Standard Specification for Engineering Survey

20 December 2023 | Version 4.0

NORTHERN TERRITORY GOVERNMENT

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Version	Date	Author	Changes made
1.0	10 April 2017	DIPL Civil Design	First Version
2.0	5 September 2018	DIPL Civil Design	Inclusion of geo-referenced aerial imagery and drive through video requirements
2.1	8 October 2018	DIPL Civil Design	Updated geo-referenced aerial imagery requirements
2.2	15 October 2018	DIPL Civil Design	Table 3, Section 11.4.6 and Section 11.4.7
3.0	9 April 2020	DIPL Civil Design	New format, changes to Sections 10.1, 10.4.3, 10.4.6, 10.9, 10.12, 10.14, 10.21.2, 12 and minor changes throughout
3.1	21 May 2020	DIPL Civil Design	Reference correction to Table 2 and Section 10.4.7 and minor change to Section 12.
3.2	7 February 2022	DIPL Civil Design	Changes to Tables 2 and 3, Sections 9, 10.14, 10.20 and 10.21, 12 and 13 and the addition of Survey Control Marks Accuracy Verification at Section 10.4.3, and Geo-referenced aerial imagery resolution at Section 10.21.2.
4.0	20 December 2023	Cross Solutions/DIPL Civil Design/DIPL Survey	Changes to Acronyms, References, Qualification od surveyors, Survey datum, Accuracy, Survey control marks, Field markings, Measurement accuracy, Surface model, Underground services, Survey Report, Lodged information, Data capture methods, and the inclusion of Replacement of destroyed marks, and Survey audits.

Acronyms	Full form
AHD	Australian Height Datum – national height datum based on mean sea level and adopted in 1971
AUSGeoid	The national quasi-geoid model for converting between GDA ellipsoid heights and AHD heights.
AUSPOS	Online processing service provided by Geoscience Australia for calculation of GDA coordinates and derived AHD from static GNSS data
BM	Bench Mark – permanent mark placed in a vertically stable location for providing height reference, usually AHD
Confidence Interval	A one dimensional range within which an estimated result is expected to fall at a particular level of confidence. It can also be thought of as the (±) range about the expected value which describes the level of uncertainty in a measurement or estimated result.
Consultant	The legal entity that is contracted to execute the survey
CRM	Coordinated Reference Mark – permanent mark placed in a stable location for providing position and height reference. These marks are registered by the Surveyor General.
CSF	Combined Scale Factor – used to convert a distances at ground level to corresponding distance on the grid such as MGA. It is the product of the point scale factor and height factor. Ground distance x CSF = Grid distance. To convert a whole project from ground level coordinates to MGA coordinates, scale in X and Y directions by the average project CSF.
DTM	Digital Terrain Model – three dimensional model of the surface features of the site
FTP	File Transfer Protocol - a standard network protocol used to transfer computer files between a client and server on a computer network
GDA	Geocentric Datum Australia – mathematical definition of the earth's shape with its origin at the centre of mass
GNSS	Global Navigation Satellite System – a constellation of orbiting satellites working in conjunction with a network of ground stations that transmit signals enabling roving receivers on the ground or in the air to determine latitude and longitude
GPR	Ground Penetrating Radar – device for locating the position and depth of underground features
GSD	Ground Sample Distance
ICSM	Intergovernmental Committee on Surveying and Mapping
IM	Indicator Mark – tall mark placed near a ground mark to indicate its location
LiDAR	Light Detection and Ranging – technology that uses ultraviolet, visible, or near infrared light to measure distance to objects and capture dense point clouds of information from a mobile platform such as a fixed wing aircraft or helicopter
MGA	Map Grid Australia – cartesian coordinates from a Transverse Mercator Projection of GDA latitudes and longitudes
MLS	Mobile Laser Scanning - technology that captures dense point clouds of information from a laser scanner mounted on a mobile platform such as a motor vehicle or boat.
NTG	Northern Territory Government
PRP	Permanent Reference Point – point of known road chainage
RCM	Road Centreline Mark – mark indicating the road centreline on site

Road Pavement	That portion of a road constructed for the structural support of, and to form the running surface, for traffic. May be sealed or unsealed.
RGB	Red, Green, Blue colour space
RPA	Remotely Piloted Aircraft - aircraft that are operated by remote control either fully or intermittently. Often they have autonomous capabilities for routine operations such as collection of imagery over a specified area.
RTK	Real Time Kinematic – GNSS technology that enables measurement of coordinates and levels in real time
SCM	Survey Control Mark – survey mark on site used as a reference for coordinates and levels
SU	Survey Uncertainty - is the uncertainty of the horizontal and/or vertical coordinates of a point relative to the survey in which it was observed and is free from the influence of any imprecision or inaccuracy in the datum connection. Therefore, SU reflects only the uncertainty resulting from survey measurements, measurement precisions, network geometry and the choice of constraint. It is expressed at the 95% confidence level.
TLS	Terrestrial Laser Scanning - technology that captures dense point clouds of information from a laser scanner mounted at a fixed location during the scanning process.

CONTENTS

1 PURPOSE

This document specifies the minimum requirements for engineering surveys conducted by or for the Northern Territory Government.

The Consultant shall perform and present all survey work in accordance with the following requirements to ensure that uniformity and consistency of detail, format, quality, accuracy and procedure is achieved.

2 SCOPE

This document applies to all engineering ground surveys commissioned for the purposes of engineering design, analysis and computation.

Any project specific requirements including exemptions or additions to this specification shall be specified in the Project Survey Brief.

Further advice and information can be obtained by contacting the relevant Project Manager.

