

Specification for Order 5 Geodetic Survey

National Geodetic Office

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Terms and definitions

For the purposes of this specification, the following terms and definitions apply.

Term/abbreviation	Definition
CORS	Continuously Operating Reference Station, eg the PositionZ stations
GNSS	Global Navigation Satellite Systems, including GPS and/or GLONASS
High Order Mark	Geodetic mark orders 0-4
Large Diameter Tube	A tube with a diameter greater than 25mm
LINZ	Land Information New Zealand
Local High Order Mark	Geodetic mark order 0-4 within the selected area
New Mark	A mark installed by the Contractor and a CSD submitted
SNAP	Survey Network Adjustment Package, is a suite of programs for adjusting the coordinates of stations in a survey network to best fit the observed data.
Upgrade Mark	A mark surveyed with a proposed Order 5 status

1 Foreword

1.1 Purpose of Specification

Section 7(1)(b) of the Cadastral Survey Act 2002 makes it a function and duty of the Surveyor-General "to maintain a national survey control system". This function has been delegated to the Chief Geodesist of the National Geodetic Office in Land Information New Zealand.

This specification was developed by the National Geodetic Office for use by contracting organisations when providing geodetic survey and maintenance services to LINZ.

1.2 Brief History of Specification

This specification is a major revision of previous National Geodetic Office Specifications and supersedes:

- Geodetic Survey, version 2.5 published 12 May 2010
- Geodetic Physical Network, version 2.5 published 12 May 2010
- Geodetic Contract Deliverables, version 1.4 published 12 May 2010

1.3 Related Rules, Standards and Specifications

The following standards, guidelines and Rules should be consulted when interpreting this specification:

- Standard for tiers, classes and orders of LINZ data – LINZS25006 (21 September 2009)
- Standard for the New Zealand survey control system – LINZS25003 (21 September 2009)
- Guideline for the provision and maintenance of the New Zealand survey control system – LINZG25704 (21 September 2009)
- Rules for Cadastral Survey 2010 (24 May 2010)

INFORMATION - Related Documents

The above standards can be obtained from:
<http://www.linz.govt.nz/geodetic/standards-publications/standards/index.aspx>

1.4 Contact Information

Chief Geodesist
National Geodetic Office
Land Information New Zealand
PO Box 5501
Lambton Quay
Wellington 6145

Phone: 04 460 0110
Email: info@linz.govt.nz

2 Introduction

2.1 Scope of this Specification

This specification defines the requirements for the provision survey control services to LINZ by contracting organisations. The requirements for physical maintenance services are specified in the Specifications for Geodetic Physical Maintenance.

2.2 Variations from this Specification

- (a) Compliance with all aspects of this specification is expected.
- (b) It is recognised that on occasions a better outcome for the survey control system may be obtained through an alternative approach. If a Contractor believes this to be the case, a variation to these specifications must be sought.
- (c) All variations must be agreed to by LINZ prior to any work being carried out.

2.3 Obtaining Specialist Maintenance Items

If unable to be supplied by the Contractor, any LINZ-specific maintenance items (such as beacons, cast iron covers and identification plaques) may be purchased from the following supplier:

Mark Dunnett
Survey Services Hawkes Bay Ltd
PO Box 3028
Hawkes Bay Mail Centre
Napier 4142

Phone: 06 844 4354
Fax: 06 844 4346
Email: mark@surveyhb.co.nz

3 General Requirements

3.1 Site Access

- (a) The Contractor must obtain permission to enter private land from the landowner/occupier prior to accessing any privately owned site.
- (b) If, after reasonable attempts, the landowner/occupier is unable to be contacted prior to private land being accessed, the Contractor must leave their contact details at the property concerned so that the landowner/occupier is aware that the site has been accessed.
- (c) The Contractor must obtain permission from the landowner and occupier to install and/or maintain marks, the site and protection structures, before any work is commenced.
- (d) The Contractor must comply with all requests from the landowner/occupier regarding access and health and safety.

INFORMATION - Site Access

Details of the land owner/occupier may be available from the LINZ Geodetic Database (see <http://www.linz.govt.nz/gdb>)

Contractors are given access to private property for the purpose of these contracts at the grace of the landowner/occupier. The landowner/occupier is entitled to place restrictions on this access, such as: defining the route/method of access, preventing access during lambing, prohibiting scrub clearance or weed spraying, requesting gates to be closed.

If a Contractor is unable to access a mark due to landowner/occupier restrictions they should advise the National Geodetic Office as soon as possible.

3.2 Health and Safety

- (a) Contractors must be fully aware of, and at all times exercise their responsibilities and obligations under, the Health and Safety in Employment Act 1992.
- (b) Sites, marks, beacons and other protection structures must be left in a respectable and safe state.

3.3 Traffic Management

- (a) Contractors must abide by the New Zealand Transport Agency and relevant local authorities Code of Practice for Temporary Traffic Management when working on or near roads.
- (b) Contractors must supply copies of all approved traffic management plans with the deliverables for this contract.

INFORMATION - Traffic Management

The deliverable requirements for providing traffic management plans are specified in section **15.9**

4 Geodetic Marks

4.1 Mark Attributes

A mark selected for upgrading to Order 5 standard must:

- (a) Be positioned to enable it to be easily located, safely occupied and observations efficiently collected,

GUIDELINE – Ease of Use

Sites should be selected considering the practicality and safety of occupying the site and the safety to the public of an unoccupied site. Factors to be considered are proximity to vehicular traffic and other known and potential hazards.

Marks close to obstructions such as fences are not acceptable due to the difficulty setting up tripods over them.

Easy access to the mark

- (b) Not be located in live traffic lanes,

GUIDELINE – Marks on Roads

The use of existing marks contained within the head of quiet urban cul-de-sac or designated parking zones are generally acceptable if all other compulsory attributes are achieved and no other suitable marks are available.

New marks must not be established on road formation.

- (c) Not be located on private land, or on public land with access restrictions, unless the mark has an existing beacon, protection structure or is an established trig,

GUIDELINE - Access

In most cases marks should be located within road reserves or other reserves that do not have access restrictions.

- (d) Be constructed and located such that it can reasonably be expected to survive and remain useable for at least 50 years,

GUIDELINE – Longevity

The location of utilities above and below ground level shall be considered when locating a geodetic mark. Where appropriate, Local Authorities and service agencies should be consulted.

Marks located in cobbled areas or between pavings are not acceptable.

- (e) Be physically located:
- (i) Flush with or above ground level if it is safe and will not pose a hazard, or
 - (ii) Buried between 0.05m and 0.30m below ground level and protected by a cast iron cover and box that is installed flush with the surrounding ground level,
 - (iii) Buried between 0.25m and 0.50m in a rural area where depth is necessary to provide protection from stock or horticulture equipment, locatable with a metal detector and indicated by a marker post, or
 - (iv) Buried less than 0.05m in a non-paved or unsealed area that does not require protection from stock or horticulture equipment and locatable with a metal detector,

GUIDELINE – Mark Depth and Protection

Marks are to be located so that they are safe when not being used (e.g. not a tripping hazard, unlikely to be damaged by mowers, etc).

New marks should not be installed above ground level. The most common “above-ground” marks are concrete benchmarks.

Marks are to be easy to locate, e.g. by metal detector, with minimal digging.

Marker posts are encouraged for marks in rural areas or where locating the mark would otherwise be difficult (e.g. in reserves or areas with few descriptive reference points).

Covers are preferred in paved or sealed areas so that the surface does not need to be disturbed and then reinstated when accessing the mark.

Marks should be raised or lowered to meet these depth and protection requirements.

- (f) Have a defined reference point for both horizontal and vertical observations that enables plumbing and heighting with a repeatability not exceeding 5mm,

GUIDELINE – Reference Point

Marks with acceptable reference points include:

- (i) Tubes, with a maximum diameter of 25mm, and where the rim of the tube is level,
- (ii) Dimples,
- (iii) Nails,
- (iv) Pins, and
- (v) Rods.

Marks need to be installed proud of the surrounding surface to enable the use of levelling staves on them.

- (g) Be sufficiently stable in terms of structure and surrounding ground so that it cannot be moved by more than 5mm in the course of normal surveying activities,

GUIDELINE - Stability

The following aspects should be considered when assessing the stability and longevity of a mark:

- (i) Order of the mark,
- (ii) Soil or rock type in which it is to be constructed,
- (iii) Ground slope,
- (iv) Impact of possible vegetation growth,
- (v) Development possibilities of the surrounding area, and
- (vi) Physical form of the mark.

- (h) Have at least 70% clear sky visibility above 15 degrees from the horizon in all directions,
- (i) Be at least 5 metres clear of obstacles such as fences and buildings that may cause multipath, and

GUIDELINE – Sky Visibility and Multipath

A mark should ideally be 20 metres clear of potential multipath sources.

A mark should ideally be clear of all obstructions above 10 degrees elevation.

The impact of expected future vegetation growth and construction around the site in the medium-term (2-5 years) should be considered in the sky visibility assessment.

- (j) Be at least 20 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

GUIDELINE – Radio Interference

A mark should ideally be 50 metres clear of sources of radio interference.

4.2 Geodetic Codes

- (a) Each mark shall be assigned a unique four-character geodetic code.
- (b) Geodetic codes shall be requested from the National Geodetic Office by the Contractor.
- (c) A mark shall retain its existing geodetic code unless:
- (i) The mark has been modified in accordance with section **10.2.1**, or
 - (ii) The height of the mark has been modified by more than 3 mm (section **10.2.2**).

4.3 Mark Names

4.3.1 Names for Existing Marks

- (a) The existing name for a mark with a geodetic code shall be retained, except that:
 - (i) All letters of the name shall be shown in upper case, however,
 - (ii) Where a Survey District forms part of the name, the Survey District name shall be enclosed in brackets, shown in sentence case, and followed by "SD".
- (b) Where an existing non-boundary mark shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan is upgraded:
 - (i) Its existing identification along with its plan number shall be used,
 - (ii) The use of "OLD" (as in OIT I) to prefix a mark name shall not be used, and
 - (iii) The latest name shown on a CSD plan shall be continued.
- (c) A single space character shall be inserted between each element of a name.

EXAMPLE - Existing Mark Names

An existing mark referred to as "Dingle Peak" should be changed to "DINGLE PEAK"

An existing mark referred to as "B MAROTIRI SD" should be changed to "B (Marotiri SD)"

An existing mark shown as "OIT IV DP 2532" on a CSD plan should be changed to "IT IV DP 2532"

An existing mark originally referred to as "IT III DP2398" but renamed to "SS 23 SO 2865" should continue to use the later name

- (d) Where a mark has an alternative name (eg a geographical location), that name shall be included in the contract deliverables.

4.3.2 Names for New Marks

- (a) New marks shall be given a unique name.
- (b) Mark names shall consist of the following components in this order:
 - (i) An abbreviation that describes the physical mark type (BP for bronze plaques, PIN for stainless steel pins),
 - (ii) A unique numeric identifier, and
 - (iii) The CSD type and number.

EXAMPLE - New Mark Names

A new bronze plaque mark shown on SO 354895 shall be named "BP 1 SO 354895"

A new stainless steel pin mark shown on SO 354897 shall be named "PIN 1 SO 354897"

4.3.3 Names for Modified Marks

- (a) Where a mark has been modified, section **10.2.1** the modified mark shall be assigned a new name.
- (b) A modified mark name shall append "NO 2" to the original name for the mark
- (c) Where a "NO 2" mark has been modified, "NO 3" shall replace "NO 2" in the mark name.
- (d) Where an original mark name is prefixed by a number or letter the number or letter is to be removed in the modified mark name.

EXAMPLE - Modified Mark Names

Where "B (Marotiri SD)" has been modified, the new mark shall be named "B (Marotiri SD) NO 2"

Where "IT IV SO 1254 NO 2" has been lowered, the new mark shall be named "IT IV SO 1254 NO 3"

Where "MT JOHN" has been modified the new mark shall be named "MT JOHN NO 2"

5 Control Survey

5.1 Mark Density

- (a) Marks must be selected to achieve the minimum mark density specified in the contract.
- (b) The selected marks must:
 - (i) Obtain full coverage of the entire area,
 - (ii) Reflect the location of existing Order 5 and High Order geodetic marks, and
 - (iii) Provide a minimum of 2 marks within every township.

5.2 Mark Selection

5.2.1 Development areas

Marks must be selected within development areas using the following preferential hierarchy:

- (a) High order NZGD1949 trigs
- (b) Bench marks
- (c) Permanent reference marks and traverse marks, shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan
- (d) Non-boundary marks shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan
- (e) New marks installed by the Contractor

GUIDELINE - NZGD1949 Trigs

High Order NZGD1949 trigs (1st, 2nd or 3rd order) are useful for constraining the control adjustments that are used to adjust cadastral networks. These trigs are shown on SO plans and normally have Order 9 coordinates.

