	hhmmss.ss
7	AngleX	Tilt of frame from horizontal - flight direction	deg
8	AngleY	Tilt of frame from horizontal - perpendicular from flight direction	deg
9	Height	Filtered Laser altimeter measured height of the Tx loop centre above ground	m
10	Height_Raw	Unfiltered Laser altimeter measured height of the Tx loop centre above ground	m
11	Lon	Longitude WGS84	deg
12	Lat	Latitude WGS84	deg
13	E_NZTM	Easting (NZGD2000 Transverse Mercator)	m
14	N_NZTM	Northing (NZGD2000 Transverse Mercator)	m
15	DTM	Digital terrain model (NZVD2016 Datum)	m
16	Alt	GPS altitude of Tx loop centre (NZVD2016 Datum)	m
17	GdSpeed	Frame ground speed	km/h
18	PLNI	Power line noise indicator	
19	HMcurrent	High moment peak transmitter current	A
20	LMcurrent	Low moment peak transmitter current	A
21:46	LM_Z_dBdt	Z-comp LM dB/dt processed and normalised (Gates 1-3 undefined)	pV/A.turns.m4
47:79	HM_Z_dBdt	Z-comp HM dB/dt processed and normalised (Gates 1-15 undefined)	pV/A.turns.m4
80:105	LM_X_dBdt	X-comp LM dB/dt processed and normalised (Gates 1-3 undefined)	pV/A.turns.m4

Wairarapa_EM_NZGD2000.GDB, Geosoft Database;			
Field	**CHANNEL**	**DESCRIPTION**	**UNITS**
106:138	HM_X_dBdt	X-comp HM dB/dt processed and normalised (Gates 1-15 undefined)	pV/A.turns.m4
139:164	RU_LM_Z_dBdt	Z-comp LM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	
165:197	RU_HM_Z_dBdt	Z-comp HM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	
198:223	RU_LM_X_dBdt	X-comp LM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	
224:256	RU_HM_X_dBdt	X-comp HM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	
257	MA1	Magnetic field reading (de-spiked and LP filtered)	nT
258	MA1_F	Manually edited Magnetic field reading	
259	BMAG	Base station diurnal magnetic field	nT
260	TMI	Total Magnetic field intensity – BMAG + BMAG datum	nT
261	IGRF	International Geomagnetic Reference Field	nT
262	TMI_IGRF	TMI corrected by IGRF + 55577	nT
263	TMI_IGRF_MLEV	Microlevelled TMI corrected by IGRF	nT

7.3 Electromagnetic data – Workbench XYZ File

Wairarapa_EM_NZGD2000_Part_XX.XYZ (where XX = 01 to 03); Workbench compatible 5Hz ASCII xyz files and Workbench ALC import template NULL = * (Voltages) and 9999 (Relative Uncertainty);			
Field	**CHANNEL**	**DESCRIPTION**	**UNITS**
1	Fid	Fiducial Number	s
2	Line	Line number	
3	Flight	Flight number	
4	DateTime	Decimal Days since midnight 31/12/1899	days
5	Date	UTC Date	yyyymmdd
6	Time	UTC Time	hhmmss.ss
7	AngleX	Tilt of frame from horizontal - flight direction	deg
8	AngleY	Tilt of frame from horizontal - perpendicular from flight direction	deg

Wairarapa_EM_NZGD2000_Part_XX.XYZ (where XX = 01 to 03); Workbench compatible 5Hz ASCII xyz files and Workbench ALC import template NULL = * (Voltages) and 9999 (Relative Uncertainty);			
Field	**CHANNEL**	**DESCRIPTION**	**UNITS**
9	Height	Filtered Laser altimeter measured height of the Tx loop centre above ground	m
10	Height_Raw	Unfiltered Laser altimeter measured height of the Tx loop centre above ground	m
11	Lon	Longitude WGS84	deg
12	Lat	Latitude WGS84	deg
13	E_NZTM	Easting (NZGD2000 Transverse Mercator)	m
14	N_NZTM	Northing (NZGD2000 Transverse Mercator)	m
15	DTM	Digital terrain model (NZVD2016 Datum)	m
16	Alt	GPS altitude of Tx loop centre (NZVD2016 Datum)	m
17	GdSpeed	Frame ground speed	km/h
18	TMI_IGRF_MLEV	Microlevelled TMI corrected by IGRF	nT
19	PLNI	Power line noise indicator	
20	LMcurrent	Low moment peak transmitter current	A
21	HMcurrent	High moment peak transmitter current	A
22:47	LM_Z_dBdt	Z-comp LM dB/dt processed and normalised (Gates 1-3 undefined)	pV/A.turns.m4
48:85	HM_Z_dBdt	Z-comp HM dB/dt processed and normalised (Gates 1-15 undefined)	pV/A.turns.m4
86:111	RU_LM_Z_dBdt	Z-comp LM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	
112:149	RU_HM_Z_dBdt	Z-comp HM dB/dt relative uncertainty (noise estimate as a fraction of the measured response)	

7.4 DTM

DTM Grid		
Format	Geosoft Grid (.grd), pdf map (.pdf), Geosoft packed map (.map) and georeferenced image (.tif)	
.grd .pdf .map .tif	Name	Description
	Wairarapa_DTM_NZGD2000	Min curvature, cell size 50 m
.png	Wairarapa_DTM_AHDCS	Colour scale for image

7.5 Flight Path

Flight Path		
Format	ESRI shape file, pdf map (.pdf)	
	Name	Description
.shp	Wairarapa _Planned_Lines_NZGD2000	Survey flight path – Planned Lines
	Wairarapa _Production_Lines_NZGD2000	Survey flight path – Production Lines
	Wairarapa _Repeat_Lines_NZGD2000	Survey flight path – Repeat Lines
.pdf	Wairarapa_Flight_Path_NZGD2000	PDF map with Planned, Production and Repeat lines plotted

7.6 Conductivity data

	Wairarapa_SCI_NZGD2000 and Wairarapa_Repeat_Lines_LCI_NZGD2000 (Geosoft gdb, and ASCII xyz) NULL = -1e32		
FIELD	**CHANNEL**	**DESCRIPTION**	**UNITS**
1	Fid	Fiducial Number	s
2	DateTime	Decimal Days since midnight 31/12/1899	days
3	Line	Line number	
4	E_NZTM	Easting (NZGD2000 Transverse Mercator)	m
5	N_NZTM	Northing (NZGD2000 Transverse Mercator)	m
6	DTM	Digital terrain model (NZVD2016 Datum)	m
7	RESI1	Residual of the data	
8	HEIGHT	Laser altimeter measured height of the Tx loop centre above ground	m
9	INVHEIGHT	Calculated inversion height of the Tx loop centre above ground	m
10	DOI	Estimated Depth of investigation, below ground level	m
11:40	Elev[XX]	Elevation to the top of the layer	m
41:70	Con[XX]	Conductivity of the layer	mS/m
71:100	Con_DOI[XX]	Conductivity of the layer masked to the depth of investigation	mS/m
101:130	RUnc[XX]	Calculated relative uncertainty of the layer conductivity	

SCI (Production Lines) & LCI (Repeat Lines) conductivity sections		
Format	Image (.png)	
	Name	Description
	LineZZZZZZ_Cond_0.001_0.3S_pr_mSCI	SCI Conductivity-depth sections ZZZZZZ = Line number; Colour scale 1-300 mS/m;
	LineZZZZZZ_Cond_0.001_0.3S_pr_mLCI	LCI Conductivity-depth sections ZZZZZZ = Line number; Colour scale 1-300 mS/m;

SCI layer (depth slice) grids		
Format	Geosoft Grids (.grd), pdf maps (.pdf), Geosoft packed maps (.map) and georeferenced images (.tif);	
.grd .pdf .map .tif	Name	Description
	*Wairarapa_WB_NZGD2000_Con0XX_doi_gm_aaa.a-bbb.bm	Masked to depth of investigation, Min curvature, cell size 50 m
.png	Wairarapa_CON_DOICS	Colour scale for images (png)

* XXX = layer number , aaa.a = Depth to top of layer, bbb.b = Depth to base of layer

7.7 Magnetic data

The located magnetic data is supplied in the EM database.

TMI IGRF MLEV grid and image (grid levelled TMI_IGRF)		
Format	Geosoft Grid (.grd), pdf map (.pdf), Geosoft packed map (.map) and georeferenced image (.tif);	
.grd .pdf .map .tif	Name	Description
	Wairarapa_TMI_IGRF_MLEV_NZGD2000	Min curvature, cell size 50 m
.png	Wairarapa_TMI_IGRF_MLEV_CS	Colour scale for image

7.8 Raw data

SkyTEM Raw Voltage Data and Raw Auxiliary Data		
Format	Binary Voltage Data (.skb), ascii auxiliary data (.sps), Workbench system geometry file (.gex), Workbench line file (.lin);	
	Name	Description
.skb	YYYYMMDD_HHMMSS_sss_RawData_prelim	Binary Raw Voltage Data *without* primary field correction applied
.skb	YYYYMMDD_HHMMSS_sss_RawData_PFC	Binary Raw Voltage Data *with* primary field correction applied
.sps	YYYYMMDD_HHMMSS_sss_NavSys	Ascii format Auxiliary data including laser heights (HE1, HE2), tilts (TL1, TL2), GPS location (GP1, GP2) and rover magnetometer (MA1);
.sps	YYYYMMDD_HHMMSS_sss_PaPc.sps	Ascii format Transmitter currents for high and low moments (TXD);
.gex	Wairarapa_312_25hz_SKB	Workbench system geometry file for working with raw data (skb, sps) and carrying out standard inversions;
.gex	Wairarapa_312_25hz_XYZ	Workbench system geometry file for working with processed data (xyz) and carrying out standard inversions;
.gex	Wairarapa_312_25hz_SKB_sr2	Workbench system geometry file for working with raw data (skb, sps) and carrying out system response inversions;
.gex	Wairarapa_312_25hz_XYZ_sr2	Workbench system geometry file for working with processed data (xyz) and carrying out system response inversions;
.sr2	Wairarapa_312_25hz_SKB_sr2.sr2	Workbench system response file for working with raw data (skb, sps)
.sr2	Wairarapa_312_25hz_XYZ_sr2.sr2	Workbench system response file for working with processed data (xyz)
.lin	10088_Wairarapa	Workbench format ascii line file (start/finish times/coordinates for each line)

8. REFERENCES

Aarhus University, n.d., Guide to 1D-LCI inversion.

Auken, E., Foged, N. and Sørensen, K., 2002, Model recognition by 1-D laterally constrained inversion of resistivity data: Proceedings – New Technologies and Research Trends Session, 8th meeting, EEGS-ES.

Auken, E., Christiansen, A. V., Jacobsen, B. H., Foged, N., and Sørensen, K. I., 2005, Piecewise 1D Laterally Constrained Inversion of resistivity data: *Geophysical Prospecting*, 53, 497–506.

