

The background features a large, central green area with a wavy, organic shape. This green area is framed by lighter green, curved borders at the top and bottom, creating a sense of depth and movement. The text is centered within the dark green area.

ROAD WORKS STANDARDS AND SPECIFICATIONS

SEPTEMBER 2019

MANUAL UPDATE AND DISTRIBUTION CONTROL

MANUAL UPDATE RESPONSIBILITY: MANAGER POLICY AND STANADRDS

Date (Board Resolution)	Employer Changes

UPDATES ADVISED

<ul style="list-style-type: none"> • Website • CEO • Head of Design & procurement • Head of Governance • Head of Risk & Compliance 	<ul style="list-style-type: none"> • Chief Financial Officer • General Manager Delivery Central • General Manager Delivery Western • General Manager Delivery Northern • General Manager Delivery Eastern • General Manager Electrical
Date	By
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Fiji Roads Authority

Road Works Standards and Specifications

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1.0 OBJECTIVE

To compile a standard road work guideline which the Fiji Roads Authority can set to maintain technical requirements and standards, and specifications for the design and construction of the roads within Fiji.

2.0 BACKGROUND

The 'Road Works Standards and Specifications' policy was formally adopted by the Fiji Roads Authority Board in November 2014. The policy provides the basis for standardized road work procedures within the Authority's road network and as such is mandatory for use and application in all instances of addressing road works.

Section 6 of the FRA Decree dictates that: *'the authority shall be responsible for all matters pertaining to construction, maintenance and development of roads in Fiji'*, which legally endows the Authority with primary responsibility on road works standards and specification.

The current 'Road Works Standards and Specifications' is produced and maintained by the Authority to set technical requirements, standards and specifications for the design and construction of the roads within Fiji.

SECTION 160 – CONSTRUCTION – GENERAL

160.01 PREAMBLE

- A. This Division of the Specifications contains general requirements relating to the Works as a whole. The general requirements contained in this division must be read in conjunction with all other divisions of the contract. In the event of any contradiction, the Contractor must notify the Contract Administrator (or Engineer) who will make a final determination and notify the Contractor which division takes precedence.
- B. These General Requirements will apply to all the contractors including direct, nominated, domestic sub-contractors, Employer appointed contractors, etc. Each contractor is to thoroughly review the full document. and the contractor shall be deemed to have included all compliance costs in its tender price.
- C. In examining the requirements of any section of the Specifications the Contractor and/or sub-contractor(s) shall examine all other sections of the Specifications and the other relevant documents and drawings, which affect the work of that section.
- D. The term “Contract Administrator” wherever it appears in any of the contract documentation, including but not limited to these General Requirements, the Scope of Works, the Specification or Drawings, is the Contract Administrator as stipulated in the Conditions of Contract, unless otherwise stipulated.
- E. Where terms such as ‘Engineer’, ‘Design Consultant’, ‘Contract Administrator’, Project Manager and the like appear in any of the contract documentation, including but not limited to these General Requirements, the Scope of Works, the Specification or Drawings etc., such terms shall be taken to mean the Contract Administrator or his assistant/s, as appropriate.
- F. Chartered Professional Engineers recognised by the Contract Administrator:

Institution	Credentials
Fiji Institute of Engineers	Professional Member FIE
Australian Institute of Engineers	MIEA CPEng
Institute of Civil Engineers UK	MICE CPEng
Engineering New Zealand, Chartered Professional Engineers	MEngNZ CPEng

160.02 SUMMARY OF WORKS

1 SUMMARY OF WORKS

A summary of the works can be found in the Request for Tender documents. The Contractor may request for further details of works from the Contract Administrator who reserve the right to decide on the level of information to be provided.

2 CONTRACT

- A. The particular division or section of Specification shall be read in conjunction with the Drawings and all other divisions and sections of the Specification. Specification given in any one division shall apply to other divisions unless specifically stated.
- B. Notwithstanding anything contained herein, the Contractor shall be responsible for complying in all respects with bylaws and regulations imposed by authorities having jurisdiction, as may be in force at the time of execution of the Works.
- C. The Contractor shall provide and do everything necessary for the proper execution of the Works accordance with the Contract Documents.
- D. The Works shall be completed in strict accordance with the Drawings and Specifications and any further drawings or instructions issued or approved by the Contract Administrator and/or Employer during the execution of the Works. Such Drawings and Specifications shall include those provided by the Contractor in compliance with any obligation to design the Works or part thereof as specified in the contract.
- E. The Works to be performed under the Contract may, as applicable include, but is not necessarily limited to survey, geotechnical investigation, design, production of coordinated working / shop drawings, furnishing of all supervision, labour, materials, temporary utilities, plant, machinery, cranes, equipment, parts, tools, taxes, duties, insurance, commissions, supplies, transportation, utilities, construction facilities, incidentals, logistic support, etc., necessary for the performance and maintenance of the Works, accomplishing the same in a workmanlike manner.
- F. All work shall be executed by skilled tradesman who shall be thoroughly acquainted with all aspects of their trade including any special local customs and modes of operation.

- G. The Contractor shall be deemed to have based his tender on the information in respect of geotechnical, hydrological, physical and climatic conditions of the Site and have inspected the Site and its surroundings and satisfied himself before submitting his tender. Visits to the Site to review the existing conditions shall be strictly by agreement with the Contract Administrator.
- H. The Contract Administrator and/or Employer and any person authorised by him shall at all times have access to the Works and to the Site and to all workshops and places where work and/or material or equipment is being obtained, stored and/or undertaken for the Works.
- I. The Contract documents include Concept Drawings, Drawings and Specifications which indicate the scope of the Works in terms of the dimensions of the installation, quality, character, and capacities and other systems of construction for the Works. The Drawings and Specifications do not necessarily indicate or describe in detail, all of the work required for the performance and completion of the Works. The Contractor shall execute all works that can be reasonably inferred, in the opinion of the Contract Administrator, whether or not specifically shown or described. The Contractor shall provide all items required for the proper execution and completion of the Works, in so far as such items are consistent with the intent, quality and character indicated on the Drawings and Specifications, all to the approval of the Contract Administrator. The Contractor shall provide all supplementary parts necessary to complete the Works whether or not each component or detail is specifically shown on the Drawings or specified in the Specification. Any modifications that appear on the construction documents that do not materially affect the design intent shall not be considered as a basis for additional compensation. Such determinations shall be made by the Contract Administrator and the Employer and in accordance with the General Conditions of Contract (GCC).
- J. The scope of the Work includes without limitation all engineering, shop drawings, labour, supervision, material, tools, equipment and other services necessary for the construction, installation, testing and commissioning and maintenance of all Works including design of the Works or parts thereof as specified the tender document.
- K. The Contractor shall be aware that the Project is proceeding on a fast track basis and as such, the structural, architectural, mechanical, electrical and other drawings included in the Tender are progress drawings and may not completely coordinated with other parties and stakeholders. Modifications that appear on completed drawings

that do not materially affect the design intent will not be considered as a basis for additional compensation and determination of this by the Contract Administrator shall be final. All conflicts between drawings and technical specifications shall be brought to the attention of the Contract Administrator, who will resolve the matter in accordance with the GCC.