5.2.2 Re-establishment areas

Marks must be selected within re-establishment areas using the following preferential hierarchy:

- (a) Existing Order 6 geodetic marks
- (b) A mark with a direct connection to an Order 6 geodetic mark
- (c) A mark with no more than three adopted measurements between it and a Order 6 geodetic mark
- (d) Permanent reference marks shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan
- (e) Non-boundary marks shown on an approved survey plan or approved Cadastral Survey Dataset (CSD) plan

- (f) New marks installed by the Contractor

GUIDELINE – Selection Hierarchy

Marks that already exist in Landonline should be chosen over marks that are not as less work is required by both LINZ and the Contractor to incorporate them.

All selected marks must also meet the mark attribute criteria specified in section 4.1.

5.3 Method of Survey

- (a) All control survey observations must be made using GNSS (including GPS) techniques.
- (b) The survey procedure shall include sufficient checks and redundancy to identify and mitigate potential errors, such as multipath or plumbing, and to ensure that survey accuracy can be proven. These checks shall include:
 - (i) Regularly calibrating and checking field equipment,
 - (ii) Making at least two independent setups at each mark,
 - (iii) Independently checking all field measurements,
 - (iv) Closing all network loops (i.e. no hanging lines), and
 - (v) Connecting all marks in a single network.
- (c) Successive observations at a mark may be considered independent if between observations:
 - (i) At least 20 minutes has elapsed,
 - (ii) The GNSS receiver is reinitialised (ie turned off or loss of satellites), and
 - (iii) The antenna is re-plumbed.

5.4 Connections to Higher Order Marks

- (a) Each network must be connected to High Order (Orders 0-4) geodetic marks.
- (b) High Order connections are in addition to the number of marks being upgraded.
- (c) The minimum number of High Order marks included in a network will be the higher of:
 - (i) 3 marks, or
 - (ii) 5% of the number of marks being upgraded.

EXAMPLE – Minimum number of high order mark

Example 1: If 500 marks are required to be upgraded, connections shall be made to at least 25 high order marks.

Example 2: If 10 marks are required to be upgraded, connections shall be made to at least 3 high order marks.

- (d) At least 75% of High Order marks shall be within 3km of each schedule and/or each cell area specified in the contract.

GUIDELINE – Local Connections

Where no High Order marks exist within the schedule area, or access is not reasonable, the Contractor shall explain this in the Contract Report and connect to at least one PositionNZ and/or GeoNet site.

- (e) High Order control marks contained within the schedule and or each cell area shall be evenly distributed.
- (f) Connections to existing Order 5 marks are not required.

GUIDELINE – Existing Order 5 mark

As all existing Order 5 marks are defined in terms of existing higher order control connections to neighbouring Order 5 marks are not required.

5.5 Survey Accuracy

All surveyed control marks must achieve the Order 5 accuracy standard.

GUIDELINE – Accuracy standard

The Order 5 accuracy standard is defined in LINZS25006 Standard for tiers, classes and orders of LINZ data.

The main Order 5 accuracy requirements are summarised below:

Horizontal tier	Vertical tier	Horizontal Class	Vertical Class
0.15 m	0.35 m	0.01 m + 5×10^{-5} m/m	0.02 m + 1×10^{-4} m/m

The process for assessing data accuracy is described in section 6.

5.6 Survey Information Cadastral Survey Datasets

- (a) A Survey Information Cadastral Survey Dataset (CSD) shall be submitted in Landonline that shows:
 - (i) New marks have been installed by the Contractor, and
 - (ii) Connections from new marks to the cadastre.
- (b) The CSD shall, as a minimum:
 - (i) Show ties from the new mark to at least two old non-boundary marks shown on an existing approved CSD plan (survey plan),
 - (ii) Show ties to at least one nearby non boundary mark shown on an existing approved CSD plan (survey plan),

EXAMPLE - Nearby Marks

A nearby mark is a mark located within half the specified mark density distance.

Example 1: when the selected area density is specified as 200m, a nearby mark will be one within 100m

Example 2: when the selected area density is specified as 2000m a nearby mark will be one within 1000m

Where no density is specified, a mark will be considered to be nearby if it located within the greater of:

1. half the distance of mark density required to cover the selected area or
2. 1000m

- (iii) Show sufficient measurements, calculations and/or adoptions to old marks to prove their reliability,
 - (iv) Comply with the Rules for Cadastral Survey 2010, and
 - (v) Show bearings rounded appropriately (to at least the nearest 0.01m).
- (c) Survey Information CSDs shall be submitted in the following manner:
 - (i) The Contractor shall prepare the CSD in Landonline and notify the National Geodetic Office it is ready for submission, before it is actually submitted.
 - (ii) The National Geodetic Office will check the CSD to ensure that the geodetic aspects of the CSD are compliant and advise the Contractor when this is complete.

GUIDELINE - CSD compliance

It is the contractor's responsibility to ensure that the CSD meets the requirements of the Rules for Cadastral Survey 2010 and any additional Landonline requirements. These aspects of the CSD are not checked or approved by the National Geodetic Office.

- (iii) The Contractor CSD shall then formally submit the CSD in Landonline.

- (iv) The CSD will undergo normal cadastral validation, once complete it will be "Approved as to Survey".
- (v) The Contractor shall then provide the full contract deliverables to the National Geodetic Office.

6 Accuracy Testing and Network Adjustment

6.1 Adjustment Set-Up

- (a) Network adjustment must be carried out using the latest version of the SNAP software, which may be downloaded from the LINZ website.
- (b) Each SNAP adjustment must have three input files: a command (.snp) file, a Mark Data file (see section **15.3**) and a Vector Data file (see section **15.5**).
- (c) The command file must contain the following:
 - (i) References to the Mark Data and Vector Data files, and
 - (ii) A reference to the LINZ configuration file 'gpstest'. This file is supplied with the SNAP download, and
 - (iii) A command to run the current NZGD2000 deformation model, and
 - (iv) A command to run LINZ specification tests, and
 - (v) Two commands to fix higher order stations. One to fix stations for a minimally constrained adjustment and one to fix stations for a constrained adjustment.

EXAMPLE – SNAP Command File

```
Title 2011100 Christchurch Order 5 Survey
coordinate_file LZ99999M.csv
data_file LZ99999V.csv
configuration gpstest
deformation type=velocity epoch=2000.0 model=igns98b.grd
test_specification order_5 all
!Minimally Constrained Fixed stations
fix MQZG
!Constrained Fixed stations
fix 5508 B87X MQZG
```

6.2 Observation Errors

- (a) Estimated errors appropriate for each observation must be selected by choosing an appropriate value in the METH column of the Vector Data File.
- (b) The METH value must be one of those listed in section **15.10.6**, or
- (c) Another value must be agreed in advance with LINZ

6.3 Redundancy Test

- (a) Redundancy must be tested in a minimally constrained adjustment
- (b) The redundancy number for each observation must be at least 0.1
- (c) The redundancy numbers for at least 99% of the observations in the adjustment must be at least 0.4

6.4 Observation Accuracy Test

- (a) Observation accuracy must be tested in a minimally constrained adjustment
- (b) All a priori standardised residuals for observations or individual baseline components must be less than the R_{max} value given in the table below, unless (c) applies. For degrees of freedom not listed, take the smaller of the nearest R_{max} values.

Degrees of freedom in adjustment	R_{max}
10	2.80
20	3.02
50	3.28
100	3.47
200	3.66
500	3.88
1000	4.05
2000	4.21
5000	4.41
10000	4.56

- (c) Where the a priori standardised residual for an observation or individual baseline component exceeds R_{max} , but in the Contractor's professional judgement it is not an outlier, it may be left in the adjustment, if:
 - (i) A justification for why the apparent outlier was accepted is recorded in the Contract Report, and
 - (ii) Re-weighting of the observations based on the standardised residual would not result in any local or network accuracy failures, and
 - (iii) No more than 0.5% of the observations in the adjustment exceed R_{max}

GUIDELINE – Accepting Observations Exceeding R_{max}

This should be a rare occurrence and would only be used where the standardised residual slightly exceeds R_{max} . This provision recognises that the estimates of observation errors are imperfect and this could result in observations or baseline components being incorrectly identified as outliers in the adjustment. Rather than requiring detailed re-weighting of individual observations, professional judgement may be used to accept the observation.

- (d) Error factors may be applied to bring the root-mean-square (RMS) value for each method close to 1.0, as long as:
 - (i) No error factor is less than 0.7, and
 - (ii) No error factor is greater than 1.4, and
 - (iii) All outliers have been rejected from the adjustment
- (e) The standard error of unit weight for the adjustment must be no more than 1.1

6.5 Local Accuracy Test

The local (relative) accuracy between all possible pairs of marks in the adjustment:

- (a) Must be tested in a minimally constrained adjustment, and
- (b) Must be tested for horizontal accuracy using the calculated a priori error ellipse at the 95% confidence level between the two marks, and
- (c) Must be tested for vertical accuracy using the calculated a priori vertical error at the 95% confidence level between the two marks, and
- (d) Must not exceed:
 - (i) $\sqrt{0.01^2 + (dist \times 0.00005)^2}$ m horizontally, where *dist* is the distance between the two marks, and
 - (ii) $\sqrt{0.02^2 + (dist \times 0.00010)^2}$ m vertically, where *dist* is the distance between the two marks

6.6 Network Accuracy Test

The network (absolute) accuracy for every mark in the adjustment, in terms of the fixed control:

- (a) Must be tested in a constrained adjustment, where all marks of Order 4 or better are held fixed, and
- (b) Must be tested for horizontal accuracy using the calculated a priori error ellipse at the 95% confidence level for the mark, and
- (c) Must be tested for vertical accuracy using the calculated a priori vertical error at the 95% confidence level for the mark, and
- (d) Must not exceed:
 - (i) 0.07m horizontally, and
 - (ii) 0.15m vertically

6.7 SNAP Deliverables

Evidence that the accuracy tests have been passed shall be provided by supplying:

- (a) A copy of the SNAP command (.snp) file used, and
- (b) A copy of the SNAP listing report (.lst) file for the minimally constrained and constrained adjustments

7 Field Notes and Raw Data

7.1 Information to be Retained

- (a) Field notes and Raw Data are shall to be retained by the Contractor and may be requested by LINZ.
- (b) Field notes and Raw Data shall be:
 - (i) Kept for a minimum period of 3 years, from the acceptance of the contract deliverables,
 - (ii) Collected for each RTK observation session,
 - (iii) Collected for each mark, for all other types of GNSS data, and
 - (iv) Provided in a format which is the most convenient for both LINZ and the Contractor.

GUIDELINE - Field Notes

Field notes should be records of information recorded at the time of observation. It is accepted that they may contain gross errors and uncorrected data. The corrections should be either clearly annotated or supplied as a supporting document.

Any corrections (such as heights) applied to the raw observations should be noted in the Contract Report.

7.2 Raw Data

All Raw Data shall be:

- (a) Provided in their original form, with any changes clearly provided as a separate file or as part of a hard copy document, and
- (b) Supplied for all marks surveyed (even for rejected sites or observations).

7.3 Hard Copy Field Notes

All hard copy field notes shall be:

- (a) Provided in their original form, with any changes clearly annotated, and
- (b) Signed by the Contractor.

7.4 Digital Field Notes

All digital field notes shall be provided:

- (a) In their original form, with any changes provided as a separate file, or
- (b) As part of a hard copy document.

7.5 Field Note Content

Field notes shall contain, as a minimum, the following information/observations collected in the field:

- (a) Geodetic code and mark name,
- (b) Schedule number and the cell code,
- (c) Name of operator(s),
- (d) Instrument/antenna make(s), model(s), and serial number(s),
- (e) Local date and time for the start and finish of observations,
- (f) Julian day of the year and the start and finish times of observations in terms of UTC,
- (g) Session number beginning from 0 or 1, that records the sequence of occupations at each mark per Julian day,
- (h) Logging interval and elevation cut off angle set in the receiver,
- (i) Antenna orientation (for antennae where this is not required include a statement in the Field Observation Section),
- (j) Vertical distance in metres between the top of the mark and the bottom of the GNSS antenna (ARP),
- (k) A diagram clearly showing all the measurements and constants used to compute the vertical distance in metres between the top of the mark and the bottom of the GNSS antenna,
- (l) Vertical distance in metres between the bottom of the antenna (ARP) and the phase centre (L1 and L2 if different) of the antenna,
- (m) Any eccentricities (document any eccentricities fully, including independent checks and diagrams),
- (n) Any problems experienced (eg equipment problems, battery failures, broken sessions, obstructions, or any potential multipath problems), and
- (o) Any sky-visibility restrictions or potential sources of multipath.