Auken, E.,Christiansen, A. V., Kirkegaard, C., Fiandaca, G., Schamper, C., Behroozmand, A. A., Binley, A., Nielsen, E., Effersø, F., Christensen, N. B., Sørensen, K., Foged, N., Vignoli, G., 2015, An overview of a highly versatile forward and stable inverse algorithm for airborne, ground-based and borehole electromagnetic and electric data: *Exploration Geophysics,* 46, 223 – 235.

Christiansen, A.V. and Auken, E., 2012, A global measure for depth of investigation: *Geophysics,* vol 77, No. 4, 171-177.

GeoFysikSamarbejdet Aarhus University, 2012, Refinement of the National TEM reference model at Lyngby June 2012 (update from Nov. 2011)

Kirkegaard, C., and Auken, E., 2015, A parallel, scaleable and memory efficient inversion code for very large-scale airborne electromagnetic surveys: *Geophysical Prospecting*, 63, 495-507.

Appendix A

Flight Diary

(excl ferry, setup, repositioning, reconnaissance and refuelling flights)

Flight	Temp (C)	Wind (kts)	Visibility	Description
20230131.02	20	7 NE	Good	Community Outreach Flight.
20230202.01	22	11 NE	Partly Cloudy	High Alt.
20230202.02	22	10 NE	Partly Cloudy	Production. Had mag issues at the very end of the flight.
20230203.01	25	15 NW	Overcast	Production. Offline at start NE end of 9900201 due to it starting on Greytown, deviation on 9900001 due to the town of Featherston.
20230204.01	13	4 NE	Partly Cloudy	Attempted production. Did the repeat line and pilot called it off due to strong winds. Mag has a good baseline but noisy and many dropouts. Repeat line 912001
20230207.01	22	6 N	Clear Skies	Production. Repeat line 912002
20230207.02	15	6 NW	Clear Skies	Production.
20230208.01	21	8 SW	Partly Cloudy	Production. Winds strong in the hills. Repeat line 912003
20230208.02	22	10 W	Partly Cloudy	Production. Attempted 1100 m but way to windy up there.
20230208.03	13	8 E	Partly Cloudy	Production. Aborted flight due to strong winds in the Western hills.
20230210.01	18	12 NE	Partly Cloudy	Production. Deviation on 116500 over sacred site as per client request.
20230210.02	12	8 E	Partly Cloudy	Production, fairly windy this flight.
20230211.01	17	10 NE	Partly Cloudy	Production.
20230211.02	21	11 NE	Partly Cloudy	Production.
20230211.03	14	8 E	Mostly Fine	Production. Wind picked up during this flight.
20230212.01	19	12 E	Partly Cloudy	Production. Deviation on SE end of 108801 due to lots of horses (small deviation on 108901)
20230212.02	13	2 NE	Mostly Cloudy	Production. Weather came in during this flight. Gap in 107800 due to houses.
20230218.01	18	2 NW	Partly Cloudy	Production. Fog on western edge of lines near the slopes and we split the lines. Hi-alt with production script - 913001
20230218.02	21	6 NW	Partly Cloudy	Production.
20230218.03	11	4 E	Partly Cloudy	Production.
20230219.01	19	3 E	Partly Cloudy	Production. Some people with horses on the ground unhappy with the helicopter, the horses didn't mind at all.
20230219.02	16	4 SE	Fine	Production. Wind picked up during this flight, landed early due to the wind.
20230220.01	20	4 E	Fine	Production, 912004 repeat, finished Masterton Block.
20230220.02	11	3 NW	Partly Cloudy	Production. Started Masterton block, deviations at southern end due to Greytown. Big deviation due to deer farm.
20230221.01	22	10 N	Fine	Production. Lots of deviations due to infrastructure.
20230221.02	17	6 SE	Fine	Production. Lots of deviations due to infrastructure.
20230222.01	22	10 SW	Cloudy in the West	Big entry heights at northern end to avoid horses.
20230222.02	10	2 SE	Fine, Cloudy To The SW	Production. Wind picked up during flight.
20230227.01	18	2 SE	Scattered Cloud, Morning Fog	Production. Low cloud at northern end. Lasers were measuring cloud level.
20230227.02	15	3 E	Scattered Cloud	Production. Pilot clipped tree avoiding glider on line 204900. Flight Aborted. Incident reported to NZ CAA and IAGSA.
20230301.00	18	3 E	Moderate Fog	400m Calibration after frame rebuild due to tree strike.

Flight	Temp (C)	Wind (kts)	Visibility	Description
				Flight was a bit longer due to pilot having to wait for clouds to lift before landing.
20230301.00	21	4 E	Light Fog	High Alt.
20230301.01	22	5 NE	Lightly Cloudy	Production. First flight after tree strike.
20230301.02	13	6 SW	Lightly Cloudy	Production. Started some lines on eastern side.
20230302.01	21	8 N	Lightly Cloudy	Production.
20230302.02	18	4 NE	Lightly Cloudy	Production. Repeat 912005.

Appendix B

Line Report

LineNumber LXXXXX:(M)MDDFF	East_Min (m)	East_Max (m)	North_Min (m)	North_Max (m)	Length (km)
L100001:22001	1807666.55	1809734.80	5445313.43	5447169.07	2.78
L100101:22001	1808273.22	1809638.36	5445136.06	5446366.88	1.84
L100201:22001	1806052.35	1809548.89	5444937.28	5448190.15	4.80
L100301:22001	1807102.10	1809481.38	5444707.38	5446896.49	3.24
L100401:22001	1800643.71	1804389.86	5448736.99	5452709.49	5.94
L100402:22001	1805683.60	1809377.60	5444550.86	5447579.24	4.85
L100501:22001	1807835.60	1809321.98	5444341.09	5445687.36	2.01
L100601:22001	1800350.55	1809211.19	5444142.40	5452317.07	12.17
L100701:22001	1807601.70	1809148.30	5443928.03	5445361.68	2.11
L100801:22001	1800098.69	1809262.55	5443569.20	5452057.72	12.52
L100901:22001	1807536.69	1809640.61	5442931.14	5444906.58	2.90
L101001:22001	1799806.18	1809721.14	5442594.23	5451704.99	13.53
L101101:22001	1807415.58	1809691.68	5442354.38	5444453.88	3.10
L101201:22001	1799565.88	1809629.77	5442134.22	5451418.10	13.76
L101301:22001	1807250.15	1809498.40	5441967.29	5444052.05	3.07
L101401:22001	1799206.54	1809388.06	5441807.15	5451181.86	14.06
L101501:22001	1807065.36	1809243.32	5441678.13	5443672.82	2.96
L101601:22001	1798298.32	1809258.90	5441384.76	5451465.26	14.95
L101701:22001	1806836.64	1809253.72	5441126.45	5443359.50	3.35
L101801:22001	1797973.69	1809250.65	5440870.88	5451225.24	15.34
L101901:22001	1806580.16	1809221.35	5440610.37	5443037.21	3.60
L102001:21902	1797895.61	1809223.20	5440324.98	5450755.79	15.50
L102101:21902	1806428.08	1809228.10	5440070.46	5442629.44	3.84
L102201:21902	1797770.06	1809191.38	5439856.56	5450586.94	15.77
L102301:21902	1806196.97	1809129.98	5439629.24	5442281.52	3.96
L102401:21902	1797413.55	1809108.65	5439368.68	5450271.34	16.55
L102501:21902	1805918.85	1809003.98	5439155.26	5442011.23	4.22
L102601:21902	1797077.37	1808931.25	5438970.91	5449896.36	16.17
L102701:21902	1805683.98	1808834.09	5438784.66	5441689.30	4.32
L102801:21902	1796915.10	1808747.12	5438603.65	5449458.50	16.12
L102901:21902	1805468.30	1808591.50	5438486.97	5441340.43	4.24
L103001:21902	1796774.88	1808410.85	5438358.67	5449192.88	15.99
L103101:21902	1805202.16	1808262.62	5438238.86	5441039.84	4.16
L103201:21901	1796473.01	1804414.81	5441489.54	5448870.10	11.00
L103202:21902	1803924.89	1808127.60	5438066.95	5441954.72	5.76
L103301:21902	1806469.74	1808044.56	5437899.56	5439532.47	2.30
L103302:21902	1805400.25	1806188.71	5439809.66	5440475.09	1.13
L103401:21901	1796294.29	1807951.33	5437689.53	5448436.55	15.97
L103501:21901	1804690.76	1806019.57	5439300.31	5440428.95	1.76
L103502:21901	1806180.66	1807830.65	5437530.15	5439064.42	2.26
L103601:21901	1796060.57	1807753.35	5437335.89	5448091.35	15.92
L103701:21901	1804446.44	1807629.14	5437172.26	5440135.55	4.36
L103801:21901	1795781.82	1807552.16	5436986.67	5447810.40	16.08
L103901:21901	1804103.18	1807465.68	5436788.90	5439858.45	4.56
L104001:21901	1795430.15	1807361.70	5436597.79	5447470.74	16.23
L104101:21901	1803775.69	1808315.86	5435478.01	5439642.54	6.17
L104201:21901	1795278.36	1809712.00	5433917.37	5447313.86	19.95
L104301:21901	1803434.88	1809967.76	5433538.99	5439411.86	8.83
L104401:21901	1796605.07	1810103.59	5433005.74	5445727.63	18.65
L104501:21901	1803082.88	1810313.23	5432534.28	5439188.85	9.84
L104601:21901	1796580.12	1810512.35	5432367.95	5445212.15	19.12
L104701:21901	1802737.72	1810383.60	5431858.36	5438960.75	10.53
L104801:21803	1806969.39	1810317.54	5431705.63	5434972.98	4.76
L104802:21803	1796370.15	1806518.82	5435381.11	5444636.78	13.85
L104901:21803	1797524.00	1806173.36	5435440.09	5443350.17	11.86
L104902:21803	1807980.86	1810283.46	5431483.92	5433401.10	3.03
L105001:21802	1807482.91	1810151.66	5431336.85	5433829.96	3.70
L105002:21803	1796150.14	1805834.16	5435306.67	5444288.82	13.29
L105101:21802	1808757.47	1810132.71	5431076.74	5432282.30	1.94
L105102:21803	1795668.68	1796339.22	5443609.92	5444353.43	1.04
L105103:21803	1796909.00	1805950.97	5434912.96	5443062.47	12.26
L105201:21802	1808619.44	1810010.26	5430889.21	5432032.00	1.84
L105202:21803	1794573.26	1805485.53	5435221.08	5445013.75	14.76
L105301:21802	1808531.68	1809934.42	5430723.01	5432148.16	2.03
L105302:21803	1794475.14	1805278.36	5434918.48	5445037.81	14.88
L105401:21802	1808212.85	1809839.34	5430516.67	5432124.42	2.32

