Asset and Geospatial Information Branch
Survey and Mapping Section

Digital Ground Survey

67-08-43

D12#434824 **Revision 113**
May 2026

Contents

Document Control

Owner	Surveying & Mapping Manager
Custodian	Senior Engineering Surveyor
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Review Frequency	Annual review, revisions as necessary.

Amendments

Revision Number	Revision Date	Description of Key Changes	Section / Page No.
1	23/08/02	Full revision of standard	
2	10/03/09	Full revision and update of standard	
3	01/06/15	Full revision and update of standard	
4	Mar 2017	Full revision and update of standard	
94	May 2021	Full review, update, add diagrams, restructure.	All
98	Oct 2021	Add/modify side entry pit, fences, tree/bush-line, and construction tolerance sections, previously disturbed maintenance zone “VD” string requirement	Page 13, 35, 36, 44,55
100	Oct 5, 2021	Fix revision number. Change annotation on “previously disturbed maintenance zone” diagrams	Page 36
102	Oct 14, 2021	Change annotation on “previously disturbed maintenance zone” diagrams	Page 36
107	Feb 02, 2022	Add point cloud delivery summary Amended summary sheets required where existing GDA94 RRM survey control used for GDA2020 project Larger pits to be defined by their extents, closed string	Sect 20 Sect 9.3 & 20 Sect 24.30
108	January 2023	Amend references to Geodetic Control Survey Standard	
109	July 2024	Amended Safety Requirements.	Sect 2.3

110	May 2025	Added requirement to lodge DXF closed polygon(s) of “VD” Previously disturbed maintenance zone. Removed need to lodge separate GenIO files of data derived from methods other than total station or RTK GNSS. New codes for non-standard point and non-standard line features – unique new codes no longer required/permitted. Some minor phrasing amendments Amended Compliance Survey/Construction Audit Tolerances section. New code “PHS” Hard Surface Spot Height Point can be used to define shape of seal (eg at intersections)	Sect 20, 22 Sect 24.11 Sect 11 & Sect 20 Sect 4, added Sect 4.1 Various Sect 7 Sect 24.1.2
111	Feb 2026	Stipulate that point cloud index must be coordinated .dxf file.	Sect 20
112	Mar 2026	Diagrams for Sign/Signal Variable Message Sign Gantry with feature codes	Sect 24.10
113	May 2026	Remove General Requirements	

1 INTRODUCTION

This document establishes the requirements for “Digital Ground Surveys” (Detail/feature surveys) conducted for Main Roads Western Australia. Surveys are to be undertaken and delivered as defined herein.

This document should be used in conjunction with Main Roads Surveying and Mapping guideline “D12#436049 Digital Ground Surveys”.

1.1 OWNERSHIP OF DATA

All materials and information as part of undertaking projects for Main Roads WA shall become the property of Main Roads WA. It shall not be used, copied or reproduced for any other purpose without the prior written approval by Main Roads WA.

1.2 REFERENCES AND RELATED DOCUMENTS

Document Number	Description
D17#301448	Survey Report, MRWA template
D17#307405	Feature Codes, Digital Ground Surveys
D22#371770	MRWA Standard “Geodetic Control Survey”
D14#152062	MRWA Standard “D14#152062 Mobile Laser Scanning”
D15#321963	MRWA Standard “D15#321963 Survey Metadata Standard"
N.A.	MRWA Metadata Statement Form – Detail Ground Surveys
N.A.	MRWA Metadata Statement Form – Point Cloud
N.A.	MRWA Metadata Statement Forms – Underground Utilities
N.A.	MRWA Guideline “Digital Ground Surveys”
N.A.	MRWA Guideline “Data Lodgement”
D18#554805	67-08-121 "Underground Utilities Survey Standard"
D15#224538	MRWA Aerial LiDAR Data Delivery Document
	Landgate Standards and Guidelines
	Land Administration Act 1997

Main Road survey standards, guidelines and documents can be found by searching the www.mainroads.wa.gov.au website.

1.3 DEFINITIONS

Term	Definition
AGI	Asset & Geospatial Information Branch, MRWA
AHD	Australian Height Datum
ALS	Aerial LiDAR Survey
BM	Benchmark
DBYD	Dial Before you Dig (1100.com.au)
DGS	Digital Ground Survey (Detail Survey)
DTM	Digital Terrain Model
Formed Surface	Unsealed Manmade / engineered surface e.g. unsealed road
GDA94	Geodetic Datum Australia 1994
GenIO	File format, required deliverable for Digital Ground Surveys
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
LiDAR	Light Detection and Ranging
MCP	Minor Control Point
MGA	Map Grid Australia
MLS	Mobile Laser Scan
MRWA	Main Roads Western Australia
MVCM	Minor Vertical Control Mark
MX	MX Road Design Software
Natural Surface	Any surface formed by natural or geological events
RPA	Remotely Piloted Aircraft
RRM	Road Reference Mark
RTK GPS	Real-time Kinematic Global Positioning System
Sealed Surface	Sealed road, path, driveway, carpark etc
SLK	MRWA Straight Line Kilometre (Refer to interactive online resource here)
SSM	Standard Survey Mark
Survey Portal	Main Roads WA online Surveying GIS web-page
TIN	Triangulated Irregular Network
TLS	Terrestrial Laser Scanner
UAV	Unmanned Aerial Vehicle
UUS	Underground Utilities Survey Standard
VCM	Vertical Control Mark
WCLT	Wide Centre-line Treatment

2 REQUIREMENTS FOR MRWA DIGITAL GROUND SURVEYS

Work and deliverables for MRWA Digital Ground Surveys (Detail/feature surveys) are to be in accordance with this standard.

2.1 EXTENTS OF SURVEY

The required extents of survey should be defined by MRWA and understood by the surveyor(s). The required extents may be defined in various ways, preferably by coordinated electronic boundary string/polygon.

Regardless of defined extents, the surveyor(s) must use judgement and their discretion with respect to including features outside of, but near or crossing the extents boundary.

3 FEATURE CODES / CODE LIST

The standard features and codes for Digital Ground Surveys are provided as a separate file/document, available here, via the Main Roads web site.

D17#307405	Feature Codes, Digital Ground Surveys

All features in the code list labelled “DGS Only” or “DGS and UUS” within the defined survey area are to be represented in the survey model/file.

The code list file also defines whether the feature must be 2D or 3D in the survey model, which features are TINABLE/NON-TINABLE for the true “ground model” triangulation (DTM TIN), the accuracy class, and whether the code applies to the DGS and/or UUS.

3.1 FEATURES NOT DEFINED IN CODE LIST

Any relevant feature not defined in the code list must still be captured and represented in the survey model/file. Text describing the feature must also be included in the model/file.

For point feature, use code	**PAA**
For line features, use code	**G0**

4 CONTINUOUS LINEAR FEATURES

Continuous linear features must be represented as single, continuous strings in the survey model file. (i.e. disconnected segments/duplicate points are not permitted)

5 REQUIRED ACCURACY

Accuracy of features captured shall be according to the relevant “Accuracy Class” specified in the feature code list, with reference to the table below:

5.1 MEASUREMENT ACCURACIES FOR FEATURES & FEATURE CLASSES

RTK GNSS/GPS must **NOT** to be used for capture of class A, B or C features.

ACCURACY CLASS	HORIZONTAL ACCURACY	VERTICAL ACCURACY
A	± 15 mm	± 10 mm
B	± 20 mm	± 15 mm
C	± 50 mm	± 20 mm
D	± 150 mm	± 40 mm
E	± 250 mm	± 50 mm

Note: Features with Class “UUS…" in feature code list denote Underground Utilities Survey (UUS) Model features.

5.1.1 CONSTRUCTION ACCURACY TOLERANCES

The accuracy tolerances mentioned in this document do not represent construction tolerances. Construction tolerances are to be referenced from other, relevant and appropriate sources (e.g. contract, or Main Roads Specifications).

5.2 MAXIMUM POINT SPACING

In addition to satisfying all other accuracy requirements, side lengths of triangles of the Digital Terrain Model generated from the survey model must not exceed **25m on sealed or formed surfaces** and **50m** in **all other areas**. Survey model point/string density and spacing must ensure that this condition is met.

5.3 DIGITAL TERRAIN MODEL (DTM) ACCURACY

Digital Terrain Model surfaces generated from the survey model must meet vertical deviation and volume difference tolerances.

5.3.1 DTM VERTICAL DEVIATION CONFORMANCE

The survey model is considered non-conforming if more than 5% of audit/comparison points fall outside the applicable vertical tolerance (as specified in the table below) when compared against the DTM generated from the survey model.

Additionally, outliers or gross errors are not acceptable. Any such errors will also render the survey model non-conforming to this MRWA standard..

SURFACE TYPE	VERTICAL TOLERANCE	ACCURACY CLASS
SEALED ROAD	± 25 mm	C
FORMED SURFACE	± 80 mm	D
NATURAL SURFACE	± 250 mm	E

5.3.2 VOLUME VERIFICATION – SURFACE CONFORMANCE

To achieve surface conformance, the volume (m^3) between the true surface (audit/comparison surface) and the survey model surface (DTM) must be less than the verification surface area (m^2) multiplied by the applicable "Volume factor" specified below.

SURFACE TYPE	VOLUME FACTOR
SEALED ROAD	0.010
FORMED SURFACE	0.020
NATURAL SURFACE	0.050

6 COMPLIANCE SURVEY / CONSTRUCTION AUDIT TOLERANCES

The accuracy tolerances mentioned in this document do not represent construction tolerances. Construction tolerances are to be referenced from other, relevant and appropriate sources (e.g. contract, or Main Roads Specifications as applicable – e.g. "SPECIFICATION 302, 501").

7 COORDINATE SYSTEM / PROJECT ZONE / SURVEY DATUM

Digital Ground Survey models are to be supplied in a Main Roads Project Zone coordinate system. The correct/appropriate zone should be specified in the request for survey.

Where more than one zone may appear applicable, the most appropriate zone is to be defined by the MRWA Senior Geodetic Surveyor or Surveying & Mapping specialist.

Where a project spans multiple zones, the areas for each zone are to be clearly defined.

Project zone parameters are available online via the Main Roads WA online Surveying GIS web-page known as "Survey Portal".

Or from the Senior Geodetic Surveyor (Ph: 138 138).
surveying@mainroads.wa.gov.au

Heights are to be relative to the Australian Height Datum (AHD).

To derive AHD height from GNSS, the following geoid models must be used:

- AUSGeoid09 for GDA94 datum surveys,
- AUSGeoid2020 for GDA2020 datum surveys

AUSGeoid models are available from the Geoscience Australia website (http://www.ga.gov.au).

The Project zone, height datum and geoid model used must be specified on the metadata statement.

8 SURVEY CONTROL

All survey control used for Digital Ground Surveys is to meet or exceed positional standards (horizontal and vertical) specified in Main Roads Standard "Geodetic Control Survey".

Survey control must be suitable and sufficient to meet the specified accuracies, considering the capture methodology and equipment used.

8.1 EXISTING CONTROL VERIFICATION

Control used for survey must be “Verified”.

In this context, “Verified” means the control mark is:

- Checked for physical stability and quality
- Checked for position by Static GNSS baseline, RTK GNSS check shot, or total station connection (from RTK points is acceptable, if/where necessary) to at least one adjacent/nearby control point.

For existing Landgate survey control:

- Check against a minimum of two reference marks (RMs) (where available)
  - Measure horizontal distances
  - Measure height difference
- These measurements to be submitted on an annotated control summary diagram.

8.1.1 HORIZONTAL CONTROL MISCLOSE RESOLUTION

If control checks or network adjustments identify Easting/Northing differences or error ellipses worse than 25mm compared to existing control values, clarification must be sought from Main Roads WA. (Contact the Main Roads Survey Manager, or Main Roads Senior Geodetic Surveyor).

8.2 VERTICAL NETWORK

A differential level traverse is to be undertaken for the extents of the survey area.

All existing control immediately adjacent to detail survey site/extents must be included in the differential level traverse.

Differential levelling is to be in accordance with MRWA standard “Geodetic Control Survey”

8.2.1 VERTICAL CONTROL MISCLOSE RESOLUTION

If level adjustment identifies misclose to existing control worse than 12rootK, clarification is to be sought from Main Roads WA (Contact the Main Roads Survey Manager or Main Roads Senior Geodetic Surveyor).

8.3 DETAILS OF SURVEY CONTROL

Details of survey control used, adjacent to, and relevant to the survey, must be provided. These are to be submitted as an Excel spreadsheet or .csv file.
Survey control details must also be included in the "Survey Report".

The requirements of any other standards applicable to the project/survey also apply.

Any new Road Reference Marks required must be established according to Main Roads Standard "Geodetic Control Survey"

If existing GDA94 RRM survey control is updated for use in GDA2020 project zone work, amended RRM summary sheets with GDA2020 coordinates added are to be lodged.

8.4 SURVEY CONTROL IN GENIO SURVEY MODEL

Survey control points used by, adjacent to and otherwise included/relevant to the survey must be included within the detail survey GenIO file. An exception is for control marks with horizontal accuracy >150mm – these are not to be included in the GenIO (e.g. Vertical Control Marks (VCM) or Minor Vertical Control Marks (MVCM) if they have only coarse XY position.)

With the exception of Landgate Benchmarks, coordinates of survey control points within the survey model file (GenIO) must be **final published/adjusted position**. (i.e. They must **not** be field captured coordinates – must not be total station radiation or captured RTK GNSS coordinates).

For Landgate benchmarks, the published Landgate benchmark height is to be used, but the horizontal XY coordinates are to be as captured in the detail survey.

8.4.1 VERTICAL CONTROL (VCM) & MINOR VERTICAL CONTROL MARKS (MVCM)

"Vertical Control Marks" (VCM) and "Minor Vertical Control Marks" (MVCM) are established as part of "Design Grade" Mobile Laser Scan (MLS) surveys. These are only to be included in the survey model file (GenIO) if their horizontal XY position is +/-150mm accuracy or better (i.e. RTK GNSS). The adjusted, spirit levelled height/z-value must be used in the GenIO.

Blue MRWA witness plates are to be used for "Vertical Control Marks" (VCM) established.

9 GNSS DATA / BASE STATIONS

9.1 ANTENNA HEIGHT MEASUREMENT RECORD

GNSS Antenna height measurement is to be recorded, and geotagged/location enabled photo file provided, as per Landgate Requirements for GNSS Surveys.

9.2 STATIC GNSS DATA ON 2+ HOUR INSTRUMENT SET-UP

When GNSS equipment is set-up on existing survey control for 2 or more hours (e.g., for RTK base stations or Mobile Laser Scanning bases), the GNSS data must be logged/recorded, and the following submitted to MRWA:

- GNSS data
  - raw and RINEX files (either version 2.x or 3.x),
- Antenna height measurement (including geotagged/location enabled photo, as per Landgate Requirements for GNSS Surveys)
- Survey Mark geotagged/location enabled photo(s) (as per Landgate Requirements for GNSS Surveys)
- Survey setup geotagged/location enabled photo (as per Landgate Requirements for GNSS Surveys)

10 THIS SECTION REMOVED WITH REVISION 110

This section previously required separate files containing features derived from methods other than total station or RTK GNSS. This is no longer required.

11 CROSSING BREAK-LINES / CROSSING FEATURES

Any crossing ground feature strings must have identical height/z-value at the crossing/intersection.

12 FEATURES EXCLUDED FROM DTM TIN GROUND TRIANGULATION

Refer to the *"Tinable?"* column of the separate feature code list for features which are excluded from ground triangulation.

Surveyors should consider including/excluding other specific points/strings to appropriately define the ground surface in the generation of the 3D DXF ground triangulation.

