

# Transformation Parameters from Chatham Islands 1979 to NZGD2000

OSG Technical Report 14

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Office of the Surveyor-General

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#### **Foreword**

Land Information NZ (LINZ) was established on 1 July 1996 and took over the responsibility for the policy, regulatory and core government service delivery functions of the former Department of Survey and Land Information (DoSLI), the Land Titles Office, and for the purchase of hydrographic services from the New Zealand Defence Force. From July 1998, as part of the restructuring of Valuation New Zealand, the Office of the Valuer-General was established within LINZ.

LINZ is focused on advising Government, administering the Crown's interests in land and making Government held land information available to the public. It is the government spatial referencing authority, and the steward and standard setter for core national land databases including: the spatial referencing system, cadastral system, land titles, topography, hydrography, Crown property (excluding the conservation estate) and valuation. Its vision is to provide world class land and seabed information services.

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This technical report is issued under the authority of the Surveyor-General who is responsible for setting geodetic standards, specifications, and guidelines in accordance with departmental policy and statutory requirements.

Any comments or amendments should be forwarded to the Surveyor-General, Land Information New Zealand.

Tony Bevin Surveyor-General

# Transformation Parameters from Chatham Islands 1979 to NZGD2000

#### 1 Introduction

Land Information New Zealand has implemented a new national geodetic datum, New Zealand Geodetic Datum 2000 (NZGD2000). NZGD2000 replaces Chatham Islands 1979 datum and New Zealand Geodetic Datum 1949 (NZGD49). The new datum provides an accurate geometric reference system for New Zealand and it's areas of territorial responsibility. NZGD2000 is a geometric datum, that is the coordinates of defining stations are computed in terms of geocentric cartesian coordinates (XYZ) that are then converted to latitude, longitude and ellipsoid height in terms of the GRS80 reference ellipsoid (Pearse, 2000).

Ellipsoid parameters:

| Name                     | International        | GRS80         |
|--------------------------|----------------------|---------------|
| Semi major axis (metres) | 6378388              | 6378137       |
| 1/flattening             | 297                  | 298.257222101 |
| Reference                | DMA, 1987            | Moritz, 1980  |
| Used by                  | Chatham Islands 1979 | NZGD2000      |

The Chatham Islands 1979 datum was based on an adjustment done in 1981 of observations and measurements carried out in 1968, 1970, 1977 and 1979. The 1979 datum superseded the Chatham Islands 1971 datum. The Chatham Islands 1979 datum uses the International (Hayford) Ellipsoid with the origin defined by the astronomical position of trig Astro Station of Latitude 43° 57' 23.60" South and Longitude 176° 34' 28.65" West. Orientation is provided by the adjusted azimuth based on astronomical observations at four stations during 1968, 1970 and 1979 and is Kahunene No 2 to B Kapangatakahu of 115° 58' 47.03".

In 1976 the United States Defense Mapping Agency (DMA) occupied four stations using Doppler and computed World Geodetic System 1972 (WGS72) coordinates for them. These observations pre-dated the establishment of the Chatham Islands 1979 datum and therefore the DMA was only able to compute transformation parameters between Chatham Islands 1971 and WGS72. These WGS72 coordinates have been used to compute transformation parameters between the Chatham Islands 1979 datum and NZGD2000.

#### 2 Transformation Parameters

The four stations which are in the Chatham Islands 1979 adjustment that were observed by Doppler in 1976 are:

| Name                                   | Doppler Number  |
|--|---|
| Satellite Station West (Waitangi West) | 30536   |
| D Te Rangaapene                        | 30535   |
| Satellite Station East (Pukerakei)     | 30352   |
| Kahunene No 2                          | 30531   |
|  | Satellite Station West (Waitangi West)<br>D Te Rangaapene<br>Satellite Station East (Pukerakei) |

The WGS72 coordinates for these marks were taken from the Doppler Summary sheets supplied by the US Defense Mapping Agency (DMA) (Appendix A).

| Geodetic Code | X           | Y          | Z           |
|---------------|-------------|------------|-------------|
| BAVC          | -4604522.18 | -255539.71 | -4391382.62 |
| BAVJ          | -4582974.53 | -293725.65 | -4411454.99 |
| BAVB          | -4606032.95 | -302573.54 | -4386866.89 |
| BARW          | -4591187.37 | -274853.73 | -4404136.79 |

**Table A:** WGS72 Coordinates

The Chatham Islands 1979 coordinates for the above four stations were downloaded from the Geodetic Database on 9 May 2000.

| Geodetic Code | Latitude        | Longitude        | MSL Height |
|---------------|-----------------|------------------|------------|
| BAVC          | 43 47 29.0952 S | 176 49 26.1061 W | 30.0       |
| BAVJ          | 44 02 29.7392 S | 176 20 00.0579 W | 101.8      |
| BAVB          | 43 44 05.9367 S | 176 14 31.4105 W | 51.0       |
| BARW          | 43 57 00.9596 S | 176 34 28.2371 W | 74.69      |

