# DRAINAGE WORKS

DIPL Roadworks Master – July 2023

## Standards and Publications

Conform to the following Standards and Publications unless specified otherwise:

**AUSTRALIAN STANDARDS**

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| **Table – Australian Standards** | |
| Use Standards, and their amendments, current as at the date for the close of tenders except where different editions and/or amendments are required by statutory authorities, including, but not limited to, NATA and the National Construction Code including the Building Code of Australia. | |
| **Designation** | **Title** |
| AS 1012(series) | Methods of testing concrete. |
| AS 1141(series) | Methods for sampling and testing aggregates. |
| AS 1289(series) | Methods of testing soil for engineering purposes. |
| AS 1348 | Road and traffic engineering – Glossary of terms |
| AS 1379 | Specification and supply of concrete. |
| AS 1478.1 | Chemical admixtures for concrete, mortar and grout – Admixtures for concrete. |
| AS 1597(series) | Precast reinforced concrete box culverts. |
| AS 1597.1 | * Small culverts (not exceeding 1200 mm span and 1200 mm height) |
| AS 1597.2 | * Large culverts (exceeding 1200 mm span or 1200 mm height and up to and including 4200 mm span and 4200 mm height) |
| AS 2350 | Methods of testing portland and blended cements |
| AS/NZS 2350.0 | * General introduction and list of methods. |
| AS/NZS 2350.1 | * Sampling |
| AS 2439.1 | Perforated plastics drainage and effluent pipe and fittings - Perforated drainage pipe and associated fittings. |
| AS 2758.1 | Aggregates and rock for engineering purposes - Concrete aggregates. |
| AS 3600 | Concrete structures. |
| AS 3610.1 | Formwork for concrete - Specifications. |
| AS 3706(series) | Geotextiles - Methods of test. |
| AS/NZS 3725 | Design for installation of buried concrete pipes. |
| AS 3972 | General purpose and blended cements. |
| AS/NZS 4058 | Precast concrete pipes (pressure and non‑pressure). |
| AS/NZS 4671 | Steel reinforcing materials |
| AS 5100.5 | Bridge Design - Concrete |

**NT TEST METHODS AND MANUALS**

NTMTM NT Materials Testing Manual accessible via [https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/materials-testing-manual](https://transport.nt.gov.au/infrastructure/technical-standards-guidelines-and-specifications/materials-testing-manual)

NTTM NT Test Methods

**AUSTROADS**

AGBT (series) Guide to Bridge Technology.

**ARRB**

Specifications for Recycled Crushed Glass as an Engineering Material

**WORK SAFE AUSTRALIA**

Excavation Work Code of Practice

## Definitions

| **Table - Definitions – Drainage Works** | |
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| **TERM** | **DEFINITION** |
| **Culvert** | An underground pipe, box or arch constructed in an embankment or trench. Typically located in a trench, embankment or road formation in a transverse crossing or in a longitudinal drainage line. |
| **Culvert Skew Angle** | The angle between a line drawn perpendicular or radial to the road centre line and the centre line of the culvert. |
| **Culvert Chainage** | The chainage measured along the road centre line at its intersection with the culvert centre line. |
| **Large Box Culverts** | Precast box culverts and link slabs having spans greater than 1200 mm, heights greater than 1200 mm or fill heights exceeding 1600 mm. |
| **Recycled Crushed Glass (RCG)** | RCG conforming to Specifications for Recycled Crushed Glass as an Engineering Material Section 9. A copy is available via |
| <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-specifications> |
| **Shall** | Is indicative of a mandatory requirement unless the context clearly indicates otherwise. |
| **Tom(s)** | Devices used to hold pipe culverts in place during backfilling of trenches. Also; Horizontal device(s), such as timbers, metal struts, hydraulic spreaders, etc, spanning across an excavation for holding soldiers (vertical timbers) or walings (horizontal timbers) in place against the sides of trenches before and during trench backfilling. |
| **Unsuitable Material** | Any material that does not conform to the properties specified for the replacement materials to be used. If properties of the replacement materials to be used are not specified, then **Unsuitable Materials** are materials which do not conform to the properties specified for standard fill. |

## General

This section applies to the construction of precast concrete pipe culverts not exceeding 1950 mm nominal diameter, precast concrete box culverts and other drainage items.

