Master Specification
Part PC-SI5

Engineering Survey

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Information

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Document Management

 This is a controlled document and it will be updated and reissued as approved changes are made.

Contents

PC-SI5 Engineering Survey

1 General

a) This Master Specification Part sets out the requirements for engineering surveys, including:

i) the documentation requirements, as set out in section 2;

ii) the survey control requirements, as set out in section 3;

iii) the survey accuracy requirements, as set out in section 4;

iv) the survey data and model requirements, as set out in section 5;

v) the underground services requirements, as set out in section 6;

vi) the boundary model requirements, as set out in section 7;

vii) the bridge model requirements, as set out in section 8;

viii) the underside bridge model requirements, as set out in section 9;

ix) the QQ model requirements, as set out in section 10;

x) the annotations requirements, as set out in section 11;

xi) the other requirements, as set out in section 12;

xii) the vegetation requirements, as set out in section 13;

xiii) the rail specific requirements, as set out in section 14; and

xiv) the engineering survey requirements, as set out in section 15.

b) Engineering surveys must comply with the requirements of the Reference Documents, including:

i) Department Engineering Surveys Project Report (available from https://dit.sa.gov.au/standards/standards_and_guidelines);

ii) Department Survey String Identifiers (available from https://dit.sa.gov.au/standards/standards_and_guidelines);

iii) Department Engineering Contractor Compliance Checklist (SUR-CT003-1) (available from https://dit.sa.gov.au/standards/standards_and_guidelines);

iv) Department publication Identification of Signs (SUR-CT003-TK01) (available from https://dit.sa.gov.au/standards/standards_and_guidelines);

v) Department Underground Services Locator Procedure (available from https://dit.sa.gov.au/standards/standards_and_guidelines);

vi) series of Department publications Engineering Survey - Locating Sequential Strings (available from https://dit.sa.gov.au/standards/standards_and_guidelines), including:

A. Depthed Underground Services;

B. Junction Boxes;

C. Lights and Gantries;

D. Linemarking;

E. Pipes and Culverts;

F. Points;

G. Rail Assets;

H. Sequential Strings;

I. Topstones;

J. Underground Services; and

K. Vegetation and Trees; and

vii) Department Cadastral Survey Guidelines (available from: https://dti.sa.gov.au/cadastral-surveying); and

viii) Department Underground Service Locator Preferred Supplier List (available from: https://dit.sa.gov.au/standards/standards_and_guidelines).

c) The Contractor is responsible for obtaining all required WTMPs in accordance with PC-SM1 "Traffic and Pedestrian Management" necessary to carry out any engineering surveys.

2 Documentation

2.1 Quality Management Records

a) For each engineering survey, the Contractor must supply the following items as part of the Quality Management Records:

i) digital data in the form of either:

A. an MX Genio or input file named CONTRACT.INP with all coordinates truncated to 3 decimal places;

B. a 12d ascii file named CONTRACT.12da;

C. as specified in the Contract Documents; or

D. another file name or format as agreed with the Principal;

ii) an Engineering Survey Project Report (presented in the following order in accordance with the Department Engineering Surveys Project Report):

A. table of contents;

B. location of survey, type, and job number;

C. survey party leader names and equipment used;

D. horizontal control, including details of the method of determining the coordinates and orientation, and a summary of the closure adjustment and accuracy achieved;

E. vertical control, including a summary of level run and accuracies achieved, datum mark adopted, and discrepancies with other marks with published AHD values;

F. a station listing, sorted by label containing station number, corresponding permanent survey mark number, coordinates, level, the type of ground mark, and witness mark;

G. list of all models;

H. exception report, including details of any abnormalities relating to the survey;

I. report of all unidentified strings;

J. a completed Department Engineering Contractor Compliance Checklist (SUR-CT003-1), completed by the survey party leader;

K. a copy of the Transport Management Plan (where relevant) and copies of all relevant approved WTMPs complying with PC-SM1 "Traffic and Pedestrian Management";

L. full details of any non-compliance indicated in Department Engineering Contractor Compliance Checklist (SUR-CT003-1);

M. verification of survey control (e.g. station set up checks);

N. a comparison between surveyed and checked points;

O. PDF of BYDA plans (if the plans were marked up by a service provider to describe accuracy of measurement, these must be provided);

P. PDF of a completed underground services checklist as supplied by the service locator (refer to Appendix B of the Department Underground Services Locator Procedure);

Q. PDF document identifying signs in accordance with Identification of Signs (SUR-CT003-TK01); and

R. copies of "certificates of title" where easements are depicted on the boundary model.

b) The Engineering Survey Project Report, required in section 2.1a)ii), must also include:

i) a computer report of:

A. all CHE checks, including instrument station numbers, reference station numbers and horizontal distances; and

B. height differences between QQ strings and the triangulated surface;

ii) a comparison of stored and calculated co-ordinates;

iii) the method used to derive coordinates in accordance with section 3.1b);

iv) any errors found between the levels of vertical network marks within the Project, in accordance with section 3.2e);

v) a list of primary survey control used, in accordance with section 3.3e);

vi) independent checks, as required by section 4.4a);

vii) records of surveys undertaken within the rail corridor, as required by section 14.2; and

viii) any errors found with the network marks, as required by section 15.2b).

c) The digital data referred to in section 2.1a)i) must contain all requested models.

d) All documentation submitted to the Principal must be supplied in electronic format.