**Table B:** Chatham Islands 1979 Coordinates

These coordinates (Table B) were converted to the following XYZ values (Table C) using the International Ellipsoid parameters.

| Geodetic Code | X            | Y           | Z            |
|---------------|--------------|-------------|--------------|
| BAVC          | -4604695.988 | -255514.261 | -4391489.354 |
| BAVJ          | -4583149.178 | -293700.253 | -4411563.962 |
| BAVB          | -4606206.637 | -302547.929 | -4386975.395 |
| BARW          | -4591361.640 | -274827.008 | -4404244.717 |

**Table C:** Chatham Islands 1979 Coordinates

The Chatham Islands 1979 XYZ values (Table C) were subtracted from the WGS72 XYZ values (Table A) resulting in the following difference and mean value for the stations BAVC, BAVJ and BARB. BARW is used as a check.

| Geodetic Code | dX     | dY     | dZ     |  |
|---------------|--------|--------|--------|--|
| BAVC          | 173.81 | -25.45 | 106.73 |  |
| BAVJ          | 174.65 | -25.40 | 108.97 |  |
| BAVB          | 173.69 | -25.61 | 108.50 |  |
| Average       | 174.05 | -25.49 | 108.07 |  |

#### Table D: Chatham Islands 1979 and WGS72 Coordinate differences

The DMA parameters for conversion between Chatham Islands 1971 and WGS84 are (DMA 1987):

$$Tx = 175 \text{ m}$$
,  $Ty = -38 \text{ m}$  and  $Tz = 113 \text{ m}$ .

To the average difference (Table D), which convert between WGS72 and Chatham Islands 1979, the parameters to convert between WGS72 and WGS84 were added.

| WGS72 to WGS84    |        | 2      |        |   | , | Rz<br>-0.554 |        |
|-------------------|--------|--------|--------|---|---|--------------|--------|
| Chat1979 to WGS84 | 174.05 | -25.49 | 112.57 | 0 | 0 | -0.554       | 0.2263 |

Resulting in the 7 parameters to convert from Chatham Islands 1979 to WGS84

To check the parameters were correct there was only one station available, BARW. The Chatham Islands 1979 coordinate from the GDB (Table B) was converted to WGS72 using the parameters in Table D and the difference after subtracting the DMA XYZ values (Table A) were -0.220 m in X, 1.231 m in Y, and 0.143 m in Z.

Without a modern GPS survey of the Chatham Islands control network the below parameters are considered to be the best available from current data.

|                   | Tx     | Ty     | Tz     | Rx | Ry | Rz     | Scale  |
|-------------------|--------|--------|--------|----|----|--------|--------|
|                   | m      | m      | m      | "  | "  | "      | ppm    |
| Chat1979 to WGS84 | 174 05 | -25 49 | 112 57 | 0  | 0  | -0.554 | 0.2263 |

Considering the accuracy of the Doppler coordinates and the limited number of stations used to compute these parameters they can equally be considered as the transformation parameters between Chatham Islands 1979 and NZGD2000.

#### 3 Recommendations

The recommended 7 parameter Molodenskii - Badekas transformation of coordinates from Chatham Island 1979 to NZGD2000 are based on Doppler observations. The converted coordinate accuracy is approximately ±2 metres. The parameters are:

Transformation parameters:

Translation (metres) 
$$T_x = 174.05$$
  $T_y = -25.49$   $T_z = 112.57$   
Rotation (seconds of arc)  $R_x = 0$   $R_y = 0$   $R_z = -0.554$   
Scale change (ppm)  $\Delta_s = 0.2263$ 

#### 4 Examples

| Station 1           |                |                 |
|---------------------|----------------|-----------------|
| Chatham Island 1979 | 43 45 00.000 S | 176 15 00.000 W |
| NZGD2000            | 43 44 58.262 S | 176 14 57.801 W |
|                     |                |                 |
| Station 2           |                |                 |
| Chatham Island 1979 | 44 15 00.000 S | 176 35 00.000 W |
| NZGD2000            | 44 14 58.322 S | 176 34 57.832 W |

#### References

DMA, **1987**. Supplement to Department of Defense World Geodetic System 1984 Technical Report: Part II - Parameters, Formulas, and Graphics for Practical Application of WGS84. *DMA TR 8350.2-B*, first edition, 30 September.

Moritz, H, **1980**. Geodetic reference system 1980. *Bulletin Geodesique*, Vol. 54, No. 3, pp. 395-405.

Pearse, M.B. (2000): Realisation of the New Zealand Geodetic Datum 2000. *Office of the Surveyor-General Technical Report No. 5*, Land Information New Zealand, Wellington, New Zealand.