3 REFERENCES

3.1 AUSTRALIAN STANDARDS AND AUSTROADS GUIDES

- AS 1100.401 (1984), Technical drawing Part 401: Engineering survey and engineering survey design drawing
- AS 1742.3 (2019), Manual of uniform traffic control devices Part 3: Traffic control for works on roads
- Austroads Guides to Temporary Traffic Management Parts 1 to 13
- AS/NZS ISO9001 (2016), Quality Management Systems
- AS 5488 (2022) Classification of Subsurface Utility Information

3.2 LEGISLATION

- Northern Territory Aboriginal Sacred Sites Act 1989
- Dangerous Goods Act 1998, Northern Territory
- Energy Pipelines Act 1981, Northern Territory
- Heritage Act 2011, Northern Territory
- Licensed Surveyors Act 1983, Northern Territory
- Work Health and Safety (National Uniform Regulations) Act 2011, Northern Territory
- Ports Management Act 2015
- Telecommunications Act 1997
- Australasia Railway (Special Provisions) Act 1999

3.3 SURVEYING STANDARDS & GUIDELINES

The following documents can be accessed at https://surveyorsboard.nt.gov.au/information

- Provisional Standards and Guidelines for the Use of GNSS on Control Surveys within the Northern Territory (March 2017), Version 3.5
- Standard for the Australian Survey Control Network (2020), Version 2.2, ICSM
- Guideline for the Adjustment and Evaluation of Survey Control (2020), Version 2.2, ICSM
- Guideline for Control Surveys by GNSS (2020), Version 2.2, ICSM
- Guideline for Control Surveys by Differential Levelling (2020), Version 2.2, ICSM
- Guideline for Conventional Traverse Surveys (2020), Version 2.2, ICSM
- Guideline for the Installation and Documentation of Survey Control Marks (2020), Version 2.2, ICSM

4 QUALITY MANAGEMENT SYSTEMS

The Consultant shall be certified to, and implement the requirements of ISO 9001 Quality Management Systems. The requirements for control and calibration of survey instruments and ancillary equipment used for completing this contract shall be complied with.

5 QUALIFICATION OF SURVEYORS

A qualified surveyor shall direct and be responsible for all survey work and able to demonstrate competence in carrying out the required tasks. Minimum qualifications for the survey elements are:

- Survey Control and Engineering Ground Survey - A person who holds a Diploma in Surveying, or a recognised equivalent, from a recognised tertiary institution and possesses at least three years appropriate practical experience as a survey party leader.
- Cadastral Boundary Model – A surveyor licensed under the NT Licensed Surveyors Act.

6 SAFE WORK PRACTICES

Further to the Conditions of Tendering and Contract, the Consultant shall ensure that their employees, agents or sub-consultants or their employees, agents or sub-contractors or their employees or agents comply in so far as they are applicable to the execution of work under the contract with the requirements of:

1. The Work Health and Safety (National Uniform Regulations) Act 2011
2. The Dangerous Goods Act 1998

And in addition to the above Acts, be cognisant of the requirements of:

- Relevant Australian Standards
- Darwin Port Operations Pty Ltd (with regard to port operations)
- Telstra, NBN (with regard to telecommunications operations)
- Origin Energy, Central Energy Australia Pty Ltd, NT Gas Pty Ltd, APA Group, Jemena, and other gas companies from time to time
- Aurizon – Rail and Freight Operator

6.1 WORK IN THE VICINITY OF POWER AND WATER CORPORATION ASSETS

Prior to commencing work in the vicinity of any sewerage system, high voltage cable or power line or other high voltage structure, the survey Consultant shall contact the Power and Water Corporation Authorisations Administrator at AuthorisationsAdministrator.PWC@powerwater.com.au, to obtain and become cognisant with written guidelines or procedures setting out safe practices for working in or adjacent to such hazardous areas.

When working in the vicinity of sewerage systems, high voltage cables or power lines or other high voltage structures the Consultant shall follow all directions and instructions issued by the Power and Water Corporation. Opening of any sewerage manholes shall be undertaken by the Power and Water Corporation.

6.2 WORK IN THE VICINITY OF GAS PIPELINES AND FUEL LINES

In accordance with the Energy Pipelines Act, the Consultant shall obtain the written approval of the relevant asset owner before commencing any of the following activities in the vicinity of gas pipelines:-

1. Any activities within the pipeline right-of-way which involve construction of any kind including:
    - excavation for drains, pipelines or sewers,
    - excavation for buried utilities or services,
    - construction or maintenance of roads or tracks,
    - boring of holes for posts or any survey or exploration work involving excavation, explosives or vibration.
2. Any nearby construction activities which are likely to affect the right-of-way, such as re-routing surface water flows, construction of high voltage lines, or erection of large metal structures.
3. Any passage of heavy vehicles and equipment over the pipeline other than on public roads.

When working in the vicinity of gas pipelines the Consultant shall follow all directions and instructions issued by the asset owner.

Similarly the Consultant shall follow all directions and instructions issued by the asset owner of fuel lines.

6.3 WORK WITHIN RAILWAY RESERVES

Prior to commencing work within any railway sites, the Consultant shall obtain the consent of Aurizon, and comply with its guidelines or procedures setting out safe practices for working in or adjacent to their sites, phone 13 23 32.

Whilst working within railway sites the Consultant shall follow all directions and instructions issued by Aurizon.

7 CULTURAL AND HERITAGE SITES

All prescribed archaeological places and objects are protected under the Heritage Act 2011 and the Northern Territory Aboriginal Sacred Sites Act 1989, whether they have been recorded or not and regardless of whether they have been disturbed in the past or otherwise. It is an offence under the Heritage Act 2016 to damage or remove a heritage place or object.

Known information about cultural and heritage sites will be provided to the Consultant including any:

- Certificates from the Aboriginal Areas Protection Authority (AAPA);
- Restrictions by an Aboriginal Land Trust or Land Council

Do not enter Aboriginal Sacred Sites without appropriate authority, and avoid disruption to identified archaeological sites. All conditions under an AAPA Certificate must be adhered to.

The Consultant shall ensure that his employees are aware of the possibility that archaeological and heritage sites may exist within the work area, and of the requirement to notify the Department if a site is encountered.

8 ENTRY TO LAND

The Consultant shall obtain permission from landowners before entering private property. The Principal's Representative will as necessary provide the Consultant with an appropriate letter to facilitate entry for the purpose of conducting the survey. The Consultant will maintain a record of all contacts made for this purpose.

Where any land proposed for survey is on a Crown Reserve, or is a designated Aboriginal Sacred Site administered under an Aboriginal Land Trust or is protected under Native Title or any other encumbrance, the Consultant shall obtain all necessary clearances or permits from the appropriate authorities and/or occupiers of the land.

New tracks shall not be formed, existing tracks altered, fencing cut, clearing carried out, or damage or disturbance of any kind effected unless strictly necessary for the purpose of the Project Survey Brief and permission and clearances have been obtained. The Consultant shall ensure that such disturbances are the minimum required and shall reinstate, clean up and leave the site as close to its pre-disturbed condition as possible, and a safe condition. The Consultant shall be responsible for the cost of reinstating any damage to property resulting from work carried out under the Project Survey Brief.