3 Survey control

3.1 Horizontal datum

a) The horizontal datum must be planar based on MGA 2020 coordinates derived from network permanent survey marks. The origin must be as near as practical to the centre of the Project. In the event that this is not practical, coordinates must be based on GNSS observations.

b) The method used to derive the coordinates must be addressed in the Engineering Survey Project Report.

3.2 Vertical datum

a) Survey stations must be surveyed to the accuracies defined in section 4.

b) One mark is to be adopted as the datum point.

c) AHD values of a vertical network mark must be adopted where such a mark exists within 200 m of the Site. In areas where no such marks exist, a local datum must be adopted.

d) Where deep bench marks exist, they must be included in the survey and numbered BM01 to BM99.

e) Any errors found between the levels of vertical network marks within the Project must be noted in the Engineering Survey Project Report.

3.3 Primary survey control (mandatory)

a) Primary survey control must be of suitable quality and be placed as near as practical to the Site to reduce the risk of disturbance throughout the life of the Project.

b) Primary survey control must be numbered S001 to S099.

c) A minimum of 3 primary control stations are required on each Project.

d) Each primary survey control point must be inter-visible with a minimum of one other primary or secondary control point.

e) The Contractor must supply a list of primary survey control used for the Project, as part of the Engineering Survey Project Report.

3.4 Secondary and tertiary survey control

a) For the purposes of this Master Specification Part:

i) “secondary survey control” refers to stations used in traversing between primary control points; and

ii) “tertiary survey control” refers to traverse stations which join between secondary control stations.

b) Together, tertiary survey control stations and secondary survey control stations must form a closed loop.

3.5 Fly stations

A “fly station” is to be radiated from a major or subsidiary traverse station. The purpose is to locate small amounts of detail where the creation of a separate traverse is considered unnecessary.

3.6 Survey station materials

Survey stations must be made of a suitable material to ensure horizontal and vertical accuracies are maintained.

3.7 Survey station markings

a) Survey station markings must be visually acceptable for the area being surveyed and must be witnessed as follows:

i) for urban surveys:

A. discreet yellow paint around the mark and station number; and

B. when appropriate, yellow paint on the edge of bitumen near the station, an arrow with distance (from point of arrow), and station number; and

ii) for rural surveys, for all primary and secondary control, a star dropper must be driven to be one metre above ground and the exposed section painted yellow. A tag must be attached to the star dropper with 2 gutter bolts and stamped with the station number, distance, and direction to the ground mark. The tags will be supplied by the Principal (Department’s Transport Services Division).

b) Where required, witness marks must be offset to positions clear of that portion of the road devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.

c) In all instances, human and stock safety must be considered in the placement of witness marks.

