

Project Controls

Master Specification

PC-SI1 Site Surveys

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PC-SI1 Surveys

1 General

- 1.1 This Part specifies the requirements for the management of the survey control network and the general survey duties necessary for the delivery of Works.
- 1.2 This Part references the following document:
 - a) Survey Act 1992 (SA).

2 Surveyor

- 2.1 The Contractor shall engage a person ("Surveyor") who:
 - a) is eligible for the grade of Member of the Spatial Sciences Institute, Australia or be eligible for membership of an allied professional organisation;
 - b) is accredited by completion of a Work Zone Traffic Management course with a trainer approved by the Department; and
 - c) has a minimum of 3 years' experience as a survey party leader on major infrastructure work (which is appropriate for this Contract) since gaining qualification.
- 2.2 The Contractor shall ensure that:
 - a) the Surveyor complies with the requirements of this Part;
 - b) the Surveyor personally carries out the duties specified herein or be on site at all times during survey work; and
 - c) all survey duties are undertaken in accordance with a certified Quality Assurance system.

3 Survey Control Network

- 3.1 The Principal will provide the Survey Control Marks to the Contractor.
- 3.2 The Contractor:
 - a) is responsible for these marks and any additional marks that form the Survey Control Network;
 - b) shall verify the integrity of the marks before commencing survey work; and
 - c) shall supply to the Principal a final list of stations immediately prior to the project completion.

Verification

- 3.3 Verification of the survey control shall be conducted periodically (at intervals not exceeding 3 months) up to the Date of Completion.
- 3.4 If discrepancies are detected between apparently undisturbed adjacent control points, the Surveyor shall report the discrepancies to the Principal who may direct further survey control verification to be carried out.

Horizontal Control

- 3.5 For horizontal control only, survey stations numbered S001 to S799 shall be used. The S300 series of survey stations are permanent survey marks registered with the Surveyor General.

Vertical Control

- 3.6 Where deep bench marks (prefixed BM) are provided by the Principal, these deep bench marks shall be used for vertical control.

- 3.7 If deep bench marks are not provided by the Principal, survey stations numbered S001 to S099 and S300 to S399 shall be used for vertical control.

Bridge Control

- 3.8 Where the Works include a bridge or major structure, the Contractor shall nominate a minimum of three control stations for each bridge site. Where the bridge length exceeds 100 m, the distance between control stations shall not exceed 100 m. Only these stations or their approved replacements are to be used for alignment, level and coordinate origin for the bridge set out and construction.
- 3.9 Where survey control for structures and bridgeworks is established, the Surveyor shall use ground distances (not grid distances) for all lines when calculating coordinates.

Re-Establishment of Control

- 3.10 If control survey stations have to be re-located or additional stations installed, these stations shall be connected to the existing survey control network. Adjustment computations for new control points shall be ancillary to the main control adjustment so that minor adjustments to the previously fixed stations are avoided. The Contractor is responsible for all costs associated with re-establishment of survey marks.

Principal Supplied Survey Coordinate Data

- 3.11 All Survey and design undertaken by the Principal is in planar Project Coordinate System.
- 3.12 All design undertaken prior to any issue of survey datasets provided by the Principal will be undertaken in either GDA 94 South Australian conformal conic projection or GDA 94 MGA Z 54H.
- 3.13 The Contractor shall be responsible for converting data to and from the preferred coordinate system as required, including for Service Authorities designs and GIS data.

4 Survey Equipment

- 4.1 The equipment used by the Surveyor shall be appropriate for the accuracy of work undertaken. The Surveyor's procedures shall address all errors introduced by survey methods and make due allowance for the effects of:
- survey equipment capability and adjustment;
 - integrity of the survey control network;
 - vertical refraction;
 - the grid scale factor;
 - the earth's curvature; and
 - the geoid – ellipsoid separation.