8 Reliability Checks

8.1 All Marks to be Proven Reliable

- (a) All existing marks that are upgraded to control marks shall be correctly identified and proven reliable.
- (b) All proof of mark reliability shall be verified as being correct in terms of this Specification by a Licensed Cadastral Surveyor.
- (c) Evidence of mark reliability shall be provided in the two forms specified in section **15.6**

GUIDELINE - Reliability Check Verification

A statement of reliability will be signed by a Licensed Cadastral Survey in the Contract Report section **15.8(e)(ii)**

8.2 Mark Reliability Requirements

- (a) NZGD1949 trigs and rural bench marks may be identified and proven reliable by visual inspection alone.
- (b) For other upgraded marks, including cadastral marks, reliability shall be proven by a obtaining a cadastral survey origin that compares:
 - (i) New measured vectors and vectors adopted from an approved cadastral plan, or
 - (ii) New measured vectors and a vector calculated from projection coordinates of 6th order or better marks.
- (c) A cadastral survey origin is shall be observed between at least:
 - (i) Three marks if terrestrial techniques are used, or
 - (ii) Two marks if GNSS techniques are used and any orientation difference on underlying surveys used in the reliability check can be independently determined.

GUIDELINE - Number of Reliability Marks

These mark numbers include the existing mark selected as a proposed control mark.

Three marks must be observed if a bearing swing is being applied to the underlying observations.

- (d) Where marks are proven reliable using adoptions from Old Cadastral survey plans or using adoptions where a bearing swing is being applied, independent verification of orientation shall be provided in the Contract Survey Report.
- (e) New measured vectors, when compared against adopted vectors or coordinate joins between Order 6 or better marks, shall not exceed the lesser of:

- (i) The tolerance specified in Section 3.1(b) of the Rules for Cadastral Survey 2010, or
 - (ii) 0.05 metres.
- (f) Where sufficient marks cannot be found or good survey practice cannot be followed the Contractor shall contact the National Geodetic Office for a solution. with the following information for a solution:
- (i) All marks that were looked for,
 - (ii) Any measurements and adoptions which have been compared,
 - (iii) The physical state of the upgraded mark, and
 - (iv) Any other evidence that supports the reliability of the mark.

GUIDELINE - Inability to Follow Good Survey Practice

In some circumstances it will not be possible to follow good survey practice when proving the reliability of marks. For example, using short origin lines or not locating sufficient old marks after extensive searching.

In this situation the Contractor should fully document the agreement with National Geodetic Office in the Contract Survey Report, the work undertaken to comply with good survey practice and provide sufficient evidence to support their conclusion that the mark surveyed is reliable. For example ties to other features or recordings on recent plans.

8.3 Orientation of Mark Reliability Check Surveys

- (a) Where GNSS has been used to prove reliability the bearings shall be considered to be in terms of NZGD2000.
- (b) If the underlying or adopted survey information is in terms of Old Cadastral or NZGD1949 bearings, then comparisons and checks shall be based on distances and angles.

GUIDELINE - Reliability Check Orientation

Distances and angles are independent of datum, as such, the recommended method is to calculate distances and angles from GNSS and compare with distances and angles from the underlying surveys.

Another acceptable method is to adopt a bearing swing off an approved CSD in the vicinity.

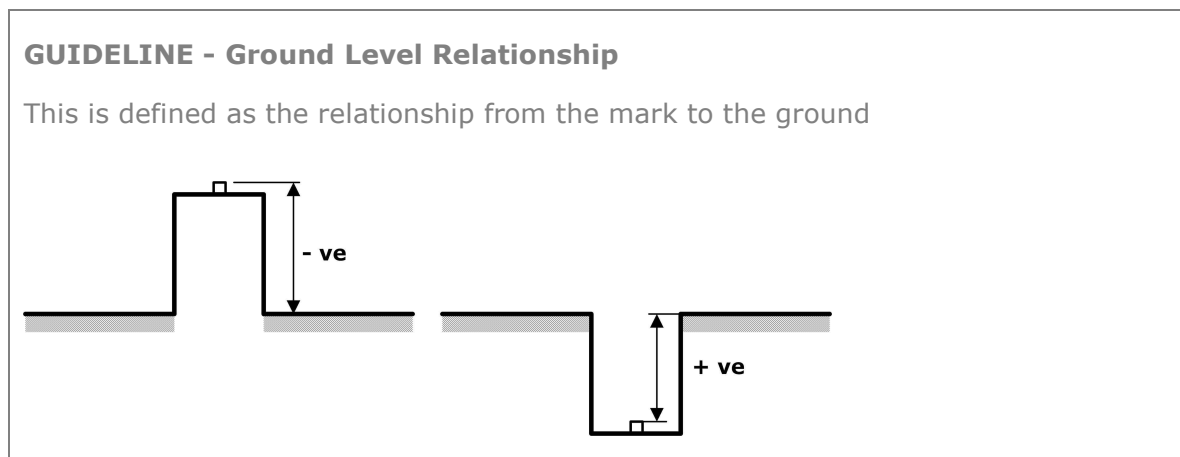
Where GNSS is not used the Contractor should endeavour to carry out the Mark Reliability Check survey in terms of NZGD2000.

9 Field Requirements

9.1 Activities to complete on site

The Contractor shall assess and verify the following for every geodetic mark visited, surveyed or maintained as part of the contract. This list is informational only, if it conflicts with other sections of this specification, the other sections take precedence.

- (a) A before photo shall be taken in accordance with section **13.4.1**
- (b) Site Maintenance in accordance with section **12**
- (c) Mark Maintenance in accordance with section sections **10**
- (d) Protections Structure Maintenance in accordance with section **11**
- (e) The following site details shall be recorded or checked for correctness for the Mark Details File in accordance with section **15.7**
 - (i) Mark type (MRKT)
 - (ii) Mark physical state (MPSC)
 - (iii) Protection structures (MRKR, MRKR2)
 - (iv) Beacon type recorded (MRKE)
 - (v) Ground level relationship (GLREL)



- (vi) Beacon and pillar heights measurements (BCNHGT, BCNHGT2, BCNHGT3, BCNHGT4, BCNHGT5, BCNHGT6) in accordance with sections **11.4.2** or **11.8.2**
- (vii) Beacon eccentricity (BECC) recorded in accordance with section **11.4.3**
- (viii) Mark details/description (MRKD) section **14.3**
- (ix) Mark location/access note (MLOC) section **14.2**
- (x) Identification plaque, identification plate and information plate are attached correctly (PLQEXIST, PLTEXIST, INFOEXIST) in accordance with sections **11.1, 11.2** and **11.3**

- (xi) Description of mark, beacon and protection structure maintenance completed (MPSM, MPSB, MPSP) in accordance with sections **10** and **11**
- (xii) Description of mark, beacon and protection structure maintenance recommended/required (MDMK, MDBE, MDPR) in accordance with sections **10** and **11**
- (xiii) Landowner/occupier name, physical address and phone number (OWNR, PHNO, PADD) section **14.5**
- (xiv) Access restrictions (ARES) section **3.1**
- (xv) GNSS suitability (GNSSU) section **14.6**
- (xvi) Cell phone coverage (CELL) section **14.7**
- (a) Access diagrams in accordance with section **14.1**
- (b) Non-standard beacon diagram in accordance with section **14.8**
- (f) On completion of maintenance the mark and site photos shall be taken in accordance with section **13.1**
- (g) Report other maintenance items that need to be completed, section **9.2**

9.2 Incomplete Maintenance

It is recognised that in some situations full maintenance of a Mark, Protection Structure and/or Site may not be completed.

- (a) This may be due to the require maintenance being:
 - (i) outside the scope of the contract
 - (ii) rejected by the Land Owner/Occupier, section **3.1**
 - (iii) rejected by LINZ
 - (iv) unsafe to complete, or
 - (v) agreed as not required by LINZ.

In this case:

- (b) the Mark, Protection Structure and Site shall be left in a tidy state, so that it does not pose a health and safety risk, section **11.4.6**
- (c) the reason for not completing this work shall be clearly stated in the Contract Report section **15.8(i)(iii)**, and
- (d) any recommended future maintenance shall be included in the Mark Details File section **15.7** fields:
 - (i) Mark maintenance required (MDMK)
 - (ii) Beacon maintenance required (MDBE) or
 - (iii) Protection maintenance required (MDPR)

10 Mark Maintenance

Maintenance of an existing mark shall be carried out when:

- (a) It is required to enable the survey to be carried out (for example, grouting a stainless steel pin into a 50mm tube), or
- (b) It is required to protect an at-risk mark (for example, where a mark is likely to be destroyed or buried), or
- (c) It is required to avert a Health and Safety hazard (for example, a protruding iron tube).

GUIDELINE - Mark Maintenance

Whenever mark maintenance work is carried out, care shall be taken to ensure that the existing mark does not have its position altered either horizontally or vertically.

If a mark is damaged or destroyed or moved it shall become classified as a modified mark.

10.1 New Geodetic Marks

10.1.1 Order 5 Marks

- (a) A new Order 5 geodetic mark must consist of a bronze (mushroom) plaque that is:
 - (i) Installed flush in a solid structure, such as a concrete berm, kerb or footpath, and
 - (ii) Stamped with the geodetic code.
- (b) Where it is not practical to use a bronze plaque a new mark must be installed in accordance with section **10.1.2**

10.1.2 Other Geodetic Marks

- (a) A new geodetic mark must consist of a 12 or 22mm stainless steel pin grouted into solid rock or an existing substantial concrete structure (such as a culvert or bridge abutment), or
- (b) Where **10.1.2(a)** is not practical, a 22mm stainless steel pin set in a stable concrete block must be used.
- (c) A concrete block must:
 - (i) Have minimum dimensions of 0.35m × 0.35m × 0.5m,
 - (ii) Be located at least 0.10m below ground level, and
 - (iii) Be covered by a cast iron protective box in accordance with section 11.7.1.
- (d) An ID plaque, stamped with the geodetic code, must be located near the grouted mark or attached to the concrete block.

10.1.3 Install a Bronze (Mushroom) Plaque

The Contractor shall supply and install a bronze (mushroom) plaque in accordance with section **10.1.1**.

10.1.4 Install a Stainless Steel Pin

The Contractor shall supply and install a stainless steel pin in accordance with section **10.1.2**.

10.2 Modifications to Existing Marks

10.2.1 Mark Modifications

If during the course of maintenance the original position of the mark is altered either horizontally or vertically by more than 3mm:

- (a) The physical change between the original and modified mark shall be reported,
- (b) The modified mark shall be named in accordance with section **4.3.3**,
- (c) A new geodetic code shall be assigned for the modified mark in accordance with section **4.2**,
- (d) Details of both the original mark and the modified mark are to be included in the Mark Details File, section **15.7** and
- (e) The Mark Physical State for the original mark shall be recorded as DEST (destroyed) in the Mark Details File, section **15.7**

10.2.2 Modify Height of an Existing Mark

- (a) Where the mark has a published normal-orthometric or ellipsoidal height and the height of the mark is changed by more than 3mm it shall be regarded as a modified mark.
- (b) The Contractor shall carry out all work described in section **10.2.1**.

GUIDELINE - Mark Height Modification

The height of a mark may need to be changed to mitigate a health and safety risk or to protect an at-risk mark

10.2.3 Upgrade an Existing Mark

Where an existing mark comprises a large diameter (greater than 25 mm) iron tube that is in good condition, the Contractor shall:

- (a) Insert a stainless steel pin inside the tube,
- (b) Secure the pin in place using cement or a suitable epoxy resin, and
- (c) Report any difference in the height of the tube and reference point of the pin in the Mark Details File, section **15.7**.

GUIDELINE - Upgrading an Existing Ground mark

The top of the pin should be the same level as the top of the tube.

If a 3D coordinate already exists for the mark and the pin is not level, it shall become classified as a modified mark and section **10.2.1** shall apply.

10.2.4 Stabilise an Existing Mark

If an existing mark can be moved horizontally or vertically by more than 3 mm (under normal conditions) then the Contractor shall stabilise the mark by:

- (a) Removing any nearby vegetation threatening the mark,
- (b) Compacting or replacing the ground around the mark with a more stable material, and
- (c) Installing a concrete collar around the mark.

GUIDELINE - When not to stabilise a mark

In some situations the site may be too unstable, due to localised deformation or draining etc. In these cases, were the mark is able to move more than 3mm horizontally or vertically, any identification plates/plaques should be removed and the mark recorded as destroyed.

10.2.5 Preserve a Mark

When the top of a corroded iron pipe or tube is protruding above the ground and its height is not posing a health and safety risk, the Contractor shall preserve the tube by:

- (a) Placing a PVC pipe around the corroded tube, to a sufficient depth below ground level to ensure mark stability, and
- (b) Securing the corroded tube within the PVC pipe with concrete.

GUIDELINE - When not to Preserve a Mark

Some marks may be too corroded or pose a Health and Safety Risk by protruding above the ground, these marks should have their height reduced in accordance with Section **10.2.2**.