3.8 Numbering of survey stations

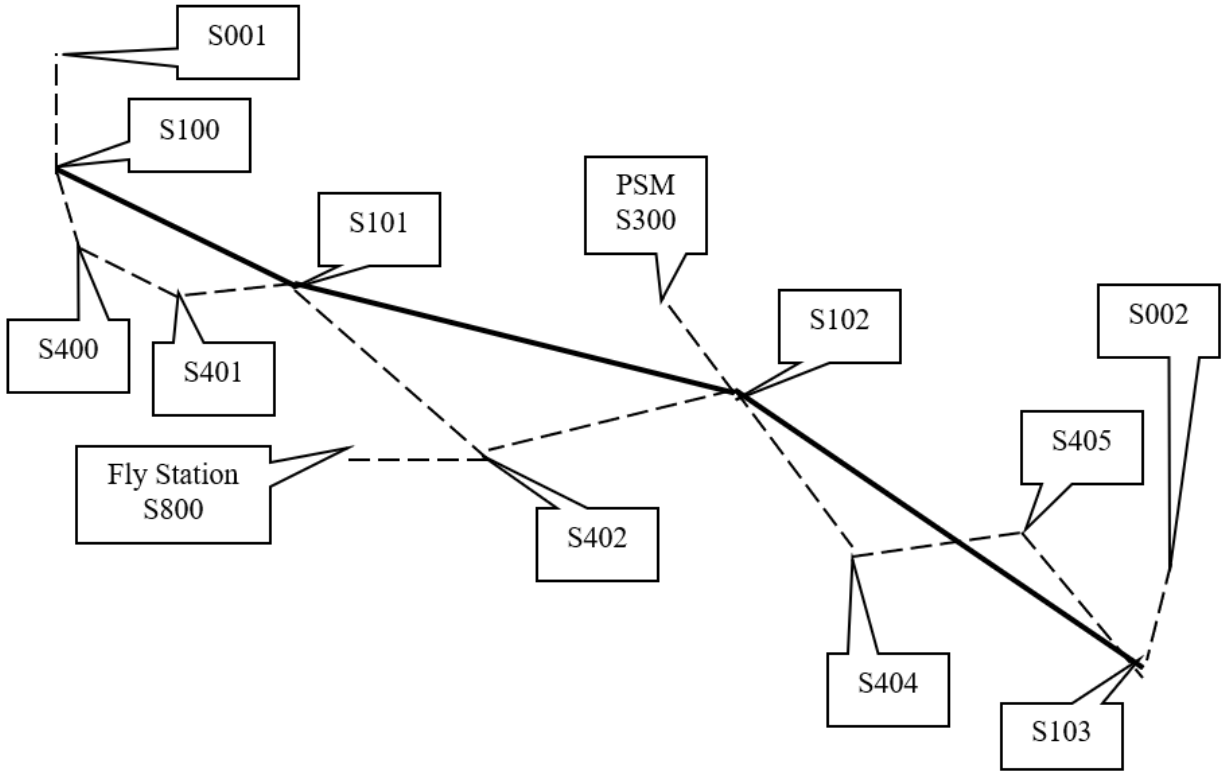
a) Survey stations must be numbered in accordance with Table PC-SI5 3-1.

b) A typical survey transverse methodology is depicted in Figure PC-SI5 3-1.

Table PC-SI5 3-1 Survey station numbering

Number	Description
S001-S099	Primary control (mandatory)
S100-S299	Secondary control
S400-S799	Tertiary control
S300-S399	Permanent survey marks registered with the Surveyor General
S800-S999	Radiations (fly stations)
BM01-BM99	Deep bench marks

Figure PC-SI5 3-1 Typical survey traverse methodology



Note: S300 is noted as a primary survey control point.

4 Survey accuracy

4.1 Survey accuracy standards

a) All feature strings must be surveyed, locating all changes of grade along and between strings. The feature strings must be accurately located for horizontal and vertical representation. Non hard stand features refer to naturally occurring features which are used to create the triangulated irregular network (TIN).

b) The accuracy standards set out in Table PC-SI5 4-1 must be maintained.

Table PC-SI5 4-1 Accuracy standards

Item	Hard stand features(1)		Non hard stand features(1)	
Urban survey	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**
Survey control	1:20 000	$12\sqrt{K}$ mm	1:20 000	$12\sqrt{K}$ mm
Figure 1: Surveyed points (refer Figure PC-SI5 4-1)	20 mm	20 mm	100 mm	50 mm
Figure 2: “Arc to chord” tolerance (refer Figure PC-SI5 4-1)	100 mm	20 mm	300 mm	100 mm
Independent checks	20 mm	20 mm	100 mm	50 mm
Rural survey	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**
Survey control	1:20 000	$12\sqrt{K}$ mm	1:20 000	$12\sqrt{K}$ mm
Figure 1: Maximum deflection between points (refer Figure PC-SI5 4-1)	30 mm	30 mm	150 mm	100 mm
Figure 2: “Arc to chord” tolerance (refer Figure PC-SI5 4-1)	200 mm	30 mm	300 mm	150 mm
Independent checks	30 mm	30 mm	150 mm	100 mm

Table notes:
(1) K = kilometres.

4.2 High accuracy survey standards

Where nominated in the Contract Documents or where specified in this Master Specification Part, the standards set out in Table PC-SI5 4-2 must be achieved for nominated features. Survey accuracy standards set out in section 4.1 apply for the remainder of the work.

