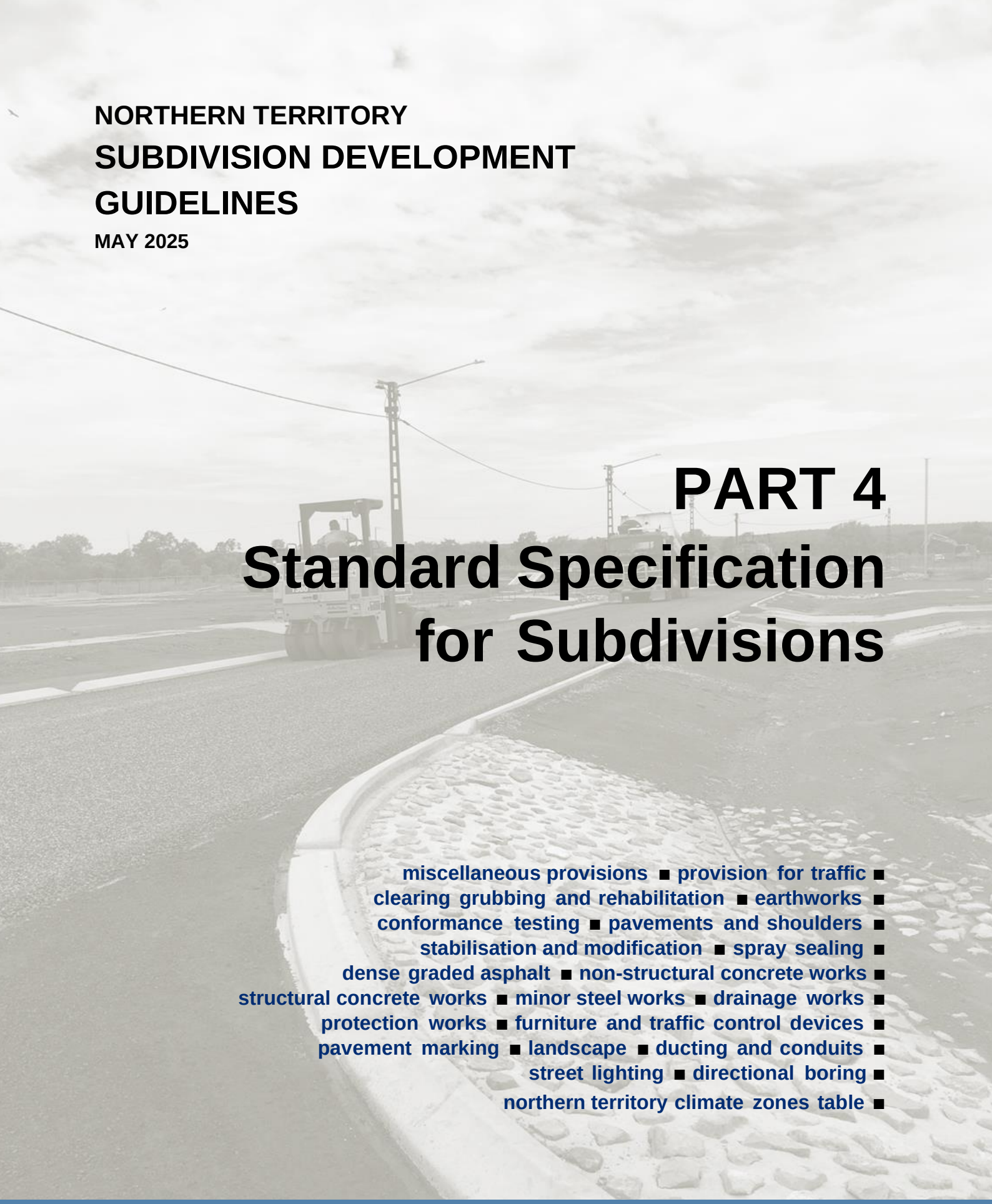
NORTHERN TERRITORY

SUBDIVISION DEVELOPMENT GUIDELINES

MAY 2025



PART 4
Standard Specification for Subdivisions

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ABOUT THIS SPECIFICATION

USE OF THIS DOCUMENT

This Standard Specification provides best practice construction standards for important Public Infrastructure such as streets and pathways, public open space and landscaping, stormwater drainage, and street lighting. It sets out the minimum standards required by Relevant Authorities to facilitate clearance of Development Permit conditions imposed on a Subdivision by the Northern Territory Development Consent Authority; the approval authority under the *Planning Act 1999* (NT).

This Standard Specification is to be used by Developers for construction of Subdivisions. It can be supplemented by Project Specific Requirements where required to provide additional detail or to vary from this Standard Specification. Project Specific Requirements must be documented using the template provided and Approved by all Relevant Authority(s) and/or Regulatory Authority(s) prior to construction.

SCOPE EXCLUSIONS

Works within Northern Territory Government Controlled Roads must be undertaken in accordance with the Department of Logistics and Infrastructure Standard Specification for Roadworks.

Traffic control signals and intelligent transport systems; traffic counting stations; and protective coatings must be undertaken in accordance with the Department of Logistics and Infrastructure Standard Specification for Roadworks. Where Subdivision streets intersect with NTG controlled roads, the Developer must consult with NTG to agree on the extent of NTG ownership and approvals, and confirm the design basis to be applied.

Utilities including water, sewer, electrical and communications Public Infrastructure must be constructed in accordance with the applicable Service Authority's requirements.

This document does not address commercial matters including, but not limited to, fees which may be imposed by Relevant Authorities for review/approval of documentation, issuing of permits, site inspections, acceptance of assets, security bonds etc. The Developer must liaise with the Relevant Authorities to inform themselves of applicable expenses.

STRUCTURE OF THE GUIDELINES

This document forms Part 4 of the Northern Territory Subdivision Development Guidelines and must be read in conjunction with the following parts:

Part 1 – Guidelines;

Part 2 - Reference Documents; and

Part 3 - Standard Drawings.

PRECEDENCE

In the event of an inconsistency, conflict, discrepancy, error, or omission between or among the provisions of these specifications and any part of the Guidelines outlined above, the Developer must immediately notify the Relevant Authority for direction on how to remedy such inconsistency, conflict, discrepancy, error, or omission.

DISCLAIMER

Reasonable efforts have been made to ensure that material in this Standard Specification is accurate and up to date at the date of publication, however, this Standard Specification in no way constitutes the provision of professional advice, and should not be relied upon as or in substitution for independent professional advice.

The Territory and each Relevant Authority does not guarantee, and accepts no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any material contained in this Standard Specification, the Guidelines, Standard Drawings, any Reference Document, Base Standard or any linked website. Developers must seek and rely upon appropriate independent professional advice for all aspects of any Subdivision or Development Works.

DOCUMENTATION AND INSPECTION POINTS

Tables of Documentation and Inspection Points, including allocation of responsibilities are available via the Subdivision Development Guidelines online platform.

SCHEDULE OF VARIATIONS

Refer to the Schedule of Variations within the Subdivision Development Guidelines (Part 1) for variations to this Specification imposed by each Relevant Authority.

PROJECT SPECIFIC REQUIREMENTS

This Standard Specification is to be used by Developers for construction of Subdivisions. It can be supplemented by Project Specific Requirements where required to provide additional detail or to vary from this Standard Specification. Project Specific Requirements must be documented using the template provided and Approved by all Relevant Authority(s) and/or Regulatory Authority(s) prior to construction.

DEFINITIONS

Adhesion Agent	A substance used for the purpose of promoting the adhesion between binder and aggregate in spray sealing and dense graded asphalt applications.
Adjacent Land	Land adjacent to but not forming part of the Development Site upon which any works in relation to a subdivision development are, or are to be, undertaken.
Allotment Fill	Fill required to achieve a design level on an allotment within a Subdivision.
Approved	Means Approved by the Relevant Authority except where applicable statutory requirements state otherwise or if a different approver is specified.
As Constructed Drawings	Detailed drawings showing the completed works and any variation to the Approved Construction Drawings carried out during the construction phase, signed and certified as complete and accurate by: • a Certifying Engineer having undertaken appropriate regular inspections and having made appropriate enquiries in respect of the state of completion of the relevant component of Public Infrastructure; and • the Developer or Developer's Representative. Detailed requirements for the format of As-Constructed Drawings is provided in Section *1.23 - As-Constructed Drawings.*
As Constructed Survey	Detailed survey plans recording any variations between the Approved Construction Drawings and as-constructed works, signed and Certified as complete and accurate by: • a Licensed Surveyor who is currently registered under the provisions of Part IV of the *Licensed Surveyors Act 1983 (NT)*; and • the Developer. Detailed requirements for the format of As-Constructed Survey is provided in *Section 1.23 - As-Constructed Drawings.*
Basecourse	That upper-most layer of constructed material immediately above the Subgrade or Sub-base and below the pavement surface (sealed or unsealed) extending for the full width of the Pavement and Shoulder.
Base Standards	The minimum design and construction standards, and the requirements under them. Set out in Part 2 - Reference documents.
Bound Materials	Materials including, but not limited to, natural gravels, crushed materials, and in-situ materials stabilised with an introduced binder, such that substantive tensile strength is imparted to the treated material.
Borrow Pit	An excavation or extraction area for obtaining fill, gravel, rock and rubble.
Business Day	A day other than a Saturday, Sunday or public holiday in the place in which the Development Site is situated, also excluding: 27th, 28th, 29th, 30th and 31st December; and any day officially registered by Bureau of Meteorology on 'Cyclone Warning' in the place in which the Development is situated.
Calendar Day	Means any day of the week, including weekends, and including Public Holidays.
Carriageway	That portion of a road for the use of vehicles, that is between kerbs or barriers where these are provided, including shoulders and auxiliary lanes.
CCTV Inspection	Closed Circuit Television camera inspection carried out by a suitably qualified professional on underground pipes, culverts and/or conduits to report on obstructions and/or Defects.

Certification	A written acknowledgment by a Certifying Engineer that the design and/or construction of each component of Development Works has been completed in accordance with the requirements of all Laws and approvals, the Guidelines, including the Standard Drawings and this Standard Specification, all Base Standards and any other relevant documentation. Approved deviations from these requirements should be clearly stated. The Term "Certified" has a corresponding meaning.
Certified Seed	Seed by record of origin, purity, and strain and conforming in character to the parent stock.
Certifying Engineer	A consultant and/or their duly authorised representative(s) appointed by the Developer to undertake design and/or construction Certification associated with each component of the Development Works. The Certifying Engineer must be an independent, professional engineer who is competent in the relevant component of the Development Works. The Certifying Engineer must be a Chartered Professional Engineer, unless noted otherwise. The Certifying Engineer, or their employing organisation, must hold an appropriate level of Professional Indemnity Insurance for the component of the Development Works being Certified.
Chainage	The distance measured along the street centre line from its nominated start point.
Coarse Grained Aggregate	Where the average grain size of the constituent minerals is greater than 1mm. The average grain size is determined optically under a petrographic microscope or by calibrated hand lens.
Conformance Testing	The testing to be carried out by the Developer to ensure that the Development Works complies with the Construction Drawings and Specifications.
Construction Drawings	'Issued For Construction' Drawings, Approved for use by a Relevant Authority pursuant to Section 2.5 of the Guidelines.
Controlled Fill	Fill for which engineering properties are to be controlled, as defined in AS 3978: *'Guidelines on Earthworks for Commercial and Residential Developments'*.
Cutter	A light petroleum distillate added to bitumen to temporarily reduce its viscosity.
Defect	Any item of work or materials which is incomplete, defective, deficient, unsafe, failing, non-complying or not Fit For Purpose in respect of any component of Public Infrastructure constructed as part of or in connection with any Development Works. This includes errors and omissions from design and/or construction works. Includes Major Defects and Minor Defects, as defined separately.
Defects Liability Period	Means the period of time the Developer is liable for any Defect occurring in relation to Public Infrastructure to be handed over to the Relevant Authority, commencing on the Practical Completion Date for that component of Public Infrastructure and expiring at the end of the relevant period defined in Part 1 of the Guidelines.
Design Documentation	Technical specifications, plans, drawings, calculations, reports and other documents required to satisfactorily detail all aspects of the Development Works.
Developer	The owner of the land the subject of a subdivision development, including the Developer's Representative(s).
Developer's Representative	A person or entity (and each of their employees, agents, Contractors, subcontractors and consultants) appointed, authorised or otherwise engaged by the Developer to act on their behalf in communications with any Relevant Authority or Regulatory Authority for the purpose of or in connection with undertaking a component of the Development Works.
Development Consent Authority	Has the meaning given to it in the *Planning Act 1999 (NT)*

Development Permit	Any permit issued by a Development Consent Authority, pursuant to the *Planning Act 1999 (NT)*.
Development Site	The parcel or parcels of land (including any part of any parcel) on which Development Works are being, have been or are to be undertaken and includes: Adjacent Land for the time and to the extent of any works on Adjacent Land; and any other land affected by External Works for the time and to the extent of any works on that land.
Development Works	All and any works that are to be undertaken on the Development Site, or Adjacent Land, and any External Works, as part of or in furtherance of the Subdivision (including works to complete the conditions of any Development Permit, or any conditions necessary to satisfy the requirements of any Relevant Authority or Regulatory Authority).
Dilapidation Report	A report on the condition of Public Infrastructure at a given point in time. Typically completed on existing Public Infrastructure prior to Development Works commencing, recording any existing damage and the state of any particular assets that may be affected by the Development Works.
Dissolution Cavities	Cavities formed in certain rocks, where portions have been dissolved by groundwaters.
Documentation Point	Any stage of the Development Works identified as a point at which certain documentation is required to be submitted. Each Documentation Point will also be either a Hold Point or a Witness Point.
Dry Density Ratio	The percentage ratio of the field dry density of a material to the Modified Maximum Dry Density (MMDD) of that material. This property is also termed Relative Compaction.
Exotic Plants	Any plants not native to Australia.
External Works	All Development Works external to the Development Site (including, but not limited to, any works on Adjacent Land) and necessary for proper subdivision or development including, but not limited to, the construction, reconstruction or upgrade of Public Infrastructure, private infrastructure, or public or privately owned lands affected by, or having effect on, the proposed Subdivision.
Fine Grained Aggregate	Where the average grain size of the constituent minerals is less than 1mm. The average grain size is determined optically under a petrographic microscope or by calibrated hand lens.
Fine Tilth	The friable soil resulting from cultivation.
Fit For Purpose	Appropriate, and of the necessary standard and quality, for its intended use or purpose.
Flux Oil	A petroleum distillate added to bitumen to produce a long-term reduction in its viscosity.
Formation	The surface of finished earthworks on which a Pavement is constructed. It includes the earthworks (cut and fill), subgrade and the general shaping of the drainage. The formation width is therefore the distance of cut or fill, including table drain(s), out to the limits of any batters as applicable.
Germination Percentage	The proportion of pure seed germinating in a fixed time under standard laboratory conditions.
Ground Cover	A measure of the quantity of nominated vegetation (e.g. grassing) covering the ground surface, as determined using the Step Point Method or Quadrat Method, to the satisfaction of the Relevant Authority. Typically expressed as a percentage (e.g. 80% Ground Cover).

Guidelines	Means all four parts of the Subdivision Development Guidelines, being: Part 1 – Design Guidelines Part 2 – Reference Documents Part 3 – Standard Drawings Part 4 – Standard Specification
Inspection and Test Plan	Any plan, Approved by each Relevant Authority, setting out the minimum inspection and testing requirements for Public Infrastructure to demonstrate conformance with the Standard Specification and the requirements of each Relevant Authority.
Inspection Point	Any stage of the Development Works identified as a point at which a physical inspection of the relevant Development Works may be required. Each Inspection Point will also be either a Hold Point or a Witness Point.
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.
Laws	Includes all statutes, regulations, by-laws and all instruments under them and consolidations, amendments, re-enactments or replacements of any of them.
Licensed Surveyor	A Licensed Surveyor who is currently registered under the provisions of Part IV of the *Licensed Surveyors Act 1983 (NT)*.
Longitudinal Markings	Any line which runs parallel to the street centre line, e.g. broken line, edge line, separation line, barrier line.
Major Defects	Defects which prohibit safe operation of Public Infrastructure and/or safe use of public areas, or cause significant loss of amenity.
Minor Defects	Defects which do not prohibit safe operation of Public Infrastructure and/or safe use of public areas, and do not cause significant loss of amenity.
Modification	A lighter form of stabilisation that treats an unbound material with small quantities of binder or granular material, to improve its unbound properties.
Mulch	Stable material spread as a surface treatment to reduce soil erosion, water loss, and weed invasion.
Native Plants	Plants that are natural to Australia.
Northern Territory Government Controlled Road Reserves	The roads, including Road Reserves, under the care, control and management of the Northern Territory Government and its relevant Department(s).
NPK Ratio	The ratio of Nitrogen (N), Phosphorus (P), and Potassium (K) in a fertiliser compound.
Nuisance	Any interference with a public or private right including, without limitation, any hazard, annoyance, interference, harm, loss (including expense) or damage caused by dust, fumes, heat, sound, vibration, escape of gases or liquids causing damage to land or other property or interfering with the use and enjoyment of them.
Optimum Moisture Content	The amount of water by mass, expressed as a percentage of the dry mass of the material, at which Maximum Modified Dry Density is obtained with the stabiliser added.
Other Markings	All diagonal lines, chevron markings and messages on the pavement, including symbols, words, numerals, arrows and kerb markings.
Pavement	That portion of road constructed for the structural support of, and to form the running surface, for traffic.

Practical Completion	In relation to each component of the Development Works intended to be handed over to a Relevant Authority, when: The Developer has provided the Relevant Authority with all items required under Part 1 of the Guidelines; and The Relevant Authority is satisfied that the works are complete in accordance with the Guidelines and the Design Documentation except for Minor Defects which: do not individually or in the aggregate prevent the Development Works from being used for their intended purpose; are of the type that the Relevant Authority is satisfied there are reasonable grounds for not promptly rectifying them; and can be rectified without affecting the convenient use of the works or any other affected Public Infrastructure.
Practical Completion Date	The date that Practical Completion has been achieved, as Certified by a Relevant Authority in a Practical Completion Letter.
Precoating Material	A material used for pre-coating aggregate to promote adhesion of bitumen. Do not use diesel.
Prime	An application of a primer to a prepared Base without cover aggregate to provide penetration of the surface temporary waterproofing and to obtain a bond between the Pavement and the subsequent Seal or Asphalt. It is a preliminary treatment to a more permanent bituminous surface.
Primerseal	An application of primer binder with a fine cover aggregate to a prepared Base to provide penetration of the surface and retain a light cover aggregate.
Process Testing	The testing carried out by the Developer, as outlined in the Inspection Test Plan(s), additional to Conformance Testing, to ensure that the Development Works is in accordance with the Construction Drawings and Specifications.
Project Specific Requirements	Means any variation of the requirements of this Standard Specification documented using the template provided and submitted to, and Approved in writing by, each Relevant Authority in respect of a particular Subdivision.
Provide	Provide and similar expressions mean supply, install, connect, test, commission, and leave ready for use. It includes development of the design beyond that documented.
Public Infrastructure	Any infrastructure currently, or proposed to be, owned and maintained by a Relevant Authority. Includes any component of the Development Works that is intended to be handed over to and accepted, and thereafter owned and maintained, by a Relevant Authority.
Recycled Crushed Glass	RCG conforming to Specifications for Recycled Crushed Glass as an Engineering Material, Section 9.
Registered Mix Design	An asphalt mix which has been placed on the Department of Logistics and Infrastructure's' Asphalt Mix Design Register and approved for use by the Regulatory Authority.
Regulatory Authority	Any governmental, semi-governmental, public, statutory or judicial body, entity, department or authority responsible for exercising statutory powers, rights or other authority under any legislation, subordinate legislation, or other legislative instrument in force from time to time in the Northern Territory and, for each component of Public Infrastructure, means any such body that regulates the design, construction, use, discharge to or from the infrastructure (whether or not that body will or is intended to own that Public Infrastructure upon completion of a subdivision development). Regulatory Authorities include, but are not limited to, the Development Consent Authority and the Power and Water Corporation in its capacity as regulator for electricity, water, and sewerage Public Infrastructure.
Relative Compaction	Has the same meaning as Dry Density Ratio.

Relevant Authority	Means, for a component of Public Infrastructure constructed as part of the Development Works, any governmental, semi-governmental, public, statutory body, statutory corporation or government owned corporation, entity, department or authority that is intended to accept handover of, own and maintain that Public Infrastructure after Practical Completion. Includes Service Authority and Local Authority as applicable.
Retroreflective	Meets specified reflectivity, expressed as minicandela per lux per square metre (mcd/lux/m2) and measured by a reflectometer Approved by the Relevant Authority.
Road Reserve(s)	Means any area of land reserved or dedicated, or to be reserved or dedicated, to the Northern Territory of Australia or a Local Authority as a road or street under the *Control of Roads Act 1953 (NT)*, *Local Government Act 2008 (NT)*, or the *Planning Act 1999 (NT)* and includes a road reserve in respect of a street as referred to in the Guidelines.
Root Ball	The finely bound fibrous root and soil removed intact from the container with the plant.
Safety Data Sheet	Provides information about hazardous materials such as identity, ingredients, health and physical hazards, safe handling and storage, emergency procedures, and disposal considerations.
Seal (Spray Seal)	A sprayed application of bituminous binder into which aggregate is incorporated. May include more than one application of binder and aggregate and may include geotextile fabric.
Service Authority	Has the meaning given to it in the *Planning Act 1999 (NT)*.
Shoulder	That portion of a road carriageway adjacent to the pavement, and flush with the surface of the pavement. Provides run-off for vehicles from traffic lanes. May be sealed or unsealed.
Soil Binding Agent	Material which stabilises and conditions soil and aids moisture retention.
Stabilisation	Process used to enhance material properties for pavement design purposes to overcome deficiencies in available materials, by incorporation of a binder or granular material (or both).
Standard Drawings	The Standard Drawings, as referenced in Part 3 of the Guidelines.
Standard Specification	This Specification.
Sub-base	One or more layers of material placed over the subgrade and below the basecourse extending for the full width of the pavement and shoulder.
Subdivision	Has the meaning given to it in the *Planning Act 1999 (NT)*.
Subgrade	Top 150 mm of material below Subgrade Surface. Also known as Subgrade Layer. Refer to Project Specific Requirements. Subgrade placed against an existing pavement is to be compacted to 98% MMDD.
Subgrade Surface	The prepared surface immediately beneath the pavement and shoulder layers.
Test Lot	An area designated for Conformance Testing, to be agreed between the Developer and Certifying Engineer, based upon: • A Test Lot will represent no more than one work shift's production. • A Test Lot will be continuous and will have been brought to completion at the same time. • A Test Lot will be composed of essentially homogeneous material with no distinct changes in attribute values.

Testing Contractor	A NATA accredited Testing Contractor(s) appointed by the Developer to undertake Process Testing and Conformance Testing for the Development Works.
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.
Traffic Control Device	Any sign, signal, pavement marking, or other installation placed or erected for the purpose of regulating, warning, guiding or providing for the safety of street users. It does not include temporary warning devices and control measures erected only for the construction period.
Traffic Controller	A person responsible for the control of traffic on public streets utilising a stop-slow bat.
Traffic Guidance Scheme	Includes, but is not limited to, plans, drawings, sketches, diagrams, instructions, and after hours arrangements, for the guidance of traffic under Approved Traffic Management Plans. Formerly referred to as Traffic Control Diagram(s).
Transverse Markings	Any line which is at right angles to the centre line of the street, e.g. stop line, hold line, pedestrian cross walk.
Unpaved Areas	Those areas within the Road Reserve which are not part of the Pavement, including any verges and medians not paved, batters and table drains and blocks, but excluding footpaths and vehicle access strips.
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 fails proof rolling and/or Conformance Testing, where specified, or is otherwise not Fit For Purpose.
Warm Mix Asphalt	Warm Mix Asphalt (WMA) is asphalt that contains a warm mix additive, or utilises a warm mix process, that has the ability to reduce the mixing and compaction temperature requirements below the typical temperatures used for that application.
Waterway	Has the meaning given to it in the *Water Act 1992 (NT)*.

GLOSSARY

AADT	Annual Average Daily Traffic
AAPA	Australian Asphalt Pavement Association
APAS	Australian Paint Approvals Scheme
ARRB	Australian Road Research Board
ASTM	American Society for Testing And Materials
AS/NZS	Australian Standard / New Zealand Standard
ATLM	Audio Tactile Line Marking
CBR	California Bearing Ratio
CCTV	Closed Circuit Television
DLI	Department of Logistics and Infrastructure
DOH	Department of Health
ESCP	Erosion and Sediment Control Plan
IRI	International Roughness Index
ISO	International Organisation for Standardisation
ITP	Inspection Test Plan
MMDD	Modified Maximum Dry Density
MPa.s	Milli Pascal Seconds – a unit measure of viscosity
NATA	National Association of Testing Authorities, Australia
NTCP	Northern Territory Codes of Practice
NTTM	Northern Territory Test Method
NTMTM	Northern Territory Materials Testing Manual
PCCP	Painting Contractors Certification Program
PMB	Polymer Modified Binder
PWC	Power and Water Corporation
RCG	Recycled Crushed Glass
SAMI	Strain Alleviating Membrane Interlayer
TGS	Traffic Guidance Scheme
TMP	Traffic Management Plan
VPD	Vehicles per lane per day

INFORMATION

This Specification is available electronically in PDF from the Northern Territory Subdivision Development Guidelines Online Platform.

For further information regarding this Specification contact: -

Subdivision Development Guidelines Management Committee
c/o Department of Lands, Planning and Environment
GPO Box 1680
Darwin NT 0800

or

Submit your inquiry through the Northern Territory Subdivision Development Guidelines Online Platform via www.ntlis.nt.gov.au/sdg-online/.

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STANDARD SPECIFICATION FOR SUBDIVISIONS 2024

CONTENTS

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1. MISCELLANEOUS PROVISIONS

1.1 STANDARDS

Conform to the following Standards, Acts and Publications unless specified otherwise:

AS/NZS 1336	Eye and face protection - Guidelines
AS/NZS 1337 (set)	Personal eye protection and Eye and face protection
AS/NZS 1338 (set)	Filters for eye protectors
AS 1348	Road and traffic engineering - Glossary of terms
AS 1379	Specification and supply of concrete
AS 1742(set)	Manual of uniform traffic control devices
AS/NZS 1800	Occupational protective helmets - Selection, care and use
AS/NZS 1801	Occupational protective helmets
AS/NZS 1906(set)	Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.4	Retroreflective materials and devices for road traffic control purposes - High-visibility materials for safety garments
AS/NZS 2161 (set)	Occupational protective gloves
AS 2187.1	Explosives - Storage, transport and use - Storage
AS 2187.2	Explosives - Storage, transport and use - Use of explosives
AS/NZS 2210 (set)	Safety, protective and occupational footwear
AS/NZS 4399	Sun protective clothing - Evaluation and classification
AS/NZS 4501.1	Occupational protective clothing - Guidelines on the selection, use, care and maintenance of protective clothing
AS/NZS 4501.2	Occupational protective clothing - General requirements
AS/NZS 4602.1	High visibility safety garments - Garments for high risk applications
AS 4742	Machine-mounted forward and reverse audible warning alarm
ISO 9533	Earth-moving machinery - Machine-mounted audible travel alarms and forward horns - Test methods and performance criteria
NTMTM	NT Materials Testing Manual
NTCP	NT Codes of Practice
NTTM	NT Test Methods

Aboriginal Land Rights (Northern Territory) Act 1976 (Cth)

Mineral Titles Act 2010 (NT)

Mining Management Act 2001 (NT)

Work Health and Safety (National Uniform Legislation) Act 2011 (NT) and *Work Health and Safety (National Uniform Legislation) Regulations 2011 (NT)*.

Dangerous Goods Act 1998 (NT) and *Dangerous Goods Regulations 1985 (NT).*

Railways of Australia (ROA) Code - Installation of Other Parties Services and Pipelines Within Railway Boundaries

Water Act 1992 (NT)

Energy Pipelines Act 1981 (NT)

Australian Communications Media Authority (ACMA) - any Standards, Acts, controls specifically required. Refer to ACMA directly.

Standard Specification for Environmental Management, DIPL publication

1.1.1 Overseas Standards

Where no Australian Standard exists, the Developer must comply with the referenced standards published by the British Standards Institute (BSI) or the American Society for Testing Materials (ASTM).

1.1.2 Currency of Standards

The Developer must comply with Standards current at the time of being granted any approval by a Relevant Authority and/or Regulatory Authority for a particular component of the Development Works, 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.

1.2 ENVIRONMENTAL MANAGEMENT

The NTG *Standard Specification for Environmental Management* applies to all Subdivisions.

1.2.1 Construction Environmental Management Plan

Documentation Point 1 –The Developer must submit a Construction Environmental Management Plan for approval by the Relevant Authority, prior to establishment and commencement of work on site.

1.3 INSPECTION TEST PLANS

Documentation Point 2 – Submit Inspection Test Plans (ITPs), detailing all procedures and test plans to be undertaken to complete the Development Works, before commencing the Development Works.

1.4 DILAPIDATION SURVEY

Prior to commencing Development Works within existing Road Reserves and/or easements, undertake a dilapidation survey to ascertain the existing condition of assets.

Documentation Point 3 – Submit a copy of the Dilapidation Report prior to commencing the Development Works.

1.5 PERMITS

1.5.1 Permit to Work in a Road Reserve

Documentation Point 4 - Obtain all necessary permits to work in Road Reserves prior to commencement of relevant Development Works.

Applications must be supported with Traffic Management Plans. Refer *Section 2 - Provision for Traffic.*

1.5.2 Permit to Interfere with a Waterway

Documentation Point 5 - Obtain all necessary Permits to Interfere with a Waterway prior to commencement of relevant Development Works.

1.5.3 Permit to Access Land for the Development Works

The Developer must obtain permission, from the entities and/or organisations with jurisdiction over the Development Site, to have access to the land where the Development Works are to be carried out.

Documentation Point 6 – Submit documentary evidence of having been granted the required permission to access the land to the Relevant Authority.

Do not enter the land until this evidence has been obtained.

1.6 ESTABLISHMENT

Liaise with the Relevant Authority regarding establishment on the Development Site, including, but not necessarily limited to, the following:

Advertise

Advertise works via Project Notice Boards as required by the Relevant Authority.

Permits

Obtain all permits required where any Development Works affect existing Public Infrastructure or Waterways.

Access to site

Access to the Development Site and construction traffic routes must be agreed with the Relevant Authority. A construction traffic management plan may be required.

Demobilisation

Prior to demobilising, restore and rehabilitate all elements of Public Infrastructure to the satisfaction of the Relevant Authority.

1.7 WASTE, CONTAMINANTS AND EXCESS MATERIALS

Remove all waste, contaminants and excess materials from the Development Site and dispose of lawfully.

1.8 VOLATILE SUBSTANCES MANAGEMENT

The Developer must become familiar with any Volatile Substance Abuse Management Plan(s) which is/are applicable in the areas where the Developer needs access so that the Development Works can be carried out. This includes, but is not limited to, the Development Site(s) of the works, the site(s) of any accommodation used by the Developer, and any access routes used by the Developer.

The Developer must comply with the requirements of any applicable Volatile Substance Abuse Management Plan(s).

Copies of Volatile Substance Abuse Management Plans are available via Part 2 – Reference Documents.

1.9 BORROW PITS

Documentation Point 7 – Obtain approval for use of Borrow Pits on land not owned by the Developer.

Where used, the establishment, operation and rehabilitation of the Borrow Pits must comply with the DIPL *Standard Specification for Roadworks and the NTG Standard Specification for Environmental Management.*

1.10 EXPLOSIVES

Comply with all Laws and the following requirements of NT WorkSafe:

- Licence to carry and store explosives.
- Vehicle licensed to carry explosives.
- Shot Firer's Certificate.

Documentation Point 8 – Where explosives are proposed to be used on the Development Site, including for External Works, notify all owners of Adjacent Land a minimum of 10 Business Days prior to commencing blasting operations. Inspect and record the condition of all structures and services subject to possible effect by use of explosives before and after blasting operations.

Documentation Point 9 - Obtain approval for the use of explosives for External Works prior to commencing blasting operations.

1.11 PLANT AND EQUIPMENT

Clean plant and equipment in a location and in a manner which prevents pollution of the surrounding environment.

Clean plant and equipment before it is brought on to the Development Site and immediately before it leaves the Development Site to make it pest and weed free.

1.11.1 Mobile Plant Machinery - Broadband Alarm

Broadband Alarms (White Sound) must be fitted to all construction vehicles and mobile plant before commencement of works and be Fit For Purpose.

1.11.2 Warning Beacons on Vehicles and Mobile Plant, Machinery, and Equipment

Provide beacons, or other mounted visual illuminated warning devices on the highest point of the cabin roof or superstructure of all vehicles, mobile plant, mobile machinery, and mobile equipment in accordance with the Vehicle-Mounted Signs And Devices Clause in the Description And Use of Signs And Devices Section of AS 1742.3 where these are being used for External Works.

Fit beacons with globes rated at a minimum of 55 watts, or the LED equivalent.

Do not use strobe lights.

Ensure that the light is operational whenever the plant or equipment is working.

Ensure that the light is visible from all approaches and not obscured by exhaust stacks, back hoe arms etc, and that the beacons or warning devices are not covered in dust.

Non-compliance with this clause may result in the Developer being directed to cease work.

1.12 SAFETY

Comply with the *Work Health and Safety (National Uniform Legislation) Act 2011 (NT) and Work Health and Safety (National Uniform Legislation) Regulations 2011 (NT)* and any applicable Codes of Practice, and any applicable Australian Standards.

All workers on site are to have undertaken and completed Prepare to work safely in the

construction industry (CPCCWHS1001), or superseding or preceding equivalent qualification

recognised by training.gov.au and hold a valid current NT White Card issued in their name by NT WorkSafe. (Interstate construction induction cards are accepted).

Site specific and Task specific induction training is still required for all work sites and is to be provided by the Developer.

1.12.1 Work Health and Safety Management Plan

The Developer must prepare and comply with a Work Health Safety Management Plan(s) as required by applicable legislation.

Provide a copy upon request by any Relevant Authority and/or Regulatory Authority.

1.12.2 Work Involving Chemicals

Comply with *Work Health and Safety (National Uniform Legislation) Act 2011 (NT) and Work Health and Safety (National Uniform Legislation) Regulations 2011 (NT).*

Safety Data Sheets documentation for chemicals used during the works must be held on site at all times during the works.

Spill clean-up equipment and materials, appropriate for the type and quantities of chemicals used on the Development Site, must be kept on site at all times during the works. Equipment and materials must be kept in a readily accessible location and must be maintained and replenished as needed.

Staff trained in the use of the spill clean-up equipment and materials must be on the Development Site at all times during the works.

Report all chemical spills to the NT Pollution Hotline, phone 1800 064 567.

Chemicals include, but are not limited to, paints, fuels, oils, herbicides, pesticides, tars, lubricants, cleaning products (domestic and industrial types), inks, dyes, toners, fertilizers etc.

1.13 SITE PERIMETER FENCING

Provide and erect site perimeter fencing, including hoardings to the satisfaction of the Relevant Authority, for the duration of Development Works to prevent accidental and/or unauthorised access to the Site.

1.14 REQUIREMENTS FOR EXCAVATIONS

Undertake dial before you dig (DBYD) prior to any work. Observe all DBYD recommendations related to safe excavation, duty of care and excavating safely.

Comply with NT Work Safe and Safe Work Australia Codes of Practice applicable to the works, including the *Safe Work Australia Code of Practice for Excavation Works.*

Provide shoring (or similar) to all trenching and/or excavations that are saturated or in unstable ground.

Provide shoring (or similar) to all trenching and/or excavations that are deeper than 1.5 metres, and where a person is required to enter, unless a suitably qualified geotechnical engineer Certifies that the trenching and/or excavation is stable. Maintain a record of such Certification on the Development Site for the duration of associated works.

1.15 UTILITIES AND OTHER SERVICES PASSING UNDER EXISTING PAVEMENTS

Do not use open trenching to run services below existing pavements, unless otherwise approved by the Relevant Authority.

Utilities and other services which are to be routed under existing pavements located in a road reserve which would otherwise not be subjected to works must be routed through directionally bored channels.

If the pavement is to be subjected to works, open trenching for the routing of utilities or services may be accepted by the Relevant Authority. Obtain approval from Relevant Authority before undertaking any excavation works for trenching across the existing pavement.

The utilities and other services are to be housed in conduits. The installations must comply with the requirements of the Relevant Authorities with jurisdiction over the utilities or services.

Comply with all conditions in the Permit to Work in the Road Reserve.

Refer to *Section 20 – Directional Boring* for additional detail.

1.16 WORK ON RAILWAY SITES

Comply with the *Work Health and Safety (National Uniform Legislation) Act 2011 (NT) and Work Health and Safety (National Uniform Legislation) Regulations 2011 (NT).*

Carry out work within railway sites to the approval of the owner and accredited operator of the railway.

The Developer must comply with all requirements, conditions and directions of the owners and accredited operators of the Railway pursuant to the *Northern Territory Rail Safety Act*. When carrying out work within 100 metres of the Railway obtain any approvals or licences required for such work.

Comply with the terms of any current existing interface agreement for work within the railway sites.

Give at least 10 Business Days written notice to the owner and operator of intent to commence work and provide a work plan showing safe working conditions for the site.

Documentation Point 10 – Obtain approval of the proposed work plan from the owner and operator of the rail system prior to commencing the relevant Development Works.

If work is required to be carried out within 3 metres of the actual rail line, this work must be co-ordinated through the owners and accredited operators of the Railway.

1.17 WORK NEAR TRAFFIC COUNTING STATIONS OR NEAR CULWEIGH STATIONS

Documentation Point 11 - Obtain the location of traffic counting station cables prior to commencing any excavation, boring of holes, blasting, rock breaking, soil compaction or similar activity in the vicinity of traffic counter station detector loops or culweigh stations.

Follow all directions and instructions issued by the Relevant Authority in relation to work in the vicinity of such cables.

1.18 SETTING OUT WORKS

Setting out of works must be undertaken using a Licensed Surveyor.

Allotment boundaries must be pegged out at the commencement of works and maintained throughout the construction phase to enable accurate visual assessment of works. Flagged fence post droppers are preferred.

1.19 LEVEL CHECKING

Check levels using a Licensed Surveyor.

All levels shown on the Construction Drawings must be checked and compared to demonstrate conformance with the specified tolerances. Any levels outside of tolerance must be clearly identified within the survey report(s) and rectified.

1.20 LEVEL AUDITING

The Relevant Authority may request to audit any level survey submitted to show conformance with the specified tolerances.

1.21 SURVEYS AND SETTING OUT

The Developer must be responsible for all setting out required for the proper execution of the Works. The design lines have not been pegged. Survey stations sufficient to establish the design line have been placed at the coordinates and levels shown in the drawings.

Prior to setting out the Works the Developer must verify the assigned coordinates and levels of all control stations. Differences outside the tolerances listed below, along with an assessment of the possible source of the problem and a proposed solution, must be reported to the Certifying Engineer for resolution, acceptance or guidance as to the method to be used for minimising or correcting adverse effects.

1.21.1 Tolerances

The precision of the x, y and z values of an adjacent control mark, as determined from the occupied control mark, are not to exceed the greater of the following:

X: ± 5 mm or ± 25 ppm

y: ± 5 mm or ± 25 ppm

z : ± 12 mm √kilometre

The Developer must take care not to disturb or cause any damage to land survey pegs and must be responsible for the payment of all fines, legal expenses, cost of re-erection and any other claims arising

1.22 SURVEY PEGS

The survey pegs are to be installed near the edges of the formation but still provide clearance for plant and equipment to be used without damaging or moving the survey pegs. The survey pegs must be installed in pairs, one on each side of the pavement, positioned and marked to have the same chainage.

The survey pegs are to be spaced at 100 m intervals longitudinally along the works.

Individual survey pegs are to be tied with high visibility flagging tape.

The survey pegs are to be marked with the design relative level of the finished pavement and the chainage at which each survey peg is located. This information must be clearly legible throughout the duration of works.

The finished pavement design levels are at points in the centre of the pavement for pavements with equal numbers of traffic lanes in each direction of travel. The finished pavement design levels are at points in the centre of 2 adjacent lanes which have opposite directions of travel for pavements with unequal numbers of traffic lanes in each direction of travel.

Any survey pegs which are damaged must be repaired or replaced and reinstated in their correct positions as soon as practicable. Any survey pegs moved but not damaged must be reinstated in their correct positions as soon as practicable.

1.23 AS-CONSTRUCTED DRAWINGS

Documentation Point 12 – Submit a procedure for approval for recording and submitting As-Constructed Drawings and associated information, prior to commencing the Development Works.

Document all changes to and variations to the Approved Construction Drawings as the Development Works proceeds, particularly items that are covered or become inaccessible.

Use a Licensed Surveyor to record the changes and variations in the form of an As Constructed Survey.

All coordinates must be in Geocentric Datum of Australia (GDA 94) and all levels to Australian Height Datum (AHD).

Provide the following As-Constructed Drawings and associated information to the Relevant Authorities progressively as the Development Works proceed and upon Practical Completion:

- PDF copies of drawings in A3 size format;
- Soft copies of drawings in AutoCad and/or Microstation format;
- Copies of text information in A4 portrait format in Microsoft Word and/or PDF format;
- Tables and schedules in Microsoft Excel and/or PDF format.; and
- Survey files in .pdf and AutoCAD/ Microstation format.

The Developer must provide the Relevant Authorities with As-Constructed Drawings to the same level of detail set on the Approved Construction Drawings, including scales, styles, notes and modified title blocks. The set of As-Constructed Drawings must include each and all drawings included in the Design Documentation. Should more drawings be required to cover the extent of constructed features, these must also be included.

As Constructed Drawings must clearly identify information on what set out and levels are design and what set out and levels are As Constructed.

As Constructed Drawings without changes must be described as “As Constructed – No Changes” in the amendment description column.

Where the As-Constructed Drawings are to be reduced, the annotation character heights must be selected so that the annotation character heights as reproduced are not less than 1.8 mm. Resolution to be a minimum of 600 dpi.

As-Constructed Drawings must be signed and Certified as complete and accurate by:

- a Certifying Engineer having undertaken appropriate regular inspections and having made appropriate enquiries in respect of the state of completion of the relevant component of Public Infrastructure; and
- the Developer or Developer’s Representative.

Documentation Point 13 – Submit As Constructed Drawings and associated documentation in accordance with the Approved procedure.

1.24 DEVELOPER SUBMISSIONS

1.24.1 Road Reserve, Permits and Approvals

Obtain all required permits, and approvals, for works, and associated activities, proposed to be carried out in areas not in the road reserve. This is in addition to all other required permits and approvals.

Provide copies of permits, and approvals, for works, and associated activities, proposed to be

carried out in areas not in the road reserve before commencing any proposed works, and activities.

1.24.2 Documents to be Submitted to Technical Records

Submit to the Certifying Engineer electronic copies (PDF or Microsoft Word) of:

– Operations and Maintenance Manuals

– Building Permits

– Occupancy Permits

1.24.3 Warranties

Provide the standard manufacturer's warranty certificates for manufactured plant, equipment, and other items. Provide installation warranties for the installation of plant, equipment, and other items, where specialised installation practices are a prerequisite for a manufacturer's warranty. Provide electronic copies of warranties at or before Practical Completion.

The warranties must include the following information for each item or type of item as a minimum:

– Product Description

– Name of the manufacturer

– Name of the supplier and contact details

– Contract details under which the items are installed

– Location of items or location area with GPS coordinates (Latitude and Longitude in decimal degrees)

– Month and year of manufacture

– Batch number

– Product code or model/type identifier (to differentiate the supplied product from other similar products of different type or model)

– Serial number of item (if applicable)

– Warranty period and end of warranty date

– Warranty conditions, and

– A declaration that provided products comply with these Specifications

2. PROVISION FOR TRAFFIC

2.1 GENERAL

Ensure the Development Site is operated and maintained in a safe and satisfactory condition.

Comply with the following general requirements.

- Ensure public safety.
- Minimise obstruction and inconvenience to the public.
- Assume responsibility for the safe conduct of traffic through, past or around the Development Site, 24 hours a day, for the duration of the Development Works.
- Provide Traffic Control for all works as required.