Electronic Distance Measuring Equipment

- 4.2 Electronic Distance Measuring equipment shall have the following:
- capability to measure distances to within 5mm +5ppm;
 - capability to for angular measurements for both horizontal and vertical angles to be less than 3" of arc;
 - one second of arc minimum count;
 - diametric vertical circle reading;
 - automatic tilt compensator; and
 - capable to electronically record and store field data including horizontal and vertical angles, distances, point notation, target and instrument heights.

- 4.3 Prior to commencement of any survey work, the Contractor shall submit evidence that all Electronic Distance Measuring equipment used for work under the Contract has been tested within the last 12 months and every 12 months for the duration of the project
- 4.4 Electronic Distance Measuring equipment shall be tested at the University of South Australia, Mawson Campus or by a company certified by a National Association of Testing Authorities (NATA) to test the equipment within the last 12 months and every 12 months for the duration of the project.
- 4.5 Submission of this evidence shall be provided at least 10 working days prior to the commencement of work on site and shall constitute a **Hold Point**.

Verification of Level Equipment

- 4.6 Prior to commencement of any survey work, the Contractor shall undertake sufficient checks to ensure the level equipment is calibrated and in tolerance, evidence shall be documented and may be requested by the principal at any time.

Global Navigation Satellite System Equipment

- 4.7 This sub-clause applies to Global Navigation Satellite System (GNSS) hardware and software systems designed for geodetic survey applications operated in differential mode where carrier phase and pseudo-range observations are recorded by the receivers.
- 4.8 At a minimum, GNSS equipment shall:
 - a) include receivers capable of recording carrier waves;
 - b) be authorised for frequency to operate a two-way radio from the Australian Communication Authority for GNSS operations; and
 - c) incorporate braced support for the receiver pole.
- 4.9 Prior to commencement of any survey work using GNSS equipment, the Contractor shall submit evidence that all GNSS equipment used for work under the Contract has been tested within the last 12 months. This requirement is specific to utilising GNSS in a Quality Assurance system.
- 4.10 Submission of this evidence shall be provided at least 10 working days prior to the commencement of work on site and shall constitute a **Hold Point**.
- 4.11 GNSS systems shall be tested on a calibration network at least once per year, immediately after any repair, after a system upgrade (hardware and / or firmware). GNSS shall not be used as the sole method of measuring length in contractor surveys. Surveyors using GNSS for contract verification purposes shall adhere to the requirements of the Surveyor General.

5 Survey Duties - General

Permanent Survey Marks

- 5.1 Permanent Survey marks shall be protected in accordance with the Survey Act 1992 (SA). The Contractor's attention is drawn to Section 52 – Interface with Survey Marks.
- 5.2 Prior to construction commencing, the Surveyor shall:
 - a) obtain location details of all permanent survey marks registered with the Surveyor General within the construction area;
 - b) give the Surveyor General a minimum of 10 working days' notice in writing of:
 - i) the commencement date of construction activities; and
 - ii) the possible destruction of a permanent survey mark registered with the Surveyor General.
- 5.3 Notification to the Surveyor general shall be sent to dpti.markmaintenance@sa.gov.au. A copy of these notifications shall be submitted to the Principal.
- 5.4 Submission of the notification shall constitute a **Hold Point**.

Re-instatement and Placement of Permanent Survey Marks

- 5.5 In the event of damage, disturbance or removal of any permanent survey mark, the Contractor:
- shall re-install and / or replace the permanent survey mark;
 - liaise with a representative from the Surveyor-General's Office when undertaking these activities;
 - ensure this work is certified by the Surveyor; and
 - submit to the Surveyor General field observations, coordinates, locality sketches and other information as reasonably requested.
- 5.6 Details for placement of permanent survey marks are outlined in Section 14.1 to 14.3 of the Cadastral Survey Guidelines, available from: <https://www.bing.com/search?q=https%3A%2F%2Fwww.sa.gov.au%2Ftopics%2Fhousing-property-and-land%2Findustry-+++professionals%2Fconveyancing-and-surveying-professionals%2Fcadastral-survey-guidelines-csg%23title5&src=IE-SearchBox&FORM=IESR3N>.
- 5.7 Details for the requirements for the coordination of permanent survey marks are outlined in Sections 5.7 & 5.8 of the Cadastral Survey Guideline, available from <https://www.bing.com/search?q=https%3A%2F%2Fwww.sa.gov.au%2Ftopics%2Fhousing-property-and-land%2Findustry-+++professionals%2Fconveyancing-and-surveying-professionals%2Fcadastral-survey-guidelines-csg%23title5&src=IE-SearchBox&FORM=IESR3N>.