9 TRAFFIC CONTROL

Where survey involves working on, or immediately adjacent to, trafficked roads, the Consultant shall submit a Traffic Management Plan in accordance with the requirements defined in the "Provision for Traffic" section of the NTG Standard Specification for Roadworks, and obtain the appropriate approvals.

The Consultant shall take measures for the protection of employees, other road users and property, and assume responsibility for minimising obstruction and inconvenience to the public, and the safe conduct of traffic through or around the works, 24 hours a day, from commencement to completion of the survey works. The Consultant additionally needs to be cognisant of "restricted work hours in built up areas" and adhere to the requirements defined in the subsection "Work in Built up Areas" of the NTG Standard Specification for Roadworks.

10 SURVEY

10.1 GENERAL

The Consultant is required to provide a three-dimensional mathematical representation (model) of the site upon which geometric design, analysis and computation can be based and should be aware that no minimum or maximum number of points, cross sections or grid criteria are requested.

Sufficient measurements are required to ensure all points and strings in the digital model accurately reflect their true in-situ geometric shapes and locations, inclusive of changes in the vertical and horizontal directions within road pavements and the general terrain.

Intersections which have been identified for upgrading will require cross sectional surface pickup along the main road at 5m spacing, extending to at least 30m down the minor road, and for at least 30m each side of the minor road centreline. Survey surface pickup can then continue at say 25m intervals.

The survey shall:

1. Establish permanent survey control marks (SCMs) from which the works can be set out.
2. Comply with the specific requirements defined in the Project Survey Brief, and ensure that,
    a. all natural and artificial features occurring within the survey project area are captured and represented in the digital model as points and strings.
    b. appropriate text annotation is provided to adequately define and describe the following:
        - Road names.
        - Rivers, streams or lake or other water course names.
        - Names and numbers of CRMs, SCMs, BMs or any other control used for the survey or located in the survey project area.
        - Permanent Reference Point (PRP) distances.
        - Distance markers legend and distances.
        - Sign annotation on all signs
        - Culvert type, size or diameter and number of pipes or boxes. Note; culvert/pipe dimensions shall be internal measurements and description of protection works.
        - Adjacent property boundaries, parcel numbers and Pastoral Station names
        - Adjacent fences
        - Pavement marking
        - Overhead services
        - Underground services
        - Chainages on road structures derived from the closest known PRP
        - Any other relevant annotation that will assist in the definition of features within the survey area.

10.2 SURVEY CONTROL MARKS

10.2.1 Replacement of Destroyed Marks

As per section 62(1) of the Licensed Surveyors Act 1983 “A person shall not, without lawful authority, destroy, obliterate, remove, injure or deface a survey mark.” Where a Coordinated Reference Mark (CRM) is destroyed during works, it is the responsibility of the contractor to replace and organise the survey of a new mark in the same general vicinity. The mark shall be coordinated to be part of the survey control network, and have a surveyed connection to the cadastre undertaken or supervised by a Northern Territory registered Licensed Surveyor. It is noted that the new mark will not have the same number, and data allocation will need to be requested at surveyservices@nt.gov.au. Data and supporting documents will need to be submitted to the Department in accordance with the requirements found in the Provisional Standards and Guidelines for the Use of GNSS on Control Surveys. The Department should be notified in advance, as a connection to the existing mark may be required before it is destroyed. If works are related to a Northern Territory Government contract, it is preferred that the surveys relating to establishing of the new CRM be undertaken by a member of the Department’s Cadastral Surveying Services Panel.

10.3 SURVEY DATUM

10.3.1 Coordinate Datum

The horizontal position of field data is to be supplied on the appropriate zone of the current Map Grid of Australia (MGA) datum unless specified otherwise in the Project Survey Brief.

A text tabulation of the identity number or name, coordinates, reduced AHD level, vertical method (adjusted spirit levelling or derived from GNSS), geoid model type of mark and status (lodged, approved, adopted) for each control point is to be included in the survey report, data file and shown on the verification plots together with identification of the marks used for horizontal and vertical datum.

10.3.2 Connection to MGA

When an alternative coordinate datum has been specified in the Project Survey Brief, the surveyor will provide a common point at each end of the project establishing the relationship between the assumed coordinate datum and the MGA coordinate system. The alternative coordinate datum must not be similar to MGA.

Include equivalent coordinates, the average Combined Scale Factor (CSF) and the difference in orientation of the north points as a text note in the data file and on the verification plots.

10.3.3 Height Datum

Where possible, the surveyor shall use Australian Height Datum (AHD). Where AHD is not possible, height information will be on an assumed datum.

For projects in coastal or marine locations the height difference between AHD and Chart Datum shall be determined where possible.

10.3.4 Chainage Datum

The chainage of the start point of the survey will be derived from the nearest Departmental Permanent Reference Point (PRP) for the road being surveyed.

Refer to the Project Survey Brief for the PRP to be used for this survey.

10.4 FIELD MARKING

10.4.1 Safety

Survey marks may constitute a danger to the public, land owners and users, if visual indicator marks have been interfered with or removed. In locations where this is likely to occur, survey marks are to be driven to ground level and be of a type suitable for the location.

The surveyor is required to locate marks in locations where minimum disturbance is likely to occur and ensure they are clear of underground services.

Survey Control Marks (SCM)

Unless already existing, the surveyor shall place a minimum of three SCMs to be used for horizontal and vertical control on each project in locations where they will be stable and unlikely to be disturbed by the future works. Marks should be located so that they are inter-visible to adjacent marks in each direction, and be no further than 300 metres apart.

Each SCM shall be a:

- CRM; or
- Star Iron not less than 600 mm long in rural areas; or
- Spike not less than 200 mm long in urban areas; or
- Other suitable mark

Each mark is to be uniquely identified by stamping the identity into a solid aluminium tag fixed to the mark or the mark itself for a CRM.

When directed by the Principal and prior to commencing field work, a request shall be made to the Survey Land Records section of the Department's Survey Branch to request an allocation of CRM numbers and requirements. These generally include:

- Proposed location
- Construction
- Recovery marks

Do not place SCMs within 20 metres of a rural road centreline, or within a table drain.

10.4.2 Indicator Marks (IM)

The surveyor will:

- Use pressed metal fence spreaders of minimum length of 1000 mm.
- Place indicator marks at SCMs.
- Not place indicator marks within 5 metres of the edge of a rural road carriageway.

10.5 ACCURACY

10.5.1 Survey Control Marks - Horizontal Uncertainty

MGA coordinates shall be determined by connection to at least two CRMs or other registered coordinated marks if existing within 10 km of the project extents. In locations where coordinated control marks do not exist, GNSS data shall be recorded on at least two SCMs and MGA coordinates calculated using the AUSPOS service.