10.3 Offset an Existing mark

- (a) A mark may be offset when:
 - (i) An existing mark has been identified as going to be damaged or destroyed by construction, or
 - (ii) An existing mark is no longer in a suitable location to enable survey.

- (b) Sufficient new marks shall be installed, clear of any unstable ground, so that the original position of the mark can be known to within 3mm both horizontally and vertically.
- (c) The offsets shall be surveyed and submitted to LINZ on a Survey Information CSD
- (d) New marks shall be installed in accordance with section **10.1**.

10.4 Replace an Existing Mark

- (a) An existing mark may be replaced when it is at risk of being damaged or destroyed by construction.
- (b) The original mark shall be offset in accordance with section **10.3** and then removed.
- (c) Once the site is no longer endangered, a new mark shall be installed in accordance with section **10.1**.
- (d) The replacement mark shall be placed both horizontally and vertically within 3mm of the position of the original mark.

GUIDELINE - Replace an Existing Mark

If the replacement mark cannot be placed in the same position (i.e. within 3mm horizontally and vertically) of the original mark, it shall become classified as a modified mark and section **10.2.1** shall apply.

10.5 Destroyed or Not Found Marks

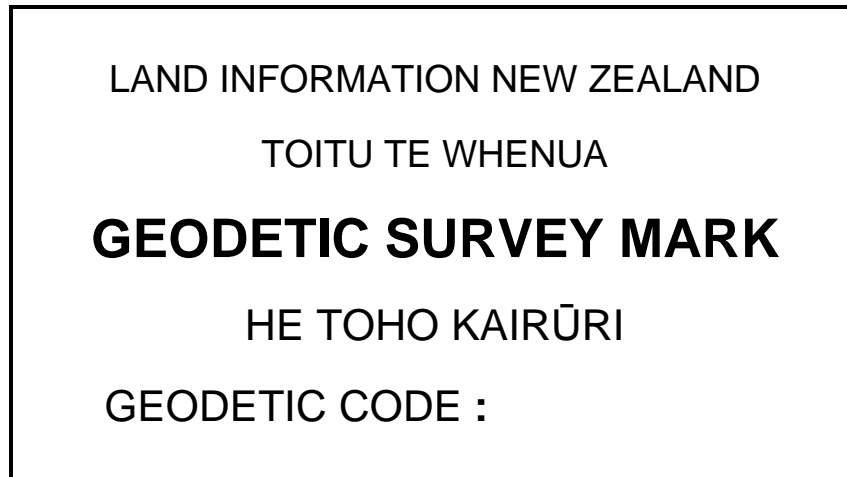
If a geodetic mark is found to be destroyed or it cannot be located within a reasonable time frame (e.g. 15 minutes), the Contractor shall:

- (a) Update the Mark Details File ,section **15.7**, to:
 - (i) DEST (destroyed) or
 - (ii) NFND (not found), and
- (b) Provide details of the search undertaken to locate the mark in the Contract Report, section **15.8(d)(v)**
- (c) Protection Structure Maintenance

11 Protection Structure Maintenance

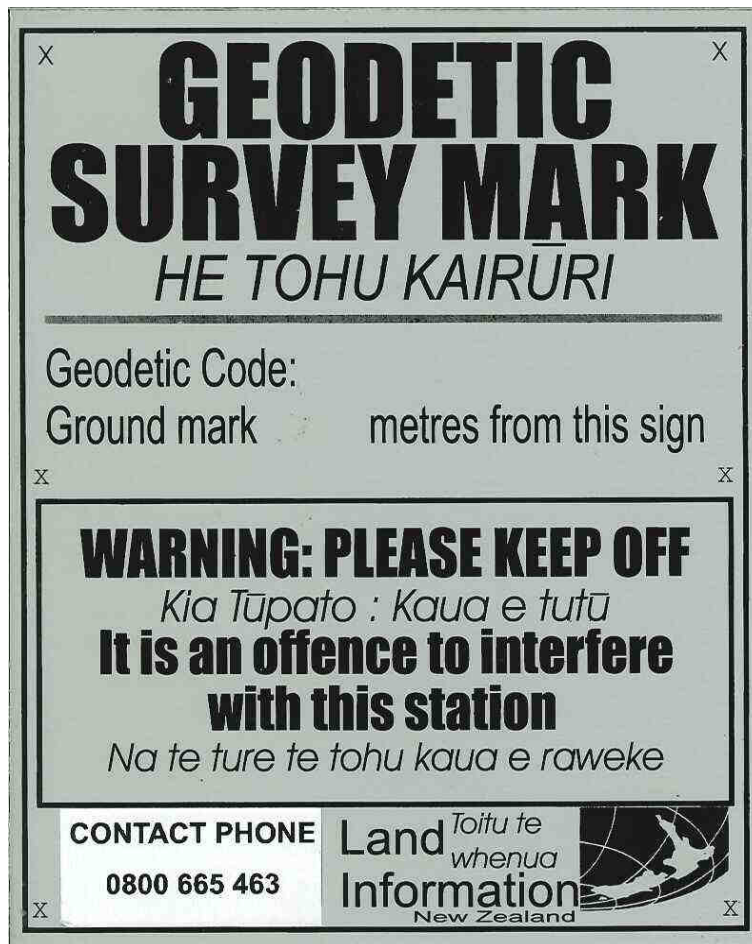
11.1 Identification Plaques

- (a) A bronze identification plaque shall be installed at all Order 4 and higher marks.
- (b) A plaque shall be in the form of and contain the wording shown below:



11.2 Identification Plates

- (a) An aluminium identification plate shall be affixed to a:
 - (i) Beacon,
 - (ii) Marker post,
 - (iii) Post and rail enclosure, and
 - (iv) Pillar.
- (b) The identification plate shall be in the form and contain the wording shown below:



11.3 Information Plates

- (a) An aluminium information plate shall be affixed to a side panel of two and four metre beacons located at sites readily and frequently accessible to the general public.
- (b) An information plate shall conform to the following requirements be in the form and contain the wording shown below:

TRIG STATION

This 'Trig Beacon' identifies a geodetic survey mark, which forms the physical component of New Zealand's geodetic system. It is part of a network of 'Trig Stations' across New Zealand that serve as physical reference points.

Land Information New Zealand (LINZ) is responsible for determining and maintaining the accurate and complete measurements and location of New Zealand's physical features. New Zealand's geodetic system provides the underlying measurements used in producing topographic maps and hydrographic charts and is an essential tool in setting and identifying property boundaries.

New Zealand's geodetic system is used by:

- surveyors and land professionals
- government departments and local authorities
- utility providers such as power, gas and telecommunications companies
- emergency services
- trampers and hikers
- mariners

Further information on Land Information New Zealand and the Geodetic System can be found at www.linz.govt.nz. You can also find out about this Trig Beacon by entering its geodetic code into the geodetic section of the LINZ website.

New Zealand Government

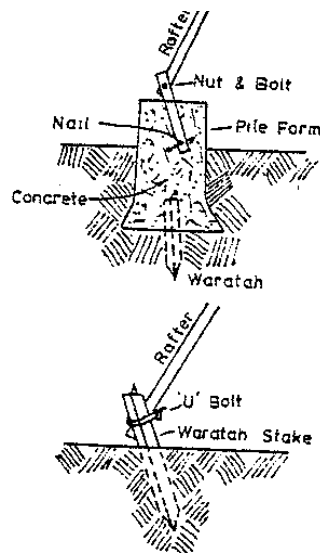


11.4 Beacons

11.4.1 Two Metre Beacon

- (a) Two metre beacons shall be constructed using the following materials:
- (i) All nuts, bolts, screws, washers, 'U' bolts, mast locking pins etc to be stainless steel,
 - (ii) Side panels, vane panels and vane braces to be 22 gauge galvanised iron sheet metal or stainless steel,
 - (iii) Mast braces to be 12 gauge galvanised iron sheet metal,
 - (iv) Mast and rafters to be 20 mm diameter galvanised iron pipes, and

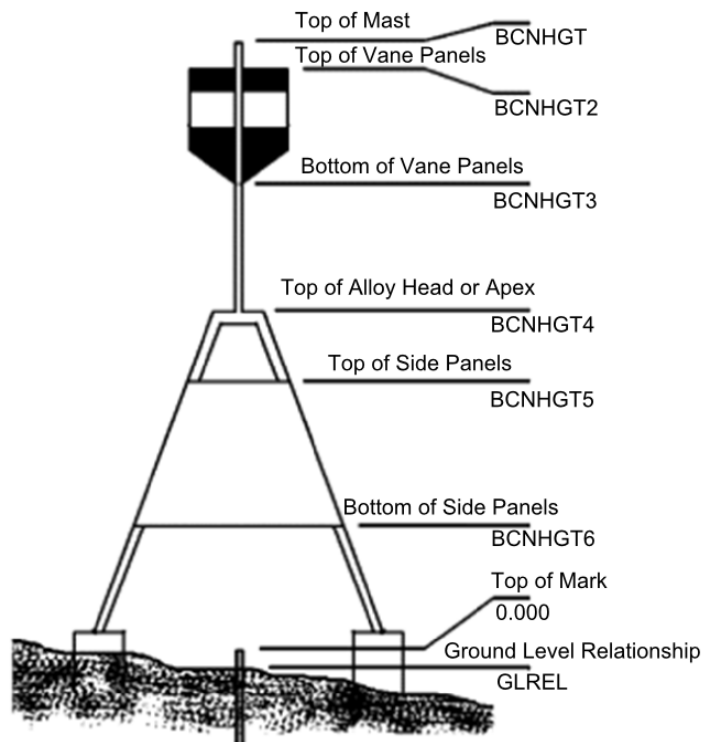
- (v) Alloy head to be cast aluminium with 28 mm internal diameter steel tubing insert.
- (b) Two metre beacons shall be painted in the following scheme:
 - (i) Side panels and vane braces painted white, and
 - (ii) Vane panels painted black.
- (c) A locking pin, U-bolt or other securing bracket shall be fixed through the mast immediately above the head to prevent the mast rotating and to hold the mast clear of the ground mark.
- (d) The bottom of the mast shall sit at least 20 mm clear of the top of the ground mark to prevent damage to the ground mark.
- (e) The beacon shall be anchored by clamping the rafters to waratahs using a nut and bolt or a 'U' bolt.
- (f) Waratahs are driven firmly into the ground and if necessary secured by a concrete collar. Concrete must not be placed around rafters (see Figure below).



- (g) New beacons shall be installed so that that the top of the alloy head is 1.2 m – 1.4 m above ground level.
- (h) The centre of the mast shall be located vertically over the centre of the mark.

11.4.2 Beacon Measurements

- (a) Two and four metre beacons shall have the following relationships measured from the top of the mark to the:
- (i) Top of mast,
 - (ii) Top of vanes (target boards),
 - (iii) Top of alloy head or apex,
 - (iv) Top of side boards (sight boards)
 - (v) Bottom of side panels



- (b) A non standard beacon shall
- (i) Be measured, as far as possible, in accordance with **11.4.2**,
 - (ii) Where **11.4.2** does not apply, measurements shall be taken from mark to observable features on the beacon.
 - (iii) Measurements shall be displayed on a non-standard beacon diagram in accordance with section **14.8**.

11.4.3 Beacon Eccentricity

- (a) Prior to survey a beacon shall be checked for eccentricity in relation to the mark.
- (b) Any eccentricity greater than 0.01m shall have the direction (north/east/south/west) and distance relative to the mark recorded in the Mark Details File, section **15.7**

11.4.4 Supply and Fit Mast Locking Pin

The Contractor shall supply and fit a mast locking pin in accordance with section **11.4.1 (c)**.

GUIDELINE - Mast Locking Pins

Locking pins are used to ensure that the beacon mast can be replaced to a consistent height above the ground mark, thereby maintaining the accuracy of the beacon height measurements.

The pins also protect the ground mark by ensuring that the mast does not rest directly on it, and prevent the mast from spinning and incurring damage to the beacon.

11.4.5 Modify a Four Metre Beacon

- (a) Wooden four metre beacons shall be modified so that they can be easily removed and accurately re-established over the ground mark by installing brackets at the base of the rafters.
- (b) Brackets and securing bolts or screws shall be made of galvanised steel or brass.
- (c) Beacon eccentricity shall be assessed, reported and corrected in accordance with section **11.4.2**.

GUIDELINE - Modifying four metre beacons

Four metre beacons were designed to enable terrestrial surveying measurements to be made from under the erect beacon. To collect GNSS observations at marks monumented by four metre beacons it is necessary to first remove the beacon.

Metal brackets should be attached to each rafter to facilitate the efficient removal and replacement of wooden four metre beacons. An example of a modified rafter is shown in the picture below.