## Clearing

Clear the site as specified in the CLEARING, GRUBBING AND REHABILITATION Section.

## Materials

Conformance testing will be the responsibility of the Contractor.

Ensure that all pipes and box culverts are indelibly marked with a Standards Australia conformance stamp.

Pipes and box culverts not stamped shall be removed from site at the Contractor's expense.

### Precast Reinforced Concrete Pipes

Pipes to be flush joint type with external rubber bands.

Pipes to be clearly marked as to their class.

### Rubber Ring Joint Pipes

Pipes to be clearly marked as to their class.

### Precast Reinforced Concrete Box Culverts – Hold Point – Witness Point

Use box culverts of the inverted U type suitable for installation on a cast‑in‑situ concrete slab.

Design and supply box culverts which have a span not greater than 1200 mm, height not more than 1200 mm and a fill height not more than 1600 mm in accordance with AS 1597.1.

Design all other box culverts in accordance with AS 1597.2.

Use Standard Vehicle Loadings including NT Standard Road Train, with addition of the HLP 400 Abnormal Vehicle Loading on all National Highways, and HLP 320 on all other routes.

Provide culverts designed for the following exposure classification (AS 5100.5 Exposure Classifications table): **[enter data]**.

[Select Exposure Classification appropriate to the site of the works from the table. Enter the classification code here. Refer to NT CLIMATE ZONES TABLE.]

**Hold point** - Provide drawings showing complete reinforcement and dimensions with tolerances and obtain the Superintendent’s approval prior to fabricating any units. Provide manufacturer’s certification that the provided culverts comply with the applicable sections of AS 5100.5 and with AS 1597. Certify that the design is reflected accurately by the shop drawings and that the design is adequate to resist all specified loads and the soil loads pertaining to the site.

Provide a table of construction axle loads versus minimum required cover for each box culvert size.

**Witness point** - Give the Superintendent notice prior to casting concrete.

### Bedding

Bedding material to be one of the following:

* A clean granular material free from sticks, stones and other deleterious material with a Plasticity Index less than 6, conforming to the ***Table - Material Size***, or
* RCG conforming to Specifications for Recycled Crushed Glass as an Engineering Material Section 9, or
* Mix blend of RCG conforming to Specifications for Recycled Crushed Glass as an Engineering Material Section 9, and clean granular material free from sticks, stones and other deleterious material with a Plasticity Index less than 6, conforming to the ***Table - Material Size***.

|  |  |
| --- | --- |
| ***Table - Material Size*** | |
| **AS Sieve (mm)** | **Percentage Passing By Dry Mass** |
| 19.0 | 100 |
| 2.36 | 50 – 100 |
| 0.60 | 20 – 90 |
| 0.30 | 10 – 60 |
| 0.15 | 0 – 25 |
| 0.075 | 0 – 10 |

### Concrete

Conform to the requirements of the MISCELLANEOUS CONCRETE WORKS Section.

### Mortar

Use one part fresh cement and three parts clean sharp sand mixed with potable water to yield a stiff but workable mixture.

### Select Fill

Conform to the requirements of the EARTHWORKS Section.

## Construction Of Culverts And Structures

Refer to the following new Civil Standard Drawings:

CS 3126 for drainage outlet chute behind kerb for rural applications.

CS 3127 to CS 3132 for batter setout dimensions and quantities

CS 3133 to CS 3140 for traversable culvert grates.

### Setting Out – Hold Point

Measure culvert length along the invert to the outside face of headwalls.

Measure pits and/or manholes to the inside face of the wall.

Finished surface levels for kerbside structures are measured at the top of the kerb.

Set out the culvert and/or structure with pegs before construction.

**Hold Point** - Obtain the Superintendent's approval for the setting out before construction.

### Excavation – Witness point

Excavate in whatever material is encountered.