Comply with all Laws, including but not limited to the following Acts and associated Regulations:

- *Control of Roads Act 1953 (NT)*
- *Traffic Act 1987 (NT)*
- *Work Health and Safety (National Uniform Legislation) Act 2011 (NT)*

2.1.1 Duty of Care

Comply with the Work Health and Safety (NUL) Act 2011 and its Regulations 2011.

Any Person Conducting a Business or Undertaking (PCBU) in connection with or pursuant to temporary traffic management or any works on a road, has a 'duty of care', so far as is reasonably practicable, that the health and safety of workers who work for the PCBU or whose activities in carrying out work are influenced or directed by the PCBU, are not exposed to health and safety risks arising from that business or undertaking.

A PCBU must ensure, so far as reasonably practicable, that other road users are not exposed to health and safety risks arising from any temporary traffic management business or undertaking.

All PCBUs involved in the procurement of the works, and involved in the delivery of the works, must consult on work health and safety issues. The decisions made, or outcomes from, these consultations must be documented and distributed to all relevant PCBUs.

2.1.2 Risk Management

Refer to the Austroads Guide to Temporary Traffic management (AGTTM).

Management of risk is central to a TMP.

The risk management process for the planning of the works must be in accordance with AGTTM Part 2: Traffic Management Planning, and AGTTM Part 10: Supporting Guidelines.

The risk management process is applicable at all levels of planning, design, implementation, and operation.

All parties involved in the procurement of the works, and involved in the delivery of the works, must consult on risk management issues. The decisions made, or outcomes from, these consultations must be documented and distributed to all relevant parties.

2.2 STANDARDS

Conform to the current editions of the following Standards and publications unless specified otherwise:

AS 1742.2	Manual of uniform traffic control devices – Traffic control devices for general use.
AS 1742.3	Manual of uniform traffic control devices - Traffic control devices for works on roads.
AS 1742.9	Manual of uniform traffic control devices – Bicycle facilities
AS 1742.10	Manual of uniform traffic control devices – Pedestrian control and protection
AS/NZS 1906.1	Retroreflective materials
AS/NZS 3845.1	Road safety barrier systems
AS 4191	Portable traffic signals
AS 4852.2	Variable Message Signs – Portable Signs
ISO 31000	Risk management
NTTM	NT Test Methods.
NTMTM	NT Materials Testing Manual.
AUSTROADS	Guide to Road Design
AUSTROADS	Guide to Bridge Technology
AUSTROADS	Guide to Road Safety Part 6: Road Safety Audit
AUSTROADS	Guide to Temporary Traffic Management (AGTTM)
NT WorkSafe	All relevant bulletins, guidelines and codes of practice.
NT WorkSafe	Code of Practice for Construction Work
NT WorkSafe	Code of Practice for Excavation Work
Safe Work	All relevant bulletins, Australia guidelines and codes of practice.

2.3 LEGISLATION

Northern Territory of Australia Control of Roads Act, and its Regulations

Northern Territory of Australia Traffic Act, and its Regulations

Northern Territory of Australia Work Health and Safety (NUL) Act, and its Regulations

2.4 INTERNAL WORKS

For all works within the parcel of land subject to Subdivision, make all necessary provisions for traffic to comply with all Laws and Standards applicable to the Development Works.

2.5 EXTERNAL WORKS

Obtain all necessary Permit(s) to work within a Road Reserve from prior to commencing any External Works within Road Reserves. Refer to *Clause 1.5 - Permits*.

Comply with all requirements of the Relevant Authorities, including preparation and submission of Traffic Management Plans and restricted working arrangements.

Comply with all Laws and Standards applicable to the Development Works.

For all External Works in Northern Territory Government Controlled Road Reserves, refer to the DLI Specification for Roadworks – Provision for Traffic Section.

2.6 TRAFFIC MANAGEMENT PERSONNEL

All personnel engaged in the Development Works must have a current valid NT Construction Induction White Card (Prepare to work safely in the construction industry, CPCCWHS1001), or equivalent qualification recognised by NT WorkSafe.

Only persons qualified in nationally accredited units of competency in WorkZone Traffic Management can be utilised for traffic management. The four levels of accreditation are:

- WorkZone Traffic Management Plan Designer (WZ1)
- WorkZone Traffic Controller (WZ2)
- WorkZone Traffic Supervisor (WZ3)
- Escort mobile road marking operations (WZ 4)

NT accreditation is provided by completion of applicable training course(s); and obtaining a WorkZone Traffic Management ID Card from NT Motor Vehicle Registry.

2.7 TRAFFIC MANAGEMENT PLANS

2.7.1 Traffic Management Plan Design

Traffic Management Plans (TMPs) are required to be designed by a Northern Territory accredited Traffic Management Plan Designer (WZ1).

Design the TMP in conformance with the requirements of AS 1742 – *'Manual of uniform Traffic Control Devices, Part 3: Traffic Control Devices for Works on Roads'.*

Include sufficient details on the TMP to explain the potential hazards, the assessed risks and the proposed treatments for the proposed Development Works activities and Development Site.

The following prerequisites must be met to enable NT accreditation as a Traffic Management Plan Designer

- hold a valid current Australian motor vehicle driver's licence, and either
- successful completion of RII09 Resources and Infrastructure Industry Training Package unit of competency RIICWD503D Prepare WorkZone Traffic Management Plans (or the replacement unit of competency if and when applicable) training course through an Northern Territory Registered Training Organisation, or
- successful completion of the RII09 Resources and Infrastructure Industry Training Package unit of competency RIICWD503D Prepare WorkZone Traffic Management Plans (or the replacement unit of competency if and when applicable) training course through a Registered Training Organisation from another State or Territory AND successfully completed a bridging course through a Northern Territory Registered Training Organisation in the above unit of competency.

Documentation Point 14 – Submit Traffic Management Plans (TMPs), including associated Traffic Guidance Schemes (TGS), prior to commencing the relevant Development Works.

2.7.2 Access to Adjacent Properties and Side Streets

Maintain access to adjacent properties and side streets at all times to a level appropriate for the type and frequency of traffic.

Provide and erect proposed and Approved signs detailing alternative access, only after approval from the Relevant Authority is obtained for the Traffic Management Plan.

Ensure adequate access is maintained for pedestrians and cyclists as required, including

delineated access if existing paths are being closed as part of the works.

2.7.3 Temporary Pedestrian Access

Conform to: AS 1742.9 and AS 1742.10.

Maintain access for pedestrians, cyclists and persons with disabilities passing through and around the Development Site. Where existing paths are to be demolished or will become inaccessible or modified due to Development Works, provide temporary access to a standard not less than the pre-existing or pre-construction standard.

Temporary access must;

- Be clearly delineated and have adequate width and height clearance.
- Be smooth, free draining and free of obstructions and loose material.
- Provide clear guidance where paths change direction.
- Be illuminated by temporary lighting to assist path users where existing street lighting has been removed or affected by the works.
- Be arranged so that path users are clearly visible to vehicle drivers and plant operators at street pedestrian crossing points.

2.7.4 Traffic Control Amendments

Modify the Traffic Management Plan (TMP) during the Development Works to suit site conditions if required or requested by the Relevant Authority.

Changes made to the TMP must be clearly marked in the amended TMP.

Documentation Point 15 – Submit all amendments to the TMPs and TGS prior to implementation of any changes, unless there is an urgent need for amendments to mitigate hazards.

In situations where immediate hazard mitigation is necessary, the changes may be implemented and notice of the changes provided as soon as practicable thereafter.

2.8 INCIDENT RESPONSE

If an incident occurs within, adjacent to, on approach to or departure from the Development Site, make a photographic record of the Traffic Control Devices, site conditions, placement of plant and equipment etc., as soon as practicable after the event. Advise the Relevant Authority of the incident as soon as possible.

Notify the following services if disruption to traffic is expected: Public Transport Operators, Emergency Services and Garbage Collection.

Organise Police control as required, or as requested by the Northern Territory Police.

2.9 RESTORATION

Upon completion of Development Works associated with the provision for traffic:

- Remove all temporary warning signage and other traffic control devices.
- Remove all temporary works and reinstate the areas to their original state.
- Stabilise all areas impacted by the Development Works to prevent erosion.
- Where applicable reseed with local native grasses and trees and shrubs.
- Comply with the requirements of the Environmental Approvals and Clearances issued by the Relevant and/or Regulatory Authorities.
- Reinstate permanent Traffic Control Devices temporarily removed during the Development Works.

3. CLEARING, GRUBBING AND REHABILITATION

3.1 GENERAL

BURNING; Do not light fires or burn any demolished material or vegetation either on or off the Development Site.

3.2 CLEARING

DEMOLITION; Remove fencing, buildings, kerbing, debris, drainage structures, old street surfaces and other structures as required.

EXTENT; Clear the Development Site only to the extent shown on the Construction Drawings and specified in this section.

EXCESS CLEARING; Where excess clearing has taken place beyond that specified or shown on the Construction Drawings for External Works, rehabilitate the areas in accordance with the Relevant Authority requirements.

3.3 TREES TO BE RETAINED

Retain selected trees shown on the Construction Drawings.

PROTECTION; Protect from damage, trees which are required to be retained. Do not remove topsoil from the areas within the dripline of the trees and keep the area free of construction equipment and materials.

DAMAGE; If a tree, which is marked to be retained, is damaged and repair work is considered impractical, or is attempted and fails, remove the tree and the root system, if so directed. Replace the tree with a tree of the same species and similar condition and size.

3.4 MULCHING

Mulch all cleared vegetative matter in mechanical brush chippers to a maximum size of 100 mm as the clearing work proceeds. Do not stockpile cleared material for later Mulching.

STUMPS; Remove stumps and other material unsuitable for Mulching from the Development Site and dispose of lawfully.

GRASSES; Do not Mulch grass clods, roots or other components containing viable propagules.

STOCKPILES; Stockpile Mulched material on the Development Site for use during reinstatement work in accordance with the Environmental Management Plan.

SURPLUS MATERIAL; Remove excess Mulch from the Development Site and dispose of lawfully.

3.5 STRIPPING OF TOP LAYER

EXTENT; Strip the top layer of natural material to a nominal depth of 100 mm unless shown otherwise on the Construction Drawings.

Stockpile stripped material on the Development Site within 1 km of the point of origin. Comply with Approved Erosion and Sediment Control Plans and relevant OH&S Legislation.

Remove excess stripped material from the Development Site and dispose of lawfully.

Spread stripped material on areas to be landscaped, following completion of earthworks.

3.6 TREATMENT OF EXISTING SEALED SURFACE

Rip the existing Sealed surface.

Conform to the following:

Table 3-1 - Treatment of Existing Sealed Surfaces

Specified Cover over Existing Seal	**Maximum Seal Fragment Size**
Fill depth 500 mm or greater	1 m2
Fill depth less than 500 mm	Remove seal from the Development Site.
Pavement re-sheeting only	Remove seal from the Development Site and replace with similar volume of Pavement.

3.7 SCARIFYING OF EXISTING STREETS

Scarify, both longitudinally and laterally, for the full width of the formation by ripping to a depth of 250 mm resulting in a maximum size of demolished seal of 100 mm.

Tyne spacing to be 500 mm maximum.

Remove demolished Seal from the Development Site and dispose of lawfully, unless otherwise Approved by the Relevant Authority. Approved

3.8 GRUBBING

Grub out and remove from the site all cleared vegetation to a depth of 200 mm below Subgrade Surface in cut and 200 mm below natural surface under fill.

Fill grub holes and other excavations as required with Type B Fill, unless otherwise directed by the Certifying Engineer, compacted to 95% Relative Compaction.

Inspection Point 1 – Obtain approval for cleared and grubbed surface prior to commencing earthworks operations.

3.9 REHABILITATION

Reinstate any clearing undertaken during the Development Works, which is not subject to landscaping, including temporary detours, to rehabilitate the area consistent with its untouched surrounds. This includes topsoiling, grassing, seeding, planting, mulching, watering and other measures necessary to rehabilitate the area.

Reinstate all existing infrastructure which has been damaged or impacted by the Development Works.

3.10 CLEANING UP

Remove all excess fill, rubble and other debris from the Development Site and dispose of lawfully.

4. EARTHWORKS

4.1 STANDARDS

Conform to the following Standard and Publication unless specified otherwise:

AS 1289 (set)	Methods of testing soils for engineering purposes.
AS 3798	Guidelines on Earthworks for Commercial and Residential Developments
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods

4.2 EARTHWORKS IN CUT – OTHER THAN ROCK

4.2.1 Description

Operations necessary for excavation in soils, including:

- shaping and trimming the cut formation;
- compaction of the Subgrade;
- removal / replacement of Unsuitable Materials; and
- removal of excess materials.

4.2.2 Excess Material

Remove all excess materials from the Development Site and dispose of lawfully.

4.2.3 Excavation and Subgrade Preparation

Excavate, shape and trim works to the nominated design Subgrade Surface level.

Rip the cut Subgrade to a depth of 150 mm and compact in accordance with *Clause 4.10 – Compaction*.

Inspection Point 2 – For earthworks in cut, proof roll the compacted Subgrade in accordance with *Clause 4.11.2 – Proof Rolling* to identify any areas of Unsuitable Material.

Conformance Testing must be undertaken to confirm the Subgrade material conforms to the required properties.

4.2.4 Unsuitable Material Below Subgrade Surface other than Rock

Inspection Point 3 – If Unsuitable Materials are encountered below Subgrade Surface other than rock, obtain direction before remedial works commence.

Replace Unsuitable Material with Type B Fill, unless otherwise directed by the Certifying Engineer, compacted to 95% Relative Compaction in Road Reserves, under buildings and for Allotment Fill.

Floodways: Replace Unsuitable Material with Floodway Fill, compacted to 95% Relative Compaction.

Detention basin embankments: Replace Unsuitable Material with Embankment Fill, compacted to 95% Relative Compaction.

4.3 EARTHWORKS IN CUT - ROCK

4.3.1 Description

Operations necessary for excavation in rock, including:

- shaping and trimming the cut formation;
- removal / replacement of Unsuitable Materials;
- removal of excess materials; and
- filling of Dissolution Cavities in cut rock.

4.3.2 Excavation and Subgrade Preparation

Inspection Point 4 - If rock is encountered below the Subgrade Surface, obtain direction before remedial works commence.

Excavate to Subgrade Surface level, taking care not to over-excavate or disturb underlying in-situ materials.

Trim the excavation to shed water.

Remove all loose and disturbed materials from the cut rock face, and rock which has been rendered unstable.

Replace excavated material with Type C Fill compacted to 95% Relative Compaction.

Do not rip and compact the rock Subgrade.

4.3.3 Dissolution Cavities in Rock

Inspection Point 5 - If Dissolution Cavities are encountered below the Subgrade Surface, provide notification for direction before remedial works commence.

Following excavation of the final profile, if Dissolution Cavities are present in rock materials, fill the cavities with lean mix concrete or cement slurry/grout.

4.4 EARTHWORKS IN FILL

4.4.1 Description

Earthworks in fill includes preparation prior to filling, winning, hauling, placing and compacting material on all prepared areas including holes, pits and other depressions.

4.4.2 Preparation of Foundation Prior to Filling other than Detention Basin Embankments

After stripping of topsoil, moisture condition the foundation and apply a minimum of three passes with maximum mass compaction equipment.

Inspection Point 6 – Once moisture conditioned and compacted, subject each Test Lot to a proof roll of the foundation prior to filling in accordance with *Clause 4.11.2 – Proof Rolling* to identify any areas of Unsuitable Material.

4.4.3 Preparation of Detention Basin Embankment Foundations Prior to Filling

Inspection Point 7 – After stripping of topsoil, obtain approval for subgrade prior to scarifying from the suitably qualified geotechnical engineer who will be undertaking Level 1 Inspection and Testing for the embankment in accordance with *Clause 4.4.7 - Placement of Fill*.

Dissolution cavities to be treated in accordance with Clause 4.4.5 Dissolution Cavities Beneath Fill.

Scarify the Approved subgrade for a depth of 300mm to remove relic soil structure and potential drainage paths, and compact to 95% Relative Compaction.

Unsuitable materials beneath the general embankment foundation must be treated in accordance with Clause 4.4.4 Unsuitable Material Beneath Fill.

The foundation must be benched with 200mm steps, where the existing surface inclines at steeper than eight horizontal to one vertical.

The foundation surface must be proof rolled to assist in locating weak and compressible soil in accordance with the Clause 4.11.2 – Proof Rolling.

The foundation surface must be cleaned of loose soil and rock prior to placing Embankment Fill.

The surface must be scarified to a depth of 50 mm immediately prior to placement of the Embankment Fill material to assist in bonding of the layers and removal of preferential seepage paths.

Inspection Point 8 – Prior to filling, the prepared foundation must be inspected and approved by the suitably qualified geotechnical engineer who will be undertaking Level 1 Inspection and Testing for the embankment in accordance with *Clause 4.4.7 - Placement of Fill*.

4.4.4 Unsuitable Material Beneath Fill

Inspection Point 9 - If Unsuitable Materials are encountered in foundations beneath fill, obtain direction before remedial works commence.

Replace Unsuitable Material with Type B Fill, unless otherwise directed by the Certifying Engineer, compacted to 95% Relative Compaction in Road Reserves, under buildings and for Allotment Fill.

Floodways: Replace Unsuitable Material with Floodway Fill, compacted to 95% Relative Compaction.

Detention basin embankments: Replace Unsuitable Material with Embankment Fill, compacted to 95% Relative Compaction.

4.4.5 Dissolution Cavities Beneath Fill

Inspection Point 10 - If Dissolution Cavities are encountered in foundations beneath fill, obtain direction before remedial works commence.

Subsequent to stripping of topsoil, if Dissolution Cavities are present in rock materials, fill the cavities with lean mix concrete or cement slurry/grout.

4.4.6 Benching

Provide benching in accordance with the Construction Drawings where the existing surface inclines at steeper than eight horizontal to one vertical.

Provide terracing in accordance with the Construction Drawings where the existing surface inclines at steeper than three horizontal to one vertical.

4.4.7 Placement of Fill other than Detention Basin Embankments

Fill must be placed as 'Controlled Fill' as follows:

- Deposit and spread the material in uniform level layers to a maximum thickness of 250 mm loose measurement, unless otherwise Specified on Construction Drawings;
- Moisture condition to fill material between +-/2% of OMC; and
- Compact each layer to the specified compaction (refer *Table 5-14 – Dry Density Ratios for Conformance*) before placing the next layer.

Use Type B Fill for the Subgrade layer, unless otherwise specified on the Construction Drawings.

Inspection Point 11 – For earthworks in fill other than detention basin embankments, proof roll the Subgrade Surface in accordance with *Clause 4.11.2 - Proof Rolling*.

Inspection Point 12 – All Allotment Fill is to be carried out under Level 1 Inspection and Testing in accordance with AS 3798 and comply with *Section 5 - Conformance Testing.*

Documentation Point 16 - Submit Level 1 Inspection and Testing certification by a suitably qualified geotechnical engineer, in accordance with AS 3798, for all Allotment Fill to the Certifying Engineer.

4.4.8 Placement of Fill for Detention Basin Embankments

Fill must be placed as 'Controlled Fill' as follows:

- Deposit and spread the material in uniform level layers to a maximum thickness of 250 mm loose measurement, unless otherwise Specified on Construction Drawings;
- Moisture condition to fill material between +-/2% of OMC;
- Compact each layer to the specified compaction (refer *Table 5-14 – Dry Density Ratios for Conformance*) before placing the next layer; and
- Before each additional lift is added to the

embankment, the previous lift shall be scarified to a depth of 50mm to ensure that the two lifts are properly joined so that no natural seepage paths are present.

Use Embankment Fill for the Subgrade layer, unless otherwise specified on the Construction Drawings.

Inspection Point 13 – For earthworks in fill for detention basin embankments, proof roll the Subgrade Surface in accordance with *Clause 4.11.2 - Proof Rolling*.

Inspection Point 14 – Placement of fill for detention basin embankments is to be carried out under Level 1 Inspection and Testing in accordance with AS 3798 and comply with *Section 5 - Conformance Testing.*

Documentation Point 17 - Submit Level 1 Inspection and Testing certification by a suitably qualified geotechnical engineer, in accordance with AS 3798, for all detention basin embankments to the Certifying Engineer. The certification must confirm that detention basin embankments are Fit For Purpose.

4.5 FILL MATERIAL

4.5.1 Type A Fill – General

Use the best locally available material, whether cut or borrow, that is free of organic matter and conforms to the following properties:

Table 4-1 – Type A Fill Properties	
CBR 4 day soaked at 95% MMDD to AS 1289:	10 Min.
CBR Swell:	1% max
Plasticity Index:	2% - 15%
Weighted Plasticity Index:	1200 max

4.5.2 Type B Fill - Standard

Must be free of organic matter and conform to the following properties:

Table 4-2 –Type B Fill Properties		
CBR 4 day soaked at 95% MMDD to AS 1289:		15 Min.
CBR Swell:		1% max
Maximum Particle Size:	For Subgrade Layers	50mm
	For other than Subgrade Layers	100mm
Plasticity Index:		2% - 15%
Weighted Plasticity Index:		1200 max

4.5.3 Type C Fill - Select

Type C Fill must be comprised of gravel, decomposed rock or broken rock, free from organic matter and lumps of clay.

Conform to the following Grading and Properties:

Table 4-3 – Grading – Type C Fill	
AS Sieve (mm)	% Passing (Dry Weight)
75.00	100
9.50	30 - 100
2.36	15 - 65
0.075	5 - 25

Table 4-4 – Type C Fill Properties	
CBR, 4 day soaked at 95% MMDD to AS 1289:	20 Min.
CBR Swell:	1% max
Plasticity Index:	2 - 15%
Weighted Plasticity Index:	1200 max
Linear Shrinkage:	2 - 6%.

4.5.4 Sand Clay Fill

Sand Clay Fill may be used as an alternative to Type C Fill.

Must be free of organic matter and conform to the following Grading and Properties:

Table 4-5 – Grading – Sand Clay Fill	
As Sieve (mm)	% Passing (Dry Weight)
4.75	80 - 100
2.36	60 - 100
0.425	30 - 60
0.075	14 - 28

Table 4-6 – Sand Clay Fill Properties	
CBR: 4 day soaked and 95% MMDD to AS 1289:	30 minimum
Plasticity Index	15% maximum
Linear Shrinkage	1 - 8%

4.5.5 Floodway Fill

Floodway fill must be used for replacement of Unsuitable Materials beneath floodways.

Floodway fill must be comprised of angular or broken rock, free from organic matter and lumps of clay.

Conform to the following Grading and Properties:

Table 4-7 – Grading – Floodway Fill	
Maximum size:	100 mm.
Plasticity Index:	10 maximum.
Linear Shrinkage	5.0 maximum.

Table 4-8 – Floodway Fill Properties	
AS Sieve (Mm)	**Percentage Passing**
75.0	40 - 100
19.0	15 - 50
2.36	0 - 25

4.5.6 Embankment Fill

Embankment fill must be used for construction of detention basin embankments.

Embankment fill must be comprised of gravelly-clay, free from organic matter, lumps of clay, rubbish and other deleterious materials.

Conform to the following Grading and Properties:

Table 4-9 – Grading – Embankment Fill	
As Sieve (mm)	% Passing (Dry Weight)
75.00	100
9.50	30 – 100
2.36	15 – 65
0.075	5 – 25

Table 4-10 – Embankment Fill Properties	
CBR, 4 day soaked at 95% MMDD to AS 1289:	20 minimum.
Plasticity Index:	2 - 15%
Linear Shrinkage:	2 - 6%.
Emerson Class	Minimum 5

4.6 PREPARATION AND MAINTENANCE OF SUBGRADE SURFACE

Trim, prepare, and maintain, Subgrade Surface to the required tolerances specified in this Section, free of depressions, cracking, laminations, organic inclusions, and other Defects. Surface to be formed and maintained to be free draining, and suitable for proof rolling.

Maintain and repair any damage to the prepared surface prior to placing further material.

4.7 EARTHWORKS FOR DRAINAGE

Comply with the requirements of the *Standard Specification for Environmental Management* and obtain all necessary permits, including *Permit to Interfere with a Waterway.*

Refer to *Section 13 – Drainage Works*

4.7.1 Site Drainage

Construct site drainage to the details, levels and dimensions as shown on the Construction Drawings.

Provide temporary site drainage as required to manage stormwater runoff during construction.

Comply with Approved Erosion and Sediment Control Plans, plus any additional requirements requested by the Relevant Authority.

4.7.2 Stream Diversions

Divert streams temporarily where it is necessary for the construction of the work.

Ensure that existing waterways are not filled, altered, or diverted except where Approved by the Relevant Authority.

Obtain a *Permit to Interfere with a Waterway* and provide a copy to the Relevant Authority as per *Clause - 1.5.2 Permit to Interfere with a Waterway.*

Comply with Approved Erosion and Sediment Control Plans, plus any additional requirements requested by the Relevant Authority.

4.7.3 Levees/Stop berms

Construct and trim levees/stop berms at locations to divert the water flow from the table drains into a stream or culvert or other Approved location.

Construct using Type B Fill with a Plasticity Index of 6% minimum.

Compact in layers not exceeding 150 mm compacted thickness.

Construct in locations, and to dimensions shown on the Construction Drawings.

4.7.4 Drains

Construct all drains including table drains, open drains and catch drains, to the dimensions shown on the Construction Drawings.

Grade to prevent ponding of water.

Trim and compact all drain bases and batters as specified in the Trim and Compact Unpaved Areas clause in this work section.

4.8 WIDENING OF EXISTING FORMATION

Cut back the existing Formation and Pavement as shown on the Construction Drawings by not less than 150 mm on each edge to sound densely compacted material to form a uniform edge (curved or straight where applicable).

Construct the widening by cutting and filling as specified.

4.9 TRIM AND COMPACT UNPAVED AREAS

Shape, grade and compact as specified.

Unpaved areas include, but are not limited to, areas beyond the shoulders, verges in urban areas and table drains.

Refer to *Table 5-1 to Table 5-5-3 – Test Frequencies for Soils (Parts 1 to 3)*.

Refer to *Table 5-14 – Dry Density Ratios for Conformance*.

4.10 COMPACTION

Mix to a homogeneous material and compact with no compaction planes and free of cracking to conform to the Dry Density Ratios specified in *Table 5-14 – Dry Density Ratios* for Conformance and to *Clause - 4.11 Conformance*.

4.11 CONFORMANCE

4.11.1 Tolerances

Finish earthworks to a smooth compacted and uniform surface within the following limits:

Formation Width:	Not less than specified.
Subgrade Surface:	Maximum 25 mm below and not above specified level.
Subgrade Width:	Not less than specified. Extend minimum 150 mm minimum beyond the back of kerb.
Unpaved Areas:	Maximum 75 mm above or below specified level, free of depressions capable of ponding water. Maximum 40mm adjacent to kerbs.
Allotment Fill Surface:	Maximum 50 mm above or below specified level, free of depressions capable of ponding water.
Batter:	Not steeper than the specified slope.
	Maximum variation at any point from specified plane of batter must be 150 mm in earth and 300 mm in rock.
Drainage Works:	Refer to *Section 13 – Drainage Works*

Works must also conform to the requirements in *Table 6-9 - - Relative height tolerances for new works abutting existing works*.

4.11.2 Proof Rolling

Documentation Point 18 - Submit a proof rolling procedure prior to commencing relevant Development Works, including the proposed method of preparing the areas, the extent of proof rolling, and details of the plant and/or equipment proposed to be used.

Proof roll all areas and obtain satisfactory results before ordering Conformance Testing of those areas.

Plant Requirements

Use plant in proof rolling procedures that comply with the following requirements:

For Infrastructure Category A localities:

- Fully loaded water cart, minimum size 12 tonne, on standard pneumatic road tyres, fully inflated.

For all other localities:

- Fully loaded water cart, minimum size 12 tonne, on standard pneumatic road tyres, fully inflated;
- Fully loaded, minimum single trailer articulated heavy vehicle, on standard pneumatic road tyres, fully inflated; or
- Pneumatic tyred compaction plant with a mass of not less than 20 tonnes and with a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre and a ground contact area of not less than .035 m2 per tyre.
- Do not use flat drum rollers.

Check areas for level tolerance and layer thickness before proof rolling.

Proof roll each layer immediately following completion of compaction. If proof rolling is carried out at a later time, water the surface and roll with the test roller prior to commencement of proof rolling.

Compliance; the proof rolling requirements are deemed to comply when an area withstands proof rolling without visible deformation, cracking, heaving, or springing.

Provide uniform and stable support for rear wheel loads when at walking pace.

Remedial work; remove and reconstruct areas that deform, break up or show signs of distress as directed by the Certifying Engineer.

4.11.3 Conformance Testing Fill

Conformance testing must be carried out on each layer of fill.

Subgrade

Subgrade surface must be tested only when it is within level tolerance and conforms to proof rolling.

Check Subgrade Surface levels prior to testing.

Documentation Point 19 – Submit evidence of Subgrade conformance prior to placing further materials.

5. CONFORMANCE TESTING

5.1 GENERAL

The Developer is responsible for all process control and Conformance Testing.

The Developer must carry out all Conformance Testing specified, and any additional testing requested by the Relevant Authority and Certifying Engineer.

The Developer is to provide Traffic Control for Conformance Testing activities.

All testing must be conducted by a NATA accredited testing laboratory.

5.2 STANDARDS

Northern Territory Test Methods (NTTM) and NT Codes of Practice (NTCP) for materials testing are given in the Northern Territory Materials Testing Manual (NTMTM). The methods contained in the Materials Testing Manual take precedence over all other test methods and procedures, and are used in conjunction with relevant Australian Standards.

The following standards are referred to in this section;

AUSTRALIAN STANDARDS

AS 1141	Methods for testing and sampling aggregates.
AS 1141.11.1	- Particle size distribution by sieving.
AS 1141.14	- Particle shape, by proportional calliper.
AS 1141.15	- Flakiness index.
AS1141.18	- Crushed particles.
AS 1141.20.1	- Average least dimension of aggregate by direct measurement (size≥10 mm).
AS 1141.20.2	- Average least dimension of aggregate by direct measurement (size 5 mm & 7 mm).
AS 1141.23	- Los Angeles value.
AS 1141.24	- Sodium sulphate soundness.
AS 1141.40	- Polished aggregate friction value - Vertical road-wheel machine.
AS 1141.41	- Polished aggregate friction value – Horizontal bed machine.
AS 1289	Methods of testing soils for engineering purposes.
AS 1289.3.1.1	- Liquid limit – Four point Casagrande method.
AS 1289.3.2.1	- Plastic limit – Standard method.
AS 1289.3.3.1	- Plasticity index.
AS 1289.3.4.1	- Linear shrinkage.
AS 1289.3.6.1	- Particle size distribution.
AS 1289.5.1.1	- Determination of the dry density/moisture content relationship – Standard compaction.
AS 1289.5.2.1	- Determination of the dry density/moisture content relationship - Modified compaction.
AS 1289.5.8.1	- Field density using a nuclear surface moisture-density gauge.
AS1289.5.4.1	- Soil compaction and density tests – Compaction control test – Dry density ratio, moisture variation and moisture ratio
AS 1289.6.1.1	- Determination of a California Bearing Ratio of a soil
AS 2341(set)	Methods of testing bitumen and related road making products.
AS/NZS 2341.2	- Dynamic viscosity (coefficient of shear) by flow through a capillary tube.
AS 2341.3	- Determination of kinematic viscosity by flow through a capillary tube.
AS/NZS 2341.4	- Determination of dynamic viscosity by rotational viscometer.
AS 2341.12	- Determination of penetration.
AS/NZS 2341.13	- Long-term exposure to heat and air.
AS 2891	Methods of sampling and testing asphalt.
AS/NZS 2891.3.1	Binder content and aggregate grading – Reflux method.
AS/NZS 2891.3.2	Binder content and aggregate grading – Centrifugal extraction method.
AS/NZS 2891.3.3	Binder content and aggregate grading – Pressure filter method.

AS/NZS 2891.5	Determination of stability and flow – Marshall procedure.
AS/NZS 2891.7.1	- Determination of maximum density of asphalt – Water displacement method
AS/NZS 2891.7.3	- Determination of maximum density of asphalt – Methylated spirit displacement
AS/NZS 2891.8	Voids and density relationships for compacted asphalt mixes.
AS/NZS 2891.9.1	Determination of bulk density of compacted asphalt - Waxing procedure.
AS/NZS 2891.9.2	Determination of bulk density of compacted asphalt - Presaturation method.
AS/NZS 2891.9.3	Determination of bulk density of compacted asphalt - Mensuration method.
AS 4049.3	Paints and related materials – Pavement marking materials Part 3: Waterborne paint – for use with surface applied glass beads.

NT CODES OF PRACTICE

NTCP 102.1	Testing field compaction for conformance
NTCP 103.1	Site selection by the stratified random technique.
NTCP 107.1A	Surface Roughness

NT TEST METHODS

NTTM 204.1	Cement content of stabilised materials – Heat of neutralisation
NTTM 204.7	Rate of spread of lime or cement
NTTM 204.8	Stabiliser distribution
NTTM 215.1	Standard ball penetration test
NTTM 216.1	Measurement of layer thickness
NTTM 304.1	Determination of skid resistance with the portable skid tester
NTTM 305.1	Determination of pavement surface texture depth - sand patch method
NTTM 404.1	Retroreflectivity testing of pavement marking
NTTM 404.3	Retroreflectivity testing of pavement marking – wet condition

AUSTROADS TEST METHODS

AGPT04H	Austroads Guide to Pavement Technology Part 4H: Test Methods
AGPT/T103	Pre-treatment and Loss on Heating of Bitumen Multigrade and polymer Binders (rolling thin film oven [RTFO] test)
AGPT/T111	Handling Viscosity of Polymer Modified Binders (Brookfield Thermosel)
AGPT/T112	Flash Point of Polymer Modified Binders
AGPT/T121	Shear Properties of Polymer Modified Binders (ARRB ELASTOMETER)
AGPT/T122	Torsional Recovery of Polymer Modified Binders
AGPT/T124	Toughness of Polymer Modified Binders (ARRB Extensiometer)
AGPT/T131	Softening Point of Polymer Modified Binders
AGPT/T231	Deformation Resistance of Asphalt Mixtures by the Wheel Tracking Test.

MAIN ROADS WESTERN AUSTRALIA, TEST METHODS

WA 730.1	Bitumen Content and Aggregate Grading.

5.3 SPECIFIC TESTS

Conduct field density testing using Nuclear Density Gauges in accordance with NTCP 102.1 and AS 1289.5.8.1.

Conduct CBR moulding using a compaction hammer conforming with the requirements of AS 1289.5.1.1 or AS 1289.5.2.1.

Where tests are required that are not included in the NTMTM, use the appropriate Australian Standard.

5.4 TESTING CONTRACTORS

The Developer must engage NATA accredited Testing Contractor(s) for all Conformance Testing.

5.5 ORDERING TESTING

When required, order the Conformance testing in writing from a NATA accredited Testing Contractor. Include on the order the following information:

- Test Lot boundaries including start and finish chainages, length and width
- Type of layer
- Type of tests required
- Date and time when Test Lot will be ready for testing

When Conformance Testing has been ordered and the relevant Development Works is not ready for testing or fails testing at the time specified by the Developer, the Developer will bear the cost of time and travel incurred by the Testing Contractor, Certifying Engineer and Relevant Authority, where applicable.

5.6 NOTICE OF TESTING

Provide the Relevant Authority and Certifying Engineer with the results of Process Testing as identified in the relevant ITP with all requests for Conformance Testing.

Documentation Point 20 – Provide notification of failed Test Lots prior to any rework being undertaken.

5.7 TABLES - TEST FREQUENCIES, CONFORMANCE TESTING

Test frequencies as per the following tables**.**

Table 5-1 - Test Frequencies For Soils – Part 1 of 3

Type Of Test	**Type A Fill**	**Type B Fill**	**Type C Fill / Sand Clay Fill**	**Embankment Fill**	**Subgrade**	**Sub-Base**	**Basecourse**
Field Density (FDD) by NTCP 102.1 and AS 1289.5.8.1.	1 in 2,500 m2 (min 3 tests)	1 in 2,500 m2 (min 3 tests)	1 in 2,500 m2 (min 3 tests)	1 in 300 m3	1 in 1,000 m2 (min 3 tests)	1 in 1,000 m2 (min 3 tests)	1 in 1,000 m2 (min 3 tests)
Modified Compaction (MMDD) by AS 1289.5.2.1	1 per FDD	1 per FDD	1 per FDD	1 per FDD	1 per FDD	1 per FDD	1 per FDD
Particle Size Distribution by AS 1289.3.6.1.	-	-	1 per each 2,000 m3	1 per each 1,000 m3	-	1 in 5000 m2 (min. 1 test)	1 in 5000 m2 (min. 1 test)
Plasticity Index by AS 1289.3.1.1, AS 1289.3.2.1, AS 1289.3.3.1	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 1,000 m3	1 in 5,000 m2 (min 1 test)	1 in 5000 m2 (min 1 test)	1 in 5000 m2 (min 1 test)
Linear Shrinkage by AS 1289.3.4.1	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 1,000 m3	1 in 5,000 m2 (min 1 test)	1 in 5000 m2 (min 1 test)	1 in 5000 m2 (min 1 test)
California Bearing Ratio by AS 1289.6.1.1	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 2,000 m3	1 per each 1,000 m3	1 in 5 FDD (min 1 test)	1 in 5 FDD (min 1 test)	1 in 5 FDD (min 1 test)
Emerson Class by AS 1289.3.8.1				1 per each 1,000 m3			
Pavement Layer Thickness by NTTM 216.1					-	1 per FDD	1 per FDD
Ball Penetration by NTTM 215.1					-	-	1 in 5,000 m2
Pavement Degree of Saturation prior to Sealing by AS 1289					-	-	1 in 5,000 m2
Stabiliser Spread Rate by NTTM 204.7					1 per run *	1 per run	1 per run
Stabiliser Content by NTTM 204.1					1 per 1000m2 (min 3 tests)	1 per 1000m2 (min 3 tests)	1 per 1000m2 (min 3 tests)
Stabiliser Distribution by NTTM 204.8					1 per 1000m2 (min 3 tests)	1 per 1000m2 (min 3 tests)	1 per 1000m2 (min 3 tests)
Soluble Salt Content of Construction Water					-	-	1 per source
Los Angeles Abrasion Value by AS 1141.23							1 per source

Notes:

Minimum number of tests, where specified, is applied per Test Lot.

For variable soil conditions, additional testing may be required.

FDD – Field Dry Density; MMDD – Maximum Modified Dry Density; Run = 1 pass of cement spreader

Table 5-2 - Test Frequencies For Soils – Part 2 of 3

Type Of Test	Unpaved Areas	Trench Foundation	Trench Backfill	Sand Bedding for Concrete Works	Culvert Bedding Material	Subsoil Filter Material
Field Density (FDD) by NTCP 102.1 and AS 1289.5.8.1	1 in 2,500 m2 (Min. 3 tests)	3 tests per 10 m3 (Min. 3 tests)	3 tests per 10 m3 (Min. 3 tests)	-	-	-
Modified Compaction (MMDD) by AS 1289.5.2.1	1 per FDD	1 per FDD	1 per FDD	-	-	-
Particle Size Distribution by AS 1289.3.6.1	-	1 per each 300 m3	1 per each 300 m3	1 in 250 t (Min. 3 tests)	1 in 250 t (Min. 3 tests)	1 in 250 t (Min. 3 tests)
Plasticity Index by AS 1289.3.1.1, AS 1289.3.2.1, AS 1289.3.3.1	1 per each 2,000 m3	1 per each 300 m3	1 per each 300 m3	1 in 250 t (Min. 3 tests)	-	-
Linear Shrinkage by AS 1289.3.4.1	1 per each 2,000 m3	1 per each 300 m3	1 per each 300 m3	1 in 250 t (Min. 3 tests)	-	-
California Bearing Ratio by AS 1289.6.1.1	1 per each 2,000 m3	1 per each 300 m3	1 per each 300 m3	-	-	-
Los Angeles Abrasion Value by AS 1141.23	-	-	-	1 per source	1 per source	1 per source

Notes:
Minimum number of tests, where specified, is applied per Test Lot.
For variable soil conditions, additional testing may be required.
FDD – Field Dry Density; MMDD – Maximum Modified Dry Density; Run = 1 pass of cement spreader

Table 5-5-3 - Test Frequencies for Soils - Part 3 of 3

Type of Test	Unpaved areas (including medians, batters, verges, table drains and blocks)
Field Density (FDD) by NTCP 102.1 and AS 1289.5.8.1	1 for every 100 lineal metres or part thereof
Modified Compaction (MMDD) by AS 1289.5.2.1	1 per each 3 FDD tests
Plasticity Index by AS 1289.3.1.1, AS 1289.3.2.1, AS 1289.3.3.1	For Table Drain blocks only - 1 per each 3 blocks

Table 5-4 – Maximum Dry Density (MDD) Minimum Curing Times (AS 1289.5.2.1:2017)		
Plasticity	**Condition of Prepared Sample**	
	Within 2% of OMC	**Greater than 2% from OMC**
Sands and Granular Material (NP)	2 hours	2 hours
Low Plasticity (LL ≤ 35%)	24 hours	48 hours
Medium Plasticity (LL > 35% to ≤ 50%)	48 hours	96 hours (4 days)
High Plasticity (LL > 50%)	96 hours (4 days)	168 hours (7 days)
NP – Non plastic LL – Liquid limit OMC – Optimum moisture content		

Table 5-5 – Test Frequencies for Bitumen Spray Sealing				
Test Method	**Property Tested**	**Cutback Bitumen/ Emulsions**	**Straight Run Binder**	**Polymer Modified Bitumen**
AS/NZS 2341.2 or AS 2341.3 or AS 2341.4	Dynamic Viscosity (60ºC)	1 per 15,000L	1 per 15,000L	-
	Dynamic Viscosity (135ºC)	-	1 per 15,000L	-
AS 2341.12	Penetration (25ºC)	-	1 per 15,000L	-
AG:PT/T121	Consistency (60ºC)	-	-	1 per 15,000L
AG:PT/T121	Stiffness at 15^{0}C (kPa)		-	1 per 15,000L
AG:PT/T111	Dynamic Viscosity (165ºC)	-	-	1 per 15,000L
AG:PT/T122	Torsional Recovery at 25ºC, 30s (%)	-	-	1 per 15,000L
AG:PT/T131	Softening Point (ºC)	-	1 per 15,000L	1 per 15,000L
AS/NZS 2341.13	Durability of base binder	1 per project	1 per project	
AG:PT/T112	Flash Point (ºC) min.	1 per project	1 per project	1 per project
AG:PT/T103	Loss on Heating (%mass) max.	1 per project	1 per project	1 per project
AG:PT/T124	Toughness at 4ºC, 100mm(Nm) min.	1 per project	1 per project	1 per project

Table 5-6 – Asphalt Testing Frequencies - During Works			
Test Method	**Test Method**	**Minimum Test Frequency**	
		Daily Production <100 tonnes	**Daily Production >100 tonnes**
-	Mixing temperature	Every mix	Every mix
-	Laying temperature	Every 30 minutes	Every 30 minutes
-	Asphalt surface temperature at commencement of compaction	Every Mix	Every mix
AS/NZS 2891.3 or WA730.1	Bitumen content	1 No.	1 per 100 t *
AS/NZS 2891.3 or WA730.1	Particle size distribution	1 No.	1 per 100 t *
AS/NZS 2891.5	Stability	1 No.	1 per 100 t *
AS/NZS 2891.5	Flow	1 No.	1 per 100 t *
AS/NZSSS2891.7.1 AS/NZSSS2891.7.3	Maximum Density	1 No.	1 per 100 t *
AS 2341.3	Viscosity of Binder	1 per work shift	1 per work shift
* One test per nominated tonnage or part thereof.			

All sampling is to be performed at the plant from safe sampling platforms.

Binder sampling is to be conducted on the binder in actual use, either at transfer to the bitumen tank on the asphalt plant or from the tank itself.

Table 5-7 – Asphalt Testing Frequencies – After Works Completed		
Test Method	**Test Method**	**Frequency**
AS 2891	Thickness of layer	1 per core
AS/NZS 2891.8	Air Voids of compacted asphalt layer	1 per core
AS/NZS 2891.9	In-situ Density	1 per core
AGPT04H – AGPT/T231	Wheel track testing (composite sample)	1 per Type or 1 per 1000 t

Carry out density testing as soon as practicable after completion of works.

Do not test within 200 mm of an edge and longitudinal joint and within 1 metre of a transverse joint. Do not test odd shaped areas completed by hand placing of asphalt.

Conform to the following number of cores per Test Lot.