## Appendix A

Copies of the original DMA coordinate sheets showing the WGS72 coordinates computed from the Doppler Observations.

| STATION NAME/LOCAL NUMBER                 |                 | - TA   18194 | LOCATION   | E - OBSER   |                 |            |          | DOPPLER NO.         |
|---|-----------------|--------------|--|---|-----------------|------------|----------|---------------------|
| WAITANGI WEST                             | Comps. T5/13    | STATION WES  | CH   | ATHAM ISLANI  | , NEW           | ZEALAN     | D        | 30536 '             |
| STAMPING ON MARK                          | 10 mps . 1 3/12 |              |  |   |                 |            |          |                     |
|   |                 |              |  |   |                 | OTAL SHAPE |          |                     |
| AGENCY (CAST IN MARK)                     |                 |              | Т  | YPE OF STATION  | MARK            |            |          |                     |
|   |                 |              |  | The second  |                 |            |          |                     |
|   |                 |              |  | ERVATIONS   | Track           | NC FOUL    | DMENT P  | EFERENCE POINT      |
| DHQ 014                                   | POINT ABO       | VE STATIC    | N MARK:  | T REFERENCE   |                 | AND ON     |          |                     |
| OBSERVED BY (AGENCY)                      | S               | ATELLITE     | (S) OBSERVE  | D   |                 | OF OCC     |          | 29-20               |
| DMATC                                     | 145111          | 30190        | and 302  | 00  | 13 -            | 18 JAN     | UARY 1   | 976                 |
|   |                 |              | TE-DERIVE  | D COORDINATE  |                 |            |          |                     |
| PASSES ACCEPTED DEGREES OF FREEDOM: 798   | RESIDUAL        |              | STATION SET  |   |                 | ELLIPSOID  |          | MINIMUM ELEV.       |
| 41 - FREEDOM: 798                         |                 |              | NWL 9D   |   |                 | NWL 8      | E        | 10                  |
|   |                 | ite-derived  | coordinates  | referred to stati   | on mark)        |            | ACCURA   | -                   |
| φ S 43° 47' 27"518 ·                      | λ<br>E 183      | ° 10' 3      | 5"201 '  | h   | 36.72m          |            |          | TERS IN EAC         |
| X   | Y               |              | 3  | Z   |                 |            | AXIS (   | 90% LINEAR          |
| -4 604 526.31m                            |                 | -255 53      | 4.11m -  | -4 391 3  |                 |            | ERROR)   |                     |
| (Sa                                       | tellite-derive  | d coordina   | tes of statio  | on mark transform   | ed to loca      | l datum)   |          |                     |
| φ s 43° 47' 27".494 ·                     | λ π 192         | ° 10' 3      | 511/61 .   | h   | 41.10m          |            | WGS 7    | 2 .                 |
|   | E 103           | .10 3        | J. 401   | Z   | +1. TOIII       |            | ELLIPS   |                     |
| × -4 604 522.18m                          | , ·             | -255 53      | 9.71m ·  | -4 391 3  | 82.62m          | ,          | WGS 7    | 2 .                 |
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|   |                 |              |  |   |                 |            |          |                     |
|   | GROUN           | D SURVEY     | COORDIN.   | ATES OF STATIO  |                 |            |          |                     |
| φ   | λ Ε 192         | ° 10' 3      | 2110024  | CHATHAM 19  |                 |            | ELLIPS   | IATIONAL .          |
| s 43° 47' 29".1019                        |                 |              |  | DATE DATE   |                 | TION OF S  |          |                     |
| DATE OF ADJUSTMENT ORDER                  | DEPT            |              | S & SURV   |   |                 | ZEALAN     |          |                     |
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| 28.2m                                     | MSL             | •            |  |   |                 |            |          |                     |
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| ORDER (ELEV.) ESTABLISHED BY DEPT OF LANI |                 |              |  |   |                 |            |          |                     |
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|   |                 |              | CTION TO L   | OCAL CONTROL  | ) AZ FRO        | M NORTH    |          | DISTANCE            |
| DEPT OF LANI                              |                 | CONNEC       | CTION TO L   | OCAL CONTROL  |                 | M NORTH    |          | DISTANCE            |
| DEPT OF LANI                              |                 | CONNEC       | CTION TO L   | OCAL CONTROL  |                 | M NORTH    |          | DISTANCE            |
| DEPT OF LANI                              |                 | CONNEC       | CTION TO L   | OCAL CONTROL  |                 | M NORTH    |          | DISTANCE            |
| DEPT OF LANI                              |                 | CONNEC       | CTION TO L   | OCAL CONTROL  |                 | M NORTH    |          | DISTANCE            |
| DEPT OF LANI                              |                 | CONNEC       | CTION TO L   | OCAL CONTROL  |                 | M NORTH    |          | DISTANCE            |
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| DEPT OF LANI                              |                 | CONNEC       |  | OTHER REL   | ) AZ FRO        | A FOR T    |          | ION<br>FION/REMARKS |
| DEPT OF LANI                              |                 | CONNEC       | STATION OCC  | OTHER REL   | ) AZ FRO        | A FOR T    | LOCA     | ION<br>FION/REMARKS |
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BAVC: Satellite Station West