Review of Data

- 5.8 The Surveyor shall:
- prepare and set out data from plans and digital design prior to and during construction;
 - provide a certificate verifying the survey coordinate information supplied by the Principal;
 - seek direction from the Superintendent if any survey stations are missing or disturbed; and
 - detect any design discrepancies or ambiguities.
- 5.9 Where there is disagreement with the Principal's co-ordinates and / or levels, the Contractor and the Principal will agree on the values to be adopted before any setting out is commenced.

Existing Survey Marks

- 5.10 The Surveyor shall maintain a site list of all existing survey marks, in the project site listing coordinates and status.
- 5.11 Prior to Completion, the Surveyor shall supply to the Principal a certificate of the site stations list, in hard copy and electronic format (MS Excel) detailing:
- the survey stations supplied by the Department that are intact;
 - the survey stations supplied by the Department that have been destroyed or disturbed;
 - a sorted station listing by label detailing the coordinates, the type of ground mark and the witness mark, of all additional survey marks placed by the Contractor;
 - permanent survey marks registered with the Surveyor General that are intact; and
 - permanent survey marks registered with the Surveyor General that have been destroyed or disturbed.
- 5.12 Provision of this certificate shall constitute a **Hold Point** and is a condition precedent to Completion.

Survey Dataset

- 5.13 All design undertaken subsequent to the issue of the survey dataset (included any updated survey dataset) by the Principal shall be undertaken in accordance with the horizontal and vertical grid consistent with the issued dataset.

Setout

- 5.14 The Contractor shall set out all necessary design information needed to achieve the required construction tolerances relevant for the Works. Verification certificates shall be provided for all points.

Survey checks for Pavement Layers

- 5.15 When undertaking pavement verification, the Contractor shall utilise the same point on all pavement layers, from subgrade to wearing course inclusive, for the purpose of determining total pavement thickness.

Survey checks for Rail Layers

- 5.16 The Contractor shall Provide Survey Data for the following:
- Turnout Crossovers – K & V Crossings;
 - Rail Signals and associated infrastructure (tuning Units, axle counters etc.);
 - new or altered rail furniture including whistle boards, speed signs, etc.;
 - structural clearance verification; and
 - rail weights / locations.

Additional Potholing of Existing Utility Services

- 5.17 The Contractor shall survey locations of all depthed and constructed services including location of and top of service, as stated in the Department's Engineering Survey Specification: SURCT-003.
- 5.18 For newly constructed services, actual positions (not offsets) of the service prior to any backfilling shall be observed.
- 5.19 The Contractor shall provide supporting information for each service:
- details of service information where possible – i.e. diameter, material, number and configuration of conduits, condition;
 - where multiple conduits (banks) are observed, the Contractor shall:
 - expose all conduits in the top layer and excavate the sides of the bank until the conduits on the outsides of the lowest layer are exposed; and
 - survey the top of each conduit in the upper layer of the bank and the underside of the outer conduits in the lowest layer, and record the configuration of the bank, (e.g. 4 X 4, 5 X 3).
 - for sewers, both the invert and obvert level of the pipe and size / diameter of the manhole / IP;
 - for Drainage structure, invert and pipe diameter for all pipes penetrating the structure, and a notation for ingress or egress of the pipe(s);
 - for water mains at valve covers, where possible record the main, otherwise record the top of the spindle and estimate a height above the main (in comments); and
 - any other relevant information, (e.g. blocked, broken, plugged, etc.).