Table 5-8 – Number of Cores per Test Lot			
Area (m2)	<100	100 – 1500	>1500
No. of Cores	1	Minimum 3	1 per 500m2 (minimum 3)

Reinstate core holes by:

- Removing waste/debris and moisture from the core hole;
- Tack coating the hole with bitumen emulsion, applied by spray or brush; and
- Filling the hole with hot mix asphalt, compacted in lifts to conform with surrounding materials.

Table 5-9 - Test Frequencies for Aggregates and Pavement Surfaces			
Type of Test	**Aggregate**	**Pavement Marking**	**Pavement Surface**
Particle Size Distribution by AS 1141.11	1 in 250 t (Minimum of 3)	-	-
Los Angeles Abrasion Value by AS 1141.23	1 in 250 t	-	-
Particle Shape by AS 1141.14 at 2:1 ratio	1 in 250 t	-	-
Flakiness Index by AS 1141.15	1 in 250 t (Minimum of 3)	-	-
Average Least Dimension by AS 1141.20.1, AS 1141.2 *	1 in 250 t (Minimum of 3)	-	-
Sulphate Soundness by AS 1141.24	1 in 1,000 t	-	-
Percentage of Crushed Faces by AS 1141.18	1 in 250 t	-	-
Polished Aggregate Friction Value by AS 1141.40 or AS 1141.41	-	-	1 in 20,000 m2
Surface Texture Depth by NTTM 305.1	-	-	1 in 5,000 m2
Skid Resistance by NTTM 304.1	-	-	As nominated by Relevant Authority
Roughness	-	-	As nominated by Relevant Authority
Retroreflectivity of Pavement Marking by NTTM 404.1 & NTTM 404.3	-	1 per 1,000 lin. m	-
Wear Assessment of Road Marking Paints – Image Analysis to AS 4049.3:2005 Appendix K, Method A Photographic Method	-	As nominated by Relevant Authority	-
* Take Average Least Dimension samples only from the stockpile on the project site.			

Table 5-10 - Test Frequencies for Surface Roughness Testing		
Type of test	**Frequency**	**Required value (IRI)**
Lane Roughness Value – Pavement and Shoulders – NTCP 107.1A	3 runs per constructed traffic lane	Maximum value
Test Lot Average Surface Roughness Value – Dense Graded Asphalt – NTCP 107.1A	3 runs per constructed traffic lane	Mean value

Table 5-11 - Sampling Frequencies For Fresh Concrete		
Type of Test	**Frequency**	**Number of samples**
Slump - AS 1012.3	Per truck	Per truck as required
Making, curing and compressive strength of concrete - AS 1012.8 and AS 1012.9	1 truck pour	1 set of cylinders *
	2 truck pour	2 sets of cylinders *
	3 - 5 truck pour	3 sets of cylinders *
	6 - 10 truck pour	4 sets of cylinders *
	11+ truck pour	4 sets of cylinders plus 1 additional set of cylinders per every additional 1 to 5 trucks after the first 10 trucks *
Kerbs and Gutters, Inverts, Drainage Structures, Floodway Margins		
Type of Test	**Frequency**	**Number of samples**
Slump - AS 1012.3	Per each set of cylinders **	Per each set of cylinders
Making, curing and compressive strength of concrete - AS 1012.8 and AS 1012.9	1 set of cylinders per 25m3 , or each Test Lot. **	1 set of cylinders *
* A set of cylinders consists of 3 cylinders unless directed otherwise. ** Or as directed by the Relevant Authority.		

Table 5-12 - Test Frequencies for Surface Roughness Testing		
Type of test	**Frequency**	**Required value (IRI)**
Lane Roughness Value – Pavement and Shoulders – NTCP 107.1A	3 runs per constructed traffic lane	Maximum value
Lot Average Surface Roughness Value – Dense Graded Asphalt – NTCP 107.1A	3 runs per constructed traffic lane	Mean value

Table 5-13 - Maximum Dry Density (MDD) Minimum Curing Times (AS 1289.5.2.1:2017)		
Plasticity	**Condition of Prepared Sample**	
	Within 2% of OMC	**Greater than 2% from OMC**
Sands and Granular Material (NP)	2 hours	2 hours
Low Plasticity (LL ≤ 35%)	24 hours	48 hours
Medium Plasticity (LL > 35% to ≤ 50%)	48 hours	96 hours (4 days)
High Plasticity (LL > 50%)	96 hours (4 days)	168 hours (7 days)
NP – Non plastic LL – Liquid limit OMC – Optimum moisture content		

5.8 CONFORMANCE TESTING RESULTS

5.8.1 Test Lot Testing

Conformance of compaction will be based on Test Lots.

Give each Test Lot a number. Number the Test Lots using a logical system to be agreed with the Certifying Engineer. Maintain a register of all Test Lots and Test Lot numbers. Include the location of each Test Lot on the Test Lot register. Provide a copy of the Test Lot register to the Relevant Authority and Certifying Engineer upon request.

Test Lots defined by the Developer must be clearly marked out on the Development Site.

Test Lots of work must be agreed between the Developer and Certifying Engineer, based upon:

- A Test Lot will represent no more than one work shift's production.
- A Test Lot will be continuous and will have been brought to completion at the same time.
- A Test Lot will be composed of essentially homogeneous material with no distinct changes in attribute values.

Each Test Lot will be subject to Conformance Testing in accordance with NTCP 102.1.

Defective sections will be excluded from the Test Lot to be tested and identified as a separate Test Lot, and will also be subjected to Test Lot testing.

Quality of the Test Lot will be judged as conformance or non-conformance of each Test Lot. This will be based on all tests conducted on the Test Lot in accordance with NTCP 102.1.

Conformance of materials is based on samples from the finished works.

When Test Lots fail to satisfy the conformance criteria, reprocess the entire Test Lot and resubmit for retesting.

Should the Test Lot under consideration be subdivided, then each subdivision will be classed as a Test Lot and each subdivided Test Lot will be subject to Test Lot testing.

Non-conforming Test Lots which are subdivided after testing will be treated as separate Test Lots and each and every subdivided Test Lot will be retested.

5.8.2 Conformance of Compaction of Soils

In situ density is expressed as a percentage of the Maximum Modified Dry Density. One Modified Dry Density test for each in situ density test will apply.

In situ density will be determined and reported in accordance with NTCP 102.1 and relevant Australian Standards.

A minimum of three tests will apply to each and every Test Lot.

The Mean Dry Density Ratio (R) is calculated as follows:

$$R = \frac{\sum x_i}{n}$$

xi = an individual test result

n = the number of results in the Test Lot.

The Characteristic Mean Dry Density Ratio (*Rc*) is calculated as follows:

$$R_c = R - k * s$$

where:

R = the mean dry density ratio for the Test Lot

k = the multiplier in *Table 5-15 – Multiplier Values for Soils***.**

s = the standard deviation.

The Standard Deviation (s) is calculated as follows:

$$s = \sqrt{\frac{\sum (x_i - R)^2}{(n-1)}}$$

where:

xi = an individual test result

R = the mean of n results

N = the number of test results in the Test Lot.

When less than six tests are used to determine conformance of a Test Lot, the Mean Dry Density Ratios in Table 5-14 – Dry Density Ratios for Conformance, Column A apply.

When six or more tests are used to determine conformance of a Test Lot, the Characteristic Mean Dry Density Ratios in Table 5-14 – Dry Density Ratios for Conformance**,** Column B, apply.

5.8.3 Conformance of Compaction of Asphalt

Air Voids Ratio is the difference between the maximum density of a mix and the bulk density of that compacted mix expressed as a percentage of the maximum density.

A minimum of three tests will apply for each Test Lot greater than 100m².

The Characteristic Air Voids Ratio is calculated as follows:

$$R = \frac{\sum x_i}{n}$$

xi = an individual test result

n = the number of results in the Test Lot.

Table 5-14 – Dry Density Ratios for Conformance

Works Components	A Mean Dry Density Ratio (R) % ("n" is 3 to 5)	B Characteristic Mean Dry Density Ratio (Rc) % ("n" is 6 or greater)	
Allotment Fill Embankment Fill Fill in Road Reserves Fill under Buildings Pavement Subgrade [1] Pavement Shoulders Unpaved Areas Unsealed Sub-Base Unsealed Basecourse	95.0 or greater	94.0 or greater	Conformance
	94.9 or less	93.9 or less	Non-conformance
Sealed Pavement Basecourse [2]	100.0 or greater	99.0 or greater	Conformance
	99.9 or less	98.9 or less	Non-conformance
Sealed Pavement Sub-Base [2] Stabilised and Modified Basecourse	98.0 or greater	97.0 or greater	Conformance
	97.9 or less	96.9 or less	Non-conformance

1. Subgrade placed against an existing pavement is to be compacted to 98% MMDD.
2. Pavement layers are considered 'Sealed' if they include a Spray Seal and/or asphalt wearing surface.
3. Backfill all test excavations with the material and density ratio specified for that layer, treated as follows:
   - Base and Sub-Base Layers: stabilised with at least 3% cement (by mass).
   - Other Layers: unstabilised.

Table 5-15 – Multiplier Values for Soils

Values of the Multiplier k for Characteristic Mean Dry Density Ratio (Rc)

Number of tests per Test Lot (n)	k
6	0.50
7	0.54
8	0.56
9	0.59
10	0.61
15	0.68
20	0.72

6. PAVEMENTS AND SHOULDERS

6.1 STANDARDS

Conform to the following standards and publications unless specified otherwise:

AS 1141 (set)	Methods for sampling and testing aggregates.
AS 1289 (set)	Methods of testing soils for engineering purposes.
NTCP 107.1A	Surface Roughness
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods

6.2 MATERIAL PROPERTIES

6.2.1 Natural Gravel

Only use where permitted.

Obtain natural gravel from sources of naturally occurring deposits.

Produce required properties by crushing, screening, mixing or other processes necessary.

Ensure particles are tough, durable and of a tightly binding nature free of organic or other deleterious materials.

Conform to *Table 6-1 - Natural Gravel Particle Sizes* and *Table 6-2 - Natural Gravel Properties* in the finished condition.

6.2.2 Fine Crushed Rock (FCR)

Manufacture from hard rock quarry operations by crushing clean, hard, durable rock free from natural gravel, clay, loam or other deleterious substances.

Conform to *Table 6-3 – Fine Crushed Rock Particle Sizes* and *Table 6-4 – Fine Crushed Rock Properties* in the finished condition.

6.2.3 Blends of Natural Gravel and Fine Crushed Rock

Not permitted for Sealed Pavements without written approval from the Relevant Authority.

6.2.4 Sand Clay

Obtain Sand Clay from sources of naturally occurring deposits.

Produce required properties by screening, mixing or other processes necessary, to produce a material of a tightly bound nature, free of organic or other deleterious materials.

Conform to the requirements of *Table 6-5 – Sand Clay - Grading* and *Table 6-6 – Sand Clay - Properties* in the finished condition.

Table 6-1 - Natural Gravel Particle Sizes

AS Sieve (mm)	Percentage Passing			
	Type 1	**Type 2**	**Type 3**	**Type 4**
75.0	100	-	-	100
37.5	80-100	100	-	80-100
19.0	50-80	70-100	100	60-100
9.5	35-65	50-80	70-100	50-95
4.75	25-50	35-65	50-80	40-80
2.36	15-40	25-50	35-65	30-65
0.425	7-20	10-30	15-35	20-50
0.075	3-13	4-16	6-20	5-25

Refer to Construction Drawings for types to be used. Generally as follows:

- Type 2 or Type 3 for Basecourse (Sealed/Unsealed)
- Type 1, Type 2, Type 3 or Type 4 for Sub-Base
- Type 3 for Shoulder Material.

Table 6-2 - Natural Gravel Properties				
Attribute	**Application**			
	Sealed Basecourse		**Unsealed Basecourse and Unsealed Shoulder Material**	**Sub-Base**
	Monsoonal North	**Tablelands**		
Liquid Limit (LL)	25% max	30%	35% max	30% max
Plasticity Index (PI)	1-6%	1 - 10%	4 – 12 %	1-10%
Linear Shrinkage (LS)	0-3%	0 - 6%	2 – 8 %	0-6%
PI x % passing 0.425 mm Sieve	180 max	300 max	400 max	400 max
California Bearing Ratio (CBR) 4 day soaked (AS 1289)	80 min	80 min	50 min	30 min
at a relative density of:	100% MMDD	100% MMDD	95% MMDD	95% MMDD
Los Angeles Abrasion (LAA) Loss	50 max	50 max	60 max	60 max
Refer Part 1 – *Subdivision Development Guidelines* for Localities across the Northern Territory including illustration of 'Monsoonal North' and 'Tablelands' climatic regions.				

Table 6-3 – Fine Crushed Rock Particle Sizes	
AS Sieve (mm)	**Percentage Passing**
37.5	100
19.0	90 - 100
13.2	75 - 90
9.5	60 - 80
4.75	38 - 60
2.36	25 - 45
0.425	12 - 26
0.075	6 - 14

Table 6-4 – Fine Crushed Rock Properties	
Property	**Value Limit(s)**
Liquid Limit (LL)	25% max.
Plasticity Index (PI)	1 - 6%
Linear Shrinkage (LS)	3% max.
Dust Ratio (DR) (% passing 0.075 mm)/(% passing 0.425 mm) x 100	25 - 50
CBR, 4 day soaked at 100% MMDD at 2.5 mm penetration (AS 1289)	100 min.
Los Angeles Abrasion (LAA) Loss: – Coarse Grained Aggregate – Fine Grained Aggregate	 35% max. 25% max.
PI x % passing 0.425 mm sieve	180 max.

Table 6-5 – Sand Clay - Grading	
AS Sieve (mm)	Percentage Passing
4.75	80 - 100
2.36	60 - 100
0.425	30 - 60
0.075	14 - 28

Table 6-6 – Sand Clay - Properties	
Plasticity Index (PI):	20% maximum for Sealed streets; 15% maximum for unsealed streets.
Linear Shrinkage (LS):	1% - 8%.
CBR: 4 day soaked at 95% MMDD to AS 1289.	50 minimum

6.3 CONSTRUCTION OF PAVEMENT LAYERS

6.3.1 Process Testing

Undertake Process Testing in Test Lots and comply with *Clause 5.8.2 - Conformance of Compaction of Soils.*

Include the following activities, as applicable:

- Borrow Pit investigative sampling, on a grid basis
- Borrow Pit confirmatory sampling, on a windrow/ stockpile basis
- On-formation testing, on a Test Lot basis.

Include the following elements of the Development Work in the Process Testing program as applicable;

- Fill
- Sub-grade
- Sub-Base
- Basecourse
- Shoulders
- Stabilisation

Rework and retest failed Test Lots a maximum of two times subsequent to an initial test failure.

Following a third test failure rip up, remove and replace the entire failed layer before carrying out any further testing.

Where relevant, provide additional Process Testing procedures for concrete, bitumen and other elements subject to Conformance Testing.

Refer to *Section 5 - Conformance Testing.*

6.3.2 Production of Natural Gravel and Sand Clay Materials

Work Borrow Pits to achieve conforming material. Control depth of winning to avoid contamination of gravel.

Screen, blend and condition materials to achieve specified material property requirements.

6.3.3 On-formation Mixing and Placing

Place material in uniform layers over Subgrade Surface or lower layers of the Pavement.

Remove segregated and contaminated material from the Development Site.

Remove deleterious materials, rocks, refuse and organic materials such as timber, branches, roots and the like by manual stick picking methods.

Do not place material on a previous layer that has:

- become waterlogged or cracked; and/or
- otherwise deteriorated.

Mix the material uniformly throughout with water to achieve a moisture content within 2% of the optimum moisture content (OMC) and the specified conforming Dry Density Ratio.

Ensure water is clean and free from oil, alkali, organic matter and other deleterious substances, and that it conforms to:

- a total soluble salts content of less than 3,000 mg/litre (total dissolved salts), and
- 1% maximum by mass of undissolved solids, in accordance with AS 3550.4

Documentation Point 21 – Where non-potable water supplies are used for pavements, submit evidence of required water quality of the proposed source.

6.3.4 Compaction

Compact in uniform layers not less than 100 mm nor greater than 200 mm compacted thickness.

Achieve a homogeneous mass with no compaction planes.

Conform to the Dry Density Ratios specified in *Table 5-14 – Dry Density Ratios for Conformance.*

Maintain the prepared pavement layer.

6.4 SUPPLY TO STOCKPILE

Comply with Approved Construction Environmental Management Plan (CEMP), including Erosion and Sediment Control Plan (ESCP). The stockpile area must comply with the following requirements;

- Clear and grade the area to ensure free draining.
- Spread and compact a 75 mm thick layer of Sub-Base to 95% Relative Compaction.

6.5 PAVEMENT ACCEPTANCE

6.5.1 Pavement Acceptance Requirements

Documentation Point 22 – Obtain approval for Pavement and Shoulders acceptance prior to any surfacing work, including satisfying all requirements for:

- Proof rolling
- Conformance testing
- Dry back
- Final Pavement layer integrity
- Surface roughness
- Other tolerances

For unsealed Pavements, obtain approval for Pavement conformance at conclusion of Pavement works.

6.5.2 Proof Rolling

Inspection Point 15 - Proof roll and obtain approval for all areas of final Pavement surface prior to commencing surfacing works.

Conform to the Approved procedure, as outlined in *Clause 4.11.2 – Proof Rolling.*

6.5.3 Conformance Testing

Refer to the Conformance Testing section for testing requirements.

Only the finished compacted Basecourse, Sub-Base and Shoulder conforming to proof rolling, level tolerance and layer thickness should be tested.

Pavements and Shoulders must be considered as separate Test Lots.

Backfill and compact all test holes in accordance with *Section 5 – Conformance Testing*.

Remedial work; rework or reconstruct areas that do not conform.

6.5.4 Surface Roughness Requirement

Surface roughness testing is to be carried out in accordance with NTCP107.1A, as directed by the Relevant Authority.

Where required, comply with the following.

Table 6-7 - Surface Roughness Tolerances	
Surface Roughness (IRI) to be less than the following limits when surveyed at 50km/hr.	
Street Classification	**Max. Surface Roughness IRI (m/km)**
Minor, Access	4.2
Secondary Collector, Primary Collector	3.4

Surface roughness tolerances represent an absolute upper limit and all lane roughness values must be less than the values specified.

Test Lotting and averaging out of field values is not permitted.

Rectify all areas where Surface Roughness exceeds specified values.

Where required, roughness testing must be collected within 7 days of completion of testing of the Basecourse.

Ensure that the Pavement and/or wearing surface is free of loose material, debris and standing water when testing is undertaken.

The following areas are excluded from the requirement to achieve specified IRI limits:

- Roundabouts;
- Railway lines (35 m after the event);
- Bridge joints (35 m after the event);
- Intersections (stop bar to stop bar);
- Inspection pit covers and related surface Defects within the wheel paths (15 m including the event);
- Surface Defects related to existing Culverts which are not part of the works (width of Culvert plus 30 m after the event); and
- Cattle grids.

In these locations, the additional requirements of *Clause 6.5.8 - Other Tolerance Requirements* still apply. Undertake best efforts to achieve a smooth ride to minimise driver discomfort in the finished condition.

6.5.5 Final Pavement Layer Integrity Requirement

Final Pavement layers must be homogeneous in appearance, uniformly bonded, free from layering, cracking, disintegration or surface tearing, uniformly hard and dense, free of laminations and roller indentations, with the coarse fraction slightly exposed.

The Pavement layer must retain these characteristics after sweeping/brooming and be suitable to receive bituminous surfacing.

Slurried up surfaces are not permitted.

Remove sticks and any loose material.

Do not introduce new material to the Pavement surface after final compaction.

Remedial work; remove and reconstruct areas that do not conform.

Ball Penetration testing to conform to *Clause - 6.5.8 - Other Tolerance Requirements*.

6.5.6 Dry Back Requirement

Allow the top 75 mm of the Pavement layer to dry back to a Moisture Ratio (Rm) equal or less than 65% for FCR and 70% for natural gravel.

Moisture Ratio (Rm) is defined as follows:

$$Rm = \frac{(100 \times wf)}{wr}$$

where:

Rm = Moisture Ratio, in percent

wf = field moisture content, in percent

wr = adjusted optimum moisture content, in percent.

The Developer must carry out all testing to determine the Moisture Ratio.

6.5.7 Remedial Work

Where Pavement thickness is 200 mm or greater, scarify to not less than 100 mm depth and recompact where finish not achieved. Where Pavement thickness is less than 200 mm scarify and recompact to full depth where finish not achieved.

6.5.8 Other Tolerance Requirements

Compliance with dimensional tolerances must be confirmed using engineering survey and captured in As-Constructed Drawings.

Refer to *Clause 1.19 - Level Checking, Clause 1.20 - Level Auditing,* and *Clause 1.23 As-Constructed Drawings.*

Comply with the following Final Surfaces Tolerances.

Grade new or rehabilitation works abutting existing works to prevent ponding of water.

Table 6-8 - Final Surfaces Tolerances	
ALL PAVEMENT TYPES	
Test Parameter	Tolerance
Straight Edge Deviation	5 mm in 3 m
Compacted Thickness	Not less than specified
Width	Not less than specified
Surface Roughness	Not more than specified in *Table 6-7 - Surface Roughness Tolerances.*

Ball Penetration Test (before Priming)	Less than or equal to 3 mm, for any individual test result (averaging not permitted) Not required for asphalt surfacing, when thickness 50 mm or greater.
KERBED PAVEMENTS	
Test Parameter	**Tolerance**
Kerb Level	-0 mm to +10 mm
Asphalt Level	-0 mm to +10 mm
Basecourse Surface Level	-5 mm to +10 mm
Sub-base Surface Level	-10 mm to +10 mm
Sub-grade Surface Level	Refer to *Section 1 – Earthworks.*
New works and rehabilitation works - abutting existing works – at junction	0 mm
UNKERBED PAVEMENTS	
Test Parameter	**Tolerance**
Basecourse Surface Level – for new works – compared to design levels across full extent of works	-20 mm to +20 mm
Base surface level – for new works and rehabilitation works - abutting existing works – at junction	0 mm

Table 6-9 - Relative height tolerances for new works abutting existing works

Pavement Type		**Abutting surfaces to be aligned**		**Tolerance**
Existing	**New abutting works**	**Existing**	**New abutting works**	
Unsealed	Unsealed	Pavement top	Pavement top	0 mm
Sealed - no reseal	Unsealed	Top surface of seal	Top surface of unsealed new works	0 mm
Sealed - no reseal	Sealed – single coat	Top surface of seal	Top surface of sealed new works	0 mm
Sealed - no reseal	Sealed – two coats	Top surface of seal	Top surface of seal	0 mm
Sealed – with reseal – one coat	Sealed – new and/or reseal – two coats	Top surface of existing seal	Top surface of second coat of seal	0 mm
Sealed – with reseal – two coats	Sealed – new and/or reseal	Top surface of first coat of reseal	Top surface of second coat of seal	0 mm

Notes:

- Cross fall of new works abutting existing works must be the same as, and aligned with, the cross fall of the abutting existing works.
- *There must be no inverts, nor any crests, at the junctions of the new works with the existing works.*
- *Abutting new works must be graded to prevent the ponding of water.*
- *If an existing sealed traffic lane surface is resealed with two coats the second coat may overlap an abutting sealed surface if it is not a traffic lane.*

7. STABILISATION AND MODIFICATION

7.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1141	Methods for sampling and testing aggregates.
AS 1160	Bitumen emulsions for construction and maintenance of pavements.
AS 1289 (set)	Method of testing soils for engineering purposes.
AS 1478.1	Chemical admixtures for use in concrete.
AS 1672.1	Limes and limestones - Limes for building.
AS 2157	Cutback bitumen.
AS 3972	General purpose and blended cements.
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods

7.2 MATERIALS

7.2.1 Binders

Lime

Use Calcium Hydroxide (hydrated lime/lime slurry), as Ca(OH)2 .

Obtain Relevant Authority's approval for use of Calcium Oxide (quicklime), as CaO.

Do not use dolomite limes (CaMg(CO3)2). Do not use agricultural lime (Calcium Carbonate (CaCO3)).

Conform to AS 1672.1

Cement

Use type GP (general purpose portland cement) or GB (general purpose blended cement).

Supply and store in a manner that protects against the weather and moisture.

Conform to AS 3972.

Bitumen

Conform to bitumen classes in *Section 8 – Spray Sealing* clauses for straight run and emulsion grades.

7.2.2 Granular Modification

For Pavement layers, final blended material to conform to requirements of *Section 6 - Pavements and Shoulders* clauses in the finished condition.

For Subgrade and fill layers, final blended material to conform to requirements of *Section 1 - Earthworks* clauses in the finished condition.

7.2.3 Additives

Documentation Point 23 – Obtain approval for stabilisation and modification additive use.

Follow manufacturer's recommendations when using retarders and water reducing additives.

7.2.4 Water

Ensure water is clean and free from oil, alkali, organic matter and other deleterious substances, and that it conforms to:

- a total soluble salts content of less than 3,000 mg/litre (total dissolved salts), and
- 1% maximum by mass of undissolved solids, in accordance with AS 3550.4

Documentation Point 24 – Where non-potable water supplies are used for stabilised and/or modified pavements, submit evidence of required water quality of the proposed source.

7.2.5 Materials to be Stabilised

Refer to Construction Drawings for details of materials to be stabilised.

7.3 IN SITU STABILISATION

7.3.1 Binder Application Rate

Refer to the Construction Drawings for binder application rate to be used.

7.3.2 Preliminary Trial

This clause applies only for Subdivisions involving greater than 1000 m2 in treated area.

Locate trial section within the Development Site.

Carry out a preliminary trial of the proposed operation to determine:

- effectiveness of mechanical plant;
- passes necessary to achieve the specified mixing;
- optimum curing time between preliminary and final mixing (lime stabiliser only); and
- field moisture content and plant pattern to achieve final compaction.

Carry out all necessary process control testing for this purpose.

Conform to Dry Density Ratios specified in *Table 5-14 – Dry Density Ratios for Conformance*.

7.3.3 Preparation of Layer

Scarify existing Pavement sections and new material, where necessary, full depth before spreading binder or granular modifier.

Tyne the surface lightly when quicklime is used.

Compact lightly to reveal irregularities in the spread material and to permit the stabilising equipment to traverse the area without excessive displacement of the surface.

Shape and trim the surface to the alignment, levels and cross-sections necessary to produce the final levels and compacted thickness.

7.3.4 Commencement and Continuity of Work

Complete full width Stabilisation in one Business Day.

Cease stabilising during the following conditions:

- Wet weather, or if rain is likely to fall.
- Windy periods which could cause loss of stabiliser, or dust Nuisance.

7.3.5 Binder Spreading

Field Application Rates

The Developer is responsible for determining the binder field application rate.

Use Process Control Testing, in accordance with NTTM 204.7 (with project field samples, source binder and field water) to determine field application rate, for layer specified, to achieve the following:

Table 7-1 – Binder Tolerances	
Element Assessed	**Parameters**
Cement Stabilised Layer (Bound)	UCS between 1.5 and 2.0 MPa
Cement Modified Layer	UCS between 0.7 and 1.5 MPa
Lime Modified Layer	Lime demand test to determine quantity to reduce Plasticity Index and increase CBR to limits in Pavements and Shoulders for natural gravel.

Documentation Point 25 – Obtain approval for binder field application rates in stabilised and/or modified pavements for each source material, prior to commencing stabilisation and/or modification works.

Spreading Requirements

Calibrate mechanical spreader and check spread rate prior to commencement.

Spreading must be visually uniform throughout each spreader run.

Documentation Point 26 – Obtain approval for bag spotting and spreading, prior to use in the relevant Development Works.

Quicklime

Water the spread material sufficiently to allow full slaking.

Avoid overwatering and avoid underwatering.

Lime Slurry

Initial mixing in separate paddle mixer or similar.

Use mechanical sprayer with agitation to maintain a lime/water ratio within ±10% of initial ratio.

Lime/water ratio to be between 1:2 and 1:0.8 (by mass) equivalent to 1 tonne of hydrated lime mixed with 2,000 and 800 litres of water respectively.

7.3.6 Binder Mixing

Use plant capable of:

- mixing the binder with the nominated layer of material uniformly over the full depth to be treated; and
- adding water uniformly to the materials while mixing with application rate between 0 to 10% (by mass) of the material being mixed.

Resultant mix to be uniform in colour and free of lenses, pockets or clumps of binder.

Prevent segregation.

Pulverise clayey material until at least 90% passes 19 mm sieve.

Add water to the materials during mixing to achieve Optimum Moisture Content.

Documentation Point 27 – Obtain approval for the use of rotary hoes or graders to mix binders in small scopes of stabilisation and/or modification works.

Cement Treated Layers

Commence compaction and finishing immediately following satisfactory mixing.

Lime Treated Layers

Shape the treated layer to the approximate cross-section after satisfactory mixing and lightly compact.

Cure for a period of 24 to 72 hours.

Commence final mixing.

Add water during mixing to achieve Optimum Moisture Content.

Resultant mix to be uniform in colour and free of lenses, pockets or clumps of lime.

7.3.7 Granular Modification

The Developer is responsible for determining the blending ratios of materials to achieve the requirements of the *Section 6 – Pavements and Shoulders* clauses, in the finished condition.

Use Process Testing.

Documentation Point 28 – Obtain approval for the blending ratios of granular modified materials, based on laboratory testing.

7.3.8 Compaction

Compact parallel to the centre line of the Pavement and for the full depth of the treated layer.

Commence compaction at the lower edge of the Pavement and work progressively towards the crown or the higher edge.

Allow for progressive and uniform overlap between passes.

Wet the surface lightly after compaction to reduce moisture loss and lay the dust when necessary.

Cement Stabilisation

Complete the mixing, compacting and finishing within two hours of adding binder and water, or within working time limits, whichever is the lesser.

7.3.9 Finishing

Final surface must be smooth, dense, closely knit, free from compaction planes and cracks and finished to the tolerances specified.

Filling or addition of material to the surface of the Pavement to meet tolerance requirements will not be permitted.

Maintain the surface material at not less than its specified Optimum Moisture Content during all finishing operations.

Reconstruct non-complying areas.

7.3.10 Construction Joints

Longitudinal Joints

Minimise longitudinal joints by stabilising the full width of traffic lanes or wider as one continuous operation.

Joints to be straight or follow street curvature as appropriate.

Transverse Joints

Form joints following any break in excess of two hours in the continuity of the Stabilisation operations.

Cut the end of the material to a plane face at an angle not exceeding 45 degrees from the vertical.

Check the surface adjacent to the joint with a straight edge prior to recommencement and further cut back the joint as necessary to achieve surface tolerance.

7.3.11 Curing of Cement Treated Layers

For cement treated layers (stabilised or modified), cure using either of the following methods:

- Keep the finished surface damp (without leaching) until further construction or other curing operations are carried out.
- Alternatively cure by applying a bitumen emulsion or a bitumen primer as specified.

For bituminous curing, apply the bituminous curing membrane as soon as possible after mixing and compaction but no later than 24 hours after Relative Compaction results are available.

Use:

- Bitumen emulsion ARS Grade 320, or
- Cut-back bitumen Class AMC 2 or Class AMC 3.

Application rate for bitumen emulsions to be 0.3 to 0.45 litres per square metre.

Maintain clear of vehicular traffic for four Calendar Days following application of bitumen emulsions.

7.4 PLANT MIX STABILISATION

7.4.1 Binder Application Rate

Refer to the Construction Drawings for binder application rate to be used.

7.4.2 Preliminary Trial

This clause applies only for Subdivisions involving greater than 1000 m2 in treated area.

Locate trial section within the Development Site.

Carry out a preliminary trial of the proposed operation to determine:

- effectiveness of mechanical plant; and
- field moisture content and plant pattern to achieve final compaction.

Test stabilised material for conformance with *Table 5-14 – Dry Density Ratios for Conformance* in Conformance Testing.

7.4.3 Commencement and Continuity of Work

Complete full width Stabilisation of Pavement in one Business Day.

Do not stabilise during wet weather, or if rain is likely to fall.

7.4.4 Care of Existing Surface

Avoid damage to existing surface on which the mix is placed.

Repair any damage.

7.4.5 Mixing

Mixing plant to be capable of maintaining the mix proportions.

Add cement and water to material to be stabilised and mix for a minimum period of 30 seconds.

Material to be uniform and without segregation.

Batch Mixer

Scales used for weighing cement for batching plants must be used solely for that purpose.

Proportion the dry materials by mass.

Continuous Mixer

Proportion the dry materials by volume. Use a continuous feeder which allows feed rate

of different aggregate sizes to be adjusted separately.

7.4.6 Delivery

Minimise segregation during loading and unloading and discharge directly into the hoppers of paving machines without spillage.

Provide open trucks with tarpaulins.

7.4.7 Laying

Paving Machine

Deposit and spread the Pavement material in one operation using self-propelled mechanical tamper-spreader.

Lay material uniformly without segregation to produce a uniform surface texture and required thickness.

Grader Laying

To be used on minor work only, where Approved by the Relevant Authority.

Spread the material in one layer not less than 75 mm nor more than 200 mm compacted thickness.

7.4.8 Compaction, Finishing, Construction Joints and Curing

Conform to the requirements specified for in-situ Stabilisation.

7.5 CONFORMANCE

7.5.1 Tolerances

For stabilised layers conform to the tolerances specified in *Section 6 – Pavements and Shoulders*, and with *Table 7-3 – Stabilised and Modified Layers Conformance***.**

7.5.2 Conformance Testing

Binder Application Rate

The Developer is responsible for checking the application rate.

Determine the stabiliser application rate in accordance with NTTM 204.7.

Refer to Conformance Testing for Test Frequencies.

Correct application deficiencies by the application of additional stabiliser and remixing if mixing has already commenced.

Stabiliser Content

The Developer must carry out Conformance Testing of the layers in the finished condition.

Compaction

The Developer must carry out Conformance Testing.

Check areas for level tolerance and layer thickness before testing.

Only the finished compacted Pavement complying with level tolerance and layer thickness is to be tested.

Dry Density Ratios must be determined 24 hours after final compaction.

Backfill test holes within 24 hours of testing with new stabilised material.

Inspection Point 16 – Obtain approval for conformance of stabilized or modified layer prior to commencing surfacing works.

7.5.3 Surface Roughness Requirement

Surface roughness testing is to be carried out as directed by the Relevant Authority. Where required, comply with the following.

Table 7-2 - Surface Roughness Tolerances

Surface Roughness (IRI) to be less than the following limits when surveyed at 50km/hr.

Street Classification	**Max. Surface Roughness IRI (m/km)**
Minor, Access	4.2
Secondary Collector, Primary Collector	3.4

Surface roughness tolerances represent an absolute upper limit and all field values must be less than the values specified.

Test Lotting and averaging out of field values is not permitted.

As a minimum, data must be collected before application and after completion of the final wearing surface.

Ensure that the Pavement and/or wearing surface is free of loose material, debris and standing water when testing is undertaken.

Rectify all areas where Surface Roughness exceeds specified level.

The following areas are excluded from the requirement to achieve specified IRI limits:

- Roundabouts;
- Railway lines (35 m after the event);
- Bridge joints (35 m after the event);
- Intersections (stop bar to stop bar);
- Inspection pit covers and related surface Defects within the wheel paths(15 m including the event);
- Surface Defects related to existing Culverts which are not part of the works (width of Culvert plus 30 m after the event); and
- Cattle grids

Table 7-3 – Stabilised and Modified Layers Conformance		
Dry Density Ratio:		Refer ***Table 5-14 – Dry Density Ratios for Conformance***.
Binder Application Rate/Content		±10% of the field application rate averaged for each Test Lot
Stabiliser Distribution:	[i]	Binder content must not vary by more than ±0.5% absolute between top and bottom half of a layer at any location as determined in accordance with NTTM 204.8.
	[ii]	Binder content must not vary by more than ±0.5% from the designated value in any point.
Moisture Content during Compaction:	[i]	±1.5% of moisture content determined at preliminary trial.
	[ii]	±1.5% of Optimum Moisture Content.
[i] apply if a preliminary trial is carried out (i.e. total area over 1,000m2) [ii] apply if a preliminary trial is not carried out (i.e. areas under 1,000m2) Take samples for Liquid Limit, Plastic Limit, Linear Shrinkage, California Bearing Ratio from the unstabilised Pavements.		

8. SPRAY SEALING

8.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1141 (set)	Methods for sampling and testing aggregates
AS 1141.14	- Particle shape, by proportional caliper
AS 1141.15	- Flakiness index
AS 1141.18	- Crushed particles in coarse aggregate derived from gravel
AS 1141.20.1	- Average least dimension – Direct measurement (nominal size 10 mm and greater)
AS 1141.20.2	- Average least dimension – Direct measurement (nominal sizes 5 mm and 7mm)
AS 1141.23	- Los Angeles value
AS 1141.24	- Aggregate soundness – Evaluation by exposure to sodium sulphate solution
AS 1141.25.1	- Degradation factor – Source rock
AS 1141.26	- Secondary minerals content in igneous rocks
AS 1141.29	- Accelerated soundness index by reflux
AS 1141.40	- Polished aggregate friction value – Vertical road wheel machine
AS 1141.41	- Polished aggregate friction value – Horizontal bed machine
AS 1141.50	- Resistance to stripping of cover aggregates from binders
AS 1160	Bituminous emulsions for the construction and maintenance of pavements
AS 1742.3	Manual of uniform traffic control devices – Traffic control for works on roads
AS 1906.3	Retroreflective materials and devices for road traffic control purposes – Raised pavement markers
AS 2008	Residual bitumen for pavements
AS 2106.2	Methods for the determination of the flash point of flammable liquids (closed cup) – Penksy Martens closed cup method
AS 2157	Cutback bitumen
AS 2341 (set)	Methods of testing bitumen and related roadmaking products
AS 2341.6	- Determination of density using a hydrometer
AS 2341.9	- Determination of water content (Dean and Stark)
AS/NZS 2341.13	- Long-term exposure to heat and air
AS 2758.2	Aggregates and rock for engineering purposes – Aggregate for sprayed bituminous surfacing
AS 2809.5	Road tank vehicles for dangerous goods – Tankers for bitumen based products
AS 3568	Oils for reducing the viscosity of residual bitumen for pavements
AS 3705	Geotextiles – Identification, marking and general data
AS 3706	Geotextiles – Methods of Test
AS 3706.1	- General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3706.2	- Determination of tensile properties – Wide strip and grab method
AS 3706.3	- Determination of tearing strength – Trapezoidal method

NORTHERN TERRITORY TEST METHODS

NTTM 215.1	Standard bell penetration test
NTTM 304.1	Determination of skid resistance with the portable skid tester

NORTHERN TERRITORY ROAD SURFACING STANDARDS

Design of Sprayed Seals Technical Directive (Supplement to Austroads Guide to Pavement Technology Part 4K)

Bituminous products - Rise and fall calculations – Industry update

Rise and Fall Calculation

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D86	Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure
ASTM D445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D1298	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D6140	Standard test method to determine asphalt retention of paving fabrics used in asphalt paving for full-width applications

AUSTROADS

AGPT04K-18	Guide to Pavement Technology - Part 4K: Selection and Design of Sprayed Seals
AGPT/T103	Pre-treatment and Loss on Heating of Bitumen Multigrade and polymer Binders (rolling thin film oven [RTFO] test)
AGPT/T108	Segregation of Polymer Modified Binders
AGPT/T111	Handling Viscosity of Polymer Modified Binders (Brookfield Thermosel)
AGPT/T112	Flash Point of Polymer Modified Binders
AGPT/T121	Shear Properties of Polymer Modified Binders (ARRB ELASTOMETER)
AGPT/T122	Torsional Recovery of Polymer Modified Binders
AGPT/T131	Softening Point of Polymer Modified Binders
AGPT/T132	Compressive Limit of Polymer Modified Binders
AGPT/T142	Rubber content of digested crumb rubber binders – Trichlor bath method
AGTTM	Austroads Guide to Temporary Traffic Management (series)
ATS 3460	Austroads Technical Specification ATS 3460 Sprayed bituminous Surfacing
ATS 3110	Austroads Technical Specification ATS 3110 Supply of Polymer Modified Binders
AP-T262/19	Austroads Performance Requirements for Bitumen Sprayers
AP-C87-15	Austroads Glossary of Terms
AP-G41-15	Bituminous Materials Sealing Safety Guide

LEGISLATION

NT Weeds Management Act 2001

8.2 SCOPE

Spray sealing treatments include:

- Prime
- Primerseal
- Enrichment
- Initial Seal or Reseal:
  - With conventional bitumen, cutback bitumen or bitumen emulsion binder
  - With modified binder
  - Incorporating geotextile fabric reinforcement.

Spray sealing work consists of:

- Supply and delivery of materials.
- Storage and handling of raw materials.
- Precoating of aggregate.
- Preparation of Pavement surfaces.
- Preparation of bituminous materials.
- Recording of Spray Sealing works.
- Sampling of Bituminous Products.
- Application of primer and/or primerbinder and/or binder.
- Spreading and rolling of aggregate.
- Removal of loose aggregate.
- Traffic Control.
- Installation of temporary Pavement markers.
- Installation and retrieval of after-care signage.
- Traceability of works and materials.
- Rectification of non-compliant works.

8.3 MATERIAL REQUIREMENTS

8.3.1 Aggregates

Aggregates must be clean, hard, durable, skid resistant, dry crushed stone, or gravel of uniform quality free from noxious weeds and other deleterious material, and conform with the properties specified. Minimum 3 crushed faces.

Nominate source of aggregate supply.

Conform to *Table 8-6 – Aggregate Grading and Average Least Dimension (ALD)*, and to *Table 8-7 – Aggregate Properties***.**

Documentation Point 29 – Submit current NATA endorsed test certificates providing evidence that the nominated Spray Seal aggregate supply conforms to specified properties.

Aggregate used for testing must be sampled from the Development Site.

8.3.2 Cutter

Cutter is to be Kerosene or Jet A1 Aviation Turbine Fuel – conform to *Table 8-2 – Cutter Oil Properties*.

8.3.3 Adhesion Agents

Adhesion Agents are to be in the concentrated form and not contain diesel as part of the mixture.

8.3.4 Precoat

Precoat all aggregates to conform to the following:

Precoat mixture is to be 100/0/100/1 and not contain Diesel as part of the mixture.

Bitumen residue (by mass):	50%.
Kerosene (by Mass)	50%
Adhesion agent (by mass):	minimum 1%

8.3.5 Bitumen

Standard Classes of bitumen to conform to the requirements of AS 2008.

Manufacture all AS 2008 bitumen in a refinery and have NATA endorsed certificates of manufacture.

Durability Value in accordance with AS/NZS 2341.13 is to be a minimum of 7 days with no maximum value.

8.3.6 Cut Back Bitumen

Conform to the requirements of AS 2157 and *Table 8-3 – Cut Back Bitumen Properties***.**

Designation is by AMC class.

8.3.7 Bitumen Emulsion

Refer to Construction Drawings for details of type of emulsion to be used.

Conform to the requirements of AS 1160.

Utilise within 90 Calendar Days of manufacture.

Spraying temperature: 60% bitumen content, 30 to 60 °C.

8.3.8 Polymer Modified Binder

A mixture of Standard AS2008 Class bitumen and elastomeric polymer or crumb rubber additive.

The PMB must be manufactured under a quality management system which is certified to AS/NZS ISO 9001 by a JASANZ accredited certifier (or accredited by another Accreditation Body Member of the International Accreditation Forum).

The manufacturer must implement a documented process control system to produce PMBs of a consistent quality conforming to the requirements of this Specification.

As a minimum, the process controls must include:

- a method for determining and controlling the formulation during the production process;
- keeping records of the composition of the constituent materials for each batch; and
- recording sampling frequencies and test results.

The manufacturer must:

- operate an Inspection and Test Plan (ITP) which demonstrates that the PMB complies with this specification and includes testing of the PMB, analysis of results (including control charts);
- ensure that all PMB supplied can be traced to the production batch and associated test report; and
- ensure that procedures / guidelines for the handling, storing, and transport of the binders that ensures homogeneity and conformity at the time of incorporation into the works are readily available to the Certifying Engineer and Relevant Authority.

Supply all quality documents to the Certifying Engineer and Relevant Authority upon request.

All Conformance Testing to be carried out in accordance with Austroads and Australian Standard Test Methods.

Base binders for the production of PMB must meet the specification limits outlined in *Table 8-8 – Base Binder for Polymer Modified Bitumen***,** from the refinery. All base binders must be process tested for conformance to ensure compliance before manufacture into PMB's.

