

# Project Controls

## Master Specification

## PC-SI5 Engineering Survey

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## PC-SI5 Engineering Survey

### 1 General

- 1.1 This Standard Specification sets out the requirements for Engineering Surveys.
- 1.2 The Contractor shall comply with the requirements of:
  - a) SUR-ES002-1 Survey String Identifiers;
  - b) SUR-ES002-4 Survey Code Summary;
  - c) SUR-CT003-1 Engineering Compliance Checklist;
  - d) SUR-CT003-TK01 Identification of Signs;
  - e) Locating Sequential strings Available on the FTP site; and
  - f) Manual of Survey Practice Volume 2 Section 2.

### 2 Survey Control

#### Horizontal Datum

- 2.1 Unless specified otherwise in the Project Brief, the horizontal datum shall be planar based on MGA coordinates derived from network Permanent Survey Marks. The origin shall be as near as practical to the centre of the project. In the event that this is not practical, coordinates shall be based on GNSS observations.
- 2.2 The method used to derive the coordinates shall be addressed in the report.

#### Vertical Datum

- 2.3 Survey stations shall be surveyed to the accuracies defined in Item 3 Survey Accuracy (below). One mark is to be adopted as the datum point. AHD values of a vertical network mark shall be adopted where such a mark exists within 200m of the limit of works. In areas where no such marks exist, a local datum shall be adopted.
- 2.4 Where Deep Bench Marks exist, they shall be included in the survey and numbered BM01 to BM99.
- 2.5 Any errors found between the levels of vertical network marks within the project shall be noted in the Project Report.

#### Primary Survey Control (Mandatory)

- 2.6 Primary survey control shall 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.
- 2.7 Primary survey control shall be numbered S001 to S099.
- 2.8 A minimum of three primary control stations are required on each project.
- 2.9 Each Primary Survey Control Point shall be inter-visible with a minimum of one other Primary or Secondary Control Point. The Contractor shall supply a list of primary survey control used for the project.

#### Secondary Survey Control

- 2.10 Secondary survey control refers to stations used in traversing between primary control points.

#### Tertiary Survey Control

- 2.11 Tertiary survey control refers to traverse stations which join between secondary control stations. Together with secondary control stations these stations shall form a closed loop.

## Fly Stations

2.12 A fly station is 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.

## Survey Station Materials

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

## Survey Station Markings

2.14 Survey station markings shall be visually acceptable for the area being surveyed and shall be witnessed as follows:

a) Urban Surveys:

- i) discreet yellow paint around the mark and station number; and
- ii) when appropriate, yellow paint on the edge of bitumen near the station, an arrow with distance (from point of arrow), and station number.

b) Rural Surveys:

- i) for all primary and secondary control a star dropper shall be driven to be one metre above ground and the exposed section painted yellow. A tag shall be attached to the star dropper with two gutter bolts and stamped with the station number, distance and direction to the ground mark. The tags will be supplied by the Department's Transport Services Division.