Installation of New Underground Utility Services

- 5.20 The Contractor shall ensure that the Surveyor:
- sets out the proposed alignment of any new service, including the location of any adjoining infrastructure that may impact on the placement of the new service; and
 - records the position of any services or conduit(s) laid in open trenches. Measurements shall be made at all changes of direction, or grade, and at regular intervals of length, (e.g. 10 m).
- 5.21 The Contractor shall ensure that the Surveyor has access to undertake measurements prior to any backfill of a services trench.

- 5.22 The Contractor shall provide bore log reports and digitised data for all underground boring. Bore logs shall clearly define the entry and exit points and show regular incremental measurements, generally at each bore rod length, represented in the Planar Grid / Project Coordinate System (x,y,z).
- 5.23 The minimum survey requirements for new underground utility services are specified in Appendix 1: Minimum Survey Requirements for Utility Services.

6 Verification Certificates

- 6.1 Prior to Completion or within any other timeframe specified in this Contract, the Contractor shall ensure that the Surveyor provides verification certificates demonstrating that the Contractor's work complies with the tolerances specified in the Contract. Unless specified otherwise, verification certificates shall:
- identify the instrument used;
 - be provided electronically in Microsoft .xlsx format;
 - include tables which display the information in a clear and logical format;
 - for each design dimension / position / level, display:
 - the design value, (X & Y Coordinates);
 - the actual value, (X & Y Coordinates); and
 - the difference between actual value and design value.
 - for pavement layers, the individual layer and total pavement thicknesses.
- 6.2 Submission of verification certificates shall constitute a **Hold Point** and is a condition precedent to Completion.
- 6.3 Where the work described below forms part of the Contract, at a minimum the verification certificates shall confirm compliance of the following:

Roadworks

- 6.4 Confirmation of that as outlined in Table PC-SI1 6-1.

Table PC-SI1 6-1 Roadworks Compliance

	String label chainage at interval of reference string	Offset from reference string	Design level	Actual level	Difference between actual and design levels	Displacement from horizontal position
Stripping Topsoil	Yes	Yes	-	-	-	-
Cuts / Fills	Yes	Yes	-	-	-	Yes
Subgrade	Yes	Yes	Yes	Yes	Yes	-
Pavement Layers including Asphalt pavement treatments	Yes	Yes	Yes	Yes	Yes	Yes
Earth Drains	Yes	Yes	Yes	Yes	Yes	Yes
Kerb and Gutter (including bus guideway system)	Yes	Yes	Yes	Yes	Yes	Yes
Median Kerb type 2, 3, 4, 4A	Yes	Yes	Yes	Yes	Yes	Yes
Median Kerb type 1, 5, 6, 7, 8	Yes	Yes	-	-	-	Yes
Drainage culverts	-	-	Yes	Yes	Yes	Yes
Drainage structures	-	-	Yes	Yes	Yes	Yes
Lighting and Traffic Signal footings	Yes	Yes	Yes	Yes	Yes	Yes
Steel Beam and Wire Rope Safety Barrier	Yes	Yes	-	-	-	Yes
Settlement Monitoring	Yes	Yes	Yes	Yes	Yes	Yes

Cuts / Fills

- 6.5 Confirmation that that fills are located within the horizontal tolerances specified in accordance with the chainages set out in the Geometric Details applicable to:
- the Reference String;
 - top of batter; and
 - batter interface string.
- 6.6 Where the length of batter exceeds 15 m additional data shall be obtained at the batter mid-point.

Subgrade and Pavement Layers including Asphalt Pavement Treatments

- 6.7 Confirmation that pavement layers are located within the horizontal tolerances specified in accordance with the chainages set out in the Geometric Details, including:
- edge of pavement strings for subgrade and granular (bound and / or unbound) pavement layers;
 - edge of bitumen strings / gutter lip / face of median kerb for new asphalt works; and
 - edge of treatment strings / gutter lip / face of median kerb for plane and reinstate asphalt works.
- 6.8 Confirmation of the pavement thickness in comparison with the design thickness for:
- subbase layer(s);
 - asphalt levelling course(s);
 - asphalt wearing course;
 - total Asphalt thickness; and
 - total pavement thickness.