Table PC-SI5 4-2 High accuracy survey standards

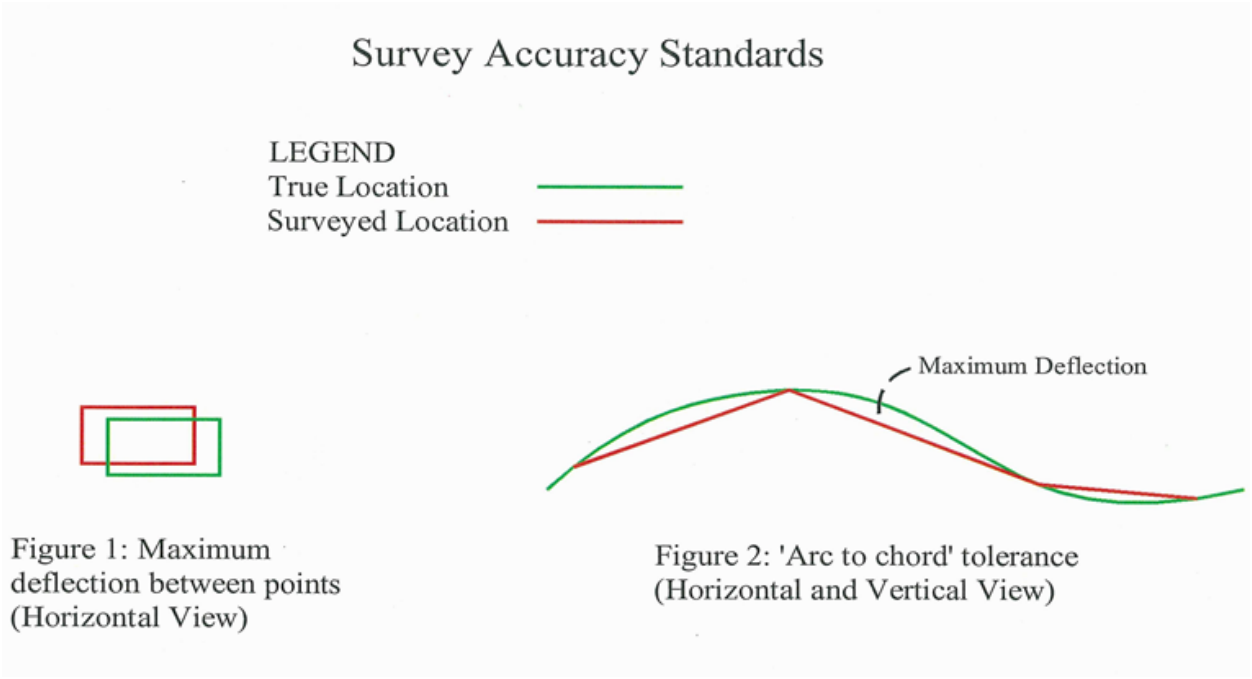
Item	Horizontal	Vertical(1)
Survey control	1:50 000	$5\sqrt{K}$ mm
Figure 1: Maximum deflection between points (Figure PC-SI5 4-1)	10 mm	10 mm
Figure 2: “Arc to chord” tolerance (Figure PC-SI5 4-1)	10 mm	10 mm
Independent check	10 mm	5 mm

Table notes:
(1) K = kilometres.

4.3 Relative vertical accuracy

The relative accuracy between adjacent points must be half of that stated in Table PC-SI5 4-1 and Table PC-SI5 4-2, as applicable (for example, the difference in grade between 2 points on a string must be within 10 mm of the actual grade in a typical urban survey on hard stand surfaces).

Figure PC-SI5 4-1 Survey accuracy standards



4.4 Verification of survey accuracy

a) Sufficient independent checks must be obtained to ensure that the appropriate accuracy standards have been met. The results of these checks must be documented in the Engineering Survey Project Report.

b) Points or strings used for verification must be placed in a model named QQ model.

5 Survey data and model requirements

5.1 General

a) Survey data must be provided in a string based format (mx.inp or 12da). All models must include sequential strings and point strings, and the associated labels as listed in the document Department Survey String Identifiers.

b) All strings must be run in accordance with the series of Department publications “Engineering Survey - Locating Sequential Strings”. Sequential strings must have more than one point.

c) All models must include sequential strings and point strings and the associated codes as listed in the document Department Survey String Identifiers. Strings are required to be located in the models listed.

d) No strings, other than boundary model strings, can be computer designed.

e) Automatically generated and curve fitted strings must not be used in the survey model.

f) Strings are required to be shown as either null level or 3d, not a combination of both (for example, a stormwater string with a known height at the invert and a null height at the end must be provided as a 2d string for the pipe and an invert point).

5.2 Model requirements

5.2.1 General

The Contractor must provide all models required by this section 5.2.

5.2.2 Survey model

a) The survey model consists of points and strings traditionally used to create the triangulated irregular network (TIN).

b) Intersecting strings are not permitted.

5.2.3 XSurvey

XSurvey relates to surveyed features whose heights are not to be used for the creation of the TIN. These points and strings must not be used to generate the TIN.