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

2.16 In all instances human and stock safety shall be considered in the placement of witness marks.

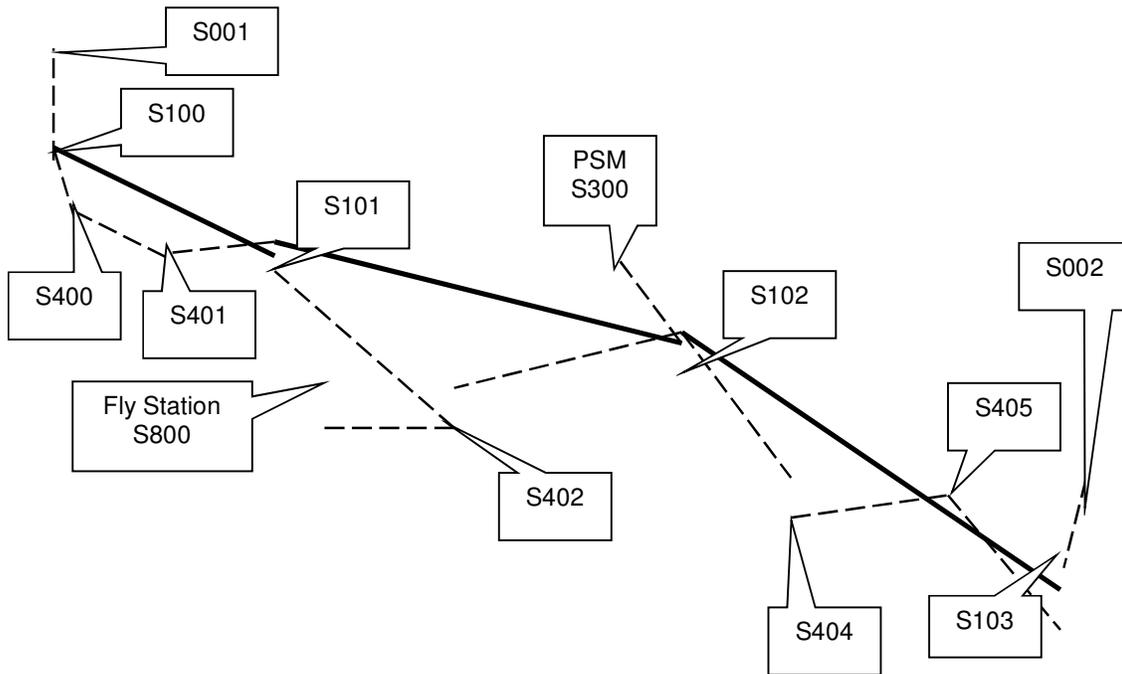
## Numbering of Survey Stations

2.17 Unless stated otherwise in the Project Brief, stations shall be numbered in accordance with Table PC-SI5 2-1.

**Table PC-SI5 2-1 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 2-1 Typical Survey Traverse Methodology



### 3 Survey Accuracy

#### Typical Survey Accuracy Standards

- 3.1 Unless stated otherwise in the project brief, these standards shall be achieved.
- 3.2 All feature strings shall be surveyed, locating all changes of grade along and between strings. The feature strings shall be accurately located for horizontal and vertical representation. Non hard stand features refer to naturally occurring features which are used to create the TIN.
- 3.3 The following accuracy standards shall be maintained:

Table PC-SI5 3-1 Accuracy Standards

	Hard Stand Features		Non Hard Stand Features	
<b>Urban Survey</b>	<b>Horizontal</b>	<b>Vertical</b>	<b>Horizontal</b>	<b>Vertical</b>
Survey Control	1:20 000	12√K mm	1:20 000	12√K mm
Figure 1: Surveyed points	20 mm	20 mm	100 mm	50 mm
Figure 2: "Arc to chord" tolerance	100 mm	20 mm	300 mm	100 mm
Independent Checks	20 mm	20 mm	100 mm	50 mm
<b>Rural Survey</b>	<b>Horizontal</b>	<b>Vertical</b>	<b>Horizontal</b>	<b>Vertical</b>
Survey Control	1:20 000	12√K mm	1:20 000	12√K mm
Figure 1: Surveyed points	30 mm	30 mm	150 mm	100 mm
Figure 2: "Arc to chord" tolerance	200 mm	30 mm	300 mm	150 mm
Independent Checks	30 mm	30 mm	150 mm	100 mm