Earth Drains

- 6.9 Confirmation of drainage string for earth drains: every 10 m and at horizontal and vertical tangent points.

Structural Works

- 6.10 Confirmation of the following:
- alignment and spacing of piles prior to placement of concrete (insitu piles);
 - alignment and spacing of piles following placement of concrete (insitu piles);
 - alignment and spacing of piles, founding Reduced Level on completion of driving (driven piles);
 - location and level of pile caps after placing concrete;
 - location and level of abutment sills after placing concrete;
 - span lengths and location and levels of bearing pedestals and / or bearings;
 - dimensions of precast girders;
 - alignment and levels of placed girders;
 - alignment and levels of deck after placing concrete;
 - alignment and levels of kerb and gutter after placing of concrete;
 - alignment and levels of barriers after installation; and
 - alignment and position of Reinforced Soil Structures.

Rail Works

- 6.11 Confirmation of the following:
- setting out of all K & V Crossings;

- b) setting out of all rail gauge face including check rails;
- c) setting out of all Signal Infrastructure;
- d) verification of structural clearance envelope;
- e) setting out and levels of piers prior to placing concrete;
- f) setting out and levels of abutment sill prior to placing concrete;
- g) setting out and levels of deck prior to placing of concrete; and
- h) setting out of Reinforced Earth Walls.

7 Survey using Global Navigation Satellite System Equipment

- 7.1 This Clause applies where GNSS equipment is used. The Surveyor shall:
- a) ensure that for each construction activity the instrument's threshold suitably meets the specified construction tolerances outlined in the contract;
 - b) validate equipment and survey by occupying established survey control stations and comparing coordinates;
 - c) prior to undertaking any observations or set out, localise onto the planar project coordinate system by observing survey control stations. The results shall be documented;
 - d) verify a sample of set out by traditional survey methods; and
 - e) document and validate the methodology for modelling the geoid and its effects on heights.
- 7.2 Real Time Kinematic GNSS may be used for horizontal set out for clearing lines, batter lines, bulk earthwork quantities and initial set out of earthworks.
- 7.3 Real Time Kinematic GNSS shall not be used for horizontal set out for any feature placed on or above the pavement course such as kerb-lines, medians, side entry pits, drainage manholes, structures such as culverts and bridges.

8 Property Boundary Marking

- 8.1 Where contract documents indicate construction activity within 500mm of a property boundary, the property line shall be determined using the most current cadastral information supplied by the Department's Land Services Group. The survey shall be carried out by or under the direct supervision of a licensed surveyor in accordance with the Survey Act (1992). SA.

9 Provision of As-Constructed Information

- 9.1 The Contractor shall provide:
- a) an electronic copy of the combined verification certificates including 3D model in either 12d ascii, MX Genio or AutoCad dwg format containing the following as specified by the Principal:
 - i) final pavement layer;
 - ii) kerbs;
 - iii) light poles;
 - iv) side entry pits;
 - v) structural elements;
 - vi) rail infrastructure;
 - vii) all newly placed underground services;
 - viii) all existing underground services retained or redundant and left in place;
 - ix) any other elements as outlined in this Contract; and
 - b) all new survey control placed and used for this project.

- c) a consolidated set out report of all design information used for the construction works as an electronic excel spreadsheet.
- 9.2 The model data shall comply with the Principal's survey codes and model naming convention in an "As- Constructed" model in accordance with SUR-CT003 Engineering Survey Specifications, available from <https://www.dpti.sa.gov.au/standards/survey>.
- 9.3 Provision of this certification shall constitute a **Hold Point** and is a condition precedent to Completion.

10 Audit

- 10.1 Survey records shall provide objective evidence that the Surveyor has completed all survey work in compliance with the requirements of this Part and that all surveys comply with the specified tolerances.