- L. The Contractor shall include any and all sundry expenses such as transportation, freight charges, taxes, interim storage, escalation, any special permits required to carry out the work, related quality control, compliance to safety requirements as called for in the Specification and in compliance with applicable laws and regulations of The Republic of Fiji.
- M. The Contractor is responsible for coordination with all other stakeholders during all phases of engineering, construction, testing, commissioning, completion and handover.

3 CONTRACTOR'S DESIGN AND ENGINEERING RESPONSIBILITY

- A. The Contractor shall submit to the Contract Administrator, for review and approval, names and credentials of their designers, including Professional Indemnity Insurance coverage, who will perform design services on behalf of the Contractor and clearly identify the scope elements and areas covered therein. The Contractor is also required to furnish the names of such designers in his Tender. The Contractor is to include provision of a Professional Engineer Registered in The Republic of Fiji (or equivalent Australian / New Zealand / International registration) if and as required for the performance of the works and in accordance with statutory and/or contractual requirements. The Contractor shall include, as a minimum, the following design and engineering responsibilities:
 - 1. All work items and systems noted in the specifications as the design and engineering responsibility of the Contractor.
 - 2. Work items and systems that are described in the specifications with requirements to comply with certain performance parameters.
 - 3. Structural steel connections, miscellaneous metal work and architectural metal work.

4. Secondary steel, embeds, concrete and/or rebar work necessitated to install mechanical, electrical, cladding etc. (Secondary work includes works that are not part of the structural system, but are required for installation of other systems).
5. Any design and engineering of systems as indicated in the Specifications, as noted in Drawings, or as designed by the Contractor and approved by the Contract Administrator, to provide a complete installation.
6. All necessary design and engineering of supports for bridges, jetties, access platforms, ladders and lifting beams for structural, mechanical or electrical installation, equipment and piping, including the provision of additional bracing of structures as required in line with imposed loads.
7. All temporary facilities, temporary works and/or supports, shoring, temporary access points, excavation works, equipment and installations; including any modifications, reinforcements, supports, etc., to the permanent Works.
8. Where required for the proper design of the Works or part thereof by the Contractor, The Contractor shall carry out soil investigation surveys the scope of which shall be provided to the Contract Administrator for comment. All results shall be submitted to the Contract Administrator in support of designs reliant on such surveys. Any delayed issuance of the Soil Investigation Survey Report that delays any foundation works shall not be accountable by the Employer or Contract Administrator, but of the Contractor.

4 WORK UNDER OTHER CONTRACTS

- A. The Employer may award other contracts in connection with, on the same site as, or adjacent to this contract. and the Contractor should refer to the Conditions of Contract and Section PROJECT MANAGEMENT AND COORDINATION of this General Requirements Document and comply with the requirements therein.
- B. The Contractor shall coordinate his work with that of any other contractors, authorities or organizations performing works under separate contracts to ensure no delay, disruption or interference is caused to such other contracts.

5 WORK SEQUENCE

- A. The overall phasing and sequence of construction shall be in conformance with the sectional completion dates (if any) as identified within the contract documents. The Works shall be performed in accordance with the Milestone Dates, Sectional Completion Dates, Priority Completion areas, the Time for Completion and the Schedule requirements in the Contract Documents. The Contractor shall fully acquaint himself with the contents of the Contract Programme and ensure compliance therewith. The Contractor shall note that the project may be based on a multiple package approach including nominated sub-contract to design as required, and construct and his Programme of works shall be flexible enough to accommodate special needs arising there from. The Contractor shall allow for certain “out of sequence” work and “come-back” work that will be necessitated on the Project. The Contractor shall allow for all costs arising out of such phasing, sequencing, out-of-sequence and come-back work.
- B. The Contractor shall refer to the Programme for phasing and completion of the Works, as detailed within Section PROGRAMMES AND SCHEDULES of this document. The Employer, Contract Administrator and other Employer appointed contractors may be present on Site and the Contractor shall allow for all costs resulting from phasing the Works around these parties.
- C. The phasing and the sequencing may be changed during the course of construction subject to the approval of the Contract Administrator. Any such change shall be considered as a shared tool for use by the Contractor and the Employer for the benefit of the Project, with priority given to the requirements of the Employer. The consequences of changes in work sequence shall be dealt with in accordance with the General Conditions of Contract

6 INSPECTION TESTING ALLOWANCES

- A. The Contractor shall allow in his rates and prices for all cost and time for carrying out all tests on the Works required by the Specifications for the provision of assistance to any Employer’s independent testing laboratories including liaison with the relative authorities.

7 PERMITS

- A. Notwithstanding that prior to the award of the Contract, the Employer has obtained approvals from any authority of The Republic of Fiji, it is the responsibility of the

Contractor to comply with all local requirements and obtaining work permits from Authorities. Where necessary to obtain Authority approval the Contractor shall appoint Third Party Independent Checking Engineer to satisfy the requirements of that Authority. The Contractor will apply for and obtain all required permits approvals that may be required for these works or the works of its nominated contractors.

- B. During the construction period, the Contractor shall submit to the Contract Administrator copies of all Certificates of Approval, Permits, or Licenses obtained from Municipality Departments and other Authorities having jurisdiction, which are required for the performance of the work.
- C. When required, the Contractor shall obtain and renew all NOC's (No Objection Certificates) and all applicable approvals, permits required for construction from various government agencies. The Contractor shall coordinate with the Contract Administrator for this requirement.
- D. The Contractor shall include for all governmental inspections as required and applicable fees during the various phases of work, as per the rules, regulations of various authorities concerned and shall include for all necessary inspections required for the operation prior to final acceptance / hand over. The Contractor shall also include liaising for permanent demarcation of the Site.
- E. Prior to the issuance of the Certificate of Practical Completion (herein after referred to the CPC) for the whole of the Works or Sections thereof, it is the responsibility of the Contractor to obtain a Certificate of Completion and Compliance (herein after referred to the CCC) confirming that the works may be used for the purpose intended. Prior to the issuance of the CPC, the Contractor shall furnish the Contract Administrator with a complete set of originals with two (2) copies of all the above-mentioned Certificates, Licenses and Permits in hard copy format and PDF format issued through the instructed means of communication for the Contract.
- F. The Contractor shall obtain prior approval of the Contract Administrator and pay fees, taxes and levies as required by the authorities for permits and approvals from the relevant local authorities for the performance of the works. The Employer will pay fees for obtaining Utility Connections and any local council approvals and the Contractor is to pay fees as required for the rest of works.