11.4.6 Repairs for Safety

- (a) This section only applies if repairs require additional maintenance subject to approval or maintenance not required as part of the contract.
- (b) Repairs shall be completed to ensure that the beacon no longer poses a health and safety hazard.
- (c) The Contractor shall supply the materials, remove, replace or secure any damaged or dangerous components of the beacon and/or protection structure including any or all of the following: rails, rafters, side panels, vane panels, hinges, and holding down devices.

11.5 Marker Post

11.5.1 Marker Post

A marker post shall:

- (a) Be constructed from a galvanised half round fence post with a minimum diameter of 125mm and approximately 1.8 m long.
- (b) Be placed no further than 5.0 m from the ground mark.
- (c) Have one third of the post's length buried. This will leave 1.2 m of post exposed above ground level
- (d) In soft or sandy soil are to be set in concrete to ensure stability
- (e) Have the flat side of the post facing the mark
- (f) Be installed immediately against the fence line or as close as possible to it, where a mark is situated close to a fence
- (g) Not use existing posts unless they were explicitly placed for mark identification eg existing concrete bench mark posts.
- (h) Prior to painting all surfaces shall be cleaned (eg. by brushing down or scraping) to remove all loose paint, moss, lichen etc
- (i) Paints shall be non toxic
- (j) Be painted in the following colour schemes:
 - (i) the top 0.3 m of exposed post painted black, and
 - (ii) the remaining exposed post painted white.
- (k) Have an identification plate that complies with section **11.2** located:
 - (i) On the flat side of post facing the ground mark and
 - (ii) On the area painted black

11.5.2 Install a Marker Post

The Contractor shall supply and install a marker post with identification plate in accordance with section **11.5.1**,

11.6 Post and Rail Enclosure

Where a mark or beacon is threatened by cattle or is required by the local authority a post and rail enclosure may be installed with approval from the National Geodetic Office.

11.6.1 Post and Rail Enclosure

A post and rail enclosure shall:

- (a) Be constructed from the following materials:
 - (i) Three or four wooden tanalised fence posts (eg half rounds) approximately 1.8 m long (post),
 - (ii) Tanalised half-round fence posts or lengths of tanalised 100mm x 50mm (rails).
- (b) Have posts at an equidistant from the ground mark, where this distance shall be between 1.8m and 2.2 m
- (c) Have at least one third of the post's length buried, leaving 1.2 m of post exposed above ground level.
- (d) Have posts in soft sandy soil, set in concrete to ensure stability.
- (e) Have the rails secured to the top of the posts using screwed in metal straps or galvanized bolts
- (f) Have rails that are generally level
- (g) Be cleaned (eg. by brushing down or scraping) prior to painting to remove all loose paint, moss, lichen etc
- (h) Be painted using non-toxic paint in the following colour scheme:
 - (i) Rails and tops of posts at rail level are to be painted white, and
 - (ii) Remainder of the posts exposed above ground level are to be painted black.
- (i) Have an identification plate in accordance with section 11.2 located on the outside of the enclosure closest to usual access.

11.6.2 Install a Post and Rail Enclosure

The Contractor shall supply and install a post and rail enclosure with identification plate in accordance with section **11.6.1**.

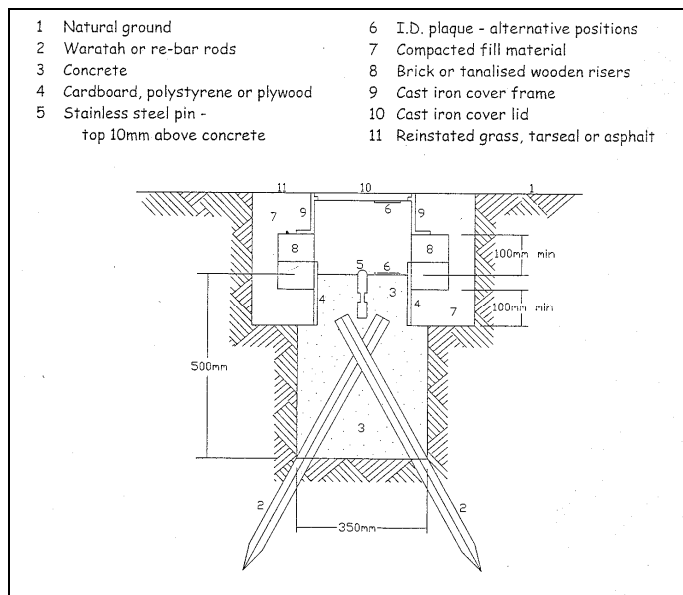
11.7 Covers

11.7.1 Cast Iron Covers and Boxes

Cast iron covers and boxes shall be:

- (a) Suitable for use in vehicular trafficked areas,
- (b) Placed in a way so that they are safe, stable and durable ,
- (c) Placed so they are flush with the surrounding surface,

- (d) Have original surface that was disturbed reinstated to a standard and finish at least equivalent to what the existing surface was like before it was disturbed ,
- (e) Have the base of the box isolated from the concrete base by a material such as plywood, or polystyrene spacers, and
- (f) Installed in accordance with the diagram below:



11.7.2 Install a Cast Iron Cover and Box

The Contractor shall:

- (a) Supply and install a cover and box in accordance with section **11.7.1**, and
- (b) Restore the surface surrounding the box to a standard at least equivalent to the state before the cover was installed.

11.7.3 Raise or Lower Cast Iron Cover and Box

Where an existing cover and box is no longer level with the surrounding surface, the Contractor shall:

- (a) Raise or lower the existing cover and box in accordance with section **11.7.1** by replacing or adjusting any brick, wood or polystyrene raisers,
- (b) Restore the surface surrounding the box to a standard at least equivalent to the state before the cover was installed, and
- (c) Dispose of all waste from the site.

11.7.4 Replace a Cast Iron Cover and Box

Where an existing cover and box is broken or a new lid can not be obtained to fit an existing box the Contractor shall:

- (a) Remove and dispose of the existing box and cover,
- (b) Supply and install a cover and box in accordance with section **11.7.1**,
- (c) Restore the surface surrounding the box to a standard at least equivalent to the state before the cover was installed, and
- (d) Dispose of all waste from the site.

11.7.5 Replace a Cast Iron Cover

Where a cast iron cover is missing or broken, the Contractor shall:

- (a) Remove and dispose of the broken cover, and
- (b) Supply and install a replacement cover in the existing box in accordance with section **11.7.1**.

GUIDELINE - Non Standard Covers and Lids

Covers and lids may vary from area to area any may not always fit the LINZ standard cover and box. If a non-standard cover can not be obtained then both the box and cover may need to be replaced.

11.7.6 Replace a Concrete Cover

Where a concrete cover is missing or broken, the Contractor shall:

- (a) Remove and dispose of the broken cover, and
- (b) Supply and install a replacement cover in accordance with sections **11.7.1 (b)** to **(d)**.

11.8 Pillars

11.8.1 Pillars

- (a) Pillars are considered to be structures over 1 metre high that can be observed to.

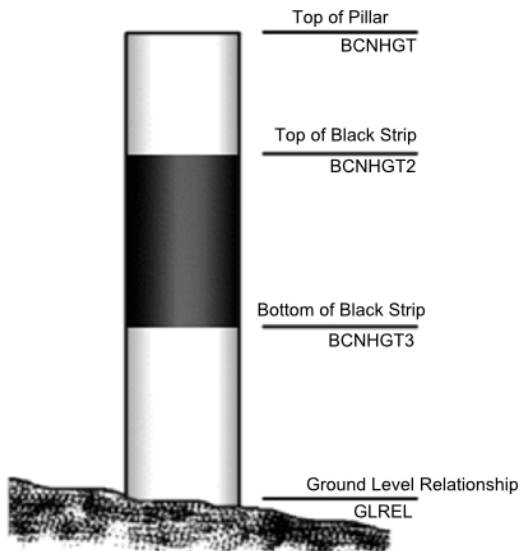
11.8.2 Pillar Height Measurements

Heights shall be measured and recorded from the top of the mark to each of the following:

- (a) Top of pillar,
- (b) Top of black strip, and
- (c) Bottom of black strip.

GUIDELINE - Pillar Height Measurements

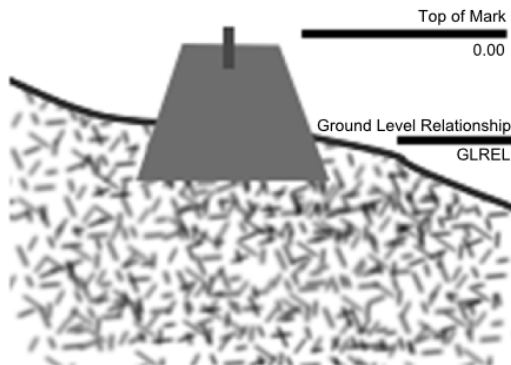
Pillars are regarded as beacons in the contract deliverables. As such 'beacon height' measurements will always be negative because the mark is above the ground.



11.9 Bench Mark Blocks

11.9.1 Bench Marks

- (a) Bench mark blocks are considered to be a mark with a concrete block protruding between 0.10 and 1.0 metres above the ground.



12 Site Maintenance

12.1 Clear Vegetation

12.1.1 Land Owner Permission

Permission from the land owner/occupier must be obtained prior to any spraying or clearance of vegetation occurring, section **3.1**.

12.1.2 Clear Tall Plants

Tall plants, including trees, shall be cleared from the site so that it is clear of all obstructions that may restrict visibility both to and from the site.

12.1.3 Clear Scrub

- (a) All scrub like vegetation which impedes access or usability of a proposed or existing site shall be cleared from within a one metre radius of the site and its protection structure.
- (b) Grass is not considered to be scrub unless it exceeds **1.0** metre in height before clearance.

GUIDELINE - Clear Scrub

The purpose of clearing scrub such as blackberry and gorse is to improve access to a mark and to enable observations to be made from it in the medium term.

In general, trimming grass does not provide improved access or mark usability after a month. Where grass requires trimming to enable other maintenance to occur (e.g. painting posts, beacons or marks) this is to be included in the unit rate for that maintenance item.

12.2 Disposal of Unwanted Materials

- (a) Any beacon, protection structure, or parts thereof that have been replaced shall be removed from the site and disposed of in an environmentally friendly manner.
- (b) Debris such as cleared plants, vegetation and excavated material that cannot be left on or near site in a safe and tidy manner (eg in urban areas) shall be removed and disposed of in an environmentally friendly manner.

GUIDELINE –Disposal of Material in Urban Areas

In urban areas all unwanted materials shall be removed from the site. Any green waste should be composted or disposed of in terms with local by-laws.

13 Photographs

13.1 Photographs Required

- (a) The following photographs must be provided for each mark:
 - (i) Mark photograph that clearly shows the mark. Mark type should be obvious,
 - (ii) Site photograph that clearly shows the mark in relation to its immediate surroundings, including any protection structures, and
 - (iii) Extended site photograph that shows a wider view of the site, its surroundings, and other features which may help to locate the mark in the future.
- (b) Photographs must be taken after all maintenance has been completed at the site.

GUIDELINE - Photographs

The mark type should be obvious in the mark photograph.

If the mark has a cast iron or concrete lid, this should be visible in at least one of the photos.

The extended site photograph should:

- (i) Be taken from more than 20m away from the mark,
- (ii) Contain enough information to convey the suitability of the mark for terrestrial or GNSS observations, and
- (iii) Place an item (such as a road cone) over the mark to identify its location where it is not obvious.

This information will be used for locating the mark in the future. Therefore photographs following any maintenance are required.