Polymer Modified Binders must conform to the requirements outlined in *Table 8-11 – Polymer Modified Binders for Sprayed Sealing Applications*.

Crumb rubber must conform to the requirements outlined in *Table 8-12 – Properties of Field-Produced Crumb Rubber Binders* and *Table 8-13 - Properties of Crumb Rubber*.

Crumb rubber must be:

- processed from waste tyres generated in Australia;
- processed by a supplier accredited with Tyre Stewardship Australia or another organisation Approved by the Relevant Authority; and
- free from cord, wire, fluff and other deleterious material.

8.3.9 Geofabric

Use non-woven, polyester, isotropic, needle punched fabric for geotextile reinforced seals. Supply certificate of compliance with the respective Test Lot data. Include Traceability of Batch Numbers with the respective Test Lot data. Geotextile fabric used with a sprayed seal must:

- be tested in accordance with AS 3706 to demonstrate compliance with the design requirements and this Specification.
- be identified in accordance with AS 3705;
- be a non-woven needle punched fabric;
- for seals of nominal maximum size of 14 mm and under have a minimum fabric mass of 135 g/m²;
- for seals of nominal maximum size of larger than 14 mm have a minimum fabric mass of 175 g/m²;
- enable bitumen to be retained at a rate of at least 0.9 l/m² when tested in accordance with ASTM D6140; and
- when tested in accordance with AS 3706, have a melting point at least 10 ºC above the maximum binder spraying temperature.

8.4 SPRAYERS AND PERSONNEL

Sprayers must have current calibration accredited by a tester nominated on the Australian Asphalt Pavement Association (AAPA) website. All calibrated sprayers must be listed on the AAPA website. A copy of the calibration certificate must be with the vehicle at all times.

Calibrate sprayers yearly.

Ensure sprayer driver and operator are skilled and trained with an understanding of sprayer calibration and an appreciation of the requirements of the work.

Ensure relevant personnel understand the types and quantities of the various materials and mixtures to be used.

Bitumen spraying plant and equipment must be in good working condition at all times.

Bitumen sprayers to meet requirements of Austroads AP-T262/14 Performance Requirements for Bitumen Sprayers.

Use in-line strainers when loading sprayer tank except for mixes which include crumbed rubber.

8.5 FINAL PREPARATION OF PAVEMENT SURFACE

Remove raised reflective Pavement markers. Repair any damage to the Pavement surface caused by the removal of raised reflective markers with an emulsion/sand mixture before Sealing.

Remove deleterious materials, rocks, refuse and organic materials such as timber, branches, leaves, and exposed roots and the like.

Immediately before spraying, sweep the entire Pavement surface to remove all loose stones, dust, dirt and foreign matter.

Do not sweep Fine Crushed Rock, or low plasticity type materials, with steel brooms.

Maintain the prepared final surface to be free of loose foreign objects.

Remove adherent patches of foreign material with a steel scraper.

Dampen the prepared surface lightly immediately before spraying for primersealing, and only when very dry for priming.

Remove water from the surface of Primed or Sealed Pavements before applying binder.

Do not allow traffic on the prepared surface.

8.6 SETTING OUT

Setting out to be by a Licensed Surveyor in accordance with *Clause 1.18 – Setting out Works.*

Include pavement widening.

Resealing works to follow existing seal, including widenings.

8.7 BINDER COAT REQUIREMENTS

8.7.1 General

Conform to *Table 8-1 – Binder Type Requirements*.

Table 8-1 – Binder Type Requirements	
Application	**Binder Type**
Prime	Class C170 / C320 applied in cutback form.
Prime and Primerseal	Class C240 / C320 applied in cutback form.
Tack Coat and Enrichment	CRS170/60 applied in emulsion form.

Table 8-1 – Binder Type Requirements	
Initial Seals and Reseals	S10E or S20E polymer modified bitumen, with an elastomeric modifier. Refer Construction Drawings for details.
SAMI Work	S25E

References

- *DIPL Design of sprayed seals Technical Directive Supplement to Austroads Guide to Pavement Technology Part 4K.*
- *Austroads Guide to Pavement Technology Part 4K Selection and Design of Sprayed Seals.*
- *AS2008 – Bitumen for Pavements.*

Requirements

Selection of binder type other than those specified above can be considered in special circumstances, subject to approval of the Relevant Authority.

Material properties for polymer modified binders are contained in Table 8-11 – Polymer Modified Binders for Sprayed Sealing Applications**.**

Heat to spraying temperature, generally between 180°C and 200°C, but do not exceed the maximum allowable. Refer *Table 8-4 – Temperature Control Requirements for Polymer Modified Binders* for Polymer Modified Bitumen. Avoid heating bitumen in quantities excess to requirements.

Remove from the Development Site binder which has been overheated or has deteriorated or become contaminated prior to its application to the street.

Prevent foaming.

Ensure product meets the requirements of the specification at point of delivery.

8.7.2 Prime, Primerseals, Seals, Pre-coats and Enrichment Coats

Provide bitumen complying with *Table 8-8 – Base Binder for Polymer Modified Bitumen***.**

Prime to be AMC 0 to AMC 00.

Emulsion Primes: Proprietary type products minimum 70% bitumen

Refer to Construction Drawings for cut back requirements for Primerseals ad Enrichment Coats.

Cut-back bitumen to be mixed on site.

Heat bitumen to a temperature appropriate for achieving final spraying temperature making allowance for incorporation of the unheated Cutter.

Add unheated Cutter to heated bitumen and circulate until a homogeneous mixture is achieved.

Spray immediately once circulation is complete.

Allow at least three Calendar Days to elapse after Priming before applying the binder coat.

Emulsion primes – allow 24 hours to elapse before applying binder coat.

Keep traffic off the primed surface for this period.

8.7.3 Straight Run Binder Coats

Do not use Straight Run Binder Coats unless you have prior approval from the Relevant Authority.

Provide straight run bitumen complying to AS 2008.

Ensure product meets the requirements of the specification at point of delivery.

8.7.4 Polymer Modified Binder Coats

Provide bitumen in conformance with *Table 8-8 – Base Binder for Polymer Modified Bitumen* blended with the required polymer as follows:

Ensure product meets the requirements of the specification at point of delivery.

Store, mix, heat and spray the polymer modified binder as recommended by the polymer manufacturer.

Both coats of two coat seals must contain polymer.

8.8 SAMPLING OF BINDER

8.8.1 Collection of Samples

Each sample must comprise three containers of product collected at the same time from the same supply source.

Sample containers must:

- be clean, rust free and leak proof;
- have a capacity of not less than one litre; and
- be capable of receiving a product at high temperatures.

Samples must be collected at point of delivery, prior to addition of Adhesion Agents, on transfer from the bulker to the sprayer. Do not take bituminous samples from the spray wagon, except for Prime samples.

All sampling must be in accordance with Australian and Austroads standards. The supplier is to perform the sampling. Ensure staff carrying out sampling are competent in sampling methods.

Ensure sampling techniques do not allow contamination of the samples.

Samples must be clearly identified with permanent marker on adhesive labels on each container.

Store all samples taken to prevent accidental damage or contamination.

8.8.2 Binder Testing

Documentation Point 30 – Undertake Conformance Testing of all binders in accordance with *Table 5-5 – Test Frequencies for Bitumen Spray Sealing*. Provide notification of non-conforming samples.

8.9 STOCKPILE SITES

8.9.1 Stockpiles of Materials

Provide a separate site for each aggregate size. Allow 15 metres between adjacent sites.

Ensure sites are well drained and on hard ground. Avoid contamination by dust.

Maintain access streets and stockpile sites.

Do not allow stockpiled aggregates to become wet due to rain. Cover all stockpiles with sheet plastic or similar material.

Avoid sites under trees, telephone lines, overhead transmission lines or where overhead clearance is less than 6 metres.

Remove from the Development Site any non-conforming aggregate.

Remove all unused aggregate from stockpile sites at conclusion of the Spray Sealing works.

8.10 PRECOATING AGGREGATE

All aggregates used must be dry before applying Precoating Material.

Precoat all SAMI aggregates with 2 L/m^3 a minimum of 7 Calendar Days before use.

No Precoating Material is required for Emulsion Seals, unless stated in the Construction Drawings.

Apply a uniform film of Precoating Material to all aggregate used for Sealing purposes.

Do not load directly into trucks from a precoater machine.

Aggregate which has been excessively precoated will be rejected.

All precoating must be performed with a powered shaking screen deck precoater, which removes dust, dirt and oversize materials and evenly applies Precoating Material to the aggregate.

8.11 ADHESION AGENT

Adhesion agent must be used. Do not use diesel based Adhesion Agents.

Use 1% Adhesion Agent in the Binder. Written approval must be obtained from the Relevant Authority for variation of this rate.

Circulate in binder for 20 minutes before spraying.

8.12 SPRAYING

Inspection Point 17 – Provide notice prior to spraying bitumen.

Store bitumen at lowest practical temperature and for the shortest possible duration.

Comply with *Table 8-4 – Temperature Control Requirements for Polymer Modified Binders*.

Seek approval from the Certifying Engineer to vary these requirements.

Remove bitumen from the Development Site when temperature limits are exceeded.

Allow for different spray rates for different traffic lanes and/or paths of travel in the same sections of the roadway.

8.12.1 Atmospheric Conditions

Commence spraying only when Pavement temperature

- is in excess of 20 °C, or
- has been in excess of 15 °C for at least one hour.

For cutback work, commence spraying when Pavement temperature is in excess of 10 °C.

For emulsion work, commence spraying when Pavement temperature is in excess of 5 °C.

Cease spraying if rain threatens, or in windy or dusty conditions.

Protect the work in the event of a sudden change in weather by closing the affected section of street or by rigidly controlling traffic speed.

8.12.2 Preparing the Sprayer

Circulate the mixture.

Check the horizontal and vertical alignment and the cleanliness of the spraybar and its extensions.

Determine the appropriate number of nozzles for the width to be sprayed. Ensure the end nozzles fitted are EAN18W.

Check that the nozzles in use are symmetrical about the sprayer.

Check the alignment and setting of the nozzle to ensure that the fans of material from intermediate nozzles are parallel and at an angle of 30 degrees to the centre line of the spraybar. Ensure that the fans from the end nozzles are parallel to each other and at an angle of 45 degrees to the centre line of the spraybar.

Set the height of the spraybar so that the lower faces of the nozzles are 250 mm (or that specified on the calibration certificate) above the Pavement when the sprayer is full.

Fit an end shield to the spraybar when necessary to prevent spraying material on the kerb, or to counter any wind effects which would compromise uniform spraying.

Position the guide rod to conform to the setting out and edges of spray. Check by making a dummy run.

8.12.3 Application Spray Rates

Application spray rates must be determined by the Developer, using *Austroads Guide to Pavement Technology Part 4K Selection and Design of Sprayed Seals***.**

Refer to *Table 5-9 - Test Frequencies for Aggregates and Pavement Surfaces* for sampling requirements of aggregates.

Documentation Point 31 – Submit spray rates, prior to commencing Spray Seal application.

Spray rates to be at 15°C and adjusted for temperature as per *Table 8-9 – Volume Correction - Bitumen (including PMB and cutback bitumen)* and *Table 8-10 – Volume Correction – Bitumen emulsion***.**

For Prime, Primerseals and polymer modified binders, the rate of application refers to the whole of the mixture, including all modifiers, cutback materials, combining oils and Adhesion Agents. For enrichments and emulsion seals, the rate of application refers to the whole of the mixture.

8.12.4 Preparation for Sprayer Run

Record the volume and temperature of the sprayer contents before each run, while sprayer is on level ground. Dip sprayer tank before and after each sprayer run. Record the dip readings, and the temperature of the sprayer contents at the time the dip was done.

Documentation Point 32 – Submit copies of records of sprayer tank dips and temperatures of tank contents within one Business Day of the completion of a day's work.

Check that the spray bar is at the correct height before the spraying begins.

Determine the length of sprayer run from the available quantity in the sprayer and the application rate. Ensure the area to be sprayed is not greater than the area that can be covered by aggregate in the loaded trucks.

Start and finish each spray run on a protective strip of paper placed on the Pavement. The paper to be wide enough to ensure the sprayed material is being discharged correctly over the full width of spray. Place sufficient protective paper to protect street fixtures.

Place paper on the Pavement and masking around areas to be sprayed or wherever the sprayer is stationary on the street Pavement.

Seal joins are only allowed where line marking is to be placed. No joins are allowed in wheel paths.

Excess overspray and spills must be removed before Sealing works proceed.

8.12.5 Installation of Temporary Pavement Markers

Temporary Pavement Markers to conform to AS 1906.3.

Spacings of temporary Pavement markers to be in accordance with AS 1742.3 or as directed by the Relevant Authority.

8.12.6 Sprayer Run

Attain uniform spraying speed before spraying commences.

Distribution of bitumen must be uniform across the whole spray bar.

Blocked Jets - cease spraying immediately, repair defect before spraying recommences.

Spraying must cease immediately if:

- any fault develops in the spray equipment, or
- a blockage or partial blockage of a nozzle occurs, or
- the bituminous material is not being uniformly applied for the full width of the sprayed area.

Spraying must not recommence until the faults have been rectified.

If the condition of the binder causes a nozzle blockage, the use of that load of binder in the sprayer, together with any binder from the same bulk tanker or supply unit load, must cease, and those binder loads must be immediately removed from the Development Site.

Avoid an excess or deficiency of material due to faulty overlap at longitudinal joints when spraying a street in half-widths.

Overlap to be 300 mm with an intermediate nozzle.

Do not use end nozzles on an overlap.

Make allowances for "Fog Spraying" when joining to existing Seals.

Cease spraying before the level of material in the tank falls to a level which reduces the full discharge of the pump.

Remove and dispose of all paper as per the Approved Construction Environmental Management Plan.

Clean off any sprayed material from street fixtures.

8.12.7 Hand Spraying

Plan work to minimise the requirement for the use of a hand sprayer.

Any strips of Pavement not adequately covered with sprayed material to be sprayed later with the hand attachment.

8.13 APPLICATION OF GEOFABRIC

Documentation Point 33 – Submit details of proposed machinery and method of application to the Certifying Engineer and Relevant Authority.

A certificate of compliance for the paving geotextile must be included with the respective Test Lot data.

Where the use of paving geotextile is specified, it must be placed in accordance with the manufacturer's instructions, any requirements specified elsewhere in the Construction Drawings, and the following:

- traffic must not be permitted to travel on the paving geotextile where this will cause damage to, or pick up of, the paving fabric;
- place the fabric under tension when laying. Any folds, creases and/or wrinkles in the paving geotextile that will impact the performance of the seal must be removed;
- overlap of the paving geotextile on longitudinal joints must be between 100 mm and 150 mm;
- longitudinal overlap of the paving geotextile must be placed within 100 mm of the centreline or lane line;
- additional binder must be applied at the longitudinal overlap to avoid the seal stripping along the joint;
- the paving geotextile must be bonded to the pavement with a bond coat sprayed wide enough to ensure the full bond coat application is achieved over the entire width of the fabric;
- appropriate jets must be used to ensure the specified bond coat rate is applied across the entire width of paving geotextile; and
- the construction practices used to place the paving geotextile must not cause undue migration of the underlying bond coat into the paving geotextile.

8.14 APPLICATION OF AGGREGATE

Load aggregate into appropriate aggregate spreading trucks using an Approved loader which does not contaminate the aggregate with dust, dirt and oversize stone.

Apply aggregate to sprayed binder within:

- 10 minutes where the Pavement temperature is 20°C or greater.
- 5 minutes where the Pavement temperature is between 15 and 20 °C.

Polymer Modified Binders: Apply aggregate within 5 minutes irrespective of Pavement temperature.

Emulsion Binders: Apply aggregate to emulsion coat before the emulsion breaks.

Use “cut off plates” on spreader boxes to ensure that the correct widths are covered in aggregate, without overlap.

In trafficked areas, apply both coats of a two coat Seal on the same Business Day. Where not trafficked apply the second coat on the following Business Day. Do not allow traffic until the second coat has been applied.

8.14.1 Aggregate Spread Rates

Spread the aggregate evenly and uniformly over the sprayed surface at a rate complying with *Table 8-5 – Aggregate Spread Rates***.**

Use a mechanical spreader; manual spreader boxes are not to be used.

Rerun or hand cover bare or insufficiently covered areas after the first spreading.

Remove all excess aggregate.

8.14.2 Rolling Rate

Roll the treated surface with self-propelled rubber tyred rollers with a minimum tyre pressure of 600 kPa and a minimum wheel load of 1 tonne.

Roller speed on the first pass to be between 5 and 10km/h, with subsequent passes between 15 and 25 km/h.

Conform to the following:

- Entire area to receive one roller pass immediately after covering.
- 75% of rolling within 1 hour of covering.
- 100% of rolling within 2 hours of covering.

Minimum Rolling Rate: 1 roller hour per 2,000 litres of binder.

Ensure a uniform distribution of aggregate. Drag broom to distribute surplus aggregate but do not dislodge embedded aggregate. Drag broom before 50% of rolling is complete. Drag brooms are not to be rotary brooms.

For two-coat treatments, double the specified rolling rate.

Roll in daylight hours only.

Sweep all loose aggregate from the Carriageway at completion of rolling.

Ensure aggregate on the final surface is uniformly distributed and firmly held by the binder.

Adjust drag broom to distribute surplus aggregate, but not to dislodge embedded aggregate.

Re-roll the surface after sweeping to ensure uniform bedding of aggregate in binder.

8.14.3 Self-Propelled Multi Rubber Tyred Vibrating Rollers

Documentation Point 34 – Obtain approval for the use of self-propelled multi rubber tyred vibrating rollers in Spray Seal works prior to using them.

Do not use steel drum rollers fitted with rubber covers.

Self-propelled multi rubber tyred vibrating rollers must not be used on works other than resealing works.

All self-propelled multi rubber tyred vibrating rollers must meet the same requirements as are required for self-propelled multi rubber tyred non-vibrating rollers in respect to rolling speeds, tyre pressures, and wheel loadings.

If the self-propelled multi rubber tyred vibrating rollers meet all the above requirements, one self-propelled multi rubber tyred vibrating roller will be considered to be equivalent to 2 self-propelled multi rubber tyred non-vibrating rollers for calculations of rolling times.

A minimum of 2 self-propelled multi rubber tyred non-vibrating rollers must be on the Development Site at all times during execution of the works.

8.15 WASTE MATERIAL

Remove all excess aggregate by suction broom. Ensure no aggregates are distributed onto the verge, Shoulders and/or table drains.

Documentation Point 35 – Obtain approval for use of rotary type brooms to windrow loose aggregate. Suction type brooms are still to be used to remove the waste aggregate.

Category A localities aggregate removal / sweeping regime:

Initial sweep after rolling has concluded

Second sweep after 24 hours

Third sweep after 48 hours.

Fourth sweep after 7 Calendar Days.

Sweep all aggregate from Shoulders in rural areas.

Remove all waste material from the Development Site and dispose of lawfully.

8.16 REPORTING

8.16.1 Spray sheets

Documentation Point 36 – Submit signed spray sheets that record the following information for all Spray Seal runs conducted.

- Contractors Name
- Project Details
- Contract Number
- Specification schedule number
- Street Name
- Product Type Sprayed
- Precoat type used, Precoat litres / m3
- Aggregate supplier, Aggregate Type, Aggregate size
- Run number, Start Time of spray run
- Pavement Temperature, Ambient Temperature
- Start Chainage of spray run – actual km of Street
- End chainage of spray run – actual km of Street
- Total Length, Width of spray run
- Total area of spray run
- Temperature of product at spraying
- Start Dip, End Dip
- Total sprayed hot, Correction factor, Total sprayed cold
- Application rate cold
- Ordered application rate
- Percent of application rate ordered
- Number of rollers used
- Bitumen sample number
- Signature of Contractor representative
- Signature section for Developer representative

8.17 CONFORMANCE

Final surfaces must conform to the following requirements. Rectify non-conforming work by methods Approved by the Relevant Authority.

8.17.1 Aggregates Properties

Aggregates must conform to *Table 8-7 – Aggregate Properties*.

8.17.2 Skid Resistance

Standard; NTTM 304.1

Conformance; Not less than that specified in NTTM 304.1, Table 2.

Skid resistance testing may be carried out by the Relevant Authority.

Final surfaces with non-conforming skid resistance will be rejected.

8.17.3 Spray Rates

Spray rates applied at less than 95% or more than 105% of the rate indicated in the procedure must be rectified by resurfacing.

Rectify bleeding and/or flushing Seals during the Defects Liability Period.

8.18 TABLES

Table 8-2 – Cutter Oil Properties			
Refer to AS 3568:2020 Table 1. Do not use high flash point cutter.			
Property	**Min**	**Max**	**Test Method**
Density at 15 °C, kg/m3	Report	Report	ASTM D1298, AS 2341.6
Distillation – Initial Boiling Point, °C – Final Boiling Point, °C	 140 -	 - 300	ASTM D86
Flash Point °C (Penksy Martens closed cup)	38	-	AS 2106.2
Viscosity, mPa.s at 40 °C	-	2.0	ASTM D445

Table 8-3 – Cut Back Bitumen Properties			
Class (AS 2157)	**Dynamic Viscosity at 60°C (Pa.s)**	**Approx. Parts Bitumen to Cutter**	**Spraying Temperature. (°C)**
Prime Coats			
AMC 00	0.008 - 0.016	100 - 100	Ambient
AMC 0	0.025 - 0.05	100 - 80	35 - 55
Primerseal Coats			
AMC 5	5.5 - 11.0	100 - 12	120 - 150
AMC 6	13.0 - 26.0	100 - 7	135 - 160
AMC 7	43.0 - 86.0	100 - 3	150 - 175

Table 8-4 – Temperature Control Requirements for Polymer Modified Binders		
Property	**Straight Run Binder**	**Polymer Modified Binder**
Temperature at point of spraying	175 to 185 °C	180 to 200 °C
Holding time at spraying temperature	7 Calendar Days max.	2 Calendar Days max.
Temperature for medium term storage	130 to 150 °C	140 to 160 °C
Holding time for medium term storage	30 Calendar Days	7 to 10 Calendar Days

Table 8-5 – Aggregate Spread Rates	
SINGLE / SINGLE SEALS	**Application Rate m^2/m^3**
Straight Run Binder Coats, Multi Grade, and Polymer Modified Binders	750/ALD to 800/ALD m^2/m^3
Emulsions and Cut-back Binders	800/ALD m^2/m^3
SAMI	1000/ALD to 1100/ALD m^2/m^3
DOUBLE / DOUBLE SEALS – FIRST COAT APPLICATIONS	
Straight Run Binder Coats, Multi Grade, and Polymer Modified Binders	950/ALD m^2/m^3
Emulsions and Cut-back Binders	850/ALD m^2/m^3
DOUBLE / DOUBLE SEALS – SECOND COAT APPLICATIONS	
All Binders	1100/ALD m^2/m^3

Table 8-6 – Aggregate Grading and Average Least Dimension (ALD)						
Sieve Size (mm)	**% Passing (Dry Mass)**					
	Nominal Size of Aggregate					
	20 mm	**16 mm**	**14 mm**	**10 mm**	**7 mm**	**5 mm**
26.5	100					
19.0	85 - 100	100				
16.0	-	80 - 100	100			
13.2	0 - 15	0 – 20	85 - 100	100		
9.5	0 - 5	0 – 2	0 - 15	85 - 100	100	
6.7	0 - 2		0 - 5	0 - 15	85 - 100	100
4.75			0 - 2	0 - 5	0 - 15	85 - 100
2.36				0 - 2	0 - 5	0 - 15
1.18					0 - 2	0 - 5
Min. ALD (1)	12.0mm	9.5mm	8.0mm	5.5mm	3.5mm	2.5mm
Note: (1). Test Methods AS 1141.20.1, AS 1141.20.2 - Direct Measurement.						

Table 8-7 – Aggregate Properties			
Aggregate Property	**Traffic Count (AADT: Two Lanes)**		
	Less Than 300 VPD	**300 to 6,000 VPD**	**More Than 6,000 VPD**
AS 1141.14 Misshapen Particles: Calliper Ratio 2:1	25% maximum	15% maximum	12% maximum
AS 1141.15 Flakiness Index	25 maximum	25 maximum	25 maximum
AS 1141.23 Los Angeles Abrasion (LAA):			
- Fine Grained Aggregate	30% maximum	25% maximum	20% maximum
- Coarse Grained Aggregate	40% maximum	35% maximum	30% maximum
AS 1141.24 Sulphate Soundness	15% maximum	12% maximum	10% maximum
AS 1141.40/41 Polished Aggregate Friction Value	40 minimum	40 minimum	45 minimum
AADT - Annual Average Daily Traffic; VPD - Vehicles Per Day			
AS 1141.18 - Crushed particles in coarse aggregate derived from gravel. Ensure 80% minimum by mass are classified as crushed particles. AS 1141.25.1 - Degradation factor – Source rock (Washington Degradation Test). Igneous rocks must have a minimum value of 50. AS 1141.26 - Secondary minerals content in igneous rocks must not exceed 25%. AS 1141.29 - Accelerated soundness index by reflux. Igneous rocks must have a minimum value of 94. AS 1141.50 - Resistance to stripping of cover aggregates from binders. Binder to be S10E with 1% adhesion agent. Precoat to be 100/0/100 with 1% adhesion agent. The maximum wet stripping (saturated, surface dry) value of the precoated aggregate must not exceed 10%.			

Table 8-8 – Base Binder for Polymer Modified Bitumen		
Property	**Specification limit minimum**	**Specification limit maximum**
Viscosity at 60°C, Pa.s	140	380
Viscosity at 135°C, Pa.s	0.25	0.65
Penetration at 25°C (100g, 5s), pu (pu unit is 0.1mm)	40	--
Flashpoint °C	250	N/A
Matter Insoluble in toluene, percent mass	N/A	1.0
Short Term effect of heat and air (Rolling Thin film Oven Test) Viscosity of residue at 60°C as a percentage of original	N/A	300
Long term effect of Heat and air, Calendar Days	7	--
Density at 15°C, t/m3	TBR	TBR

Equivalent volumes of bituminous material measured at higher temperature are to be converted an equivalent volume at 15°C (15°C converted higher temperature).

Table 8-9 – Volume Correction - Bitumen (including PMB and cutback bitumen)

Multiply by "A" to reduce volume at T^{O}C to volume at 15^{O}C

Multiply by "B" to increase volume at 15^{O}C to volume at T^{O}C

A	Temp.(T^{O}C)	B	A	Temp. (T^{O}C)	B
.9856	38	1.0146	**.9356**	**120**	**1.0688**
.9844	**40**	**1.0158**	.9344	122	1.0702
.9831	42	1.0172	.9332	124	1.0716
.9819	44	1.0184	.9320	126	1.0730
.9806	46	1.0198	.9308	128	1.0743
.9794	48	1.0210	**.9296**	**130**	**1.0757**
.9782	**50**	**1.0223**	.9284	132	1.0771
.9769	52	1.0236	.9272	134	1.0785
.9757	54	1.0249	.9260	136	1.0799
.9745	56	1.0262	.9249	138	1.0812
.9732	58	1.0275	**.9237**	**140**	**1.0826**
.9720	**60**	**1.0288**	.9225	142	1.0840
.9708	62	1.0301	.9213	144	1.0854
.9695	64	1.0315	.9201	146	1.0868
.9683	66	1.0327	.9189	148	1.0883
.9671	68	1.0340	**.9178**	**150**	**1.0896**
.9659	**70**	**1.0353**	.9166	152	1.0910
.9646	72	1.0367	.9154	154	1.0924
.9634	74	1.0380	.9142	156	1.0939
.9622	76	1.0393	.9130	158	1.0953
.9610	78	1.0406	**.9119**	**160**	**1.0966**
.9597	**80**	**1.0420**	.9107	162	1.0981
.9585	82	1.0433	.9095	164	1.0995
.9573	84	1.0446	.9084	166	1.1009
.9561	86	1.0459	.9072	168	1.1023
.9549	88	1.0472	**.9060**	**170**	**1.1038**
.9537	**90**	**1.0486**	.9049	172	1.1051
.9524	92	1.0500	.9037	174	1.1066
.9512	94	1.0513	.9025	176	1.1080
.9500	96	1.0526	.9014	178	1.1094
.9488	98	1.0540	**.9002**	**180**	**1.1109**
.9476	**100**	**1.0553**	.8990	182	1.1123
.9464	102	1.0566	.8979	184	1.1137
.9452	104	1.0580	.8967	186	1.1152
.9440	106	1.0593	.8956	188	1.1166
.9428	108	1.0607	**.8944**	**190**	**1.1181**
.9416	**110**	**1.0620**	.8933	192	1.1195
.9404	112	1.0634	.8921	194	1.1209
.9392	114	1.0647	.8909	196	1.1224
.9380	116	1.0661	.8898	198	1.1239
.9368	118	1.0675	**.8886**	**200**	**1.1253**

Table 8-10 – Volume Correction – Bitumen emulsion

Multiply by "A" to reduce volume at T^{O}C to volume at 15^{O}C

Multiply by "B" to increase volume at 15^{O}C to volume at T^{O}C

60% Bitumen emulsion			**70% Bitumen emulsion**			**80% Bitumen emulsion**		
A	**Temp (T^{O}C)**	**B**	**A**	**Temp (T^{O}C)**	**B**	**A**	**Temp (T^{O}C)**	**B**
1.0000	15	1.0000	1.0000	15	1.0000	1.0000	15	1.0000
.9998	16	1.0002	**.9977**	**20**	**1.0023**	**.9974**	**20**	**1.0026**
.9989	18	1.0011	.9951	25	1.0049	.9948	25	1.0052
.9980	**20**	**1.0020**	**.9924**	**30**	**1.0076**	**.9921**	**30**	**1.0079**
.9971	22	1.0029	.9899	35	1.0102	.9895	35	1.0106
.9962	24	1.0038	**.9872**	**40**	**1.0129**	**.9868**	**40**	**1.0134**
.9953	26	1.0047	.9840	46	1.0162	.9837	46	1.0166
.9944	28	1.0056	.9830	48	1.0172	.9826	48	1.0177
.9935	**30**	**1.0065**	**.9819**	**50**	**1.0184**	**.9816**	**50**	**1.0187**
.9926	32	1.0074	.9809	52	1.0194	.9805	52	1.0199
.9917	34	1.0083	.9798	54	1.0206	.9794	54	1.0210
.9908	36	1.0092	.9788	56	1.0216	.9783	56	1.0222
.9899	**38**	1.0102	.9777	58	1.0228	.9773	58	1.0232
.9890	**40**	**1.0111**	**.9767**	**60**	**1.0238**	**.9762**	**60**	**1.0244**
.9881	42	1.0120	.9752	62	1.0254	.9751	62	1.0255
.9872	44	1.0129	.9746	64	1.0260	.9740	64	1.0267
.9863	46	1.0138	.9736	66	1.0271	.9730	66	1.0277
.9854	48	1.0148	.9725	68	1.0282	.9719	68	**1.0289**
.9845	**50**	**1.0157**	**.9715**	**70**	**1.0293**	**.9709**	**70**	**1.0300**
.9836	52	1.0166	.9704	72	1.0305	.9698	72	1.0311
.9827	54	1.0176	.9693	74	1.0316	.9687	74	1.0323
.9818	56	1.0185	.9683	76	1.0327	.9677	76	1.0334
.9809	58	1.0194	.9672	78	1.0339	.9667	78	1.0344
.9800	**60**	**1.0204**	**.9662**	**80**	**1.0349**	**.9656**	**80**	**1.0356**
.9791	62	1.0213	.9651	82	1.0361	.9643	82	1.0370
.9782	64	1.0222	.9640	84	1.0373	.9630	84	1.0384
.9773	66	1.0232	.9630	86	1.0384	.9616	86	1.0399
.9764	68	1.0241	.9619	88	1.0396	.9603	88	1.0413
.9755	**70**	**1.0251**	**.9608**	**90**	**1.0407**	**.9590**	**90**	**1.0427**

Table 8-11 – Polymer Modified Binders for Sprayed Sealing Applications

Test Method	Binder Property	Class					
		S10E	**S15E**	**S20E**	**S25E**	**S35E**	**S45R[1]**
AS/NZS 2341.4 or AGPT/T111[2]	Viscosity at 165 °C (Pa.s) max[2]	0.55	0.55	0.6	0.9	0.55	4.5[2]
AGPT/T122	Torsional recovery at 25 °C, 30 s (%)	22-50	32-62	38-70	55-80	16-32	25-55
AGPT/T131	Softening point (°C)	48-64	55-75	65-95	82-105	48-56	55-65
AGPT/T125	Stress ratio at 10 °C min.	TBR[3]	TBR	TBR	TBR	TBR	TBR
AGPT/T121	Consistency 6% at 60 °C (Pa.s) min.[4]	300	400	500	900	250	800
AGPT/T121	Stiffness at 15 °C (kPa) max.	140	140	NA[5]	NA	180	180
AGPT/T121	Stiffness at 25 °C (kPa) max.	NA	NA	35	30	NA	NA
AGPT/T132	Compression Limit at 70 °C, 2kg (mm) min.	NA	NA	NA	NA	NA	0.2
AGPT/T108	Segregation (%) max.	8	8	8	8	8	8
AGPT/T112	Flash point (°C) min.	250	250	250	250	250	250
AGPT/T103	Loss on heating (% mass) max.	0.6	0.6	0.6	0.6	0.6	0.6

Notes:

1. Class S45R binder must be manufactured by the incorporation of crumb rubber derived from used vehicle tyres.
2. L series Brookfield is recommended together with spindle SC4-31, except in the case of S45R where spindle SC4-29 is recommended. The shear rate involved in determining viscosity by AS/NZS 2341.4 and AGPT/T111 must be calculated and recorded. AGPT/T111 has been retained to allow laboratories sufficient time to adopt AS/NZS 2341.4.
3. 'TBR' throughout = to be reported.
4. Consistency 6% at 60 °C of S10E and S35E must be determined using mould B (breakpoint of 5 mm and a test speed of 1.5 mm/s). Other grades must be tested using mould A (breakpoint of 10 mm and a test speed of 1 mm/s).
5. 'NA' throughout indicates that the property is considered not applicable for that PMB class.
6. S35E must be manufactured with Polybutadiene (PBD) polymers and to have a proven record of performance. To be used only if approved by the Relevant Authority, as an alternative to S10E.

Table 8-12 – Properties of Field-Produced Crumb Rubber Binders				
Property	**Method**	**S15RF[1]**	**S18RF[1]**	**A27RF[2]**
Nominal rubber concentration (%)		15	18	25-30
Rubber content by analysis (%) min.	AGPT/T142[3]	13	16	
Torsional recovery (%) min.	AGPT/T122	25	30	
Softening point (°C) min.	AGPT/T131	55	62	
Consistency 6% at 60 °C (Pa.s)	AGPT/T121	Report	Report	

Notes:

1. Specification for two grades of crumb rubber available for either sealing class.
2. 'Dry mix' asphalt is normally based on an asphalt mix design with the crumb rubber added at, typically, 25% crumb rubber in the total binder. Size 30 is normally used for the 'Dry mix' asphalt system.
3. A soxhlet extraction using toluene may also be used.
4. For sealing grades, the sampling is from the mixing vessel after digestion but prior to the addition of cutter oil. Samples must be free of diluents for subsequent testing to be meaningful. The agreed digestion period (at mixing temperature) must be completed before sampling.

Table 8-13 - Properties of Crumb Rubber			
Test	**Method**	**Size 16**	**Size 30**
Grading	AGPT/T143		
- passing 2.36 mm		100	100
- passing 1.18 mm		80 min.	100
- passing 600 µm		10 max.	60 min.
- passing 300 µm		--	20 max.
Particle length (mm) max	AGPT/T143	3	3
Bulk density (kg/m3)	AGPT/T144	Report	Report
Water content (%) max.	AGPT/T143	1	1
Foreign materials – other than iron (%) max.	AGPT/T143	0.1	0.1
Foreign materials – metallic iron (%) max.	AGPT/T143	0.1	0.1

9. DENSE GRADED ASPHALT

9.1 DEVELOPERS RESPONSIBILITIES

The Developer is responsible for the production and placing of the registered and Approved design mix in accordance with the technical requirements of this specification.

The Developer must undertake Conformance Testing in accordance with Conformance Testing and maintain a record of test results in accordance with the Developer's Quality System.

9.2 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1141 (set)	Methods for sampling and testing aggregate.
AS 1160	Bituminous emulsion for the construction and maintenance of pavements.
AS 2008	Bitumen for pavements.
AS 2150	Asphalt – a guide to good practice.
AS 2157	Cut back bitumen.
AS 2758 (set)	Aggregates and rock for engineering purposes.
AS 2891 (set)	Methods of sampling and testing asphalt.

AUSTRALIAN ASPHALT PAVEMENT ASSOCIATION (AAPA)

Guide to the manufacture, storage and handling of polymer modified binders

Advisory Note 7 Guide to the manufacture, storage and handling of binders for Spray Sealing (and hot mix asphalt)

AUSTROADS

AGPT04B	Austroads Guide to Pavement Technology Part 4B Asphalt
AGPT04H	Austroads Guide to Pavement Technology Part 4H: Test Methods
AGPT/T103	Pre-treatment and Loss on Heating of Bitumen Multigrade and polymer Binders (rolling thin film oven [RTFO] test)
AGPT/T111	Handling Viscosity of Polymer Modified Binders (Brookfield Thermosel)
AGPT/T112	Flash Point of Polymer Modified Binders
AGPT/T121	Shear Properties of Polymer Modified Binders (ARRB ELASTOMETER)
AGPT/T122	Torsional Recovery of Polymer Modified Binders
AGPT/T131	Softening Point of Polymer Modified Binders
AGPT/T190	Austroads Framework Specification for Polymer Modified Binders and Multigrade Bitumen

Austroads Technical Specification ATS 3110 Supply of Polymer Modified Binders.

Austroads Test Method ATM 453 Surface Deviation Using a Straight Edge.

NT PUBLICATIONS

NTCP 103.1	Site selection by the stratified random technique
NTCP 107.1	Ride Quality
NTMTM	Northern Territory Materials Testing Manual
NTTM	Northern Territory Test Method

NORTHERN TERRITORY ROAD SURFACING STANDARDS

Bituminous Rise and Fall

OTHER PUBLICATIONS

MRWA	Main Roads Western Australia, Test Methods

9.3 MATERIALS

9.3.1 Coarse Aggregates

Coarse aggregates must consist of crushed stone, with a minimum of 3 crushed faces, which is clean, hard, of high strength, angular, which has adequate skid resistance, which is durable and free from laminated particles, clay and other aggregations of fine material, soil, organic matter and any other deleterious material. Coarse aggregate must not fracture under compaction equipment or deteriorate rapidly. Coarse aggregate materials must conform to the requirements of *Table 9-2 - Properties - Coarse Aggregates***.**

9.3.2 Fine Aggregates

Fine aggregates must consist of clean, hard, sharp, washed, durable natural sand and/or material manufactured from crushed stone of uniform quality free from clay and other aggregations of fine material, soil, organic matter and any other deleterious material.

Where crushed fine materials are from sources other than the source of the coarse material used

in the asphalt mix, the parent rock must meet all requirements listed in *Table 9-2 - Properties - Coarse Aggregates*.

Fine aggregates must meet the requirements of *Table 9-3 - Properties - Fine Aggregate*.

9.3.3 Mineral Filler

Filler must consist of mineral material, natural or crushed mineral materials, hydrated lime or cement with a particle size less than 0.075 mm.

Filler must be dry, free from lumps, clay, organic material or any other deleterious material, and complies in all respects with the requirements of AS 2150.

9.3.4 Bituminous Binder

Refined bitumen must be Class 320, conforming to the requirements of AS 2008.

Polymer Modified Binders (PMB) must comply to the requirements of *Austroads Framework Specification for Polymer Modified Binders and Multigrade Bitumen, AGPT/T190*. Properties of PMB grades referred to in this specification are outlined in *Table 9-4 – Properties of Polymer Modified Binders for* Asphalt Applications

Bitumen handling and storage must be in accordance with AAPA Guide to the Manufacture, Storage and Handling of Polymer Modified Binders and with AAPA Advisory Note 7 Guide to the manufacture, storage and handling of binders for spray sealing (and hot mix asphalt).

Where requested, provide evidence that the binder used for asphalt manufacture has been handled and stored according to these requirements. Shape and Surface Roughness

9.3.5 Shape and Surface Roughness

Where surface shape of an existing pavement is corrected by cold planning, the application of

the resurfacing asphalt layer is considered to be new work. For the purposes of measuring surface roughness, the asphalt surfacing following correction of surface shape by cold planning

will be designated as new work and roughness limits specified in *Table 9-6 – Finished Pavement Properties*.

Note, Cold milling forward cutting speed must not exceed 15mpm.

9.3.6 Bitumen Emulsion

A rapid setting bitumen emulsion, conforming to requirements of AS 1160 when applied as a tack coat.

9.3.7 Additives

Additives such as bitumen Adhesion Agents, hydrated lime and the like may be proposed to be used in the mix, provided that full details of the type of additive are provided. The material must be nominated and shown as part of the mix design in accordance with the Asphalt Mix Design clause.

9.3.8 Reclaimed Asphalt Pavement

Crush and screen reclaimed asphalt pavement (RAP) from milling or excavation of existing asphalt as necessary to achieve a well graded, free flowing and consistent product. Ensure a maximum size no greater than the maximum size of the asphalt being produced.

RAP material must not contain tar binder and must be free of contaminants such as unbound granular base material, concrete, clay, soil, organic matter or any other deleterious material.

Processed RAP material must be placed in separate stockpiles prior to use. Where RAP material has been stockpiled for some time and is no longer in a free-flowing condition, reprocessing must be undertaken to ensure that it is free flowing at the time of incorporation into the manufacturing of new asphalt materials.

RAP addition in manufactured asphalt must not exceed:

- 15% by mass in base layers, and
- 10% by mass in the wearing course.

9.4 ASPHALT MIX DESIGN

9.4.1 Mix Type and Design Traffic Category

Refer to Construction Drawings for mix type.

Refer to *Table 9-1 - Mix Type and Binder Type for Traffic Categories Designation* for traffic category, binder type and aggregate size for different mix types.

9.4.2 Design Mix Requirements

All asphalt mixes proposed for use must be a Registered Mix Design with Department of Logistics and Infrastructure.

Where a new design mix is proposed, the Developer must register the mix in accordance with the Department of Logistics and Infrastructure's Code of Practice for Registration of Asphalt Mix Designs.

Documentation Point 37 – Obtain approval for asphalt materials and mix designs prior to use in the Development Works.

Approval of the Registered Mix Design for use does not relieve the Developer from employing suitable manufacturing and handling techniques to ensure performance of the mix. The Developer is also accountable for rectification of Defects should the mix not perform.

The manufacturer must notify the Relevant Authority of any proposed changes to the components or proportions of components used in the Registered Mix Design.

Where it is proposed to change the source grading or nature of the components or binders, new mix designs must be carried out and Approved.

Documentation Point 38 – Obtain approval for amendments to the Approved asphalt materials and mix designs prior to use in the Development Works.

Registration of mix designs must be renewed every 2 years from the date of acceptance.

If a Registered Mix Design has unsatisfactory handling or field performance, the Developer, Certifying Engineer or Relevant Authority may request the mix be de-registered.

9.5 PAVING PLANS

Submit detailed Paving Plans within 21 Calendar Days of Relevant Authority providing Notice of Acceptance, with detailed diagrams in a form of aerial photographs, design drawings or similar and daily tonnages of the works – see below for minimum requirements.

- Date, Shift number - relate this to the paving plans, time of works, tonnes of Asphalt, square metres.
- Ensure paving run numbers are shown on plan diagrams.
- Paving Plan must be accurate to allow for efficient Communications planning.
- Submit paving / section plan in Excel, editable format.
- Submit detailed pictures of the sites with reference to the shift number and date.
- All paving plans are to be aligned with the TGS.

Make allowances under Provision for Traffic for mandatory attendance of WZ1 traffic scheme designer to be onsite at all times while works are being carried out.

9.6 SURFACE PREPARATION

9.6.1 New Construction

Inspection Point 18 - Provide notice of the scheduled commencement time of surface preparation works for each asphalt work program.