13 DTM TIN MODEL - 3D DXF OF GROUND TRIANGULATION

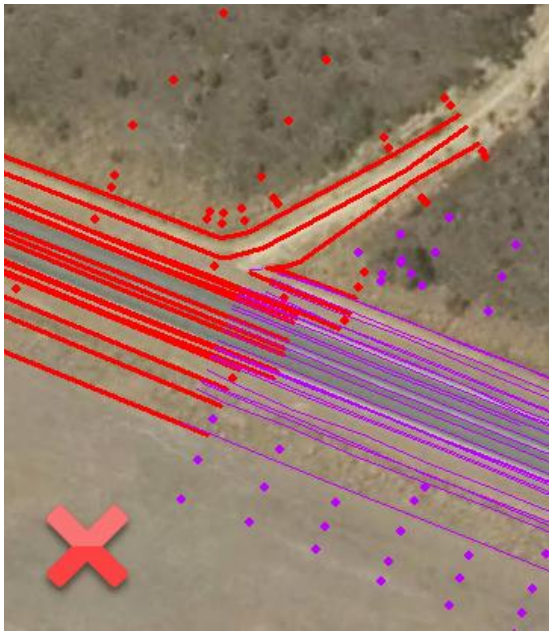
A "ground model" triangulation (DTM TIN) is to be generated using appropriate features/points/strings/break-lines. A 3D DXF of the TIN terrain model (ground surface) is to be provided as a deliverable.

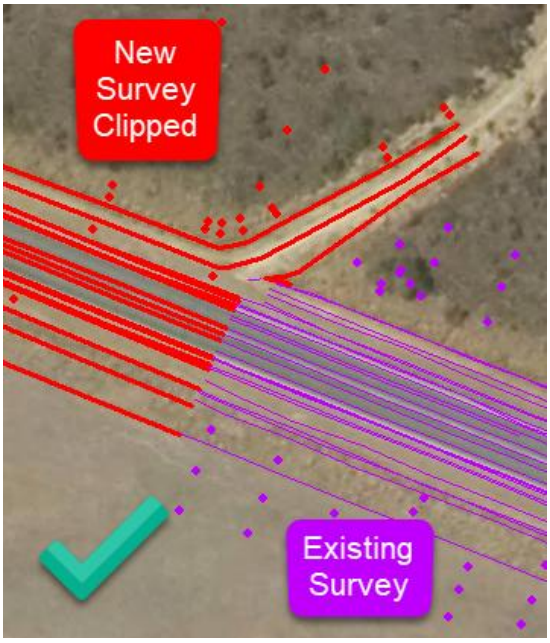
Refer to separate feature code list file and *"Tinable?"* column for features typically excluded from ground model triangulation.

14 SEAMLESSLY ABUTTING EXISTING SURVEY MODEL

Where the delivery of a new survey is required to seamlessly abut an existing survey model, the following applies:

- Main Roads WA will supply existing survey models (or relevant subset), in the same project zone coordinates as the requested new survey.
- The new survey data is to be processed such that when it is imported and overlaid with the old, it appears to form continuous linear features without overlap or gap.
- MRWA recognises and accepts that “abutting” points in the new survey may incorporate end-point data from the “existing” survey – the “new” survey may include features with end-points that are “snapped” to the position of the features in the existing survey model.
- Positional difference between existing abutting points and the new survey are to be checked. Where an abutting difference greater than the relevant feature accuracy class from table 5.1 “MEASUREMENT ACCURACIES FOR FEATURES & FEATURE CLASSES” is found, contact the survey manager. E.g. If sealed road “Accuracy Class C” adjoining points differ by more than +/-20mm in height and +/-50mm horizontal.





15 TEXT / ANNOTATION

Text / Annotation within the survey model GenIO is required for the following features at a minimum:

- Culvert type/material, dimensions and number of pipes or boxes
  - NOTE: Culvert / pipe dimensions must be internal measurements.
  - Culvert/environment condition should be noted if invert could not be accessed.
- Road names
- Names and numbers of SSM's, RRM's, Minor Control, BM's or any other control used for the survey or located in the survey project area
- Sign contents / description (e.g. speed signs "90km/h")
- On-road painted text/lettering.
- Information on services markers (e.g. Optic Cable 1.2m o/s North parallel to road)
- SLK post distance values
- Focal point sign distance values

Additional text / annotation for other relevant / significant features or characteristics within or adjacent to the survey area should be included.

Text / annotation must be situated at an appropriate coordinate location accompanying the feature or characteristic being described. The orientation of the text / annotation should maximise legibility but minimize interference with other features.
Text / annotation for linear features should be aligned with the feature. Culvert descriptions must be in line with the direction of the culvert. Text / annotation for survey control, sign descriptions and details, SLK posts and focal point distance markers should be aligned perpendicular to the road.

The maximum length (including spaces) for any single element of text / annotation is 44 characters.

If the content exceeds 44 characters, multiple text elements are required and must be positioned to ensure legibility.

A single text element's content must be in one line. (i.e. not contain "carriage returns")

The text content must contain only alpha-numeric characters and spaces (i.e. no special characters, e.g. _ - " , . /).

The size of text is to be **1m** in ground units.

16 GENIO FILE FORMAT - POINT OR STRING CODES

Point feature codes must start with “P”.

Any feature with code starting with a letter which is not “P” must be a line/string (i.e. contain a minimum or 2 connected points). Line/String codes must be defined by a 2-character alpha code and must not start with a “P”.

(Note: Individual points coded without a “P” as the first letter are likely to have a “P” prefix added automatically when exporting to GenIO – this results in erroneous coding in the GenIO model.)

17 GENIO FILE FORMAT – MODEL NAME IN HEADER

Format for model/layer name in GenIO header is to be as follows

H006 25 27 DGS YYYYYYYY

Where;

H006 is the Main Roads Road Number;
25 27 is the approx. “from” and “to” SLK of the Road;
YYYYYYYY is the Project Zone / coordinate system *(can be more than 3 characters where necessary).*

It must only contain alphanumeric characters and “spaces”.
Length must be no more than 26 characters, including spaces.

All data must be in **one model/layer.**

E.g.

GENIO **M53 2 14 DGS PCG94**
017,NORM
001FORMAT(3D23.17,/,D23.17,11A4)

Note: SLK’s (and road numbers/names) can be obtained interactively from the Main Roads WA online Surveying GIS web-page

18 PHOTOS WITH LOCATION GEOTAG

Photos are encouraged where they may be beneficial / add relevant information. Location / geotagging should be enabled and embedded within the lodged photo file.

19 LODGED INFORMATION / DELIVERABLES

The following are the deliverables to be lodged for Digital Ground Surveys:

- Complete Digital Ground Survey MX GenIO file
  - All data must be in **one model/layer**
- 3D DXF of TIN terrain model (ground surface)
- DXF of "VD" Previously disturbed maintenance zone, as closed polygon(s)
- If any of the survey model is derived from scanning/point cloud, geo-referenced point cloud must be lodged in accordance with MRWA standards/documents.
    - MLS: MRWA Standard "D14#152062 Mobile Laser Scanning"
    - ALS: MRWA Aerial LiDAR Data Delivery Document
  - A limited summary of point cloud minimum requirements:
    - .laz point cloud file format
    - Individual files not to exceed 100 million points
    - Lodged point cloud data from Terrestrial Laser Scan (TLS) is to have a minimum point spacing of 5mm (i.e. maximum point density 40,000 pts/m^2)
    - Lodged point cloud data from Terrestrial Laser Scan (TLS) does not need to be classified or contain RGB values.
    - Lodged point cloud data from Terrestrial Laser Scan (TLS) requires a tile index. (Index file must be a coordinated .dxf file)
    - Lodged point cloud data from Terrestrial Laser Scan (TLS) does not need to follow a file-naming convention, but data is to be named logically and match the tile index. (Index file must be a coordinated .dxf file)
    - Include Metadata Statement – Point Cloud (link to metadata form)
- Metadata Statement in accordance with Main Roads Western Australia standard (using MRWA template, available here)
- Metadata is to be included in the GenIO file header as comment lines. Metadata detail/comment lines in the GenIO file must be preceded by at least three spaces, or zeroes (000).
- Survey Report, as per MRWA template/document
- Any photos (e.g. culverts) - "Location enabled/geotagged", .jpg
- If existing GDA94 RRM survey control is updated for use in GDA2020 project zone work, amended RRM summary sheets with GDA2020 coordinates added are to be lodged.

Digital Ground Survey outputs/deliverables must be lodged to the nominated Main Roads officer and to surveying@mainroads.wa.gov.au.

The Main Roads officer receiving survey deliverables must also ensure all information is delivered to the Surveying Data Manager. If unsure, contact, or email survey information to surveying@mainroads.wa.gov.au.

20 SURVEY REPORT & METADATA

Metadata statements in accordance with Main Roads Western Australia standard are to accompany lodged and supplied survey data models. (using MRWA template, available here)

Survey report is to be completed and lodged, using the MRWA template.
Survey Report/Metadata to include, at a minimum:

- Statement that the project has been conducted and completed according to this Digital Ground Survey standard, noting the revision # (or define any variations/deviations from this standard)
- Project Name / Description (Include MRWA contract reference, where applicable)
- Project Zone Name
- Road Name, Number and SLK extents, or location description as applicable.
- Summary and description of any non-standard feature codes used/in the GenIO model
- Information of all control used and established
- Summary of contact with landowners and members of public
- New control point (RRM) information in accordance with MRWA Standard "Geodetic Control Survey"
- New control point (MCP) information in accordance with MRWA Standard "Geodetic Control Survey"

Note: The "Data Lodged / Deliverables Supplied" section must only list finalised/amended files that make up the final submission accepted by Main Roads WA.

21 FILE NAMING

Lodged GenIO model, metadata, report, 3D dxf triangulation and "VD" Previously Disturbed Maintenance Zone files must be appropriately named according to the naming convention below:

H006_25.3_27.5_ XXXXXX_ YYYYYYYY*.ext*

Where;

H006 is the Main Roads Road Number;
25.3_27.5 is the "from" and "to" SLK of the Road;

XXXXXX is either:

"DGSGEN" Complete Digital Ground Survey, GenIO;
"DGSMTD" Metadata, .pdf;
"DGSREP" Survey Report, .pdf/.doc/.docx;
"DGSTIN" 3D DXF of TIN terrain model (ground surface), .dxf;
"ENV_VD" 3D closed polygon DXF of "VD" Previously Disturbed Maintenance Zone, .dxf;

YYYYYYYY is the Project Zone / coordinate system.

.ext is the file type extension.
.gen for GenIO file.
.pdf for metadata, in accordance with MRWA metadata requirements and template format
.doc, .docx, .pdf for survey report - word or portable document format (pdf)
.dxf for 3D DXF of TIN terrain model (ground surface) and "VD".

If any of the survey model is derived from scanning/point cloud, the point cloud must be lodged. MLS and ALS requirements are defined in the relevant Main Roads WA Documents (MLS: D14#152062, ALS: D15#224538)

When spherical imagery, driven video, or similar data is captured, it may be requested as a deliverable

Note: SLK's (and road numbers/names) can be obtained interactively from the Main Roads WA online Surveying GIS web-page, or datasets/layers available on https://www.data.wa.gov.au/

22 UNDERGROUND UTILITIES MODELS

Underground utility survey/models may be requested with Digital Ground Survey projects.

These are to be in accordance with MRWA standard 67-08-121 "Underground Utilities Survey Standard" ("UUS" standard) to the "Class" requested/specified.

MRWA may supply some spatial utilities information which may be useful for modelling and GenIO output in accordance with the Class C & Class D UUS requirements. This information is to be extracted and supplied by (or under the direction of) the MRWA Data Manager, Asset & Geospatial Information (AGI).

Datasets may also be available from the government open data portals:

https://portal-mainroads.opendata.arcgis.com/
https://data.gov.au

Any MRWA supplied or open data portal information should be validated against current DBYD data to ensure completeness, currency and congruency.

Underground utilities may exist that are not defined by Before You Dig Australia (BYDA). These must be identified and sourced/modelled as necessary to satisfy the requirements of the request/UUS standard.

23 DETAIL DEFINITION & FEATURE CODING

All natural and artificial features occurring within the survey project area shall be captured and represented as coded points or strings in the model. Some feature codes are directional – The appropriate directional code must be applied.

Measurement accuracies of points and string features shall be in accordance with their accuracy class from the feature code list. Positional accuracies for each accuracy class are defined in 5.1.

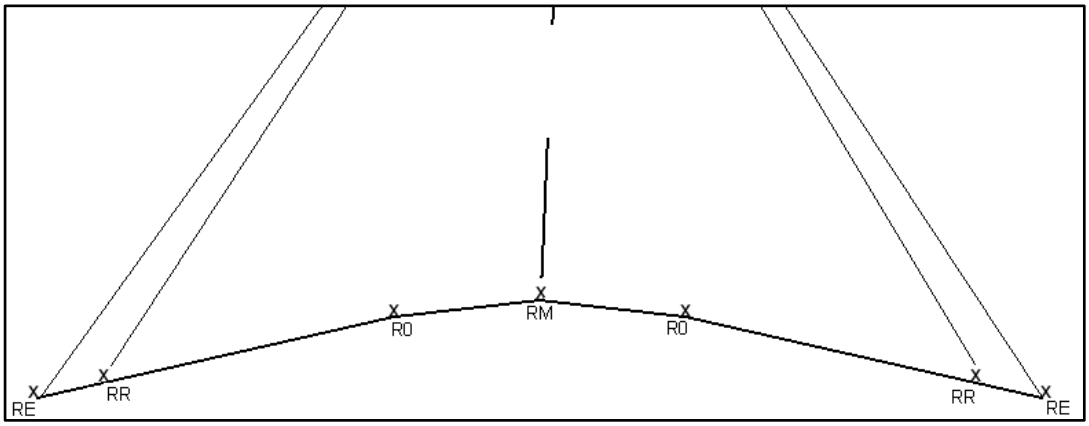
If features or codes need clarification, surveyor(s) to contact the MRWA survey manager, or email surveying@mainroads.wa.gov.au / ph 138 138.

23.1 SEALED ROAD SURFACES

Accuracy Class A, B or C features, must **NOT** be captured with RTK GNSS/GPS. This includes sealed road features.

23.1.1 REQUIREMENTS TO DEFINE SHAPE OF SEALED ROAD

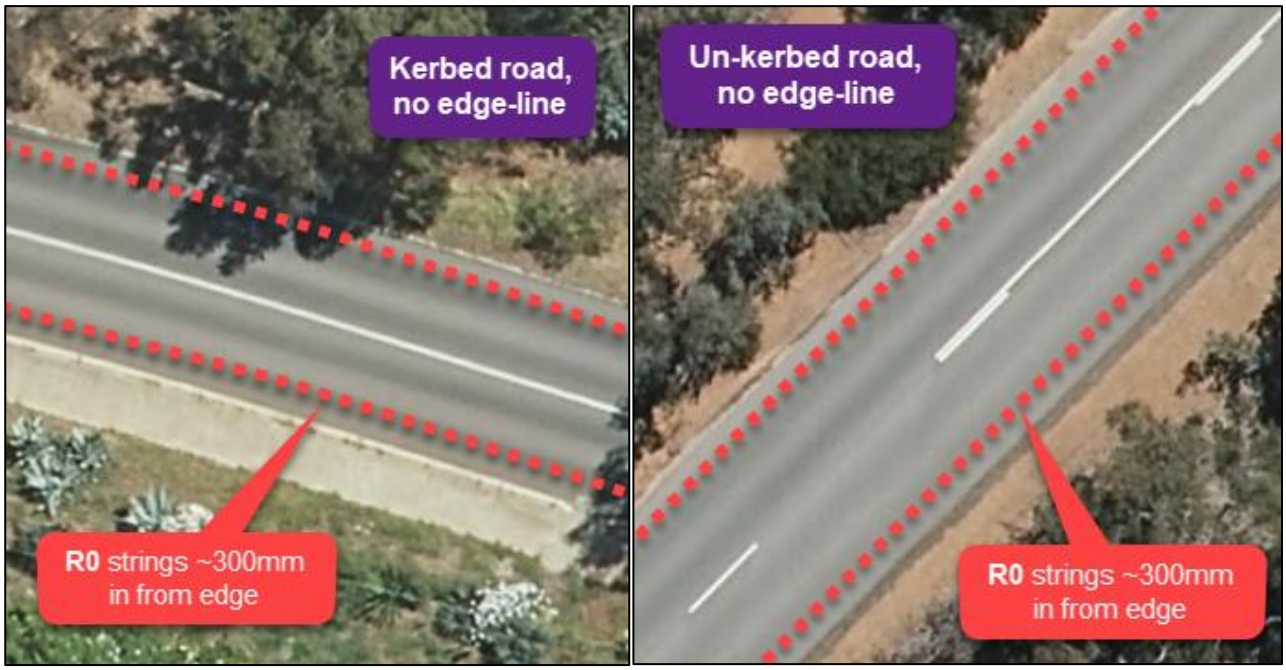
Sufficient strings must be captured/modelled across road surfaces to ensure the shape is accurately defined to specified accuracies and tolerances. At a minimum, any sealed road surface with a crown requires a string to be surveyed approximately 1m either side of the crown and coded "R0". All line marking must be captured and coded appropriately according to type.