- G. The Contractor shall be responsible for arranging and paying all fees in connection with obtaining temporary utility services connections necessary for its own operations in implementing the contract. The requirements under this Clause includes also for the provision of all temporary facilities, utilities and the like, as appropriate; however, all costs resulting thereof shall be borne by the Contractor.

160.03 ADMINISTRATION OF PROJECT SITE

1 CONTRACTOR USE OF PREMISES

- A. The Contractor shall not use the Site for any purpose other than carrying out the Works.
- B. Access to the Site shall be agreed with the Contract Administrator prior to commencement and in accordance with the GCC. The Contractor shall take all necessary steps to ensure the safety of all persons. In addition, the Contractor shall be responsible for all damage resulting from the use of the agreed access.
- C. All construction operations shall be confined to within the Site boundaries as shown on the Drawings unless otherwise agreed with the Contract Administrator. The Contractor shall be responsible for arranging other works areas, plant yards, offices and the like which shall be outside of the site boundaries unless otherwise approved by the Contract Administrator. The Contractor shall be responsible for safeguarding all properties, structures and the like in the vicinity of his work from any damage arising from the construction activity.
- D. Should any work performed under the Contract expose previously unknown or unforeseen conditions whose presence could cause additional construction cost or endanger the Project in any way, such work shall be stopped and the matter reported immediately to the Contract Administrator for instruction. However, the Contractor shall immediately use measures or methods necessary to ensure safety and prevent any threatened or further damage, injury or loss.
- E. The Contractor shall have possession of the Site at the location of the Works only and be subject to the rights and obligations of other contractors and be responsible for arranging his own working space, the storage of materials, locating all temporary stores, offices, utilities and other logistical issues at locations to be agreed with the Contract Administrator. No claim whatsoever will be entertained for any reason regarding the location, allocation or relocation of any working space regardless of the distance.

- F. The Contractor shall perform his Works in a manner not to cause danger, inconvenience, or difficulties to road users, private and public vehicles, schools, in and around the Site. The Contractor shall plan the site logistic accordingly and submit for the approval of the Contract Administrator.
- G. The Contractor shall ensure that his activities are conducted to limit any interference with vehicular traffic to the extent practicable. Lights, markers, notices, traffic management systems and other such provisions shall be exhibited at all times and places as required by the Municipality, Works departments, Traffic Police and in accordance with relevant regulations. A Traffic and Pedestrian Management Plan must be prepared by the Contractors Traffic Management Team/Specialist for approval by the Contract Administrator prior to submission to relevant Authorities where their approval is required.
- H. The Contractor shall be responsible for consulting regularly through the Contract Administrator with the relevant authorities to confirm that his method of working is not such as to unnecessarily impede in any way vehicular road traffic and for modifying his method of working if any operations or activities are adversely affected by his activities. On the instruction of the Contract Administrator, the Contractor shall promptly remove any vehicle or equipment and plant within his control that may be causing obstruction to the use of the existing facilities by others.

2 INSPECTION AND INVESTIGATION OF SITE

- A. The existing elevations of the Site indicated in the Drawings shall be verified by the Contractor. No guarantee can be given to the Contractor that the elevation details shown on the Drawings are accurate.
- B. The Contractor shall inspect and examine the Site and its surroundings and shall satisfy himself before submitting his Tender as to the nature of the ground and sub-soil, the quantities and nature of the Works and materials, tools and equipment necessary for the completion of the Works.
- C. The information and details given on the Drawings regarding obstacles are not guaranteed to be accurate or correct and are given only for guidance in compiling and submitting a Tender. The Contractor shall make his own investigations and inquiries of the Municipality, other authorities and utility companies to ascertain the exact positions, sizes, numbers and details of all obstacles to be encountered.

D. The Contractor shall obtain all further information required as to the risks, contingencies and other circumstances, which may influence or affect the execution of the Works and include the costs thereof in his Tender.

3 SITE ESTABLISHMENT AND WORK AREA

A. The Contractor will be required to make its own arrangements for the purposes of establishment, storage of plant, or stock piling of materials. The Contractor shall make all necessary arrangements and must advise the Contract Administrator of these arrangements.

B. The Contractor shall make arrangements for all temporary services, such as electricity, telephone, water and sewage disposal, which may be required and shall pay all associated costs and charges. The Contractor shall be totally responsible for the supply of temporary services to Subcontractors.

C. The Contractor must reinstate all areas affected by the works under the Contract, including the establishment and working areas to a condition at least equal to that at the commencement of the Contract. The Contractor must prepare a full photographic record of the Site including all areas to be repaired prior to starting the work at his own expense. These photos must be submitted to the Contract Administrator before works commence.

D. The Contractor shall maintain the establishment and work areas in a clean tidy condition for the duration of the Contract.

E. The Contractor must be responsible for the provision of all amenities and accommodation, for the Contractor's workers and for the Subcontractors and their respective workers, necessary for the construction of the Works and shall make whatever arrangements as are necessary for locating these amenities.

F. The Contractor must collocate at the site an office for Contract Administrator's personnel. The office must have 2 desks and 4 chairs for Contract Administrator's use.

G. The Contractor shall be responsible for arranging land entry agreements necessary to fulfil the Contractual requirements and must comply with all conditions of access onto the land.

4 ARCHAEOLOGICAL PROTOCOLS

A. Upon discovery of any likely cultural or historic remains, the Contractor or its staff on site shall take the following action:

1. Cease all works immediately. The plant operator will immediately shut down all machinery or activity, leave the area and advise the Contract Administrator of the occurrence.
2. The Contract Administrator will immediately contact the Principal, who will arrange for an archaeologist to assess the site. If there is any evidence of culturally sensitive archaeological or paleontological items, then the Principal will arrange for an appropriate Tribal authority representative(s) to assess the site.
3. The Contract Administrator will immediately take steps to secure the area and ensure that the remains are untouched as far as possible in the circumstances.
4. The Principal, will notify the Fiji Museum that a suspected archaeological find has been uncovered at the site.
5. If evidence of human remains is uncovered, then the Fiji Police will be contacted immediately.
6. Work at the site will not resume until all appropriate steps are taken to protect, preserve, record or properly remove the findings. Approval from the Employer and the Fiji Police will also be required before work can recommence.

B. The Employer will allow the archaeologist(s) and the appropriate local tribal authority representative(s) access to the site to carry out their respective responsibilities in consultation with the appropriate local tribal authority representative(s). The Contractor will remain responsible for on-site safety.

5 EXISTING SERVICES

A. The extent, position, size and type of existing public utilities shown on the utility mapping Drawings have been based on information extracted from the records of the various public utilities, Ministries and the Project survey and must be regarded as approximate and indicative only. The Contractor shall ascertain from the public utility authorities the positions of all existing underground services and he shall then maintain, protect or divert

as required. The Contractor shall coordinate as necessary with all utility companies for relocation of the services. The Contractor shall phase the installation of the works in coordination with the utility companies to support the completion of the works as required in and around the site.