5.2.4 Tria survey / tria bridge

a) All surveys must include a survey DTM. The survey DTM forms the ground surface guaranteed by the Contractor. Where a bridge structure exists, a bridge DTM must be included. The model(s) must be supplied in 12da, AutoCAD 3d dxf, or Land XML format and must be named TIN TRIA SURVEY.

b) Points and strings defined as “TIN-able” may be used to create the surface at the discretion of the Contractor. These models must be named using the following convention: TIN TRIA (Model Name), for example, TIN TRIA BRIDGE.

6 Underground Utility Services

6.1 General

a) Where required by the Contract Documents, the Contractor must also undertake ground marking of Utility Service locations. Utility Services must be shown as a 2 dimensional string unless the Utility Service is entirely visible. Depthing may be required and will be addressed specifically in the Contract Documents. This work must be undertaken in accordance with the Department Underground Service Locator Preferred Supplier List.

b) Utility Services must be supplied in a continuous string representing the entire run (e.g. from transformer to pit).

6.2 Utility Services models

a) Underground Utility Services must be placed in models according to their accuracy of capture. The models to be supplied must comply with the requirements of this section 6.

b) Details of Utility Services must be populated as string and vertex attributes within the Utility Services models.

6.3 Utility Services direct

“Direct location” is the highest accuracy order of data capture. It refers to Utility Services which have been directly surveyed, therefore horizontal and vertical location is subject only to the accuracies of the survey methodology. Examples may include:

a) depthed service points (pot holing);

b) exposed pipes;

c) as-constructed survey data;

d) open cable trenches; and

e) direct invert / obvert measurement.

6.4 Utility Services active

a) Active Utility Services must be located using active location methods whereby cables are traced using an electromagnetic signal emitted from the transmitter and received by the cable detection device.

b) Active location methods include using a “direct connection” or “induction clamp” readings are required to be marked on the ground's surface (refer to the Department Underground Services Locator Procedure). The resulting marks are to be surveyed for incorporation into the digital model.

c) Active location methods are suitable for metal conduits or cables that are welded, soldered, or braided together, or where a tracing wire is present.

6.5 Utility Services passive

a) “Passive services” are located using passive location methods which do not use an electromagnetic signal. In this case the cable detection device is used as a standalone.

b) Examples of passive service capture include radiolocation or ground-penetrating radar. Readings are required to be marked on the ground's surface (refer to the Department Underground Services Locator Procedure). The resulting marks are to be surveyed for incorporation into the digital model.

c) Passive location methods are commonly used for materials such as plastic poly tubing, clay, concrete, or insulated cast iron where active methodology is not possible.

6.6 Utility Services unverified

a) For the purpose of this Master Specification Part “unverified services” are Utility Services that incorporate data that has been collected without confirmation by any of the methods listed in this section 6.

b) Unverified Utility Services can include information from sources such as:

   i) Before You Dig Australia (BYDA);

   ii) GIS datasets;

   iii) as-constructed plans;

   iv) cable marker posts (offset measurement); or

   v) other forms of digital plan or record.

c) If a Utility Service is unable to be traced or located in the field, the Utility Service must be displayed in an approximate location and placed in the Utility Services unverified model.

d) Unverified Utility Services will not be marked on the ground and must be depicted in the model by interpreting the marked up BYDA plan supplied by underground Utility Service locators.

e) Examples of unverified Utility Service capture include non-visible stormwater pipes and optical fibre cables.

f) Not all councils are listed in BYDA, and it is the responsibility of the Contractor to follow up with all of the relevant councils to obtain Utility Service information.

6.7 Survey requirements for underground Utility Services location

Where Utility Services are located to passive or active standard, the following location requirements must apply:

a) Utility Services must be surveyed at points with no greater than 20 m intervals on linear runs and at all changes in direction for all Utility Services;

b) indicative depths must be recorded at less than 40 m intervals and at all changes in depth for all Utility Services;

c) asset ownership must be recorded at the start and finish of the cable run and at less than 100 m intervals (not required for TransAdelaide cabling);

d) cabling type (e.g. optic fibre, high voltage, main cable, communications cable, or signal feed cable) must be marked at the start of the cable run and at less than 100 m intervals;

e) pipe construction type and size must be provided where information is available (e.g. RCP 450 mm means reinforced concrete pipe of 450 mm diameter) at the start of the cable run;

f) any additional information regarding assets (e.g. “HPGM” means high pressure gas main, “pump” means pumping mains, and “grav” means gravity mains) must be annotated where applicable; and

g) when supplying pipe inverts, levels must be supplied in the “services direct model”. In the event that the invert level is not accessible, note the reason as text in the “services unverified model” (refer section 6.6), such as “sump blocked”, “manhole locked”, etc.

6.8 Survey requirements for depthing underground services (potholing or rodding)

Underground Utility Service details must be supplied in the format detailed in section 16 Appendix 1 - Underground Utility Service details.