L105402:21803	1793869.51	1805294.90	5434854.97	5445378.26	15.61
L105501:21802	1808379.85	1810076.02	5430057.96	5431788.12	2.45
L105502:21803	1793318.99	1805137.45	5434612.20	5445579.19	16.30
L105601:21802	1807464.19	1810116.78	5429708.54	5432154.46	3.62
L105602:21803	1793151.09	1805158.71	5434399.34	5445351.99	16.30
L105701:21802	1806764.77	1810058.96	5429505.18	5432427.96	4.43
L105702:21803	1792985.45	1795513.69	5443041.38	5445179.70	3.34
L105703:21803	1795868.72	1804981.68	5434153.93	5442769.03	12.60
L105801:21802	1806108.56	1806470.55	5432448.77	5432816.68	0.54
L105802:21802	1806779.73	1809947.69	5429338.99	5432058.07	4.20
L105803:21803	1792873.35	1805167.65	5433563.90	5445060.43	16.89
L105901:21802	1806489.51	1809868.65	5429147.93	5432391.20	4.76
L105902:21803	1792715.32	1804902.67	5433541.69	5444939.02	16.78
L106001:21802	1805811.92	1809743.05	5428968.48	5432582.65	5.38
L106002:21802	1799998.20	1804845.33	5433405.68	5437914.13	6.66
L106003:21803	1792579.33	1800542.28	5437429.96	5444795.42	10.88
L106101:21802	1792395.34	1809646.30	5428796.36	5444630.15	23.59
L106201:21802	1792263.07	1809581.56	5428564.11	5444531.80	23.62
L106301:21802	1792086.50	1809534.79	5428367.43	5444375.86	23.78
L106401:21802	1791993.06	1809488.59	5428149.59	5444237.49	23.87
L106501:21802	1791828.26	1809400.89	5427927.33	5444102.18	23.95
L106601:21802	1791730.56	1809384.42	5427685.68	5443942.05	24.06
L106701:21801	1791572.76	1801579.94	5434587.78	5443785.27	13.64
L106702:21802	1801068.70	1809282.72	5427492.54	5435058.74	11.19
L106801:21801	1791416.87	1809244.58	5427241.71	5443673.02	24.29
L106901:21801	1791230.28	1809146.89	5427079.75	5443534.78	24.38
L107001:21801	1791116.72	1809000.48	5426939.95	5443426.71	24.38
L107101:21801	1793683.53	1808853.90	5426799.11	5440788.36	20.68
L107102:21801	1790947.59	1794146.87	5440357.77	5443276.90	4.34
L107201:21801	1793511.15	1808798.05	5426590.38	5440645.97	20.79
L107202:21801	1790782.78	1794150.22	5440052.02	5443175.21	4.60
L107301:21801	1793688.82	1808675.05	5426437.23	5440217.56	20.45
L107302:21801	1790632.89	1794212.80	5439719.23	5443031.51	4.88
L107401:21801	1793479.91	1808569.89	5426259.59	5440146.03	20.56
L107402:21801	1790494.44	1794020.14	5439661.83	5442899.41	4.79
L107501:21202	1790346.91	1801144.83	5432817.08	5442763.77	14.72
L107502:21801	1800680.41	1808458.86	5426091.72	5433244.75	10.58
L107601:21202	1790198.36	1808362.08	5425915.36	5442624.86	24.71
L107701:21202	1790006.07	1794322.86	5438548.88	5442485.81	5.87
L107702:21202	1793894.29	1808300.14	5425692.25	5438931.42	19.62
L107801:21202	1804505.63	1808151.54	5425559.05	5429119.72	5.16
L107802:21202	1789880.58	1803271.94	5430220.75	5442345.36	18.13
L107901:21202	1789746.12	1808001.77	5425407.74	5442217.99	24.92
L108001:21202	1789611.73	1807970.68	5425187.62	5442060.65	24.98
L108101:21202	1789473.31	1807800.92	5425047.99	5441913.42	24.95
L108201:21201	1794285.37	1807685.01	5424874.74	5437233.41	18.32
L108202:21202	1789347.88	1794712.09	5436838.29	5441780.17	7.30
L108301:21201	1789218.38	1807579.63	5424708.76	5441617.57	25.02
L108401:21201	1789083.82	1807465.80	5424553.15	5441479.67	25.05
L108501:21201	1788963.56	1807369.16	5424391.62	5441330.22	25.07
L108601:21201	1788820.10	1807309.20	5424294.57	5441170.93	25.12
L108701:21201	1788657.74	1807087.11	5424083.08	5441027.61	25.09
L108801:21201	1806232.35	1806892.88	5423981.98	5424689.02	0.99
L108802:21201	1788555.33	1805647.37	5425102.15	5440869.47	23.30
L108901:21201	1788405.99	1806665.33	5423924.98	5440730.28	24.89
L109001:21103	1793939.53	1806452.78	5423831.40	5435370.60	17.20
L109002:21201	1788298.94	1794393.15	5434950.29	5440560.20	8.29
L109101:21103	1788164.34	1806243.17	5423753.79	5440422.88	24.64
L109201:21103	1787995.76	1806071.67	5423654.62	5440276.78	24.60
L109301:21103	1787924.03	1801916.14	5427225.37	5440171.70	19.13
L109311:21103	1804447.02	1805810.23	5423601.96	5424872.70	1.88
L109401:21103	1787709.50	1801547.73	5427276.45	5439948.15	18.82
L109501:21103	1787631.90	1801351.48	5427219.34	5439849.43	18.72
L109601:21103	1787483.43	1800344.52	5427853.26	5439669.53	17.49
L109701:21103	1787377.47	1800092.11	5427806.79	5439543.55	17.37
L109801:21102	1794213.30	1799859.44	5427704.51	5432958.07	7.73
L109802:21103	1787235.82	1794654.16	5432540.08	5439372.64	10.09
L109901:21102	1787078.09	1799744.89	5427592.28	5439228.61	17.23

L110001:21102	1786958.69	1799605.93	5427441.84	5439072.15	17.20
L110101:21102	1786830.67	1799456.94	5427298.22	5438945.62	17.20
L110201:21102	1786691.47	1799227.18	5427238.12	5438786.35	17.07
L110301:21102	1786569.12	1798981.84	5427182.88	5438620.02	16.91
L110401:21102	1786429.22	1798273.78	5427542.82	5438474.87	16.14
L110601:21102	1786193.28	1797906.76	5427384.12	5438107.95	15.92
L110801:21102	1785938.51	1797552.70	5427191.70	5437845.20	15.78
L111001:21102	1785702.26	1797106.27	5426972.63	5437588.85	15.63
L111201:21102	1785426.42	1796759.55	5426794.58	5437237.56	15.45
L111401:21102	1785100.41	1796363.16	5426619.24	5436981.41	15.37
L111601:21101	1789608.08	1795982.50	5426409.06	5432310.76	8.69
L111602:21102	1784801.96	1790050.10	5431887.62	5436620.92	7.09
L111801:21101	1784673.75	1795600.22	5426228.77	5436481.99	15.11
L112001:21101	1784315.46	1795267.67	5426073.43	5436110.29	14.90
L112201:21101	1783998.94	1794862.71	5425823.07	5435834.30	14.80
L112401:21101	1783705.56	1794508.14	5425587.55	5435544.45	14.72
L112601:21101	1783400.74	1794208.10	5425345.78	5435278.24	14.69
L112801:21101	1783108.72	1793975.65	5425050.57	5434991.72	14.75
L113001:21101	1782841.53	1793642.11	5424772.79	5434760.54	14.73
L113201:21101	1782508.05	1793372.27	5424494.00	5434467.87	14.76
L113401:21101	1782214.47	1793088.42	5424201.88	5434171.76	14.77
L113601:21101	1781958.85	1792852.37	5423898.03	5433890.77	14.81
L113801:21101	1781684.64	1792510.64	5423636.88	5433616.15	14.75
L114001:21002	1787498.88	1792181.82	5423430.47	5427734.06	6.39
L114002:21101	1781428.98	1787957.42	5427271.41	5433300.40	8.89
L114201:21002	1781269.07	1791862.63	5423145.28	5432881.52	14.42
L114401:21002	1781118.42	1791639.16	5422801.52	5432494.79	14.34
L114601:21002	1780942.94	1791482.55	5422421.70	5432106.65	14.34
L114801:21002	1780535.98	1791333.81	5422020.05	5431942.27	14.71
L115001:21002	1780194.55	1791146.00	5421621.76	5431708.37	14.91
L115201:21002	1779882.97	1790972.56	5421257.54	5431460.94	15.10
L115301:21002	1779689.42	1790851.03	5421084.52	5431319.96	15.24
L115401:21002	1779569.55	1790832.66	5420848.65	5431211.04	15.36
L115501:21002	1779428.45	1790818.83	5420572.51	5431091.77	15.54
L115601:21002	1779262.25	1790791.04	5420341.48	5430951.31	15.70
L115701:21002	1779083.70	1790766.16	5420080.68	5430827.92	15.94
L115801:21001	1784482.07	1790737.47	5419816.22	5425547.98	8.50
L115802:21002	1778966.06	1785007.85	5425101.57	5430709.16	8.26
L115901:21001	1778759.90	1790712.98	5419558.22	5430573.02	16.27
L116001:21001	1778629.19	1790627.12	5419377.04	5430434.33	16.34
L116101:21001	1778513.30	1790449.14	5419272.50	5430310.33	16.31
L116201:21001	1778421.95	1790268.04	5419165.58	5430084.78	16.14
L116301:21001	1778380.47	1790088.45	5419059.58	5429867.50	15.95
L116401:21001	1778298.92	1789936.75	5418939.33	5429640.62	15.85
L116501:21001	1778284.41	1785544.59	5422624.90	5429476.93	10.07
L116502:21001	1785949.85	1789746.90	5418827.65	5422292.81	5.15
L116601:21001	1778224.65	1789590.82	5418712.95	5429177.64	15.47
L116701:21001	1778252.81	1789401.09	5418613.98	5428900.49	15.22
L116801:21001	1778239.72	1789225.24	5418469.26	5428599.37	14.98
L116901:21001	1778269.55	1789064.95	5418401.60	5428325.52	14.68
L117001:21001	1778283.60	1788861.02	5418285.42	5428051.35	14.41
L117101:20803	1778309.97	1788699.86	5418173.55	5427761.95	14.17
L117201:20803	1778378.31	1788495.40	5418082.88	5427560.30	13.92
L117301:20803	1778316.78	1788341.84	5417971.92	5427176.08	13.64
L117401:20802	1778721.30	1785082.89	5420719.11	5426559.12	8.68
L117402:20803	1784641.57	1788166.66	5417855.51	5421109.30	4.81
L117501:20802	1779120.81	1788003.86	5417737.79	5425900.07	12.10
L117601:20802	1779189.46	1787799.82	5417627.86	5425597.16	11.77
L117701:20802	1779274.44	1787626.99	5417546.61	5425219.70	11.37
L117801:20802	1779182.16	1787861.80	5417037.59	5425045.47	11.84
L117901:20802	1779044.64	1788083.68	5416576.88	5424871.10	12.32
L118001:20802	1778926.41	1788255.06	5416125.32	5424729.53	12.78
L118101:20802	1778791.87	1788278.92	5415846.77	5424568.51	12.92
L118201:20802	1778657.07	1788347.63	5415499.46	5424425.27	13.20
L118301:20802	1778533.85	1788564.69	5415061.30	5424238.11	13.62
L118401:20802	1778373.00	1788577.05	5414736.26	5424106.11	13.88
L118501:20802	1778225.05	1788631.20	5414412.77	5424014.03	14.18
L118601:20802	1777987.72	1788675.52	5414160.94	5423893.23	14.49