The SU of Control Marks relative to the nearest MGA datum mark or new adjoining marks shall be no more than a maximum horizontal circular confidence of radius (r) at the 95% confidence interval.

$$r = 2.45 \times 15(K+0.2) \text{ mm}$$

Where:

K = distance between nearest marks in km

10.5.2 Survey Control Marks - Vertical Uncertainty

The levels of all survey control points shall be established by differential levelling or GNSS observations separately or in combination using known marks with AHD levels (Bench Mark, CRM, other registered coordinated marks). In locations where known marks do not exist, the AHD levels of SCMs calculated using the AUSPOS service are to be used.

- Two-way differential levelling from a known mark, or
- One-way differential levelling between at least two known marks, or .
- Static GNSS methods between at least three known marks.

The level difference, in metres, between the forward and backward levelling of a two-way run or between two known Bench Marks in a single run shall not exceed 12√K mm, where K is the distance in kilometres and K is greater than or equal to 1 km. The vertical accuracy for distances less than 1 km shall be on a pro rata basis relative to the 1 km tolerance, 12 mm.

10.5.3 Survey Control Marks – Standards and Guidelines

The survey and evaluation of SCMs shall be in line with the standards and guidelines outlined below as applicable to the measurement methodology used:

- Provisional Standards and Guidelines for the Use of GNSS on Control Surveys within the Northern Territory, https://surveyorsboard.nt.gov.au/__data/assets/pdf_file/0017/410246/Provisional-Stds-and-Guide-GNSS-Control-Surveys-V3.5-20170313.pdf
- Intergovernmental Committee on Surveying and Mapping (ICSM), Standard for the Australian Survey Control Network Special Publication 1 (SP1), https://www.icsm.gov.au/standard-australian-survey-control-network-special-publication-1-sp1

The survey report shall describe the methods used for determining the coordinates and heights, connection to datum, adjustments and the Survey Uncertainty achieved. Adjustment reports are to be included or attached.

Should the establishment on new CRM's be specifically included in the project scope, the Surveyor shall lodge the required survey data in accordance with the relevant requirements of the Director of Survey, Land Information Group, DIPL.

10.5.4 Measurement Accuracy for Points and Linear Features

Survey control, technologies, observation methodologies, error mitigation and processing shall ensure that measurements to point and linear features are within the specified positional and height accuracy requirements.

The uncertainties stated are relative to the adopted values of the nearest survey control mark.

Table 1: Measurement Accuracy for Point and Linear Feature Classification

Classification	Horizontal Uncertainty	Vertical Uncertainty
A	15 mm	10 mm
B	20 mm	15 mm
C	30 mm	20 mm
D	50 mm	30 mm
E	100 mm	50 mm
F	200 mm	50 mm
G	50 mm	50 mm
H	300 mm	500 mm

Note: Uncertainties are at the 95% Confidence Interval

Table 2: Feature Type and Accuracy Classification

Feature Type	Classification
Asphalt Resurfacing of Paved Surfaces	A
Kerbs, Rails, Cadastral Boundary Marks, Bridges	B
Sealed Roads, Other Hard Surfaces, Drainage Structure Inverts, A/G Services (Headwalls, Pits, Manholes, Valve covers etc.)	C
Unsealed Paved Roads	D
Unpaved Roads, Formed Surfaces, Road Furniture, General Features (Buildings, Fences, Walls, light poles, traffic lights, power poles etc.)	E
Natural Surface, Open Drains, Ground Features, Trees	F
U/G Services Quality Level A (refer Section 10.13)	G
U/G Services Quality Level B (refer Section 10.13)	H

Regardless of defined uncertainties, linear and point features must adhere to their true position relative to the position of adjacent features.

Note that the highest order of accuracy will be required for asphalting construction works to establish true and relevant grading of the road surface.

10.5.5 Interpolated Points on Feature Strings

Linear features shall be captured such that the accuracies of interpolated points on the defined string are within twice the nominated accuracy for the relevant classification.

10.5.6 Barrier Strings

The production of the final triangulation mesh is to be controlled through the use of barrier strings/break lines. These strings will represent features that form the edges of triangles in the Digital Terrain Model (DTM), such as tops of banks or road shoulders.

The barrier string attribute is implicit within the feature coding and shall be the only acceptable form of triangle modification. All barrier strings appearing in the survey data must be coded in the field.

The DTM must be capable of re-creation directly from the survey information supplied, without the need for interactive editing.

10.5.7 Surface Model

Within the survey project area, sufficient points and linear features shall be captured to ensure that the DTM meets the following uncertainty requirements.

Points interpolated on the planar triangulation surface, shall be within the vertical uncertainty nominated in the table below for the relevant surface type.

Table 3: Interpolated Surface Uncertainty

Surface Type	Vertical Uncertainty
Asphalt Resurfacing of Paved Surfaces	10 mm
Sealed Roads, Other Hard Surfaces	40 mm
Paved Roads (Unsealed)	60 mm
Unpaved Roads, Formed Surfaces, Open Drains, Natural Surface	100 mm

Note: Uncertainties are at the 95% Confidence Interval

10.5.8 Verification of the Survey Model

Unless specified otherwise in the Project Survey Brief all methods of survey data collection are subject to verification of the DTM by ground survey.

Verification shall be carried out by measuring 'quality line strings' across the project using equipment and methodology that meets or exceeds the accuracies in Section 10.5.4. A quality line string is a series of surveyed points measured approximately in a straight line across the project to give a good indication of the terrain surface. The summary of results are to be included in the survey report.

Measurements shall be observed independently from the engineering survey and use the same survey control marks. The quality line strings shall be placed on one layer and separate to all other points and strings of the survey model.

The quality line strings shall be taken at locations that do not coincide with the points in the barrier strings/break lines or the spot heights. Strings must cross the model centreline at approximately 45°.

The number of quality line strings to be observed is a minimum of three per project comprising:

- Two strings per road intersection, and
- Five strings per kilometre on urban projects, or
- Three strings per kilometre on rural projects.

The number of points along the quality line strings shall be sufficient to profile changes of grade in the model within the accuracies in Table 1. The differences in the level of the points compared to the survey model are to be calculated. To be compliant, 95% of the level differences must be within the vertical accuracies described in Sections 10.5.4 and 10.5.7 or as defined in the project scope/brief separate to this specification. Systematic errors shall not exceed half the specified vertical accuracy.