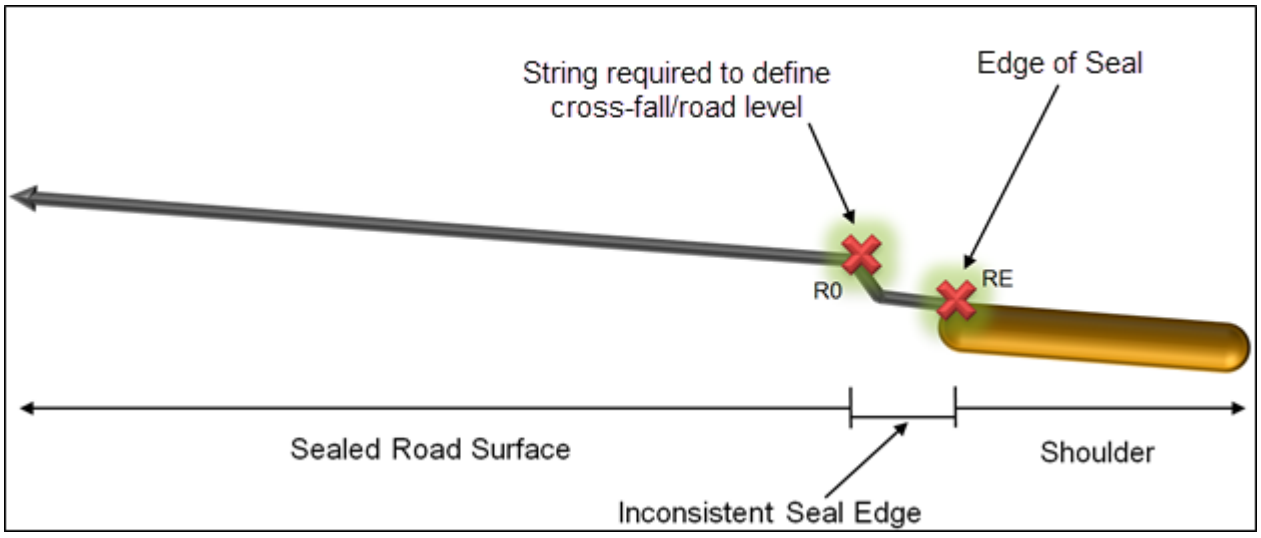
Cross Section of Typical Crowned Road

Cross-sectional and longitudinal shape of the seal must be accurately defined within specified accuracy tolerances.

Where the sealed road does not have a painted edge-line, strings on the seal ~300mm *in* from each edge of seal must be captured/modelled (code R0). This includes kerbed roads without painted edge-line.



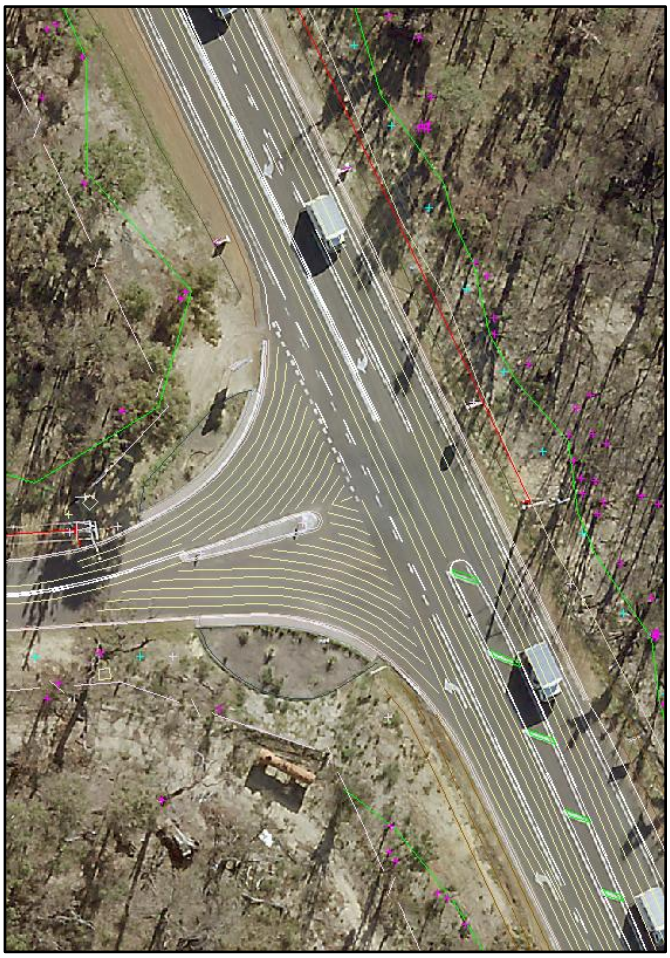
Captured/modelled points for edges of seal must be positioned carefully to ensure accurate cross-fall representation.
If the seal edge is inconsistent such that the edge of seal string would be misrepresentative of the road's cross-fall, an additional string is required where the height appropriately defines the road level. This string would be coded "R0"



Cross Section of Road at Edge of Seal

Strings defining the road and formation shall be captured such that their respective points align perpendicular to the direction of the road. Refer to example in image below.

23.1.2 INTERSECTIONS / AREAS WITH COMPLEX SURFACE SHAPE



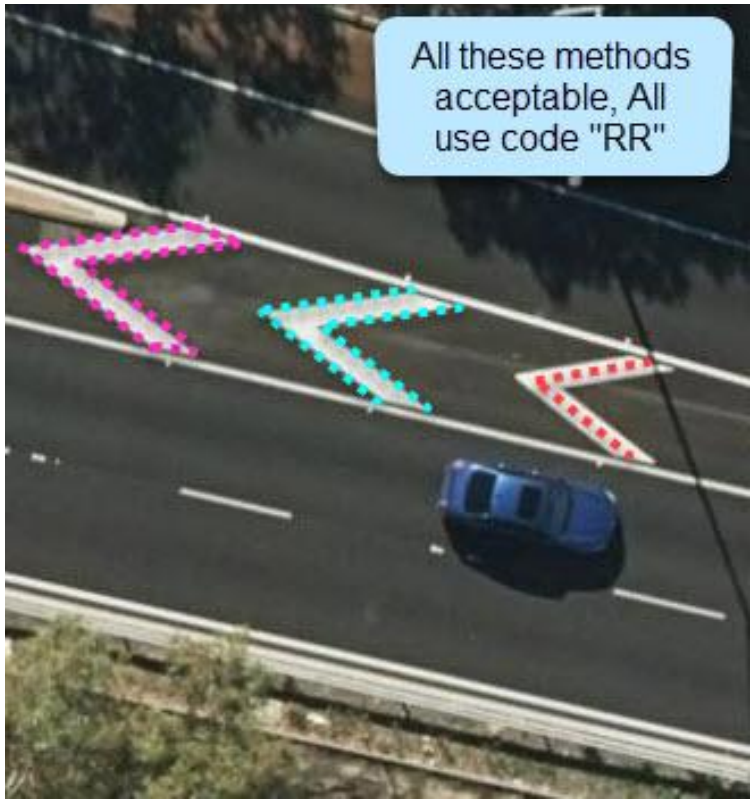
Intersections often have complex surface shapes that cannot be adequately defined and represented by capturing specific detail features alone.

Sufficient strings must be captured/modelled to accurately define the shape and achieve the required surface accuracies and tolerances.

On-road/seal must not be captured with RTK GNSS.

To define shape without specific features, use strings coded "R0", or points coded "PHS" (Hard surface spot height point).

23.1.3 GORE / CHEVRON LINEMARKING



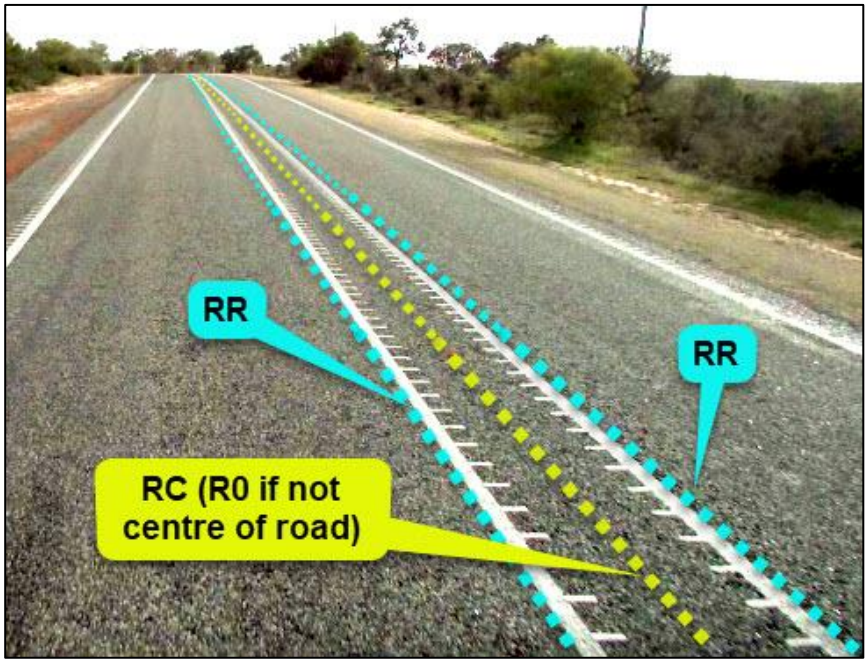
Gore / Chevron Line-marking to be defined using feature code “RR” LANE MARKINGS (Single Solid Line).

Feature defined by a line at the centre of the painted feature, or by the outside edges of each painted area (can be a closed polygon).

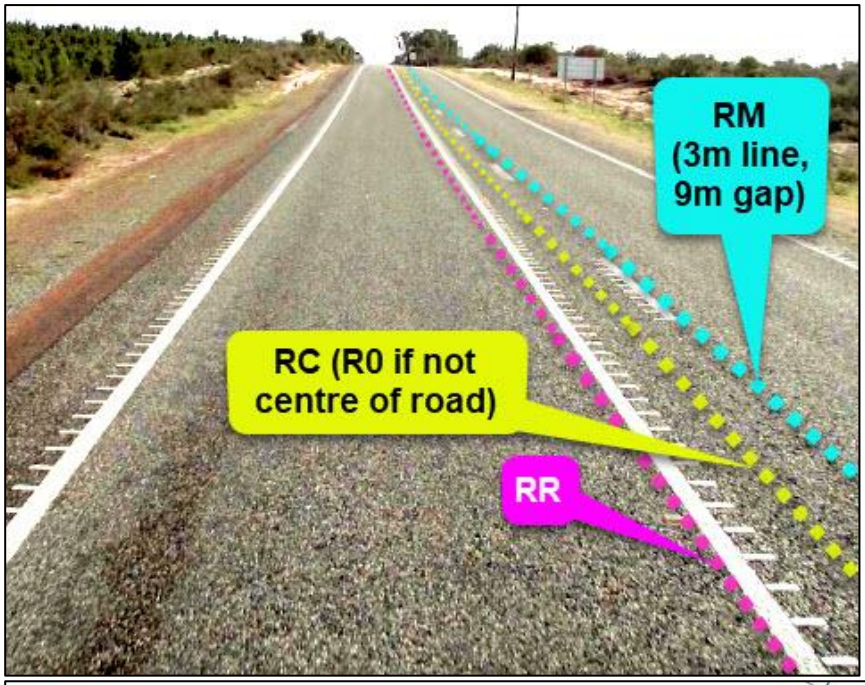
23.1.4 WIDE CENTRE-LINE TREATMENT ("WCLT")

For "Wide centre-line treatment" (WCLT), strings are to be captured/modelled, as per the diagrams.

(Both lines of the WCLT are modelled independently, coded RR)

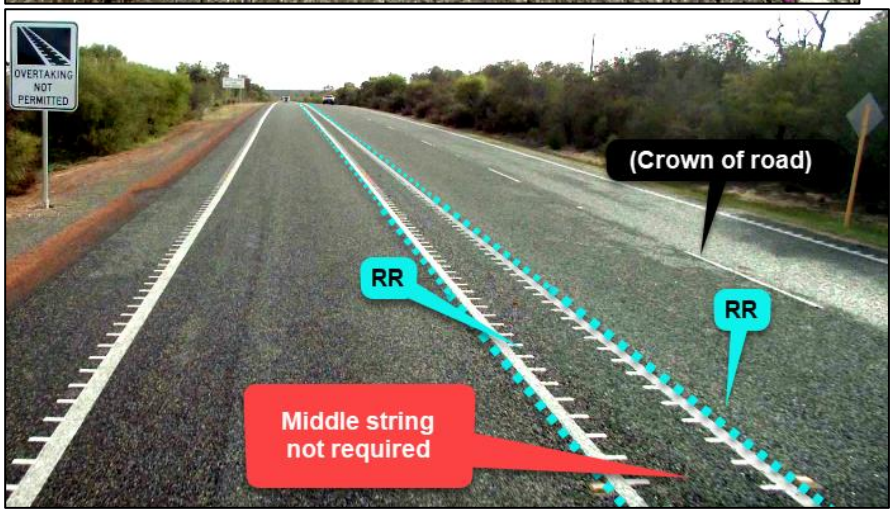


Where the WCLT contains the road's crown, a 3rd string on the crown/in the middle of the WCLT is required, coded "R0", or "RC" (road centre) as applicable.



Where the cross-fall is consistent between the edges of the WCLT, 2 RR strings are sufficient.

Note: In the examples depicted here, the audible lane marking would also need to be represented, coded "LA"



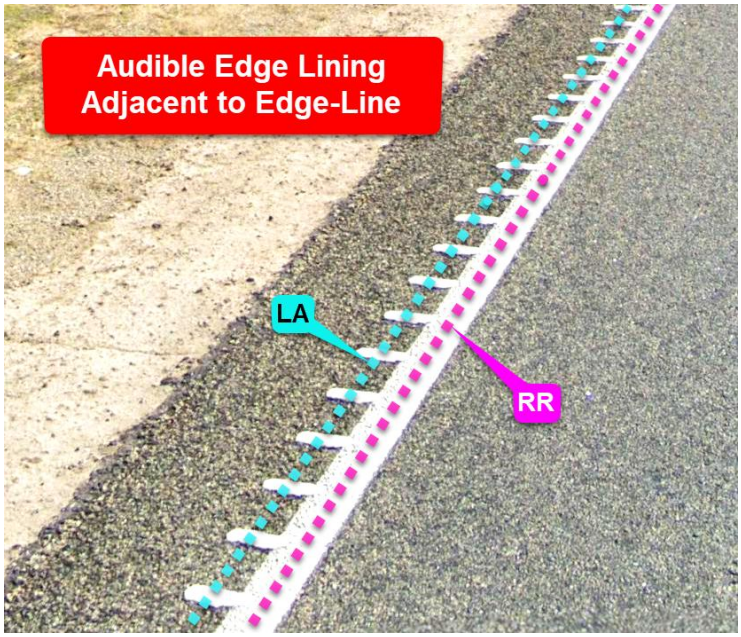
23.2 AUDIBLE EDGE LINING / AUDIBLE LANE MARKING

Audible edge lining / audible lane marking must be represented in the survey model, with code “LA”.

Where audible line marking is either on top of a solid white line, or exists in isolation, a single string, coded “LA”, is to be modelled.

Where the audible marking is adjacent to other line-marking, both must be represented in the model.