|            | ION NAME/LO   | CAL NUMBER  |            |  | LOCATION   |   |  |  | DOPPLER NO.  |
|------------|---------------|-------------|------------|--|--|---|--|--|--|
| DI         | TE RANGAA     | PENE -      |            |  | OWENGA   | , CHATHAM I   | ISLAND, NEW  | ZEALAND  | 30535 ·  |
| STAMP      | PING ON MAR   | K           |            |  |  |   |  |  |  |
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|            |               |             |            | DOF  | PLER OBSI  | ERVATIONS   |  |  |  |
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| REMA       |               | М           |            | ТО   | GEODETIC IN<br>STATION DES<br>SURVEY DIAC<br>STATION SIT<br>PHOTOIDENT               | DATA CUPATION REPORT FORMATION REPOR SCRIPTION GRAM TE SKETCH IFICATION C COORDINATES | AVAIL.   | OR THIS STATE LOCAL DMA  | TION TION/REMARKS TC TC  |
| REMA       |               | М           |            | ТО   | GEODETIC IN<br>STATION DES<br>SURVEY DIAC<br>STATION SIT<br>PHOTOIDENT<br>ASTRONOMIC | DATA CUPATION REPORT FORMATION REPOR SCRIPTION GRAM TE SKETCH IFICATION C COORDINATES | ) AZ FROM NO   | DMA  | TION TION/REMARKS TC TC  |
| PREP       |               | ATE         | CHECK      | TO ED BY/DATE  | GEODETIC IN STATION DES SURVEY DIAC STATION SIT PHOTOIDENT ASTRONOMIC STATION PHO    | DATA CUPATION REPORT FORMATION REPOR SCRIPTION GRAM TE SKETCH IFICATION C COORDINATES | DAZ FROM NO  | DMA  DMA  DMA  DMA  DMA  CHECKED   | TION TION/REMARKS TC TC TC   |