B. The Contractor shall, before using excavation machineries in the vicinity of existing services, carry out full and adequate preliminary investigations by means of hand-dug trial holes and the like, to verify the location of existing services.

C. The Contractor shall refer to and comply with the current regulations and specifications of utilities authorities before commencing any works adjacent to equipment, plant, cables, pipelines, etc. The above requirement will not relieve the Contractor of any responsibility for taking every precaution to avoid damage to equipment, plant, cables, pipelines, etc. and he will be held responsible for the cost or repair of all damage in accordance with the Conditions of Contract and Specification.

6 PROTECTION OF EXISTING UTILITIES AND SERVICES

A. During construction, the Contractor shall provide all protection for existing utilities and services as may be required for his construction operations, including protection for the construction of detours and diversions as potentially indicated on the Drawings, as directed by the Contract Administrator and as required by the Contract Documents.

B. Permanent protection of certain items shall be as included under other sections of the Specification. In addition to the requirements as specified elsewhere, the Contractor shall comply with the following explicit minimum requirements:

1. Use of all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances. In particular, the Contractor shall take adequate measures to prevent undermining of utilities and services, whether they are presently in service or not. The Contractor is to liaise with all utility providers in the area prior to any excavation. The Contractor is responsible for locating all services prior to construction.
2. Protect existing or new utilities and services when considered necessary and directed by the Contract Administrator. The Contractor shall physically locate all underground/utility services before commencing with excavation. The Contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage to the same. The protection

of utilities and services as specified herein will not be paid for separately but shall be deemed to be included in the Contract Sum.

3. The Contractor shall make his own arrangements for any diversion or removal of existing services which he may require for his own convenience or because of his proposed method of working and shall in all cases inform the Contract Administrator in advance of his proposals.
4. The Contractor shall expose all existing underground/utility services, public and private as required. If failure to explore ahead necessitates altering work already done, then the cost of altering shall be borne by the Contractor.
5. The Contractor shall make provisions and maintain any existing services with regards to capacity and use at all times.
6. The Contractor shall recover, remove or abandon redundant utility and service lines as required by the Drawings and Specification and/or as directed by the Contract Administrator and/or relevant local authorities.
7. The Contractor shall not remove any utility or service line, conduit or structure until he has received written permission from the Contract Administrator.
8. The Contractor shall, at all times during the progress of the Works, afford facilities to properly accredited agents of any Authority for access to all or any of their equipment situated in or under the Site, as may be necessary for inspecting, reporting, maintaining, removing, renewing or altering such equipment in connection with the construction of the Works or for any other purpose whatsoever.
9. The Contractor shall pay all necessary fees, permits, insurance, bank guarantees etc. as required by any authorised third party to the Contract.

C. Prior to commencing construction and subsequent to the Contractor's determination of the location of the existing utility and service lines and the condition of the adjacent areas, the Contractor shall prepare and submit to the Contract Administrator for his review shop drawings complete with the description of procedure and materials and related data of the Contractor's proposed method of protection for the said lines. Review, comments

and approval by the Contract Administrator shall in no way relieve the Contractor of the full responsibility for all protection of services and precautions required during the Works.

7 DAMAGE TO EXISTING UTILITIES AND PROPERTIES

- A. After tender award, the Contractor may wish to undertake a dilapidation survey of the site and surrounding area prior to commencing works on site.
- B. If, in the opinion of the Contract Administrator, damage may be caused by the operation of mechanical plant over or adjacent to existing services, the Contractor will be required to excavate by hand in their vicinity at no additional cost.
- C. In the event of any damage to utilities or properties as a result of work carried out by the Contractor, his agents, employees, or by any sub-contractors or their agents, or employees, the Contractor shall be held liable, and will indemnify the Employer, the Employer's Consultants and the Contract Administrator against such damages, whether stated in the GCC or not.
- D. The Employer and/or the Contract Administrator shall have the right, upon receiving any claims from the party concerned in respect of such damages, to deduct the actual costs charged to the Employer from monies due or becoming due to the Contractor without it being necessary to serve a notice or warning or to take any legal action and the Contractor shall not be entitled to object, refrain from or suspend the work on account of such deduction.
- E. In the event of any damage whatsoever to any existing or relocated utility and/or service lines, the Contractor shall immediately notify the Employer, the Contract Administrator and the relevant utility or authorities or companies. The Contractor shall co-operate with the Employer and the Contract Administrator and the owner of such utility or service and take whatever steps necessary to repair and restore such utility or service all in accordance with the requirements of the Drawings and Specification. The decision of the Employer and/or the Contract Administrator regarding responsibility for any damage or interruption of any utility or service shall be final.
- F. The Employer may make such arrangements as in his opinion are necessary, whether by employment of the Contractor or otherwise, to effect rapid repair of any service which may be damaged in the execution of the Works. Such arrangement shall not affect the extent of the liability of the Contractor in respect of such damage.

8 RESTRICTION ON USE OF ADJACENT ROADWAYS

A. The Contractor shall not make use of the adjacent roads for depositing or storing plant, vehicles, machineries, materials, tools or implements as may from time to time be required for use on the Works.

9 CONDITION OF ROAD SURFACE

A. This clause is applicable to existing formed roads that require re-sheeting, structural repair, culvert repair, etc.

B. The Contractor shall carry out works in a manner that protects the works and permits the safe and convenient passage of traffic through the sites with a minimum of delay. The road length shall be maintained firm, relatively smooth and readily negotiable to all traffic under all weather conditions. The Contractor is responsible for taking all reasonable measures to mitigate structural deterioration of the carriageway subgrade during the construction period. All costs associated with repair of subgrade damage not evident at the time of commencement will be the Contractors.

C. The Contractor shall leave the work site in a safe and trafficable condition at the end of each day's work such that:

1. No temporary speed restriction is required; or
2. Appropriate traffic control measures are in place to ensure safe use of the road while the site is unattended.

10 ADVERTISING PUBLICITY AND CONFIDENTIALITY

A. The Contractor shall not display or permit any signs, posters, or other advertising on or about the premises without the prior written approval of the Contract Administrator and the Employer.

B. All aspects of the Project shall remain confidential. The Contractor, his sub-Contractors, suppliers or agents shall not make public to the media any information relating to the Project unless granted specific permission to do so in writing from the Employer and Contract Administrator.