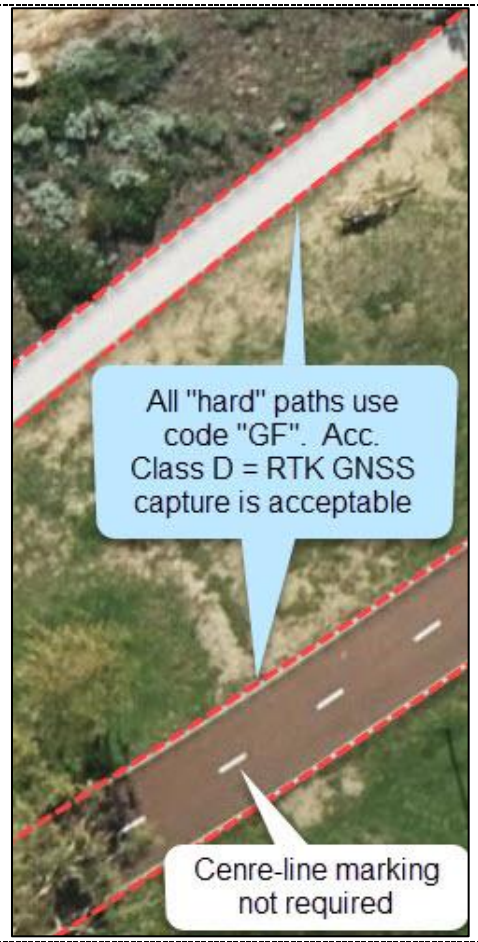
The audible lane-marking feature may be generated as an 80mm parallel offset copy of the other adjacent feature, with the same Z-values. i.e. The adjacent “LA” does not necessarily need independent field survey capture or point cloud extraction.



23.3 UNSEALED ROADS

Unsealed roads exceeding 4m in width must have a string at their approximate centre, coded “N0”.

23.4 FOOTPATHS, SHARED PATHS/CYCLE PATHS, WALKING TRACKS/TRAILS



All types of “hard” surface footpath or shared path can be represented by the code “GF”.

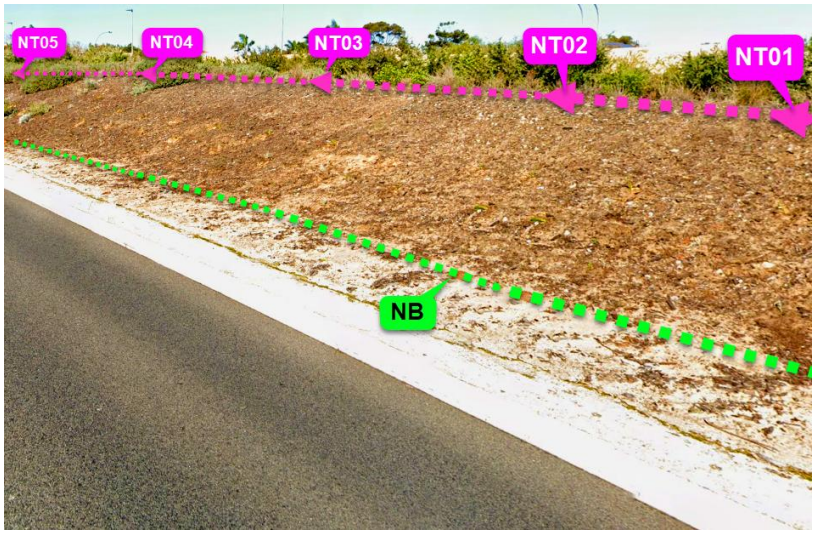
Code GF is accuracy class “D”, and thus the features may be captured with RTK GNSS equipment.

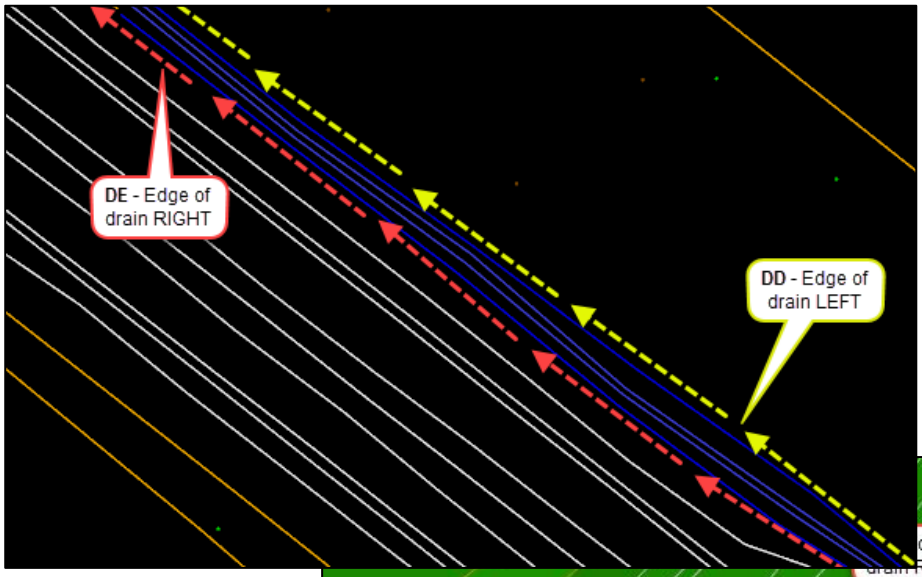
Line-marking on shared paths/cycle paths is <u>not</u> required.

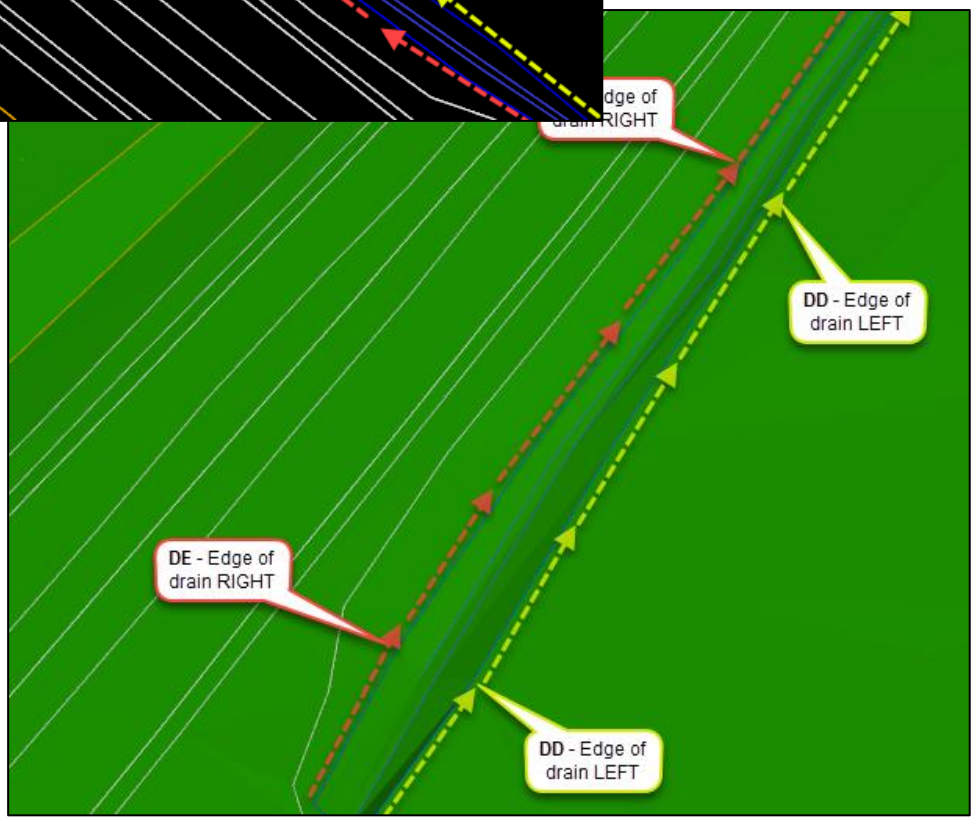
23.5 DIRECTIONAL CODE STRING FEATURES

String feature codes with "Left" or "Right" are directional. (e.g. Top of bank, edge of drain, edge of concrete, building). The direction of the string and the code used are to be such that the feature is on that side.

In the case of top of banks, the feature is the bank itself, and directional string coding is to suit accordingly. E.g. NT is "BANK TOP – LEFT".







23.6 RAIL BOOM GATES

RAIL BOOM GATE	D	GX

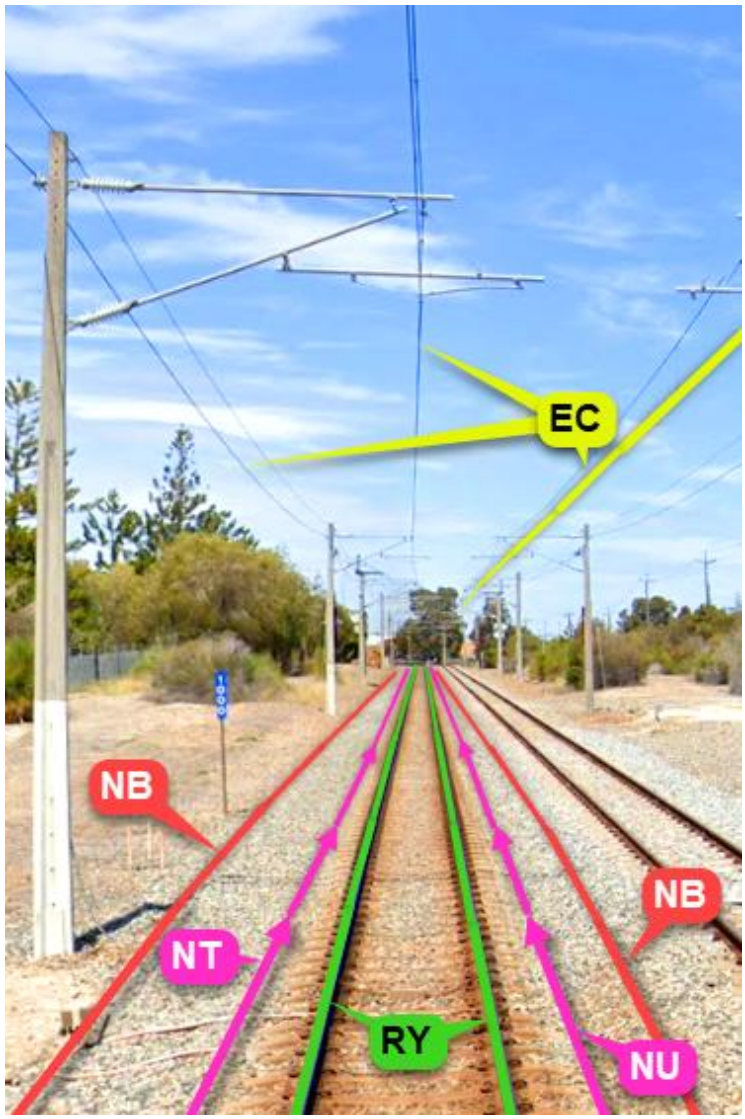
Boom Gates are defined by a string with the first measurement at boom gate's support post and the second measurement at the end of the boom at its lowered position. Both point's height/z-value must be at ground level.

23.7 RAIL TRACKS, BALLAST & POWER

The top of the rails and shape of the ballast are to be modelled.

Any overhead wires/power-lines are to be represented with the general power-line codes; “EA” if 2D/null height or “EC” if 3D/at true height (Only the lowest line(s) is/are required.)

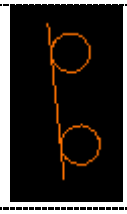
Codes used in example pictured:
EC: *O/head power-lines true height*
NB: *Bottom of bank*
NT: *Bank top – Left*
NU: *Bank top – Right*
RY: *On rail*

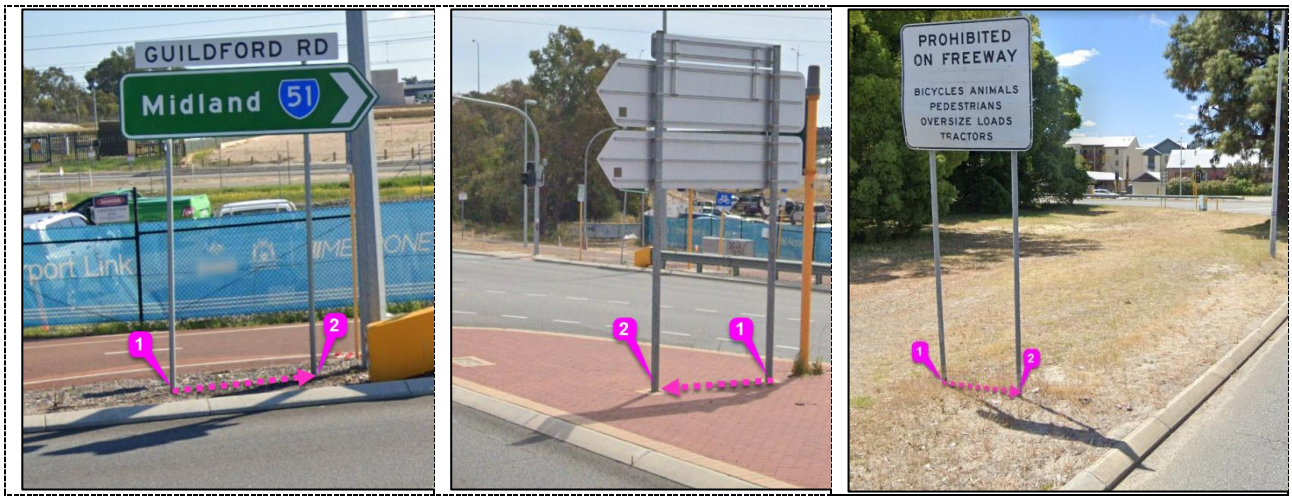


23.7.1 2-POLE SIGN (CODE RN)

2-pole signs features (code “RN”) are directional features – The line-style used to present signs on drawing/in design defines a front and back of sign.

When facing the front of a 2-pole sign, the string is to be captured/modelled from left to right, as per example diagrams below.





23.8 TRAFFIC SIGNALS – CODES FOR FACES/DIRECTION

The different codes are used to define how many directions the signals face, mounted on/originating from one pole. Pedestrian signals on traffic signal pole are not to be included/counted for faces/directions.

A pole with only a pedestrian signal has its own separate code.

A traffic signal pole with a pedestrian signal is coded only according to the traffic signal(s) (i.e. The pedestrian signal is ignored.)

Description	Acc. Class	Code
TRAFFIC SIGNALS - 1 Direction/Face	D	PTS
TRAFFIC SIGNALS - 2 Directions/Faces	D	PTT
TRAFFIC SIGNALS - 3 Directions/Faces	D	PTU
TRAFFIC SIGNALS - 4 Directions/Faces	D	PTV
PEDESTRIAN SIGNAL	D	PPS

23.9 POLES/POSTS NOT DEFINED BY SPECIFIC FEATURE CODES

Where a pole exists that isn't defined by a specific existing code, use the code "PPO" OTHER POLE/POST, accompanied by text/annotation in the GenIO describing the pole/post as well as possible.

Description	Acc. Class	Code
OTHER POLE/POST	D	PPO


1 Direction
/Face PTS


2 Directions/
Faces PTT


2 Directions/
Faces PTT


3 Directions/
Faces PTU


2 Directions/
Faces PTT


2 Directions/
Faces PTT


Pedestrian
Signal PPS

23.10 SIGN/SIGNAL GANTRY / VARIABLE MESSAGE SIGN

23.11 TREES

All trees within the survey area with trunk diameter greater than 0.1m are to be captured/modelled and represented in the survey model.

Trunk diameters are to be evaluated at 1.5m above ground, and the appropriate feature code used.

TREE 0.1 - 0.3m PTA
TREE 0.3 - 0.5m PTD
TREE 0.5 - 1.0m PTF
TREE >1.0m PTG

Where a tree has multiple stems/limbs at 1.5m above ground, classify and code according to the largest single stem/limb.

Tree point features are to have ground level height/z-value.