Additional or corrective survey shall be undertaken to correct the model if the 95% confidence interval is not achieved initially.

Survey Audits

An audit may be carried out to determine the compliance of a completed survey with the Standard Specification and any project specific requirements in the survey brief to ensure that a survey is fit for purpose. The audit may involve:

- A review to confirm that self-checks are consistent with the survey deliverables.
- A more detailed review of presentation of the deliverables.
- A field audit to verify accuracy of survey control and the DTM.
- A field audit to verify that all features are included and their location and definition is correct.

10.6 BOUNDARIES

10.6.1 Property Boundaries

The surveyor shall locate and connect to, sufficient original marks to establish connection with property boundaries over the length of the project within an accuracy of 0.15 m in urban areas and 0.5 m in rural areas. A surveyor licensed under the Licensed Surveyors Act 1983 shall be responsible for the boundary model.

10.6.2 Site Boundaries

Where sacred and heritage sites have been identified, the surveyor shall mark the site boundaries at 25 metre intervals with indicator marks if specified in the Project Survey Brief.

10.7 NATURAL AND ARTIFICIAL SURFACES

The Consultant must:

- describe natural terrain surfaces and man-made surfaces by observing changes of grade and measuring as many intermediate points between the changes of grade as are needed to ensure the description of a feature maintains 'model accuracy'. For example, if a road has varying cross-fall/grade because of rutting or pavement deformations, pick up intermediate points to accurately record those surface variations.
- unless specified otherwise in the Project Survey Brief, locate and level the natural inverts of creeks for a minimum distance of 50 metres upstream and downstream from the road or corridor centreline. Cross sections at right angles to the creek are to extend for a minimum of 50 metres from the invert or to the top of the highest bank, whichever is the further from the invert.
- describe table drains, off-let drains and windrows sufficient to enable volume computations and indicate the drainage pattern.
- undertake any additional survey requirements that may be specified in the Project Survey Brief at proposed bridge or culvert sites.
- unless specified in the Project Survey Brief, adopt a minimum survey corridor of interest of 25 metres left and right of the road centreline in a rural road situation. In some projects, the survey corridor of interest may be specified to cover a wider part of a road reserve, or the full width of the road reserve.

10.8 PITS

The Consultant must describe the top of access chambers and large pits that are flush with the surface by a single string to indicate size, shape and grade of the top.

If the chamber or pit top is above or below the surrounding surface by an amount greater than 50 mm then a corresponding string at surface level is required in addition to the pit outline.

Small Telstra jointing boxes, water gate valve covers etc. can be shown as a single central point.

10.9 BEDROCK

The Consultant is required to describe the extent and surface of bedrock outcrops.

10.10 KERB PROFILES AND CONCRETE INVERTS

Kerb and concrete invert profiles are shown on NTG Standard Drawing CS3300.

To enable new works to match into existing infrastructure or allow the modification of pavements, the survey shall ensure that the following points on each profile, as shown on standard drawing CS3300, are measured and described as per kerb profiles in standard drawing CS3300.

- Top of kerb at back of kerb
- Top of kerb at face of kerb where the set out invert point is greater than 25mm away
- Set out invert point
- Gutter edge against sealed surface
- Edges of concrete invert

10.11 VEGETATION

10.11.1 Standard Requirements

The Consultant must:

- locate all significant trees that are special due to size, colour, species, cultural or heritage value. Significant size definition is when the trunk diameter exceeds 600 mm at 1 metre above ground level and multi-stem specimens when the combined trunk diameter exceeds 600 mm and the average stem diameter is greater than 200 mm at 1 metre above ground level.

  Individual specimens are to be described by type, height, canopy diameter, trunk diameter, and location at ground level.
- describe other vegetation that falls within the project site as an outline around the denser groups or as the edge between woodland and plain.
- describe group outlines of vegetation by a general type description, average height, typical canopy diameter, average trunk diameter.

  Where the entire project area falls within open woodland with none of the features described above, a text description to that effect will suffice.

10.11.2 Project Specific Requirements

When specified in the Project Survey Brief that individual specimens are to be surveyed, the Consultant shall identify and locate:

- Individual specimens if the trunk diameter exceeds 150 mm at 1 metre above ground level
- Multi-stem specimens when at least one stem exceeds 100 mm at 1 metre above ground level

Otherwise use a perimeter string or other comment to indicate smaller specimens.

10.12 STRUCTURES

The Consultant shall describe the following (as a minimum):

Buildings:	Locate the outer wall surface.
	Wall cladding material and floor type.
	Locate protruding awnings
	Record the reduced level of the floor.
	Locate and level low eave lines.
	Locate and level overflow relief gullies
Fencing:	Location, type, height and condition including gate openings.
Bridges:	Shape and size of the deck
	Abutment and expansion joint.
Culverts:	Head wall location and levels
	Wing wall location and levels
	Apron location and levels
	Invert level of each opening and dimensions of opening
	Clear silts and gravels before invert levels are taken and standing water levels are to be observed.
	Description protection works
	Culvert type (e.g. RCP/RCBC/Corrugated Steel Pipe/Ductile Iron Pipe etc.)
Footings:	Shape, size, height, depth.
Aerials:	Sag point, and the like to enable the identification of site constraints

10.12.1 Abandoned Infrastructure

The Consultant shall locate and describe derelict, abandoned or partially demolished structures.

10.13 UNDERGROUND SERVICES

The requirements for locating of services are described in the following sections for each type of asset.

For underground services, Australian Standard AS 5488.1:2022 Classification of Subsurface Utility Information "Quality Levels" shall apply.

Each Quality Level is determined in terms of attribute information and metadata, and describes the amount and accuracy of information that is collected.

The quality level classification options are:

- Quality Level A - positive visual identification of the exposed service and direct measurement to obtain spatial position in three dimensions. Typically excavation or potholing with hydro-jet or vacuum-jet is used to expose the service for direct measurement at intervals. In this case Quality Level A only applies at those points. Refer to Table 1: Measurement Accuracy for Point and Linear Feature Classification for this Quality Level.
- Quality Level B – traced in three dimensions using electronic detection methods such as ground penetrating radar, electromagnetic detection and acoustic detection as well as interpreting surface features and services plans. The traced depths and positions are measured by survey to obtain spatial position in three dimensions. Refer to Table 1: Measurement Accuracy for Point and Linear Feature Classification for this Quality Level.
- Quality Level C – interpretation of the approximate location and attributes of the service using a combination of service plans and a site survey of visible surface features. The horizontal accuracy required by the Standard is 300 mm, however for the purposes of civil design, a higher accuracy is required for above ground services features as shown in Table 1: Measurement Accuracy for Point and Linear Feature Classification.
- Quality Level D – interpretation of the service attributes compiled from sources such as existing records, cursory site inspection and anecdotal evidence. It does not encompass any verification involving direct measurement and is only a broad indication of the location and type of the utility.