Use of explosives shall be in accordance with the MISCELLANEOUS PROVISIONS Section.

Pump, bail, sheet, shore and brace as necessary.

Divert water when necessary.

Rectify foundations which are affected by rain or surface water entering the excavation.

The total width of trench at and below the level of the top of the culvert shall be in accordance with the Department’s civil standard drawings or the project drawings.

Backfill with select fill up to the specified level if the trench is excavated too deep. Any such backfilling shall be at the Contractor's expense.

**Witness point** - Excavate unsuitable material below specified level if directed by the Superintendent.

Replace with select fill, compacted as specified.

### Foundation Compaction below Precast Box Culvert

The foundation layer directly below the precast box culvert insitu concrete base must be ripped to a depth of 150mm and re-compacted to 95% MMDD. The area treated must extend beyond the entrance apron/ headwalls and continue beyond the protection works of the outlet.

### Culverts in Fill under Construction

Refer to EARTHWORKS, **Earthworks in Fill** clause, **Construction Methods** sub-clause, Compacted Layer Method paragraph.

Place and compact fill to Manufacturer’s instructions and design specifications. Use select fill.

Manufacturer’s instructions and design specifications ***[enter data]***

[Add any additional requirements or any alteration to the reference text.]

Conform to Compacted Layer Method in EARTHWORKS.

Excavate the fill in accordance with the **Excavation** sub-clause in this clause to permit the construction of the culvert.

### Construction Loading on Culverts

Provide the minimum compacted thickness of cover specified in the ***Table - Minimum Required Cover Thickness (Metres)*** before allowing traffic to cross a culvert.

Do not permit construction vehicles having axle loads greater than 10 tonnes to cross large box culverts, having spans greater than 1200 mm, or heights greater than 1200 mm, under any depth of fill unless specific certification is provided by the culvert crown unit manufacturer that the culverts have been designed to cope with those loads.

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| ***Table – Minimum Required Cover Thickness (Metres)*** | | | | | | | |
| **Maximum Construction Vehicle Axle Load (Tonne)** | **Type, Size And Class Of Culvert** | | | | | | |
| **Concrete Pipes, By Pipe Class** | | | | | | **Boxes** |
| **Less Than 1200 mm Nominal Diameter** | | | **1200 mm Nominal Diameter Or More** | | | **Less Than 1200 mm Span, 1200 Height And 1600 Final Fill Height** |
| **Concrete Pipe Class (AS/NZS 4058)** | | | | | |
| **X(2)** | **Y(3)** | **Z(4)** | **X(2)** | **Y(3)** | **Z(4)** |  |
| **9** | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.1 |
| **20** | 0.8 | 0.6 | 0.4 | 0.5 | 0.4 | 0.4 | 0.6 |
| **35** | 1.3 | 0.8 | 0.6 | 1.3 | 0.4 | 0.4 | 0.9 |
| **50** | 1.0 | 0.8 | -- | 1.0 | 0.4 | -- | 1.2 |
| Concrete pipe classes to AS/NZS 4058 ***Table – Test loads for load classes 2 to 10 (circumferentially reinforced concrete pipes).*** Class 2 (X), Class 3 (Y), Class 4 (Z) | | | | | | | |

### Bedding

Place bedding 75 mm compacted thickness for the full width of the trench or 0.6 m greater than the width of the culvert for non‑trench conditions.

Compact bedding to 90% relative compaction.

Shape the bedding to hold pipes in position during compaction of additional fill.

Place and compact a further (haunching) layer of bedding in accordance with the Department’s civil standard drawings or the project drawings, and AS/NZS 3725.

### Laying

#### Laying Generally

Lay culverts commencing from the downstream end.

End caps, when used, shall provide a tight waterproof seal.

#### Laying Pipe Culverts

Face rebates or sockets upstream.

Rest the full length of the pipe barrel on the bedding.

Position pipes so that the ‘TOP’ markings on the pipes are visible on the tops of the pipes and the pipes are orientated so that the markings are within 5 degrees of the vertical axis.