L118701:20801	1780696.16	1788566.07	5413960.27	5421208.57	10.72
L118702:20802	1777861.35	1781102.35	5420801.58	5423801.40	4.44
L118801:20801	1777638.10	1783839.51	5418035.32	5423706.24	8.42
L118802:20801	1782803.59	1788437.35	5413799.78	5418992.16	7.68
L118901:20801	1777409.77	1788262.90	5413692.92	5423680.86	14.81
L119001:20801	1777184.88	1788059.63	5413597.74	5423593.73	14.87
L119101:20801	1776972.76	1787891.60	5413463.97	5423525.78	14.88
L119201:20801	1776720.19	1787697.97	5413383.73	5423480.40	14.96
L119301:20801	1776542.56	1787542.79	5413316.18	5423388.07	15.13
L119401:20801	1776272.43	1787275.17	5413244.58	5423315.11	14.94
L119501:20801	1776085.01	1787081.48	5413203.34	5423253.52	14.93
L119601:20801	1775903.27	1786818.21	5413119.46	5423237.78	14.91
L119701:20801	1775634.56	1786632.25	5412992.10	5423141.68	14.99
L119801:20801	1775474.21	1786490.53	5412864.15	5423089.48	15.07
L119901:20702	1779044.21	1786360.01	5412695.07	5419465.85	10.02
L119902:20801	1775273.61	1779553.04	5418980.73	5422921.70	5.83
L120001:20702	1775125.72	1786291.69	5412505.41	5422810.92	15.25
L120101:20702	1774994.42	1786137.08	5412375.85	5422642.26	15.22
L120201:20702	1774884.64	1786011.51	5412214.11	5422509.15	15.20
L120301:20702	1774734.32	1785892.35	5412052.02	5422330.88	15.23
L120401:20702	1774603.85	1785765.41	5411893.91	5422170.90	15.22
L120501:20702	1774488.11	1785662.62	5411734.65	5422013.91	15.25
L120601:20702	1774357.74	1785531.19	5411564.65	5421861.39	15.22
L120701:20702	1774234.29	1785421.97	5411404.62	5421705.39	15.27
L120801:20702	1774091.29	1785279.63	5411252.59	5421567.43	15.36
L120901:20702	1779961.15	1785147.94	5411123.35	5415927.43	7.08
L120902:20702	1773967.90	1779506.51	5416364.54	5421407.74	7.52
L121001:20702	1773858.90	1779251.62	5416316.53	5421256.98	7.35
L121002:20702	1779872.29	1784338.48	5411583.36	5415758.40	6.16
L121101:20701	1779591.76	1783529.85	5412079.54	5415703.22	5.43
L121102:20701	1776822.49	1779230.08	5416031.85	5418254.28	3.29
L121103:20702	1773733.59	1777303.12	5417775.44	5421070.69	4.88
L121201:20701	1773616.43	1779104.07	5415832.68	5420865.29	7.49
L121202:20701	1779498.54	1782521.07	5412703.18	5415462.16	4.12
L121301:20701	1773542.37	1781557.95	5413319.82	5420708.60	11.00
L121401:20701	1773430.06	1780555.45	5413947.22	5420506.65	9.73
L121501:20701	1773326.91	1779598.03	5414593.04	5420366.91	8.54
L121601:20701	1773227.18	1779413.90	5414483.66	5420155.73	8.41
L121701:20701	1773125.44	1779324.67	5414326.34	5419986.91	8.40
L121801:20701	1773011.37	1779220.69	5414114.78	5419808.14	8.44
L121901:20701	1772950.00	1779111.63	5413964.27	5419608.57	8.37
L122001:20701	1772836.88	1779015.88	5413774.77	5419447.34	8.40
L122101:20701	1772709.74	1778535.13	5413893.05	5419314.52	7.97
L122201:20701	1772548.07	1777915.99	5414217.44	5419137.32	7.29
L122301:20701	1772439.01	1777285.87	5414514.33	5419008.94	6.62
L122401:20701	1772322.16	1776754.74	5414739.94	5418860.24	6.07
L122501:20701	1772187.10	1776277.93	5414913.19	5418700.52	5.63
L122601:20701	1772085.92	1773762.23	5416940.50	5418518.19	2.32
L122701:20701	1772058.51	1773328.01	5417102.56	5418257.25	1.73
L122801:20701	1771963.35	1772862.58	5417245.90	5418025.93	1.20
L122901:20701	1771922.98	1772435.56	5417396.44	5417858.60	0.70
L200001:22201	1814063.80	1815301.61	5473819.51	5475738.53	2.29
L200101:22201	1813639.75	1815561.13	5472775.96	5475736.09	3.53
L200201:22201	1812753.48	1815696.46	5471016.02	5475779.07	5.62
L200301:22201	1812372.84	1816011.37	5470038.04	5475693.96	6.77
L200401:22002	1801157.27	1802278.04	5452137.88	5453888.00	2.08
L200411:22201	1812532.43	1816188.03	5469810.74	5475717.73	6.97
L200501:22002	1801250.68	1802758.55	5451920.39	5454308.16	2.86
L200511:22201	1812719.92	1816454.26	5469621.98	5475658.30	7.22
L200601:22002	1801379.95	1803162.15	5451772.71	5454543.73	3.32
L200611:22201	1812778.19	1816696.50	5469535.18	5475660.59	7.29
L200701:22002	1801535.54	1803631.45	5451623.07	5454959.00	3.97
L200711:22201	1813407.47	1816885.42	5469861.24	5475667.69	6.85
L200712:22201	1812870.12	1813227.93	5469308.25	5469586.39	0.46
L200801:22002	1801603.78	1804174.10	5451473.45	5455373.47	4.72
L200811:22201	1812923.80	1817149.71	5468979.86	5475641.12	7.94
L200901:22002	1801795.45	1804430.73	5451269.21	5455407.64	4.93
L200911:22201	1813046.82	1813075.94	5468444.72	5468724.50	0.28

L200912:22201	1812931.83	1817341.36	5468659.36	5475619.54	8.29
L201001:22002	1801925.32	1804675.29	5451093.85	5455418.69	5.18
L201011:22201	1813522.13	1817597.14	5469466.44	5475604.43	7.46
L201101:22002	1802033.40	1805040.30	5450924.20	5455624.46	5.60
L201111:22201	1813162.22	1817785.67	5468287.46	5475271.85	8.45
L201201:22002	1802155.09	1806127.28	5450766.43	5456944.61	7.44
L201211:22201	1813284.20	1818037.49	5468136.92	5475434.34	8.85
L201301:22002	1802292.53	1806856.77	5450584.76	5457590.49	8.41
L201311:22201	1813456.41	1818306.70	5467966.31	5475590.57	9.09
L201401:22002	1802421.05	1807115.75	5450354.05	5457725.85	8.85
L201411:22201	1813548.75	1818512.70	5467780.44	5475539.02	9.31
L201501:22002	1802488.29	1807362.42	5450156.15	5457751.38	9.04
L201511:22201	1813682.62	1818730.70	5467617.11	5475549.98	9.51
L201601:22002	1802584.39	1802997.08	5449916.09	5450369.07	0.62
L201602:22002	1803252.31	1807673.59	5450793.63	5457869.73	8.40
L201611:22201	1813797.87	1818957.33	5467454.03	5475534.11	9.60
L201701:22002	1803287.99	1808659.12	5450682.36	5459081.20	10.01
L201702:22101	1802688.92	1802952.54	5449692.67	5450138.53	0.57
L201711:22201	1813951.05	1819198.53	5467308.97	5475497.07	9.76
L201801:22002	1803499.37	1809472.94	5450566.10	5459939.04	11.22
L201802:22101	1802792.52	1803085.32	5449520.82	5449998.46	0.56
L201811:22102	1814070.60	1819414.17	5467157.26	5475487.11	9.92
L201901:22002	1803690.05	1809798.83	5450451.58	5460056.98	11.47
L201902:22101	1802970.96	1803311.39	5449408.26	5449954.34	0.67
L201911:22102	1814255.83	1819648.68	5467037.87	5475490.82	10.06
L202001:22002	1803833.50	1810058.07	5450377.37	5460120.79	11.66
L202002:22101	1803138.11	1803459.69	5449264.44	5449839.46	0.67
L202011:22102	1814378.22	1819875.08	5466857.21	5475479.48	10.34
L202101:22002	1803954.44	1810177.12	5450356.32	5460181.85	11.77
L202102:22101	1803293.15	1803625.77	5449195.66	5449752.97	0.67
L202111:22102	1814547.68	1820146.06	5466705.24	5475458.66	10.46
L202201:22002	1804214.45	1810594.85	5450313.44	5460210.19	12.00
L202202:22101	1803457.70	1803818.41	5449063.76	5449641.33	0.68
L202211:22102	1814131.17	1820346.49	5465744.22	5475439.38	11.58
L202301:22002	1804382.46	1811069.51	5450256.23	5460602.45	12.43
L202302:22101	1803635.38	1804131.78	5448973.63	5449688.88	0.92
L202311:22102	1814133.61	1820636.07	5465368.84	5475526.79	12.12
L202401:22002	1805517.61	1810487.63	5451420.37	5459273.72	9.42
L202402:22101	1809842.73	1812499.86	5458330.59	5462436.01	4.96
L202403:22101	1803798.14	1804254.00	5448848.16	5449593.24	0.88
L202411:22101	1813927.89	1820898.84	5464671.19	5475554.87	12.96
L202501:22101	1807457.12	1812903.50	5453954.83	5462688.17	10.38
L202502:22101	1803968.85	1807141.44	5448756.11	5453420.78	5.73
L202511:22101	1814730.32	1815497.78	5465507.91	5466668.58	1.46
L202512:22101	1815206.28	1821421.69	5466572.73	5476018.98	11.38
L202513:22101	1813801.64	1814618.43	5464097.57	5465657.28	1.78
L202601:22101	1804176.93	1806401.85	5448714.34	5451932.56	3.98
L202602:22101	1806687.04	1813119.55	5452330.51	5462701.47	12.31
L202611:22101	1813769.68	1814732.72	5463384.14	5465473.19	2.37
L202612:22101	1815558.83	1821920.05	5466696.48	5476414.20	11.72
L202701:22101	1818838.37	1822204.27	5471142.79	5476451.00	6.43
L202702:22101	1816234.44	1818666.44	5467434.73	5470677.37	4.15
L202703:22101	1815285.71	1816027.76	5465426.64	5467130.54	1.91
L202704:22101	1805871.00	1813774.01	5450796.10	5463093.14	14.80
L202705:22101	1804394.80	1805620.09	5448649.07	5450364.63	2.23
L202801:22101	1804555.39	1805744.37	5448612.96	5450304.98	2.11
L202802:22101	1805977.74	1814217.33	5450555.39	5463808.13	15.75
L202803:22101	1816071.78	1822553.04	5466320.69	5476676.12	12.32
L202901:22101	1816790.67	1822829.11	5467144.62	5476788.57	11.44
L202902:22101	1816084.35	1816624.61	5465986.89	5466693.18	0.92
L202903:22101	1809708.95	1814208.69	5456349.94	5463036.62	8.17
L202904:22102	1805100.75	1809932.11	5449016.84	5456798.54	9.25
L203001:22102	1805225.93	1810127.41	5448894.62	5456270.18	9.09
L203002:22102	1810973.34	1814609.42	5457550.91	5463304.38	6.89
L203003:22102	1816168.59	1823351.11	5465899.21	5477182.79	13.53
L203101:22102	1817269.81	1823668.61	5467003.49	5477297.02	12.27
L203102:22102	1816178.24	1816794.45	5465293.29	5466268.48	1.22
L203103:22102	1810993.95	1815148.14	5457248.20	5463741.30	7.79