23.11.1 TREE-LINE / BUSH-LINE, TREE CANOPIES

Tree-line TL strings are to be captured at the road-side face of tree trunks.

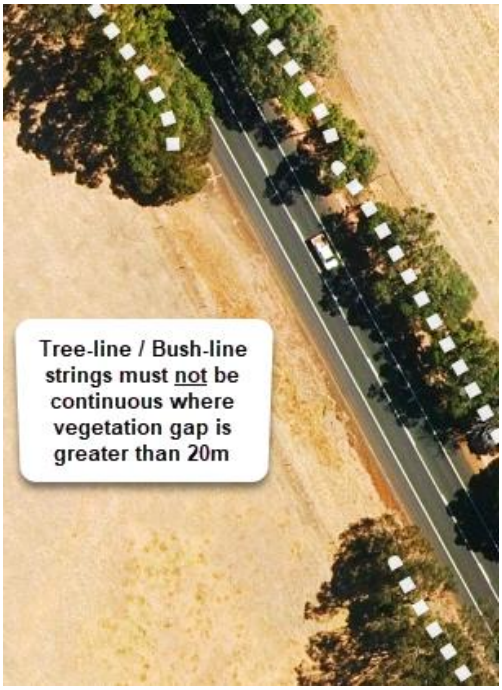
Areas of 0.1m > diameter trees/vegetation are to be delineated with “TL” TREE-LINE – FACE OF TRUNKS or “GS” BUSH-LINE coded line, as appropriate.

Tree-line / Bush-line strings must not be continuous where gap in vegetation is greater than 20m.

Tree-line, Tree Canopy and Bush-line strings TL/GT/GS are to be 2D *(i.e. have null height, -999 in GenIO file)*.

Tree Canopies are not required, unless specifically requested (Code GT).

If detailed tree trunk diameters are requested to be provided, these are to be represented as a string with length of the trunk diameter, Coded “TD”. TD features are to be 2D strings *(i.e. have null height, -999 in GenIO file).* A point feature with appropriate trunk diameter tree code is required as well.



23.12 PREVIOUSLY DISTURBED MAINTENANCE ZONE (CODE “VD")

The extents of the previously disturbed maintenance/construction zone within road corridor are to be delineated in the GenIO model as strings, using feature code “VD”.

Original construction earthworks should be considered, not only where the current vegetation appears cleared.

In some places/situations, this may result in effectively the same line/string as the tree-line/bush-line. In this case, the previously disturbed maintenance zone “VD” string is to remain continuous, replicating/duplicating any tree-line or bush-line string which it may coincide with.

A separate DXF file of only the VD data must also be compiled and delivered. This must contain closed polygons.

Code “VD” - PREVIOUSLY DISTURBED MAINTENANCE ZONE.

23.13 SPECIAL ENVIRONMENT MARKERS ("YELLOW HOCKEY STICKS")

Special Environment Markers are to be captured, and coded "PEE".

23.14 DRAINAGE STRUCTURES

Invert and obvert of pipe/structure must be captured for open/accessible drainage structures. ("Obvert" level is top *inside* edge of pipe/box)

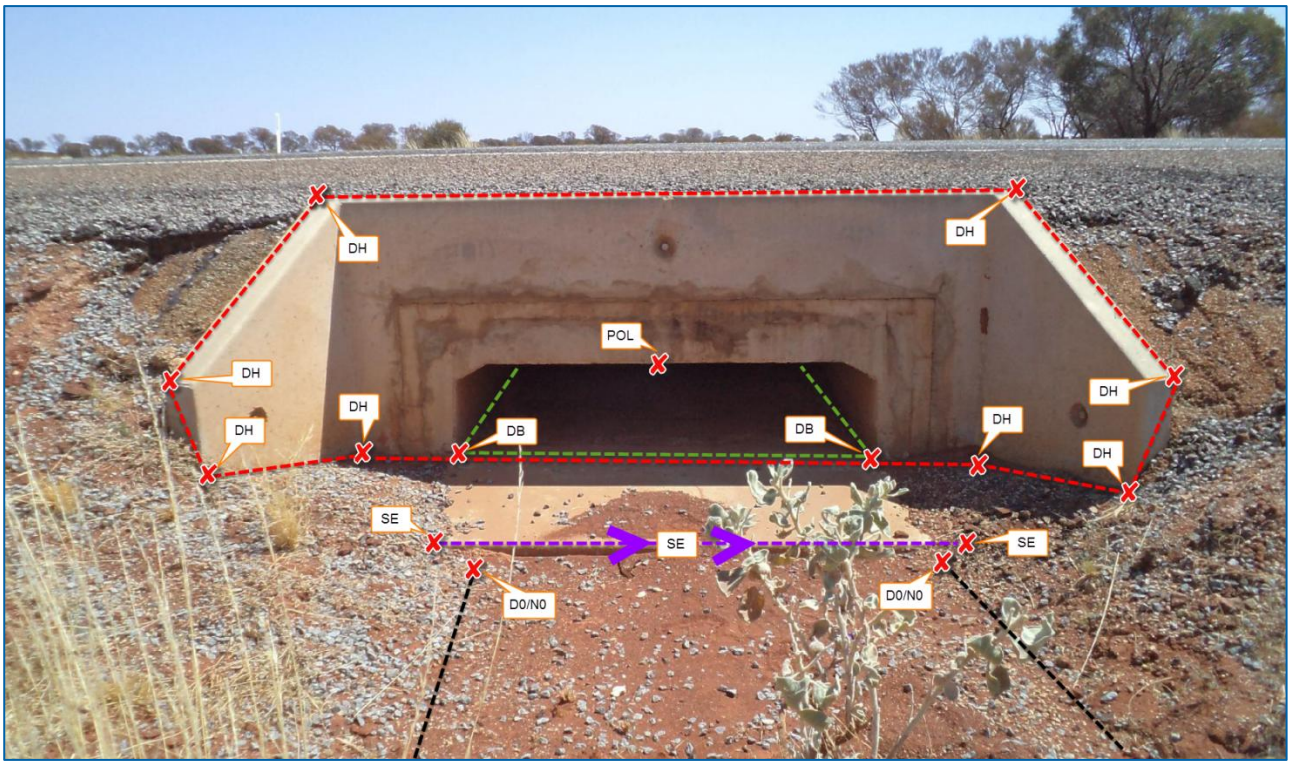
Where possible/known, the connection of pipes/boxes is to be depicted by appropriately coded string(s) (e.g. "DC" – Culvert, "DB" – Box Culvert (Both Internal Edges). Ends of these strings are to be at invert level.

Where possible/known, obvert points must also be connected and represented as a string, using the code "DO".

When these invert/obvert strings are used, separate invert "PIL" and "POL" points are not required.

Box culverts must be captured with a "DB" coded string at inside edge of box structure.

Where a concrete apron exists, only the reasonably accessible/exposed section need be captured (Edge of concrete, directional code; SE/SF).



Internal dimension and description of pipes / boxes are to be recorded and displayed as text/annotation in the model. (e.g. 2xRCP 450MM)

Text/Annotation for the condition of the drainage site/structure is also to be included where relevant.

Enclosed drainage structures are ***not*** to be accessed and captured unless specifically requested. The ground surface feature must still be represented (i.e. lid/manhole cover, metal grate, side entry pit…)

Where enclosed drainage structures *are* required, pipe inverts are to be coded “DC” and obvert “DO” where their connection/direction is known, otherwise inverts coded “PIL” and obverts “POL”.

Where an invert cannot reasonably be accessed due to site conditions (e.g. significant silting), text/annotation is to be included in the survey model/GenIO to describe the issue.

In the case of a round pipe’s invert obscured by significant silting, obtaining an internal diameter measurement from an accessible cross section of the pipe, and applying that dimension to create an invert as offset from the obvert should be considered.

23.15 ABOVE GROUND WATER PIPE / EXPOSED UTILITIES

WATER PIPE: Top outside of pipe to be captured/modelled, and coded “WP”. A string at ground level next to the pipe also required, coded “N0”, line of levels.

Text/annotation of pipe’s external diameter to be included in the GenIO model.

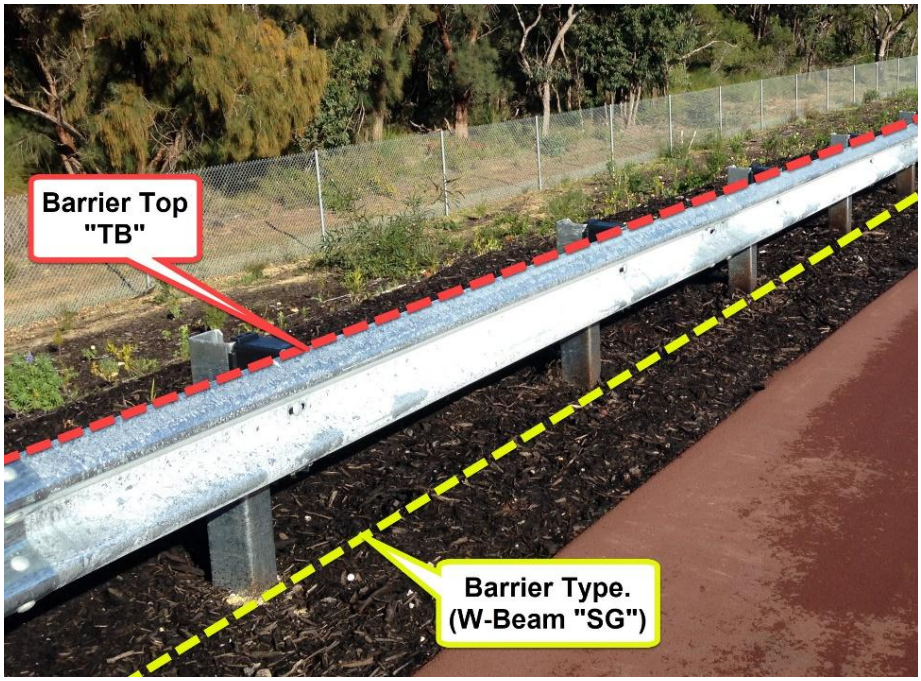
OTHER UTILITIES are to be captured/modelled at outside top-centre of the feature and coded according to type.

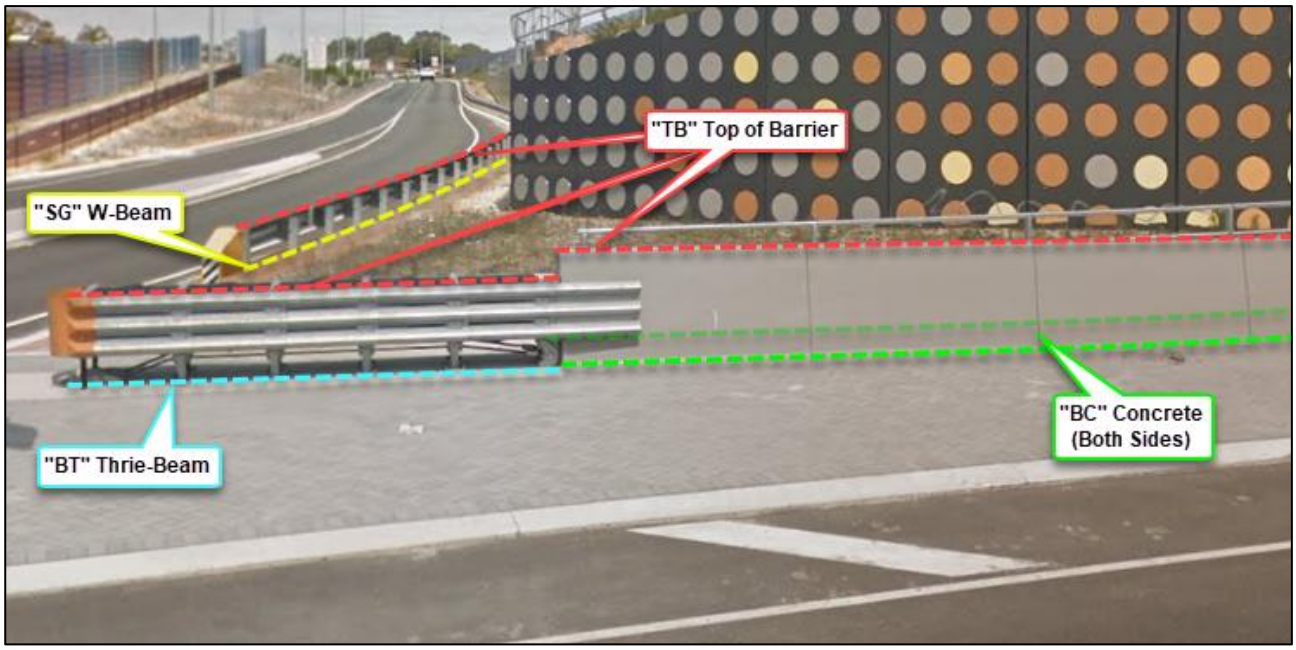
NOTE: Code Culvert “DC” must only be used when modelling the invert level of a pipe.

23.16 GUARDRAILS / BARRIERS

The road-side face of guardrails and barriers must be captured at ground level and appropriately coded according to type. An additional string must be captured at the top of the structure (Barrier Top - Code TB). This defines the height of the barrier / guardrail.

Concrete barriers are to have both faces captured at the base, plus a single “TB” string along the top.