#### High Survey Accuracy Standards

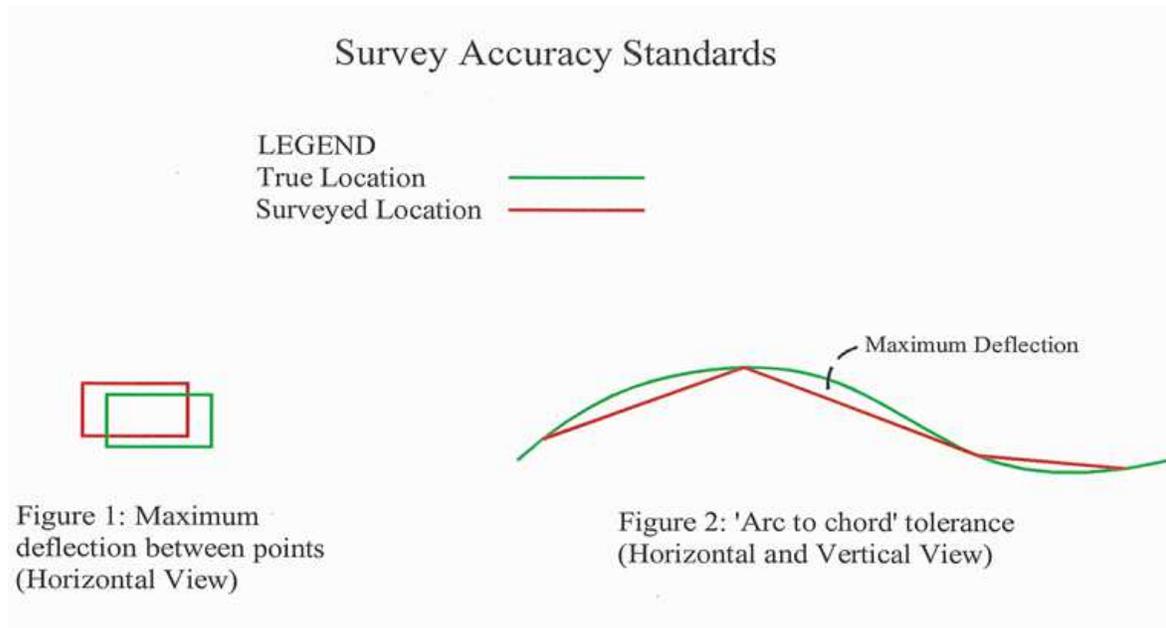
- 3.4 If requested, these standards shall be achieved for nominated features. Typical survey accuracy standards apply for the remainder of the work.

Table PC-SI5 3-2 High Survey Accuracy Standards

Item	Horizontal	Vertical
Survey Control	1:50 000	$5\sqrt{K}$ mm
Figure 1: Surveyed points	10 mm	10 mm
Figure 2: "Arc to chord" tolerance	10 mm	10 mm
Independent check	10 mm	5 mm

## Relative Vertical Accuracy

- 3.5 The relative accuracy between adjacent points shall be half of that stated above. For example, the difference in grade between two points on a string shall be within 10 mm of the actual grade in a typical urban survey on hard stand surfaces



## Verification of Survey Accuracy

- 3.6 Sufficient independent checks shall be obtained to ensure that the appropriate accuracy standards have been met. The results of these checks are to be documented in the survey report.
- 3.7 Points or strings used for verification shall be placed in a model named QQ Model.

## 4 Deliverables

### General

- 4.1 The survey data is to be provided in a string based format (mx.inp or 12da). All models shall include sequential strings and point strings and the associated labels as listed in SUR-ES002-1 "Survey String Identifiers".
- 4.2 All strings shall be run in accordance with the "Locating Sequential Strings" file available on the FTP site. Sequential Strings shall have more than one point.
- 4.3 All models shall include sequential strings and point strings and the associated codes as listed in SUR-ES002-1 "Survey String Identifiers". Unless specified otherwise by the principal, strings are required to be located in the models listed.
- 4.4 No strings, other than boundary model strings, shall be computer designed.
- 4.5 Automatically generated and curve fitted strings shall not be used in the survey model.

- 4.6 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 shall be provided as a 2d string for the pipe and an invert point.

## Summary of Models to be Provided

### Survey Model

- 4.7 The Survey Model consists of points and strings traditionally used to create the Triangulated Irregular Network (TIN). Points and strings defaulting to the Survey Model in SUR-ES002-4 "Survey Code Summary" shall be supplied in that model in standard surveys.
- 4.8 Intersecting strings are not permitted.