BAVJ: D Te Rangaapene

| STATION NAME/LOCAL NUMBER PUKERAKEI DOSU SATELLITE STATION EAST |                            |                        | KAINGAROA, CHATHAM ISLAND, NEW Z                                     |   |                     |                      |          | 7FAT AN              | DOPPLER NO           |  |
|---|----------------------------|------------------------|--|---|---------------------|----------------------|----------|----------------------|----------------------|--|
| STAMPING ON MARK  | omps T5/13                 |                        | KAINGAN  | OA, CI  | INTIMIT I           | JUNIO                | , 11011  | ZILICLER             | 9 30332              |  |
| NONE  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| AGENCY (CAST IN MARK)   |                            |                        |  |   | STATION M           |                      | 011 77 0 | II DEC               |                      |  |
| NONE  |                            |                        |  |   | IN CENTE            | R OF                 | 2 A 2    | . FEG                |                      |  |
|   | Lunia                      |                        | PPLER OBS  |   |                     | TRACK                | ING FOIL | PMFNT R              | EFERENCE POI         |  |
| DHO 014   | DHQ 014 POINT ABOVE STATIC |                        |  | G EQUIPMENT REFERENCE ON MARK: 1.123m '                                   |                     | RED BAND ON ANTENNA  |          |                      |                      |  |
|   |                            |                        | (S) OBSERVED   |   |                     | PERIOD OF OCCUPATION |          |                      |                      |  |
| DMATC -   |                            | 30190                  | and 3020   | 0 '   |                     | 7 - 1                | 3 JANU   | JARY 19              | 76 -                 |  |
|   |                            | SATELL                 | ITE-DERIVE   |   |                     |                      |          |                      |                      |  |
| PASSES ACCEPTED DEGREES OF                                      | RE                         | SIDUAL RMS             | STATION SE   |   | GRAVITY MO          |                      |          |                      | ANGLE: 100           |  |
| 44 - FREEDOM: 8   |                            |                        | NWL 9D   |   |                     |                      | NWL 8    | SE -                 | 100                  |  |
|   | (                          | Satellite-derive       | d coordinate:  | s referre   | d to station        | n mark)              |          |                      |                      |  |
| φ a /20 //1 0/11201   | λ                          | 183° 45 <b>'</b> 2     | niinen .   | h   |                     |                      | 5.91m ′  |                      | 1.5 METERS IN EA     |  |
| s 43° 44' 04"301  | Y                          | 103 43 2               | . 9 . 900  | 7   |                     |                      |          |                      |                      |  |
| -4 606 037.14m  |                            | -302 56                | 7.98m  | -   | 386 870             | ).52m                |          | ERROR).              |                      |  |
| , 000 037.1411  |                            | derived coordin        |  |   |                     |                      |          |                      |                      |  |
| φ   | lλ                         |                        |  | h   |                     |                      |          | DATUM                |                      |  |
| s 43° 44' 04"277  | · E                        | E 183° 45' 30"240      |  |   | 61.29m              |                      |          | WGS 72               |                      |  |
| X   | Y                          | 200 5                  | 70 51 -  | Z,  |                     |                      |          | ELLIPSOID            |                      |  |
| -4 606 032.95m  |                            | -302 573.              |  | -   | -4 386 866.89m '    |                      |          | WGS 72               |                      |  |
| Δχ  | ΔΥ                         | ΔΥ                     |  | ΔZ  | Δz                  |                      |          | DATE                 | r I KANSFORMA        |  |
|   |                            | ROUND SURVE            | V COORDIN  | ATESO   | F STATION           | MARK                 |          |                      |                      |  |
| 4   | lλ                         | KOOND SURVE            | COOKDIN  |   | M (HORIZON          |                      |          | ELLIPS               | OID                  |  |
| s 43° 44' 05".9334  |                            |                        |  | 1   | CHATHAM 1971        |                      |          | INTERNATIONAL ·      |                      |  |
| DATE OF ADJUSTMENT ORDER  |                            | PT OF LANI             |  |   |                     |                      | TION OF  |                      | DATA                 |  |
| ELEVATION (H) 51.1m   |                            | DATUM (VERTICAL) MSL - |  | GEOIC   | GEOID HEIGHT (N)    |                      |          | ELLIPSOID HEIGHT (h) |                      |  |
| ORDER (ELEV.) ESTABLISHED DEPT OF LA                            |                            | SURVEYS .              | ATE  | SOURC   | CE OF (N)           |                      |          |                      |                      |  |
|   |                            |                        | CTION TO L   | OCAL  | CONTROL             |                      |          |                      |                      |  |
|   |                            | то                     |  | (   |                     | ) AZ FROM NORT       |          | H DISTANCE           |                      |  |
| FROM  | 1                          |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  |   |                     |                      |          |                      |                      |  |
| FROM  |                            |                        |  | OT  | HER RELA            | TED DA               | TA FOR T |                      | TON                  |  |
|   |                            |                        |  | OT<br>DATA  |                     | TED DAT              |          | HIS STAT             | TION<br>TION/REMARKS |  |
|   |                            |                        | STATION OC   | DATA  | REPORT              | T                    | IL.      | HIS STAT             | TION/REMARKS         |  |
|   |                            |                        | GEODETIC IN  | DATA<br>CUPATION<br>NFORMATION  | REPORT<br>ON REPORT | AVA                  | IL.      | HIS STAT             | TION/REMARKS         |  |
|   |                            |                        | GEODETIC IN  | DATA CUPATION NFORMATION SCRIPTION  | REPORT<br>ON REPORT | AVA                  | IL.      | HIS STAT             | TION/REMARKS         |  |
|   |                            |                        | GEODETIC IN<br>STATION DE<br>SURVEY DIA                              | DATA CUPATION NFORMATION SCRIPTION GRAM                                   | REPORT<br>ON REPORT | X                    | IL.      | LOCA DMAT            | TION/REMARKS<br>C    |  |
|   |                            |                        | GEODETIC IN<br>STATION DE<br>SURVEY DIA<br>STATION SIT               | DATA CUPATION NFORMATIO SCRIPTION GRAM TE SKETCH                          | REPORT ON REPORT    | AVA                  | IL.      | HIS STAT             | TION/REMARKS<br>C    |  |
|   |                            |                        | GEODETIC IN<br>STATION DE<br>SURVEY DIA<br>STATION SIT<br>PHOTOIDENT | DATA CUPATION NFORMATION SCRIPTION GRAM TE SKETCH                         | REPORT<br>ON REPORT | X                    | IL.      | LOCA DMAT            | TION/REMARKS<br>C    |  |
|   |                            |                        | GEODETIC IN<br>STATION DE<br>SURVEY DIA<br>STATION SIT               | DATA CUPATION NFORMATIC SCRIPTION GRAM TE SKETCH TEIGATION C COORDIN      | REPORT<br>ON REPORT | X                    | IL.      | HIS STAT LOCA DMAT   | TION/REMARKS<br>C    |  |
|   |                            |                        | GEODETIC IN STATION DE SURVEY DIA STATION SI PHOTOIDENT ASTRONOMIO   | DATA CUPATION NFORMATIC SCRIPTION GRAM TE SKETCH TEIGATION C COORDIN      | REPORT<br>ON REPORT | X                    | IL.      | LOCA DMAT            | TION/REMARKS<br>C    |  |
|   | CHEC                       | KED BY/DATE            | GEODETIC IN STATION DE SURVEY DIA STATION SI PHOTOIDENT ASTRONOMIO   | DATA CUPATION NEORMATIC SCRIPTION GRAM TE SKETCH TEIGATION C COORDIN OTOS | REPORT<br>ON REPORT | X                    |          | HIS STAT LOCA DMAT   | C<br>C<br>C          |  |