The Developer must prepare existing surfaces to ensure that asphalt construction can be completed in accordance with the requirements of This Specification. The Developer must:

- ensure that the surface has been adequately prepared so that the specified asphalt material density can be achieved;
- ensure that the surface has been adequately prepared to achieve shape and level requirements where required;
- ensure that the exposed granular base layer is tightly bound and free from vegetation and other foreign matter;
- ensure there are no laminations or false Pavements within the exposed surface;
- remove all foreign matter by sweeping or other means; and
- ensure that exposed granular layers have sufficiently dried back to the requirements of *Clause 6.5.5 - Final Pavement Layer Integrity Requirement* prior to the application of the bituminous spray Primerseal.

The Developer must apply a bituminous Spray Seal Prime coat to the exposed granular surface as specified in SPRAY SEALING. Allow for curing time, as specified, prior to application of asphalt.

Refer to Construction Drawings for details of the bituminous Seal.

Prior to laying base or wearing surface asphalt all depressions greater than 15 mm must be filled with an asphalt correction course layer. Minimum asphalt layer thicknesses must be observed during this procedure.

9.6.2 Resurfacing of Existing Surfaces

All vegetation and loose and extraneous matter must be removed prior to the application of bituminous resurfacing materials.

Depressions greater than 25 mm must be filled with an asphalt correction course layer. Minimum asphalt layer thicknesses must be observed during this procedure.

9.6.3 Tack Coat

Apply a fine spray of bitumen emulsion lightly and evenly over the whole of the area to be covered with asphalt at a rate of 0.3 litres/m2 unless otherwise directed by the Certifying Engineer.

The Pavement must be dry and dust free before any application of tack coat.

Apply tack coat by spray bar fitted to mechanical sprayer. Hand spray only in areas where it is impractical to use a spray bar.

Protective splash boards or spray skirts must be used to eliminate over spray beyond the surface where tack coat is being applied.

Allow the tack coat to ‘break' before laying the asphalt.

Clean and tack coat existing surfaces against which new work is to be laid.

Re-apply tack coat where damaged by construction traffic or weather.

9.7 MIXING

Asphalt materials must be manufactured in a plant capable of consistently producing asphalt that complies with the Approved Registered Mix Design. The asphalt material must meet manufacturing temperature requirements outlined in *Table 9-5 – Acceptable Temperature Ranges by Materials*.

9.7.1 Asphalt Material Storage

Asphalt may be stored in hot storage facilities for a period not exceeding 24 hours from the time of manufacture.

9.8 TRANSPORT AND SUPPLY

9.8.1 Transport

Asphalt materials must be transported by trucks with clean trays which permit seamless discharge of the asphalt material to the receiving hopper. All transport vehicles must be free from oil leaks.

The asphalt material must be covered with suitable tarps to reduce the rate of cooling during transport.

Delivery trucks must be fitted with adjustable tailgate(s) to allow control of the mix during discharge into the receiving hopper.

All delivery dockets must provide information that can trace each load to the manufacturing cycle and also point of placement.

Delivery dockets must record:

- Unique Docket Number
- Time of Departure
- Temperature at point of discharge from the manufacturing plant
- Product Type and Bitumen Type
- Mass of Materials – Individual load tonnage and cumulative tonnage

9.8.2 Rate of Supply

The frequency of asphalt material deliveries must be planned to achieve a uniform rate in line with the capacity of spreading and compaction processes.

Rate of delivery must allow continuous placing of the asphalt material having regard to;

- the number of haulage vehicles available; and
- the haulage distance to the work site.

Cooling must be minimised by prompt delivery and placement of the asphalt material at the Development Site.

9.9 SPREADING

9.9.1 General

Inspection Point 19 - Provide notice before commencement of asphalt material spreading.

The asphalt material must be laid at a uniform thickness to the tolerances listed in *Table 9-6 – Finished Pavement Properties*. The paving operation must be one continuous operation where practicable. Where a break in paving occurs due to a planned stop or prolonged delay period, a transverse joint must be constructed.

Asphalt that has cooled below acceptable initial rolling temperature(s) must be removed from the Development Site and replaced prior to initial rolling.

Asphalt must not be laid when rain is imminent. Paving must cease during heavy or continuous rain, or in wet conditions where the material will not adhere or key to existing surfaces.

Remove from the Development Site all rain affected and/or temperature depleted materials.

9.9.2 Mechanical Spreading

Paving machines must be self-propelled and equipped and operated with an electronic levelling apparatus.

Where limited quantities of asphalt are required, or the area to be paved is restricted or of limited width, such as footpaths or parking areas, other spreaders Approved by the Relevant Authority may be used.

9.9.3 Hand Spreading

Hand spreading will be permitted only in locations where spreading with a paving machine is impractical. Hand spreading may be used to correct localised depressions and/or irregularities.

Spreading of excess material over newly placed asphalt during joint matching is not permitted. All excess material must be removed and discarded from the Development Site.

Broadcasting of asphalt over the mat is not permitted at any time.

9.9.4 Laying Pattern

Work must be completed as one continuous operation where practicable.

Documentation Point 39 - Submit a construction program and paving plan minimum 7 Calendar Days prior to commencement of asphalt works. Paving plans must be confirmed prior to the commencement of each work shift.

Laying patterns are not to have longitudinal joints programmed to be left as cold joints. Full width paving must be programmed.

9.9.5 Construction Joints

Paving plans must detail the construction processes and procedures. Use processes and procedures which minimise longitudinal and transverse construction joints.

Longitudinal joints must be located within the lane line of the Pavement or the traffic sump line.

Longitudinal joints must not be located under wheel paths.

Longitudinal joints must be laterally offset by 100 mm and transverse joints by 500 mm when paving multiple layers.

Construction joints must be minimised within intersections, and within braking zones in approaches to intersections, and within acceleration zones of intersections.

During paving, overlap each adjoining lane by at least 25 mm to form an even transverse surface. Proud asphalt material must be raked back immediately to form a ridge along the top of the joint. Where excess material remains in place, this material must be removed from the joint area prior to compaction rolling. Following rolling the resultant joint must be smooth and of similar texture to the Pavement in general.

9.9.6 Transverse Joints

Form transverse joints by cutting with a purpose-built asphalt cut off wheel, or diamond saw, or profiler, to form a vertical face. All waste asphalt is to be removed from the Development Site.

When constructing transverse joints, ensure that the joint and the approaches to the joint do not deviate more than 5 mm under a 3 metre straight edge. Cut back existing Pavement to a true level surface with no deviation. Cut back must be a minimum of 200 mm or be sufficient in length to match existing Pavement levels and to also maintain cross-falls.

Transverse joints include joints created where a paving machine has stopped in any surfacing works.

Exposed joint faces must be treated with bitumen emulsion tack coat prior to placing asphalt against them.

Offset transverse joints in adjacent runs by 1m minimum.

Transverse Match of Overlay to Existing Pavement:

- Saw cut existing asphalt Pavement 20 mm depth along the match line of joint.
- Remove taper wedge of existing asphalt Pavement along the overlay side of match joint.
- Feather the asphalt overlay down to the existing Pavement to achieve a maximum slope of 1 in 10 and for the full width of the Pavement.
- Ensure depth of overlay above existing Pavement in taper wedge area is not less than 20 mm.

9.9.7 Longitudinal Joints

Documentation Point 40 – Provide a plan showing all proposed longitudinal joints in asphalt works. The plan must be Approved prior to the relevant works commencing.

Do not leave unfinished longitudinal joints. Where in unforeseen circumstances longitudinal joints must be left unfinished, the Development Site must have traffic management in place, with traffic management personnel onsite, until the joint is finished.

All longitudinal joints must be parallel to and follow the shape of the street alignment, unless directed otherwise by the Relevant Authority.

Edges must not remain unsupported unless directed otherwise by the Relevant Authority. Unsupported edges must be cut back at least 75 mm if adjacent runs are not paved within the time taken to cool below acceptable paving temperatures.

All unsupported edges left over-night must have tapered edges and must be cut back prior to paving adjacent runs.

All open faces must be treated with bitumen emulsion tack coat prior to paving.

9.9.8 Temporary Ramps

Provide compacted asphalt ramps measuring a maximum 1% grade relative to existing surrounding Pavement grades, where transverse joints are left overnight under traffic.

Longitudinal ramps must be a minimum of 300 mm wide under traffic, and must be visually monitored at all times for the period the ramps are in use.

9.10 COMPACTION

9.10.1 Compaction Generally

All plant and equipment used for the execution of the Development Works must be free of oil and fuel leaks.

Compaction methodology must be used so that rollers do not stop on the hot new asphalt surface.

Defer rolling if excessive displacement of the asphalt occurs but only until the asphalt has cooled sufficiently to permit rolling to continue.

The depth of each layer compacted must not exceed 5 times the nominated aggregate maximum size.

9.10.2 Compaction Temperatures

Compaction must be completed prior to cooling of the asphalt material below temperatures at which point the material may be damaged by rolling or at the point at which densification ceases.

9.10.3 Initial Rolling

Initial breakdown rolling must commence immediately following asphalt placement behind the spreader using a steel wheeled roller. Initial rolling must not result in adverse displacement or cracking.

Steel wheeled rollers must be fitted with adjustable scrapers and the drums must be kept moist with water to prevent the mix from sticking to the drums.

9.10.4 Intermediate Rolling

Self-propelled pneumatic tyred rollers with the same tyre pressure in all compacting tyres must be used for intermediate rolling. Rollers must be fitted with water lubricant systems that stop the asphalt sticking to the rubber tyres. Do not use detergents or other chemicals for lubrication. Sand may be spread on the new asphalt to prevent the asphalt sticking to the tyres. Rolling must be completed during applicable material temperatures.

9.10.5 Final Rolling

A static steel wheeled roller must be used during final rolling. This procedure must remove all roller marks from the surface to ensure a smooth even surface.

9.10.6 Joint Compaction

All joints and free edges must be constructed and compacted to obtain acceptable surface texture.

Offset transverse joints in adjoining runs by 1 m minimum.

Rolling of unsupported edges must not result in shape loss and/or excessive lateral displacement.

Finished joints must obtain a smooth even surface which does not exceed 5 mm deviation under a 3 m straight edge.

Test all joints for straight edge compliance immediately as a joint is created.

9.10.7 Hand Tampers

Compact asphalt materials by vibratory plates or hand tampers in locations inaccessible to rollers. Finish hand tamped surfaces to a smooth even surface conforming with machine finished areas.

All free edges not laterally supported are to be pushed up with a heavy hand rake and tamped, to form a firm and cohesive edge of not less than 60^{o} slope prior to rolling the free edge or applying the adjacent paving run.

9.11 CONFORMANCE

9.11.1 Conformance Testing

The Developer must undertake internal Process Testing.

The Developer is responsible for carrying out all Conformance Testing of materials and completed Pavement properties.

Bitumen used in the asphalt production must be tested in accordance with *Section 5 – Conformance Testing* and *Section 8 – Spray Sealing*.

Surface roughness testing will be carried out at the discretion of the Relevant Authority.

9.11.2 Process Testing

Supply individual Test Lot process test results daily, for all shifts, including Bitumen and Asphalt results in excel format, at a minimum to AAPA Pavement Work Tips No.15.

Detail individual lots with chainages.

9.11.3 Finished Pavement Properties

The works must conform to the requirements listed in:

Table 6-9 - Relative Height Tolerances for New Works Abutting Existing Works

Table 9-6 – Finished Pavement Properties, and

Table 9-8 – Surface Shape Requirements.

9.11.4 Flood Testing

The Relevant Authority may request the Developer undertake flood testing to show conformance with the specified tolerances as required.

9.11.5 Conformance on Asphalt Production

Conform to the variation limits to the Registered Mix Design shown in *Table 9-9 - Variation Limits To The Registered Mix Design*.

9.11.6 Conformance Sampling and Testing Frequencies

The Developer is responsible for undertaking conformance sampling of asphalt materials taken from trucks at the mixing plant and finished asphalt Pavement in accordance with the requirements of Conformance Testing.

9.11.7 Asphalt Compaction

The Developer must provide details of Test Lots to the Relevant Authority, including:

- map of Lot location(s) relative to land marks including direction;
- Test Lot numbers; and
- Test Lot register.

Test Lots must:

- consist of no more than one work shift's production;
- be continuous; and
- consist of homogeneous material without distinct changes in characteristic properties.

Each Test Lot will be subject to Conformance Testing including:

- asphalt material testing;
- in-situ compaction;
- level compliance where appropriate:
- roughness; and
- visual assessment.

Should the Test Lot under consideration be subdivided then each subdivided Test Lot will be subjected to separate testing.

Non-conforming Test Lots, which are subdivided must be retested individually following subdivision.

Core sample locations must be selected by the laboratory on a stratified random basis in accordance with NTCP 103.1. Supply copies of the completed stratified random selection with each compaction report.

Carry out density testing as soon as practicable after completion of works. The work represented by a Test Lot will be assessed as the characteristic value of in-situ air voids where the Characteristic Value of Air Voids is calculated in accordance with Conformance Testing.

Conform to *Table 9-10 - Characteristic Value of Air Voids*.

Clause 5.8.3 - Conformance of Compaction of Asphalt only applies for specified asphalt thickness greater than or equal to 30 mm.

9.11.8 Ride Quality

Surface roughness testing is to be carried out as directed by the Relevant Authority. Where required, comply with the following.

Conform to *Table 9-7 - Surface Roughness Tolerances*.

Surface roughness tolerances represent an absolute upper limit and all field values must be less than the values specified. Test Lotting and averaging out of field values is not permitted.

As a minimum, data must be collected before application and after completion of the final wearing surface.

Ensure that the Pavement and/or wearing surface is free of loose material, debris and standing water when testing is undertaken.

Rectify all areas where Surface Roughness exceeds specified level.

The following areas are excluded from the requirement to achieve specified IRI limits:

- Roundabouts;
- Railway lines (35 m after the event);
- Bridge joints (35 m after the event);
- Intersections (stop bar to stop bar);
- Inspection pit covers and related surface Defects within the wheel paths (15 m including the event);
- Surface Defects related to existing Culverts which are not part of the works (width of Culvert plus 30 m after the event); and
- Cattle grids.

Table 9-1 - Mix Type and Binder Type for Traffic Categories Designation			
Traffic Category	**Mix Type**	**Application**	**Binder Type**
Light	1 & 2	Cycle paths and pedestrian traffic	Class 320 or S10E
Medium	2, 3 & 6	Car parking and low volume Traffic and Car Parks	Class S10E
Heavy	3	Regional rural subdivisions outside urban areas, and regional rural asphalt	A20E
Heavy	5	All Urban Roads and Intersections and Industrial Estates	A15E
All	4	Structural layers	A15E

Table 9-1(2) Mix Type Designation						
Mix Type	**1**	**2**	**3**	**4**	**5**	**6**
Aggregate Size (mm)	7	10	14	20	14 (A15E)	10 (Car Park)

Table 9-2 - Properties - Coarse Aggregates		
Item	Acceptance Criteria	Test Method
Proportion of misshapen particles	15% max. at 2:1 calliper ratio	AS 1141.14
Los Angeles Abrasion	35% maximum loss	AS 1141.23
PAFV	45 minimum	AS 1141.41 & AS 1141.42
Wet Strength	150 kN minimum	AS 1141.22
Wet/Dry Strength Variation	35% maximum	AS 1141.22
Dry Density	Report	AS 1141.6.1
SSD Density	Report	AS 1141.6.1
Water Absorption	Maximum 2.5%	AS 1141.6.1

Table 9-3 - Properties - Fine Aggregates		
Item	Acceptance Criteria	Test Method
Soundness	≤12% weighted loss	AS 1141.24
Dry Density	Report	AS 1141.5
SSD Density	Report	AS 1141.5
Water Absorption (crushed materials)	3.0% maximum	AS 1141.5
Water Absorption (Quartz Sands)	1.5% maximum	AS 1141.5

Table 9-4 – Properties of Polymer Modified Binders for Asphalt Applications						
Test Method	**Binder Property**	**Class**				
		A35P	**A25E**	**A20E**	**A15E**	**A10E**
AS/NZS 2341.4 or AGPT/T111(1)	Viscosity at 165°C (Pa.s) max. (1)	0.6	0.6	0.6	0.9	1.1
AGPT/T122	Torsional recovery at 25°C, 30 s (%)	6-21	17-30	38-70	55-80	60-86
AGPT/T131	Softening point (°C) min.	62-74	52-62	65-95	82-105	88-110
AGPT/T125	Stress ratio at 10 °C min.	TBR(2)	TBR	TBR	TBR	TBR
AGPT/T121	Consistency 6% at 60 °C (Pa.s) min.(3)	1000	400	500	900	1000
AGPT/T121	Stiffness at 25 °C (kPa) max.	120	45	35	30	30
AGPT/T108	Segregation (%) max.	8	8	8	8	8
AGPT/T112	Flash point (°C) min.	250	250	250	250	250
AGPT/T103	Loss on heating (% mass) max.	0.6	0.6	0.6	0.6	0.6

Table 9-5 – Acceptable Temperature Ranges by Materials		
Material	**Minimum Manufacturing Temperature (°C)**	**Maximum Manufacturing Temperature (°C)**
Class 320 Bitumen	150	170
A20E PMB	160	175
A15E PMB	160	175
Asphalt at discharge from asphalt mixing plant	135 *	170
* Minimum of 130 °C when produced as Warm Mix Asphalt. The Developer must retain records of temperatures with Test Lot Testing records.		

Table 9-6 – Finished Pavement Properties	
Finish Pavement surfaces smooth, dense, true to shape and to the following tolerances;	
Thickness:	Not less than specified.
Surface levels:	Maximum deviation from design level 0 to +10 mm under a 3m straight edge
Surface roughness:	Comply with ***Table 9-7 - Surface Roughness Tolerances***.
Contamination from chemicals, petroleums (including oils, petrol and diesel) or solvents	Non-conformance – Remove and replace affected areas.
The Developer must retain records of Straight Edge Testing with Test Lot Testing records.	

Table 9-7 - Surface Roughness Tolerances	
Surface Roughness (IRI) to be less than the following limits when surveyed at 50km/hr.	
Street Classification	**Max. Surface Roughness IRI (m/km)**
Minor Street / Access Street	4.2
Secondary Collector / Primary Collector	3.4

Table 9-8 – Surface Shape Requirements		
Layer	**All Roads – Maximum Deviation Below 3m Straight Edge (mm) (to ATM 453)**	
	Parallel to Centreline	**Transverse to Centreline**
Wearing Course	5	7
Intermediate and Base	8	12

Table 9-9 - Variation Limits To The Registered Mix Design	
Grading:	
AS SIEVE (mm)	% PASSING (by mass)
4.75 or larger	+ or - 7
2.36	+ or - 5
1.18 to 0.30	+ or - 4
0.15	+ or - 3
0.075	+ or - 2
Bitumen Content:	Maximum variation 0.3% by mass to the Registered Mix Design.
Maximum Density:	Maximum variation 5% by mass to the Registered Mix Design

Table 9-10 - Characteristic Value of Air Voids			
Traffic Category:	Light	Medium	Heavy
Conformance:	3.0 – 8.0	3.0 – 8.0	3.0 – 7.0

10. NON-STRUCTURAL CONCRETE WORKS

10.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1012:	Methods of testing concrete
AS 1141:	Methods for sampling and testing aggregates
AS 1289:	Methods of testing soils for engineering purposes
AS 1379:	Specification and supply of concrete
AS 1478.1:	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS 2350.0:	Method of sampling portland and blended cements – General introduction and list of methods
AS 2350.1:	Method of sampling portland, blended and masonry cements - Sampling
AS 2785.1:	Aggregates for rock for engineering purposes – concrete aggregates
AS 2876:	Concrete kerbs and channels (gutters) – Manually or machine placed
AS 3600:	Concrete structures
AS 3610:	Formwork for concrete
AS 3610.1:	Documentation and surface finish.
AS 3799:	Liquid membrane-forming curing compounds for concrete
AS 3972:	Portland and Blended Cements
AS/NZS 4200:	Pliable building membranes and underlays
AS 4654:	Waterproofing membrane systems for exterior use – Above ground level
AS 4654.2:	Design and installation
AS/NZS 4671:	Steel reinforcing materials
AS/NZS 4680:	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
NTMTM	NT Material Testing Manual
NTTM	NT Test Methods

10.2 GENERAL

This section specifies requirements for minor concrete works including kerbs, drainage inverts, footpaths, and vehicle crossovers. This section does not apply to rigid Pavements, buildings, bridges or other structural works.

Refer to *Clause* 5.7 – *Tables - Test Frequencies, Conformance Testing*.

Refer to *Section 11 - Structural Concrete Works* for specifications on structural concrete.

10.3 CONCRETE SUPPLY AND PLACEMENT

Generally, conform to AS1379 and AS3600.

Conform to *Section 11 – Structural Concrete Works*.

10.3.1 Recycled Crushed Glass

Recycled Crushed Glass (RCG) may be used as a replacement of fine aggregate in concrete, where Approved by the Relevant Authority.

Where Approved, use RCG conforming to *Specifications for Recycled Crushed Glass as an Engineering Material - Section 9*.

10.4 FOUNDATION PREPARATION

Rip and compact Subgrade to a depth of 150mm to achieve min 95% Relative Compaction.

Provide min 50 mm thick sand for all concrete Pavements. Sand bedding must be either:

- clean washed compacted river sand, free from debris and organic materials; or
- manufactured sands from fine crushed rock ('cracker dust') conforming to the material properties specified in *Table 6-4 – Fine Crushed Rock Properties* and the grading in *Table 10-1 – Manufactured Sand Grading*:

Table 10-1 – Manufactured Sand Grading

AS Sieve (mm)	Percentage Passing
6.7	100
4.75	90 - 100
2.36	70 - 100
1.18	40 - 90
0.600	15 - 80
0.300	5 - 40
0.150	0 - 25
0.075	0 - 15

Where damp proof membranes are not specified, moisten the sand bedding sufficiently in advance of placing to ensure a firm, uniform moist surface at the time of placing.

Remove loose material and debris from the surface. Do not operate construction equipment on the prepared surface.

10.5 DAMP PROOF MEMBRANES STANDARDS

10.5.1 Schedule

Location:	As shown on Construction Drawings
Membrane type:	Polythene Builders Film
Proprietary item:	Fortecon (or similar)
Total thickness:	200µm

10.5.2 Placement

The laying of damp proof membranes must be strictly in accordance with the manufacturer's requirements.

All joints must be lapped for a minimum 300 mm and securely sealed with pressure tape. Care must be taken in placing the membrane to avoid creases and wrinkles.

Prior to the concrete pour, the membrane must be inspected, and any punctures or tears repaired.

10.6 REINFORCEMENT AND FORMWORK STANDARDS

Conform to *Section 11 – Structural Concrete Works* generally.

Construct kerbs and inverts as integral units by extrusion using a kerb machine. Comply with *AS 2876: Concrete kerbs and channels (gutters) – Manually or machine placed*.

10.7 JOINTS

10.7.1 Expansion joints

Locations

Provide expansion joints as follows:

- Footpaths/Shared Paths: 6 m max spacing
- Inverts: 15 m max spacing
- At all junctions with other concrete structures or services
- As shown on the Construction Drawings

Details

Conform to Standard Drawings for footpaths and shared paths.

Conform to the following for kerbs / inverts:

- Joint Filler: use 20 mm thick Bitumen Impregnated Ableflex closed cell compressible filler strip (or similar Approved).

Form the edge of the concrete placed first to provide a smooth vertical face. Fix the joint filler with waterproof adhesive.

- Once concrete has been poured and hardened, detach the removable top strip of the Joint Filler and fill with Fosroc Thioflex 600 (or similar Approved) joint sealant.

Conform to Construction Drawings otherwise.

10.7.2 Contraction joints

Locations

Provide contraction joints as follows:

- Footpaths: 2m spacing maximum
- Kerbs / Inverts: 3m spacing maximum
- As shown on the Construction Drawings

Details

Conform to Standard Drawings for footpaths and shared paths.

Conform to the following for kerbs / inverts:

- Form weakened plane joints to a width of 3 mm and a depth at least one quarter of the depth of concrete.

Withdraw the former during finishing and tool the joint to a 6mm radius.

Conform to Construction Drawings otherwise.

Where Approved, contraction joints may be constructed by sawing the hardened concrete.

Documentation Point 41 – Obtain approval for use of saw cut joints, prior to use in the Development Works.

10.7.3 Construction joints

Terminate each day's placing with a construction joint coinciding with a contraction joint or expansion joint.

Where fresh concrete is to be placed against hardened concrete, scabble and clean the existing concrete surface prior to casting. Ensure that the joints are saturated and the joint surface is dry ('Saturated Surface Dry') prior to casting the second pour.

10.8 FINISHES

Immediately after compaction of the concrete, carry out transverse finishing using a vibrating screed followed by hand finishing and broom finishing. Produce surfaces to tolerance Class U3, as defined in *Clause 11.11.2 - Unformed Surfaces*.

Hand finish: Eliminate minor irregularities and score marks with hand operated long handled floats.

Broom finish: When most of the water glaze or sheen has disappeared and before the concrete becomes non-plastic, texture the whole surface of the Pavement at right angles to the direction of the placing of the concrete using coarse brooms at least 500 mm wide with bristles made of nylon or flexible wire. Wash brooms regularly to remove slurry.

Joints and edges: Finish with a jointing tool.

Finished Pavement surface: Provide a surface uniform in appearance and free from depressions

in which water can pond, with an average texture depth of 2 mm to 2.5 mm.

Remove and replace rain damaged concrete.

10.9 CURING

Concrete works to be moist cured for at least 72 hours immediately after the concrete has taken its initial set.

Do not use curing compounds in lieu of moist curing unless Approved by the Relevant Authority.

10.10 CONFORMANCE

Refer to *Clause 11.13 – Conformance*.

Conform to *Table 10-2 - Tolerances for Miscellaneous Concrete Works*.

Table 10-2 – Tolerances for Miscellaneous Concrete Works

Aspect Measured	**Tolerance**
Finished level	±15 mm from specified level
Invert level	±5 mm from specified level
Straight edge deviation of surface	3 mm max. in 3 m
	6 mm max. in 15 m
Alignment	±10 mm from the specified alignment
Chainage at vehicle crossing	±150 mm
Width of vehicle crossing	± 25 mm

11. STRUCTURAL CONCRETE WORKS

11.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1012:	Methods of testing concrete
AS 1141:	Methods for sampling and testing aggregates
AS 1289:	Methods of testing soils for engineering purposes
AS 1379:	Specification and supply of concrete
AS 1478.1:	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS 2349:	Method of sampling Portland and blended cements
AS 2350.0:	Method of sampling portland and blended cements – General introduction and list of methods
AS 2350.1:	Method of sampling portland, blended and masonry cements - Sampling
AS 2785.1:	Aggregates for rock for engineering purposes – concrete aggregates
AS 2876:	Concrete kerbs and channels (gutters) – Manually or machine placed
AS 3600:	Concrete structures
AS 3610:	Formwork for concrete
AS 3610.1:	Documentation and surface finish.
AS 3799:	Liquid membrane-forming curing compounds for concrete
AS 3972:	Portland and Blended Cements
AS/NZS 4200:	Pliable building membranes and underlays
AS 4654:	Waterproofing membrane systems for exterior use – Above ground level
AS 4654.2:	Design and installation
AS/NZS 4671:	Steel reinforcing materials
AS/NZS 4680:	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
NTMTM	NT Material Testing Manual
NTTM	NT Test Methods

11.2 GENERAL

This section specifies requirements for typical structural concrete works associated with Subdivisions. It does not apply to buildings or bridges.

11.3 CONCRETE QUALITY CONTROL

11.3.1 Responsibility

The Developer is wholly responsible for the supply of concrete and construction of concrete works in accordance with This Specification and the Construction Drawings.

11.3.2 Concrete Quality Plans

The Developer must submit a Concrete Quality Plan to the Relevant Authority and Certifying Engineer including, but not limited to the following:

- Concrete Placing Method Statement; and
- Pre-pour Check List.

Documentation Point 42 – Submit a Concrete Quality Plan for approval prior to commencing any concreting operations.

Acceptance of these plans does not relieve the Developer of responsibility to ensure the concrete works comply with the requirements of this Specification.

11.3.3 Certifications

All concrete supplied must, at arrival on site, be supplied with batch plant certificates for the respective batches. Batch certificates must contain all information about the concrete supplied as required by AS1379 and This Specification.

The plant from which the concrete is supplied must be certified to ISO 9001.

11.3.4 Sampling and Testing

Compressive strength

Sample, test, and assess: To AS 3600 and

AS 1379.

Project assessment: Required.

Documentation Point 43 – Obtain approval for the method of concrete strength assessment, prior to ordering concrete.

Production assessment may be used if applicable and if the project is registered with the concrete producer for dissemination of production assessment statistics to the Relevant Authority and Certifying Engineer.

Other Quality Parameters

Sample, test and assess: To: AS 1379.

Slump: Test not less than one sample from each batch before placing concrete from that batch in the Development Works. Take the samples at the point of discharge on the Development Site.

Additional tests: None

Rejection

Remove rejected concrete from the Development Site.

Testing Authority

NATA registered.

11.3.5 Inspection and Test Plans

Refer to *Clause 11.13 – Conformance.*

The Developer must prepare Inspection and Test Plans (ITP) for the concrete supply and placement works. No concreting operation must commence before the Concrete Quality Plans have been reviewed and Approved by the Relevant Authority and Certifying Engineer.

Inspections must be undertaken at the following stages:

- Completed formwork, and reinforcement, cores and embedment fixed in place.
- Commencement of concrete placing.

11.3.6 Records

The Developer must keep records of:

- Concrete delivery dockets related to pours and approximate locations in pours;
- Supplier quality statements and records;
- Reinforcement inspections;
- Formwork inspections; and
- Concrete placements.

The Developer must retain on-site records of slump tests, concrete test results, weather conditions under which concrete is placed, and the location of the concrete poured.

11.3.7 Rejection of Concrete

Refer to *Clause 11.13 – Conformance*.

11.4 FOUNDATION PREPARATION

Rip and compact Subgrade to a depth of 150mm to achieve min 95% MMDD compaction.

Provide min 50mm thick sand for all concrete Pavements. Sand bedding must be either:

- clean washed compacted river sand, free from debris and organic materials; or
- manufactured sands from fine crushed rock ('cracker dust') conforming to the material properties specified in *Table 6-4 – Fine Crushed Rock Properties* and the grading in *Table 11-1 – Manufactured Sand Grading*.

Where damp proof membranes are not specified, moisten the sand bedding sufficiently in advance of placing to ensure a firm, uniform moist surface at the time of placing.

Remove loose material and debris from the surface. Do not operate construction equipment on the prepared surface.

Table 11-1 – Manufactured Sand Grading	
AS Sieve (mm)	Percentage Passing
6.7	100
4.75	90 - 100
2.36	70 - 100
1.18	40 - 90
0.600	15 - 80
0.300	5 - 40
0.150	0 - 25
0.075	0 - 15

11.5 DAMP PROOF MEMBRANES

11.5.1 Schedule

Location:	As shown on Drawings
Membrane type:	Polythene Builders Film
Proprietary item:	Fortecon (or similar)
Total thickness:	200µm

11.5.2 Placement

The laying of vapour barriers and waterproofing membranes must be strictly in accordance with the manufacturer's requirements.

All joints must be lapped for a minimum 300 mm and securely sealed with pressure tape. Care must be taken in placing the membrane to avoid creases and wrinkles.

Prior to the concrete pour, the membrane must be inspected, and any punctures or tears repaired.

11.6 REINFORCEMENT

11.6.1 General

Supply and fix reinforcement, including tie wires, support chairs, spacers and accessories.

11.6.2 Storage

Reinforcement must, upon delivery to the Development Site, be stored on blocks or racks clear of the ground and must be protected to prevent accumulation of dust and other harmful substances.

Reinforcement must be readily identifiable as to grade and origin, with different types and sizes of reinforcement stored separately and clearly marked.

11.6.3 Cleaning

Reinforcement must be supplied and maintained free from loose mill scale, loose rust, mud, oil, grease and other coatings which would reduce the bond with the concrete.

11.6.4 Cutting and Bending

Unless shown otherwise, the reinforcement must be accurately cut, bent, and fabricated to the shapes and sizes shown on the Construction Drawings and to the dimensional tolerances allowed by AS 3600.

Documentation Point 44 - Reinforcing bars must be bent cold in a manner that will not damage them, unless a written Approval for hot bending is obtained.

Documentation Point 45 - Any reinforcing bar that has already been bent must not be re-bent at the site of the original bend without Approval.

Documentation Point 46 - Flame cutting of reinforcing steel is not allowed without prior Approval.

11.6.5 Cover Requirements

Minimum cover to reinforcement must be as specified on Construction Drawings, and taken to include negative tolerances as detailed in AS 3600.

Cover to reinforcement must be inspected as part of the pre-pour inspection. Any non-conformance must be fixed prior to concrete pour.

11.6.6 Supports

Any metal device used for connecting bars or for maintaining reinforcement in the correct position must not remain within the specified minimum concrete cover to reinforcement except where expressly instructed by the Certifying Engineer or provided for herein.

For concrete works cast on ground, bar chairs and other support legs must be placed on plastic discs to prevent damage to the membrane and/or sinking into the ground.

Secure reinforcement and bar or mesh reinforcement supports to prevent displacement during construction and concrete placement. Use plastic reinforcement supports.

11.6.7 Splicing

Splicing of reinforcement must be by lapping and must be in accordance with Section 13 of AS 3600, unless otherwise shown on the Construction Drawings or Approved by the Relevant Authority.

Mechanical splices must be used only where shown on the Construction Drawings.

Welded steel wire fabric (or mesh) must be lapped as detailed on the Construction Drawings and where not detailed must overlap by at least one complete mesh on all sides such that the end cross wire of one sheet overlaps with the second end wire of the adjacent sheet.

11.6.8 Fixing

Reinforcement must be accurately placed as shown on the Construction Drawings or as directed by the Certifying Engineer, and must be securely tired and held in position so that it will not be displaced during construction and concrete placement.

Bar crossings must be secured with at least one turn of soft galvanised annealed tying wire of 16 s.w.g. (1.5 mm diameter); the ends of the tie being twisted and turned down into the work. Patent ties may be used for securing bars, but the Developer must obtain Approval from the Certifying Engineer for the type and number to be used.

11.6.9 Welding

No welding of reinforcement is allowed, unless Approved by the Relevant Authority and Certifying Engineer in writing.

11.6.10 Tolerances

Unless shown otherwise, the reinforcement must be cut, bent, and fabricated to the dimensional tolerances allowed by AS 3600.

11.6.11 Galvanic Corrosion

Where metals of different types are used together for reinforcement, supports and/or fixings, the Developer must ensure there is no risk of Galvanic Corrosion.

11.6.12 Reinforcement Inspection

Inspection Point 20 - Do not place concrete until the reinforcement has been inspected and Approved.

Reinforcement must be inspected in place and, depending on the type of concrete element, Approved by the Relevant Authority and Certifying Engineer prior to completion of the formwork. The Developer must inspect the reinforcement and correct any Defects prior to requesting an inspection by the Relevant Authority.

11.7 FORMWORK

11.7.1 General

All concrete must be placed in formwork except on the underside of slabs, foundations and the like which are placed directly on the ground, and where suitable precautions have been taken to ensure no loss of moisture to the ground.

All forms and the use of formwork must conform to the current requirements of AS 3610.

All formwork must be designed and constructed to produce concrete members which will conform within the specified tolerances to the shapes, lines, levels, dimensions and surface finish required by the Construction Drawings and This Specification.

11.7.2 Design of Formwork

The Developer is responsible for the design and structural adequacy of all formwork.

11.7.3 Formwork Construction

General

Formwork must be rigidly constructed and ensure that the finished concrete is true to the required shape, position and level, and to the standard of finish specified.

All forms must have joints sufficiently tight to prevent the escape of any mortar, slurry or free water.

Construct forms so that they can be removed without damaging the concrete.

Chamfers

Except where specifically detailed on the Construction Drawings, or where further elements are to be placed against them, all exposed horizontal and vertical arises must have a symmetrical chamfer. This chamfer must be 25mm x 25mm unless detailed otherwise on the Construction Drawings.

Form Ties

Form bolts and ties must be designed and installed so that they may be extracted without damaging the surrounding concrete. All cavities caused by their removal must be degreased, cleaned, wetted and carefully packed with shrinkage compensated mortar that provides equivalent durability to the parent concrete.

Block-outs, Inserts and Embedded Items

Block-outs, inserts and embedded items must be firmly located in a manner such that construction tolerances are complied with.

Embedded metallic items must be isolated from the reinforcing steel and must not encroach on the designated cover unless suitable corrosion protection is applied.

Galvanize ferrous fixings (other than stainless steel) to AS/NZS 4680 or AS 1214. Passivate galvanized surfaces to be embedded in concrete by dipping in 0.2% sodium dichromate solution.

Treatment of Forms

The Developer must select the form lining or facing to produce the required finished concrete surface.

Form linings must be thoroughly cleaned and coated with a suitable release agent prior to placing concrete in compliance with AS 3610 and which will not affect the colour of the finished concrete. No part of the reinforcement or adjacent concrete faces must be coated with release agent. Mould oils must be selected to minimise the formation of bug-holes on the concrete surface.

Prior to concrete pour, forms must be blown out to remove dust, minor debris, and free water.

11.7.4 Formwork Inspection

Inspection Point 21 - Do not place concrete until the formwork has been inspected and Approved.

Should any forms show signs of bulging or sagging after the concrete has been placed, the concrete must be removed as directed by the Relevant Authority and the forms reconstructed to the Relevant Authority's satisfaction.

11.7.5 Removal of Formworks

Stripping and removal of formwork, including timeframes for removal, must comply with AS 3610.

11.8 JOINTS

11.8.1 Joint Locations

Provide joints at locations as nominated on the Construction Drawings.

11.8.2 Joint Details

Refer to Construction Drawings for joint details.

Finish visible jointing material neatly flush with adjoining surfaces.

Before filling joints, dry and clean the joint surfaces, and prime to the manufacturer's recommendation.

11.8.3 Joint Materials

Documentation Point 47 - Submit copies of supplier/manufacturer product data sheets and specifications for all jointing materials.

Comply with those specifications.

Foamed materials: (in compressible fillers); Use closed-cell or impregnated types, which do not absorb water.

Bond breakers: Back-up materials for sealants, including backing rods and the like, must not adhere to the sealant, or be faced with a non-adhering material.

Sealants: Use low modulus self-priming sealant, unless otherwise nominated on Construction Drawings. Colour to match adjoining surface finish.

11.8.4 Construction Joints

Terminate each day's placing with a construction joint coinciding with a contraction joint or expansion joint.

Where fresh concrete is to be placed against hardened concrete, scabble and clean the existing concrete surface prior to casting. Ensure that the joints are saturated and the joint surface is dry ('Saturated Surface Dry') prior to casting the second pour.

11.9 CONCRETE SUPPLY AND PLACEMENT

11.9.1 Ready Mixed Supply

Refer to *Clause 11.3.4* - Sampling and Testing and *Table 5-11 - Sampling Frequencies For Fresh Concrete* in the Conformance Testing section.

Supply concrete with the following properties unless specified otherwise:

Table 11-2 – Concrete Properties	
Property	**Required Measure**
Compressive Strength	N25
Aggregate Size – Generally – Machine Extruded Kerbs and Gutters	 20 mm 10 mm
Slump – Generally – Machine Extruded Kerbs and Gutters	 80 mm ± 15 mm 40 mm

Conduct slump testing on site for each and every truck.

To: AS 1379: Section 5. Nominate the slump and mix proportions prior to supplying any concrete. These values must be used for acceptance or rejection of concrete onsite.

11.9.2 Chemical admixtures

Documentation Point 48 – Obtain approval for the use of concrete admixtures, prior to incorporating them into a concrete mix.

Chemical admixtures for concrete and their use must conform to AS 1478.1.

Where two or more chemical admixtures are proposed for incorporation into a concrete mix, their compatibility must be certified by the manufacturers.

Storage: Store admixtures in accordance with the manufacturers recommendations.

11.9.3 Addition of Admixtures

Chemical admixtures must only be added after slump test compliance confirmation. A further slump test post admixtures addition may also be required.

Where the Certifying Engineer has Approved the addition of superplasticisers at the plant prior to dispatch of any concrete, a slump test of each batch must be performed and recorded by a NATA accredited testing laboratory prior to the addition of the superplasticisers. The slump test report must record the time of the addition of the superplasticisers, amount of the superplasticiser added and product identification.

Chemical admixtures: Admixtures are to be added in accurate amounts. Amounts being added are to be exact and measured using accurate and regularly maintained and calibrated devices.

Delay the addition of superplasticisers as long as practicable before the concrete is discharged from the concrete mixer. Make allowance for the reversion time of superplasticisers.

Agitate concrete for at least 5 minutes following the addition of superplasticiser before dispensing.

11.9.4 Concrete Placing

Inspection Point 22 - Provide notice so that inspection may be made before and during pouring concrete.

Ensure all constituent materials, formwork, falsework, reinforcement, and environmental conditions comply with all requirements prior to casting concrete.

Place and compact concrete within the following time after the addition of the mixing water to the mix:

Table 11-3 – Maximum Time to Place Concrete after Mixing	
Concrete Temp at Time of Placing	**Maximum Time (minutes)**
25°C to 28°C	75
28°C to 32°C	60
32°C to 35°C	45

Fully compact the concrete to remove entrapped air. Avoid over-vibration that may cause segregation.

Place concrete in layers such that each succeeding layer is blended into the preceding one by the compaction process.

Placing slabs and Pavements: Place concrete uniformly over the width of the slab so that the face is generally vertical and normal to the direction of placing.

Place concrete in a continuous operation between construction joints so that the face of the concrete is in a plastic state when succeeding concrete is placed against it.

Do not allow concrete to free-fall from a height greater than 1.5 metres.

Place all concrete in dry weather unless otherwise Approved by the Certifying Engineer.

For each truck of premixed concrete provide an identification certificate on delivery listing the information required by AS 1379.

11.9.5 Hot Weather Placing

The provisions of this clause apply to concreting when the surrounding shaded outdoor temperature is greater than 32ºC.

Mixing: Do not mix concrete when the outdoor shaded temperature on the site exceeds 38oC, unless otherwise Approved and then only subject to such conditions as may be imposed.

Handling: Take precautions to prevent premature stiffening of the fresh mix and to reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete as rapidly as possible.

Placing: Before and during concrete placing maintain the formwork and reinforcement at a temperature not greater than 32°C by protection, cold water spraying, or other effective means. When placed in the formwork, the temperature of the concrete must not exceed 35°C.

Temperature control methods:

Documentation Point 49 - Submit proposed method(s) of maintaining the specified temperatures of placed concrete.

Methods may include:

- using chilled mixing water; or
- spraying the coarse aggregate with cold water; or
- covering the container in which the concrete is transported to the forms; or
- a combination of these methods.

Evaporation Control: Erect barriers to protect freshly laid concrete from drying winds.

Immediately after placement, cover the concrete with an impervious membrane, or hessian kept wet, until curing begins.

As an alternative to immediate covering where temperature exceeds 25ºC or where not protected against drying winds, protect the concrete with a fog spray application of aliphatic alcohol evaporation retardant.

11.9.6 Curing – General

The Developer is responsible for the provision of curing and protection of the concrete meeting the requirements of This Specification and, where more stringent, the requirements of AS 3600.

Curing of the concrete must comprise measures to:

- Prevent plastic cracking in plastic concrete; and
- Ensure specified hardened concrete properties are achieved.

All curing methods are subject to Approval of the Relevant Authority and Certifying Engineer.

11.9.7 Prevention of Moisture Loss from Plastic Concrete

Protection of unformed surfaces from premature drying due to exposure to sun and/or drying winds must be prevented with the use of shades, screens and/or by spraying the exposed surface with an Approved evaporation retarder (e.g. Aliphatic Alcohol).

Any concrete which exhibits plastic drying shrinkage cracking is liable to rejection by the Relevant Authority.

11.9.8 Prevention of Moisture Loss from Hardened Concrete

Protect and cure all exposed surfaces immediately after the concrete has taken its initial set.

During the curing period continuously maintain the concrete, with minimum moisture loss, at a reasonably constant temperature, not excessively hot or cold, by a suitable method which may include the following:

- Ponding or continuous sprinkling with water (wet curing).
- An impermeable membrane.
- An absorptive cover kept continuously wet.
- An Approved curing compound.

Documentation Point 50 – Obtain approval for the use of curing compounds on concrete, in lieu of moist curing, prior to placing the relevant concrete works.

Prevent staining during the curing process of all concrete surfaces that will be visible in the completed works.

Continuously maintain the protection and curing of each element for the minimum time specified by AS 3600 to provide the concrete with durability corresponding to the specified exposure classification, or minimum 3 Calendar Days (whichever is greater).