L203104:22102	1806838.77	1810407.07	5450896.52	5456359.02	6.59
L203201:22201	1806851.69	1810629.89	5450616.73	5456296.77	6.91
L203202:22201	1811420.27	1814953.59	5457564.54	5463068.33	6.61
L203203:22201	1816570.09	1824138.43	5465594.95	5477639.97	14.32
L203301:22202	1807010.21	1810828.12	5450443.79	5456248.73	7.03
L203302:22202	1811381.98	1814972.82	5457162.89	5462873.56	6.80
L203303:22202	1816137.30	1824431.57	5464568.32	5477756.77	15.65
L203304:22202	1815252.92	1815695.41	5463162.34	5463839.85	0.82
L203401:22202	1821890.59	1824640.34	5473686.87	5477806.45	5.04
L203402:22202	1817607.91	1821626.90	5466655.82	5473256.63	7.77
L203403:22202	1807108.53	1816828.60	5450359.22	5465249.21	17.96
L203501:22202	1807227.78	1813941.48	5450305.14	5460404.03	12.27
L203502:22202	1814485.21	1815301.96	5461251.16	5462508.98	1.56
L203503:22202	1815659.33	1816434.94	5463086.32	5464299.14	1.49
L203504:22202	1816979.70	1824920.24	5465118.50	5477755.05	15.03
L203505:22701	1805579.75	1806136.27	5447590.54	5448303.39	0.96
L203601:22202	1812137.46	1825110.41	5457211.32	5477669.28	24.41
L203602:22202	1807877.05	1811638.08	5450713.74	5456464.67	6.90
L203603:22701	1805806.58	1806802.98	5447468.79	5448871.41	1.86
L203701:22202	1812227.43	1814013.13	5457175.28	5459780.48	3.22
L203702:22202	1814554.02	1815956.04	5460586.91	5462917.13	2.76
L203703:22202	1816307.82	1817422.67	5463768.19	5465238.52	1.91
L203704:22202	1818584.11	1825266.38	5466885.72	5477579.58	12.72
L203705:22701	1805939.97	1806950.79	5447374.19	5448830.49	1.80
L203706:22202	1807889.57	1811125.80	5450405.73	5455655.92	6.39
L203707:22202	1811077.60	1811532.64	5455764.90	5456150.11	0.61
L203801:22202	1817206.03	1825425.06	5464509.07	5477436.83	15.52
L203802:22202	1812393.72	1816131.57	5457110.66	5462715.00	6.82
L203803:22701	1806135.96	1807250.42	5447302.66	5448779.02	1.94
L203804:22702	1808342.95	1810193.00	5450926.99	5453620.38	3.32
L203805:22702	1807496.50	1808038.41	5449330.34	5450554.92	1.38
L203901:22202	1812483.99	1816146.17	5457040.49	5462561.11	6.67
L203902:22701	1806360.79	1807398.53	5447221.42	5448771.60	1.91
L203903:22701	1807633.25	1810318.91	5449071.13	5453387.16	5.14
L203904:22701	1818143.35	1825537.64	5465388.63	5477265.21	14.06
L204001:22701	1806510.91	1810468.79	5447139.35	5453376.92	7.51
L204002:22701	1812946.23	1816594.53	5457085.91	5462754.81	6.79
L204003:22701	1817609.03	1825655.34	5464259.25	5477064.48	15.18
L204101:22701	1806680.46	1810593.67	5447037.87	5453273.43	7.39
L204102:22701	1813050.91	1813900.17	5456987.93	5458579.57	1.88
L204103:22701	1813951.93	1817007.19	5458743.26	5462881.42	5.21
L204104:22701	1817776.93	1818221.93	5464081.29	5464814.16	0.95
L204105:22701	1818730.82	1825735.51	5465619.34	5476834.87	13.32
L204201:22701	1806824.58	1810965.57	5446897.74	5453165.16	7.54
L204202:22701	1822016.09	1825816.11	5470421.83	5476582.67	7.30
L204203:22701	1819235.52	1821506.65	5466584.12	5469515.97	3.81
L204204:22701	1813204.47	1813920.64	5457000.69	5457773.20	1.08
L204205:22701	1814358.64	1818329.14	5458422.79	5465105.97	7.87
L204301:22701	1807070.84	1811168.85	5446863.74	5453080.60	7.50
L204302:22701	1823087.19	1825968.78	5471621.98	5476469.48	5.67
L204303:22701	1818123.58	1819341.68	5463995.79	5466262.52	2.66
L204304:22701	1819571.37	1822377.92	5466648.56	5470616.33	4.95
L204305:22701	1813495.68	1817266.18	5457014.90	5462745.39	6.96
L204401:22701	1814460.69	1817563.48	5457977.97	5462713.71	5.71
L204402:22701	1807265.46	1811958.62	5446825.18	5454076.57	8.67
L204403:22701	1822871.30	1826125.60	5470921.26	5476303.94	6.33
L204404:22701	1818092.35	1822668.86	5463505.53	5470658.88	8.70
L204501:22702	1807472.84	1812290.62	5446813.14	5454055.76	8.75
L204502:22702	1813494.07	1822091.39	5456012.51	5469412.19	16.16
L204503:22702	1822707.88	1826315.70	5470370.84	5476231.93	6.92
L204601:22702	1813089.70	1826515.46	5455045.72	5476163.56	25.23
L204602:22702	1807717.54	1812550.12	5446824.46	5454170.47	8.83
L204701:22702	1807910.07	1819538.61	5446712.81	5464648.61	21.80
L204702:22702	1819896.10	1826638.51	5465217.88	5476000.00	12.82
L204801:22702	1819442.61	1826749.00	5464196.82	5475798.97	13.79
L204802:22702	1808004.92	1818102.36	5446519.25	5462077.95	18.73
L204901:22702	1808182.81	1809145.52	5446395.28	5447903.91	1.79
L204902:30101	1808152.89	1817848.43	5446369.90	5461500.67	18.04

L204903:30101	1819503.45	1820276.94	5463900.53	5465057.17	1.44
L204904:30101	1820791.61	1826822.71	5465871.38	5475560.54	11.48
L205001:30101	1808302.26	1827003.93	5446233.29	5475447.40	34.90
L205101:30101	1808465.78	1827101.21	5446129.94	5475239.97	34.72
L205201:30101	1822646.79	1827210.87	5468151.86	5475017.97	8.36
L205202:30101	1818716.45	1821881.65	5461628.68	5466932.47	6.24
L205203:30101	1808603.69	1818058.99	5445968.22	5460480.63	17.38
L205301:30101	1824473.26	1827360.58	5470283.25	5474925.25	5.49
L205302:30101	1822896.90	1823852.89	5467666.88	5469231.75	1.91
L205303:30101	1808786.16	1818580.09	5445866.82	5460930.50	18.14
L205304:30101	1818671.29	1820206.60	5461195.87	5463475.80	2.86
L205305:30101	1820846.78	1822062.80	5464536.16	5466374.95	2.27
L205401:30101	1808913.01	1821028.60	5445714.41	5464809.18	22.80
L205402:30101	1824593.49	1827524.52	5470046.62	5474767.54	5.62
L205403:30101	1822852.74	1824149.09	5467213.14	5469240.25	2.53
L205501:30101	1809108.29	1815807.87	5445638.49	5456104.90	12.46
L205502:30202	1815244.23	1819772.81	5455228.38	5462526.69	8.65
L205503:30202	1821565.04	1822479.32	5465314.71	5466261.82	1.37
L205504:30202	1822795.17	1827661.93	5466803.42	5474626.89	9.33
L205601:30202	1824382.98	1827826.84	5468938.71	5474493.00	6.57
L205602:30202	1822152.81	1823913.12	5465622.06	5468111.15	3.18
L205603:30301	1809271.71	1819653.81	5445530.49	5461821.98	19.38
L205701:30202	1822302.63	1824086.36	5465559.52	5468038.48	3.10
L205702:30202	1824401.12	1827926.76	5468556.92	5474289.75	6.78
L205703:30301	1817739.68	1819974.67	5458183.20	5461823.45	4.31
L205704:30301	1809411.89	1817415.15	5445354.08	5457684.62	14.78
L205801:30202	1825304.44	1827941.89	5469825.82	5473977.31	4.94
L205802:30202	1822470.40	1824280.52	5465108.86	5468239.27	3.67
L205803:30301	1809593.79	1820090.53	5445309.32	5461738.02	19.54
L205901:30202	1825442.27	1828024.85	5469732.52	5473668.58	4.74
L205902:30202	1822493.87	1824386.29	5464848.18	5468180.02	3.87
L205903:30301	1810204.43	1820270.54	5445878.24	5461580.56	18.77
L206001:30202	1825620.60	1827902.49	5469639.04	5473217.16	4.26
L206002:30202	1822696.18	1824393.13	5464766.91	5467599.51	3.35
L206003:30301	1810393.35	1820365.16	5445804.38	5461465.32	18.67
L206101:30202	1825758.83	1827998.83	5469548.28	5472902.53	4.06
L206102:30202	1822808.49	1824472.14	5464802.11	5467490.16	3.18
L206103:30301	1810636.95	1820580.96	5445791.51	5461380.86	18.60
L206201:30202	1826155.99	1827888.33	5469509.16	5472404.34	3.39
L206202:30202	1822958.25	1824622.28	5464706.49	5467259.35	3.10
L206203:30301	1811026.91	1820782.77	5446061.88	5461303.34	18.18
L206301:30202	1825644.33	1827507.80	5468215.93	5471412.39	3.76
L206302:30202	1823357.09	1824752.28	5464894.12	5467136.80	2.67
L206303:30301	1811571.83	1820909.83	5446522.61	5461219.75	17.52
L206401:30201	1817340.79	1820989.73	5454904.10	5461049.62	7.23
L206402:30201	1811873.41	1816955.06	5446625.39	5454295.21	9.31
L206403:30202	1826513.54	1827442.55	5469289.10	5470970.39	1.94
L206404:30202	1823519.96	1824684.69	5464873.65	5466613.17	2.16
L206501:30201	1812234.59	1821627.79	5446813.14	5461302.04	17.39
L206502:30202	1825494.28	1827368.89	5467608.66	5470455.48	3.48
L206503:30202	1823728.97	1824748.56	5464739.93	5466470.88	2.04
L206601:30201	1812517.47	1821480.92	5446881.33	5461007.75	16.84
L206602:30202	1825211.13	1827287.38	5466817.99	5469967.31	3.91
L206603:30202	1823910.76	1824607.93	5464737.83	5465991.37	1.46
L206701:30201	1812714.65	1814597.02	5446837.66	5449500.76	3.32
L206702:30201	1814893.36	1822276.15	5449994.25	5461672.26	13.97
L206703:30202	1825826.17	1827260.65	5467053.85	5469537.03	2.92
L206801:30201	1820886.63	1822431.77	5458985.95	5461519.04	3.02
L206802:30201	1812868.82	1820547.06	5446699.66	5458437.63	14.13
L206803:30202	1825808.19	1827218.89	5466824.80	5469187.18	2.77
L206901:30201	1813035.54	1822288.94	5446556.81	5460782.41	17.09
L206902:30202	1825910.37	1827433.35	5466756.66	5469077.41	2.82
L207001:30201	1813239.30	1822735.15	5446538.74	5461367.55	17.73
L207002:30202	1826154.12	1827619.88	5466622.54	5468992.17	2.82
L207101:30201	1813445.49	1822927.84	5446516.53	5461260.27	17.59
L207102:30202	1826242.30	1827634.17	5466520.78	5468652.23	2.62
L207201:30201	1813656.87	1823106.94	5446442.94	5461201.97	17.64
L207202:30202	1826075.64	1827730.29	5465772.92	5468452.83	3.19