The standard requirement in urban areas involves tracing of service locations to Quality Level B. The Quality Level for other locations is specified in the Project Survey Brief.

10.14 RAILWAY

The Consultant shall:

- locate the position, shape and grade of the formation, ballast bed and tracks within the survey corridor of interest, and
- locate and level communication cables and connection pits, signalling devices, and track crossing barriers and signs.

10.15 EXISTING ROADS AND TRACKS

As a general requirement, the Consultant shall:

- locate, describe and measure the shape and grade of the trafficable surface, shoulders, kerbing, side entry pits, kerb crossings, islands, fill and cut batters, table drains and windrows at all horizontal and vertical changes to depict the true shape and location of the area.
- extend the survey to the road reserve boundaries, or as defined in the Project Survey Brief.
- at intersections, survey the side road for a minimum distance of 100 metres from the intersecting point, or as specified in the Project Survey Brief.
- locate the actual crown line which divides the surfaces or the high point of the road pavement where it does not coincide with the centre line.
- locate, describe and measure road furniture, signage, safety barriers (inclusive of post locations), line markings (by line type as per CS3400), painted pavement markings, and chevron outlines etc. line marking at intersections will need to identify the sections of painted lines (including gaps between lines).
- locate, describe and measure traffic lights, controller boxes, conduits, junction pits, electricity supply, communication pits and in-pavement vehicle detection loops.
- locate, describe and measure concrete margins and protection works of floodways.
- locate, describe and measure lined or unlined drains, batter tops and toes, drainage structures with invert levels, etc.
- All road related infrastructure strings shall be relative to the surface they are on and not at unrelated random heights.

10.16 FUEL AND GAS PIPES

The Consultant shall:

- locate and describe the position, depth below or height above ground level, the diameter, type of pipe, fuel type and valves.
- locate and level pipe racks and the support structure.

10.17 ELECTRICITY

10.17.1 Overhead Electricity Reticulation

The Consultant shall:

- locate, describe and measure the position of every main and stay pole within the project site.
- locate, describe and measure the alignment of the conductors with a line string.
- where an existing alignment or proposed centreline passes under overhead conductors;
    - locate, describe and measure the position and reduced level of the lowest conductor at the intersecting point,
    - locate, describe and measure the position and levels of the base of the poles on each side of the crossing, and
    - locate, describe and measure the position and reduced level of the sag point of the lowest conductor.
- locate, describe and measure the height of the lowest conductor where the service runs parallel to the project area.
- locate, describe and measure service poles, aerial transformers, and aerial and ground stay wires.

10.17.2 Overhead Electricity HV Transmission

In addition to the above, the Consultant shall locate, describe and measure each footing of each tower and any protection works.

10.17.3 Underground Transmission/Reticulation

The Consultant shall:

- locate, describe and measure electrical cabling by the position of pits, signs of trenching and surface markers in conjunction with service plans and with the assistance of Power and Water Corporation.
- define and describe the cable alignment with a line string.
- ascertain from plans, the depth of cables and verify where possible in the pits.
- record the size, depth and construction of pits.
- locate, describe and measure the slab of ground level transformers.
- describe whether the service is low or high voltage supply.

10.17.4 Street Lighting

The Consultant shall:

- locate, describe and measure street lighting poles within the project area and electricity supply poles adjacent to the project area when the electricity supply crosses the project boundary.
- locate, describe and measure underground electricity supply cables and cable pits.
- define the alignment of overhead and underground electricity supply with a line string.

10.17.5 Substations and Switch Yards

The Consultant shall:

- describe the substation or yard by the outline of the perimeter and whether it is stand alone or part of a structure.
- describe details inside the substation as specified in the Project Survey Brief.

10.18 WATER SUPPLY

The Consultant shall:

- locate, describe and measure the position, pipe type, diameter, and reduced levels for above ground and, where applicable and possible, below ground pipelines.
- describe the pipe alignment with a line string.
- locate, describe and measure air and scour valves, stop valves and fire hydrants.
- locate, describe and measure the size, shape and depth of associated pits.
- where requested, liaise with the PowerWater Corporation to expose pipes to locate and measure and define pipe orientation and grade information.
- when pipes are exposed, record the position of flange faces, the diameter of the flange and the number of bolt holes.
- locate, describe and measure bore compound fencing and gate openings.
- locate, describe and measure concrete slabs within the compound.
- locate, describe and measure electrical cabinets and associated electricity supply.
- locate, describe and measure the feet of bore tripods at ground level.
- note the bore identity.
- locate, describe and measure the top of the bore casing and the diameter.
- describe and measure the natural surface beside the casing and a 20 metre area at 5 metre intervals about the casing.
- locate, describe and measure the inlet and outlet pipes to the tank.
- locate, describe and measure the base of the tank and measure the wall height and the maximum water level.
- note the diameter and type of tank.
- locate, describe and measure the tank stand feet at ground level.
- locate, describe and measure the tank stand platform.
- locate the flow controller box and associated valves.

10.19 TELECOMMUNICATIONS

The Consultant shall:

- locate, describe and measure the position of the telecommunication asset, and where specified in the project survey brief, measure the depth below surface, or the height above ground level to the asset. Liaise with Telstra and other telecommunications providers where necessary.
- define the alignment of underground cables or overhead lines with a line string.
- describe whether the asset is optical fibre or copper wire.
- locate, describe and measure small boxes and pillars as a point, and large pits by outline.
- locate, describe and measure the size, shape and depth of large pits.
- locate, describe and measure security fencing surrounding aerials, and the associated sheds.

10.20 SEWERAGE

10.20.1 Sewer Alignment and Chambers

The Consultant shall:

- locate, describe and measure the position of access chambers and, where specified in the project survey brief, the depth of pipe below the surface, type and diameter of pipe.
- define the pipe alignment with a line string.
- locate, describe and measure the shape and size of the top of the access chamber.
- record the number on the lid.
- locate, describe and measure the top of the lid and the inlet and outlet inverts where possible otherwise the centre invert. Make sure external drop structures are identified and both inlet inverts levelled.
- locate, describe and measure air valves and scour valves on rising mains.