### XSurvey

- 4.9 XSurvey relates to surveyed features whose heights are not to be used for the creation of the TIN. Points and strings defaulting to the XSurvey in SUR-ES002-4 "Survey Code Summary" shall be supplied in that model in standard surveys. These points and strings shall not be used to generate the TIN.

### Tria Survey / Tria Bridge

- 4.10 All surveys shall include a Survey DTM. The Survey DTM forms the ground surface guaranteed by the Contractor. Where a bridge structure exists a Bridge DTM shall be included. The model(s) shall be supplied in 12da, AutoCAD 3d dxf or Land XML format and named TIN TRIA SURVEY.
- 4.11 Points and strings listed as "TIN-able" in SUR-ES002-4 "Survey Code Summary" may be used to create the surface at the discretion of the Contractor. These models shall be named using the following convention: TIN TRIA (Model Name), for example, TIN TRIA BRIDGE.

## 5 Underground Services

### General

- 5.1 If stated in the Project Brief, the Contractor shall also undertake ground marking of service locations. Services shall be shown as a two dimensional string unless the service is entirely visible. Depthing may be required and will be addressed specifically in the Project Brief. This work shall be undertaken by accredited Service Provider.
- 5.2 Services shall be supplied in a continuous string representing the entire run (e.g. from transformer to pit).

### Services Models

- 5.3 Underground services shall be placed in models according to their accuracy of capture. The models to be supplied are as follows:

### Services Direct

- 5.4 Direct location is the highest accuracy order of data capture. It refers to services which have been directly surveyed, therefore horizontal and vertical location is subject only to the accuracies of the survey methodology.
- 5.5 Examples may include: Depthed service points (pot holing), exposed pipes, as-constructed survey data or open cable trenches or direct invert / obvert measurement.

### Services Active

- 5.6 Active services are to 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.

- 5.7 Active location methods include using a “Direct connection” or “Induction clamp” readings are required to be marked on the ground’s surface refer "4.2.4.3 Ground marking requirements for underground services". The resulting marks are to be surveyed for incorporation into the digital model.
- 5.8 Active location methods are suitable for metal conduits or cables that are welded, soldered or braided together or where a tracing wire is present.

## Services Passive

- 5.9 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.
- 5.10 Examples of Passive service capture include radiolocation or ground-penetrating radar. Readings are required to be marked on the ground's surface refer 4.2.4.3 “Ground marking requirements for underground services”. The resulting marks are to be surveyed for incorporation into the digital model.
- 5.11 Passive location methods are commonly used for materials such as Ground Penetrating Radar, Plastic poly tubing, clay, concrete or insulated cast iron where active methodology is not possible.

## Services Unverified

- 5.12 Unverified are services that incorporate data that has been collected without confirmation by any of the above mentioned methods.
- 5.13 Unverified services can include information from sources such as:
- Dial Before You Dig [DBYD] Plans, GIS datasets, As-Constructed plans, Cable marker posts (offset measurement) or other form of digital plan or record. If a service is unable to be traced or located in the field, the service shall be displayed in an approximate location and be placed in the Services Unverified model.
- 5.14 Unverified services will not be marked on the ground and shall be depicted in the model by interpreting the marked up DBYD plan supplied by underground service locators.
- 5.15 Examples of Unverified service capture include non-visible stormwater pipes and Optical Fibre cables.
- 5.16 Note: Not all councils are listed in DBYD. It is the responsibility of the Contractor to follow up with all of the relevant councils to obtain service information.