11 Payment

- 11.1 Unless a separate payment item or amount for an activity pursuant to this Part is included in the Schedule of Rates or Schedule of Prices, separate payment will not be made for survey work. Payment for survey work for which there is no separate payment item or amount is deemed to be included in other rates and amounts generally.

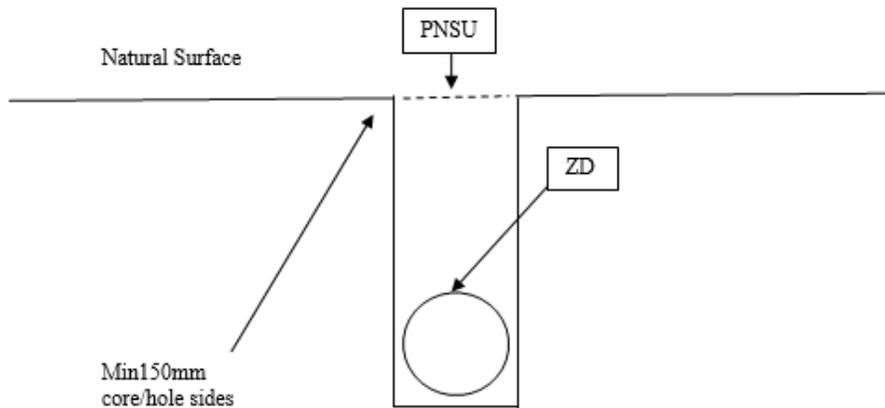
12 Hold Points

- 12.1 The following is a summary of Hold Points referenced in this Part:

Document Ref.	Hold Point	Response Time
4.5	Evidence of EDM test	10 working days
4.10	Evidence of GNSS equipment test	10 working days
5.4	Permanent survey marks	2 working days
5.12	Existing survey marks certificate	2 working days
6	Verification Certificates	3 working days
9	Provision of as-constructed information	7 working days

13 Appendix 1: Minimum Survey Requirements for Utility Services

Figure PC-SI1 13-1 Cross Section of a Hole



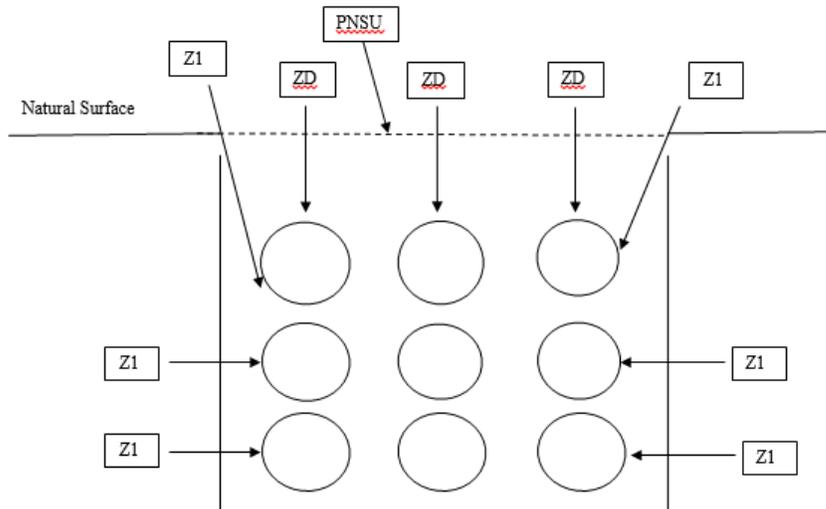
13.1 Example notation and requirements for a cross section of a hole by the verified method:

ZD – Z = denotes top of service; D = 100 m dia (letter varies depending on service diameter)

PNSS – denotes natural surface RL at the hole

Note – Labelling to be in accordance with the Department's Geospatial Services Survey String Identifiers

Figure PC-SI1 13-2 Cross Section of a 'Trenched Multi Conduit Run' or 'Trench / Slot'