Curing compounds, where Approved for use, must comply with AS 3799. Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to toppings such as concrete toppings and cement-based render. Apply as a continuous coating without visible breaks or pinholes, at the rate recommended by the manufacturer.

11.9.9 Protection of Concrete Surfaces

The Developer must protect all finished concrete surfaces from damage and staining from any source. Any damages or staining must be removed or made good to the satisfaction of the Relevant Authority.

11.10 PRECAST CONCRETE

Documentation Point 51 – Obtain approval for all precast concrete works prior to manufacturing.

Where Approved, precast concrete must generally comply with all other requirements specified in this Section, AS 3850 and the following clauses.

11.10.1 Manufacture

Precast concrete units must be designed and fabricated by an experienced and acceptable precast concrete manufacturer.

Lifting devices must be designed in accordance with precast industry design standards. The precast manufacturer must supply structural engineering Certification confirming adequacy of proposed lifting devices.

Design must consider stresses induced during handling, shipping and installation to avoid product cracking or other handling damage.

Casting methods must be designed to ensure that no damage occurs to the units.

Documentation Point 52 - Submit the following items 5 Business Days prior to fabrication of the precast concrete item commencing:

- Shop drawings, including installation and construction requirements;
- Product data sheets and installation instructions for anchors, lifting inserts and other devices;
- Concrete production and placing method statements;
- Copies of material certifications and/or laboratory test reports for all materials used in construction, finishing and curing of the precast concrete; and
- Recent in-plant QA/QC inspection reports.

The units must be free from any grout loss, honeycombing, cracking or spalling. Units with Defects of this nature must be rejected.

All units must be marked such that it can be related to shop drawings and other quality control reports, including an identification mark and the production date.

Manufacture the units accurately. Fix the units securely and accurately in their final positions. Supply components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar.

Consider the strength of the units and all forces and loads that will possibly be imposed on the units prior to being finally fixed in final position, and make appropriate allowances when handling, transporting and placing.

11.10.2 Handling, Storage and Delivery

Precast concrete units must be handled, stored and transported in a manner to minimise damage.

Units must only be lifted from the specified lifting points.

Units must not be handled or transported until they have reached sufficient strength, as determined by the manufacturer, to ensure no damage to the units will occur.

Documentation Point 53 – Submit evidence that all precast concrete units have been inspected and signed-off by the manufacturer's inspector, in a format to be Approved, prior to delivery of the unit to the Development Site.

Any units damaged during handling, storage or delivery must be replaced.

11.10.3 Installation

Precast concrete units must be installed to the lines and grades shown in the Construction Drawings.

Precast concrete units must be lifted by suitable lifting devices at Certified points provided by the precast concrete manufacturer.

The precast concrete manufacturer must provide installation instructions, in accordance with industry standards. The Developer must ensure all installation instructions are followed.

No precast concrete units are to be lifted until a structural engineering Certificate is provided by the manufacturer, confirming the lifting devices are adequate and the proposed method of erection will not cause damage or overstress of the units.

11.11 SURFACE FINISHES

11.11.1 Formed Surfaces

All formed concrete surfaces are to be Class 3 in accordance with AS3610, unless noted otherwise in the Construction Drawings.

Any remedial treatment to formed surfaces must be agreed with the Relevant Authority and Certifying Engineer following inspection immediately after removing the formwork and must be carried out without delay unless otherwise specified or directed.

Apart from the filling of minor surface blemishes, as provided for above, plastering of Defective concrete as a means of making good is not permitted.

11.11.2 Unformed Surfaces

Unformed surfaces are limited to the top faces of slabs and those permanently concealed surfaces which could be constructed to within the required tolerances without formwork but subject to

Approval by the Relevant Authority and Certifying Engineer to do so.

Refer to *Table 11-4 – Unformed Concrete Finishes Schedule* for description and tolerances.

All unformed surfaces which are permanently concealed must be of U1 finish. All unformed surfaces which are exposed or above ground must be of U2 (floated) finish, except concrete pavements which must be of U3 (broomed) or U4 (exposed aggregate) finish.

Note tolerances for project specific elements are specified in *Clause 11.12 – Dimensional Tolerances*.

11.11.3 Finishing Methods

Finish surfaces to a smooth and even colour.

Remove free surface water during final screeding of unformed surfaces.

Round off exposed edges and corners.

Protect exposed surfaces from rain until final set has occurred.

Wood float finish: Produce the final finish with a wood float.

Steel trowelled finish: Use steel hand trowels to produce the final finish free of trowel marks and uniform in texture and appearance.

Broom finish: After wood floating, use a broom to produce an even textured slip-resistant surface.

Exposed aggregate finish: After wood floating, apply a uniform coat of surface retarder onto the surface as soon as the initial bleeding of the concrete has finished but before initial set. Protect the sprayed surface from direct sunlight, wind, rain, and dirt by covering with damp proof membranes (or similar). Once adequate time has elapsed, typically 2 to 12 hours depending on concrete type and ambient conditions, remove the soft paste which has formed on the concrete surface using a broom and wash down with clean water to produce an even textured slip-resistant surface. Comply with supplier/manufacturer specifications for use of surface retarders. Ensure that concrete mix supply and placement methods are consistent to produce an exposed aggregate finish with uniform appearance.

Documentation Point 54 – Prior to undertaking concreting works involving exposed aggregate finish, conduct a trial and obtain approval for product selection, application rates, construction methodologies, timeframes for removal of paste, and agreed surface finish quality.

11.12 DIMENSIONAL TOLERANCES

11.12.1 Standard

To: AS 3600 - Tolerances for Structures and Members sub-clause, except where the requirements of this clause or AS 3610.1 - Physical Quality sub-clause are more stringent.

11.12.2 Project Specific Tolerances

Tolerances must be as nominated in *Table 11-5 – Tolerances for Concrete Surfaces, Inserts and Reinforcement***.**

Refer to *Section 13 – Drainage Works* for additional tolerances on kerbs, inverts, Culverts, pipes and drainage structures.

11.13 CONFORMANCE

Concrete which is not placed, cured or finished as specified, does not have the specified strength or other specified properties, is not sound, dense, durable or crack-free will be considered Defective. Defective concrete must be addressed as outlined below.

The Developer must bear all cost and delays resulting from the rejection of concrete and subsequent rectification.

11.13.1 Minor Defects

Where Approved by the Relevant Authority, Minor Defects can be repaired.

The Developer must submit details of all proposed repair procedures for all repair types to the Relevant Authority and Certifying Engineer for Approval. Repaired concrete will be rejected unless the repair method has been Approved.

Approval for repairs will not be given if the Defective area is too extensive or the techniques proposed are not adequate to ensure a visually acceptable and durable repair.

11.13.2 Major Defects

Concrete with Major Defects, where approval for repairs is not granted, must be removed to a point agreed with the Relevant Authority and Certifying Engineer at which a visually and structurally acceptable construction joint can be made, and the Defective element rebuilt.

Table 11-4 – Unformed Concrete Finishes Schedule		
Type	Description	Surface Tolerance
U1	A wood floated finish to produce a uniform surface without surface pitting or cavities.	Max 5mm abrupt; and Max 15mm over a 3m Straight Edge
U2	A high-quality steel floated finish having a dense smooth impervious finish without surface pitting or cavities.	Nil abrupt; and Max 5mm over a 3m Straight Edge
U3	A wood floated surface with a broomed finish.	Max 3mm abrupt; and Max 5mm over a 3m Straight Edge
U4	A wood floated surface with an exposed aggregate finish.	Max 3mm abrupt; and Max 5mm over a 3m Straight Edge

Table 11-5 – Tolerances for Concrete Surfaces, Inserts and Reinforcement			
Type	Irregularity	Formed Finish	Unformed Finish
General Exposed Concrete	Departure from alignment ad grade	+10 mm -10 mm	Refer Table 11.4 – Unformed Concrete Finishes Schedule
	Variations in cross-sectional dimensions	+10 mm -5 mm	
	Straight Edge Deviation	3mm max in 3m 6mm max in 15m	
Inserts	Variations in locations of inserts, block-outs and openings	5 mm	
	Variations in sizes of inserts, block-outs and openings	+5 mm -0 mm	
Reinforcement	Variation in reinforcement cover from that designated	As per AS3600. Note minimum cover nominated is absolute minimum, including negative tolerance.	
	Variation in reinforcement spacing from that designated	20 mm	
	Variation in number of bars based on specified spacing	None	

12. MINOR STEEL WORKS

12.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS/NZS 1111:	ISO metric hexagon bolts and screws
AS/NZS 1163:	Cold formed structural steel hollow sections
AS 1214:	Hot-dipped galvanized coatings on threaded fasteners (ISO metric course thread series)
AS 1252:	High strength steel bolts with associated nuts and washers for structural engineering
AS 1397:	Continuous hot-dipped metallic coated steel sheet and strip – Coatings of zinc and zinc alloyed with aluminium and magnesium
AS/NZS 1554:	Structural steel welding
AS/NZS 1554.1:	Welding of steel structures
AS 1627:	Metal finishing – Preparation and pre-treatment of surfaces
AS/NZS 3678:	Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1:	Structural steel – Hot-rolled bars and sections
AS 4100:	Steel structures
AS/NZS 4600:	Cold-formed steel structures
AS/NZS 4680:	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

12.2 GENERAL

This section details requirements for minor steel works, including but not limited to handrails, guard rails, fencing and ancillaries to civil infrastructure.

This section does not apply to concrete reinforcement or structural steel works.

Inspection Point 23 – Provide notice for commencement of shop fabrication.

12.2.1 Cross References

For reinforcement steel generally, refer to *Section 11 - Structural Concrete Works*.

12.3 DEVELOPER'S SUBMISSIONS

12.3.1 Shop drawings

Shop drawings must contain the following information:

- Relevant details of each assembly, component and connection.
- Amended specification for the fabrication, surface treatment, transport and erection.

Documentation Point 55 - Submit shop drawings for minor streel works prior to fabrication.

12.3.2 Compliance

Documentation Point 56 – Submit evidence that steel used complies with the required material standards, prior to use in the Development Works.

12.4 MATERIALS AND COMPONENTS

12.4.1 Standards

Materials generally: To: AS 4100 - Section 2.

Cold-formed sections: To: AS/NZS 4600.

12.4.2 Steel Grades

Refer *Table 12-1 - Steel Grades* for details.

Table 12-1 - Steel Grades

Type of steel	Standard	Grade
Hot rolled structural bars and sections To: AS/NZS 3679.1 Table 1 – Chemical composition of bars and sections	AS/NZS 3679.1	250
Hot rolled plates, floor plates and slabs To: AZ/NZS 3678 Table 2 – Chemical composition – Mechanical property grades	AS/NZS 3678	250
Cold-formed structural Hollow sections To: AS/NZS 1163	AS/NZS 1163	250 or 350 as available.
Cold formed purlins and girts To: AS 1397	AS 1397	G450 or Z350

12.5 CONSTRUCTION GENERALLY

12.5.1 Availability

If steel members are not available in the required section, grade or length, submit full details of proposal including location of proposed splices or joints and their fabrication details. Approval must be obtained, before substituting other sections or grades or splicing shorter lengths.

12.5.2 Site work

Do not fabricate or weld steel onsite without the approvals of the Relevant Authority.

12.5.3 Identification marks

Provide marks or other means for identifying each member, and for the setting out, location, erection and connection of the steelwork. If the work includes more than one bolting category, mark bolted connections to show the bolting category.

12.6 BOLTED CONNECTIONS

12.6.1 Bolting Category

Refer Construction Drawings for bolting category.

12.6.2 Enlargement of Bolt Holes

Documentation Point 57 – Obtain approval for enlargement of bolt holes, via flame cutting or otherwise, prior to undertaking.

12.7 WELDING

12.7.1 General

All welds must be in accordance with AS/NZS 1554.1.

Documentation Point 58 - Submit a Weld Procedure Specification, prior to commencement of any welding.

12.7.2 Weld category

Refer Construction Drawings for weld categories.

12.7.3 Weld type

Weld type not shown on the drawings: 6 mm continuous fillet weld made using E48XX electrodes or equivalent.

12.7.4 Welding of Reinforcement

No welding of reinforcement is allowed, unless Approved by the Relevant Authority and Certifying Engineer in writing.

12.7.5 Certification of Welders and Welding Supervisors

Welders and welding supervisors must be certified to AS 1554.1.

The Relevant Authority may at any time request to see the “Welder Qualification Records (WQR)” of any welder involved in the steelwork fabrication and/or hold the welding of a test piece.

Do not use welders that are not prequalified for the welding operation they are to perform.

All welding must be carried out under supervision of personnel who have had suitable training and experience in the fabrication of welded structures and who are certified in accordance with AS/NZS 1554.1.

12.7.6 Preparation

Inspect all SP weld preparations to ensure correct setup of root gap and weld preparation size.

A suitably qualified Certifying Engineer must be engaged in accordance with AS/NZS 1554.1 to inspect all weld preparations and Certify their compliance.

Documentation Point 59 – Submit Certification of all weld preparation.

12.7.7 Non-destructive Weld Examination

Standard: To AS/NZS 1554.1, Section 7.

Conform to *Table 12-2 - Non-destructive Weld Examination (NDE)*.

Where possible, place steelwork in a suitable position and orientation to enable testing to be carried out safely.

Methods: Inspect welds in conformance with the Non-destructive weld examination (NDE) table.

Table 12-2 - Non-destructive Weld Examination (NDE)

Type of Weld and Category	Examination Method	Extent of Total Weld Length (%)
GP Shop Fillet Welds	Visual means	100%
SP Welds	Visual; and MPI or Ultrasonic Inspection	Visual – 100% MPI or UI – 10%
SP Welds on Splicing	MPI or Ultrasonic Inspection	100%

Radiographic and ultrasonic inspection: Have the examination performed by an independent NATA registered testing authority.

Documentation Point 60 – Submit Certification of all radiographic and ultrasonic weld inspections, where required.

Repairs: Repair welds revealed as faulty by non-destructive examination and repeat the examination.

12.7.8 Cleaning Welds

Degrease and clean all welds and black metal surfaces. Coat welds done after galvanising with two-pack organic zinc rich primer to APAS Specification 2916, DFT greater or equal to 70µm.

12.8 PROTECTIVE COATINGS

12.8.1 Surface preparation

All steel surfaces must be prepared for protective coatings in accordance with AS 1627. Remove loose mill scale, loose rust, oil, grease, dirt, globules of weld metal, weld slag and other foreign matter.

Time Delay: Apply protective coatings as soon as possible after surface preparation and prior to any deterioration of the surface. If the surface is contaminated or rust bloomed, repeat the surface preparation.

Inspection Point 24 – Do not apply protective coatings to steel works until the surface preparation has been inspected and Approved.

12.8.2 Galvanising

Generally: All exposed steel must be heavy duty hot dip galvanised in accordance with AS/NZS 4680.

Passivation: Galvanised steel to be in contact with concrete to be passivated by dipping in 0.2% sodium dichromate solution.

Shop work: Steel work fabricated offsite must be galvanised and passivated prior to delivery to the Development Site.

12.8.3 Protection and Repairs

Protect the coatings from damage during transport and handling.

After erection/installation, repair any damage to the coatings.

All damaged coatings to be thoroughly wire brushed and treated with two coats (each min 50µm DFT) of two-pack organic zinc rich primer overlapping original coating.

13. DRAINAGE WORKS

13.1 STANDARDS

Conform to the following Standards and Publications unless specified otherwise:

AS 1012(set)	Methods of testing concrete.
AS 1141(set)	Methods for sampling and testing aggregates.
AS 1289(set)	Methods of testing soil for engineering purposes.
AS 1379	Specification and supply of concrete.
AS 1478.1	Chemical admixtures for concrete.
AS 1597(set)	Precast reinforced concrete box culverts.
AS/NZS 2041 (set)	Buried corrugated metal structures.
AS 2349	Method of sampling portland and blended cements.
AS 2350	Methods of testing portland and blended cements.
AS 2439	Perforated plastics drainage and effluent pipe and fittings.
AS 2758.1	Aggregates and rock for engineering purposes - Concrete aggregates.
AS 3600	Concrete structures.
AS 3610	Formwork for concrete.
AS 3706(set)	Geotextiles - Methods of test.
AS/NZS 3725	Design for installation of buried concrete pipes.
AS 3972	Portland 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
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods
AUSTROADS	
AGBT Set	Guide to Bridge Technology.
ARRB	

Specifications for Recycled Crushed Glass as an Engineering Material

WorkSafe Australia Excavation Work Code of Practice

13.2 GENERAL

This section applies to the construction of various drainage works, including the following items:

- Pipes and box Culverts;
- Drainage structures;
- Kerbing / concrete inverts, catch drains, table drains and open drains;
- Inlet/outlet channels;
- Subsoil drains;
- Removal of existing drainage structures; and
- Cleanout and CCTV Inspections.

This section does not cover construction specifications for the following items. Refer to Construction Drawings and Project Specific Requirements for details:

- Floodways;
- Detention basins; and
- Stormwater quality treatment devices.

13.3 CLEARING

Clear the Development Site as specified in *Section 3 – Clearing, Grubbing and Rehabilitation*.

Interfering with a waterway without authorisation is an offence under the Water Act 1992 (NT). All Subdivision works interfering with waterways require a 'Permit to Interfere with a Waterway' pursuant to Section 41(1) of the *Water Act 1992 (NT)*.

13.4 MATERIALS

Undertake all necessary Conformance Testing.

Ensure that all precast items, including pipes and box Culverts, are indelibly marked with a Standards Australia conformance stamp. Precast items not stamped must be removed from the Development Site.

13.4.1 Precast Reinforced Concrete Pipes (RCP or RC Pipe)

Reinforced concrete, including fibre reinforced concrete, manufactured and tested to Australian Standards.

Pipes must be minimum Class 2, unless noted otherwise on Construction Drawings. Pipes to be clearly marked as to their class.

Provide sealed joints, such as Rubber Ring Joints (RRJ) or Flush Joint (FJ) with External Bands (EB).

13.4.2 Precast Reinforced Concrete Box Culverts (RCBC)

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 exposure classification of the site of the works, determined from AS 5100.5 Exposure Classifications Table. Refer to *Section 21 - NT Climate Zones Table*.

Documentation Point 61 - Submit shop drawings for precast reinforced box culverts, prior to fabricating any units.

Shop drawings must:

- show complete reinforcement and dimensions with tolerances;
- Certify that the culverts comply with the applicable sections of AS 5100.5 and with AS 1597; and
- Certify that the culverts are adequate to resist all specified loads and the soil loads pertaining to the Development Site.

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

Inspection Point 25 - Provide notice prior to casting precast reinforced concrete box culverts.

13.4.3 Subsoil Drain Pipe

Use 100 mm diameter (DN100) Class 400 (SN8) corrugated poly subsoil pipe. Include filter sock where subsoils are installed in rock and geotextile fabric is omitted.

Use compatible couplings and fittings.

13.4.4 Filter Material

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

Conform to the grading specified by the manufacturer of the subsoil pipe.

If manufacturer's grading not supplied, filter material is to consist of a single sized aggregate of 20mm particle size, with a maximum of 5% passing the AS 0.15mm sieve.

13.4.5 Bedding Material

Bedding material to be clean granular screened aggregate free from sticks, stones and other deleterious material.

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

For Reinforced Concrete Pipe (RCP) culverts; use single sized aggregate of 14mm particle size, with a maximum of 5% passing the AS 0.15mm sieve.

For Reinforced Concrete Box Culverts (RCBC); use material with a Plasticity Index less than 6, conforming to *Table 13-1 – RCBC Bedding Material Size*.

Recycled Crushed Glass, conforming to the Specifications for Recycled Crushed Glass as an Engineering Material Section 9, may be used where Approved by the Relevant Authority.

Table 13-1 – RCBC Bedding Material Size

AS Sieve (mm)	Percentage Passing
19.0	100
2.36	50 - 100
0.60	20 - 90
0.30	10 - 60
0.15	0 - 25
0.075	0 - 10

13.4.6 Geotextile Fabric

Conform to the requirements of the Protection Works Section.

13.4.7 Type A Fill

Conform to the requirements of the Earthworks Section.

13.4.8 Type B Fill

Conform to the requirements of the Earthworks Section.

13.4.9 Type 3 Gravel Backfill

Conform to the requirements of the Pavements and Shoulders Section.

13.4.10 Flowable Fill (Cement Stabilised)

Conform to Appendix A of AS/NZS 3725 for ‘Controlled Low Strength Materials’.

28day characteristic compressive strength to be max 7 MPa.

13.4.11 Concrete

Conform to the requirements of *Section 11 – Structural Concrete Works*.

13.4.12 Sand Bedding

Conform to the requirements of *Section 11 – Structural Concrete Works*.

13.4.13 Damp Proof Membrane

Conform to the requirements of *Section 11 – Structural Concrete Works*.

13.4.14 Mortar

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

13.4.15 Grouted Stone Pitching

Conform to the requirements of *Section 14 – Protection Works*.

13.5 CONSTRUCTION OF PIPES AND BOX CULVERTS

13.5.1 Standard Drawings

Refer to Standard Drawings.

13.5.2 Setting Out

Measure Culvert length along the invert to the outside face of headwalls or inside face of pit walls.

Set out the Culverts with pegs before construction.

13.5.3 Excavation

Excavate in whatever material is encountered.

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.

Construct trench to dimensions shown on Standard Drawings.

Backfill with Type 3 Gravel Backfill up to the specified level if the trench is excavated too deep.

Inspection Point 26 - If Unsuitable Materials or Dissolution Cavities are encountered in the foundations or trench walls for pipe and box culverts, obtain direction before remedial works commence.

Replace Unsuitable Material with Type B Fill, unless otherwise directed by the Certifying Engineer, compacted to 95% Relative Compaction.

13.5.4 Culverts in Fill under Construction

Place and compact fill, type as specified, to 300mm above the design level of the top of Culvert, or to Subgrade Surface if less, prior to construction of the Culvert.

Excavate the fill in accordance with *Clause 13.5.3 - Excavation* to permit the construction of the Culvert.

13.5.5 Foundation Preparation

Compact the trench foundation, with a vibrating plate or similar, and undertake treatment of Unsuitable Materials and Dissolution Cavities in rock in accordance with the *Section 1 – Earthworks*.

13.5.6 Bedding

Place a layer of Bedding Material in the trench, thickness as specified on Standard Drawings, and compact with a vibrating plate or similar.

Pipe Culverts; shape the Bedding material to hold the pipe Culverts in position during placement and compaction of additional backfill materials. Place and compact a further (haunching) layer of bedding in accordance with Standard Drawings and AS/NZS 3725.

13.5.7 Laying Generally

Lay Culverts commencing from the downstream end.

Lifting equipment must be certified for the Culvert load and should be sized so as not to damage the Culvert. Ensure correct lifting techniques are employed as per the Culvert manufacturer's recommendations.

Do not lift the Culverts unless the lifting points are Certified by the manufacturer. Refer to *Clause 11.10 - Precast Concrete*.

Install and secure plugs or apply mortar in lifting holes, as per the Culvert manufacturer's recommendations.

Plugs, when used, must provide a tight waterproof seal.

Where required to use part-lengths of Culverts, protect all cut faces with epoxy coating of sufficient thickness to provide equivalent durability to the remainder of the Culvert.

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

13.5.8 Laying Pipe Culverts

Refer Standard Drawings for Pipe Laying Details.

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.

Maximum joint deflections must comply with manufacturer's guidelines and provide a water tight joint.

Fill all joints with stiff mortar firmly rammed into openings. Remove excess mortar from barrel of Culvert. Apply external rubber bands to Flush Joint (FJ) Pipes.

Brace pipes of 1200 mm diameter and greater with Toms until the completion of the embankment and Pavement. The Toms must 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 around the barrel of the pipe to one-half of the pipe diameter.

13.5.9 Laying Box Culverts

Refer Standard for Box Culvert Laying Details.

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.

Mortar external joints and apply external joint seals, Densopol HT60 or equivalent, 150 mm wide.

13.5.10 Connection to Existing Systems

Repair all cut openings and make watertight. Protect all cut faces with epoxy coating of sufficient thickness to provide equivalent durability to the remainder of the drainage structure.

Demolish existing endwalls/ headwalls/ wingwalls to make way for the extension of the Culvert, where applicable.

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

Inspection Point 27 – Obtain approval for cleaning out of existing drainage systems once completed.

13.5.11 Backfill

Inspection Point 28 – Obtain approval for pipe and/or box culvert installations prior to backfilling.

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

Backfill around the Culvert and for the remainder of the trench with material as specified in the Standard Drawings, placed and compacted in accordance with the *Section 1 - Earthworks* and as follows.

- 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.
- 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 Pavement. Produce a uniform mix. Complete compaction within one hour of adding mixing water.
- 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.
- Use compaction equipment which will not damage the Culvert and drainage structures.
- Carry out Conformance Testing.

Stabilise top 150 mm of backfill, for a distance of 1 m adjacent to culvert endwalls/ headwalls/ wingwalls, so as to be erosion resistant.

Remove surplus material from the Development Site.

Documentation Point 62 – Obtain approval for use of Flowable Fill as an alternative backfill material in Culvert works.

For External Works, reinstate any damaged surfaces to the satisfaction of the Relevant Authority.

Reinstate trenches cut outside of pavements and other construction by backfilling with Type B Fill compacted to 90% relative compaction.

13.5.12 Construction Loading on Culverts

Provide the minimum compacted thickness of cover specified in *Table 13-2 – 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 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.

Table 13-2 – 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						
	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

13.6 CONSTRUCTION OF CONCRETE DRAINAGE STRUCTURES

13.6.1 General

This section relates to construction of the following structures:

- Culvert Endwalls/Headwalls/Wingwalls; and
- Drainage Pits.

13.6.2 Standard Drawings

Refer Standard Drawings for:

endwall, headwall and wingwall details;

standard and grated side entry pits;

manholes and grated inlet pits; and

letter box pits.

13.6.3 Setting Out

Measure pits to the inside face of the wall.

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

Set out the structure with pegs before construction.

13.6.4 Excavation

Excavate in whatever material is encountered.

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.

Backfill with Type 3 Gravel Backfill up to the specified level if excavated too deep.

Inspection Point 29 - If Unsuitable Materials or Dissolution Cavities are encountered in the foundations or trench walls for pipe and box culverts, obtain direction before remedial works commence.

Replace Unsuitable Material with Type B Fill, unless otherwise directed by the Certifying Engineer, compacted to 95% Relative Compaction.

13.6.5 Concrete Works

Conform to *Section 11 – Structural Concrete Works* for all concrete works, including but not limited to:

- Foundation Preparation;
- Damp Proof Membranes;
- Reinforcement;
- Formwork;
- Concrete Supply and Placement;
- Surface Finishes;
- Dimensional Tolerances; and
- Conformance.

13.6.6 Precast Drainage Structures

Precast drainage structures may be used, subject to Approval by the Relevant Authority.

Comply with *Clause 11.10 - Precast Concrete.*

13.6.7 Steel Works

Conform to *Section 12 – Minor Steel Works* for all steel works, including but not limited to:

- Materials and Components;
- Bolted Connections;
- Welding; and
- Protective Coatings.

13.7 KERBING AND CONCRETE INVERTS

13.7.1 Standard Drawings

Refer to Standard Drawings for kerbing and concrete invert details.

13.7.2 General

Finish Pavement wearing surface 5mm proud of kerbing and concrete inverts to ensure positive drainage.

13.7.3 Concrete Works

Construct kerbing and concrete inverts in accordance with *Section 10 – Non-Structural Concrete Works*.

Provide joints as specified.

13.8 CONSTRUCTION OF CATCH DRAINS, TABLE DRAINS AND OPEN DRAINS

13.8.1 General

Construct all drains in accordance with Construction Drawings and *Section 1 – Earthworks*.

13.8.2 Drop Structures

Construct drop structures, where specified on Construction Drawings.

Refer DIPL Standard Drawing CS-3123 for Gabion Drop Structure details. Refer Construction Drawings for other drop structure types.

13.8.3 Stabilisation

Stabilise all drain bases and batters as specified on Construction Drawings.

Where not specified, provide minimum 100 mm topsoil and dryland grassing in accordance with *Section 17 – Landscape*.

13.9 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.

13.10 INLET AND OUTLET CHANNELS

Excavate the inlet and outlets of all Culverts to facilitate the flow of water.

Conform to the following:

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

Side batters: 6 horizontal to 1 vertical, or flatter.

Bed grade: Minimum 0.5% in the direction of flow.

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

Documentation Point 63 – Advise Relevant Authority within 2 Calendar Days when cleaning out is completed.

13.11 SUBSOIL DRAINS

13.11.1 General

Refer Standard Drawing SS-3000 for Subsoil Drainage Details.

Provide minimum 0.50% longitudinal grade to all subsoil drains.

13.11.2 Excavation

Excavate trenches to dimensions shown in the Standard Drawings.

Ensure the base of the excavation is dense and provides positive fall towards the outlet.

Line the trench with geotextile fabric. Refer to *Clause 14.3 – Geotextile Fabrics*.

Inspection Point 30 – Where subsoil drain trenches are excavated in rock and subsoil drain pipes are fitted with filter socks, geotextile fabric may be omitted where Approved.

13.11.3 Bedding and Pipe Laying

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

Lay subsoil drain pipe central to trench.

Inspection Point 31 – Obtain approval of the subsoil pipe installation before backfilling.

13.11.4 Backfilling

Place and compact Filter Material to extents shown in the Standard Drawings in layers not exceeding 300 mm.

Compact backfill with a vibrating plate compactor or similar.

Prevent contamination of the Filter Material.

13.11.5 Flushing Points

Construct flushing points in accordance with Standard Drawing SS-3000.

Flushing points consist of inspection openings and caps supported in a concrete surround, suitable for Class D loading.

Provide flushing points at top of the line and at maximum 60 metre spacings, in accordance with the Standard Drawings.

Locate flushing points to avoid other infrastructure, including allotment accesses and services.

13.11.6 Connections to Drainage Structures

Connect subsoil drain pipes into drainage pits and headwalls to provide an outlet for water.

13.12 REMOVAL OF EXISTING CULVERTS AND DRAINAGE STRUCTURES

Demolish and remove from the Development Site, as specified, existing Culverts and drainage structures.

13.13 CLEANOUT OF DRAINAGE WORKS

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

Inspection Point 32 – Obtain approval for cleanliness of all new and existing affected drainage works.

13.14 CCTV INSPECTIONS

CCTV Inspections that can confirm the absence of Defects are required for all new underground stormwater drainage systems.

The Relevant Authority may request additional CCTV Inspections be undertaken for existing underground stormwater drainage systems, where the Development may impact the existing stormwater infrastructure.

Documentation Point 64 – Submit a copy of the CCTV Inspection Report, including video footage and still images, supported by a statement that all the works are conforming (or otherwise).

In the event there are Defects within the new systems, all necessary rectification works are required to be undertaken.

13.15 CONFORMANCE

Conform to the following:

Table 13-13-3 – Drainage Works Tolerances	
Property/dimension	**Tolerance**
Invert Level and Grade Line of All Drainage Works	No ponding of water (free draining)
Kerbing / Concrete Inverts	Vertical: +/- 5mm Horizontal: +/- 10mm Dimensions: +/-5mm
Open Drains with grassing	Vertical: +/- 50 mm Horizontal: +/- 200mm
Open Drains with hard lining	Vertical: +/- 20 mm Horizontal: +/- 200mm
Cross Road Culverts	Vertical: +/- 20 mm Horizontal: +/- 200mm
Underground Pipe Culverts	Vertical: +/- 20 mm Horizontal: +/- 20mm
Drainage Structures	Vertical: +/- 20 mm Horizontal: +/- 20mm Dimensions: +/- 5 mm
Concrete Works	Concrete Thickness: Not less than specified.
Subsoil Drains	Vertical: +/- 50 mm Horizontal: +/- 200mm Slope: max 25mm sag in 8 m

14. PROTECTION WORKS

14.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1012	Methods of testing concrete.
AS 1141(set)	Methods of sampling and testing aggregates.
AS 1141.25.1	Degradation factor – Source rock (Washington Degradation Test).
AS 1141.26	Secondary minerals content in basic igneous rocks
AS 1141.29	Accelerated soundness index by reflux. Basic igneous rocks
AS 1289(set)	Methods of testing soils for engineering purposes.
AS 1725(set)	Chain link fabric fencing.
AS 2001.2.3.2	Methods of test for textiles – Method 2.3.2: Physical tests – Determination of maximum force using the grab method.
AS 2423	Coated steel wire fencing products for terrestrial, aquatic and general use.
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates.
AS 3706(set)	Geotextiles – Methods of test.
AS 3972	General purpose and blended cements.
AS 4133(set)	Methods of testing rocks for engineering purposes.
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles.
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods

14.2 FOUNDATIONS

Excavate, fill and trim the foundations to the required shape prior to commencing the protection works.

Compact the Subgrade, on which protection works are to be laid to 95% Relative Compaction.

14.3 GEOTEXTILE FABRICS

14.3.1 General

Install geotextile fabrics where shown on the Standard Drawings and Construction Drawings.

Supply and lay non-woven polypropylene or polyester geotextile fabric, consisting of long chain synthetic polymers composed of at least 95% by mass of polyolefins or polyesters. The geotextile filaments must be rot-proof, chemically stable and must have low water absorbency. Filaments must resist delamination and maintain their dimensional stability in the geotextile.

Non-woven geotextiles must have filaments bonded by needle punching, heat or chemical bonding processes.

Woven geotextiles must have filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.

Geotextiles must be free of any flaws which may have an adverse effect on the physical and mechanical properties of the geotextile.

Geotextiles must be stabilised against ultra-violet radiation such that, when tested in accordance with AS 3706.11, must have a retained strength of at least 50% after 500 hours of exposure.

14.3.2 Storage, Packaging and Handling

Geotextiles must be stored under protective cover or wrapped with a waterproof, opaque UV protective sheeting to avoid damage prior to installation.

Geotextiles must not be stored directly on the ground or in any manner in which they may be affected adversely by heat, water or soil. The method of storage must be in accordance with recommendations by the manufacturer.

The protected geotextile rolls must be clearly labelled showing manufacturer, type of geotextile, and batch identification number.

Handle rolls with forklifts or similar, using dedicated slings, free of sharp hooks or tongs. Rolls that are dropped, dragged or pushed around on the ground will be rejected.

14.3.3 Delivery and Product Certification

Geotextile must be delivered to the Development Site at least 5 Business Days prior to commencement of installation.

Provide a Certificate of Compliance that the geotextile complies with all the requirements as specified, together with test results reported on NATA endorsed test documents. The certificate must not be more than 12 months old.

The Certificate of Compliance to include: quality control documentation for the relevant batch/Test Lots, physical properties sheet, and manufacturer's letter of certification stating compliance.

14.3.4 Construction

Prepare smooth surfaces for placement of the geotextile, free of sharp objects, large rocks and protruding vegetation.

Place geotextiles just ahead of the advancing face of construction work, with a maximum of 48 hours of placement prior to covering.

Repair punctures and tears in accordance with manufacturer's specifications.

Where used in trenches or other drainage configurations, place the geotextile to the shape of the prepared surface, folding and overlapping where required. Fully envelope drainage materials in trenches.

Unless specified elsewhere, the overlap must be minimum 300 mm. Overlap to be minimum 500 mm where large ground deformations are expected. Sewing may be permitted provided the seam strength exceeds the parent material grab strength.

Direct travel of machinery over geotextile not permitted. Conform to the following initial layer of material thicknesses prior to trafficking with machinery:

Table 14-1 - Minimum Initial Layer Thickness Prior to Trafficking with Machinery (mm)

Nominal Maximum Particle Size D85 of Initial Fill Layer (mm)	Minimum Initial Layer Thickness (mm)
< 150	300
150 - 300	400
300 - 500	500

Rock armour placed directly on geotextiles must be placed with a drop height of less than 1.5m, and placed in a such a manner so as not to damage, puncture or tear the geotextile.

Obtain Relevant Authority approval for use of vibratory compaction methods on the initial layer.

14.3.5 Geotextile Grades

Unless specified elsewhere, use: non-woven, Strength Grade B.

All strength grades, where specified, based on a Characteristic Values (Q), to conform to the following table:

Table 14-2 – Geotextile Strength Grade Properties

Geo textile Strength Grade	Elong-ation (1)	Grade Strength (2) (N)	Tear (2) (N)	G Rating (2)
A	>30% <30%	500 800	180 300	900 1350
B	>30% <30%	700 1100	250 400	1350 2000
C	>30% <30%	900 1400	350 500	2000 3000
D	>30% <30%	1200 1900	450 700	3000 4500
E	>30%	1600	650	4500

Table Notes:

1. % Elongation corresponding to max CBR burst strength as per AS 3706.4. Generally <30% for wovens, >30% for non-wovens.
2. Property value is 80th percentile characteristic value (mean strength – 0.83 x standard deviation), as per relevant AS test.
3. N = Newtons

Filtration properties relevant to each grade to be certified as part of Clause 14.3.3 - Delivery and Product Certification.

14.3.6 Conformance Testing

Where project requirement is less than 15,000 m^2, sampling and testing is not required.

Provide samples to independent, NATA accredited testing laboratory when project exceeds 15,000 m^2, to the following test frequencies:

Table 14-3 – Test Frequencies

Description	**Units**	**Test Method**	**Test Frequency**
Tensile Strength	kN/m	AS 3706.2	1 per 15,000 m^2
Tear Strength	N	AS 3706.3	1 per 15,000 m^2
CBR Burst Strength	N	AS 3706.4	1 per 15,000 m^2
Grade Tensile Strength	N	AS 2001.2. 3.2	1 per 15,000 m^2
Flow Rate	l/m2/s	AS 3706.9	1 per 90,000 m^2

Samples to be 15 m^2 in size, cut across full width of the roll, not within 2 m of the end of a roll.

14.4 ROCK PROPERTIES

The rock properties specified in this clause apply to the rock, stone, aggregate and boulders specified in the following clauses in this section;

- Stone Pitching
- Dumped Rock
- Quarter Tonne Dumped Rock
- Rubble
- Gabions
- Reno Mattresses

Requirements: Clean, dry, durable crushed stone of uniform quality, free from declared weeds and their seeds, vegetable matter and other deleterious materials.

Particles must have at least 2 crushed faces and comply with the following standards;

AS 1141.25.1	Degradation factor – Source rock (Washington Degradation Test). Basic igneous rocks, e.g. Basalt aggregates, must have a minimum value of 50.
AS 1141.26	Secondary minerals content in basic igneous rocks, e.g. Basalt aggregates, must not exceed 25□.
AS 1141.29	Accelerated soundness index by reflux. Basic igneous rocks, e.g. Basalt aggregates, must have a minimum value of 94.

14.5 STONE PITCHING

14.5.1 Stone Pitching

The stone to be spalls of hard durable rock complying with *Clause 14.4 - Rock Properties* and with no dimension less than 150 mm and not larger than 200 mm.

Hand place the stones so that they are firmly bedded in layers.

The average plane of the exposed face to be within 100 mm of the specified plane and all exposed faces of stones to be within 50 mm of the average plane.

14.5.2 Grouted Stone Pitching

Place stones as specified in *Clause 14.5.1 - Stone Pitching*.

Inspection Point 33 - Obtain approval of stone pitching before grouting.

Grout stone pitching with cement mortar.

Cement mortar to consist of one part cement to three parts of clean sand mixed with potable water to form a workable mixture.

Work the mortar into gaps between the stones of the stone pitching to bind the stones. Work from the lower end of the slope of the pitching up the slope.

Allow the mortar to cure for at least 48 hours.

Remove Defective mortar and re-grout any loose stones.

Provide 75 mm diameter uPVC pipe sections to form weep holes penetrating the full thickness of the stone pitching and grout at the rate of one every 5 square metres of stone pitching.

14.6 DUMPED ROCK PROTECTION

Large spalls or boulders complying with *Clause 14.4 - Rock Properties* and having at least dimension of 200 mm.

Dump into the specified area.

Protect adjacent areas from damage due to dumping.

The average plane of the exposed rock face to be within 100 mm of the specified position.

14.7 QUARTER TONNE CLASS DUMPED ROCK PROTECTION

Use large spalls or boulders complying with *Clause 14.4 - Rock Properties* and having the following grading.

Table 14-4 – Rock – Size and Grading

Rock Size	Minimum % Larger Than
35kg	90
250kg	50
500kg	0

Dump into the specified area.

Protect adjacent areas from damage due to dumping.

The average plane of the exposed rock face to be within 100 mm of the specified position.

14.8 RUBBLE

Broken rock complying with *Clause 14.4 - Rock Properties*.

Maximum size of rubble to be 200 mm.

At least 30% by mass to have a nominal size of 100 mm or greater.

No more than 20% by mass to pass the 2.36 mm sieve.

Dump rubble without segregation onto the prepared area.

Compact rubble to a tight finish.

The average plane of the exposed face to be within 100 mm of that specified.

The exposed face to be within 100 mm of the average plane.

14.9 GABIONS

14.9.1 General

A flexible, hexagonal woven steel wire mesh box, filled with packed stone, complying with *Clause 14.4 - Rock Properties* and securely laced with steel wire.

14.9.2 Steel Wire Mesh

Use galvanized steel wire, Grade W15Z380 to AS 2423.

Zinc coating; 250 g/sq.m Galvanization to be carried out prior to weaving of the mesh.

Minimum tensile strength of wire: 380 MPa

Mesh openings to be 80 mm x 100 mm maximum, hexagonal in shape with flexible joints consisting of not less than two full turns.

All wire to be coated with average thickness of 0.55 mm extruded grey PVC firmly attached to the wire. The minimum thickness of coating to be 0.40 mm in accordance with AS 2423.

The PVC coating may not be required where abrasion of wire is not likely to be of concern, or where deleterious effects on the wire of ground water, soil salinity, natural weather exposure and water emersion is not significant.

Documentation Point 65 – Where proposed, obtain approval for omission of the PVC coating on gabion steel wire mesh, prior to fabrication of gabion baskets.

Conform to the following wire sizes and galvanizing weights:

Table 14-5 – Wire Properties - Gabions

Wire Type	Minimum Diameter (mm)
Body wire	2.7
Binding and lacing wire	2.2
Selvedge wire	3.4

Selvedge wire must be woven integrally along all edges of the mesh, in accordance with the manufacturer's instructions, and such that the mesh must not unravel.

The steel wire mesh must be sized so that it can be folded into regular boxes, complete with diaphragms, having dimensions specified. Diaphragms to be at 1,000 mm spacings.

14.9.3 Construction

Assemble and erect in accordance with the manufacturer's instructions.

Pretension the wire framework against a firm anchor or adjacent units.

Retain the shape of the wire framework with spreaders.

Fill with hard durable stone, complying with *Clause 14.4 - Rock Properties* and placed in stages to achieve the tightest packing of stone.

Maximum stone dimension: 250 mm.

Minimum stone dimension: 100 mm.

Overfill the framework by 20 mm to 50 mm to allow for subsequent movement of the stone.

Perform lacing operations using lacing wire conforming to the properties specified for Steel Wire Mesh. Wire to pass around the edges being joined using alternative single and double loops through each mesh in turn. Tightness of the mesh and wiring is essential.

Ensure a tightly packed, neat and uniform construction.

14.10 RENO MATTRESSES

14.10.1 General

A flexible, hexagonal woven steel wire mesh box, filled with packed stone, complying with *Clause 14.4 - Rock Properties* and securely laced with steel wire.

14.10.2 Steel Wire Mesh

Use galvanized steel wire, Grade W15Z380 to AS 2423.

Zinc coating; 250 g/sq.m. Galvanization to be carried out prior to the weaving of the mesh.

Minimum tensile strength of wire: 380 MPa.

Mesh openings to be 60 mm x 80 mm maximum, hexagonal in shape with flexible joints consisting of not less than two full turns.

All wire to be coated with average thickness of 0.55 mm extruded grey PVC firmly attached to the wire. The minimum thickness of coating to be 0.40 mm in accordance with AS 2423.

The PVC coating may not be required where abrasion of wire is not likely to be of concern, or where deleterious effects on the wire of ground water, soil salinity, natural weather exposure and water emersion is not significant.

Documentation Point 66 – Where proposed, obtain approval for omission of the PVC coating on reno mattress steel wire mesh, prior to fabrication of reno mattress baskets.

Conform with the following wire sizes and galvanizing weights:

Table 14-6 – Wire Properties – Reno Mattresses

Wire Type	Minimum Diameter (mm)
Body wire	2.0
Binding and lacing wire	2.2
Selvedge wire	2.4

Selvedge wire to be woven integrally along all edges of the mesh, in accordance with the manufacturer's instructions.