## Survey Requirements for Underground Services Location

- 5.17 Where services are located to passive or active standard, the following location requirements shall apply:
- Services shall be surveyed at points no greater than 20 m intervals on linear runs and at all changes in direction for all services.
  - If requested by the principal, indicative depths to be recorded at less than 40 m intervals and at all changes in depth for all services.
  - Asset ownership to be recorded at start and finish of cable run and less than 100 m intervals. (Not required for TransAdelaide cabling).
  - Cabling type (e.g. Optic fibre, High Voltage, Main cable, SSI cable, communications cable or signal feed cable) to be marked at start of cable run and at less than 100 m intervals.
  - Pipe construction type and size to be provided where information is available (eg RCP 450 mm means Reinforced Concrete Pipe of 450 mm diameter) at start of run.
  - Any additional information regarding assets (e.g. HPGM means High Pressure Gas Main, Pump means Pumping Mains and Grav means Gravity Mains) to be annotated where applicable.
  - Where pipe inverts are requested, levels shall 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”, such as “Sump Blocked”, “Manhole Locked”, etc.

## Survey Requirements for Depthing Underground Services (Potholing or Rodding)

5.18 Where requested by the principal, underground service details shall be supplied in the following format:

**Table PC-SI5 5-1 Underground Service Details**

Pothole No.	Service ID	Easting	Northing	Code	Quality Class
581	SW 22	278040.098	6137195.522	PUUP	A
593	TE16	278045.235	6137225.321	PNFD	A
599	TE 25	278065.398	6137236.987	PUTT	B

Point located	RL Existing Ground Surface	RL of point located	Depth to Service	Depth to obstacle or not found
Top of pipe	127.405	126.755	0.650	
Conc capping	127.037	124.537		2.500
Rodded	51.627	50.827	0.800	

Diameter	Material and Colour	Comments
350	Concrete	
	Concrete capping	Service may be below
100	White PVC (Fibre Optic)	

## 6 Boundary Model

- 6.1 A boundary model shall be created if required by the Project Scope.
- 6.2 The boundary model shall be named Bdy Model.
- 6.3 The boundary model shall be obtained by compiling data from plans lodged with the Lands Titles Office and Certificates of Title. The model will cover all main road and side road boundaries. All side property boundaries are not required unless requested.
- 6.4 Sufficient survey marks shall 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 shall be included in the survey report.
- 6.5 A full boundary definition is not required.
- 6.6 Boundaries are not to be marked in the field.
- 6.7 The boundary model shall be presented as solid red lines on paper plots, with string labels pre-fixed BD.
- 6.8 Where easements appear within the project scope, these shall be identified by an EZ string. Text identifying the easement appurtenances shall be annotated to mirror the information on the Certificate of Title (e.g. A/B, etc.). The text shall be at a height of 2.5 mm. A copy of the Certificate of Title shall be submitted with the deliverables.
- 6.9 Null levels shall be assigned to all BD and EZ strings within the boundary model.

## 7 Bridge Model

- 7.1 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.
- 7.2 All detail on the deck shall be surveyed. All strings on the bridge deck shall be separate from the Survey and XSurvey models and placed in a "Bridge Model".
- 7.3 All strings leading to and underneath the bridge deck form part of the "Survey Model". This includes all abutments and piers.

## 8 Underside Bridge Model

- 8.1 The Underside Bridge Model is located to the same standards as the bridge model. Features include soffits and services.

## 9 QQ Model

- 9.1 The QQ Model shall contain surveyed independent checks used to verify the survey model.

## 10 Annotations

### General Notes

- 10.1 Annotation is required in the corresponding model.
- 10.2 The following shall be annotated on the plots and in the model:
- MARS marker numbers (e.g. MM45.0);
  - road and street names;
  - U, UX, and JB sequential strings and PUPP, PUPL and PUKK point strings;
  - all undefined sequential and point strings;
  - significant buildings and landmarks;
  - Underground Services.
- 10.3 For sign annotations, refer to SUR-CT003-TK01 "Identification of Signs".
- 10.4 Annotations shall be text strings within the appropriate model, labelled \*A for all features in accordance with SUR-ES002-1 "Survey String Identifiers". Road names shall be duplicated and shown at the same locations in both the SURVEY MODEL and BDY MODEL.
- 10.5 The size of the annotations (regardless of scale) shall be 2.5 mm.