L207301:30201	1813864.06	1823624.54	5446402.06	5461514.56	18.06
L207302:30202	1826668.35	1827977.69	5466094.42	5468064.70	2.48
L207401:30201	1814060.79	1823939.52	5446328.95	5461673.43	18.32
L207402:30202	1826709.19	1827902.38	5465930.75	5467917.54	2.35
L207501:30201	1814295.35	1823956.56	5446307.08	5461528.36	18.14
L207502:30202	1827140.95	1827916.96	5466128.08	5467585.02	1.73
L207601:30201	1821047.73	1824128.05	5456511.45	5461537.24	5.96
L207602:30202	1827128.91	1828019.26	5465786.32	5467368.67	1.92
L207603:30301	1814531.80	1821796.65	5446313.72	5457668.38	13.49
L207701:30202	1827216.08	1828141.90	5465519.22	5467160.78	1.93
L207702:30301	1814883.16	1825895.46	5446496.52	5463374.81	20.33
L207703:30301	1826797.92	1827938.54	5464807.04	5466950.59	2.44
L207801:30202	1824077.29	1828187.53	5460241.01	5466943.65	7.90
L207802:30202	1815179.79	1823337.95	5446606.59	5459070.83	14.99
L207803:30301	1826049.47	1826425.66	5463639.96	5464231.50	0.73
L207901:30202	1815474.57	1825041.78	5446673.31	5461602.18	17.78
L207902:30301	1824340.83	1828368.58	5460563.35	5466614.58	7.34
L208001:30202	1819937.69	1825205.47	5453313.60	5461648.59	9.90
L208002:30302	1824466.07	1828310.92	5460327.29	5466374.47	7.22
L208003:30301	1815721.43	1821580.53	5446679.81	5455833.83	10.88
L208101:30301	1816355.25	1819764.29	5447310.19	5452648.03	6.34
L208102:30302	1819145.00	1828234.80	5451701.78	5465937.01	16.97
L208201:30302	1823149.82	1828310.32	5457524.70	5465604.47	9.70
L208202:30303	1816619.49	1823564.37	5447361.61	5458218.32	12.91
L208301:30302	1823345.31	1828308.62	5457496.79	5465239.73	9.26
L208302:30303	1816998.08	1823716.78	5447500.54	5458094.11	12.61
L208401:30302	1824635.30	1828367.70	5458873.74	5464955.72	7.23
L208402:30302	1817335.48	1824345.15	5447720.74	5458388.06	12.82
L208501:30302	1823647.03	1828656.36	5457199.42	5465043.34	9.33
L208502:30302	1817675.54	1824141.96	5447987.08	5458015.22	11.96
L208601:30302	1823808.70	1828955.89	5457123.17	5465129.60	9.56
L208602:30302	1818045.20	1824368.71	5448085.01	5457998.11	11.79
L208701:30302	1823810.16	1829358.47	5456719.52	5465386.95	10.33
L208702:30302	1818335.86	1824350.55	5448161.57	5457606.02	11.22
L208801:30302	1823998.09	1829622.68	5456653.39	5465445.04	10.47
L208802:30302	1818599.87	1824465.62	5448219.78	5457364.42	10.90
L208901:30302	1818912.49	1829892.87	5448340.83	5465475.47	20.48
L209001:30302	1819172.51	1830281.68	5448384.10	5465715.32	20.64
L209101:30302	1819633.84	1830560.64	5448738.72	5465778.87	20.31
L209211:30102	1819888.09	1830766.40	5448776.04	5465760.08	20.23
L209301:30102	1820118.54	1824836.54	5448755.36	5456073.98	8.75
L209311:30102	1825699.37	1830954.06	5457449.81	5465668.76	9.77
L209401:30102	1820342.16	1824106.82	5448704.23	5454610.48	7.04
L209411:30102	1826105.79	1831130.81	5457702.85	5465569.82	9.40
L209501:30102	1820591.64	1823998.78	5448744.08	5454078.16	6.34
L209511:30102	1827708.78	1831312.35	5459635.06	5465464.27	6.88
L209512:30102	1826426.76	1826999.17	5457850.83	5458599.64	0.97
L209601:30102	1820877.38	1824125.88	5448802.10	5453880.04	6.05
L209611:30102	1827358.74	1831467.64	5458668.59	5465369.09	7.99
L209701:30102	1821215.41	1824236.95	5448963.35	5453707.10	5.65
L209711:30102	1827900.78	1831635.92	5459409.27	5465147.10	6.86
L209801:30102	1821506.53	1824364.34	5449060.96	5453533.00	5.33
L209811:30102	1828440.85	1831609.17	5459778.36	5464837.45	6.00
L209901:30102	1821713.91	1824491.44	5449004.26	5453352.24	5.17
L209911:30102	1828914.54	1831789.88	5460081.36	5464753.15	5.51
L210001:30102	1821891.96	1824633.06	5448876.98	5453187.45	5.12
L210011:30102	1829177.91	1831938.69	5460166.60	5464603.61	5.33
L210101:30102	1822254.29	1824754.36	5448863.35	5453034.51	4.89
L210111:30102	1831403.04	1831986.57	5463143.37	5464308.95	1.33
L210112:30102	1829438.64	1831126.70	5460314.66	5462745.15	2.99
L210201:30102	1822612.05	1824903.12	5449291.04	5452859.23	4.25
L210211:30102	1829839.27	1831799.45	5460533.79	5463637.89	3.71
L210301:30102	1823029.85	1825031.65	5449547.15	5452700.56	3.74
L210311:30102	1830458.49	1831776.61	5461443.11	5463227.77	2.25
L210401:30102	1823342.41	1825159.76	5449710.59	5452546.53	3.37
L210501:30102	1823999.55	1825337.64	5450352.03	5452361.37	2.44
L912001:20401	1778518.86	1780932.25	5419252.85	5421757.24	3.50
L912002:20701	1778525.95	1780930.07	5419211.26	5421813.89	3.55

L912003:20801	1778493.79	1780931.07	5419227.96	5421836.22	3.57
L912004:22001	1796854.59	1799936.96	5435546.21	5438405.18	4.21
L912005:30202	1813250.17	1815223.97	5452114.47	5455200.18	3.70
L9900001:20301	1778771.82	1801638.17	5426725.38	5451502.28	34.14
L9900101:20301	1773115.57	1803109.48	5417080.20	5449389.66	44.23
L9900201:20301	1775722.78	1804918.81	5416236.76	5447953.32	43.24
L9900301:20202	1807683.24	1831496.00	5446791.17	5464778.28	30.47
L9900401:20202	1808052.67	1831863.14	5446754.31	5464768.91	30.45
L9900501:20202	1799697.23	1807563.23	5438314.42	5446872.72	11.65
L9900502:20202	1778401.10	1800108.10	5415166.10	5438761.41	32.23
L9900601:20202	1782580.07	1809664.69	5416344.32	5445419.36	39.83
L9900701:30303	1811785.08	1823765.09	5453316.40	5460893.60	14.31
L9900801:30303	1812209.85	1824759.50	5456364.38	5462709.81	14.52
				TOTAL	**5680.24**