10.20.2 Sewer Treatment ponds and spray out areas

The Consultant shall:

- locate, describe and measure the top and bottom of the pond walls.
- measure the maximum effluent level, the inlet invert and the outlet level.
- locate, describe and measure overflow flood ways.
- measure the current floor of the ponds.
- locate, describe and measure the bypass system and valves.
- locate electrical and monitoring cabinets.
- locate the water supply and wash down points.
- locate, describe and measure the spray out pump, concrete slab and valves.
- locate and measure the ground level at each spray. Note the height of the spray head.
- describe the spray out network and all associated valves.

10.20.3 Sewer Pump stations

The Consultant shall:

- locate the outline of the collection and pump chambers.
- locate the water and electricity supplies.
- locate and measure inlet and outlet inverts, top and floor of chambers and maximum storage levels.

10.20.4 Septic systems

The Consultant shall:

- locate and measure the outline of the tank, inspection points, absorption lines and adjacent building outline.
- locate and measure the outlet from the building, the overflow point, and the inlet and outlet of the tank.

10.21 STORMWATER DRAINAGE

The Consultant shall:

- locate the position of access chambers, type and diameter of pipe systems crossing or within the corridor of interest.
- locate the shape and size of the top of access chambers within the corridor.
- record the number on the lid.
- measure the top of the lid, the invert of the pit and the pipe inverts.
- describe open lined and unlined drains by size, shape and grade of the channel.
- indicate the type and thickness of any lining.
- locate and measure the extent of any rock intrusions.
- locate, describe and measure levels of drop structures, rock baskets and concrete mattress by type, thickness and shape.

10.22 PHOTOGRAPHY

10.22.1 Photographs

The Consultant shall provide colour digital photographs of:

- the site
- culvert inlet & outlet structures
- signs
- any features of particular interest to the road designer, and

label or number and geo-tag photographs. The Consultant shall provide an index that includes the location of the feature, and the position and view direction from which the photograph was taken.

10.22.2 Geo-referenced Aerial Imagery

If requested in the Project Survey Brief, the Consultant shall provide geo-referenced aerial imagery of the site using drone photography (not Google Earth or similar imagery). The imagery quality and resolution will be such that surfaces and surface features are clear and legible, and shall:

- Have a resolution of 2cm – 3cm GSD
- One RGB Orth-rectified Geo-referenced image file per project (TIFF, JP2 or ECW format) of Max file size of 1GB. If project area is greater than 3 km^2 and likely to require a larger file size, then project imagery is to be presented/delivered as 1km x 1km non overlapping tiles.
- Evidence of accuracy of Geo-referencing to be provided and to include Ground Control Survey Report and Aero-triangulation report that shows adjustment results with residuals observed on established control points. The georeferenced Ortho image needs to fit to these visible control points within required accuracy (nominally 2 x GSD)
- General quality requirements of imagery are consistent and even colour balance, minimal cast shadow, no distortions, pixel smear or displacement of structures and linear features.

The use of “drones” will need to comply with the conditions and requirements of the Civil Aviation Safety Authority (CASA). Verification that those condition are able to be met will need to be provided as part of the tender submission.

Refer to the Project Survey Brief for the area where imagery is required.

10.22.3 Drive-through Video

If requested in the Project Survey Brief, the Consultant shall provide drive-through video of the site in both directions. Resolution and frame rate must not be less than 1280x720 (HD) and 25fps respectively. Accepted video file formats are MP4 and AVI.

11 DIGITAL SURVEY DATA

The digital data file shall meet the following requirements:

- AutoCAD (DWG) format in 3D.
- Data shall be formatted in accordance with the AutoCAD File Structure Table in Appendix B.
- Comply with AS 1100.401 Technical drawing – Part 401 Engineering survey and engineering survey design drawing.
- Drafting and presentation suitable for plotting at a scale of 1:1000 for rural areas or 1:250 for the urban areas, unless an alternative scale is specified.
- Contain all relevant details and data specified elsewhere in this specification.
- Tabulation of co-ordinates and levels for survey control used and established.
- Contoured at 0.1m intervals unless specifically directed to use an alternative contour interval.
- Include the following Metadata:
    - Consultant name, address, e-mail, phone number and reference number.
    - Description of Project
    - Date of Survey
    - North Point
    - Plan Scale
    - Geodetic Datum
    - Height Datum
    - The average Combined Scale Factor (CSF) value adopted to convert distances from ground to grid
    - Contour interval

12 SURVEY REPORT

The Consultant shall provide Certification that the survey procedures needed to satisfy the project scope, standards and accuracy were applied and ensure that the report is signed by the responsible surveyor.

The survey report shall include the following as a minimum:

- Table of Contents.
- Location of the survey.
- Surveyor name(s) and qualifications.
- Equipment used, type, specifications, accuracy capability and date of last calibration.
- Deviations from the Specification
- Summary of the survey methodology and work flows.
- Horizontal Control - a description of the method used, source of the datum coordinates, closure adjustment and the Survey Uncertainty achieved. Adjustment reports are to be included or attached.
- Vertical Control - a summary table of the accuracies and closures achieved by the levelling observations and values adopted; the source of the datum mark(s); the Survey Uncertainty achieved; and any discrepancies with published AHD values. Adjustment reports are to be included or attached.
- The vertical difference between Chart Datum and AHD and how it was determined, if applicable.
- Control network diagram.
- Datum Control Station listing showing identity number or name, coordinates, reduced AHD level, vertical method (adjusted spirit levelling or derived from GNSS), geoid model, type of mark and status (lodged, approved, adopted) for each control point.
- New Control Station listing of only those marks sufficiently stable and precise for use as construction set-out. The listing shall include station identifier; Map Grid of Australia (MGA) coordinates; MGA Zone; AHD level; the type of ground mark and witness mark and the relevant survey data requirements listed in Section 10.4.3.If applicable, details of the relationship between an alternative coordinate datum and MGA.
- The average CSF value adopted to convert distances from ground to grid.
- List of any layers and features used in the CAD file that do not comply with the AutoCAD File Structure Table.
- Describe the verification of survey methodology and provide the results of the survey verification of the surface model in a summary table format and include an assessment of systematic errors to demonstrate that they are less than half the specified accuracy for each feature classification.
- Evidence of accuracy of Geo-referencing of the aerial imagery including the Ground Control Survey Report and Aero-triangulation report that shows adjustment results with residuals observed on established control points.
- The estimated accuracy of the cadastral boundary model.
- Detail of any abnormalities that may have compromised the survey.
- Any matters that may be of interest to the project designer, such as identification of partially blocked drainage structures etc.