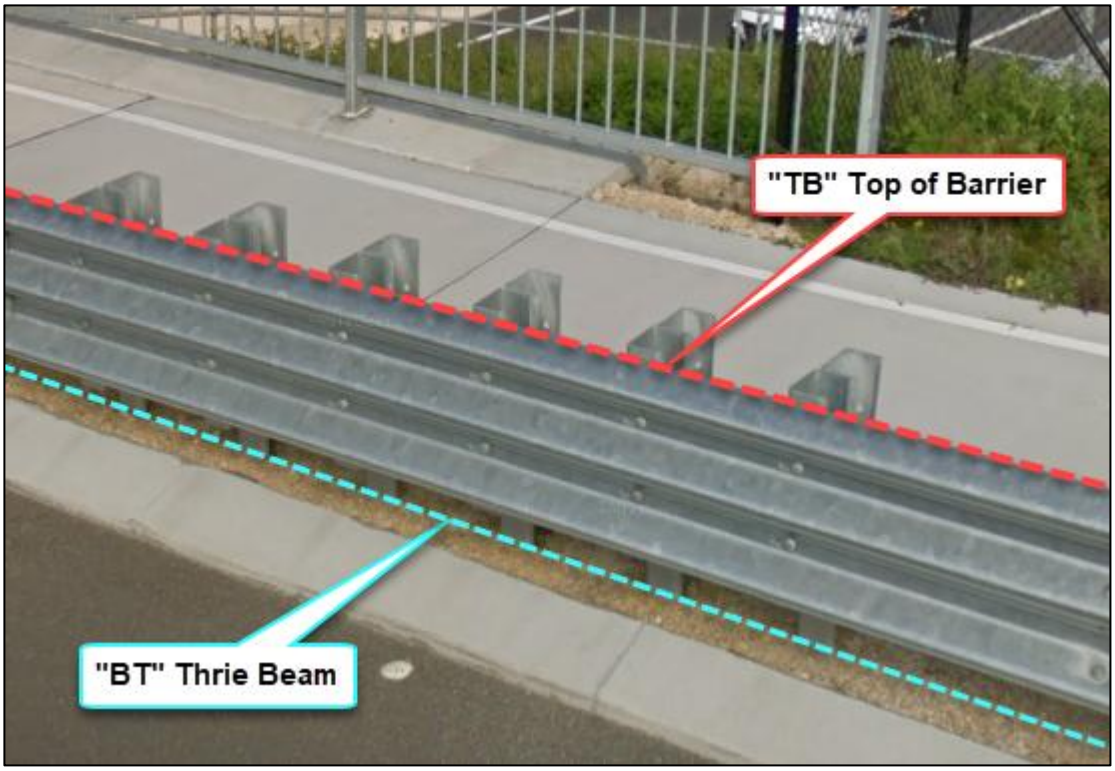




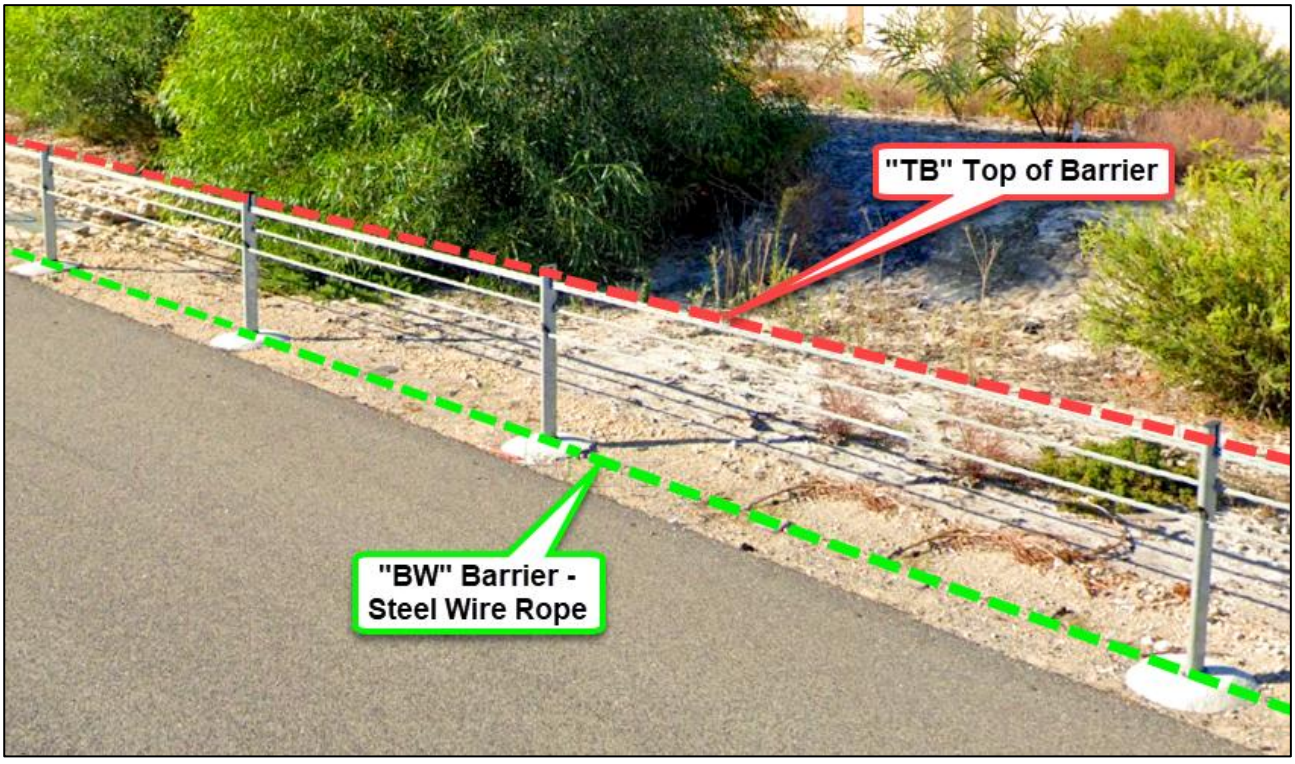
23.16.1 BARRIER – GUARD RAIL W-BEAM, CODE SG

23.16.2 BARRIER / GUARDRAIL – THRIE BEAM, CODE BT

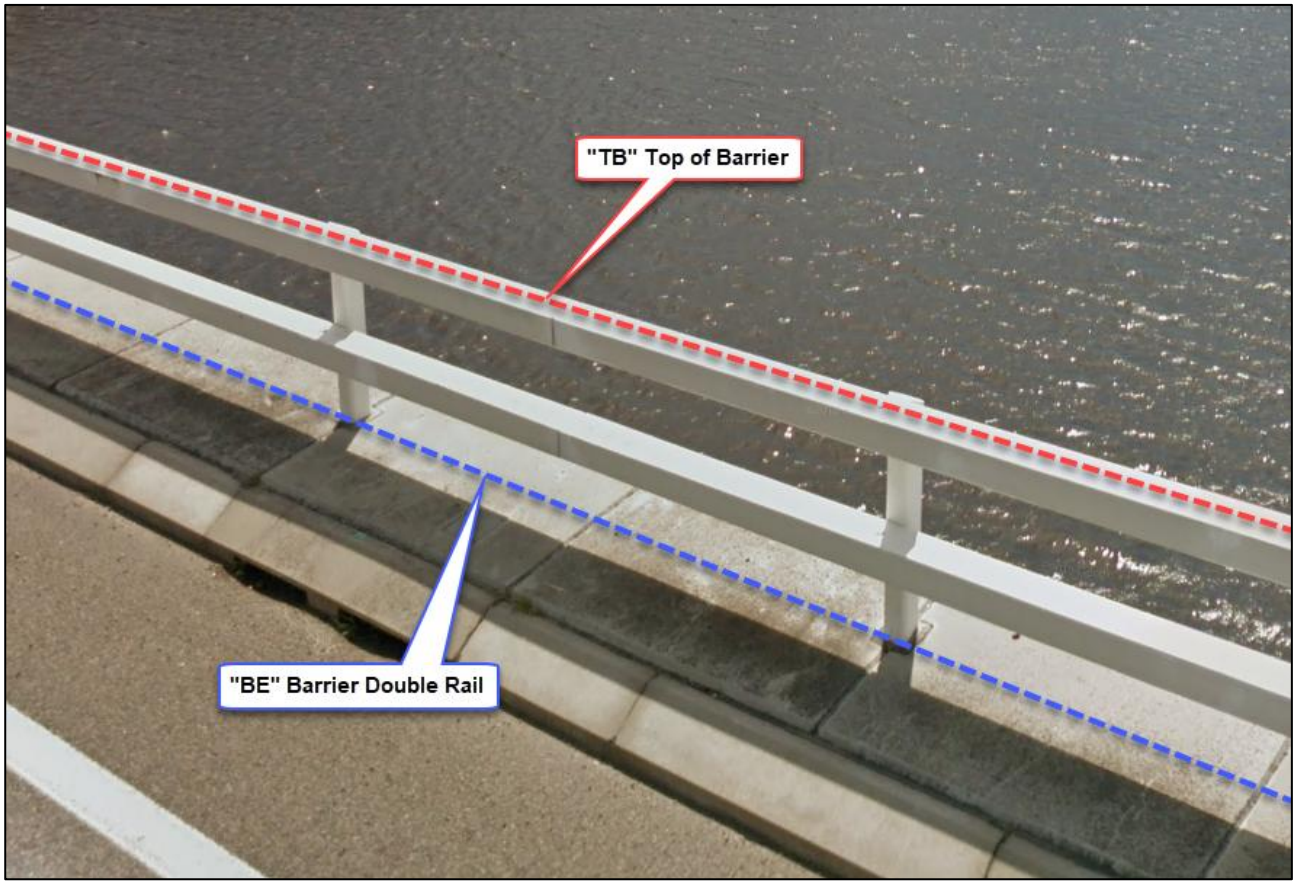
Similar to W-Beam, but with an additional corrugation.



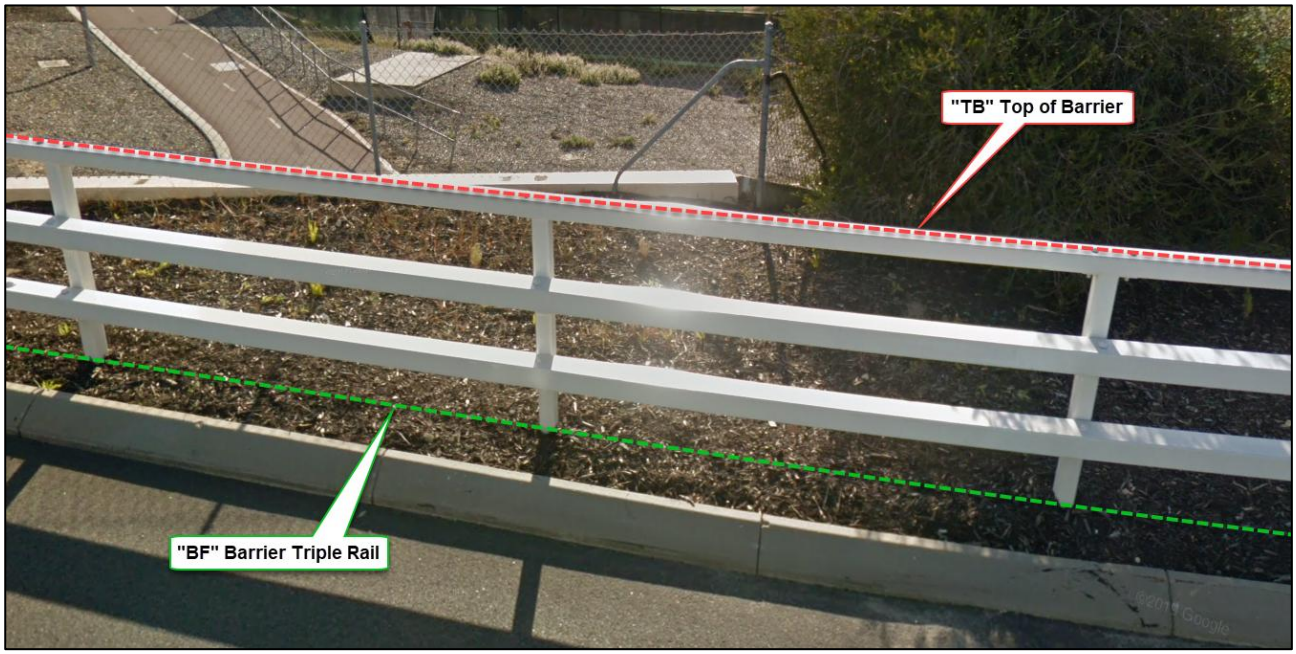
23.16.3 BARRIER – STEEL WIRE ROPE, CODE BW



23.16.4 BARRIER – DOUBLE RAIL, CODE BE



23.16.5 BARRIER – TRIPLE RAIL, CODE BF



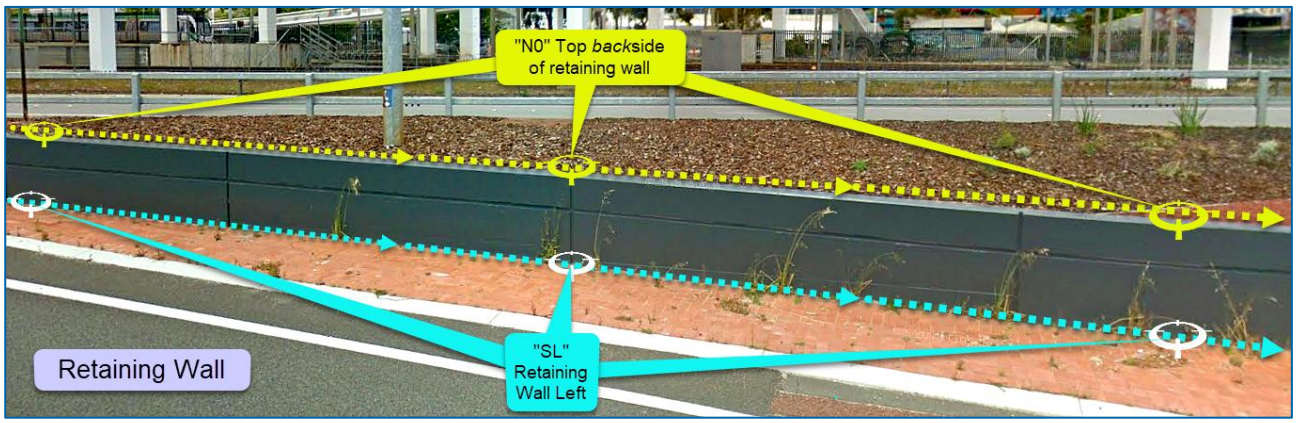
23.16.6 OTHER BARRIER TYPES ON BRIDGES

Where a barrier type on a bridge does not fit existing code categorisation, use Code “BB” - Bridge Barrier (all other types), and include a “Top of barrier” “TB” string.

23.17 RETAINING WALLS / NOISE-WALLS

23.17.1 RETAINING WALLS

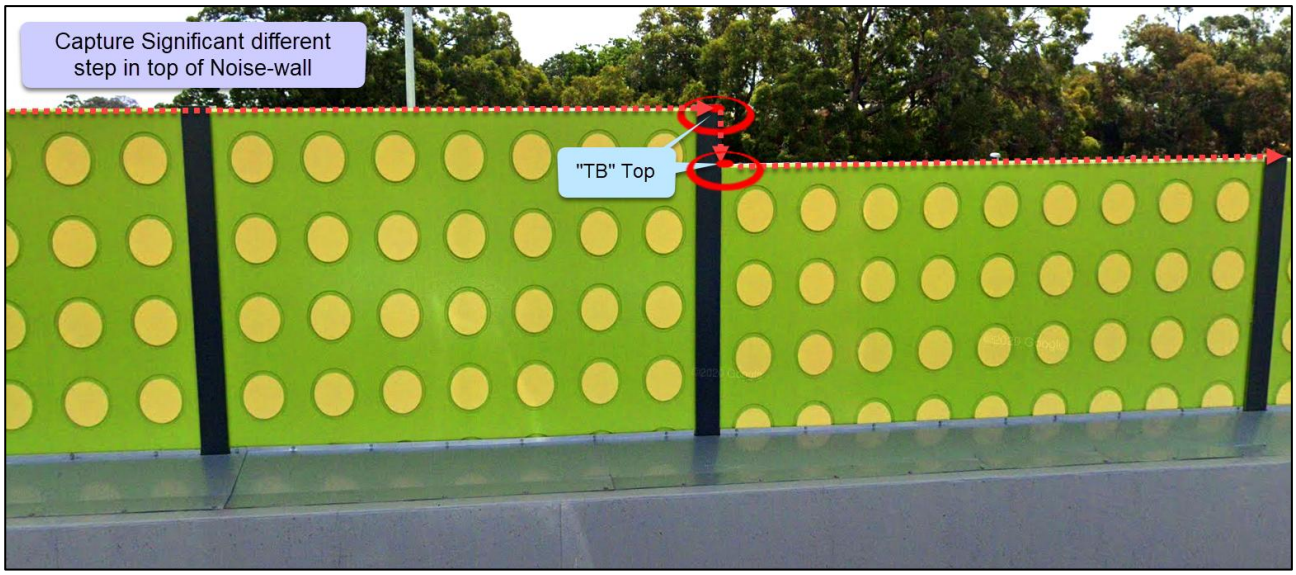
The directional retaining wall line/string (“SL” or “SM”) is to be modelled at the bottom face of the wall, with “N0” coded line/string along the top back-side of the wall.



23.17.2 NOISE-WALLS

All noise-walls within or at the boundary of required survey extents are to be represented in the survey model. The top of all noise-walls must also be modelled at true height, with a line/string coded “TB”. Where the gradient of the top of the wall string is fairly consistent, capture points can be regularly spaced regardless of individual wall panels (as pictured).

Where a significant step/difference in height occurs between wall panels, the step must be represented with a pair of capture points.



Capture for significant step between noise-wall panels

23.18 FENCES

All fences, regardless of type are to be coded as “F0”, unless otherwise requested. The F0 feature is to have height/z-value at ground level. The height of fences is not required unless specifically requested.