Fill all joints with stiff mortar firmly rammed into openings. Remove excess mortar from barrel of culvert. Apply external rubber bands.

Brace pipes of 1200 mm diameter and greater with toms until the completion of the embankment and pavement. The toms shall bear against a sill along the invert and a cap against the crown of the pipe. Provide toms opposite every pipe joint.

Cast collars and blocks in one operation. Restrain the culvert prior to constructing the collars or blocks by partially backfilling with bedding around the barrel of the culvert to one‑half of the pipe diameter.

#### Laying Box Culverts

Lay precast box culverts on a cast‑in‑situ reinforced concrete base slab.

Ensure concrete base slab exceeds external width of box culverts as shown on the typical details.

Butt box culverts firmly together.

Cut away lifting hooks and seal over the affected area with an approved epoxy resin.

Fill all joints with a stiff mortar firmly rammed into the openings. Remove excess mortar from the barrel of the culvert and apply external joint seals to all joints, Densopol HT60 or equivalent, 150 mm wide.

### Connection to Existing Systems - Witness Point

Repair all cut openings and make watertight.

Demolish existing headwalls to make way for the extension of the culvert.

Clean out new work and existing work affected by the new work.

**Witness Point** - Advise the Superintendent within 2 days when cleaning out is completed.

### Backfill – Witness Point – Hold Point

**Witness point** - Notify the Superintendent before backfilling where holes or fissures occur in rock trenches.

**Hold point** - Do not place backfill against any in‑situ concrete structure until the concrete has attained 80% characteristic strength and approval has been given.

Place backfill in layers not exceeding 150 mm compacted thickness.

Ensure the maximum difference in height of backfill on each side of a culvert is 300 mm.

Backfill around the culvert for the full width of the trench, and for a minimum 300 mm above the top of the culvert, or to subgrade surface if less, with select fill.

Backfill the remainder of the trench with standard fill.

Stabilise all backfill with 2% cement by mass and compact to 95% relative compaction where the trench or embankment is located, or will be located, beneath a road pavement.

Stabilise all backfill with 2% cement by mass and compact to 95% relative compaction for the full width between headwalls at transverse crossings of a road.

Produce a uniform mix. Complete compaction within one hour of adding mixing water.

Use compaction equipment which will not damage the culvert and in‑situ structures.

Carry out conformance testing using the Department’s Panel Period Contractors for Testing.

Stabilise top 150 mm of backfill, for a distance of 1 m adjacent to culvert headwalls and wing walls, so as to be erosion resistant.

Remove surplus material from the site.

Reinstate to subgrade level trenches cut through pavements and other construction by backfilling the trench with stabilised select fill compacted to 95% relative compaction.

Construct base/sub‑base layers of the pavement in accordance with the PAVEMENTS AND SHOULDERS Section.

Reinstate surface.

Reinstate trenches cut outside of pavements and other construction by backfilling with standard fill compacted to 90% relative compaction.

## Inlet And Outlet Structures, Pits, Headwalls, and Other Structures

Construct in accordance with the specifications.

Compact foundations to 95% relative compaction to a depth of 150 mm minimum.

Replace unsuitable material as specified in the **Excavation** sub-clause, in the **Construction of Culverts and Structures** clause in this work section.

## Inlet And Outlet Channels - Witness Point

Excavate the inlet and outlet of all culverts to facilitate the flow of water.

Refer to CS 3126 for drainage outlet chute behind kerb for rural applications.

Conform to the following:

Bed width: Minimum 150 mm greater than overall width of culvert.

Side batters: 45 degrees maximum to horizontal.

Bed grade: 0.5% in the direction of flow for a minimum distance of 50 metres.

Clean out new work and existing work affected by the new work.

**Witness Point** - Advise the Superintendent within 2 days when cleaning out is completed.

## Open Unlined Drains

Excavate and dispose of all excess material as specified in the EARTHWORKS Section.

Trim drains to form neat levees.

Compact levees to 95% relative compaction.