7 Boundary model

a) A boundary model must be created if required by the Contract Documents.

b) Where a boundary model is required:

i) the boundary model must be named “Bdy Model”;

ii) the boundary model must be obtained by compiling data from plans lodged with Land Services SA and “certificates of title”. The model will cover all main road and side road boundaries. All side property boundaries are not required unless requested;

iii) sufficient survey marks must be located over the extent of the survey to produce a model accurate within 0.15 m in urban areas, including rural townships, and 0.50 m in rural areas. Exceptions must be included in the Engineering Survey Project Report;

iv) a full boundary definition is not required;

v) boundaries are not to be marked in the field;

vi) the boundary model must be presented as solid red lines on paper plots, with string labels pre-fixed BD;

vii) where easements appear within the Project scope, these must be identified by an EZ string. Text identifying the easement appurtenances must be annotated to mirror the information on the certificate of title (e.g. A/B, etc.). The text must be at a height of 2.5 mm. A copy of the Certificate of Title must be submitted in the Engineering Survey Project Report; and

viii) null levels must be assigned to all BD and EZ strings within the boundary model.

8 Bridge model

a) For the purpose of this Master Specification Part, the “bridge deck” is the area of detail suspended from the natural surface of the land. It is usually identified by concrete expansion joints at each end.

b) All detail on the bridge deck must be surveyed. All strings on the bridge deck must be separate from the survey and xsurvey models and placed in a “bridge model”.

c) All strings leading to and underneath the bridge deck form part of the “survey model”. This includes all abutments and piers.

9 Underside bridge model

The “underside bridge model” must be located to the same standards as the bridge model. Features include soffits and services.

10 QQ model

The “QQ Model” must contain surveyed independent checks used to verify the survey model.

11 Annotations

11.1 General notes

a) Annotation is required in the corresponding model.

b) The following must be annotated on the plots and in the model:

i) MARS marker numbers (e.g. MM45.0);

ii) road and street names;

iii) U, UX, and JB sequential strings and PUPP, PUPL and PUKK point strings;

iv) all undefined sequential and point strings;

v) significant buildings and landmarks; and

vi) underground services.

c) For sign annotations, refer to Department publication Identification of Signs (SUR-CT003-TK01).

d) Annotations must be text strings within the appropriate model, labelled *A for all features in accordance with the document Department Survey String Identifiers. Road names must be duplicated and shown at the same locations in both the survey model and boundary model.

e) The size of the annotations (regardless of scale) must be 2.5 mm.

11.2 Underground service annotations

a) All services within the services model must be presented as follows:

i) text strings labels pre-fixed *A;

ii) text size of 2.5 mm; and

iii) at a scale advised for each project.

b) All annotations must be parallel to and on top of each string. Further annotation must be at every substantial bend in the string, except in circumstances that will result in a cluttered plot and model.

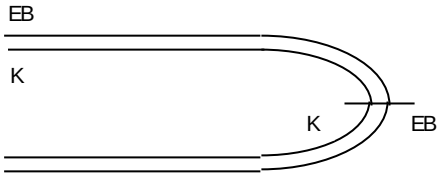
c) All service annotations must be described as shown in the Department publication Engineering Survey - Locating Sequential Strings - Underground Services.

12 Other requirements

12.1 Looped strings

Strings must not be looped (that is, a string must not change direction and run approximately parallel to itself in the opposite direction). A separate string must commence at the change of direction, as set out in Figure PC-SI5 12-1.

Figure PC-SI5 12-1 Example of string definition to avoid looped strings



12.2 Unidentified strings

If a label on the list cannot adequately define the feature, the Contractor must use U, UX, and JB (unknown junction box) for a sequential string and PUPP, PUPL, and PUKK (unknown service) for a point string.

12.3 Natural surface strings

a) The natural surface must be defined by either running N strings or spot height points (coded PNSS).

b) All natural surface strings must run approximately parallel to the main corridor. On side roads beyond the main corridor bandwidth specified, natural surface strings must run parallel to the side roads.

c) Natural surface (N) strings must not cross, but end as close as possible to other surveyed features.

d) N strings must not be used to identify any features which appear in the sequential strings identifiers list.

12.4 Domestic outlets

Domestic drainage outlets must be located as a point string (PIDD) invert (for X, Y, Z) at the outlet of the pipe at the gutter.

12.5 Signs

a) All signs, on urban and rural surveys, must be located. Sign posts must be identified as PPSA or PPSB point strings. Larger signs must be identified as RS (road sign / hoarding).

b) For sign annotations, refer to Identification of Signs (SUR-CT003-TK01).