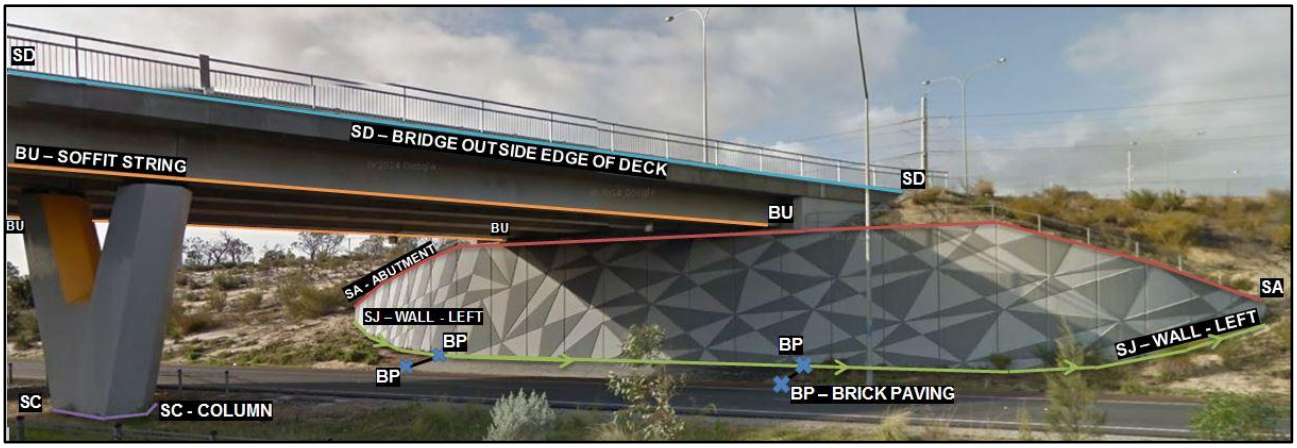
23.19 BRIDGES

Bridges are to be represented using available codes.

All features pertaining to bridges must be separate strings for the area of the bridge between abutments. i.e. Continuing longitudinal feature strings must be split/broken between the bridge abutments. This may require duplicate points at start/ends of strings such that the features still appear connected as appropriate.

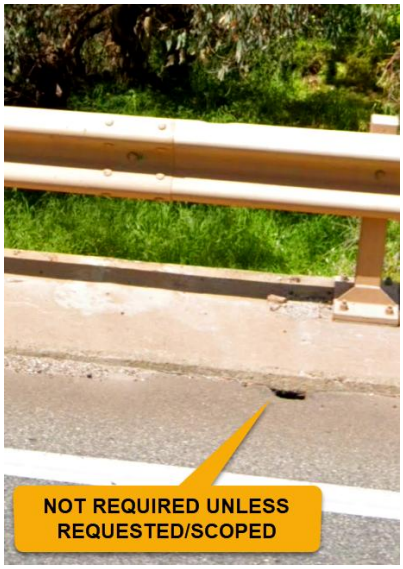
Bridge expansion joints are to be captured as a string, Coded “BJ”, with sufficient points to follow the shape of the road and other strings/break-lines. The “BJ” string is to extend to the outside edge of bridge deck (i.e. out to the “SD” string, as defined in other diagrams below)

A guide to expectations and use of coding follows in the images below.



23.19.1 BRIDGE DRAINAGE FEATURES / SCUPPERS

Drainage features (e.g. scuppers) on bridge decks do not need to be captured unless specifically requested/scoped.



23.20 GUIDEPOSTS (PGP)

Guideposts must be captured/modelled and included in GenIO model, as per code “PGP”.

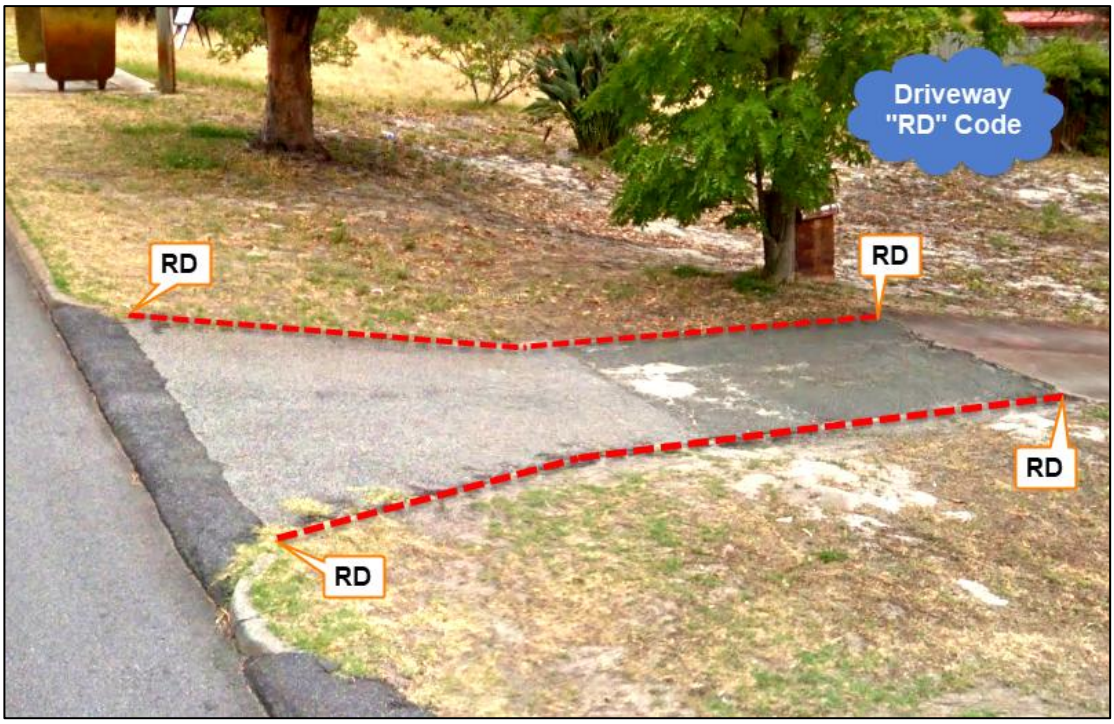
23.21 ROADSIDE MEMORIALS / WHITE CROSSES

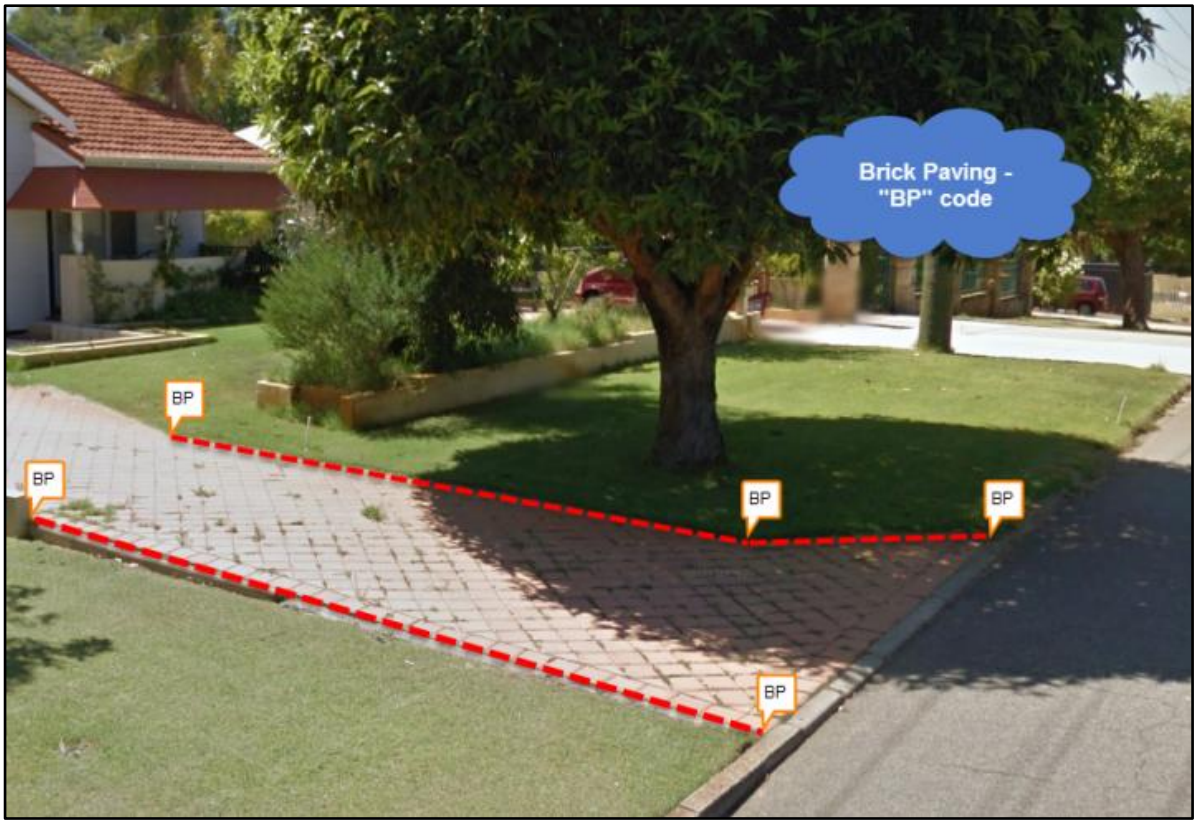
Roadside memorial crosses are to be captured as a point feature using code “PMC”

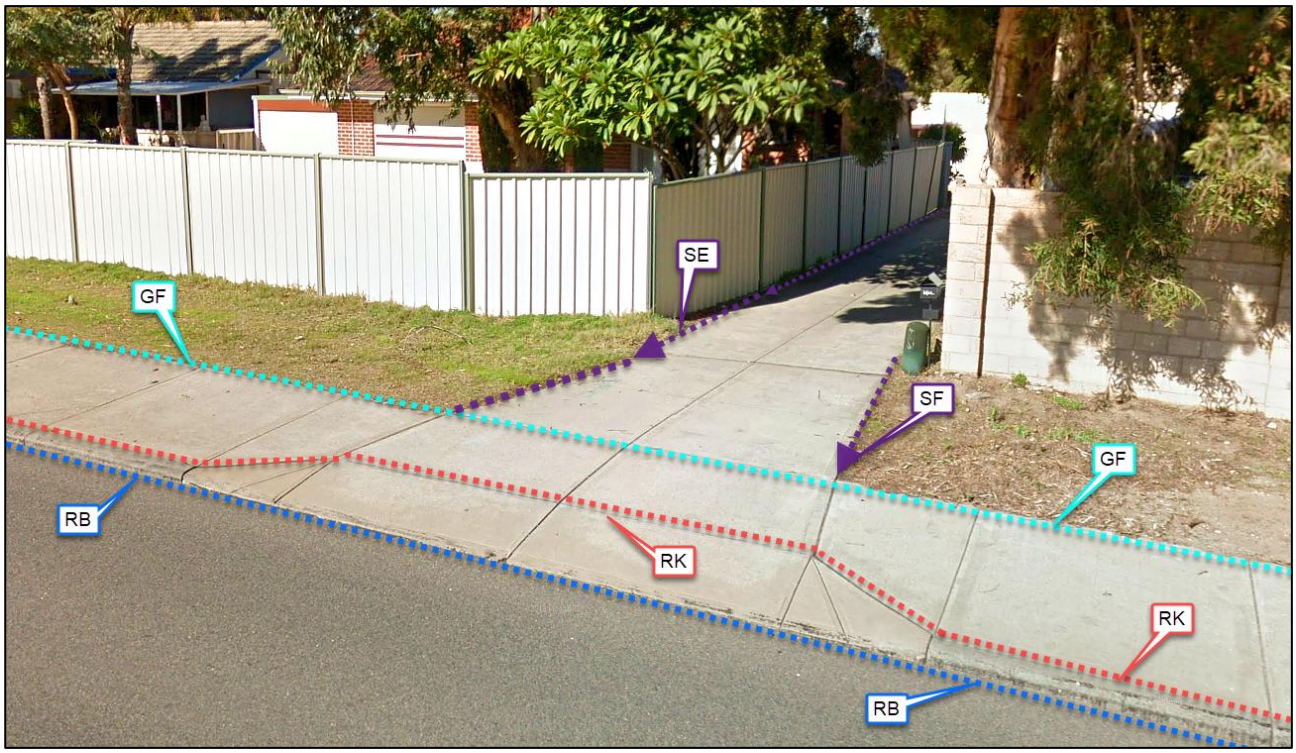
23.22 DRIVEWAYS

Driveway material types are to be represented using available codes.

Unsealed driveways/access tracks etc are to be coded with “RU”.


Driveway
"RD" Code
RD
RD
RD
RD


Brick Paving -
"BP" code
BP
BP
BP
BP
BP



23.23 POWER-LINES (2D & TRUE HEIGHT) & GUY/STAY/ANCHOR WIRES

A line/string must denote the location of lines between poles and/or structures (such as buildings). Lines must be captured to at least the edge of the requested survey extent.

Where the true height of power-lines and guy/stay/anchor wires can be obtained/extracted readily, the power-line feature is to be modelled with true height/3D. (e.g. if survey is captured by LiDAR scan/point cloud data) A minimum of 3 points are required for each span – a point at either end/pole and one point at the lowest point. Code “EC” is to be used for “True height” power-lines and “EQ for high-tension lines.

Where multiple wires exist on the same alignment/poles, only one line need be represented in the GenIO. Where the line is modelled at true height/3D, only the lowest line is to be defined.

Otherwise, overhead power-lines are to be modelled as 2D strings *(i.e. null height, -999 in GenIO file)*, coded “EA” for overhead power-lines, and “EP” for high-tension lines.

Wires which are not likely to be transmitting electricity, such as guy/stay/anchor wires, are to be coded “EY” for null height (2D), and “EW” when at true height (3D).

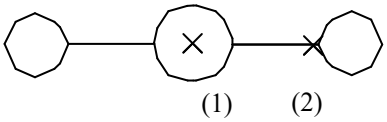
23.24 ELECTRIC LIGHT POLES, POWER POLES & ELECTRIC SUPPLY POLES

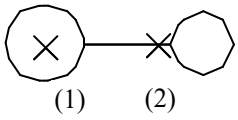
MULTIPLE LIGHT POLE	D	LM
ELECTRIC LIGHT POLE	D	EL
POWER POLE	D	PPP
ELECTRIC SUPPLY POLE	D	PPE

These codes represent multiple and single electric light poles. These are defined by a first measurement (1) at the centre of the pole with a second measurement (2) in the direction of the light/luminaire. The second point must be no farther than the next linear feature/breakline in the survey model. In the case of a multiple light, the second measurement is taken towards one light/luminaire only.

Both points are to have ground level height/z-value.

Where a power-line also connects to a pole with a light, the pole feature is to be captured and coded as EL (electric light pole). The power-line is also to be represented.



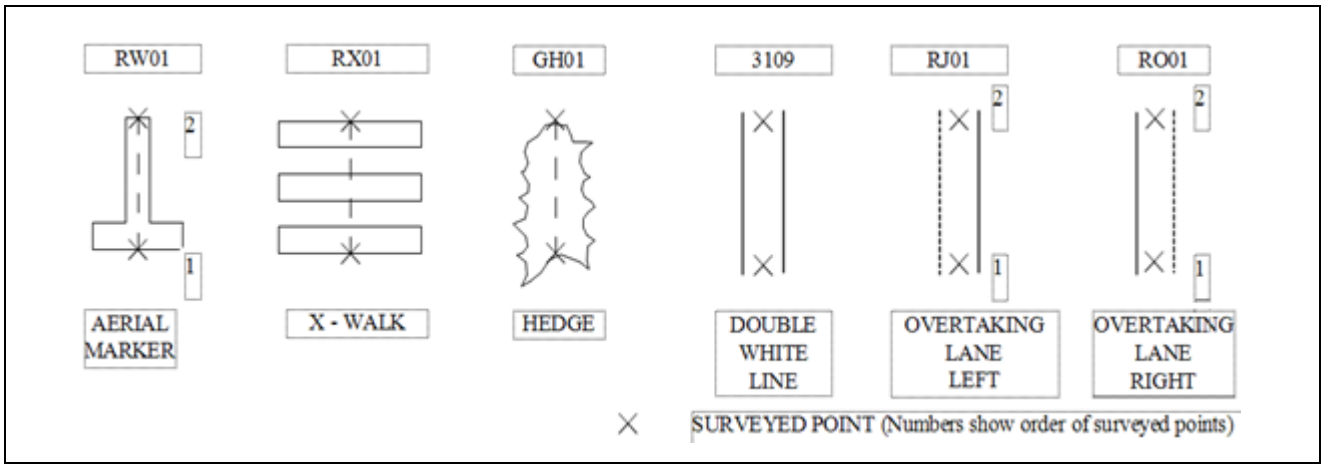


Power-poles are to be represented. If a power pole also has street lighting attached, the pole should be represented with electric light pole code (“EL” or “LM”).