Cut to shape where necessary.

Mattress Panels

Bottom panel: Includes both sides and both end panels.

Top panel: Must have the same dimension as the bottom, without the sides and ends, and be supplied separately.

Diaphragms: Extend over the full width of the mattress from top to bottom at maximum intervals of 1 m.

14.10.3 Construction

Assemble and erect in accordance with the manufacturer's instructions.

Align diaphragms perpendicular to the direction of flow unless otherwise specified.

Pretension the wire framework against a firm anchor or adjacent units.

Retain the shape of the wire framework with spreaders.

Fill with hard durable stone complying with *Clause 14.4 - Rock Properties* and placed in stages to achieve the tightest packing of stone.

Maximum stone dimension:

120 mm when mattress depth 170 mm.

150 mm when mattress depth 230 mm.

200 mm when mattress depth 300 mm or greater.

Minimum least stone dimension: 80 mm.

Overfill the framework by 20 mm to 50 mm to allow for subsequent movement of the stone.

Perform lacing operations using lacing wire conforming to the properties specified for Steel Wire Mesh. Wire to pass round the edges being joined using alternative single and double loops through each mesh in turn. Tightness of the mesh and wiring is essential.

Last panel on downstream side, or at base of slope, must be a whole unit (i.e. not cut).

Ensure a tightly packed, neat and uniform construction.

14.11 REVETMENT MATTRESSES

14.11.1 General

A nylon fabric material filled with mortar with filter points for the relief of hydrostatic uplift pressure.

Conform to the manufacturer's instructions.

14.11.2 Materials

Mortar mix proportions:

Table 14-7 – Mortar Mix Proportions – Revetment Mattresses

Cement Type GP or GB	Fine Sand	Coarse Sand	Water
1 (500kg)	1.2 (600kg)	2.2 (1,100kg)	450 l/m^3

Adjust fine sand/coarse sand proportions if required to provide workable mix.

14.11.3 Construction

Toe-in to provide cut-off walls minimum 300 mm deep and width not less than maximum thickness of mattress.

Lay, cut and stitch mattress on prepared surface. Make allowance for take up of fabric resulting from filling mattress with mortar.

All stitching and seams to be neat in appearance and strength to withstand filling pressure.

Ensure mattress is anchored prior to mortar pumping to prevent creep during placement of mortar.

Provide openings in fabric at a maximum of one every 50 sq.m for placement of mortar. Opening to match size of pumping hose.

Make good openings on completion of mortar pumping.

All areas of mattress to be hard filled with mortar with smooth surface.

Do not permit any loading on the mattress until one hour after mortar pumping has been completed.

Remove spilt mortar from surface of mattress by hand only. Do not use water to wash spilt mortar.

Make good any Defective areas.

14.12 EMBANKMENT PROTECTION - CONCRETE

Construct embankment protection from concrete reinforced with a single layer of centrally located SL72 mesh. Conform to *Section 10 – Non-Structural Concrete Works.*

Overlap the mesh by 200 mm at joints.

Make contraction joints in the vertical plane, at 2 m maximum spacing.

Continue reinforcement mesh across construction joints

Where margins are required, construct the embankment protection and the margins as an integral unit.

Where there are adjacent protection works, construct the toe of the embankment protection

and the adjacent protection work as an integral unit.

Drainage weepholes to be 75 mm diameter penetrating the full thickness of the protection works. Install the drainage holes at 3 m intervals just above the toe.

Install additional rows of drainage holes parallel to the first, and at 3 m intervals and spacings, where shown on Construction Drawings.

The exposed surface to be within 50 mm of the specified position.

14.13 MARGINS

Construct margins with reinforced concrete, conforming to the requirements of *Section 10 – Non-Structural Concrete Works.*

Make contraction joints at 3 m maximum spacing.

Form the top 75 mm of the vertical face nearer the Pavement, and any exposed outer face, true to line and level.

Wood float and broom finish the upper surface of the margin. Finish flush with the top of the Pavement.

Where adjacent Pavement is Sealed, overlap the bituminous Seal on the margins by not less than 100 mm.

TOLERANCES

Width: Not less than specified.

Level: + or – 10 mm of top of adjacent Pavement.

15. FURNITURE AND TRAFFIC CONTROL DEVICES

15.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1012(set)	Methods of testing concrete
AS 1074	Steel tubes and tubulars for ordinary services
AS/NZS 1111(set)	ISO metric hexagon commercial bolts and screws Set
AS/NZS 1112(set)	ISO metric hexagon nuts, including thin nuts, slotted nuts and castle nuts Set
AS/NZS 1252	High strength steel bolts with associated nuts and washers for structural engineering
AS 1273	Unplasticised PVC (UPVC) downpipe and fittings for rainwater
AS 1397	Steel sheet and strip hot dipped zinc coated or aluminium/zinc coated
AS 1428.4.1	Design for access and mobility – Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS/NZS 1554(set)	Structural steel welding (Set)
AS/NZS 1594	Hot rolled steel flat products
AS 1604.1	Specification for preservative treatment – Sawn and round timber
AS 1722	Pipe threads of Whitworth form
AS 1725(set)	Chain link fabric fencing
AS/NZS 1734	Aluminium and aluminium alloys - Flat sheet, coiled sheet and plate
AS 1742(set)	Manual of uniform traffic control devices
AS 1743	Road signs – Specifications
AS 1744	Standard alphabet for road signs
AS/NZS 1906(set)	Retroreflective materials and devices for road traffic control purposes
AS 2423	Coated steel wire fencing products for terrestrial, aquatic and general use
AS 2700	Colour standards for general purposes
AS 2759	Steel wire rope – Use, operation and maintenance
AS/NZS 3750.9	Paints for steel structures - Organic zinc-rich primer
AS/NZS 3845.1	Road safety barrier systems and devices - Road safety barrier systems
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS 4687	Temporary fencing and hoardings
EN 1317	Road restraint systems
NCHRP 350	Recommended Procedures for the Safety Performance Evaluation of Highway Features
APAS 1441/1	Permanent graffiti barrier, clear, exterior
APAS 1442/1	Temporary graffiti barrier, clear, exterior
APAS 1443	Graffiti Remover
APAS 2916	Organic zinc rich coating for protection of steel
NTMTM	NT Materials Testing Manual
NTTM	NT Test Methods

15.2 TACTILE GROUND SURFACE INDICATORS

TGSI devices used must conform to AS 1428.4.1 and AS 4586.

TGSI devices used must conform to AS 4586. Use preformed plastic units.

Use integrated units. Do not use discrete units in outdoor applications.

Material is to be high density, fibre reinforced, UV stabilised, polymer containing Herculite, fabricated by a sheet moulding compression method.

Units must be fixed with tamper resistant screw fasteners.

Surface fixed units must have tapered edges. Provide cast-in units which have lugs which are embedded in the concrete substrate and which enable replacement of the TGSI unit if it needs to be replaced. Concrete to be flush with TGSI units at the abutting edges.

Documentation Point 67 – Submit proposed Tactile Ground Surface Indicator details prior to installation

15.3 FENCING

15.3.1 General

Construct all fencing in accordance with the applicable Standard Drawings, including:

- Security fence
- Pedestrian safety fence

- Vehicle movement barriers/fences
- Cyclist holding rails
- Culvert crossing fences

Refer Construction Drawings for nominated locations and set out.

15.3.2 Clearing

Clear fencing lines including the removal of trees, shrubs, vegetable matter and debris. Grub out all roots that interfere with the placement of posts.

15.3.3 Erection

Erect fences so that the line of the tops of the posts is uniform. Adjust the position of posts to compensate for the irregularities of the ground.

15.3.4 Gates

Provide gates where nominated on Construction Drawings and across existing access tracks, driveways and streets.

15.3.5 Interface with Existing Fences

Install a post at the intersection of new fence with existing fence and fix the wiring of both fences to that post.

Complete the necessary sections of new fencing before removing or opening a boundary or internal fence.

Obtain the owners agreement to the proposed fence removal and advise the owner or occupier in writing of the date the fence will be removed.

Erect gates or grids at fence openings as specified on Construction Drawings.

15.3.6 Temporary Site Safety Fence

Materials, construction, and installation to AS 4687.

Erect the fence in accordance with manufacturer's and/or supplier's specifications.

Ensure installation methods are consistent with possible local weather events.

This sub-clause is not applicable to temporary road safety barriers for works. Refer to PROVISION FOR TRAFFIC, NT Specific Directions for Road Work Signs clause, Road Safety Barriers sub-clause, for temporary road safety barriers.

15.3.7 Pedestrian Fence

To civil standard drawing CS 3307. Refer to AS 1742.10, Pedestrian Fencing clause.

15.4 BOLLARDS

15.4.1 General

Refer Construction Drawings for nominated bollard types, locations and set out.

Where bollard details are not specified on Construction Drawings, comply with the following:

15.4.2 Recycled Plastic Bollards

Supply round pre-moulded recycled plastic bollards, 1.5 m length x 150 mm dia. with built-in colours and UV stabilised, resistant to termites, microorganisms and moisture.

Install recycled plastic bollards as per manufacturer's recommendations.

15.4.3 Timber Bollards

Use Stringybark, Woollybutt or Pine timber, pressure impregnated with ACQ preservative formulation, copper oxide (CuO) and quaternary ammonium compound (DDAC) to Category H4 of AS 1604.

Do not use preservative treatments that contain arsenic or chromium.

15.4.4 Metal Bollards

Supply and install metal bollards as per manufacturer's recommendations.

15.5 FLEXIBLE GUIDE POSTS

15.5.1 Posts

Supply and install thermoplastic guide posts manufactured from plastic alloy ASA/PC (or similar) in accordance with Standard Drawings and conforming to the following:

Colour: Opaque white.

Finish: Smooth, glossy.

Length: 1380 mm. Installation tolerance - height to be 1100 mm to 900 mm above finished surface.

Width: 95 mm minimum, 105 mm maximum, width to be constant to within 1 mm.

Web thickness: 3 mm minimum, 5 mm maximum.

15.5.2 Certification of Guide Posts

Guide posts must comply with the following:

- Where installed in normal working conditions, guide posts are capable of self-erecting after 10 impacts head on, from an average sedan travelling at 60 km/h.
- After 2,000 hours of exposure in an Atlas Weatherometer, the guide posts do not change colour by more than 10 points on a Delta E colour chart.
- The guide post material has a minimum Vicat softening point of 120ºC.
- Physical testing as specified.
- Resistant to termites.

Documentation Point 68 - Provide certification that guide posts conform to specified requirements.

15.5.3 Guide Post Characteristics

Provide guide posts which have the following:

- An anti-withdrawal device which will prevent the guide post from being withdrawn without dislodgement of the compacted backfill. Anti-withdrawal devices must be engaged on each and every guide post prior to installation of guide posts.
- Legible and indelible markings similar to those used to mark uPVC sewer and water pipes, in letters no less than 5 mm high, showing month and year of manufacture and located approximately 400 mm from the top of the post. Stick-on labels are not permitted.
- Legible and indelible marking 380 mm from the bottom of the guide post, to indicate depth for installation. Stick-on labels are not permitted.

15.5.4 Delineators

Rectangular Retroreflectors

To be of Class 1A Retroreflective material.

Size to be 200 mm x 50 mm for red delineators; and for white delineators. Area minimum 100 cm2 (10,000 mm2).

Discrete Device Type Retroreflectors

Maximum projected face area for red delineator devices and white delineator devices to be 100 cm2 (10,000 mm^2). Minimum length of shortest projected dimension to be 60 mm.

Installation

Attach one red and one white delineator to each guide post, 50 mm from the top of the post.

The red delineator to be attached to the convex side of curved guide posts where applicable.

Attach any discrete device type retroreflectors required as specified.

Red delineators to be on the left and white delineators to be on the right when viewed in the direction of travel.

15.6 SIGNS

15.6.1 General

Refer Standard Drawings for street name signs.

Refer Construction Drawings for nominated sign types, locations and set out

15.6.2 Materials

Non-Reflective Materials

In accordance with AS 1743.

Reflective Material

Use high intensity Class 1 standard in accordance with AS/NZS 1906.1 for all signs, including temporary signs, and hazard markers with the exception that all black legends are to be non-reflective.

Blanks

Use aluminium marine grade alloy designation 5052 - H38. Thickness 1.6 mm.

Steel sheets may only be used for temporary signs.

Manufacture

Chemically clean aluminium blanks before painting or bonding of reflective material.

Stamp the month and year of manufacture and the Relevant Authority's symbol on the backs of all signs.

Posts

Post sizes to conform to *Table 15-3 – Roadside Signs – Mounting* Selection unless specified otherwise.

Posts to be medium grade galvanized pipe with plain ends and constructed from a single length of pipe. Cap each post with a galvanized cap. Do not use "Ingal" posts.

Standard; to AS 1074.

Anti-Graffiti Coating

Apply Anti-Graffiti products to all new signs in Residential, Mixed Use and Industrial Subdivisions, and as specified.

Documentation Point 69 – Submit details of proposed Anti-Graffiti film or coating products, prior to use in the relevant Development Works.

15.6.3 Anti-Spear Fixings for Hazard Markers (Sight Boards)

Hazard markers (D4-1-1A), and other signs at similar heights and with similar dimensions, which are installed parallel to the path of travel of traffic, require anti-spear fixings.

Hazard marker signs are to comprise two D4-1-1A signs, mounted end to end.

The bracing rails are to be aluminium extrusions, each made up of two equal length sections, spliced at the centre line. The aluminium extrusions are to be Capral EK8891S WA Type A, or Ullrich UA6490, or equal equivalent.

Refer to Civil Standard Drawings CS-3516, CS-3517, and CS-3518.

15.6.4 Supply and Delivery

Supply all brackets, bolts, nuts and bracings.

Fix bracings to the signs prior to delivery.

15.6.5 Location of Signs

Street signs to be located clear of vegetation and be clearly visible under headlight illumination.

Lateral Placement

Lateral placement to be measured to the edge of the sign nearest the street.

Lateral placement to be as follows:

Unkerbed streets: 2 to 4 m clear from the edge of the traffic lane, and 600 mm minimum clear from the outer edge of the Shoulder.

Kerbed streets: 500 mm to 1000 mm from the front face of the kerb.

Height

Height to be measured as the clearance to the lowest edge of the lowest sign in an assembly.

Heights for street signs to be as follows:

Table 15-1 – Heights for signs	
Unkerbed Streets	
Fingerboard (G3) and street name signs (G5):	2 m above the near edge of the Pavement.
Other signs:	1 m to 1.5 m above the near edge of the Pavement.
Kerbed Streets:	
Signs overhanging a footpath/shared path:	2.5 m minimum above footway.
Signs not overhanging a footpath/shared path:	1 m to 1.5 m clearance except for those specific signs on medians and islands given below.

Table 15-2 – Height of specific signs on medians and traffic islands
The following signs, when used on medians and traffic islands, to have a clearance 150 mm above the kerb:
D4-1-2 Hazard Marker
D4-2-2 Hazard Marker
D4-3 Hazard Marker
R2-3 (Keep Left) (Keep Right)
R2-5 (No U Turn)
R2-6 (No Right Turn) (No Left Turn)
R2-15 (U Turn Permitted).

15.6.6 Installation

Conform to *Table 15-3 – Roadside Signs – Mounting* Selection**.**

Install posts vertically.

For signs with post sizes less than or equal to 48.3 mm, provide and install a galvanised steel sleeve when installing signposts in concreted or paved medians.

Sleeves, when specified, to be the length of the specified ground footing depth and extend 50 mm above the finished surface level.

Attach the post to the sleeve with a galvanized M10 bolt, 25 mm from the top of the sleeve. Encase the post, or sleeve when used, in a footing of 25 MPa concrete.

Orientation of street sign face:

Vertical, and turned 3 degrees to 5 degrees horizontally from oncoming traffic on straight sections. On curves, at right angles to centre line of street.

Exception: Parking signs to be oriented 5 degrees from parallel to the kerb to face oncoming traffic.

15.6.7 Remotely Activated Road Condition Information Signs

These are fixed signs with some permanent messaging/text, and some variable messaging/text, with messaging varied via remote connection to electronic displays built in to the sign board.

Refer to the Construction Drawings.

Provide the signs including, but not limited to:

– the permanent messaging on the sign,

– the sign board and its posts, footings, and fixings,

– the solar panels, their support structures, the footings if any, and any ancillary cabling, conduits, fixtures, and fittings,

– the cabinets, their footings if any, and any ancillary cabling, conduits, fixtures and fittings,

– all the components housed in the cabinets,

– the batteries,

– the electronic message display units,

– any slide in message plates (back up for when there is a failure of the electronic message display units which cannot be repaired in a short time frame),

– the communications devices and associated cabling, conduits, aerials, and connectors at the sign,

– any power supply devices and connections at the sign,

– the communications devices and ancillary items at the base station, including portable computers, and

– all software required for the system to function properly. Software is to include notification back to base verifying sign display changes.

Make all connections and test the connections. Install and test all software. Ensure the sign works as intended.

Provide documented licensing details for any software or other items requiring licensing. Licences to be in the name of the Relevant Authority.

15.6.8 Reinstatement and Relocation of Existing Signs

Dismantle existing post and signs carefully.

Store in a manner to prevent damage.

Backfill the hole left by the post and its footing with Type B Fill, unless otherwise directed by the Certifying Engineer, and compact the fill to the same density as the surrounding area.

Erect signs in new locations as shown on the Construction Drawings.

The Developer must replace all signs damaged during dismantling, transport, storage and/or erection with new signs.

15.6.9 General Requirements

- Spacing between posts:
  - 2 post signs - 0.6 times sign width.
  - 3 post signs - 0.4 times sign width.
  - 4 post signs - 0.3 times sign width.
- Brace spacing to be 380 mm maximum.
- Adopt the nearest size in the list for intermediate sizes.
- Post sizes for galvanized pipe posts are for sign clearance of less than 2 m above the Pavement. For sign clearances greater than 2 m, increase the nominal diameter of the pipe size by a percentage equal to the percentage increase in height above 2 m.
- Where signs are erected in groups treat the overall dimensions of the group as one sign size to determine the post requirement from *Table 15-3 – Roadside Signs – Mounting* Selection.

15.7 FLOOD GAUGE POSTS

15.7.1 Posts and Gauges

Supply and install posts and gauges in accordance with Standard Drawings.

Use galvanized posts, single length 150 mm x 50 mm x 3 mm RHS with a 3 mm end cap welded to the top.

Paint welds with zinc rich organic paint to APAS specification 2916.

15.7.2 Installation

Erect the post vertically at the outer edge of the Shoulder or concrete margin, on the left hand side when viewed in the direction of travel.

Install a concrete footing, of 20 MPa concrete, with a depth of 650 mm and a diameter of 300 mm.

Cast a suitable galvanized sleeve, 650 mm in length, in the footing so that the sleeve extends 50 mm above the finished surface level.

Attach post to sleeve with a galvanized M10 bolt 25 mm from the top of the sleeve.

Secure gauge to post with No 10 galvanized Tek screws or 4 mm blind pop rivets at 300 mm centres staggered alternately each side.

Position gauge zero to comply with lowest spot on floodway along the street centre line.

15.8 STEEL BEAM GUARDRAIL

15.8.1 Materials

Refer to Civil Standard Drawing CS-3200 for the installation of accepted MASH tested products.

Rails

Use accepted MASH tested guardrail to AS/NZS 3845.1 and per the Department's Safety Barrier Technical Conditions of Use and the related Manufacturer's product manual.

Terminal Sections

Use accepted MASH tested terminals as per the Department's Safety Barrier Technical Conditions of Use and the related Manufacturer's product manual.

Posts

Use posts and block outs as detailed in the Manufacturer's product manual of accepted MASH tested safety barriers as per the Department's Safety Barrier Technical Conditions of Use.

Bolts And Nuts

Shape bolt shoulders and holes in rail elements to prevent the bolts from turning.

Length of bolts to be sufficient to extend 6 mm to 12 mm beyond the nuts.

Galvanizing

All accepted MASH tested steel rail product components as per the Department's Safety

Barrier Technical Conditions of Use and the related Manufacturer's product manual must be hot dip galvanized, after fabrication, to AS/NZS 4680.

Where the galvanising on guard rail or associated fittings has been damaged, the coating must be repaired by regalvanising or by painting with a minimum of two coats of a zinc-rich inorganic paint in accordance with AS/NZS 3750.9 and one coat of aluminium paint.

Compliance

Traceability of components - To: AS/NZS 3845 Part 1

All steel rails, posts and other critical components must be permanently marked in lettering at least 10 mm high with the name of System

Manufacturer, the date and month of manufacture the grade of steel and base metal thickness (BMT) to allow the product to be traced.

Where plastic components make up a key element of the system, they must be permanently marked clearly indicating the month and year of manufacture in a location that can be easily inspected.

Bolts must be marked in accordance with AS 1111.1 or AS/NZS 1252.

Certificate(s) of compliance - To: AS/NZS 1594

Provide Certificate(s) of compliance from the manufacturer that the steel used in the manufacture of the steel beam guardrails is of structural grade HA 350.

Certificate(s) of compliance - To: AS/NZS 4680

Provide Certificate(s) of compliance from the galvanizer that the galvanizing complies with AS/NZS 4680.

15.8.2 Installation

Erect the rail in a manner that produces a smooth, continuous, taut rail closely conforming to the line and grade of the Carriageway.

Lap rails so that the ends of rails do not face oncoming traffic in the adjacent lane.

Attach reflective delineators to the guardrail in accordance with the manufacturer's specifications.

Delineator heights to match heights of delineators on guide posts.

Delineator dimensions detailed in *Clause 15.5.4 - Delineators*.

15.9 Steel Wire Rope System

Materials and installation to AS/NZS 3845.1, to AS 2759, to the Department's Safety Barrier Technical Conditions of Use, and to the manufacturers' product manuals. Use only accepted MASH tested steel wire safety systems. Obtain Superintendent's approval for any proposed Steel Wire Rope Road Safety Barrier System before ordering any components.

Attach retroreflective delineators to the guardrail in accordance with the manufacturer's specification.

Delineator heights to match heights of delineators on guide posts.

15.10 SIGN MOUNTING SELECTION TABLES

Table 15-3 – Roadside Signs – Mounting Selection

Sign Size W x D (mm)	No. and NB Gal. Pipe Posts	Sign Attachment Brackets (Or M8 Bolts) Per Post	Bracing	Min. Bored Footing Size	
				Depth (mm)	Diameter (mm)
300 x 300	1 x 50	2	No	600	300
300 x 450	1 x 50	2	No	600	300
450 x 450	1 x 50	2	No	600	300
450 x 300	1 x 50	2	No	600	300
450 x 600	1 x 50	2	No	600	300
450 x 750	1 x 50	2	No	600	300
450 x 900	1 x 50	2	No	600	300
600 x 450	1 x 50	2	No	600	300
600 x 600	1 x 50	2	No	600	300
600 x 750	1 x 50	2	No	600	300
600 x 900	1 x 50	3	No	600	300
600 x 1050	1 x 50	3	No	600	300
750 x 450	1 x 50	2	No	600	300
750 x 600	1 x 50	2	No	600	300
750 x 750	1 x 50	2	No	600	300

Table 15-3 – Roadside Signs – Mounting Selection

Sign Size W x D (mm)	No. and NB Gal. Pipe Posts	Sign Attachment Brackets (Or M8 Bolts) Per Post	Bracing	Min. Bored Footing Size	
				Depth (mm)	Diameter (mm)
750 x 900	1 x 50	2	No	1500	300
750 x 1200	1 x 50	3	No	1000	300
900 x 300	1 x 50	2	Yes	600	300
900 x 600	1 x 50	2	Yes	600	300
900 x 900	1 x 50	3	Yes	600	300
900 x 1350	1 x 50	4	Yes	1000	300
1050 x 600	1 x 50	2	Yes	1000	300
1050 x 900	1 x 50	3	Yes	1000	300
1200 x 600	2 x 50	2	Yes	600	300
1500 x 800	2 x 50	2	Yes	1000	300
1800 x 600	2 x 50	2	Yes	1000	300
1800 x 1200	2 x 80	4	Yes	1000	300
2400 x 1200	2 x 80	4	Yes	1200	450
2400 x 1800	2 x 100	5	Yes	1200	450
3000 x 600	2 x 50	2	Yes	1000	300
3000 x 1200	2 x 80	4	Yes	1200	450
3000 x 1800	2 x 100	5	Yes	1500	450
3700 x 600	2 x 80	2	Yes	1000	300
3700 x 1200	3 x 80	4	Yes	1200	450
3700 x 1800	3 x 100	5	Yes	1500	450
3700 x 2400	4 x 100	7	Yes	1500	450
4300 x 600	2 x 80	2	Yes	1000	300
4300 x 1200	3 x 80	4	Yes	1200	450
4300 x 1800	3 x 100	5	Yes	1500	450
4900 x 600	3 x 80	2	Yes	1000	300
4900 x 1200	3 x 100	4	Yes	1200	450
4900 x 1800	3 x 100	5	Yes	1500	450
5500 x 600	3 x 80	2	Yes	1000	300
5500 x 1200	3 x 100	4	Yes	1200	450
5500 x 1800	4 x 100	5	Yes	1500	450
6100 x 600	3 x 80	2	Yes	1000	300
6100 x 1200	3 x 100	4	Yes	1200	450
6100 x 1800	4 x 100	5	Yes	1500	450

Table 15-4 – TGSI Minimum Performance Standards					
Slip Resistance					
Test	**Method**	**Result**		**Class**	
		Warning Type	**Directional type**	**Warning type**	**Directional type**
AS 4586 Appendix A	Wet Pendulum Slider 96	71	54	P5	P4
	Wet Pendulum Slider 55	64	41	P5	P4
AS 4586 Appendix C	Wet Barefoot Inclining Platform	29°C	16°C	C	A
AS 4586 Appendix D	Oil - Wet Inclining Platform	24°C	22°C	R11	R11
Luminous Reflectance					
Test	**Method**	**Dry Luminous Reflectance**		**Wet Luminous Reflectance**	
		Warning Type	**Directional type**	**Warning type**	**Directional type**
AS 1428.4.1 Appendix E Luminous Reflectance	Luminous Reflectance Material Colour – **White**	73.5	74.6	72.5	73.7
	Luminous Reflectance Material Colour – **Black**	3.1	5.2	2.5	3.5
	Luminous Reflectance Material Colour – **Yellow**	55.3	57.2	54.2	54.3
	Luminous Reflectance Material Colour - **Blue**	19.5	20.9	18.4	19.5
Minimum required luminance contrast between TGSI units and the surrounds/substrate is 30%.					
Dimensions: Must comply with AS 1428.4.1					
Colours: Refer to drawings, or to PROJECT SPECIFIC REQUIREMENTS in the RFT/RFQ					

16. PAVEMENT MARKING

16.1 GENERAL

This section specifies the materials, testing and standards of workmanship for marking of Pavements with road marking paint and/or thermoplastic material, including glass beads.

16.2 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS/NZS 1580(set)	Paints and related materials - Methods of test
AS/NZS 1580.205.4	Application properties - Airless spraying
AS 1742(set)	Manual of uniform traffic control devices
AS 1742.3	Traffic control for works on roads
AS 1744	Standard alphabets for road signs
AS 1906(set)	Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.1	Retroreflective sheeting
AS/NZS 1906.3	Raised pavement markers (retroreflective and non-retroreflective)
AS/NZS 2009	Glass beads for road marking materials
AS/NZS 2310	Glossary of paint and painting terms
AS/NZS 2433	Plastics - Method for exposure to ultraviolet lamps
AS 2700 (set)	Colour standards for general purposes
AS 2890 (set)	Parking facilities
AS 4049.(set)	Paints and related materials - pavement marking materials
APAS AP-S0041/2	Pavement marking paint, solvent-borne
APAS AP-S0041/3	Pavement marking paint, cold applied plastic
APAS AP-S0041/4	Road marking paint, thermoplastic
APAS AP-S0041/5	Road marking paint, water borne
APAS AP-S0042	Glass beads for pavement marking paint
NTTM 401.1	Operation of wet film thickness comb
NTTM 402.1	Field procedure for measurement of the rate of application of spherical glass beads
NTTM 405.1	Certification of pavement line marking apparatus

Standard Drawings

CS 3400	Line marking
CS 3401	Pavement markings – Chevrons and raised retroreflective pavement markers – Sheet 1
CS 3402	Pavement markings – Chevrons and raised retroreflective pavement markers – Sheet 2
CS 3403	Edge line with audio-tactile ribs

16.3 SCOPE

This section specifies the materials, testing and standards of workmanship for marking of Pavements.

Pavement marking treatments include, but are not limited to:

- Traffic control
- Set out of Pavement markings to Australian and Northern Territory Standards
- Painting of markings with waterborne, thermoplastic and cold applied paints
- Installation and removal of Raised Retroreflective Pavement markers
- Removal and disposal of temporary Pavement markers
- Removal and storage of temporary road signs after resealing works
- Coordination of works with resealing contractor (for new works only)
- Reporting of works performed

16.4 CONTRACTOR ACCREDITATION

All Pavement marking work must be carried out by a contractor accredited to the Painting Contractor Certification Program (PCCP) in a class or category applicable to the Development Works. The PCCP is administered by the CSIRO. Information regarding the PCCP can be obtained at http://www.apas.gov.au/pccp/.

The Relevant Authority may give an exemption for this clause at their discretion.

16.5 PAVEMENT MARKING PAINT

Documentation Point 70 - Submit Certificates of Compliance, issued by an accredited testing authority, stating that the pavement marking paints proposed to be used conform to, or comply with the relevant Australian Standards and/or APAS specifications.

16.5.1 Pavement Marking Paint Types

Use Approved water based white pavement marking paint conforming to APAS AP-S0041/5 and suitable for application by spray equipment in accordance with Test Method AS/NZS 1580.205.4 to asphalt and bituminous sealed street surfaces and for use with Type B-HR and/or Type D-HR drop-on spherical glass beads.

16.5.2 Pavement Marking Paint Colours

The standards for pavement marking paint colours are:

- White pavement marking paint must have a white colour to AS 2700S(N14);
- Yellow pavement marking paint must have a golden yellow colour to AS 2700S(Y14); and
- Black pavement marking paint must have a black colour to AS 2700S(N61).

16.6 GLASS BEADS

Use glass beads conforming to AS/NZS 2009 and APAS specification AP-S0042.

Documentation Point 71 - Submit a Certificate of Compliance in respect to the glass beads complying with the relevant Australian Standard and APAS specification.

Infrastructure Category A: use Type B-HR glass beads for initial application, and Type D-HR glass beads for second application.

Infrastructure Category B to E: use Type B-HR glass beads for initial and remark applications.

Refer to *Table 16-2 - Application Times – All Longitudinal and Transverse Pavement Markings***.**

16.7 THERMOPLASTIC MATERIALS

Documentation Point 72 – Obtain approval for use of thermoplastic materials.

Thermoplastic pavement marking materials must comply with AS 4049.2 and with APAS Specification AP-S0041/4.

Thermoplastic pavement marking material must consist of aggregate, pigment, binder, glass beads and extenders, capable of being softened by heating and hardened by cooling.

For continuous thermoplastic pavement marking, 100 mm drainage gaps must be provided, at a maximum spacing of 3m, to allow adequate drainage of the pavement surface. Nominate the method of identifying the location and spacing for these gaps.

16.8 COLD APPLIED PLASTIC MATERIALS

Use Approved plastic pavement marking materials to *APAS AP-S0041/36 Cold Applied Plastic*.

Documentation Point 73 – Obtain approval for use of cold applied plastic materials.

Documentation Point 74 - Provide evidence that all proprietary cold applied plastic material products, such as epoxy or plastic products, have demonstrated satisfactory field performance for a period of at least three years.

Material – Generally: A two part Poly Methyl Methacrylate resin based pavement marking material that complies with the requirements for colour, luminance and bead content of AS 4049.2, and which complies with AS 4049.4, sprayed or screeded onto the Pavement, containing pre-mixed glass beads, with additional drop-on beads being added during application, conforming with the following requirements of AS 4049.2: Clause 5.1 – Colour, Clause 5.2 – Luminance, and Clause 7 - Field Testing. The material must have a maximum no-pick-up time of 60 minutes.

Do not use cold applied plastic materials on new works for Infrastructure Category A.

16.9 PAVEMENT MARKING SETTING OUT

The location of all pavement markings on new surfaces, including RRPMs, must be set out by spotting with paint or other Approved method prior to application of the markings.

Ensure the distance between the centre line of the marking and the centre line of the set out mark is less than 30 mm. The apparent line of the markings must be a smooth continuous alignment when viewed in the direction of the line.

New work: Set out line marking to the line pattern specified in accordance with AS 1742 and Standard Drawings for Line Marking, including the setting out of arrows, letters, numerals, chevrons and RRPMs.

Remarking: Remark along the line of the existing line marking and to the tolerances specified for new work.

16.10 PAVEMENT MARKING APPLICATION

Apply the marking materials using a self-propelled mobile sprayer, hand sprayer, hand painting or hand screeding as directed by the Relevant Authority.

Documentation Point 75 – Submit details of type of equipment to be used for applying Pavement marking materials.

Documentation Point 76 - Submit documented evidence to show that the pavement marking spraying equipment has been calibrated in accordance with NTTM 405.1 and with PCCP requirements and is certified by PCCP as being suitable for the Development Works to be carried out.

Substrate: Ensure that the Pavement surface is free from dirt, loose detritus, mud and other extraneous matter, and is dry before and after painting operations.

Protect all applications from traffic until the binder has hardened sufficiently to retain the glass beads.

Produce markings so that they are straight, with smooth even curves where necessary. Remove any marking material beyond the defined marking leaving a neat and smooth marking on the pavement.

Produce markings free from ghosting and raggedness on the sides and ends and parallel with the general alignment of the Carriageway with the lines level, uniform and free from streaks.

Reinstate pavement markings that are damaged by traffic during paint drying time and remove all tyre pickup marks.

16.10.1 Longitudinal Application

Apply the marking materials using a self-propelled mobile sprayer having a minimum capacity of 200 litres of paint.

Apply paint evenly to the Pavement surface at the specified film thicknesses and immediately after apply an even application of glass beads at the specified rates.

On all new work, apply one coat of paint and glass beads to the Pavement in the direction of traffic flow.

For remarking, apply one coat of paint and glass beads to the surface in the direction of traffic flow.

16.10.2 Transverse and Other Marking Applications

Apply the marking materials using a self-propelled or hand sprayer with a capacity of 20 litres of paint.

Apply paint evenly to the Pavement surface to the specified film thickness and immediately after apply an even application of glass beads at the specified rates.

16.10.3 Markings on Concrete Pavement

Prime the concrete Pavement surface with an Approved primer before applying markings. Allow sufficient time for primer to cure to manufacturer's recommendations before applying markings.

16.10.4 Glass Beads

Apply glass beads by low pressure or delivered by gravity dispenser, D-HR beads may require application by static drop method in conjunction with air pressures to retain beads.

Maximum application speed for glass beads must be as per manufacturer's recommendations.

The application rates specified for glass beads are the amounts that are retained in the painted surface after three weeks of trafficking.

Ensure that the loss in glass beads after three weeks traffic does not exceed ten per cent of total applied.

16.11 CONFORMANCE AND TOLERANCES

Documentation Point 77 – Provide evidence that the complete Pavement marking complies with the requirements of this specification.

Pavement marking must conform to the following tables:

- *Table 16-1 - Application Rates – All Longitudinal and Transverse Pavement Markings*
- *Table 16-2 - Application Times – All Longitudinal and Transverse Pavement Markings*
- *Table 16-3 – Dimensional Tolerances for Pavement Markings*

Remove defective marking by sand blasting, or other Approved methods, make good the surface in an Approved manner.

Remark all Pavement marking at the end of the Defects Liability Period.

Table 16-1 - Application Rates – All Longitudinal and Transverse Pavement Markings					
Infrastructure Category	**Works**	**Wet film paint thickness**	**Dry film paint thickness**	**Glass beads type**	**Rate of glass beads to be retained**
Infrastructure Category A	Initial marking	> 0.360 mm	> 0.230 mm	B-HR	> 300g/m^2
	Remarking	> 0.515 mm	> 0.330 mm	D-HR	> 400g/m^2
Infrastructure Category B to E	Initial marking	> 0.360 mm	> 0.230 mm	B-HR	> 300g/m^2
	Remarking	> 0.360 mm	> 0.230 mm	B-HR	> 300g/m^2
Notes: - Paint film thickness tolerances exclude surface applied glass beads.					

Table 16-2 - Application Times – All Longitudinal and Transverse Pavement Markings			
Infrastructure Category	**Works**	**Longitudinal Markings**	**Transverse Markings**
Infrastructure Category A	Initial marking	Before opening of works to traffic	Before opening of works to traffic
	Resurfacing/ Resealing	Within 2 Calendar Days	Hold lines – 1 Calendar Day Other lines - within 2 Calendar Days
	Remarking	9 months maximum	9 months maximum
Infrastructure Category B to E	Initial marking	Before opening of works to traffic	Before opening of works to traffic
	Resurfacing/ Resealing	Within 21 Calendar Days	Within 21 Calendar Days
	Resurfacing/ Resealing – Overtaking Lanes	Within 5 Calendar Days	Within 5 Calendar Days
	Remarking	3 to 6 months	3 to 6 months

Table 16-3 – Dimensional Tolerances for Pavement Markings		
Properties	**Tolerances**	
	New work	**Remarking work**
If no tolerance is explicitly stated for an attribute of the works, the tolerance is zero.		
Locations other than Aerodromes		
Locations of centrelines of markings	< 20 mm from locations as shown on drawings	+/- 5 mm
Widths of lines	+/- 5 mm	+/- 10 mm
Lengths of lines	+/- 50 mm	+/- 100 mm
Locations of arrows, chevrons, letters, numerals	+/- 50 mm	+/- 50 mm
Deviation and/or trueness of lines	< 15 mm in 2 metres	< 15 mm in 2 metres

16.12 FIELD TESTING

Undertake the following Conformance Testing:

Wet film thickness: Check the thickness of the wet film applied to the Pavement by the method NTTM 401.1 - Operation of Wet Film Thickness Comb.

Glass bead application: Check the application rate of glass beads to the surface of the marked line by the method NTTM 402.1 - Field Procedure for Measurement of the Rate of Application of Spherical Glass Beads.

Wear assessment limits: The degree of wear is defined as the area of Pavement marking remaining after a period of time, relative to the initial area of the Pavement marking.

Degree of wear: At the Relevant Authority's discretion, determine the degree of wear using Image Analysis in accordance with AS 4049.3:2005 Appendix K, Method A, Photographic Method.

Wear limits for Pavement marking: 95% intact area after six months.

Remark Pavement marking that does not conform to the specified limits.

16.13 RAISED RETROREFLECTIVE PAVEMENT MARKERS (RRPMS)

Use Raised Retroreflective Pavement Markers (RRPMs) conforming to AS/NZS 1906 Retroreflective materials and devices for road traffic control purposes.

Documentation Point 78 – Submit details in relation to the manufacturer's warranties, performance, durability and maintenance of the raised retroreflective pavement markers.

Provide raised retroreflective pavement markers with the following attributes:

Table 16-4 – Raised Retroreflective Pavement Markers Dimensions

Aspect	Dimension
Height (above pavement level when installed)	18 – 25 mm
Width at right angles to the direction of the traffic	110 – 130 mm
Length parallel to the direction of the traffic	80 – 110 mm

16.13.1 Materials

Use markers fixed to the Pavement surface as recommended by the manufacturer of the marker.

Use adhesives as recommended by the manufacturer.

Use adhesives within the time recommended by the adhesive manufacturer.

16.13.2 Pavement Preparation

Clean the Pavement.

Ensure each RRPM site is free of dirt, oil, grease, paint and any other material which would affect the bond of adhesive to the Pavement.

Abrasive blast, chip, or burn Pavements that cannot be cleaned by sweeping.

Do not place markers if moisture is present. Ensure pavement is dry before applying markers.

16.13.3 Placing Markers

Place markers in accordance with AS 1742.3 and Standard Drawings.

Place the reflectors to face the oncoming traffic.

Do not obscure the reflective faces by adhesive.

Ensure that the surface finish is smooth.

Discard markers which are not positioned correctly within the time recommended by the manufacturer for use of the adhesive. Remove stale adhesive from the Pavement surface.

Do not place markers over joints in concrete pavement.

Wear limits for pavement markers: 95% intact area after six months.

Replace markers that have dislodged within 12 months of installation.

16.14 REMOVAL OF PAVEMENT MARKINGS

Documentation Point 79 – Obtain approval of the method used for line marking removal before commencing removal operations.

Removal of Pavement marking must not adversely affect the integrity of the Pavement surface.

When Longitudinal and Transverse Markings are removed, the marks left on the Pavement surface must not confuse the motorist with ghosting or incorrect directions. Where removal is outside of 100 mm of the existing lines then the entire width of the lane is to be consistent with the line removal texture.

When arrows, letters or figures are to be removed or temporarily blacked out, the removal pattern must be in the shape of a rectangle or square to minimise confusion to the motorists.

Remove all materials and debris generated by removal operations from the Development Site and dispose of lawfully. Repair any surface Defects caused by the removal process.

The following methods may be considered and will be dependent on the type of surface, extent and application.

16.14.1 Resealing and Asphalting

Spray sealing and/or Asphalt replacement is the preferred method for replacement. Determination of materials must be in accordance with existing materials. Conform to specification requirements.

Where this method is used, the reworking needs to be for the full width of the Pavement.

16.14.2 Sandblasting or Water Blasting

This methodology is the preferred method for marking removal on asphalt and concrete surfaces.

Use a skirt or guard around the blaster to minimise the spraying of material away from the immediate work area.

Remove waste material before it can be transported by rain, wind or traffic. This will generally require the use of a vacuum attachment operating concurrently with the blasting operation or alternative method Approved by the Relevant Authority.

16.14.3 Machine Grinding

This method may be considered for use on smaller removal jobs where surface finish is not a concern. It can be used on most asphalt and concrete surfaces.

16.14.4 Paint Blackout

Paint blackout may be considered as a temporary measure only and must be removed upon completion of the Development Works.

16.14.5 Other Methods

Other methods such heat lance or paint stripping may also be considered, where Approved by the Relevant Authority.

16.14.6 Raised Reflective Pavement Marker Removal

Where required, remove raised Pavement markers by breaking the bond between the adhesive, the street surface and the base of the raised Pavement marker.

Repair all divots caused by the removal of raised Pavement markers with hot melt adhesive or epoxy adhesive to the level of the surrounding Pavement.

16.15 REPORTING

Documentation Point 80 – Submit pavement marking reports.

Reports to contain the following information, in Microsoft Excel spreadsheet format:

- Date
- Street ID
- Chainages – start point and finish point of each section of works
- GPS coordinates in Decimal Degrees - start point and finish point of each section of works
- Type of carriageway – inbound / outbound (for duel carriageways) and full width (for two way carriageway)
- Bead size used and Paint application rate

17. LANDSCAPE

17.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 2303	Tree stock for landscaping use
AS 2698(set)	Plastic pipes and fittings for irrigation and rural applications
AS 2698.2	Polyethylene rural pipe
AS 2698.3	Mechanical joint fittings for use with polyethylene micro-irrigation pipes
AS/NZS 3500(set)	Plumbing and drainage
AS 4373	Pruning of amenity trees
AS 4419	Soils for landscaping and garden use.
AS 4454	Composts, soil conditioners and mulches
AS/NZS 4685(set)	General Safety Requirements and Test Methods
AS 4486	Playgrounds and Playground Equipment Development, Installation, Inspection, Maintenance and Operation.

17.2 MATERIALS

Refer to AS 2303 for tree stock requirements.

17.2.1 Trees, Shrubs and Ground Covers

Provide trees, shrubs and ground covers which have the following characteristics:

- Trunks/stems to be sturdy and well hardened.
- A well-developed vigorous root system.
- A minimum of three months in their container.
- Be sound, healthy, vigorous, and free from insect pests, plant diseases, sun scalds, fresh abrasions of the bark, or other disfigurements.

17.2.2 Rock

Site rock: Rock which has been salvaged and stockpiled onsite for placement in landscaping works. Remove all other rock from the Development Site and dispose of lawfully.

Imported rock: Rock which has been selected prior to delivery. Types may include Granite spalls, Porcelinite, Acacia Blue, Coffee Rock and Weathered Limestone.