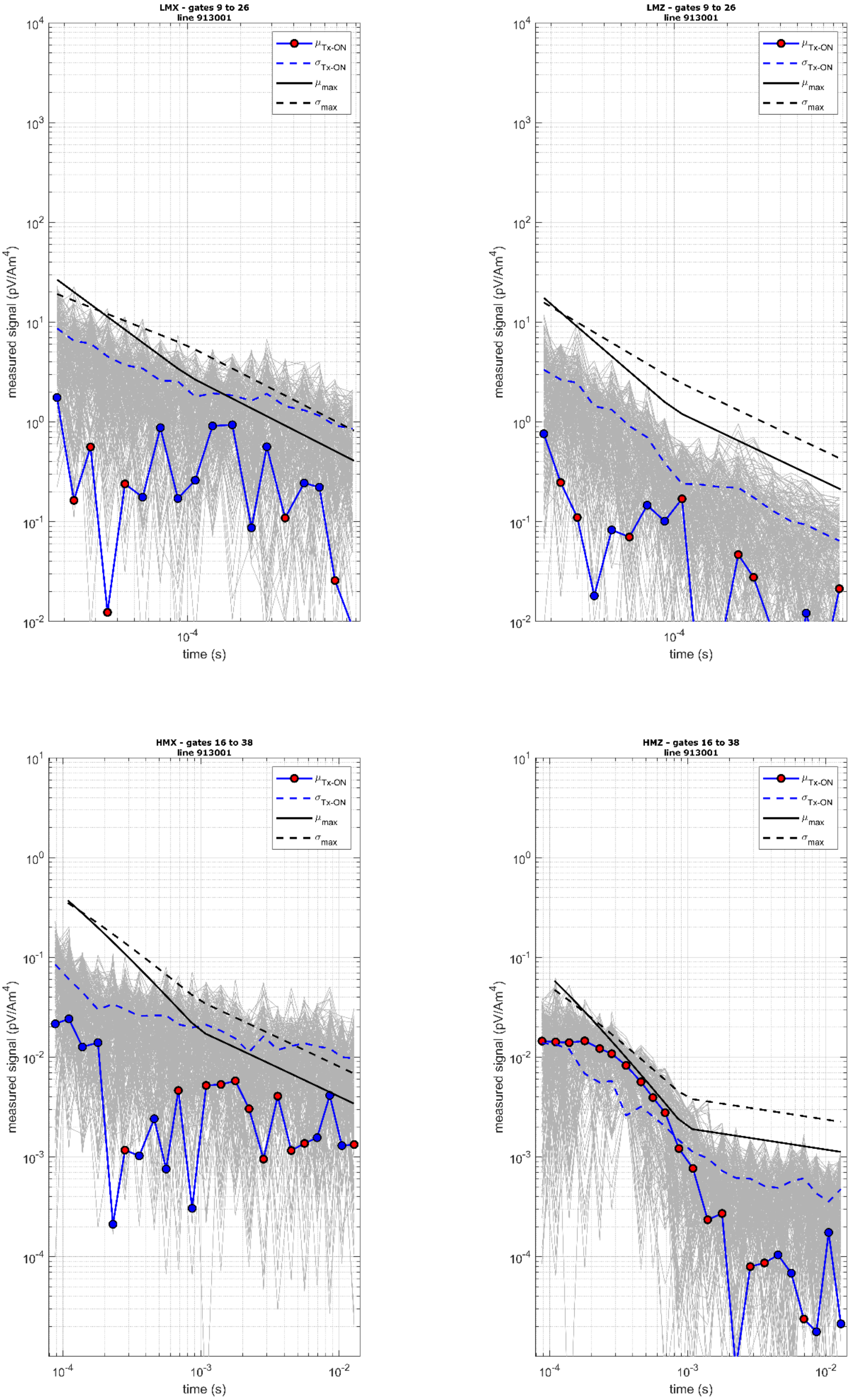
Appendix C

High Level Flights

Summary Table of Hi Level Results

(Stdev = standard deviation of gate voltage, and Mean = mean gate voltage). Note that all high level tests pass the required number of gates (75%) for mean value and standard deviation.

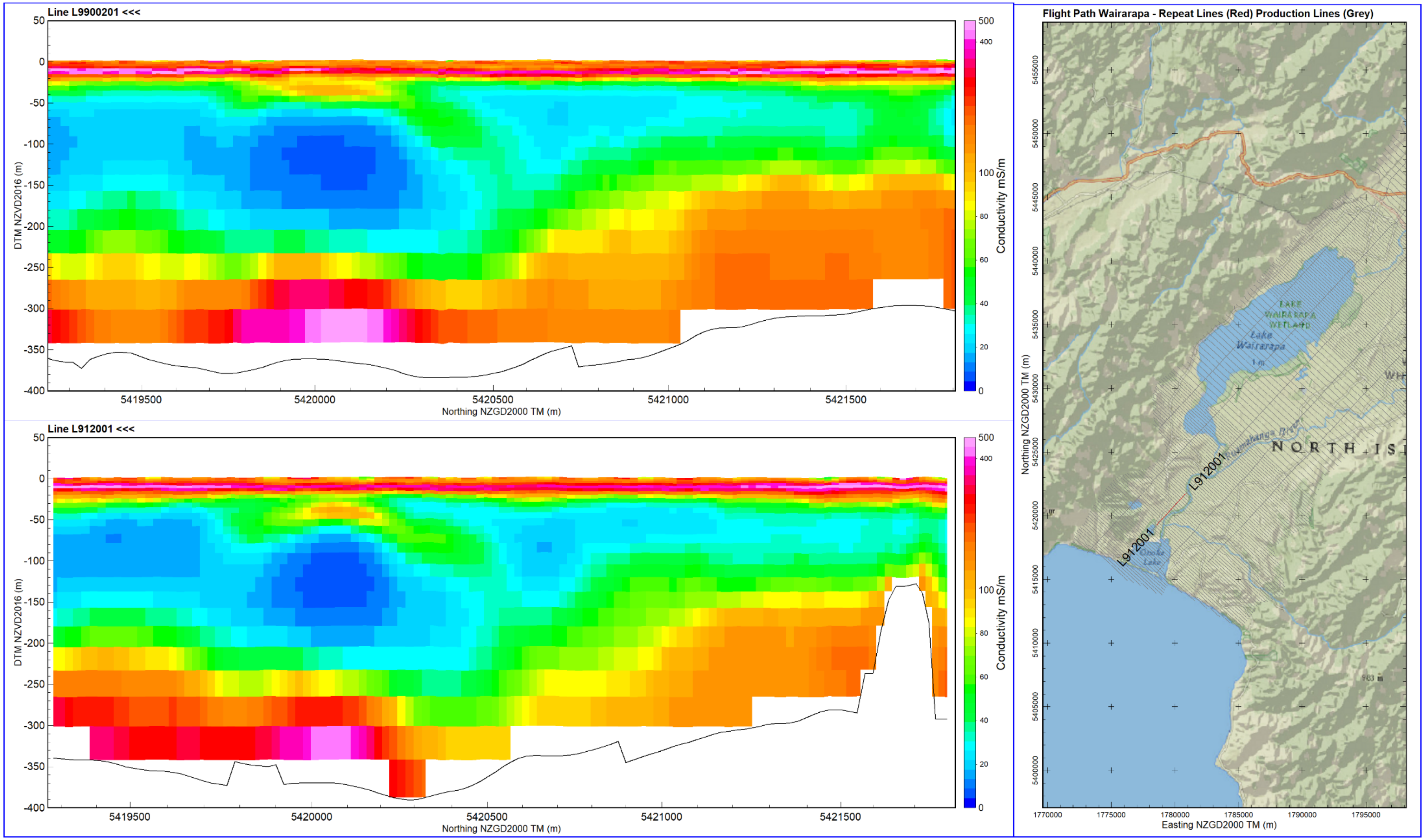
Line	LMX Stdev failed gates	LMX Mean Failed Gates	LMZ Stdev failed gates	LMZ Mean Failed Gates	HMX Stdev failed gates	HMX Mean Failed Gates	HMZ Stdev failed gates	HMZ Mean Failed Gates
913001	1	0	0	0	5	0	0	0



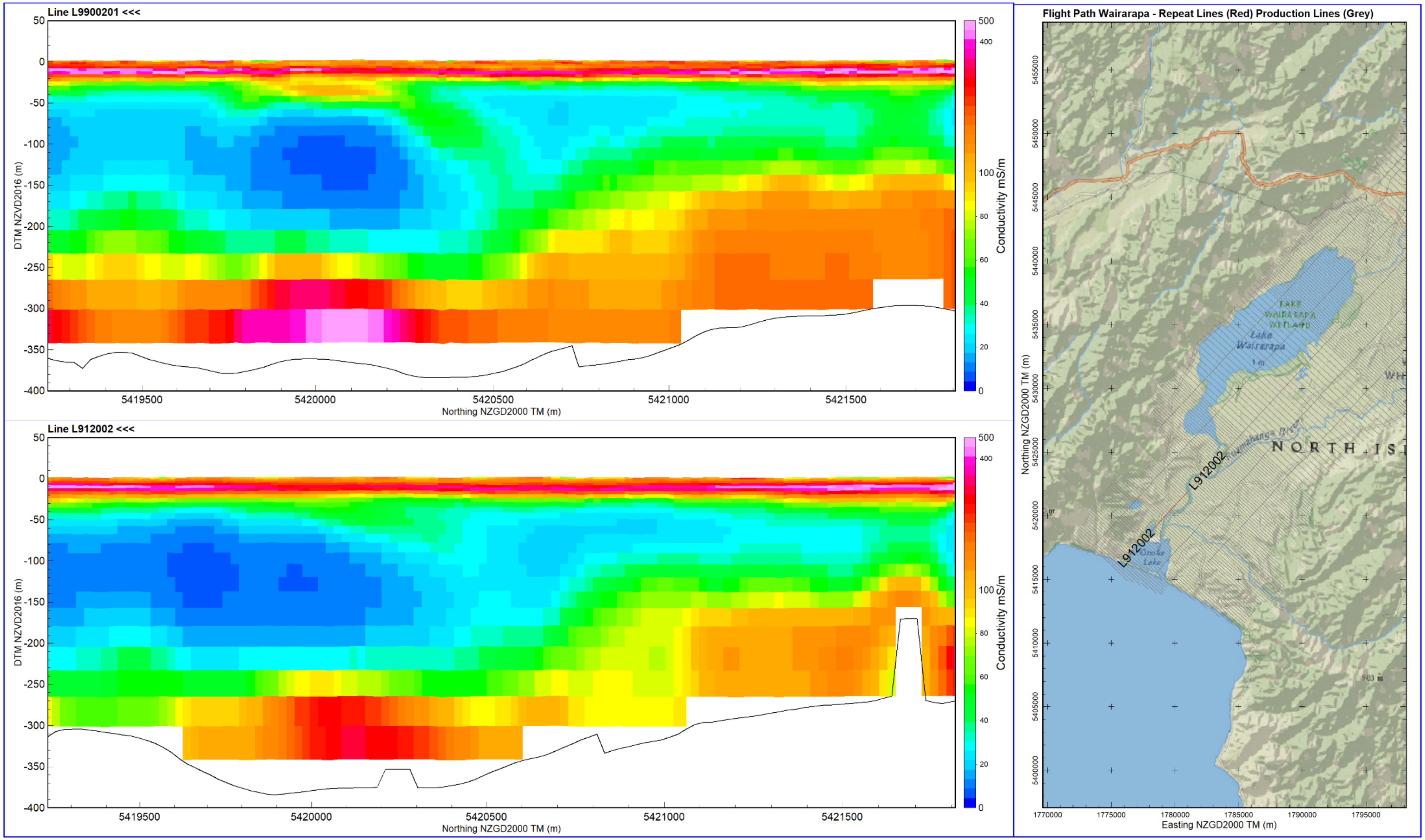
LMX, LMZ, HMX and LMZ High Level Graphs for Line 913001