Power-poles without street-lights coded “PPP”, and “PHT” for poles supporting high-tension power-lines.

23.25 CENTRALLY LOCATED STRING FEATURES

Some features are defined by a string running through the centre of the feature.

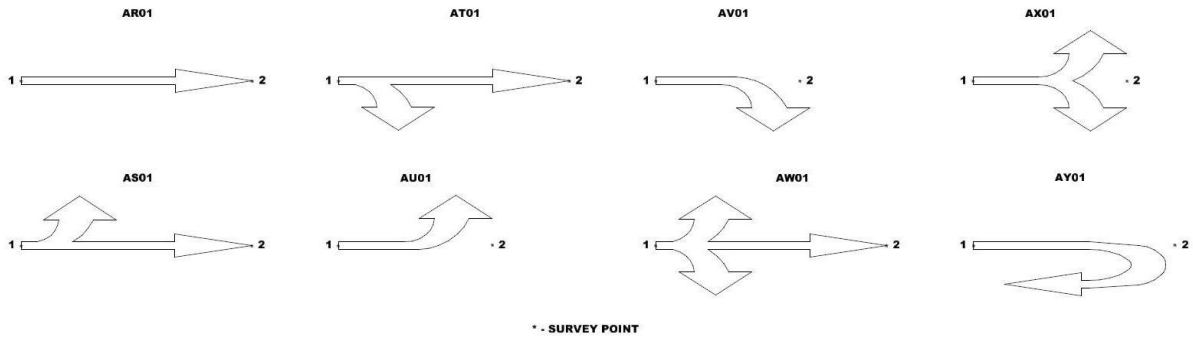


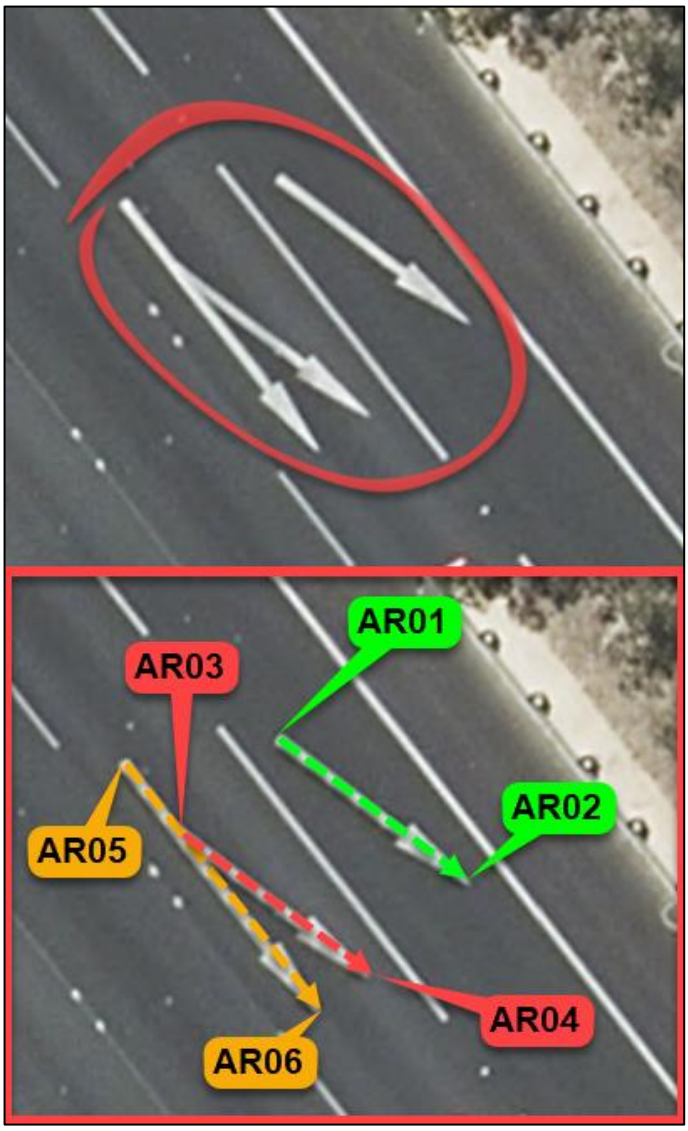
23.26 STEPS / STAIRS

Steps / Stairs are to have their extremities captured resulting in a closed polygon (Code SS)

23.27 PAVEMENT ARROWS

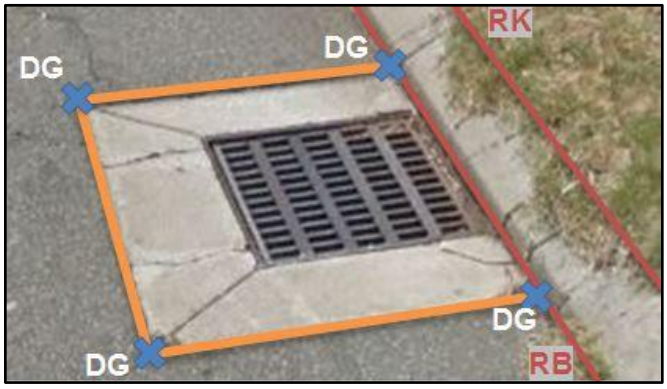
These codes represent various pavement turning arrows. These are defined by a first measurement (1) at the start or base of the arrow with a second measurement (2) taken along the axis of the arrow at its point of extremity.

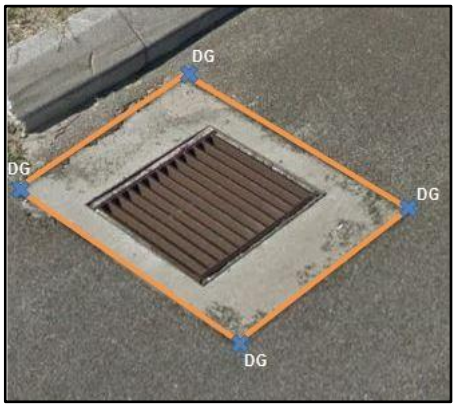




23.28 MANHOLES - CIRCULAR AND SQUARE (INCLUDING GULLIES)

These structures are to be closed polygon string features (i.e. the first and last point of the string is to be the same point, except where the feature abuts another coded feature (e.g. kerb). The feature is to be defined by its outer extremity (not the lid/cover). Circular manholes are to be represented with sufficient points in the GenIO to ensure a smooth circle is plotted.

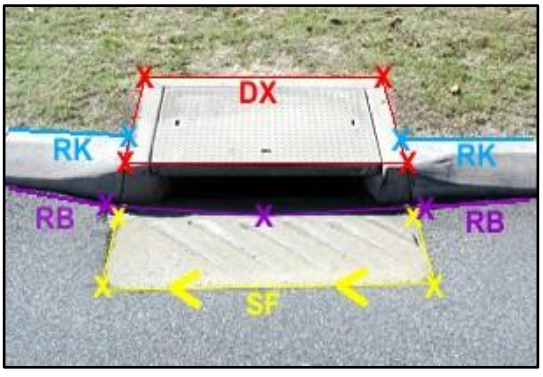




23.29 SIDE ENTRY PITS

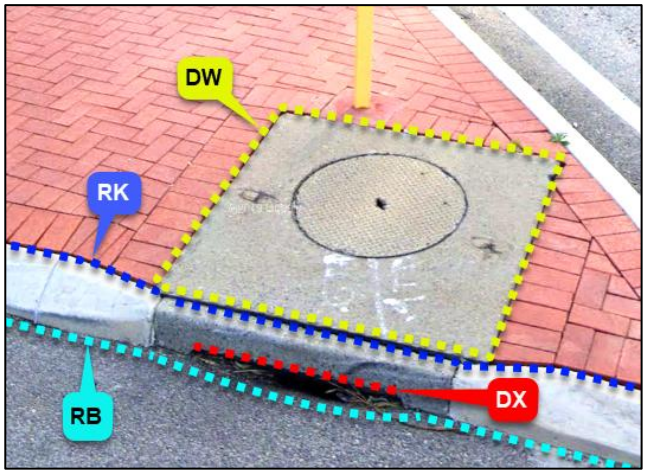
SIDE ENTRY PIT	B	DX

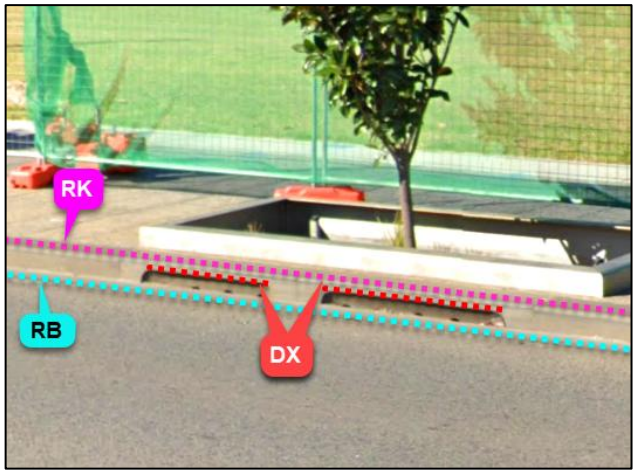
Side entry pits have a manhole access lid behind the kerb. The pit opening and the manhole must be surveyed. The concrete apron deflector slab at the entry of the pit must be captured with an appropriate directional “Edge of concrete” code (SE / SF). The “KERB, BOTTOM / GULLY” (RB) string runs across the opening of the side entry pit with a point captured at the centre of the throat on the concrete apron.

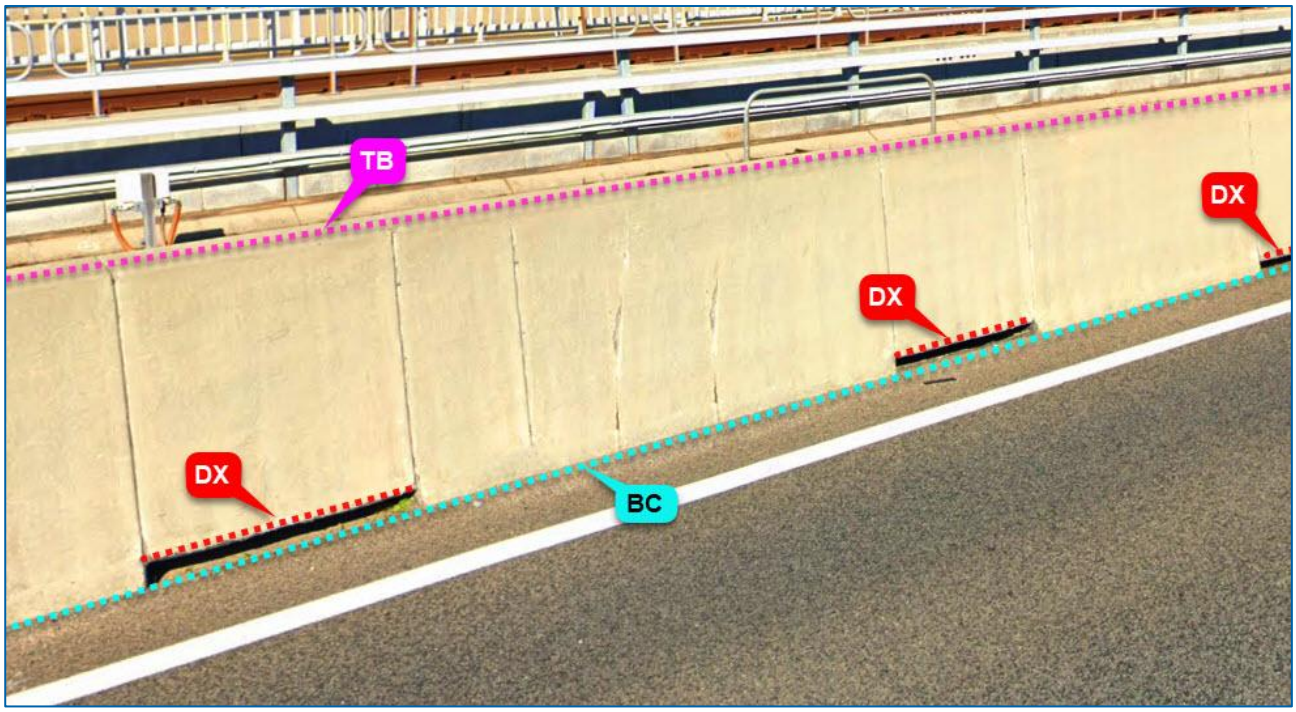


23.30 DRAINAGE FEATURES IN BARRIERS / KERBS

Drains in barriers or kerbs are to be represented in the model with reference to the following diagrams as examples:



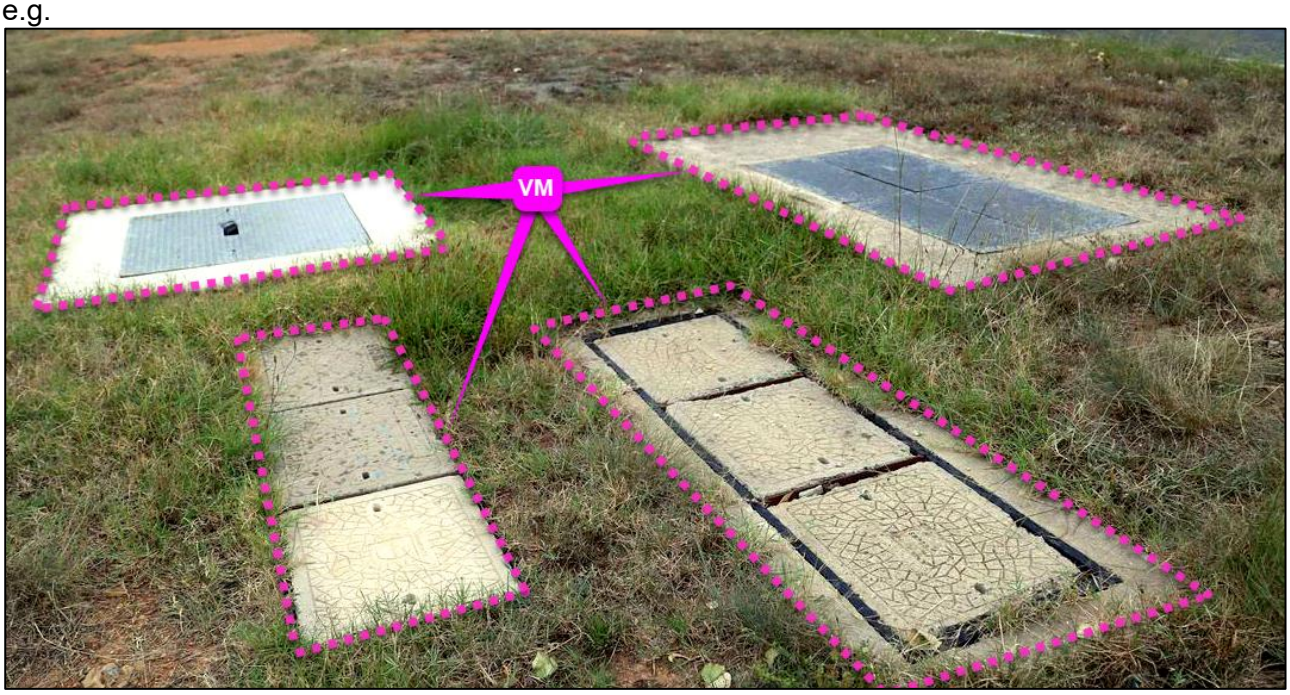




23.31 LARGER PITS / GROUPS OF PITS TO BE DEFINED BY PERIMETER EXTENTS

Pits or groups of pits larger than 700mm in any dimension are to defined by outer extremity (not the lid/cover), with closed polygon string features

e.g.



23.32 BUS SHELTER

BUS SHELTER	D	SB

Bus Shelters are to have their extremity defined as a closed polygon (Code SB). Levels of points are to be at ground level. Any associated concrete slab or paving / path etc must be captured and coded accordingly.