12.6 Gantry signs

12.6.1 Standard gantry location

a) For the purpose of this Master Specification Part, “gantry signs” are large directional overhead signs, usually suspended over main road carriageways.

b) All gantry signs and associated poles must be located in accordance with Department publication Engineering Survey - Locating Sequential Strings - Lights and Gantries.

c) All gantry signs must be coded as (OR) outreach by surveying the internal face of the gantry.

d) The (OR) code is used similarly on lighting outreaches and signalling combo pole outreaches.

e) The upper edge of the gantry (sign backing only) must be surveyed and coded as (LT).

f) The underside of the gantry (sign backing only) must be surveyed and coded as (LU).

12.6.2 Gantry structural survey

a) When requested in the Contract Documents, full detail of the gantry structure is required. This includes all features such as walkways, underside of gantry, detection cameras, radius of arm, and location of footings.

b) Typically, codes are not available for many of these features referred to in section 12.6.2a). These features must be coded as unknown points and strings with descriptive text.

12.7 Temporary signs

Temporary signs are not required to be surveyed.

12.8 Drainage requirements

a) All drainage structures including headwalls, culverts, and pipe inverts for both sides of the road must be located.

b) At each drainage structure, the survey bandwidth must be extended by a distance of 15 m from the front face of each structure. The Contractor must define the drainage channel features including centre of drain, bank top, and bank bottom strings; and a natural surface string must be extended 5 m beyond each bank top.

12.9 Pavement markings

All line marking, pavement arrows, pavement bars, and chevrons must be located in accordance with the series of Department publications Engineering Survey - Locating Sequential Strings (available from: https://dit.sa.gov.au/standards/standards_and_guidelines). Null levels must be assigned to the string label PMPB (pavement bars).

12.10 Directional strings

Specific strings as noted in the document Department Survey String Identifiers are required to be located with the feature to the right. This will enable the feature to display correctly.

13 Vegetation

13.1 Standard requirements

a) All single stem trees or shrubs with a butt diameter equal to or greater than 150 mm, measured approximately 1.0 m above ground and all multi-stem trees or shrubs with at least one of the stems of diameter equal to or greater than 100 mm, approximately 1.0 m above the ground must be surveyed in accordance with codes PSHH, PTRT, PTRS, PTRM, PTRL, PTRX, and PTRZ (refer to section 13.1b)).

b) All significant trees (code PTRZ) are to be located. These are defined as:

   i) any tree with a single diameter greater than 625 mm; or

   ii) any multi stemmed tree where:

      A. the combined diameter is greater than 625 mm; and

      B. the average stem diameter is greater than 170 mm.

c) Areas of dense vegetation may be surveyed as “edge of vegetation”. Significant trees (PTRZ) are required to be located individually within these areas. Edge of vegetation strings are to be a closed polygon.

d) Natural surface and other appropriate strings must continue to run through the area of vegetation. The distances between shots must be no greater than 30 m, in urban or rural areas. The distances between strings must be as per the standard for all strings in an urban or rural area.

e) Edge of vegetation strings may be given null levels if the topography has accurately been defined by other strings.

13.2 Additional vegetation requirements

Where required by the Contract Documents, the following additional requirements are to be undertaken:

a) additional requirement 1 - trees and shrubs greater than 2 m tall:

i) trees or shrubs greater than 2 m tall which do not qualify under the existing butt diameter conditions (undersized) must be coded PTRU and included in the survey;

ii) all trees and shrubs greater than 2 m tall must be located individually using codes PSHH, PTRU, PTRT, PTRS, PTRM, PTRL, PTRX, and PTRZ; and

iii) areas of dense vegetation may be surveyed as “edge of vegetation”. Significant trees (PTRZ) are required to be located individually within these areas. Edge of vegetation strings are to be a closed polygon.

13.3 Phytophthora hygiene

Where a Site has been identified by the Principal (or by the Contractor) as a high-risk Phytophthora zone, the Contractor must work in accordance with Appendix C - Phytophthora Hygiene Procedure for Minor Works and Site Inspections, of the Department Phytophthora (Dieback) Control Environmental Instruction. This instruction must be followed if soil is sticking to equipment, footwear, or vehicle tyres.

14 Rail specific requirements

14.1 Survey accuracy requirements

Surveys of rail infrastructure must be undertaken to high accuracy survey standards as noted within section 4.2.

14.2 Survey coordinate system

Surveys within the rail corridor must be undertaken using the existing rail project coordinate system and recorded as such in the Engineering Survey Project Report (as described in section 2.1a)ii)).

14.3 Verification of control

a) Prior to commencement of work, horizontal checks must be taken to 2 separate survey control marks. Vertical checks must be undertaken using two-way digital levelling within a closed loop.

b) Tolerances must be within high accuracy survey standards for survey control as noted within section 4.2.

c) In the event that these accuracies are not achieved, the surveyor must re-establish control from existing major control points. Subsidiary control must be adjusted, and the methodology and adjusted coordinates must be submitted as a part of the Engineering Survey Project Report.