BAVB: Satellite Station East

| KAHUNENE NO. 2  TAMPING ON MARK NONE  GENCY (CAST IN MARK) NONE  QUIPMENT/SERIAL NO. DHQ 014 \ BSERVED BY (AGENCY) DMATC \  SSES ACCEPTED DEGREES OF FREEDOM: 835  S 43° 56' 59"377 \ -4 591 191.51m \( (Soft) )  S 43° 56' 59"377 \( (Soft) ) | HEIGHT OF TRACKIN POINT ABOVE STATIC  SATELLITE 30190  SATELLITE 40190  SATELLITE 70190  SA | PPLER OBS G EQUIPMEN ON MARK: and 3020 ITE-DERIVE STATION SE NWL 9D d coordinate: 33.166   | 1.125m ED OO  ED COORDINAT: IT GRAVITY NWL  s referred to sta  h  Z  -4 404 on mark transform   | TRACKING RED BAI PERIOD C 23 - 2 ES MODEL EL LOE   | 5 EQUIP<br>ND ON<br>F OCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  CCY ETERS IN EA   |  |
|--|--|--|---|--|---|--|---|--|
| NONE  GENCY (CAST IN MARK)  NONE  QUIPMENT/SERIAL NO. DHQ 014 ~  BSERVED BY (AGENCY)  DMATC ~  SSES ACCEPTED   DEGREES OF FREEDOM: 835  S 43° 56' 59"377 ~  -4 591 191.51m /  (Sat.  S 43° 56' 59"353 ~  -4 591 187.37m ~  | HEIGHT OF TRACKIN POINT ABOVE STATIC  SATELLITE 30190  SATELLITE 40190  SATELLITE 70190  SA | G EQUIPMEN ON MARK:  (S) OBSERVE and 302( ITE-DERIVE STATION SE  NWL 9D  d coordinate:  33.166  48.17m  ates of stati  | IRON PIPE ERVATIONS IT REFERENCE 1.125m  DO  OO  ED COORDINATI T GRAVITY NWL  s referred to sta  h  Z  -4 404  on mark transform h  | TRACKING RED BAI PERIOD C 23 - 2. ES MODEL EL 10E . It in mark)  80.28m  | ND ON<br>FOCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  ANGLE: 10°  CCY ETERS IN EA   |  |
| NONE  QUIPMENT/SERIAL NO. DHQ 014 - BSERVED BY (AGENCY) DMATC .  SSES ACCEPTED DEGREES OF FREEDOM: 835  S 43° 56' 59".3774 591 191.51m ' (Sat.  S 43° 56' 59".3534 591 187.37m -   | HEIGHT OF TRACKIN POINT ABOVE STATIC  SATELLITE 30190  SATELLITE 40190  SATELLITE 70190  SA | G EQUIPMEN ON MARK:  (S) OBSERVE and 302( ITE-DERIVE STATION SE  NWL 9D  d coordinate:  33.166  48.17m  ates of stati  | IRON PIPE ERVATIONS IT REFERENCE 1.125m  DO  OO  ED COORDINATI T GRAVITY NWL  s referred to sta  h  Z  -4 404  on mark transform h  | TRACKING RED BAI PERIOD C 23 - 2. ES MODEL EL 10E . It in mark)  80.28m  | ND ON<br>FOCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  ANGLE: 10°  CCY ETERS IN EA   |  |
| QUIPMENT/SERIAL NO. DHQ 014 ~ BSERVED BY (AGENCY) DMATC ~  SSES ACCEPTED DEGREES OF FREEDOM: 835  S 43° 56' 59".377 ~  -4 591 191.51m / (Sat.  S 43° 56' 59".353 ~  -4 591 187.37m ~   | HEIGHT OF TRACKIN POINT ABOVE STATIC  SATELLITE 30190  SATELLITE 40190  SATELLITE 70190  SA | G EQUIPMEN ON MARK:  (S) OBSERVE and 3020  ITE-DERIVE STATION SE NWL 9D d coordinate:  33.166  48.17m totes of stati  33.426   | ERVATIONS IT REFERENCE 1.125m  DO  OO  ED COORDINATI IT GRAVITY  NWL  s referred to sta  h  Z  -4 404  on mark transform  h   | RED BAI PERIOD C 23 - 2 ES MODEL   EL IOE   1 tion mark) 80.28m 140.42m med to local decay.  | ND ON<br>FOCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  CCY ETERS IN E. (90% LINEA)   |  |
| DHQ 014 \ BSERVED BY (AGENCY) DMATC \  SSES ACCEPTED   DEGREES OF FREEDOM: 835  S 43° 56' 59"377 \ -4 591 191.51m \( (Soft) )  | HEIGHT OF TRACKIN POINT ABOVE STATIC  SATELLITE 30190  SATELLITE 40190  SATELLITE 70190  SA | G EQUIPMEN ON MARK:  (S) OBSERVE and 3020  ITE-DERIVE STATION SE NWL 9D d coordinate:  33.166  48.17m totes of stati  33.426   | TREFERENCE  1.125m  ED  COORDINATI  TO  GRAVITY  NWL  s referred to sta  h  Z  -4 404  on mark transform  h   | RED BAI PERIOD C 23 - 2 ES MODEL   EL IOE   1 tion mark) 80.28m 140.42m med to local decay.  | ND ON<br>FOCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  CCY ETERS IN E. (90% LINEA)   |  |