11 WORKING HOURS

- A. Unless otherwise specified in the contract, the Site will be accessible for construction activities from 0600 to 1800, Monday through Saturday. If the Contractor requires to work out side of these times and days the Contractor shall apply for, pay all relative fees, permits, insurance, bank guarantees and all any other associated fees and obtain approval from any authority of the Republic of Fiji in cooperation with the Employer for twenty-two hours, seven days per week (22/7) construction operations, before work can occur outside of normal working hours. Any equipment imposed by any authority of the Republic of Fiji such as CCTV, mobile telephone and wireless connection etc. due to additional working hours shall be solely borne by the Contractor.
- B. The normal working hours of the Contract Administrator are from 0800 to 1700 hours on Mondays through Friday. Any Inspections required outside of these hours will be at the Contractor's expense – i.e. the Contractor will be charged for this overtime of the Contractor administrator, or its staff.
- C. Whenever working outside normal hours is proposed, the Contractor shall request approval from the Contract Administrator giving not less than forty-eight (48) hours' notice, specifying times, types and locations of work and approximate number of men involved. The notification period of forty-eight (48) hours may be relaxed under special circumstances, as determined by the Contract Administrator.
- D. Any work executed outside normal hours for which approval has not been given may be required to be opened up for inspection and reinstated at the Contractor's expense. This shall include any concealed works and permanent works.
- E. The Contract Administrator shall approve the starting and finishing times, lunch and tea breaks of the day shift proposed by the Contractor.
- F. The Contractor is allowed, subject to the prior approval of the Contract Administrator to work in multiple shifts as necessary to meet the construction schedule.
- G. The Contractor shall note that staggered work hours may require to be adopted to ease congestion on or around the site, access road routes, security gates, and elsewhere on or adjacent to the Site or to avoid inconvenience to the existing Neighbourhood residences, business, schools, public stadiums and public as applicable. The Contractor shall arrange its operations, and timing of operations on the Site(s) so as to avoid unnecessary interference with peak traffic, businesses, schools etc

12 ADJOINING PROPERTY

- A. All reasonable precautions must be taken by the Contractor to prevent damage to all adjoining properties. Extent and type of monitoring, if required, shall be submitted to the Contract Administrator for review and approval.
- B. The Contractor shall obtain permission as necessary from owners of adjoining property if requiring to erect scaffolding or otherwise use adjoining property, and shall pay all charges and shall clear away and made good on completion or when directed.
- C. The Contractor shall take all measures necessary to protect existing structures, fences, gates, walls, paving and other site features from damage during the currency of the Contract.
- D. Fences, hoarding, walls, etc. crossed by the Works and forming boundaries of plots outside the area occupied by the Works shall not be cut through or destroyed for more than the distance necessary to permit the erection of new fencing etc. and the Contractor shall make the ends of the cut fences reasonably secure. Where fences, walls etc. are damaged or destroyed, the whole shall be restored and reinstated with like materials to the satisfaction of the owners or occupiers and the Contract Administrator.

13 STRUCTURAL FABRIC

- A. The Contractor shall provide and maintain during the execution of the Works all shoring, strutting, needling and other supports as may be necessary to preserve the stability of the buildings, whether new or existing, on the Site or adjoining that may be potentially endangered or affected by the Works.

14 ROADS AND FOOTPATHS

- A. The Contractor shall ensure that no damage is caused by Site traffic to roads and footpaths outside the site boundaries and shall adequately maintain and keep safe and clean the approaches to the Site on a daily basis. The Contractor will be required to repair damage attributable to his work, such as, excavation and trenches access the site access road including replacing and making good street paving around the site boundary. The Contractor shall comply with all procedures laid out by statutory authorities having jurisdiction and costs arising thereof shall be borne by the Contractor. Unless otherwise approved by the Contract Administrator, at no time shall the general public be restricted

in use of roads and footpaths and that the Contractor shall make sufficient requirements in accordance with the Authority regulations to maintain General Public access.

15 LABOUR RECORD

- A. The Contractor shall provide a daily record to the Contract Administrator on the following morning in a format to be approved by the Contract Administrator, showing the number and description of managers, consultants, craftsmen, labourers and other persons employed on or in connection with the Works, including those employed by the Contractor and his sub-Contractors. This record shall be incorporated in the “Daily Report” (hereinafter referred to as Daily Report) in Section PROGRESS MONITORING & REPORTING.
- B. The Contractor shall deploy only competent workmen legally permitted to work in The Republic of Fiji, who shall hold valid visa and employment permit under the sponsorship of the Contractor.

16 PLANT RECORD

- A. The Contractor shall provide a daily record to the Contract Administrator in a format to be approved by the Contract Administrator, showing the type, model and capacity, complete with current inspection reports, of all mechanical and power-operated plant employed on the works. The Contractor will not be permitted to remove any plant or material unless written approval is obtained from the Contract Administrator. This record shall be incorporated in the Daily Report in Section PROGRESS MONITORING & REPORTING.
- B. Contractor to obtain required certifications from Local Authorities for Plant and Equipment in accordance with statutory requirements. The Contractor shall also provide certified documentation that all Plant and Equipment is registered and legal to work within The Republic of Fiji. All Plant and Equipment shall have the latest calibration certificate and any movement of Piling Rigs; Crane etc. from site to site shall obtain the approval from the Land Transport Authority.

17 MATERIAL RECORD

- A. A daily record shall be provided by the Contractor to the Contract Administrator in a format to be approved by the Contract Administrator, showing the make, model, serial number,

delivery number and date, quantity, specification section number, building area of any product or material delivered to Site. The Contractor will not be permitted to remove any material unless written approval is obtained from the Contract Administrator. Material which has not been inspected and approved by the Contractor Administrator shall not be used for the work by the Contractor. This record shall be incorporated in the Daily Report in Section PROGRESS MONITORING & REPORTING.

18 VISITORS RECORD

- A. The Contractor shall maintain a record of visitors to the Site in a format to be designated by the Contract Administrator. The Contractor shall provide a reasonable amount of Safety Work Boots, Safety Helmets (Hard Hats) and High Visibility Jackets, as required for visitors to the site. All equipment shall be labelled "VISITOR" with no other markings on the equipment. Any other Personnel Protective Equipment (PPE) such as ear protection, eye protection, gloves etc. shall be made available by the Contractor if required and/or at the request of the Employer or Contract Administrator.

- B. The Contractor shall not admit members of the media unless the Contractor has received prior written approval from, and are escorted by the Employer. Under no circumstances shall any members of the media be allowed access without written approval from the Employer. The Contractor shall maintain a record of Media visitors to the Site in the format approved by the Contract Administrator.

19 AVOIDANCE OF NUISANCE

- A. The Contractor shall ensure at all times that spillage does not occur of concrete, oils or other deleterious material into any new or existing drainage, duct system or water course. Nevertheless, should any drainage or duct system or water course be fouled by such materials the Contractor shall immediately clean the drainage or duct system or water course at his own expense, to the satisfaction of the Contract Administrator. The Contractor's program to address these issues is to be included in the "Contractor's Environment Management Plan".

- B. The Contractor shall ensure that there is no spillage of oil or other contaminant on to the public roads or water courses.

20 EXISTING GROUND LEVELS

- A. The Contractor shall, before commencing work, check, verify and satisfy himself as to the existing levels of the Site and existing structures and agree them with the Contract Administrator. Before any excavation or breaking out, the Contractor shall define reference lines for setting out the Works.