### Underground Service Annotations

- 10.6 All services within the services model shall be presented as follows:
- text strings labels pre-fixed \*A;
  - text size of 2.5 mm;
  - at a scale advised for each project.
- 10.7 All annotations shall be parallel to and on top of each string. Further annotation shall be at every substantial bend in the string, except in circumstances that will result in a cluttered plot and model.
- 10.8 All service annotations shall be described as shown in the Locating Sequential Strings – Underground Services.

## 11 Items to be Supplied by Contractor

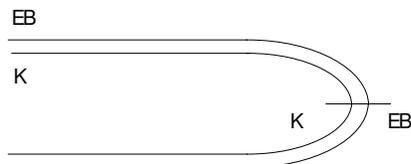
- 11.1 The Contractor shall supply the following items:
- Digital data in the form of either:
    - an MX Genio or input file named CONTRACT.INP with all coordinates truncated to three decimal places; or
    - a 12d ascii file named CONTRACT.12da.
  - The data shall contain all requested models.
- 11.2 Project Report (presented in the following order):

- a) Table of Contents;
  - b) Location of survey, type and job number;
  - c) Survey Party Leader names and equipment used;
  - d) Horizontal Control: details of the method of determining the coordinates and orientation and a summary of the closure adjustment and accuracy achieved;
  - e) Vertical Control: 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: details of any abnormalities relating to the survey;
  - i) Report of all unidentified strings;
  - j) SUR-CT003-1 "Compliance Checklist" completed by the Survey Party Leader;
  - k) A copy of the Contractor's Traffic Management Plan;
  - l) Full details of any non-compliance indicated on the SUR-CT003-1 "Engineering Compliance Checklist";
  - m) Verification of survey control (e.g. Station set up checks);
  - n) A comparison between surveyed and checked points;
  - o) Pdf of DBYD plans. If the plans were marked up by a service provider to describe accuracy of measurement, these shall be provided;
  - p) Pdf of Underground Services checklist as supplied by the service locator (Appendix B – Underground Service Location Procedure);
  - q) Pdf document identifying signs in accordance with SUR-CT003-TK01 "Identification of Signs"; and
  - r) Copies of Certificates of Title where easements are depicted on the Bdy Model.
  - s) Completed Daily Work-Zone Traffic Management plans
- 11.3 All documentation shall be supplied in electronic format.
- 11.4 The Contractor shall retain evidence to satisfy the requirements herein. The evidence is subject to a random audit, at the Contractor's premises by the Department's Transport Services Division.

## 12 Notes

### Looped Strings

- 12.1 Strings shall not be looped. That is, a string shall not change direction and run approximately parallel to itself in the opposite direction. A separate string shall commence at the change of direction. See example below.



### Unidentified Strings

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

## Natural Surface Strings

- 12.3 The natural surface shall be defined by either running N strings or spot height points (Coded PNSS).
- 12.4 All natural surface strings shall run approximately parallel to the main corridor. On side roads beyond the main corridor bandwidth specified, natural surface strings shall run parallel to the side roads.
- 12.5 Natural Surface (N) Strings shall not cross, but end as close as possible to other surveyed features.
- 12.6 N Strings shall not be used to identify any features which appear in the Sequential Strings Identifiers List.

## Domestic Outlets

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

## Signs

- 12.8 All signs, on urban and rural surveys, shall be located. Sign posts shall be identified as PPSA or PPSB Point Strings. Larger signs shall be identified as RS (Road Sign / Hoarding).
- 12.9 For sign annotations, refer to SUR-CT003-TK01 "Identification of Signs".

## Gantry Signs

### Standard Gantry Location

- 12.10 Gantry signs are large directional overhead signs, usually suspended over main road carriageways.
- 12.11 All gantry signs and associated poles shall be located in accordance with SUR-ES002-TK07 "Locating Sequential Strings".
- 12.12 All gantry signs shall be coded as (OR) Outreach by surveying the internal face of the gantry.
- 12.13 The (OR) code is used similarly on lighting outreaches and signalling combo pole outreaches.
- 12.14 The upper edge of the Gantry (Sign backing only) shall be surveyed and coded as (LT).
- 12.15 The underside of the Gantry (Sign backing only) shall be surveyed and coded as (LU).