13 LODGED INFORMATION

13.1 TO THE PRINCIPAL'S REPRESENTATIVE

The following project deliverables are applicable, unless specified otherwise:

- Digital survey file in AutoCAD format
- Verification plot in PDF format showing all relevant information. Some layers may be omitted for clarity.
- Survey Report in PDF format
- Tabulation of the verification points in the quality line strings listed in a table that includes coordinates, level, DTM level, chainage and offset relative to the road centreline.
- Details of contact with private land owners and occupiers in PDF format
- Photos in JPEG format and index
- Video in MP4 or AVI formats
- Survey Deliverable Assessment checklist.

13.2 TO THE DEPARTMENT'S SURVEY BRANCH

- Details regarding damaged or missing BMs and CRMs
- Should the establishment on new CRM's be specifically included in the project scope, the Surveyor shall lodge the required survey data in accordance with the relevant survey requirements of the Director of Survey, Land Information Group, DIPL.

14 TRANSFER OF DELIVERABLES

The project deliverables are to be provided by:

- E-mail, or
- Stored on a digital medium agreed with the Project Manager, or
- On-line facility such as File Transfer Protocol (FTP).

File compression is permissible but no self-extracting executable formats are to be used.

APPENDIX A

Data Capture Methods

Various new and emerging methods for capturing survey measurements are currently available. The Department is interested in utilising these where appropriate to the project. The suitability of each is dependent on the accuracy required by this specification. Projects for planning, feasibility and concept may specify in the Project Survey Brief a lower accuracy to meet their requirements. Table 4 shows typical accuracies for the feature survey component of engineering surveys. Higher or lower accuracies may be achieved depending on factors such as the measurement equipment, environmental conditions, calibration, measurement procedure and data processing.

Table 4: Feature Survey Methods Achievable Accuracy

Method	Horizontal Uncertainty	Vertical Uncertainty	Suitable for Feature Classifications
Total Station	10 mm	10 mm	A-H
Terrestrial Laser Scanning	10 mm	10 mm	A-H
Mobile Laser Scanning	20 mm	10 mm	B-H
RTK GNSS	20 mm	30 mm	D-H
Photogrammetry	50 mm	50 mm	E-G
LiDAR	700 mm	250 mm	N/A

Note: Accuracies are at the 95% Confidence Interval

TOTAL STATION EQUIPMENT

The Total Station represents the most common method of data capture available for engineering ground survey able to achieve SU better than 10 mm for horizontal position and 10 mm for height.

Relevant applications include:

- Establishment of horizontal control by traversing.
- Establishment of vertical control by differential levelling as an alternative to using a digital level and staff.
- Modelling of project areas which contain all feature classifications A to H.
- Final design applications where horizontal and vertical accuracy is critical and classifications A and B apply.

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

Static GNSS is a common method for establishing survey control and is generally able to achieve SU within 10 mm for horizontal and 15 mm for height when operated using appropriate procedures. GNSS height measurements are based on an ellipsoid and cannot directly measure heights on a gravity-based datum such as AHD. However for distances more than 1 km, appropriate static control methods used in conjunction with AUSGeoid can achieve derived AHD levels comparable to the required SU of 12 mm√K relative to local AHD control.

Real Time Kinematic (RTK) GNSS surveying is used for ground data capture and is generally able to achieve SU within 20 mm for horizontal and 30 mm for height, provided it is operated using appropriate procedures.

Relevant applications include:

- Establishment of horizontal and vertical control with a static GNSS network.
- Modelling of project areas which contain feature classifications D to H using RTK GNSS.

TERRESTRIAL LASER SCANNING (TLS)

This technology captures dense point clouds of information from a laser scanner set in a series of fixed locations around the project. They are particularly useful in obtaining detailed survey information of surfaces or structures where access is difficult or hazardous or where a more complete model is required. They are often used in conjunction with total stations and are capable of achieving SU better than 10 mm with accuracy meeting classifications A to H.

Relevant applications include:

- Structures such as bridges and retaining walls
- Urban road intersections

MOBILE LASER SCANNING (MLS)

Like Terrestrial Laser Scanning, Mobile Laser Scanning technology captures dense point clouds from a moving platform such as a motor vehicle or boat. It has an advantage by minimising traffic management requirements and lane closures on freeways and major highways. Vertical accuracy meeting classifications B to H are achieved with rigorous ground control and post-processing.

Relevant applications include:

- Roads, freeways and highways
- Bridges and structures over water

PHOTOGRAMMETRY

Mapping from digital aerial photography is suitable to capture ground data for a lower accuracy project. The digital camera can be mounted in a small Remotely Piloted Aircraft (RPA), helicopter or fixed wing aircraft. Survey control on the ground is required to achieve suitable accuracies from the post-processed imagery. The best achievable vertical SU is typically 50 mm depending on the surface, vegetation, flying height, camera type and other factors.

Applications include:

- Route analysis, 'greenfield' road alignment, waterway, embankment and stockpile surveys.
- Production of colour ortho-photo maps.

When projects are only for the purpose of planning, feasibility and concept studies there may not be a requirement for ground control.

LiDAR

Where a large scale terrain model is required for planning or concept design purposes, LiDAR surveys can provide a detailed model where accuracies of between 200 mm and 300 mm in height are required. The need for access on the ground is minimal so these surveys can be very useful in areas that are remote, inaccessible or where sensitive landowners exist.

Lidar methodologies with improved accuracy are welcomed and will need to be verified by comparison, before the methodology or equipment is accepted for use in other Classifications.

Emerging / Innovative Technologies

Consultants may submit for assessment new and emerging systems for the department's consideration. Requirements for consideration and details will be derived on a case by case.

APPENDIX B

A standard set of Civil and Survey Drawing Profiles can be downloaded from the following site, along with the related Setup Instructions.

https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/road-design-drafting-tools

If additional profiles are required to ensure that different forms of road assets, such as pavement markings or kerb types, are able to be clearly delineated in the survey, then refer to Section 6 of the Department's NTG Technical Drawings Part 2 – Civil CADD Manual, at;

https://dipl.nt.gov.au/__data/assets/pdf_file/0017/430019/ntg-technical-drawings-part-2-civil-cadd-manual.pdf