| DHQ 014 \ BSERVED BY (AGENCY) DMATC \  SSES ACCEPTED   DEGREES OF FREEDOM: 835  S 43° 56' 59"377 \ -4 591 191.51m \( (Soft) )  | SATELLITE 30190  SATELLITE 30190  SATELLITE 30190  SATELLITE 30190  SATELLITE 30190  Concept Service State of the service of t | and 3020  TE-DERIVE  STATION SE  NWL 9D  d coordinates  33.166  48.17m  the sof station  33.426  | 1.125m ED OO  ED COORDINAT: IT GRAVITY NWL  s referred to sta  h  Z  -4 404 on mark transform   | RED BAI PERIOD C 23 - 2 ES MODEL   EL IOE   1 tion mark) 80.28m 140.42m med to local decay.  | ND ON<br>FOCCU<br>8 JAN<br>LIPSOID<br>NWL 8   | ANTER UPATION UARY ACCURA 1.5 MI AXIS ERROR  | MINIMUM ELEVANGLE: 10°  CCY ETERS IN E. (90% LINEA)   |  |
| DMATC \ SSES ACCEPTED   DEGREES OF FREEDOM: 835  S 43° 56' 59".3774 591 191.51m / (Sort) S 43° 56' 59".3534 591 187.37m  | 30190  SATELLI RESIDUAL RMS 0.23m  (Satellite-derived   \[ \text{L 183}^\circ 25\] \]  Y  -274 84  ellite-derived coordina  \[ \text{E 183}^\circ 25\] \]  Y  -274 85  | and 3020 ITE-DERIVE STATION SE NWL 9D d coordinate: 48.17m ates of stati   | DOON SEED COORDINATION OF THE PROPERTY OF THE | 23 - 2  ES  MODEL EL  10E 1  tion mark)  80.28m  140.42m  ned to local a   | 8 JAN   | ACCURA 1.5 MI AXIS ERROR   | MINIMUM ELECANGLE: 10°  CCY ETERS IN E. (90% LINEA)   |  |
| SSES ACCEPTED   DEGREES OF FREEDOM: 835    S 43° 56' 59".377   -4 591 191.51m   (Sort S 43° 56' 59".353   -4 591 187.37m   | SATELLI RESIDUAL RMS 0.23m (Satellite-derived  X E 183° 25' 3 Y -274 84 ellite-derived coordina X E 183° 25' 3 Y -274 85   | STE-DERIVE STATION SE NWL 9D d coordinate: 33.166 548.17m cates of station 33.426  | ED COORDINAT: T GRAVITY NWL s referred to sta h Z -4 404 on mark transfort  | MODEL ELL 10E 1 10m mark) 80.28m 140.42m 1140.42m 1140.42m   | NWL 8   | ACCURA 1.5 MI AXIS ERROR   | MINIMUM ELEVANGLE: 10°  CCY ETERS IN E.  (90% LINEAL  |  |
| 45 \ FREEDOM: 835  S 43° 56' 59!'377 \ -4 591 191.51m \( (Sat) \) S 43° 56' 59!'353 \ -4 591 187.37m \( \)   | RESIDUAL RMS 0.23m (Satellite-derived)  E 183° 25' 3  Y  | NWL 9D d coordinate: 33.166 18.17m ates of stations at the sta | RAVITY NWL s referred to sta h Z -4 404 on mark transfort   | MODEL   EL   10E   1   110n mark) 80.28m 140.42m 140.42m   | NWL 8   | ACCURA 1.5 MI AXIS ERROR   | ANGLE: 10°  CCY  ETERS IN E.  (90% LINEA  |  |
| 45 \ FREEDOM: 835  S 43° 56' 59!'377 \ -4 591 191.51m \( (Sat) \) S 43° 56' 59!'353 \ -4 591 187.37m \( \)   | 0.23m · (Satellite-derived)  λ E 183° 25' 3  Υ   | NWL 9D d coordinate: 33.166 - 48.17m dess of station 33.426  | NWL s referred to state h Z   | 10E \ 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  | NWL 8   | ACCURA 1.5 MI AXIS ERROR   | ANGLE: 10°  CCY  ETERS IN E.  (90% LINEA  |  |
| S 43° 56' 59"377 -  -4 591 191.51m ' (Sot.  S 43° 56' 59"353 -  -4 591 187.37m '   | (Satellite-derived  \[ \lambda \] E 183° 25' 3 \[ Y \cdots \] -274 84  ellite-derived coordina \[ \lambda \] E 183° 25' 3 \[ Y \] -274 85 \[ \Delta \]   | d coordinate: 33".166  | s referred to state h   Z   | 80.28m 140.42m med to local d  |   | ACCURA<br>1.5 MI<br>AXIS (<br>ERROR)   | ETERS IN EA   |  |