### Gantry Structural Survey

- 12.16 When requested specifically, full detail of the gantry structure is required. This includes all features such as walkways, underside of gantry, detection cameras, and radius of arm and location of footings.
- 12.17 Typically, codes are not available for many of these features. These features shall be coded as unknown points and strings with descriptive text.

## Temporary Signs

- 12.18 All temporary signs are not required to be surveyed.

## Passing Lanes

- 12.19 A reference line of galvanised iron nails is required for each project.
- 12.20 The reference line shall:
  - a) be placed along the painted white line as advised at 10 m intervals and placed to a chainage accuracy of  $\pm 20$  mm;
  - b) commence and finish at chainages as specified;
  - c) be marked by a circle of yellow paint around each nail, with the running chainage commencing at 00 and chainages marked at 10 m intervals;

- d) be surveyed as individual points (PGII) for X, Y and Z running in the same direction, as one continuous string; and
  - e) have the chainages annotated within the model every 10 m.
- 12.21 From the reference line, all detail is required in cross section format opposite each nail, across the paved road to the extents of each edge of shoulder.
- 12.22 Beyond the edge of shoulder, the Contractor shall survey all strings to the rural standard.

## Drainage Requirements

- 12.23 All drainage structures including headwalls, culverts and pipe inverts for both sides of the road shall be located.
- 12.24 At each drainage structure, the survey bandwidth shall be extended by a distance of 15 m from the front face of each structure. The Contractor shall define the drainage channel features including centre of drain, bank top and bank bottom strings and a natural surface string shall be extended 5 m beyond each bank top.

## Pavement Markings

- 12.25 All line marking, pavement arrows, pavement bars and chevrons shall be located in accordance with SUR-ES002-TK07 "Locating Sequential Strings". Null levels shall be assigned to the string label PMPB (Pavement Bars).

## Directional Strings

- 12.26 Specific strings as noted in SUR-ES002-1 "Survey String Identifiers" are required to be located with the feature to the right. This will enable the feature to display correctly.

# 13 Vegetation

## Standard Requirements

- 13.1 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 shall be surveyed in accordance with codes PSHH, PTRT, PTRS, PTRM, PTRL PTRX and PTRZ (See below).
- 13.2 All significant trees Code (PTRZ) are to be located. These are defined as:
- a) any tree with a single diameter greater than 625 mm; or
  - b) any multi stemmed tree where:
    - i) the combined diameter is greater than 625 mm metres AND
    - ii) the average stem diameter is greater than 170 mm.
- 13.3 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.
- 13.4 Natural surface and other appropriate strings shall continue to run through the area of vegetation. The distances between shots shall be no greater than 30 m, in urban or rural areas. The distances between strings shall be as per the standard for all strings in an urban or rural area.
- 13.5 Edge of vegetation strings may be given null levels if the topography has accurately been defined by other strings.

## Additional Vegetation Requirements

- 13.6 If requested, the following additional requirements are to be undertaken.

**Additional Requirement 1 – Trees and shrubs greater than two metres tall**

- 13.7 Trees or shrubs greater than two metres tall which do not qualify under the existing butt diameter conditions (Undersized) shall be coded PTRU and included in the survey.
- 13.8 All trees and shrubs greater than two metres tall shall be located individually using codes PSHH, PTRU, PTRT, PTRS, PTRM, PTRL PTRX and PTRZ.
- 13.9 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.

**Phytophthora Hygiene**

- 13.10 Where a site has been identified by the principal as a high risk Phytophthora zone, the Contractor shall work in accordance with Operating Instruction 21.3 Appendix 3: Phytophthora Hygiene Procedure for Minor Works and Site Inspections. This instruction shall be followed if soil is sticking to equipment, footwear or vehicle tyres.