Appendix D

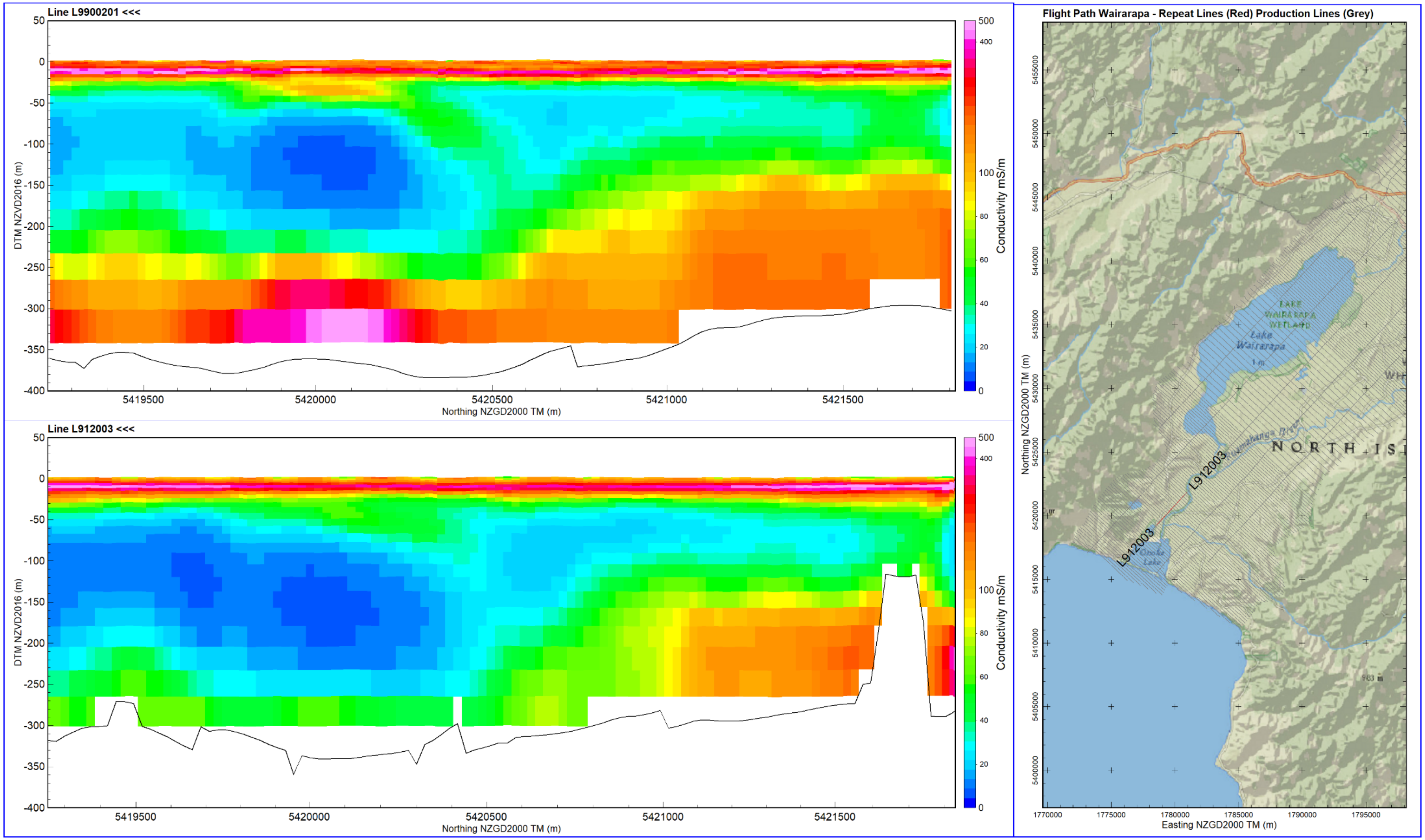
Repeat Lines



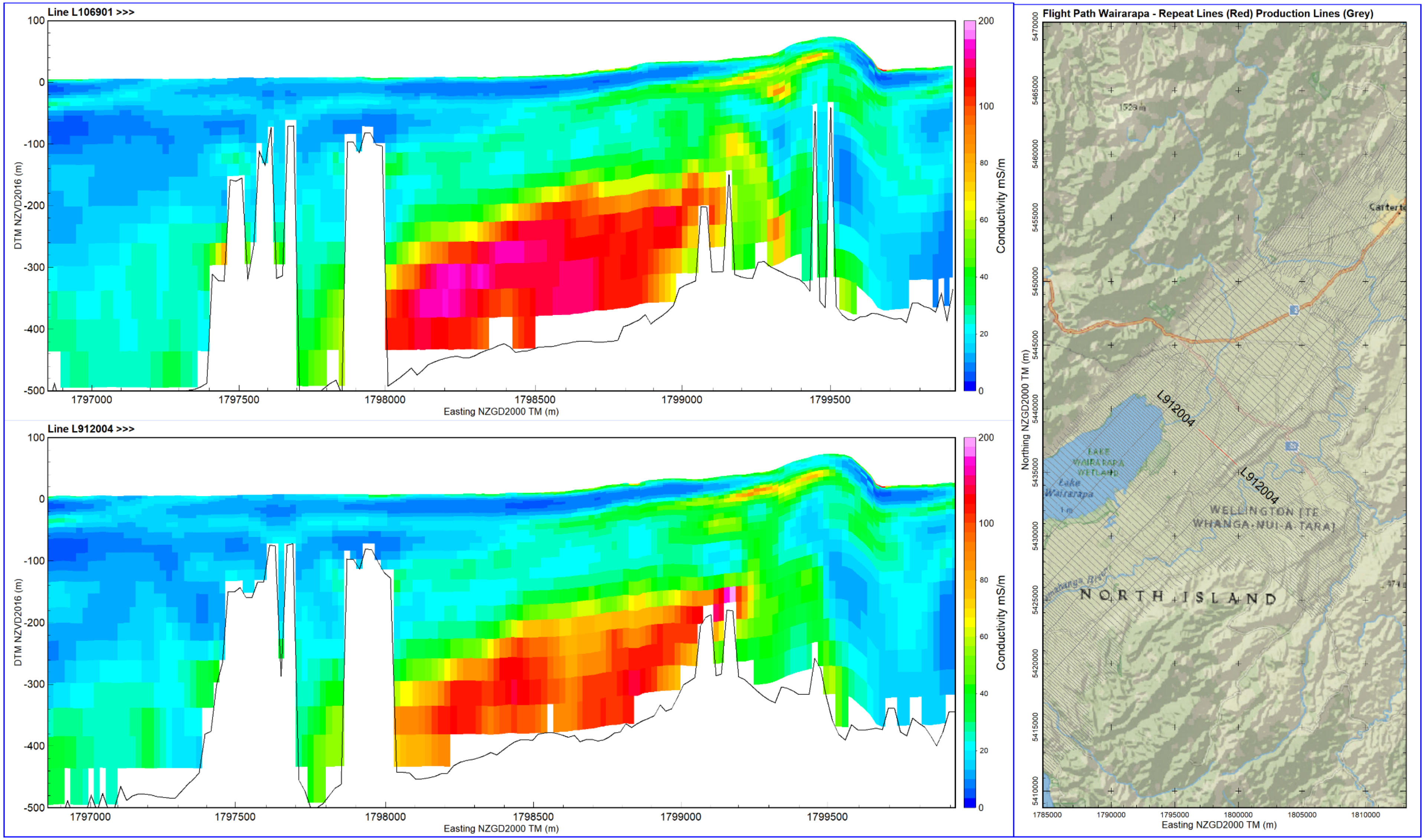
Comparison of production and repeat line conductivity sections from Wairarapa:
Top: Segment of production line 9900201. Bottom: Corresponding repeat line 912001.



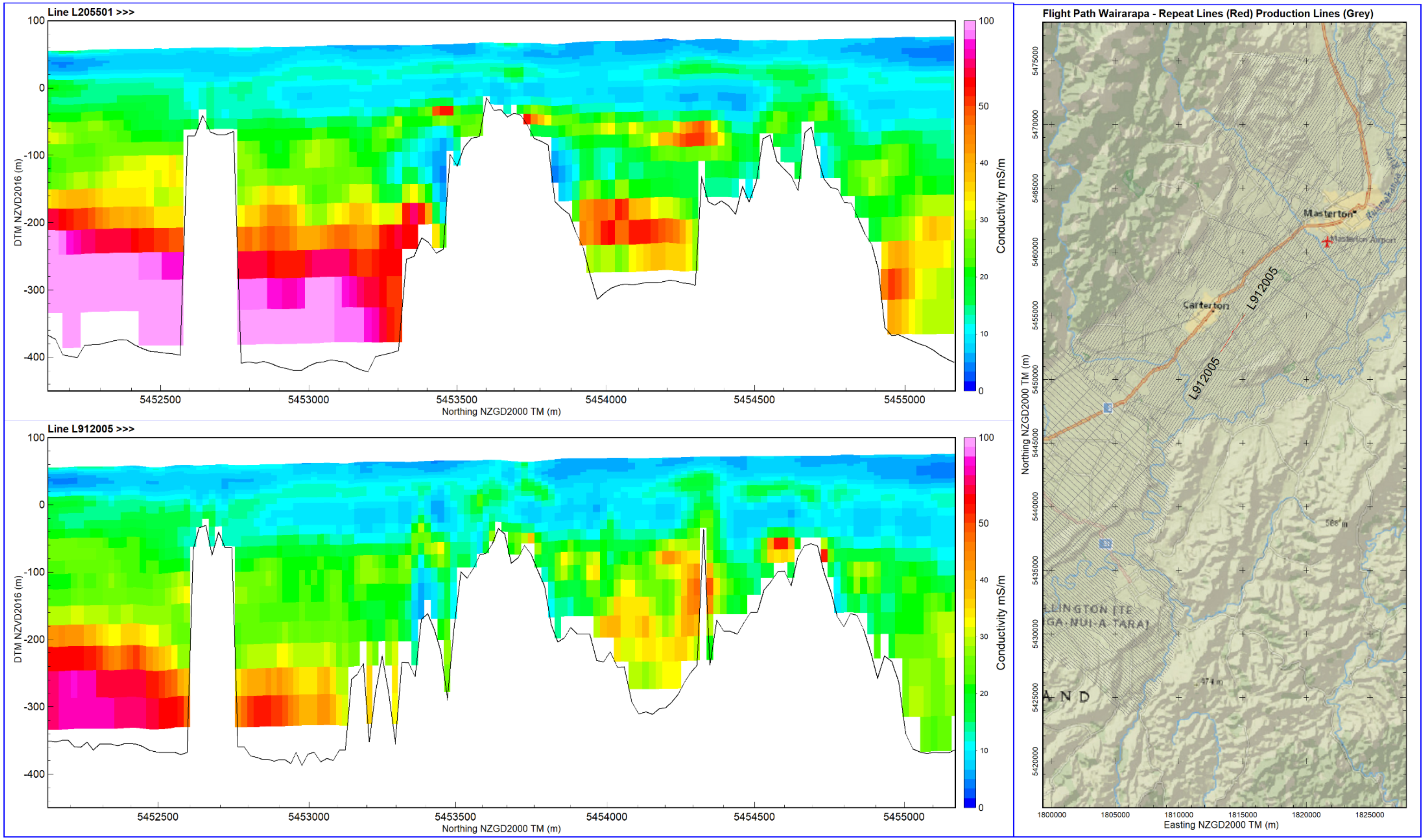
Comparison of production and repeat line conductivity sections from Wairarapa:
Top: Segment of production line 9900201. Bottom: Corresponding repeat line 912002.



Comparison of production and repeat line conductivity sections from Wairarapa:
Top: Segment of production line 9900201. Bottom: Corresponding repeat line 912003.



Comparison of production and repeat line conductivity sections from Wairarapa:
Top: Segment of production line 106901. Bottom: Corresponding repeat line 912004.



Comparison of production and repeat line conductivity sections from Wairarapa:
Top: Segment of production line 205501. Bottom: Corresponding repeat line 912005.