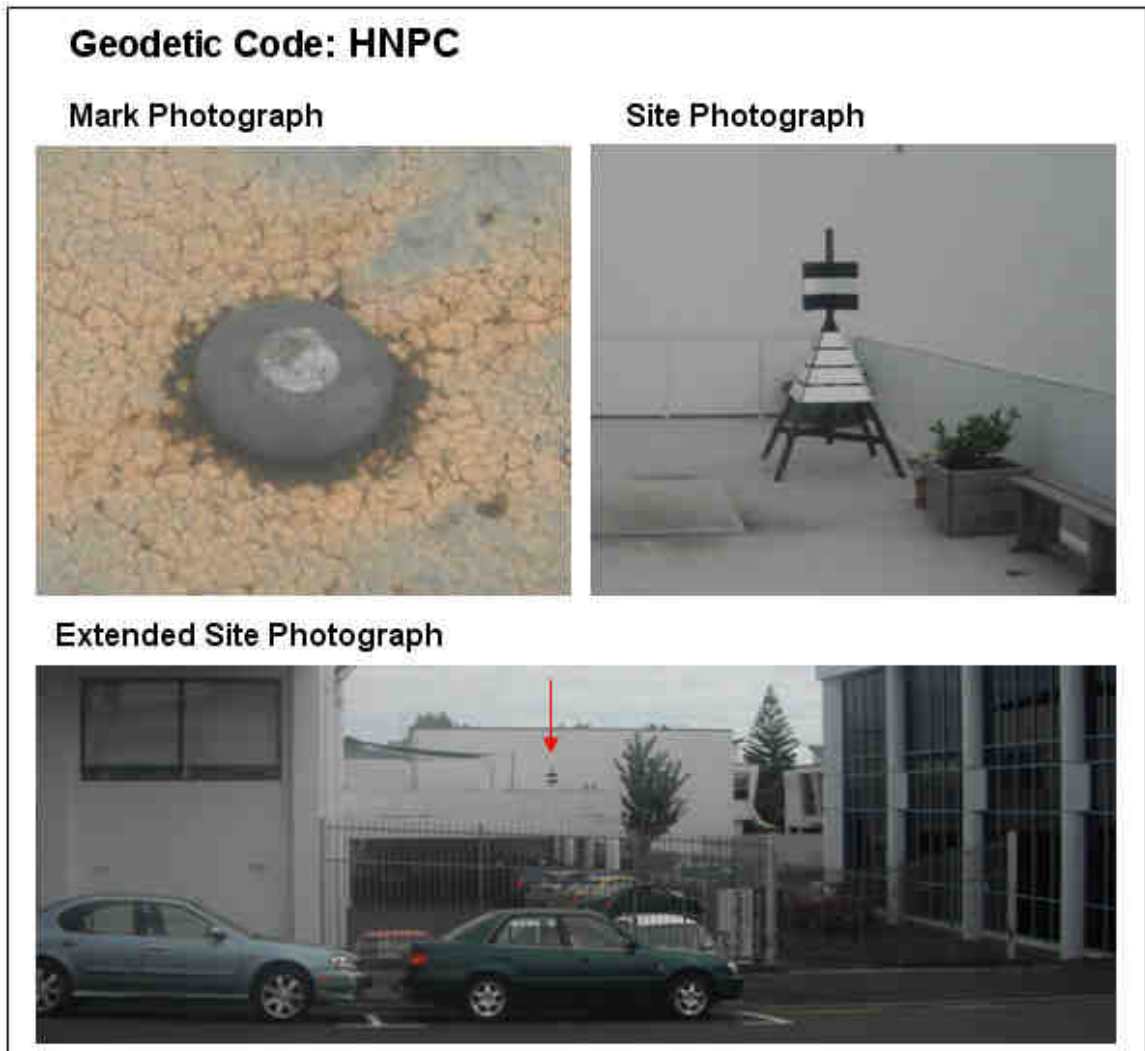
13.2 Photographs Characteristics

All photographs must:

- (a) Not include members of the public, or anything else that could compromise an individual's privacy, bearing in mind that these photographs will be made available over the internet in a public database,
- (b) Be vertically aligned for ease of viewing (ie, ground at the bottom of the photograph, sky at the top), and
- (c) Not be digitally altered, except to:
 - (i) Overcome privacy issues, or
 - (ii) Identify the location of the mark if it is not obvious in the photo.

13.3 Mark and Site Image

- (a) The photographs required by section **13.1** must be provided as a single mark and site image that shows the:
 - (i) Geodetic code of the mark,
 - (ii) Mark photograph,
 - (iii) Site photograph, and
 - (iv) Extended site photograph.
- (c) The mark and site image shall be provided in accordance with section **15.11**.
- (b) Each photograph must be labelled appropriately, (ie Mark Photograph, Site Photograph, or Extended Site Photograph).
- (c) The mark and site image must adhere to the following template:



13.4 Maintenance Photographs

- (a) The following photographs must be supplied if physical maintenance is carried out at a mark, protection structure or site:
 - (i) Before photographs, and
 - (ii) After photographs.
- (b) Sufficient 'before' and 'after' mark and site photographs shall be supplied to provide evidence of maintenance work completed.
- (d) Maintenance photographs shall be provided in accordance with section **15.11**.
- (c) 'After' photographs are not required if the mark and site image required in section **13.3** clearly shows all maintenance completed.

13.4.1 Before photos

Before photographs must:

- (a) Be taken prior to commencement of any maintenance work, and
- (b) Clearly show the nature of the maintenance work required.

13.4.2 After photos

After photographs must:

- (a) Be taken upon completion of all maintenance work, and
- (b) Clearly show the maintenance work carried out and/or any additional maintenance required.

GUIDELINE - Maintenance Photographs

"Before" and "after" photos are used to verify the need for maintenance to be undertaken and to show that it has been satisfactorily completed.

It is important for the supplied images to contain sufficient detail to enable this assessment to be completed.

14 Mark and Site Information

14.1 Access and Finder Diagrams

- (a) An access or finder diagram must be provided for every mark included in the Mark Details File section **15.7**, irrespective of whether it was maintained or not.
- (b) The following types of diagram shall be provided:
 - (i) Access diagrams shall be provided for all trigs and marks with complex access instructions, or
 - (ii) Finder Diagrams shall be provided in all other cases.
- (c) An existing mark diagram may be used as an access or finder diagram if:
 - (i) The content is still applicable and correct, and
 - (ii) It complies with the requirements of this section and is supplied in accordance with section **15.11**.
- (d) Access diagrams shall provide enough information to ensure that anyone locating the mark will travel via the safest, most direct route or the route preferred by the landowner/occupier.
- (e) Finder diagrams shall include street names and ties to at least three nearby physical objects to allow the mark to be located in a timely manner
- (f) All diagrams must:
 - (i) Be drawn at a scale appropriate to show features useful in accessing the mark,
 - (ii) Have a north arrow and be aligned so that the north arrow points up the page,
 - (iii) Show all topographical features and names useful in accessing the mark, including the geodetic code of the mark, and
 - (iv) Show the measured relationship of physical features with respect to the ground mark, which would allow the mark to be located within a timely manner.
 - (v) Show the relationship of any marker post with respect to the ground mark.
- (g) Diagrams must be square in shape and contain detail that is clearly visible when the image is displayed at 8cm x 8 cm.

14.2 Access Description

A text description of the information provided on the Access/Finder Diagram, shall be included in the Mark Details File (MLOC – Mark Location) section **15.7**. As a minimum the description will include:

- (a) location of the mark, in respect to
 - (i) topographical or
 - (ii) nearby permanent features
- (b) Directions to the mark, from the nearest road

14.3 Mark Description

A text description of the ground mark, as found, shall be included in the Mark Details File (MRKD – Mark Details) section **15.7**.

GUIDELINE – Mark description

There is no need to include information in this section which is detailed elsewhere in the Mark Details File. Expect, where a mark has been destroyed, this should be reported in the MRKD field.

For a wooden Beacon state if it can or can not be easily removed.

For existing geodetic marks the mark description from the geodetic database (including the information on scanned mark diagrams) shall be used and edited/updated with new information, if required. The original information should not be lost/deleted unless it is incorrect.

14.4 Plan References

At least one survey plan relevant to the mark shall be listed in the Mark Details File (PLRF – Plan References) section **15.7**.

GUIDELINE – Plan Reference

For existing marks the plan references from the geodetic database (including those listed on scanned mark diagrams) shall be used.

It is not necessary to research all plans that have used the mark

In the case there are no relevant survey plans this field shall be left blank.

14.5 Owner Occupier information

After gaining permission to access a site, section **3.1**, the name of the contact person (OWNER), their phone number (PHNO) and their Physical address (ARES) shall be collected and recorded in the Mark Details File section **15.7**.

GUIDELINE – Owner/Occupier Information

As a minimum, the name of the contact person able to permit to access and occupation the mark (OWNER) must be supplied.

If the mark is in the road reserve state: 'Road Reserve'

14.6 GNSS Suitability

Each site shall be accessed for its suitability for making observations using GNSS techniques. This information shall be recorded in the Mark Details File (GNSSU – GNSS Suitability), section **15.7**. The site shall be accessed as either:

(a) Good

- (i) Have at least 70% clear sky visibility above 15 degrees from the horizon in all directions,
- (ii) Be at least 5 metres clear of obstacles such as fences and buildings that may cause multipath, and
- (iii) Be at least 20 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

(b) Poor

- (i) Have less than 70% clear sky visibility above 15 degrees from the horizon in all directions, or
- (ii) Be less than 5 metres clear of obstacles such as fences and buildings that may cause multipath, or
- (iii) Be between 20 - 10 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

(c) Unsuitable

- (i) Have less than 40% clear sky visibility above 15 degrees from the horizon in all directions, or
- (ii) Be less than 5 metres clear of multiple obstacles such as fences and buildings that may cause multipath, or
- (iii) Be less than 10 metres clear of sources of radio interference such as radio transmitters, cell-phone transmitters and high-tension power lines.

14.7 Cell Phone Coverage

Each site shall be accessed for its cell phone coverage, for at least one provider. This information shall be recorded in the Mark Details File (CELL – Cell phone Coverage), section **15.7**. The site shall be accessed in terms with the table in section **15.10.12**,

14.8 Non-Standard Beacon Diagrams

- (a) A Non-Standard Beacon Diagram shall be provided for every mark included in the 'Report of Maintenance Work Completed' that has a beacon type (MRKE) that is not "4M", "2M", "PL" or "NB".
- (b) An existing non-standard beacon diagram may be used if:
 - (i) The content is still applicable and correct, and
 - (ii) It complies with the requirements of this section and is supplied in accordance with section **15.11**.
- (c) Non-Standard Beacon Diagrams must:
 - (i) Clearly depict the appearance and prominent parts of the beacon,
 - (ii) Show the height, in decimal metres, of each prominent beacon part above (+ve) or below (-ve) the top of the mark, and
 - (iii) Show the height of the ground (in decimal metres) above (+ve) or below (-ve) the top of the mark.
- (d) Diagrams must be square in shape and contain detail that is clearly visible when the image is displayed at 8cm x 8 cm.

15 Contract Deliverables

15.1 General

- (a) All information relating to geodetic contracts shall be provided to the National Geodetic Office in digital form only.
- (b) Information shall be provided:
 - (i) Physically on a CD, DVD or flash drive, or
 - (ii) By LINZ downloading directly from the Contractor's FTP site, or
 - (iii) By the Contractor uploading to the LINZ FTP site.
- (c) Individual files which are being resubmitted may be delivered by email.

15.2 Invoices

- (a) A hard copy invoice for full or progress payment of work completed shall be provided to the National Geodetic Office.
- (b) Digital copies of all provided invoices shall be supplied in accordance with section **15.11**.

15.3 Mark Data File

- (a) A Mark Data File shall be supplied that contains a list of marks referenced in the Vector Data File (section **15.5**) or Height Difference Data File (section **15.4**).
- (b) The following fields shall be provided for each mark included in the Mark Data File:

Field Name	Contents	Format
CODE	Geodetic Code	4 character geodetic code
MRKS	Mark Status	See section 15.10.1
MRKT	Mark Type	See section 15.10.3
EXMK	Existing Mark	See section 15.10.2
DISTRICT	Land District	See section 15.10.4
CROD	Coordinate Order	See section 15.10.5
ORDV1	NZGD2000 Latitude	Decimal degrees to 8 decimal places (+ve North, -ve South)
ORDV2	NZGD2000 Longitude	Decimal degrees to 8 decimal places (+ve East, -ve West)
ORDV3	NZGD2000 Ellipsoidal Height (if available)	Metres to 3 decimal places, blank if unknown
NAME	Mark Name	See section 4.3
ALTN	Alternative Mark Name	See section 4.3
COMM	Optional Comments	Text, for information only. These comments will not be loaded in to the Geodetic Database or Landonline

- (c) Marks shall be listed in the Mark Data File in the following order:
- (i) Existing geodetic marks of Order 0 to 4
 - (ii) Existing geodetic marks of Order 5
 - (iii) Existing marks being upgraded to Order 5
 - (iv) New marks being upgraded to Order 5
- (d) The Mark Data File shall
- (i) Be supplied in comma delimited format (CSV),
 - (ii) Contain the following header line:
CODE,MRKS,MRKT,EXMK,DISTRICT,CROD,ORDV1,ORDV2,ORDV3,NAME,ALTN,COMM
 - (iii) Contain information about one data file per line, and
 - (iv) Be named in accordance with section **15.11**.

GUIDELINE - Mark Data File

The Mark Data file is used with the Vector and Height Difference files to load new marks and observations into Landonline.

An example Mark Data File (listing one mark) is:

```
CODE,MRKS,MRKT,EXMK,DISTRICT,CROD,ORDV1,ORDV2,ORDV3,NAME,ALTN,COMM
AP8Y,COMM,PIN,Y,HN,2k2,-37.95659775,177.00867006,209.716,WHAKATANE NO 2,
WHAKATANE, 2nd Order Control Mark
```

15.4 Height Difference File

- (a) A Height Difference File shall be supplied that contains all normal-orthometric height differences observed between marks.
- (b) The following fields shall be provided for each observation included in the Height Difference File:

Field Name	Contents	Format
FCODE	Geodetic code of mark observation is from	4 character geodetic code
TCODE	Geodetic code of mark observation is to	4 character geodetic code
DATE	Date of observation	YYYY.MM.DD
TIME	NZST time at start of levelling run	HH.MM
DHGT	Unadjusted height difference between from and to marks	Metres to 4 decimal places
LVDIST	Slope distance levelled	Metres, to nearest metre
COMM	Optional Comments	Text, for information only. These comments will not be loaded.