21 RADIO AND TELEPHONE COMMUNICATION

- A. The Contractor shall be responsible for all necessary communications with all relevant authorities.
- B. The Contractor shall obtain permits and licenses from the authorities having jurisdiction prior to operating two-way radios in the Site. Two-way radios may be required to be used by the Contractor's personnel for safety and security purposes. The Contractor shall provide & maintain a sufficient number of radio and mobile phone/data repeaters throughout the project to ensure complete coverage of radios, mobile phones and wireless data coverage in all parts of the works.
- C. All radio equipment shall be operated on a private frequency that shall not interfere with any other local transmission or other equipment of any type. The Contractor is responsible for ensuring that the transmissions and equipment comply with the requirements of the appropriate Statutory Authorities.

22 CONVERSION OF METRIC AND IMPERIAL UNITS

- A. Conversion of metric to imperial units and vice versa shall be carried out in accordance with the conversion factors in B.S. 350 Part 1 and 2 and B.S.I. Publication PD6030 and PD6031.

23 COMMUNICATION LANGUAGE

- A. All Project communication, both verbal and written shall be in the English language. The Contractor, his sub-contractors, suppliers or agents shall ensure that their assigned Project Team, supervisory staff and labour operatives are capable of communicating in and understanding written and verbal English.

24 TESTING AND INSPECTION

- A. Wherever it is required under the Contract that the Contractor is required to undertake testing or inspection of any materials or installed works, a minimum of seven (7) days' notice of the date of testing (or other such notice as may be specified in the contract for particular testing) shall be provided. The Contractor shall also provide for the Contract

Administrator being present, and if required, provide adequate facilities and assistance to validate the tests. The Contractor shall report all test results to the Contract Administrator promptly.

B. The Contractor may be required to establish an on-Site laboratory in accordance with specific requirements detailed elsewhere in the specifications. When instructed by the Contract Administrator, the Contractor shall arrange establishment of a testing laboratory that shall be managed to an accredited standard.

C. For all other laboratory requirements, the Contractor shall use the facilities of an established laboratory, approved by the Contract Administrator.

25 EMERGENCY ARRANGEMENTS

A. The Contractor shall maintain arrangements whereby he can quickly call out labour outside normal working hours to carry out work needed for an emergency associated with the Works. The Contract Administrator shall be provided at all times with a list of addresses and telephone numbers of the Contractor's staff who are currently responsible for organizing emergency work.

B. The Contractor shall acquaint himself and his employees with any relevant local arrangements that are in existence for dealing with emergencies.

26 CLEARANCE OF SITE ON COMPLETION

A. The Contractor shall leave the whole of the Works clean and tidy on completion, all to the satisfaction of the Contract Administrator.

27 CORRESPONDENCE / SUBMITTALS

A. Only standard sizes of drawings shall be used. The maximum size used shall be A0 or as directed by the Contract Administrator. The format of the drawings such as title blocks, approvals stamp blocks, numbering system, etc., shall be subject to the approval of the Contract Administrator.

B. All project correspondence shall be in the format required by the Contract Administrator.

C. The transmittal forms used for submittals shall be in a format designated by the Contract Administrator.

28 HOLIDAYS

- A. The Contractor shall, in all his dealings with his staff and labour have due regard to all recognized public, National and specific to The Republic of Fiji, religious holidays and festivals. He should take due notice and ensure that specific staff be in place to cover those staff members who may be on leave or holidays and ensure that the Project Site operations are maintained as required to meet the Project's requirements.

160.04 ALTERNATIVES**1 ALTERNATIVES**

- A. An "Alternative" (hereinafter referred to either as Alternate or Alternative) shall be any material, product, detail, equipment, system, installer, manufacturer, supplier, sub-contractor, country of origin, codes, standards, warranties or any other detail, proposed by the Contractor that are not specified or indicated in the List of Manufacturers or sub-contractors or Materials or equivalent in the Specification.
- B. The Contractor shall not propose Alternatives to materials, product, manufacturers, sub-contractors, etc., that are not in the specified list of acceptable manufacturers, sub-contractors, materials, or similar in the Specifications unless provisions of this section are satisfied.
- C. Proposals for Alternatives shall be submitted for review by the Contract Administrator only if specifically authorized to do so by the Contract Administrator.
- D. Proposals for an Alternative shall be returned without review if any deviation from the Specification has not been clearly identified. The Contract Administrator reserves the right to reject any proposed "Alternative".
- E. The proposed items that are not specifically listed in the Specifications under "Acceptable Manufacturers" or similar, but are submitted under "or Approved Equal" category will be considered as Alternatives, unless the Contract Administrator and/or the Employer accepts, based upon the recommendation by the Contract Administrator, the proposed items as 'equals' to the list specified. Until that time, the proposed items shall be considered only as Alternatives.

- F. If the Contractor proposes to submit an Alternative product which is rejected by the Employer and/or Contract Administrator, the Contractor shall not be entitled to any delay or cost claim as a result of rejection.

2 PROPRIETARY PRODUCTS

- A. Where items of material or product are described by, or where reference is made to, proprietary manufacturer(s) or product(s) the Contractor shall be deemed to have included for the provision of such items by the brand name(s). Any deviation in this respect, even if specifically detailed in the submitted Tender, shall be disregarded.
- B. Where the material or product detailed in such submissions does not exactly comply with the Drawings and Specification, and is therefore a proposed alternative, approval of this alternative shall be at the sole discretion of the Employer, notwithstanding that the proposal was made at Tender; approval shall be as an Alternative in accordance with this Section. Where approval is refused, the Contractor shall provide a material or product that fully conforms to and in accordance with the Drawings and Specification.
- C. Where the Contractor proposed a superior material or product with his Tender, the Contractor shall be obligated to provide that material or product without any additional cost & time, unless rejected by the Employer or the Contract Administrator. In case of rejection by the Employer or the Contract Administrator, the Contractor shall provide a material or product from that listed in the Specification without any cost, time or any other implications.
- D. Proprietary manufacturer or product shall mean any reference to a manufacturer, part number, brand name or trade mark. Patented brand name(s) are specified solely to establish the required quality standard.

3 PROCEDURES

- A. If the Contractor wants to propose an Alternative, then his proposal shall be applicable to engineering, and details, subject to the approval of the Contract Administrator. This shall be clearly indicated as such on the submittal. Approval of any such Alternative shall be entirely at the discretion of the Contract Administrator and shall not relieve the Contractor of any of his liabilities or obligations under the Contract. Any changes to the design or related designs or drawings as a consequence of the proposed Alternative shall be at the responsibility and cost of the Contractor. Any increase in cost or any related costs incurred by the Employer shall be borne by the Contractor and any saving shall be to the benefit of the Employer. Any delays to the project resultant from requests

and/or repeated requests for alternative products will be the sole responsibility of the Contractor.