Allow natural surface runoff.

## Removal Of Existing Culverts And Drainage Structures

Demolish and remove from the site, as specified, existing culverts and drainage structures.

## Subsoil Drainage systems

### Subsoil Drainage

#### Excavation

Excavate to the depths indicated on the applicable Civil Standard Drawings and/or the project drawings..

Line the trench with geotextile fabric. Refer to PROTECTION WORKS.

Place a bedding layer of 50 mm of filter material in the trench and compact with a vibrating plate or similar.

#### Filter Material

Shall be a hard durable stone having a Los Angeles Abrasion Loss not greater than 35%.

For Type B subsoil drains, backfill material is to consist of a single sized aggregate of 20mm particle size, with a maximum of 5% passing the AS 0.15mm sieve.

#### Geotextile Fabric

Conform to the requirements of **Geotextile Fabrics** clause in PROTECTION WORKS.

#### Subsoil Drain Pipe

Use minimum 100 mm diameter pipe, Class 400 behind kerbs, Class 1000 minimum under roads (trafficable areas).

Use compatible couplings and fittings.

Connect solid wall pipe to the subsoil drain pipe for the disposal of collected water.

#### Laying and Backfilling – Hold Point

Lay pipe on 1% minimum grade.

Fit the pipelines with inspection openings, flushing points, and appropriate caps, supported in concrete collars suitable for Class D loading.

**Hold point** - Obtain Superintendent's approval of the pipe installation before backfilling.

Place filter material around the barrel of the pipe and to a height of 200 mm above the pipe.

Compact with a vibrating plate compactor or similar.

Place and compact remaining layers of the filter in layers not exceeding 300 mm.

Prevent contamination of the filter.

Place and compact basecourse gravel, as specified in the PAVEMENTS AND SHOULDERS Section in the top 300 mm of trench.

Place the material in two equal layers compacted to 95% relative compaction.

Where trench excavated through pavement compact upper layer of basecourse gravel to 100% relative compaction and reinstate surface.

Backfill above solid wall pipes as specified in the **Backfill** sub-clause, in the **Construction of Culverts and Structures** clause in this work section.

#### End Walls - Witness Point

Construct end walls at the outlet of subsoil drains as specified.

Secure 19 mm galvanised wire mesh over the opening.

Mark end walls with guide posts.

Clean out new work and existing work affected by the new work.

**Witness Point** - Advise the Superintendent within 2 days of when cleaning out is completed.

### Drainage Blankets

#### Excavation

Excavate to the depths indicated on the project drawings and consistent with Civil Standard Drawing CS3122.

Compact excavated base to 95% MMDD and provide either a two way slope extending from the road centreline, or a one way slope across the entire width.

The excavation base slope shall be minimum 1%.

#### Filter Material

Filter material is to consist of an open-graded 20mm crushed rock, with a maximum of 3% material passing the AS 0.075mm sieve produced by blending 50% of 20mm and 50% of 10mm aggregate.

#### Geotextile Fabric

Conform to the requirements of **Geotextile Fabrics** as per Civil Standard Drawing 3122.

The geotextile fabric is to wrap and encase the filter material so that no filter material is exposed.

#### Drainage Pipe

Use minimum 100mm DN Class 1000 subsoil pipe in the drainage blanket and join to 100mm NB uPVC outlet pipe. Cast outlet pipe in a headwall. Headwall is to be placed on a slope to match the batter slope.

## Conformance

Conform to ***Table - Drainage Works Tolerances***.

| ***Table - Drainage Works Tolerances*** | |
| --- | --- |
| **Property/dimension** | **Tolerance** |
| Invert level and grade line | No ponding of water. |
| Open unlined drains | + or - 50 mm. |
| Culverts or lined drains | + or - 20 mm |
| Plan position | + or - 200 mm. |
| Culverts parallel to kerbs | + or - 50 mm. |
| Concrete structure dimension | + or - 5 mm. |
| Concrete thickness: | Not less than specified. |
| Subsoil drain slope | 25 mm maximum sag in 8 m. |