- (c) Supplied height differences must be reduced to account for instrumental and atmospheric errors, but normal-orthometric correction shall not be applied.
- (d) The Height Difference File shall

- (i) Be supplied in comma delimited format (CSV),
- (ii) Contain the following header line:
FCODE,TCODE,DATE,TIME,DHGT,LVDIST,COMM
- (iii) Contain one height difference observation per line, and
- (iv) Be named in accordance with section **15.11**.

GUIDELINE - Height Difference File

The Height Difference file lists all height differences that have been observed by the Contractor.

This file must contain the same height differences that are provided in the SNAP observation file (see section **6.7**).

It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (eg Year.Month.Day: yyyy.mm.dd and Time: hh.mm).

An example Height Difference File (listing one observation) is:

```
FCODE,TCODE,DATE,TIME,DHGT,LVDIST,COMM
AP8Y,AP83,1999.12.25,09.59,-6.4534,465,
```

15.5 Vector Data File

- (a) A Vector Data File shall be supplied that contains all GNSS vectors observed between marks.
- (b) The following fields shall be provided for each observation included in the Vector Data File:

Field Name	Contents	Format
FCODE	Geodetic code of mark observation is from	4 character geodetic code
TCODE	Geodetic code of mark observation is to	4 character geodetic code
DATE	Date of observation	YYYY.MM.DD
TIME	NZST time at start of GNSS observation	HH.MM
dX	Delta X vector component	Metres to 3 decimal places
dY	Delta Y vector component	Metres to 3 decimal places
dZ	Delta Z vector component	Metres to 3 decimal places
METH	Method used to determine the GNSS vector. Used to assign errors in SNAP	See section 15.10.6
EFAC	Error factor used in SNAP to scale the vector	2 decimal places
COMM	Optional Comments	Text, for information only. These comments will not be loaded.

- (c) The Vector Data File shall
 - (i) Be supplied in comma delimited format (CSV),
 - (ii) Contain the following header line:


```
FCODE,TCODE,DATE,TIME,dX,dY,dZ,METH,EFAC,COMM
```
 - (iii) Contain one GNSS vector per line, and
 - (iv) Be named in accordance with section 15.11.

GUIDELINE - Vector Data File

The Vector Data file lists all three-dimensional vectors that have been observed by the Contractor.

This file is used to provide the data for the SNAP adjustment (see section 6.1).

It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (eg Year.Month.Day: yyyy.mm.dd and Time: hh.mm).

An example Vector data File (listing one observation) is:

```
FCODE,TCODE,DATE,TIME,dX,dY,dZ,METH,EFAC,COMM
1163, A79B, 2006.359, 12.59, -12440.912, -7725.093, 12799.139,STAT1,1.00,
```

15.6 Mark Reliability Checks

Mark Reliability Checks shall be supplied in both of the two forms:

- (a) Reliability File, section **15.6.1** and
- (b) Reliability Traverse Sheet, section **15.6.2**

15.6.1 Reliability File

- (a) One mark Reliability File shall be supplied as a Microsoft Excel spreadsheet in terms with section **15.11**.
- (b) The Reliability File shall provide sufficient information to prove the reliability of all proposed Order 5 marks.
- (c) The Reliability File shall be made up of one or more of the following check types:

- (i) A report comparing new survey data with observations adopted from cadastral survey plans shall contain the following column headings and data:

Column Heading	Data requirements
CODE	Geodetic code
NAME	Mark name
FMKN	From mark name
TMKN	To mark name
CNBR	Contract data bearing (in terms of meridional circuit)
CNDT	Contract data Distance (ellipsoidal distances)
ADBR	Adopted bearing (in terms of meridional circuit)
ADDT	Adopted distance (ellipsoidal distances)
APRF	Adopted plan reference, mandatory if adopted vectors used.
ADDM	Datum and circuit of adopted plan (mandatory if adopted vectors used)
MSCL	Actual misclose, mandatory
ALMC	Allowed misclose, mandatory
DATM	Datum and circuit of measured observations, mandatory

- (ii) A report comparing new survey data with coordinate joins to order 6 or better marks shall contain the following column headings and data:

Column Heading	Data requirements
CODE	Geodetic code
NAME	Mark name
FMKN	From mark name
TMKN	To mark name
CNBR	Contract data bearing (in terms of meridional circuit)
CNDT	Contract data Distance (ellipsoidal distances)
CLBR	Bearing calculated between Order 6 or better marks
CLDT	Distance calculated between Order 6 or better marks
MSCL	Actual misclose, mandatory
ALMC	Allowed misclose, mandatory
DATM	Datum and circuit of measured observations, mandatory

- (iii) For (i) and (ii), the total misclose, either of complete loops or onto coordinates derived from new observations (e.g. RTK) shall be stated and meridional circuit coordinates derived.
- (iv) For (i) and (ii), the maximum allowable misclose shall be stated.
- (v) For (i) and (ii), the datum in which reliability is proven shall be provided.

A report describing NZGD1949 trigs and rural bench marks proven by visual inspection only shall contain the following column headings and data:

Column Heading	Data requirements
CODE	Geodetic code
NAME	Mark name
PVIO	Proved by visual inspection only

- (vi) A report describing new marks establish for the purposes of the contract shall contain the following column headings and data:

Column Heading	Data requirements
CODE	Geodetic code
NAME	Mark name
SOPN	SO CSD reference for marks installed during the contract.

- (d) Where two or more check types are to be provided, these shall be supplied on separate worksheets within the one Reliability File.

15.6.2 Reliability Traverse Sheet

- (a) One Reliability Traverse Sheet image will be supplied for each proposed Order 5 mark surveyed, in terms with section **15.11**.
- (b) The Reliability Traverse Sheet image shall provide sufficient information to prove the reliability of each proposed Order 5 mark.
- (c) Any format generally accepted for traverse sheets on cadastral surveys (including header information) will be acceptable.
- (d) The source of all fixed coordinates and adopted observations shall be made clear.
- (e) If bearings adopted from one survey have had a correction applied which is adopted from a different survey, this must also be stated.
- (f) The traverse sheet header shall state the meridional circuit of the coordinates and the datum.
- (g) An example of the traverse information, less the header, is given below:

1.	5125			712 345.678	345 678.901	5125 (IT II SO 6789) - GNSS coord.
2.	IT XII	302° 27' 30"	126.4 9	712 413.557	345 572.178	IT XII DP 9012 – GNSS coord. – Obs adpt DP 12345
3.		Total Misclose	0.009			
4.		Max Misclose	0.033			
5.						
6.	5125			712 345.678	345 678.901	5125 (IT II SO 6789) – line 1
7.	IS III	37° 05' 00"	80.35	712 409.775	345 727.360	IS II adpt SO 6789 – Obs adpt SO 6789
8.	IS I	81°59' 00"	88.60	712 422.128	345 815.105	IS I DP 34567 – GNSS coord. – Obs adpt DP 34567
9.		Total Misclose	0.019			
10		Max Misclose	0.040			

15.7 Mark Details File

- (a) A report shall be supplied that provides updated information about all geodetic marks visited, maintained and searched for by the Contractor.
- (b) PositionNZ stations shall not be included in the Mark Details File.
- (c) The following fields shall be provided for each mark included in the Vector Data File:

Field Name	Contents	Format
CODE	Geodetic Code	4 character geodetic code
NAME	Mark Name	See section 4.3
EXMK	Existing Mark	See section 15.10.2
MRKT	Mark Type	See section 15.10.3
MPSC	Mark Physical State	See section 15.10.7
PLRF	Plan references	See section 14.4 , blank if none found
EDAT	Date mark originally established	YYYY.MM.DD
MRKR	Most prominent mark protection	See section 15.10.8
MRKR2	Secondary mark protection	See section 15.10.8 , blank if none present
MRKE	Beacon type	See section 15.10.9 , blank if none present
GLREL	Ground level relationship	Metres to 2 decimal places, see section 9.1(e)(v) , blank if not required to be measured
BCNHGT	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BCNHGT2	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BCNHGT3	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BCNHGT4	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BCNHGT5	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BCNHGT6	Height measurement for beacons and pillars	See section 11.4.2 and 11.8.2 , blank if not required to be measured
BDAT	Date Beacon Erected	YYYY.MM.DD, blank if not known
BECC	Beacon Eccentricity	See section 11.4.3 , blank if not

		required to be measured
MRKD	Description of ground mark	Text, see section 14.3
MLOC	Description of site and Location	Text, see section 14.2
PLQEXIST	ID plaque existence	See section 15.10.10
PLTEXIST	ID plate existence	See section 15.10.10
INFOEXIST	Information plate existence	See section 15.10.10
MDAT	Date of most recent maintenance or site inspection	YYYY.MM.DD
MPSM	Description of mark maintenance completed	Text, state "None" if no work completed
MPSB	Description of beacon maintenance completed	Text, state "None" if no work completed
MPSP	Description of protection maintenance completed	Text, state "None" if no work completed
MDMK	Description of mark maintenance required	Text, state "None" if no work required, see section 9.2
MDBE	Description of beacon maintenance required	Text, state "None" if no work required, see section 9.2
MDPR	Description of protection maintenance required	Text, state "None" if no work required, see section 9.2
OWNR	Name of contact person to permit access to and occupation of mark, or "Road Reserve" if in road reserve	Text, see section 14.5
PHNO	Phone number of OWRN	(0X) XXX XXXX, blank if OWRN is road reserve, see section 14.5
PADD	Physical address of OWRN, where they can be contacted	Text, blank if OWRN is road reserve, see section 14.5
ARES	Restrictions to accessing mark	Text, state if no access restrictions, see section 3.1
GNSSU	GNSS Suitability	See sections 14.6 and 15.10.11
CELL1	Telecom cell phone network coverage	See sections 14.7 and 15.10.12
ADAT	Date that owner/occupier information and access data was verified	YYYY.MM.DD
COMM	Optional comments	Text, for information only. These comments will not be loaded in to the Geodetic Database or Landonline

- (d) The Mark Details File shall
 - (i) Be supplied in comma delimited format (CSV),
 - (ii) Contain the following header line:


```
CODE,NAME,EXMK,MRKT,MPSC,PLRF,EDAT,MRKR,MRKR2,MRKE,GLREL,
BCNHGT,BCNHGT2,BCNHGT3,BCNHGT4,BCNHGT5,BCNHGT6,BDAT,BECC,MRKD,
MLOC,PLQEXIST,PLTEXIST,MDAT,MPSM,MPSB,MPSP,MDMK,MDBE,MDPR,OWNER,
PHNO,PADD,ARES,GNSSU,CELL1,CELL2,ADAT,COMM
```
 - (iii) Contain information about one mark per line, and
 - (iv) Be named in accordance with section **15.11**.

GUIDELINE - Mark Details File

The Mark Details File contains mark information that a Contractor has collected or verified. It is used to update Landonline and the geodetic database with the latest information about geodetic marks.

It is important to ensure data formats are maintained in CSV files, particularly the specified number of characters (eg Year.Month.Day: YYYY.MM.DD).

Information regarding PositionZ or CORS sites not visited by the contractor should not be included in the Mark Details File.

15.8 Contract Report

The Contract Report shall be arranged in the following order and contain a discussion on each of the listed points:

- (a) Heading
 - (i) Contact Name
 - (ii) Schedule Number
 - (iii) Schedule Name
- (b) Personnel
 - A list of the staff involved and their role in this contract
- (c) Summary, Issues, Problems and Variations
 - (i) Specified Requirements
 - A summary of the contract requirements, include: total number of marks surveyed, density requirements and mark selection criteria.
 - (ii) Variations
 - Where any dispensations have been agreed by LINZ, either by correspondence or a formal variation to the contract, these should be stated.
 - (iii) Certification of Compliance with Specifications

The following declaration, signed by the Contractor, shall be included in the Contract Report:

All work undertaken as part of this Contract is fully compliant with the Specification for Order 5 Geodetic Survey.

Signed: _____

Name: _____

Contractor

Any dispensations agreed by LINZ, should be stated in section **(c)(ii)** above.

(iv) Issues

Describe any difficulties experienced and how these were managed. Include any inconsistencies found with or recommendations for the specification

(v) Compulsory Attributes

The following declaration, signed by the Contractor, shall be included in the Contract Report.

All marks upgraded as part of this Contract fully comply with the required Geodetic Mark Attributes, Section 4.1 Specification for Order 5 Geodetic Survey.