- B. All Proposals shall be submitted to the Contract Administrator, copied to the Employer, in writing, and shall include the following minimum data and documentation in respect of each item:
1. Manufacturer's data of proposed material or product. The data shall be in the form of complete catalogues, brochures, calculations, data sheets in the original, and / or copy / description of specified detail and copy / description of proposed detail.
 2. Copy of specified code or standard, and copy of proposed code or standard.
 3. Comparison between the specified and proposed material or product, and / or description of variances between the specified and proposed detail.
 4. Comparison between the specified and proposed code or standard. This comparison shall be limited to the salient points for the material or detail in question.
 5. A cost analysis shall be provided with the Alternative, including all required related charges. The cost analysis shall be supported with calculations, invoices, and all other required substantiation. CIF quotation of specified and of proposed material or product shall be provided.
 6. Impact upon the approved Programme for the Alternative shall be provided. This shall be supported with calculations and all other required substantiation. Written evidence of supply source, availability of sufficient quantity, and delivery dates shall be provided.
 7. Reason for Proposal. The Proposal will not be considered unless the Contractor identifies one or more of the following reasons:
 - a. When the specified products are no longer available. The proposed Alternative will not be considered unless proof is submitted that a firm order was placed within ten (10) days of the review and approval of the corresponding submittal by the Contract Administrator of the item listed in the Specification, or the unavailability is due to strikes, plant

shutdown, lockouts, discontinuation of the product line, bankruptcy, or a national disaster.

- b. When a guarantee of performance is required. In which case, in the opinion of the Contractor, the specified product will not produce the desired result.
- c. Where substantial cost and/or time benefit shall accrue to the Employer.

C. Alternatives will not be considered if:

- 1. They are indicated or implied in the Contractor furnished drawings and other information without presenting a formal request as stipulated above.
- 2. They are directly requested by a supplier or sub-contractor, and do not meet the criteria noted above.
- 3. Subject to the Employer, if acceptance will result in substantial revision to the Contract.

4 VALUE ENGINEERING

A. The Contractor is encouraged to propose alternate methods / engineering for installation that would reduce the cost and/or improve the schedule both during the Tender (where alternative bids are allowed) and the course of the Works, under the following conditions, (unless otherwise specified in the Contract):

- 1. The Contractor shall clearly identify the alternate method / materials in his tender or if the proposed Value Engineering is offered after contract award, the Contractor shall submit appropriate correspondence clearly explaining same and providing sufficient information in order for the Contract Administrator and/or Employer to make an informed decision regarding its acceptance.
- 2. The Contractor shall be fully responsible for the design of the proposed alternate method / materials.
- 3. The proposed suggestions shall in no way delay the Project schedule or result in additional cost to the Employer.

4. Proposals shall be subject to review and acceptance of the Contract Administrator and the Employer.
 5. All costs associated with the additional review required by the Contract Administrator and/or appropriate governing authorities shall be borne by the Contractor.
 6. Value engineering suggestions detailed with the Tender shall be accompanied with a guaranteed minimum saving.
- B. Value engineering suggestions shall be submitted with an estimate of the resultant minimum cost and time savings. It shall include a detailed breakdown of the labour and material savings. Upon acceptance and completion of the detailed engineering, the cost saving shall be finalized.
- C. While submitting a comparative potential saving for the suggested value engineering proposal, it shall remain the responsibility of the Contractor to identify consequential effects, both positive and negative, on other trade disciplines and/or on the work of other Contractors and sub-contractors and to identify costs and time associated with such impacts in the potential savings. No impact to any Milestone Date, additional time for completion or Sectional Completion Date or an extension to Time for Completion shall be accepted by the Employer if it is determined by the Contract Administrator that the time impact is due to the consequence of the Contractor proposed value engineering suggestion.

160.05 PROJECT TEAM AND COORDINATION

1 CONTRACTOR'S PROJECT TEAM

- A. The Contractor shall be responsible for the proper management, coordination, execution and completion of the Works as required by this document and the Conditions of Contract. In fulfilling this responsibility, the Contractor shall deploy a qualified project team to meet the requirements of the contract. Senior personnel that interact regularly with the Contract Administrator shall have both written and verbal skills in technical English.
- B. The Contractor's Project Manager shall be the representative of the Contractor and is the first point of contact between the Contractor and the Contract Administrator. The

Contractor's Project Manager shall be well qualified and experienced to perform the functions that are required of him. The Contractor's Project Manager shall have at the minimum a bachelor's degree in engineering and/or construction. The Contractor's Project Manager shall be well versed in the overall management of his team, contractual obligations, time and cost aspects of the contract, planning and executing the Works, implementation of work discipline on and off Site, various construction complexities, etc. The Contractor's Project Manager shall generally have a minimum fifteen (15) years' experience in the construction industry and shall have extensive job specific experience.

- C. Engineering: The Contractor's engineering team shall be headed by an Engineering Manager who shall be responsible for production of all shop drawings, construction details, fabrication drawings and coordination drawings. The Contractor's Engineering Manager shall have a minimum fifteen (15) years' experience in construction and/or road works. The Engineering team shall be responsible for all submittals of materials, samples and drawings. The team shall ensure that submittals are comprehensive and in conformance with the Contract Specifications and Drawings and also make sure that submittals are made in a timely manner. The team shall be capable of identifying any discrepancies in the Contract Specifications and Drawings and bring to the notice of the Contract Administrator for resolution. The Contractor's engineering team shall be responsible for coordinating all submittals and drawings of the Contractor's sub-contractors and other relevant package Contractors. The Contractor's Engineering Manager shall have substantial experience along with multi-discipline qualifications and training. The Engineering Manager shall have problem solving capabilities and shall be able to generate construction details and solutions quickly, when required. The engineering team shall consist of qualified and experienced trade engineers relevant to the package scope of work.
- D. Contractor's Geotechnical Engineer: The Contractor's Geotechnical Engineer (if applicable) shall be responsible to carry out any further Soil Investigation works. He shall submit monitoring and instrumentation report including interpretation to the Contract Administrator and any other authorities when instructed. The Geotechnical Engineer shall approve any non-blasting excavation method of rock. He shall also report on any change in soil/rock type and properties immediately these are encountered and review the excavation method. He shall also place attention to any flow or draw down of ground water and take measures to ensure that these will not have any adverse impact to existing pavement, structures, etc. He also shall have at least 10 years of working experience and holds at least a Bachelor's degree in Engineering.