| S 43° 56' 59"377 '  -4 591 191.51m '  (Sot.  S 43° 56' 59"353 .  -4 591 187.37m .  | λ E 183° 25' 3 Υ   | 33".166 ~ 48.17m orders of station 33".426   | h Z -4 404 on mark transfor   | 80.28m<br>140.42m<br>ned to local d  |   | 1.5 MI<br>AXIS<br>ERROR  | ETERS IN EA   |  |
| S 43° 56' 59"377 '  -4 591 191.51m '  (Sot.  S 43° 56' 59"353 .  -4 591 187.37m .  | E 183° 25' 3 Y .   | 48.17m ates of stati   | Z -4 404 :  | 140.42m <sup>*</sup><br>med to local d   |   | 1.5 MI<br>AXIS<br>ERROR  | ETERS IN EA   |  |
| -4 591 191.51m ′ (Sat.<br>S 43° 56' 59!'353 ·<br>-4 591 187.37m ·  | Y . —274 84 ellite-derived coordina  \( \lambda \) E 183° 25' 3  \( \lambda \) —274 85 \( \Delta \tag{Y} \)  | 48.17m ates of stati   | Z -4 404 on mark transform  | 140.42m <sup>*</sup><br>med to local d   |   | AXIS<br>ERROR  | (90% LINEAR   |  |
| -4 591 191.51m ′ (Sat.  S 43° 56' 59!'353 ·  | -274 84 ellite-derived coordina λ E 183° 25' 3 Υ -274 85   | ates of stati  | on mark transform   | med to local d   |   | ERROR)   |   |  |
| (Sat. S 43° 56' 59".353 · -4 591 187.37m ·   | ellite-derived coording  \[ \lambda \]  E 183° 25' 3  Y -274 85  \[ \Delta \gamma \]   | ates of stati  | on mark transform   | med to local d   |   |  | 1.  |  |
| S 43° 56' 59".353 · -4 591 187.37m ·   | λ E 183° 25' 3 Υ   | 33"426   | h Z   |  | 1   |  |   |  |
| S 43° 56' 59".353 · -4 591 187.37m ·   | E 183° 25' 3 Υ -274 85   |  | Z   | 84.66m   | 37  | DATUM  |   |  |
| -4 591 187.37m ·   | Υ –274 85<br>ΔΥ  |  |   | O F. COM   |   | WGS 72   |   |  |
|  | -274 85<br>ΔΥ  | 53.73m ·   |   |  |   | ELLIPS   | 4   |  |
|  | ΔΥ   | , . , . ,  | -4 4114   | -4 404 136.79m   |   |  | WGS 72 ·  |  |
| X  |  |  | ΔZ  |  |   | DATE OF TRANSFORMA   |   |  |
|  |  |  | 142   |  |   |  |   |  |
|  | GROUND SURVE   | Y COORDIN  | ATES OF STAT  | ON MARK  |   |  |   |  |
|  | λ  |  |   | DATUM (HORIZONTAL)   |   |  | OID   |  |
| S 43° 57' 00".9587 ·   | E 183° 25' 3   | 31"7642  | CHATHAM   | CHATHAM 1971   |   |  | INTERNATIONAL '   |  |
| ATE OF ADJUSTMENT ORDER  | SURVEY BY (AGENCY)   |  | DATE  |  | -   |  |   |  |
| 4th  | DEPT. OF LANDS   |  | RVEYS 1970  | DEPT.  | OF LA   | NDS A  | ND SURVEYS  |  |
| LEVATION (H)   | DATUM (VERTICAL)   |  |   | GEOID HEIGHT (N)   |   |  | OID HEIGHT (h)  |  |
| 73.27m ' .   | MSL ~  |  |   |  |   |  |   |  |
| RDER (ELEV.) ESTABLISHED BY (  | AGENCY) D  | ATE  | SOURCE OF (N  | )  |   |  |   |  |
| EVELS - DEPT. OF LAND  |  |  | 1   |  |   |  |   |  |
|  | CONNE  | CTION TO L   |   |  |   | -  |   |  |
| FROM   | TO<br>KAPANGATAKAHU  |  | GEODETIC ) AZ   |  | Z FROM NORTH  |  | DISTANCE  |  |
| 30531  |  |  | 295° 58' 56".   |  |   |  |   |  |
|  |  |  |   |  |   |  |   |  |
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|  |  |  |   |  |   |  |   |  |
| <u> </u>   | L  |  | OTHER DE  | ATED DATA  | FOR TH  | HIS STAT   | ION   |  |
| EMARKS   |  |  |   |  |   |  | TION/REMARKS  |  |
|  | STATION OCC  |  |   |  |   |  |   |  |
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|  |  | _  |   |  |   | DMARK  | 2   |  |
|  |  |  |   | The state of the s | -   |  |   |  |
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|  |  |  |   |  |   | -  |   |  |
|  |  |  |   | V V  |   | TXX A ma   | C   |  |
|  |  | STATION PHO  | 0.03  | X  | 111   | DMAT   | C   |  |
|  | CHECKED BY/DATE  | 1  | REVISED BY/DA   | TF   | Сн  | ECKED F  | BY/DATE   |  |
| DEDARED BY /DATE   |  |  | THE TOUR DITOR  |  |   | AHTC/B   |   |  |
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