14.4 Survey for track and other infrastructure

a) Critical rail infrastructure must be observed as detailed in Table PC-SI5 14-1.

b) For additional information refer to the document Department Survey String Identifiers.

Table PC-SI5 14-1 Rail infrastructure survey

Activity	Methodology
Survey of theoretical gauge point	Rail measurements must be observed to the theoretical gauge point. This is a 3-dimensional point located: a) horizontally, as the intersection of the inside gauge face measured 16 mm down from the top of the rail; and b) vertically, as the top of rail.
Survey of platform coping / edge	Coping measurements must be taken at the intersection of the face and top of platform.
Survey of structural clearances or infrastructure, for example, fences, retaining walls, bridge abutments and electrification gantries / masts	Structures within 3 m of the track must be observed along the inside face closest to the running track.
Survey of toe of switch / point of blade and nose of V and K crossings	Features must be measured at the actual / theoretical point as required.
Placement of track monuments	Track monuments must be placed in accordance with the P.T.S. naming and numbering convention standard.
Set out of horizontal and vertical framing points	Marks must be placed in accordance with the P.T.S. naming and numbering convention standard.
Set out of offsets	All offsets must be set out with reference to the theoretical gauge point.

14.5 Tools and equipment

Critical tasks must be undertaken using the tools as highlighted in Table PC-SI5 14-2.

Table PC-SI5 14-2 Critical task equipment

Task	Equipment
Survey of theoretical gauge point	Rail gauge face tool with target height of <150 mm
Survey of platform coping / edge	Rail gauge face tool with target height of <150 mm
Survey of structural clearances	Reflectorless total station or distance and horizontal offset observation
Survey of critical rail infrastructure including point of turnout blades, K & V crossing tips	Pogo point with target height of <150 mm

15 Engineering survey guidelines

15.1 General

The field techniques set out in this section 15 outline acceptable field procedures in the collection and reporting on key issues which may be adopted in order to achieve the required standards of the Contract Documents.

15.2 Levelling techniques

a) All survey stations must be levelled twice by differential levelling techniques (i.e. spirit, automatic, or digital level) and the 2 reduced levels must not differ by more than 5 mm.

b) Any errors found with the network marks must be noted in the Engineering Survey Project Report.

15.3 CHE checks

At the beginning and end of each instrument setup, the Contractor must electronically or manually record CHE checks to 2 adjacent stations. The calculated results must satisfy the required tolerances.

15.4 QQ checks

a) QQ checks must be recorded across the model from instrument stations different to that used to generate the model. A minimum of one per station setup is required with at least 2 QQs per job.

b) A QQ check must be performed across the junction of 2 models when joining to an existing survey. In addition a feature check must be performed from a station in the new model to a prominent feature in the existing survey.

15.5 Measurement interval and tolerances

a) Subject to section 15.5b), the measurement intervals and tolerances, as detailed in Table PC-SI5 15-1, must not be exceeded.

b) If any of the tolerances, as detailed in Table PC-SI5 15-1, are exceeded, details of the non-compliance must be completed on the Department Engineering Contractor Compliance Checklist (SUR-CT003-1).

Table PC-SI5 15-1 Measurement interval and tolerances

Description	Urban	Rural
Surveyed points		
Maximum distance between shots	10 m	15 m
Maximum distance between strings	10 m	15 m
Maximum length of radiations (except QQs)	100 m	150 m
CHE checks		
Level difference between observed and fixed	7 mm / 100 m	10 mm / 100 m
For distances less than 100 m	7 mm	10 mm
QQ checks		
Pavement and hard surfaces level differences	20 mm	30 mm
Natural surface strings level differences	50 mm	100 mm

16 Appendix 1 - Underground Utility Service details

Table PC-SI5 16-1 sets out the details and formats that must be supplied for underground Utility Services.

Table PC-SI5 16-1 Underground Utility Service details

Pothole no.	Service ID	Easting	Northing	Code	Quality class	Point located	RL existing ground surface	RL of point located	Depth to service	Depth to obstacle or not found	Diameter	Material and colour	Comments
581	SW 22	278040.098	6137195.522	PUUP	A	Top of pipe	127.405	126.755	0.650		350	Concrete	
593	TE16	278045.235	6137225.321	PNFD	A	Conc capping	127.037	124.537		2.500		Concrete capping	Service may be below
599	TE 25	278065.398	6137236.987	PUTT	B	Rodded	51.627	50.827	0.800		100	White PVC (Fibre Optic)	