Signed: _____

Name: _____

Contractor

Any dispensations agreed by LINZ, should be stated in section **(c)(ii)** above.

(d) Marks Selected

(i) High Order Marks

List all High Order Marks connected to, include: Geodetic Code, Mark Name and Order.

(ii) Local High Order Marks

List all Local High Order Marks connected to, include: Geodetic Code, Mark Name and Order.

(iii) Existing Proposed Upgraded Marks

List all existing marks surveyed for upgrade to Order 5, include: Geodetic Code and Mark Name and current Order.

(iv) New Proposed Upgraded Marks

List all new marks installed and surveyed for upgrade to Order 5, include: Geodetic Code and Mark Name.

(v) Marks Looked For but Not Found or Found Destroyed

List all marks looked for and not found: Geodetic Code and Mark Name and any evidence to support this.

(e) Reliability Checks

(i) Reliability Check Methodology

Describe the methodology used to prove reliable, the marks being upgraded to Order 5.

(ii) Reliability Check Certification

The following declaration, signed by a Licensed Cadastral Surveyor, shall be included in the Contract Report:

All proposed control marks within this contract have been correctly identified and are reliable.

Signed: _____

Name: _____

Licensed Cadastral Surveyor

Any dispensations agreed by LINZ, should be stated in section **(c)(ii)** above.

(iii) Nearby Marks Test

After running the Nearby Marks Test comment on any discrepancies identified and provide evidence for the correct name.

<p>INFORMATION – Nearby Marks Test</p> <p>The Near Marks Test can be found on the LINZ website:</p> <p>http://www.linz.govt.nz/apps/gdbmatchcoords/index.aspx</p>

(f) Field Observations

(i) Summary of Field Operations

Outline field procedures, mark selection and observation schedule

(ii) Equipment Used

Provide details of the equipment used and its calibration

(iii) Methodology

Describe the methodology used to upgrade marks and ensure accuracy standards are met.

(g) Data Processing

(i) Software Used

List data processing software used.

(ii) Data Quality

Describe quality assurance checks

- (iii) Baseline Processing
 - Describe the baseline processing methodology and processing style(s) used.
- (h) Adjustment
 - (i) Software Used
 - List adjustment software used.
 - (ii) Fixed Stations
 - List, for each adjustment, all fixed stations include: Geodetic Code
 - (iii) Observation Errors
 - List, the observation errors used for each adjustment.
 - (iv) Adjustment Compliance.
 - Demonstrate compliance with section **6**: Observation accuracy test, Local Accuracy Test and Network Accuracy Test. Justify any allowable outliers.
- (i) Maintenance
 - (i) Higher Order Marks
 - For each High Order Mark, for which maintenance was completed, list each mark and describe the maintenance.
 - (ii) Upgraded Marks
 - For each upgraded mark (either new or existing), for which maintenance was completed, list each mark and describe the maintenance.
 - (iii) Marks not Maintained - Reporting
 - For each mark visited, for which maintenance was not completed, list each mark and describe the maintenance required.
 - (iv) Appendices (Optional)
 - (i) Network Diagrams
 - Provide network diagrams for each selected area.

GUIDELINE - Contract Report

The Contract Report may be presented in the Contractor's corporate style. However, the above headings need to be used to enable a consistent review by the National Geodetic Office. This report structure also helps to ensure that all required points are discussed by the Contractor and thereby reduce the likelihood of re-work. Where there is no information applicable to a heading, this should be clearly stated. Additional headings may be added by the Contractor, if required.

15.9 Approved Traffic Management Plans

All Traffic Management Plans should be approved by the relevant local authority or their delegate. Approved copies of these plans should be supplied in the form specified in section **15.11**

15.10 Field Codes

15.10.1 Mark Status

The following MRKS codes shall be used to indicate the status of a mark:

MRKS Code	Description
PEND	Mark is not currently in the geodetic database
COMM	Mark exists in the geodetic database

15.10.2 Existing Mark

The following EXMK codes shall be used to indicate the status of a mark:

MRKS Code	Description
N	Mark is not currently in the geodetic database
Y	Mark exists in the geodetic database

15.10.3 Mark Type

The following MRKT codes shall be used to indicate the type of mark:

MRKS Code	Description
IS	Iron Spike Iron Rod
IT	Iron Tube Iron Pipe
LP	Lead Plug
NAIL	Nail
PIN	Stainless Steel Pin Bronze Plaque
OTHR	Any other mark type, including forced centring
UNMK	Unmarked
UNKN	Not Specified

15.10.4 Land District

The following MRKT codes shall be used to indicate the land district a mark is located in:

DISTRICT Code	Description
AA	Antarctica
CH	Canterbury
CI	Chatham Islands
GS	Gisborne
NA	Hawkes Bay
BM	Marlborough
NN	Nelson
AK	North Auckland
OI	Offshore Islands
DN	Otago
HN	South Auckland
IN	Southland
NP	Taranaki
WN	Wellington
HK	Westland

15.10.5 Coordinate Order

The following CROD codes shall be used to indicate the existing Order of mark:

CROD Code	Description
2k0	Order 0
2k1	Order 1
2k2	Order 2
2k3	Order 3
2k4	Order 4
2k5	Order 5
2k6	Order 6 or lower

15.10.6 Observation Method

The following METH codes shall be used to indicate the methodology used to make the observations:

		Standard Error Constant Component			Standard Error Proportional Component		
METH Code	Description	East mm	North mm	Up mm	East ppm	North ppm	Up ppm
CORS1	Vector derived from static or fast static GNSS data where at least one mark is a Continuously Operating Reference Station (CORS)	3	3	6	0.4	0.4	0.8
STAT1	Vector derived from static or fast static GNSS data	4	4	8	0.5	0.5	1
RTK1	Vector derived from RTK, PPK or Network RTK data	8	8	12	1	1	1

15.10.7 Mark Physical State

The following MPSC codes shall be used to indicate the physical state of a mark:

MPSC Code	Description
DEST	Destroyed
DMGD	Damaged
NFND	Not Found
RELB	Reliable
THRT	Threatened
NSPE	Not Specified

15.10.8 Mark Protection Type

The following MRKR and MRKR2 codes shall be used to indicate the mark protection structure:

MRKR/MRKR2 Code	Description
2MBE	2m Beacon
4MBE	3m or 4m Beacon
CICV	Cast Iron Cover
COVR	Wooden or Concrete Cover and Box
MKPT	Marker Post
PREN	Post and Rail Enclosure
NOPR	No Protection
NSPE	Not Specified
NSTD	Non Standard Beacon

15.10.9 Beacon Type

The following MRKE codes shall be used to indicate the beacon type:

MRKE Code	Description
AA	Cairn
CN	Chimney
LH	Lighthouse
MR	Marine Beacon
MS	Mast
NB	Not Beacons
ND	Unknown
PL	Pillar
TO	Tower
TT	Transmission Tower
2M	2m Beacon
4M	3m or 4m Beacon
NS	Non Standard Beacon

15.10.10 ID Plate, Plaque and Information Plate

(a) The following PLQEXIST, PLTEXIST and INFOEXIST codes shall be used to indicate the presence of ID plaques, ID plates and Information plates:

PLQEXIST, PLTEXIST, INFOEXIST Code	Description
E	ID plaque, ID plate or information plate exists
Y	ID plaque, ID plate or information plate installed
N	ID Plaque or ID plate non-existent and not installed

- (b) Where an ID plaque or ID plate does not exist and a replacement has not been installed, this shall be explained in the COMM field of the Mark Details File, section 15.6.

15.10.11 GNSS Suitability

The following GNSSU codes shall be used to indicate the GNSS suitability of a mark:

GNSSU Code	Description
GD	Good
PR	Poor
US	Unsuitable

15.10.12 Cell Phone Coverage

The CELL field shall be used to indicate cell phone coverage of at least one provider at a mark:

Status	Description
Good	Strong signal
Poor	Weak but reliable signal
No Coverage	No signal or unreliable signal
No Tested	Network signal not tested

The cell phone coverage at a mark shall be reported in the following format:

Provider: status, Provider: status, Provider: status
--

Eg. Telecom: Good, Vodafone: Good, 2Degrees: Not Tested

15.11 File Names

(a) Contract deliverable files shall use the following naming conventions:

File Type	File Name Format	File Format
Before Photo	CODEYYpbV.jpg	JPG
After Photo	CODEYYpV.jpg	JPG
Mark and Site Image	CODEYYpV.jpg	JPG
Access Diagram	CODEYYad.png	PNG
Finder Diagram	CODEYYad.png	PNG
Non-standard beacon Diagram	CODEYYbd.png	PNG
Mark data file	BBEEEEEm.csv	CSV
Height difference data	BBEEEEEl.csv	CSV
Vector data	BBEEEEEv.csv	CSV
Mark Reliability File	YYNNNNrV.xls	XLS
Mark Reliability Traverse Sheet	CODEYYrV.tif	TIF
Mark Details File	YYNNNNmV.csv	CSV
Contract report	YYNNNNs.doc YYNNNNs.pdf	DOC PDFS
Network diagram	YYNNNNV.tif YYNNNNV.jpg	TIF JPG
SNAP command file	BBNNNN.snp	SNAP
SNAP listing file (minimally constrained adjustment)	BBfNNNN.lst	SNAP
SNAP listing file (constrained adjustment)	BBcNNNN.lst	SNAP
Progress payment invoice	BBNNNNiV.pdf	PDF
Final invoice	BBINVOICE.pdf	PDF
Approved traffic management plans	BBEEEEEE.pdf	PDF

- (b) Files shall be provided in the following formats:

Format	Document Type	Details
JPG	JPEG Image	Resolution: 200 dpi Colour: True Colour
TIF	TIFF Image	Resolution: 200 dpi Colour: Black and white Compression: CCITT Group 4 (2d)
PNG	PNG Image	Resolution: 200 dpi Colour: Black and white
DOC	Microsoft Word Document	
XLS	Microsoft Excel Spreadsheet	
CSV	Comma delimited text file	
PDF	PDF Document	Searchable text is not compulsory
PDFS	PDF Document	Text within document is searchable
SNAP	SNAP adjustment files	Meet SNAP data format specifications

15.12 Abbreviations

- (a) Upper case characters in file names and in record formats represent:

Abbreviation	Description	Example
CODE	Geodetic Code	HNPC
YY	Year of information (last two digits)	11
HH.MM	24 hour time of information	13.25
YYYY.MM.DD	Date of information	2011.04.15
V	Sequential file number	1
NNNNNNN	Schedule code	2006102
NNNNNNNNN	Cell code	200610201
NNNN	Last 4 digits of cell code	0201
FFF	Sequential file number, assigned by Contractor	001
BB	Contractor ID (assigned to Contractor by LINZ, see 15.12(b) below)	LI
EEEE	Unique number within deliverables, assigned by Contractor	1234
EEEEEE	Unique number within deliverables, assigned by Contractor	12345

- (b) Where a Contractor has not been assigned an ID, the abbreviation **XX** shall be used in deliverable file names.

15.13 Summary of Required Files (Information Only)

The following table summarises the files that are to be provided with the contract deliverables. The table is informational only, if it conflicts with other sections of this specification, the other sections take precedence.

It is the responsibility of the Contractor to ensure that all necessary files are correctly provided to fulfil their contractual obligations to LINZ.

Deliverable	Format	Reference	Comment
Mark Data File	CSV	Section 15.3	Lists all marks referenced in vector or height data files
Height Difference File	CSV	Section 15.4	Lists height difference observations
Vector Data File	CSV	Section 15.5	Lists vector observations
Mark Details File	CSV	Section 15.6	Lists all marks visited or maintained in a contract
Adjustment Command File	SNAP .cmd	Section 6.7	Free and constrained SNAP adjustment command files
Adjustment Listing File	SNAP .lst	Section 6.7	Free and constrained SNAP adjustment listing files
Contract Report	DOC PDFS	Section 15.8	Report
Final Invoice	PDF	Section 15.2	Final digital invoice
Progress Payment Invoice	PDF	Section 15.2	Digital progress payment invoice(s)
Before Photo	JPG	Section 13.4.1	Photo of Mark, Site and Protection Structure before maintenance
Mark and Site Image	JPG	Section 13.3	Template showing Mark, Site and Extended Site photos
Access Diagram/Finder Diagram	PNG	Section 14.1	Picture conveying mark location
Non-standard Beacon diagram	PNG	Section 14.8	Image of a non-standard beacon and its heights
Approved traffic management plans	PDF	Section 15.9	Final approved traffic management plans
CSD for new marks	Landonline	Section 5.6	All new marks shall be shown on a CSD
Reliability Traverse Sheet	TIF	Section 15.6	Provides evidence that the marks are reliable and correctly identified
Reliability File	XLS	Section 15.6	Provides evidence that the marks are reliable and correctly identified