13.2 Example notation and requirements for a cross section of a trench by the verified method:

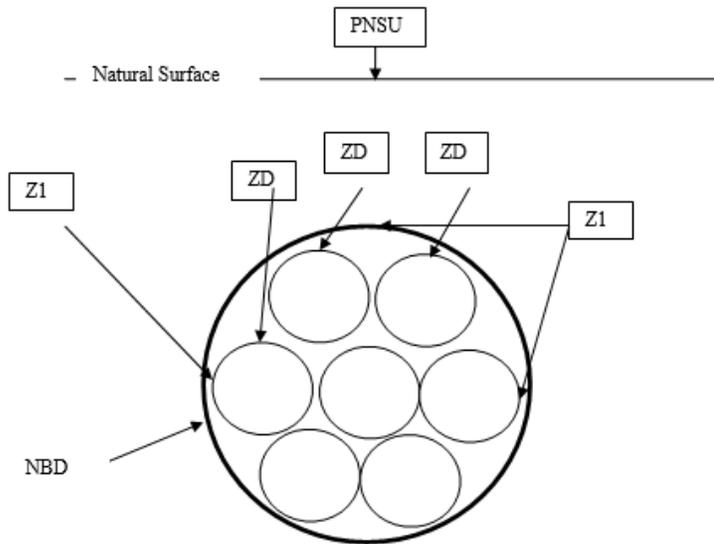
Z1 – denotes pipe bundle edge

ZD – Z = denotes top of service; D = 100 m dia (letter varies depending on service diameter) PNSS-

denotes natural surface RL at the trench / slot

Note – Labelling to be in accordance with the Department's Geospatial Services Survey String Identifiers

Figure PC-SI1 13-3 Cross Section Of A Bore Of Bundled Conduits



13.3 Example notation and requirements for a bore of bundled conduits by the verified method:

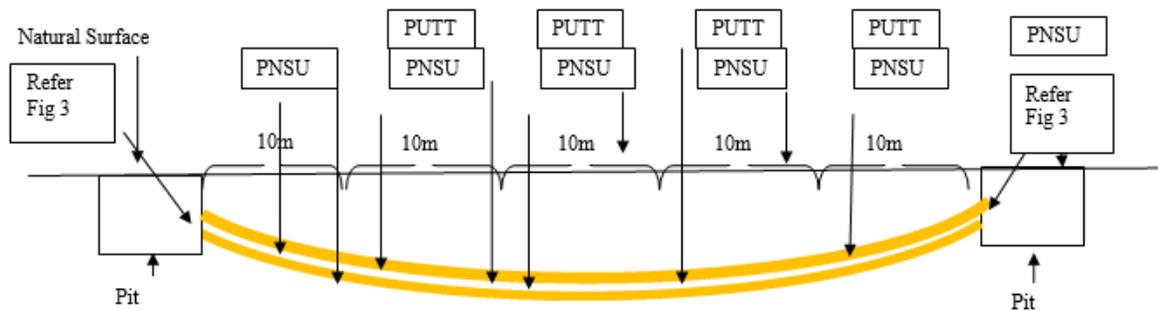
Z1 – denotes pipe bundle edge located using verified method (refer to Figure PC-SI1 13-1)

ZD – Z = denotes top of service; D = 100 m dia (letter varies depending on service diameter) PNSU - denotes natural surface RL, at 10 m intervals above bore

NBD – denotes Nominal Bore Diameter (to be recorded on ‘Service Depthing Record’ in under the ‘Other Comments’ column.

Note – Labelling to be in accordance with the Department’s Geospatial Services Survey String Identifiers

Figure PC-SI1 13-4 Long Section Of An Underbore



13.4 Example notation and requirements for an underbore using the verified and passive method:

PNSU – denotes natural surface RL, at 10 m intervals above bore

PUTT – denotes top of conduit bundle, at 10 m intervals, either potholed (verified method) or through bore logs (passive method)

Note – Labelling to be in accordance with the Department’s Geospatial Services Survey String Identifiers