17.2.3 Grass

Provide Certified Seed with an appropriately numbered seed analysis report or certificate cross referenced to the number on the seed packaging.

Documentation Point 81 – Submit grass seed certificates prior to application of grassing.

Seed must be used only if its report or certificate has been issued within the previous six months.

Seed used must be true to label.

Seed must have minimum Germination Percentage of 80%.

Certified Seed must comply with the following purity characteristics:

- Clean seed, minimum 94% by weight.
- Weed seed, maximum 0.2% by weight.
- Other crop seed, maximum 0.8% by weight.
- Inert matter, maximum 5.0% by weight.
- Must not contain any species of plants declared as a weed under the *Weeds Management Act 2001 (NT)*.

Certified Seed mixes must conform to the requirements of the Relevant Authority.

Grass to exhibit 90% Ground Cover prior to the Practical Completion Date.

Grass to achieve 100% Ground Cover prior to end of Defects Liability Period.

17.2.4 Fertiliser

Fertilisers must be stored in waterproof sealed bags under shelter away from water and direct sunlight.

Fertilisers must conform to *Table 17-3 - Fertilisers*.

17.2.5 Site Topsoil

Topsoil excavated from the Development Site which has the following characteristics:

- Contains organic matter; and
- Supports plant life.

Inspection Point 34 – Obtain approval for re-use of site topsoil on the Development Site prior to application.

17.2.6 Imported Topsoil

Imported topsoil must be Certified to comply with AS 4419 and the following requirements:

- Be free draining;
- Be red-brown or black sandy loam;
- Contain no grass or weed growth;
- Maximum stone size of 50 mm; and
- Must not contain any material from plant species declared as weeds under the *Weeds Management Act 2001 (NT)*.

Documentation Point 82 - Submit Certified test reports and associated delivery dockets confirming imported topsoil complies with AS 4419.

17.2.7 Insecticide

Use Fipronil (or similar Approved) for termite control.

Insecticide must be used strictly in accordance with the manufacturer's specifications.

17.2.8 Mulch

Organic

- Must be stable, free from impurity, and be sufficiently heavy to prevent dispersal by wind.
- Must be shredded bark, wood chips or similar.
- Wood chips must be a maximum size of 50 mm, inert, and must be free of resinous toxins and termites.
- Must conform generally to AS 4454.

Inorganic

- Must be washed and screened lateritic gravel or brick chips with particle sizes in the range 6 mm minimum to 25 mm maximum.

Imported Mulch

Documentation Point 83 – Submit Certified test reports ad associated delivery dockets confirming imported mulch complies with AS 4454.

17.3 SITE PREPARATION

17.3.1 Setting Out

The Developer is responsible for accurately setting out the works in accordance with the Construction Drawings.

Trees must be installed with consideration of the following:

- provision of clear sightlines at vehicular intersections;
- clearance from light poles and CCTV to prevent compromising light spills and CCTV Views.
- provision of clear sightlines of pedestrians and cars at driveways and pedestrian crossing locations; and
- 3 metres vegetation clearance to fire hydrants.
- do not obscure traffic signs, signals, or other essential roadside features.

17.3.2 Protection of Existing Vegetation

Ensure all trees, shrubs, and other vegetation to be retained within the limits of work are protected in accordance with AS 4970 protection of trees on development sites.

Protect vegetation prior to commencing construction work in the vicinity of that vegetation.

Do not place or dump any chemical type materials including oil, paint, bituminous products, fuels, and cement/concrete near the vegetation. Prevent windblown chemical type materials, such as cement, from affecting vegetation.

Do not stockpile bulk materials - such as spoil from excavation, boulders, cleared vegetation - under or near vegetation. Ensure spoil is not placed against trunks.

Do not remove topsoil from within the dripline (i.e. canopy area) of trees to be retained unless essential to the works. For excavation within the dripline, keep open as short a period as possible and use excavation methods that preserve the root system intact and undamaged.

Where excavation around the root system is unavoidable, non-mechanical excavation methods such as hydro excavation must be used.

Cut roots only where it is absolutely necessary. When cutting roots ensure cuts are made with a clean bladed saw to the minimum number of roots possible. Under no circumstances are roots to be pruned using excavation machinery.

Backfill excavation around tree roots with material of at least comparable quality to that excavated. Consolidate backfill and do not backfill around trunks above the original level. Thoroughly water backfilling.

Avoid damage to overhead limbs by machinery. Only remove the minimum amount required if limbs must be removed to allow machinery to work.

Where branches are to be removed, cut them back to the branch collar. Pruning should be undertaken by a qualified arborist and conform to AS 4373.

17.3.3 Clearing and Grubbing

Conform to *Section 3 – Clearing, Grubbing and Rehabilitation*.

17.3.4 Earthworks

Conform to *Section 1 - Earthworks*.

17.3.5 Subgrade Cultivation

Prepare Subgrade prior to spreading of topsoil.

Rip Subgrade to a depth of min 200mm across the direction of slope and cultivate so that the sub-surface soil can be worked freely to a minimum depth of 150mm.

Areas to be ripped must not be worked when subsoil is wet or plastic.

Do not disturb services or tree roots; if necessary cultivate these areas by hand. Cultivate manually within 300 mm of paths and structures, and other infrastructure which may be damaged.

Allow for clearing and removing stones exceeding 25 mm, perennial weeds and any rubbish or other deleterious material brought to the surface during cultivation.

During cultivation, thoroughly mix in any materials required to be incorporated into the subsoil.

Trim surfaces to specified levels after cultivation.

17.4 TOPSOIL

17.4.1 Source

Use compliant site topsoil or imported topsoil from an Approved off-site source. Refer to *Clauses 17.2.5 - Site Topsoil* and *17.2.6 - Imported Topsoil*.

17.4.2 Placing topsoil

Spread the topsoil on the prepared subsoil and grade evenly, making the necessary allowances to permit the following:

- Required finished levels and contours may be achieved after light compaction.
- Grassed areas may be finished 20mm lower than adjacent hard surfaces such as kerbs, paths and mowing strips.

17.4.3 Consolidation

Compact lightly and uniformly in 150 mm layers. Avoid differential subsidence and excess compaction and produce a finished topsoil surface which has the following characteristics:

- Finished to design levels.
- Smooth and free from stones or lumps of soil in excess of 50 mm diameter.
- Graded to drain freely, without ponding, to catchment points.
- Graded evenly into adjoining ground surfaces.
- Ready for planting.

17.4.4 Topsoil depths

Spread topsoil to the following typical depths:

- Grassed areas: 100 mm
- Garden beds: 300 mm
- Refer Construction Drawings for nominated topsoil depths, where slopes exceed 1:6.

17.5 ROCKWORK

Use Approved Site Rock, otherwise provide Imported Rock. Refer to *Clause 17.5 - Rockwork.*

Place rocks while earthworks is being carried out.

Bury rock two thirds by volume, with weathered faces exposed. Protect the weathered faces from damage. Ensure all rock faces have no sharp edges or laminating faces.

17.6 EDGING

Supply and install 150 mm wide x 150 mm deep concrete edging to all garden beds, tree pits, planter boxes, between garden beds and loose surface finishes, and grassed areas and edge of retained trees and vegetation.

17.7 GRASSING

17.7.1 Topsoil Preparation

Bring the area to a Fine Tilth and conform to the prescribed finished levels prior to the placement of grass seed.

17.7.2 Supply of Grass Seeds

Supply fresh Certified Seeds conforming to *Clause 17.2.3* - Grass*.* Certified Seed mixes must conform to the requirements of the Relevant Authority.

17.7.3 Fertiliser Application

Apply fertiliser complying with *Table 17-3 - Fertilisers* with minimum application rates in accordance with *Table 17-5 - Fertiliser Application Rates*, to the finished topsoiled surface and lightly work into the soil.

The fertiliser may be applied simultaneously with the grass seed.

17.7.4 Application

Apply Certified Seed in accordance with the mixture application rate nominated by the Relevant Authority, as a minimum, to the prepared topsoiled surface and lightly work into the soil.

The grass seed may be applied simultaneously with the fertiliser.

Apply seed uniformly by mechanical means or hydro-mulching. Hand distribution must only be used in areas inaccessible to machinery.

The seed must be sown on a calm day and applied in two equal sowings in transverse directions.

17.7.5 Reseeding

Reseed any areas that fail to gain 90% Ground Cover prior to the Practical Completion Date.

Bring area requiring reseeding to a fine tilth by hand raking only.

17.7.6 Establishment

Irrigate and fertilise grassing to maintain it in a healthy condition.

Maintain grassed area free of all weeds and insects.

Ensure grass has and maintains uniform Ground Cover with active growth.

17.7.7 Mowing

Mow the grass to maintain a maximum height as follows:

- Residential/mixed use zones: 70 mm
- Industrial zones: 70 mm
- Rural zones: 150 mm

17.8 PLANTING

17.8.1 General

Refer to Standard Drawings for typical planting details generally.

17.8.2 Setting Out of Holes

Accurately set out the locations for trees/shrubs to be planted in accordance with the Construction Drawings.

Inspection Point 35 - Obtain approval of the planting set out before commencing any planting.

17.8.3 Preparation and Treatment of Holes

Identify all cable and services locations prior to excavating any holes.

Prepare holes initially in accordance with *Table 17-4 – Initial Planting Hole Preparation Chart***.**

Remove excess excavated material, rubbish and cut vegetation from the Development Site.

Excavate planting holes by mechanical or manual means, as appropriate.

Size of planting holes must be as shown on the Standard Drawings.

Cultivate the subgrade and scarify the sides of holes.

Treat planting holes in hard, dense material prior to planting by:

- placing 1 kg Gypsum or Claybreaker around the sides and bottom of the hole; and
- filling hole with water and allowing to drain.

Treat holes with Fipronil in accordance with manufacturer's instructions prior to planting.

Inspection Point 36 - Provide notification of completing preparation and treatment requirements for plant holes.

17.8.4 Supply of Plants

Place an order with an Approved nursery for the supply of all plants required to complete the works.

Supply plants conforming to AS 2303 – 'Tree Stock for Landscape Use' and pruned in accordance with AS 4373 Pruning of 'Amenity Trees'. Trees grown in air root pruning pots are preferred. Trees that do not conform with the nominated Standards must be rejected.

Ensure that a minimum of five number or 5%, whichever is the greater, additional plants of each species nominated is available if necessary for replacement purposes.

Remove immediately from the Development Site all dead, dying or diseased plants and replace with new plants of the same species.

Alternative plant species, other than those nominated in the Approved Construction Drawings, must not be used in the Development Works without approval.

Documentation Point 84 – Obtain approval for use of alternative plant species, prior to ordering plants.

Plant species for use in stormwater quality treatment systems (e.g. lakes, wetlands) must not be substituted.

17.8.5 Treatment of Plants

Containerised plantings must be well watered prior to despatch from the nursery and must remain in the containers until required for planting.

Protect all plants during transportation, against excessive sunlight, wind and drought.

Trees and shrubs which are not immediately planted must be stood upright on level ground, protected and maintained in good condition by the Developer.

Replace immediately all plantings which have become damaged, gone missing or fallen below the specified standards for supply.

Drive any tree stakes required into the ground before planting so as not to damage the Root Ball.

For the duration of the Defects Liability Period, check regularly for any termite/insect attack or fungal infestation and carry out eradication by use of sprayed insecticide or fungicide in accordance with the manufacturer's specifications.

17.8.6 Planting of Trees, Shrubs and Ground Cover

Planting must take place only in conditions where shaded temperature is below 32 °C.

Root barriers must be installed to street trees adjacent to services and footpaths. Refer Standard Drawings for root barrier placement. Ensure root barriers do not encircle trees.

Maintain the integrity of the plant root zone and the surrounding earth mound.

Place fertiliser in the hole adjacent to, but not in contact with, the root zone of the plant. Fertiliser must be in accordance with *Table 17-3 - Fertilisers*. Application rates in accordance with *Table 17-5 - Fertiliser Application Rates***.**

17.8.7 Backfilling

Backfill material must be in accordance with *Table 17-4 – Initial Planting Hole Preparation Chart***.**

Backfill the hole to finished surface level, firming progressively, so that the plant is contained firmly in the ground in a vertical position.

Work surface fertiliser into top 50 mm of backfill. Fertiliser must be in accordance with *Table 17-3 - Fertilisers*. Application rates in accordance with *Table 17-5 - Fertiliser Application Rates*.

Water backfill material immediately after surface fertilisation to ensure no air voids or loose material surround the plant root zone.

17.8.8 Mulching

Supply Mulch as specified that is free from weeds, seeds, sticks, stones, insects, diseases and other deleterious matter.

Provide organic Mulch in a 100 mm thick compacted layer to cover the radius of the planting hole. Shape to create a 400mm diameter watering basin around the main stem.

Ensure a gap of 100 mm is retained between the main stem and the Mulch.

17.8.9 Maintenance

Establish and maintain all garden beds and planting areas during the Defects Liability Period, including:

- irrigating and fertilising to maintain all vegetation in a healthy condition;
- maintaining 100 mm organic Mulch;
- eradicating all weeds to a schedule agreed with the Relevant Authority; and
- Pruning to conform to *AS4373 – 'Pruning of Amenity Trees'*.

17.9 HYDROSEEDING

17.9.1 General

Use an Approved hydraulically-applied proprietary erosion control Engineered Fibre Matrix (EFM) product.

The EFM is to be 100% biodegradable, and is to be composed of 100% recycled, thermally refined (within a pressurized vessel) virgin wood fibres, crimped interlocking biodegradable fibres, mineral activators and Soil Binding Agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents).

The EFM is to be phytosanitised, free from plastic netting, and when cured is to form an intimate bond with the soil surface to create a continuous, porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.

The EFM is to perform as a Bonded Fibre Matrix (BFM) product and may require a 4-24 hour curing period to achieve maximum performance.

17.9.2 Developer Submissions

Product Data:

Documentation Point 85 - Submit manufacturer's product data and installation instructions. Include required substrate preparation, list of materials and application rates.

17.9.3 Delivery, Storage, and Handling

Deliver materials and products in UV and weather-resistant factory labelled packages.

Store and handle in strict compliance with manufacturer's instructions and recommendations.

Protect from damage, weather, excessive temperatures and construction operations.

17.9.4 Materials

The EFM must conform to the following typical property values when uniformly applied at a rate of 3,900 kilograms per hectare under laboratory conditions.

Table 17-1 - Engineered Fibre Matrix Properties

Property	**Test Method**	**Required Tested Value**
Physical		
Mass Per Unit Area	ASTM D6566[1]	≥ 390 g/m^2
Thickness	ASTM D6525[1]	≥ 4 mm
Ground Cover	ASTM D6567[1]	≥ 98%
Water Holding Capacity	ASTM D7367	≥ 1,400%
Material Colour	Observed	Green
Performance		
Cover Factor[2]	Large Scale Testing	≤ 0.05
% Effectiveness[3]	Large Scale Testing	≥ 95 %
Cure time	Observed	4 – 24 hours
Vegetation Establishment	ASTM D73221	≥ 600 %

Table 17-1 - Engineered Fibre Matrix Properties		
Functional Longevity[4]	ASTM D5338	≤ 12 months
Environmental		
Ecotoxicity	EPA 2021.0 (USA)	48-hr LC50 > 100%
Biodegradability	ASTM D5338	Yes

NOTES

- ASTM test methods developed for Rolled Erosion Control Products and have been modified to accommodate Hydraulically-Applied Erosion Control Products.
- Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.
- % Effectiveness = One minus Cover Factor multiplied by 100%.
- Functional Longevity is the estimated time period, based upon ASTM D5338 testing and field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors.

17.9.5 Composition

All components of the EFM must be pre-packaged by the Manufacturer to assure both material performance and compliance with the following values.

- Thermally Processed* (within a pressurized vessel) Virgin Wood Fibres – 77%
  - *Heated to a temperature greater than 193 degrees Celsius for 5 minutes at a pressure greater than 345 kPa.
- Soil Binding Agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents) – 18%
- Crimped Biodegradable Interlocking Fibres – 2.5%
- Micro-Pore Granules – 2.5%

Under no circumstances must field mixing of components be permitted.

No chemical additives with the exception of fertilizer, soil neutralizers and biostimulant materials should be added to this product.

Documentation Point 86 – Obtain approval for use of chemical additives to hydroseeding mixes other than fertilizer, soil neutralizers and biostimulant materials.

17.9.6 Substrate and Seedbed Preparation

Examine substrates and conditions where materials will be applied.

Apply products to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope.

Do not proceed with installation until satisfactory conditions are established.

Depending upon project sequencing and intended application, prepare seedbed in compliance with other specifications.

17.9.7 Installation

Strictly comply with equipment manufacturer's installation instructions and recommendations.

Use Approved hydroseeding machines with fan-type nozzle (50-degree tip).

To achieve optimum soil surface coverage, apply EFM from opposing directions to soil surface.

Rough surfaces (rocky terrain, cat tracked and ripped soils) may require higher application rates to achieve 100% cover.

Slope interruption devices or water diversion techniques are recommended when slope lengths (3H:1V) exceed 15m. Slope interruption intervals may need to be decreased based on steeper slopes or other site conditions.

EFM is not recommended for channels or areas with concentrated water flow unless used in conjunction with a rolled erosion control product designed to accommodate the anticipated hydraulic conditions.

For erosion control and revegetation: to ensure proper application rates, measure and stake area.

For maximum performance, apply EFM in a two-step process:

Step One: Apply fertilizer with specified prescriptive agronomic formulations and typically 50% of specified seed mix with a small amount EFM for visual metering. Do not leave seeded surfaces unprotected, especially if precipitation is imminent.

Step Two: Mix balance of seed and apply EFM at a rate of 22.7 kg per 316 litres of water over freshly seeded surfaces. Confirm loading rates with equipment manufacturer.

Depending upon site conditions EFM may be applied in a one-step process where all components may be mixed together in single tank loads. Consult with Manufacturer for further details.

Best results and more rapid curing are achieved at temperatures exceeding 15°C. Curing times may be accelerated in high temperature, low humidity conditions with product applied on dry soils.

Mixing: Use a mechanically agitated hydroseeding machine:

- Fill 1/3 of mechanically agitated hydroseeder with water. Turn pump on for 15 seconds and purge and pre-wet lines. Turn pump off.
- Turn agitator on and load low density materials first (i.e. seed).
- Continue slowly filling tank with water while loading fibre matrix into tank.
- Consult application and loading charts to determine number of bags to be added for desired area and application rate. Mix at a rate of 22.7 kg per 316 litres of water.
- All EFM should be completely loaded before water level reaches 75% of the top of tank.
- Top off with water and mix until all fibre is fully broken apart and hydrated (minimum of 10 minutes — increase mixing time when applying in cold conditions). This is very important to fully activate the bonding additives and to obtain proper viscosity.
- Add fertilizer and any other Approved additives.
- Shut off recirculation valve to minimize potential for air entrainment within the slurry.
- Slow down agitator and start applying with a 50-degree fan tip nozzle.
- Spray in opposing directions for maximum soil coverage.

Application Rates: The following application rates are for standard conditions. Increase application rates on rough surfaces.

Refer to Manufacturer's information for additional details including mixing ratios/loading rates for specific machine sizes and visual keys for proper application.

Table 17-2 - Application Rates	
Slope Gradient / Condition	Application rate
≤ 4H to 1V	2,800 kg/ha
> 4H to 1V and ≤ 3H to 1V	3,360 to 3,400 kg/ha
> 3H to 1V and ≤ 2H to 1V	3,900 to 3,920 kg/h
> 2H to 1V and ≤ 1H to 1V	4,480 to 4,500 kg/ha
For slopes steeper than 1H to 1V use alternative stabilization methods.	
H = horizontal V = vertical	

17.9.8 Cleaning and Protection

Clean spills promptly.

Do not allow treated areas to be trafficked or subjected to grazing.

17.9.9 Inspection and Maintenance

Initial inspections must ensure installations are in accordance with the project plans and specifications with material quantities and activities fully documented.

Subsequent inspections must be conducted at pre-determined time intervals and corrective maintenance activities directed after each significant rainfall event or other potentially damaging weather or site event.

17.10 IRRIGATION

17.10.1 General

Irrigate all soft landscaping during the Defects Liability Period. Where permanent irrigation is absent, temporary irrigation may be required to assist with establishment and maintenance of soft landscaping.

Remove all temporary irrigation installed must prior to completion of the Defects Liability Period, unless otherwise agreed with the Relevant Authority.

17.10.2 Irrigation Systems

General

Standard: To AS/NZS 3500.1

Place a high priority on avoiding surface runoff when selecting system components. Use low trajectory sprinklers where possible. Select components to keep the sprinkler precipitation rate below the infiltration rate of the soil and/or use repeat cycles to allow water to soak into the root zones.

Where possible, separate station/zones for irrigation at the top and bottom of sloped areas.

Irrigation system to be designed to the Relevant Authority irrigation system requirements.

Documentation Point 87 – Submit irrigation designs prior to installation of irrigation systems.

Materials

Pipework upstream of control valves: Use uPVC class 12.

Pipework downstream of control valves: Use uPVC class 9 or high-density polyethylene.

Performance

Coverage (mm of water over area to be watered):

- 50 mm per week, applied as two applications of 4 mm per day, during the first 13 weeks.
- Progressively hardening off to suit the local conditions during the remainder of the Defects Liability Period.

Ensure that final water usage is such that plant health and vigour is maintained without wastage of water.

17.10.3 Water Source

Documentation Point 88 - Liaise with the Service Authority and obtain approval for connections in relation to water supply requirements.

Carry out the excavation necessary to locate and expose the connection point. On completion, reinstate any surfaces and elements which have been disturbed.

Fit a backflow prevention device as required to meet the approval of the Service Authority.

17.10.4 Telemetric Control Station Details

Telemetric operated Irrigation control stations must be constructed to comply with the Relevant Authority requirements.

17.11 SHADE STRUCTURES

17.11.1 Construction

Construct all shade structures in accordance with the Construction Drawings.

17.11.2 Permits and Certification

Obtain all necessary Building Permits and Certification.

Documentation Point 89 – Submit a copy of all Building Permit(s) and Certificate(s) of Occupancy.

17.12 SPORTING AND PARK FURNITURE AND EQUIPMENT

Supply all park furniture and play equipment as specified in Construction Drawings and in accordance with all relevant Australian Standards including, but not limited to, AS 4422, AS 4486 and AS 4685.

Install all park furniture and play equipment in accordance with manufacturer's specifications, unless advised otherwise by the Relevant Authority.

All soft fall areas must be constructed with subsoil drainage in accordance with *Clause 13.11 - Subsoil Drains.*

Any concrete works, such as footings, are to be carried out in accordance with Structural Concrete Works Section and Construction Drawings.

17.13 LANDSCAPE MAINTENANCE

The Defects Liability Period is 12 months for landscaping works, including grassing and planting.

Where existing grassing or planting is within the Development Site, maintain it as for the corresponding classifications of new grassing or planting.

Throughout the Defects Liability Period, carry out maintenance work including, watering, mowing, weeding, fertilising, pest and disease control, reseeding, returfing, staking and tying, replanting, cultivating, pruning, hedge clipping, aerating, reinstatement of Mulch, renovating, top dressing, and keeping the Development Site neat and tidy.

Replace diseased or poorly formed plants.

Commence grass maintenance works at the completion of sowing, hydroseeding and turfing. Maintain healthy weed-free growth.

17.14 LANDSCAPE TABLES

Table 17-3 - Fertilisers

Use	General Plant Category	Where Used	Component Requirements
Planting	Native	Surface	Native Plant Feed Mix
	Exotic	Surface	Exotic Planting and Feeding Mix
	Native and/or Exotic	Hole	Granular or Tablet Slow Release (6 month minimum) 20:10:10 NPK Ratio
Feeding	All existing plants	Surface	As for Planting - Surface
Grassing	All seeding, both new and existing	Surface	Fast Release 15:7:7 NPK Ratio Trace Elements
Do not use fertiliser with Grevillia and Banksia plant varieties.			

Table 17-4 – Initial Planting Hole Preparation Chart				
Land Categories and Soil Characteristics				
Land Categories	**Category 1 - Marine Sediments**	**Category 2 - Soil and Gravel** (depth greater than 600 mm)	**Category 3 - Shallow Soils**	**Category 4 - Surface Rock** (soil depth overlaying rock less than 600 mm)
Visual appearance	Grey and brown muds, silts and clays: occasionally pale beach sands	Usually red, yellow and brown sandy loams to sandy clay loams with varying amounts of ironstone gravel; occasionally siltstone and quartz gravel	Soil material similar to Category 2, overlaying laterite on siltstone*	Very little or no soil; extensive areas out of cropping laterite on siltstone*
Operational Steps				
Initial Rock Break	-	-	-	Rip and rock break.
Initial Excavation	Hole size dependent upon species and area	Excavate to 600 mm.	Excavate hole until machine rejection (commonly bed rock layer).	Excavate hole to 600 mm minimum.
Secondary Rock Break	-	-	Rock break bottom to a depth of 1200 mm.	Rock break bottom further 600 mm down.
Secondary	-	Excavate rocks.	Excavate rocks greater than 150 mm.	Excavate rocks greater than 150 mm.
Excavation Hole Backfilling	In situ excavated material	If excavated soil has less than 30% gravel, then no additive is required.	Backfill with imported topsoil.	Backfill with imported topsoil.
		If excavated soil has 30 to 70% gravel, then a 50% mixture with imported topsoil is required. If excavated soil has greater than 70% gravel, then backfill of imported topsoil is required.	NOTE If existing soil is free draining or humic, then it may be substituted for imported topsoil.	

***** Laterite - rough textured rock, reddish brown in colour, with orange and yellow mottles (splotches of colour), contains ironstone gravels and pores.

***** Siltstone - relatively smooth textured, white, reddish and yellowish layered rock, often with mottles. No ironstone gravel and pores.

Table 17-5 - Fertiliser Application Rates		
Plant Type, Use, Planting Method	**Size of container or plant**	**Application Rate per container or per plant**
Native, Planting Surface	Tube stock 150 mm container 200 mm container 250 mm container 300 mm container 20 litre bag	10 g 30 g 80 g 100 g 150 g 300 g
Exotic, Planting, Surface	Plant height: 0.5 m 1.0 m 2.0 m	 100 g 200 g 300 g
Native and/or Exotic, Planting, Hole	Ground covers and shrubs 10 cm tall Ground covers and shrubs 20 cm tall	10 g 20 g
	Plants to 1 m Plants to 2 m Plants to 3 - 4 m	40 g 80 g 120 g
	Advanced trees and palms 2 m - Advanced trees and palms 3 m - Advanced trees and palms 4 m -	200 g 300 g 400 g
	These rates apply to both granular compound and equivalent products.	
Native, Feeding, Hole and/or surface	Ground covers: up to 300 mm wide 300 - 600 mm wide 600 - 900 mm wide 900 - 1000 mm wide Thereafter	 30 g 50 g 75 g 100 g 100 g per metre
	Shrubs: up to 300 mm high/wide 300 - 600 mm high/wide 600 - 900 mm high/wide 900 - 1000 mm high/wide Thereafter	 50 g 75 g 100 g 150 g 200 g/metre of height or width
	Trees	200 g/metre of height
Exotic, Feeding, Hole and/or surface	Plants	250 g/metre of plant height

18. DUCTING AND CONDUITS

18.1 STANDARDS

Conform to the following Standards and publications unless specified otherwise, and with the requirements of applicable Service Authorities:

AS 1345	Identification of the contents of pipes, conduits and ducts.
AS/NZS 2053	Conduits and fittings for electrical installations.
AS/NZS 3000	Electrical installations (Australian/New Zealand Wiring Rules)
AS/NZS 3500	Plumbing and drainage
NTMTM	NT Materials Testing Manual.
NTTM	NT Test Methods

18.2 SUPPLY AND INSTALLATION

In kerbed areas, terminate duct crossings 500 mm behind kerbs unless specified otherwise.

In areas of no kerbing, terminate duct crossings clear of the Pavement as specified.

Excavate trench to a width appropriate for the ducting and which allows compaction of the backfill to be readily undertaken.

Provide the specified minimum cover required by the relevant authority, but not less than 750 mm.

Locate ducts to avoid other services.

Lay at right angles to the street centre line and with straight lines and grades unless specified otherwise.

Minimum fall to be 1% to the lower side of the street.

Lay ducting on 50 mm thick sand bedding.

Install 4 mm galvanised draw wires in all conduits. One draw wire to remain in place in conduit.

Cap all conduits with standard uPVC caps.

Place marker tape from each end of the conduit to the surface.

Backfill the trench with Type C Fill to Subgrade Surface level and compact to 95% Relative Compaction.

Where trench excavated through existing Pavement, backfill above Subgrade Surface with Basecourse, as specified in *Section 6 – Pavements and Shoulders*, compacted to 100% Relative Compaction. Reinstate the wearing surface.

18.3 MARKINGS

In kerbed areas, mark kerbs with a letter to identify the type of ducts which pass under them as follows:

Electrical:	‘E’.
Communications:	‘T’.
Water:	‘W’.
Height of letter:	50 mm.
Width of letter:	30 mm.

Stamp the letter into new kerb after the concrete has taken its initial set and before final set.

In existing kerbed areas, mark existing kerb with an aluminium plate containing the identification letters as specified.

Outside of kerbed areas, provide markers in accordance with Relevant Authority requirements..

18.4 CONDUIT MARKERS

Erect 600 mm x 600 mm signs at locations specified to highlight the existence of conduits. Refer to *Table 15-3 – Roadside Signs – Mounting* Selection.

Sign legend to be:

"Service Conduits Laid. Opening of Road Surface Prohibited."

18.5 ELECTRICAL DUCTING (‘E’)

Ducting conduit must be heavy duty uPVC coloured light orange and solvent cement jointed.

Lay a copper earth cable (35 mm2) in a continuous strip along the bottom of each trench where high voltage and low voltage cables are to be installed.

Install a 35 mm2 Cu insulated cable within all street lighting conduits to AS/NZS3000 Category A installation requirements.

Supply and install orange PVC cable marker tape over the ducts as specified. Refer to *Clause 19.8 - Cable Installation*.

for Street Lighting.

Liaise with the Service Authority regarding the installation of the ducts.

18.6 WATER DUCTING (‘W’)

Ducting conduit to be heavy duty PVC, 100 mm diameter, coloured white and solvent cement jointed.

Use uPVC class 9.

Lay conduits two to a trench opposite each alternate allotment boundary.

Service each allotment by a separate conduit.

Liaise with the Service Authority regarding the installation of the ducts.

18.7 COMMUNICATIONS DUCTING ('T')

Liaise with the Service Authority(s) and give minimum 10 Business Days' notice prior to the need for ducting to be installed for inspection purposes.

19. STREET LIGHTING

19.1 OUTLINE DESCRIPTION

Supply, install, test and commission new underground power supplied street lighting as specified herein and as shown on the Construction Drawings.

Modify and replace existing street lighting as specified herein and as shown on the Construction Drawings.

19.2 CROSS REFERENCES

Refer to the following sections:

- *Section 1 – Miscellaneous Provisions* for Utilities and Other Services Passing Under Existing Pavements.
- *Section 4 - Earthworks* for excavation and trenching.
- *Section 11 - Structural Concrete Works* for pole footings.

Refer to Standard Drawings.

19.3 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS/NZS 1158(set)	Lighting for roads and public places.
AS 1742(set)	Manual of uniform traffic control devices.
AS/NZS 3000	Electrical Installations - Australian/New Zealand Wiring Rules.
Power and Water Corporation – Power Networks	Design and Construction Guidelines
Power and Water Corporation	Power Supply Volumes, Volume 3, Street Lighting Manual.

19.4 MATERIALS

19.4.1 Columns

Requirement: Provide columns in accordance with Standard Drawings, to suit the individual street lighting design requirements.

Erection: Upon erection ensure columns stand vertically, in all directions, under final loading conditions.

19.4.2 Footings and Ragbolt Assemblies

Construct footings and ragbolt assemblies in accordance with Standard Drawings.

19.4.3 Terrain Category

Columns, footings and ragbolt assemblies must be suitable for the wind loading conditions of the area in which they are to be installed.

19.4.4 Luminaires

Provide street light luminaires of the types specified on the Construction Drawings.

Time control main switchboard: Control luminaires via a time switch controlled contactor with a PE-cell override feature located in a new plinth mounted main switchboards for underground areas. When luminaires are to be controlled by individual PE-cells, time control will not be required. Refer to Standard Drawings showing the details of non-time controlled main switchboard option.

Switch Packs: Provide switch pack in the base of each pole. In each switch pack provide a terminal strip for terminating the active and neutral conductors. Provide an automatic residual current circuit breaker rated at 10A with a fault level of 10kVA with B-curve characteristics for each luminaire. Refer to Standard Drawings.

19.5 EARTHING

The Multiple Earthed Neutral (MEN) system must be employed. Earth all light fittings, columns, trays and parts of the installation as required by AS/NZS 3000 and as detailed in Standard Drawings.

Provide an M10x25mm earth stud located inside the column, near the bottom equipment mounting bracket. Weld the stud to the column prior to hot dip galvanising. Stud is to be accessible through the access door.

Connect all columns to the main 1x 35mm2 copper earth cable at the earth stud.

19.6 EXCAVATION

19.6.1 General

Excavate for footings and trenches as shown on the Construction Drawings and Standard Drawings.

19.6.2 Column Footings

Vertically excavate all column footing holes 150 mm greater than the maximum dimension of the footing and avoid larger than necessary excavations.

Where necessary, carry out pumping to remove ground, storm and /or surface water.

If the final hole is larger than specified, backfill with concrete to the undisturbed soil.

Inspection Point 37 - If rock is encountered which prevents excavation to the required dimensions, obtain direction prior to proceeding.

19.6.3 Trenches

Nominal trench width: 300 mm.

Nominal trench depth: 1000 mm.

19.6.4 Existing Services

Excavate with care when crossing existing underground services. Increase the trench depth to provide a minimum of 150 mm clearance between the lowest part of the service and the first layer of marking tape.

Ramp the trench back from the obstruction.

19.7 FOOTINGS

Supply and place concrete footings in accordance with *Section 11 – Structural Concrete Works*.

19.8 CABLE INSTALLATION

All underground street lighting power cables to be fully enclosed in 80mm heavy-duty orange uPVC underground conduit laid to AS/NZS 3000 Category A installation requirements.

Protect the street lighting cables with a 10 Amp single pole miniature DIN type automatic circuit breaker with a rated interrupting capacity of 9 kA at 240V AC symmetrical.

Residual Current Device (RCD) to be installed at the RODP, at the point of supply.

Carry out cable installation in accordance with the following:

- Cover the bottom of the trench with 50 mm bedding sand.
- Lay conduits on the bedding sand.
- Top up with bedding sand to form a layer 150 mm minimum over cables.
- Lay the first cable marker tape.
- Backfill the trench with a second marker tape at a depth of 300 mm below finished ground level.

Inspection Point 38 – Obtain approval for street lighting trench excavation and cable installation prior to commencing backfilling.

19.8.1 Bedding

Bedding sand: Use clean washed river sand.

The Developer must compact the bedding to ensure there are no air spaces left, particularly in close vicinity of the cables and ducts, which would give an increase in external thermal resistance. Mechanically operated rammers must not be used for this purpose.

Bedding must not be placed in any excavation containing free water or slurry.

19.8.2 Backfilling

Backfill: Use Type C Fill, as specified *Section 4 - Earthworks*.

Place backfill in 150 mm maximum layers and compacted to 95% Relative Compaction.

19.8.3 Cable Marker Tapes

Lay two cable marker tape strips as follows:

Strip 1: Directly on top of the 150 mm bedding sand layer covering the conduit.

Strip 2: 300 mm below the finished ground level.

Lay cable marker tapes with a 600 mm minimum overlap at joins.

19.8.4 Polymeric Cable Protection Covers at Street Crossings

For all street crossings, lay two polymeric cable protection covers as follows:

Strip 1: Directly on top of the 150 mm bedding sand layer covering the conduit.

Strip 2: 300 mm below the finished ground level.

Lay cable protection covers with a 600 mm minimum overlap at joins.

19.9 INSTALLATION OF LIGHT COLUMNS

Install light columns, outreaches, luminaires and fittings in accordance with the Standard Drawings, and as specified in the Construction Drawings.

19.9.1 Nameplate Details

The Developer must provide a permanent nameplate label, to be fixed with screws to the outside of lighting column beneath the access cover, with the following information:

Manufacturer's name, address and phone number.

Customer:

Contract No:

Date of Manufacture.

Labels must be engraved laminated plastic or photo anodised rigid aluminium and must comply with the following requirements:

Engraved lettering must be black on a white background with minimum 3 mm high lettering.

19.10 EXISTING STREET LIGHTING

19.10.1 Disconnection and Removal

Make safe, disconnect and remove existing wiring.

Dismantle existing street lighting installations, taking care to avoid damage to items during dismantling operations and transport.

Deliver the salvaged materials to a storage shed to be nominated by the Relevant Authority.

Excavate and remove from the site all traces of abandoned concrete footings, hold down bolts and cabling.

19.10.2 Temporary Lighting

Provide temporary lighting at intersections during periods of construction if existing street lighting is removed before new street lighting is installed.

Provide temporary lighting to a Category agreed with the Relevant Authority.

Documentation Point 90 – Submit plans of the proposed temporary street lighting for approval prior to removal of existing street lights.

19.11 TESTING AND COMMISSIONING

19.11.1 Testing

Measure and record in Megohms the insulation resistance between each conductor and earth.

Check continuity of each cable installed.

Check correct phasings of all active cables of the low voltage distribution system.

Check polarity at each street lighting column to ensure that neutral and active cables are not inadvertently interchanged. Incorrect polarity at a street lighting column would result in a live column.

19.11.2 Commissioning

Inspection Point 39 - Arrange for commissioning work to live up the newly installed street lighting distribution system.

Commissioning must not be scheduled until all the above test results are found satisfactory.

19.12 REINSTATEMENT

Reinstate any damage to streets, footpaths, verges, drainage structures and vehicle driveways to their original condition.

20. DIRECTIONAL BORING

20.1 GENERAL

This section specifies the underground boring of passages for the installation of piping, piped services, or cabled services, beneath trafficked surfaces, buildings or other nominated areas without trenching, disruption to traffic or subsidence.

Directional bore all installations beneath existing streets, unless otherwise Approved by the Relevant Authority.

20.2 CROSS REFERENCES

Section 13 - Drainage Works

Section 17 - Landscape

Section 18 - Ducting and Conduits

Section 19 - Street Lighting

20.3 STANDARDS

Conform to the following Standards and publications unless specified otherwise:

AS 1579	Arc welded steel pipes and fittings for water and waste water.
AS/NZS 3000	Electrical installations (Australian/New Zealand Wiring Rules)
AS/NZS 3500 (set)	Plumbing and drainage
AS/NZS 4645	Gas distribution networks

Conform to the requirements of the Relevant Authorities if their services are to be installed in the bored passages.

20.4 PROPOSED METHOD

Documentation Point 91 – Submit details of the proposed method of thrust boring not less than 10 Business Days prior to commencement of construction using that method.

Include details of proposed filling of cavities. No disruption or excavation of the surface is to take place over the length nominated.

Co-ordinate boring works those with jurisdiction over the services installed in the bored passages.

20.4.1 Directional Boring with Pipe Casing

Keep dimensions of jacking pits to the minimum necessary.

Use pipe jacking equipment inspected and Approved and certified as fit for use by a competent person. The certification of fitness for use must have been issued not more than one year prior to the date of the scheduled completion of the works plus one calendar month. A competent person is defined in the NT Work Safe Bulletin 09.01.16 *Competent Persons for Inspection and Maintenance of Plant*.

Comply with the guidance provided in the Safe Work Australia Code of Practice: *Managing Risks of Plant in the Workplace*.

Documentation Point 92 – Submit Certification that the pipe jacking equipment is fit for use, 10 Business Days prior to commencement of construction using that method.

Certification must be issued by a competent person, as defined in the NT Work Safe Bulletin cited above. Submit evidence of qualifications and competence upon request.

Provide documented evidence 10 Business Days prior to commencement of construction using that method.

Use a welded mild steel pipe casing manufactured in accordance with AS 1579 and of sufficient strength to withstand the forces generated irrespective of the nature of sub-surface material encountered.

Ensure the inside diameter of the casing is 50 mm greater than the maximum outside diameter of the pipe joints, skids, cradle runners or other protrusions related to pipe insertion.

20.4.2 Directional Boring without Pipe Casing

Documentation Point 93 – Obtain approval to use directional boring without pipe casing.

Bore the hole cleanly without projections to a diameter at least 50 mm greater than the maximum outside diameter of the pipe joints, skids or other protrusions related to pipe insertion.

Use plastic skids extending the whole length of the pipe apart from joints to ensure the pipe is at least 10 mm clear of the hole perimeter. Insert the pipe so that the joints are neither stressed nor pulled apart.

20.5 TESTING OF SERVICES

Co-ordinate testing of services with the applicable Relevant Authority with jurisdiction over the installed service to be tested. Comply with all applicable Standards and the requirements of the Relevant Authority.

If any installation is tested, and fails that test, the Developer is to rectify the installation and test the installation again.

20.6 FILLING OF CAVITIES

This sub-clause is in respect to piping installed in passages bored without pipe casings.

Pressure Service Pipes

Carry out grouting of the pipe/casing cavity with pumped cementitious grout (Class 10 MPa)

containing an appropriate plasticising agent. Pipe to be under a pressure equal to normal expected operating pressure when grouting takes place.

Non-pressure Service Pipes

Fill cavities with granular material free of clay, dust, fines, salt or organic matter complying with either of the following gradings and properties:

Table 20-1 - Granular Bedding Material Gradings

Sieve Size	Percentage Passing By Weight	
	Type 1a	**Type 1b**
9.5 mm	100	-
6.75 mm	100	90 – 100
2.36 mm	100	75 – 100
1.18 mm	95 – 100	45 – 95
600 µm	80 – 100	20 – 80
300 µm	40 – 80	5 – 40
150 µm	0 – 6	0 – 6
75 µm	0 – 6	0 - 6

Linear shrinkage of materials passing a 425 µm sieve to be less than 2.5%.

20.7 END CAPS

Fit end caps to a bored passage if services will not be installed in the passage on the day it is bored.

Fit end caps to pipe casing if services will not be installed in the pipe casing on the day it is bored/installed.

Plug ends of bored passages around the installed services after installation, testing, and commissioning of the services is complete. Use an appropriate plugging material which is compatible with the materials of the installed services with which the plugging material will come into contact.

21. NORTHERN TERRITORY CLIMATE ZONE TABLE

NORTHERN TERRITORY CLIMATE ZONES TABLE – Updated 12June2020

The categorisations below do not take in to account aggressive environments. Special design considerations need to be put in place for aggressive environments.

ACC – Atmospheric Corrosivity Classification

		NTCZ 01 Areas south of, and including, Tennant Creek	NTCZ 02 Areas north of Tennant Creek and south of and including Katherine, and areas more than 50 km from the coast or tidal estuaries	NTCZ 03 Areas north of Katherine and areas between 10 km and 50 km from the coast or tidal estuaries	NTCZ 04 Areas less than 10 km from the coast or tidal estuaries	NTCZ 05 Areas inside buildings
AS 1170	**Wind Region**	A4	B	B & C	C	n/a
AS 1192	**Service Condition Category**	2	3	4	5	n/a
	Corrosion Category	B	C & F	D	E	C
AS 1231	**Thickness Grade**	AA15	AA25	AA25	AA25	AA10 Low airborne moisture AA15 High airborne moisture
AS/NZS 2312	**ACC**	C3	C4	C5, CX & CT	C5, CX & CT	C2
AS 2423	**Climatic Category**	B	C & F	D	E	A
AS 2699	**Durability Classification**	R1 (Green mark)	R2 (Yellow mark)	R3 (Red mark)	R4 (White or blue mk)	R1 (Green mark)
AS 3566.2	**Corrosion Resistance Class**	3	4	4	4	2
AS 3600	**Exposure Classification**	A	A	B1	B2 or C	A
AS 3715	**Service Condition Category**	3	4	5	5	n/a
	ACC	3	4	5	5	n/a
AS 4145	**Corrosion Resistance Category**	C6	C6	C7	C7	C6
AS 4312	**ACC**	C3	C4	C5	C5	C2
AS/NZS 4534	**ACC**	C (=C3)	D (=C4)	E (=C5)	E or F (=C5orCT)	B (=C2)
BCA Vol.2 Table 3.5.1.1	**Environment category**	Low	Low	Medium	High - Very High	n/a