**14 Rail Specific Requirements****Survey Accuracy Requirements**

- 14.1 Surveys of rail infrastructure shall be undertaken to high accuracy survey standards as noted in 3.3 above.

**Survey Coordinate System**

- 14.2 Surveys within the rail corridor shall be undertaken using the existing rail project coordinate system.

**Verification of Control**

- 14.3 Prior to commencement of work, horizontal checks shall be taken to 2 separate survey control marks. Vertical checks shall be undertaken using two way digital levelling within a closed loop.
- 14.4 Tolerances shall be within high accuracy survey standards for survey control as noted in 3.3 above.
- 14.5 In the event that these accuracies are not achieved, the surveyor shall re-establish control from existing major control points. Subsidiary control shall be adjusted and the methodology and adjusted coordinates be submitted as a part of the report.

**Survey for Track and Other Infrastructure**

- 14.6 Critical rail infrastructure shall be observed as detailed below:

**Table PC-SI5 14-1 Rail Infrastructure Survey**

<b>Activity</b>	<b>Methodology</b>
Survey of theoretical gauge point	Rail measurements shall be observed to the theoretical gauge point. This is a three dimensional point located: Horizontally as the intersection of the inside gauge face measured 16 mm down from the top of the rail Vertically as the top of rail
Survey of platform coping / edge	Coping measurements shall 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 metres of the track shall 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 shall be measured at the actual / theoretical point as required

Activity	Methodology
Placement of Track Monuments	Track Monuments shall be placed in accordance with the P.T.S. Naming and Numbering Convention standard.
Set out of horizontal and vertical framing points	Marks shall be placed in accordance with the P.T.S. Naming and Numbering convention standard
Set out of offsets	All offsets shall be set out with reference to the theoretical gauge point

14.7 For additional information refer to SUR-ES002-1 "Survey String Identifiers".

## Tools and Equipment

14.8 Critical tasks shall be undertaken using the tools as highlighted below:

**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 & 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 In order to achieve the required standards, the following field techniques may be adopted. These guidelines outline acceptable field procedures in the collection and reporting on key issues.

### Levelling Techniques

15.2 All survey stations shall be levelled twice by differential levelling techniques (i.e. Spirit, Automatic or Digital Level) and the two reduced levels shall not differ by more than 5 mm.

15.3 Any errors found with the network marks shall be noted in the Project Report.

### CHE Checks

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

### QQ Checks

15.5 QQ checks shall 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 two QQs per job.

15.6 A QQ check shall be performed across the junction of two models when joining to an existing survey. In addition a feature check shall be performed from a station in the new model to a prominent feature in the existing survey.

### Tolerances

15.7 The tolerances, as detailed in Table PC-SI5 15-1, shall not be exceeded.

**Table PC-SI5 15-1 Tolerances**

Description	Urban	Rural
<b>Surveyed Points</b>		
Distance between shots	10 m	15 m

Description	Urban	Rural
Distance between strings	10 m	15 m
Length of Radiations (except QQs)	100 m	150 m
<b>CHE Checks</b>		
Level difference between observed and fixed	7 mm / 100 m	10 mm / 100 m
For distances less than 100 m	7 mm	10 mm
<b>QQ Checks</b>		
Pavement & hard surfaces level differences	20 mm	30 mm
Natural surface strings level differences	50 mm	100 mm

15.8 If any of the above tolerances are exceeded details of the non-compliance shall be completed on the SUR-CT003-1 "Engineering Compliance Checklist".

## Items to be Supplied by Contractor

15.9 The following details shall be supplied within the project report:

- a) A computer report of all CHE checks that includes:
  - i) Instrument station numbers;
  - ii) Reference station numbers; and
  - iii) Horizontal distances.
- b) A comparison of stored and calculated co-ordinates; and
- c) A computer report detailing height differences between QQ strings and the triangulated surface.

## 16 Hold Points

16.1 There are no Hold Points referenced in this Part.

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