- E. Contractor's Geotechnical Geologist: The Contractor's Geologist (if applicable) shall examine the available Soil Investigation Report and assess the type of rock that are present on site. He shall carry out further investigation such that the geological formation can be determined. As the excavation progress the Geologist shall examine the excavated rock face and make any recommendation necessary to stabilise the excavated rock face safely. He also shall have at least 10 years of working experience and holds at least a Bachelor's degree in Engineering.
- F. Construction: The Contractor's Construction team shall be headed by a Construction Manager who shall be qualified in engineering and/or construction disciplines and have a minimum of fifteen (15) years' experience in construction and/or road works. The Construction Manager shall be well versed with construction organization, site logistics, security, arranging and allocating manpower and equipment resources, capacities and limitations of construction equipment, job site safety, implementation of quality control, job site planning and progress control, considerable knowledge of various engineering disciplines (civil, Architectural, structural, mechanical and electrical), coordination between different trade disciplines, etc. The Contractor's Construction Manager shall have trouble shooting skills, and capabilities to expedite corrective actions as and when any delay occurs. The Contractor's Construction Manager shall make plans for the execution of Works at Site and have alternatives and contingency plans worked out in order to achieve the Project schedule and Milestone requirements. The Contractor's Construction Manager shall liaise with the representatives of the Contract Administrator who is involved with on-Site activities. The Contractor's Construction Manager shall also coordinate with authorities having jurisdiction such as local government, semi-government and non-government agencies as required. The Contractor's Construction Manager shall have extensive job specific experience. The construction team shall consist of qualified and experienced trade engineers relevant to the package scope of work who shall be responsible for execution and the planning and scheduling of work activities. The Contractor shall deploy sufficient number of supervisors with at least fifteen (15) years' experience in the trade in which they will be engaged. Well-experienced supervisors and foremen shall ensure that job Site works are performed in accordance with the requirements of the Contract.
- G. Coordination: The Contractor's Engineering team shall have members with strong multi-discipline (road works, structural, architectural, cladding, mechanical and electrical) background who will take a leading role with the inter-contract and subcontracts coordination (if applicable) during the engineering phase (preparation of drawings, submittals and the like). In addition, sufficient engineers with similar backgrounds shall

be in the Construction team for taking a lead role with the inter-contract and subcontracts coordination during construction. The sub-contractors shall have dedicated coordination engineers in similar capacities. The coordination engineers shall be suitably qualified and shall have a minimum of fifteen (15) years of suitable experience.

- H. Planning & Scheduling: If required by the Contract Administrator, the Contractor shall designate a full-time qualified and experienced Senior Planning & Scheduling Manager who shall have a minimum of ten (10) years' experience in planning and scheduling activities. They must be qualified and competent to operate Primavera P6 software and shall be responsible for all functions relating to planning, scheduling and reporting.
- I. Procurement: The Contractor shall have dedicated staff that shall be responsible for all material procurement. The Procurement team shall be given all "required on job" dates for all materials as soon as Construction Schedule is finalized. The Procurement team shall be headed by a Procurement Officer who is well versed in identifying all long lead items and knowledgeable in sourcing all materials. The Contractor's Procurement Officer shall have extensive and in-depth knowledge of local market, availability of vendors, fabricators of specialist materials, government authorities' regulations, banking rules, world markets for sourcing of materials and products, customs procedures, shipping procedures, etc. The Contractor's Procurement Officer shall act as an expeditor to place orders, follow up with vendors and manufacturers, ensure that quality norms are achieved by the vendors and manufacturers, get the required inspections done and certified, and ensure that deliveries are made in satisfaction of the Project requirements.
- J. Logistics: The Contractor shall have a dedicated crew supervised by a competent and experienced Logistics Superintendent (if applicable) with a Supervisor and team of adequate number of technicians and administrators. The Logistics Superintendent shall be responsible for all material handling, movement of men, plant and materials, arranging carnage and hoisting facilities, access control to the Site, Site cleaning, site security management etc. The Logistics Superintendent shall closely work with the Construction Manager and the Safety Manager. The Logistics Superintendent shall have at least ten (10) years' experience on construction projects of this kind. The Contractor shall comply with all items as identified in this document.
- K. Quality: The Contractor's Quality Management team, QA/QC Manager, the team's responsibilities and functions are explained in this document. The Contractor shall have a dedicated crew supervised by a qualified QA/QC Manager to ensure that the works are executed in accordance with the project specifications and contract requirements. The

Contractor shall appoint a QA/QC Manager who shall have at least ten (10) years experience. The QA/QC Manager shall as a minimum be a qualified engineer with additional qualifications and training pertaining to Quality Control Management.

L. Traffic Management: The Contractor shall have a dedicated crew supervised by a qualified Traffic Manager or Engineer to ensure that the works are executed in accordance with the approved Traffic Management Plan by the local authorities. The Contractor shall appoint a Traffic Manager or Engineer who shall have at least eight (8) years experience. The Traffic Manager shall as a minimum be a qualified engineer with additional qualifications and training pertaining to Traffic Management.

M. Safety: The Contractor's Safety organization and staffing, responsibilities and functions are explained in this document. The Contractor shall appoint a full-time Safety Manager for the site and shall have a minimum of fifteen (15) years' experience in Safety and is qualified in accordance with The Republic of Fiji Safety requirements. The Safety Manager shall have full authority to direct work stoppages and to expend the Contractor's funds, as necessary, to eliminate hazards and imminent danger conditions on the Site. The Safety Manager is responsible for the implementation and further development of the Contractors Safety Program. His duties will include the following: Conduct daily/weekly safety meetings / workshops / toolbox talks with Site personnel and equipment operators, conduct and record pre-task plans (PTP) to the PM/CM prior to works commencing, inspect the Project daily, and record all visible safety hazards, including identification of violators and shall take immediate corrective action, follow through on timely correction of safety hazards, making immediate corrections as necessary, monitor on Site safety meetings and report same on his Daily Report, foster 'Safety Awareness' in all tradesmen and supervisors on the Project, follow up, for insurance purposes, all relevant safety reports, check all areas at least once a day for housekeeping and cleanup. Take immediate action to ensure compliance with requirements, submit a job hazard analysis to the Contract Administrator for each major phase or element of work as necessary, ensure safety signage, lights, and barriers are provided throughout the project site and take immediate corrective action to eliminate the unsafe condition, conduct employee indoctrination for all new personnel prior to granting permission for them to enter the site, ensure training is carried out for specific tasks, especially high risk activities and work of a non-standard nature. Prepare a pre-task plan for high risk and non-standard activities, and shall be a member of the Site Crisis Management Team organized to deal with emergencies.

- N. Environmental: The Contractor shall have an environmental manager (and team if applicable), the team's responsibilities and functions are explained in this document. The Contractor shall an Environmental Manager with minimum 10 years' construction experience on projects of similar size and scope; familiarity with Environmental Management Systems (EMS) such as ISO 14001]; familiarity with environmental regulations applicable to construction operations. His responsibilities shall include compliance with applicable The Republic of Fiji and local environmental regulations, including maintaining required documentation implementation of the Waste Management Plan, implementation of the IAQ Management Plan, implementation of the Environmental Management Plan, training for Contractor personnel in accordance with their position requirements, monitoring and documentation of environmental procedures, reporting of Environmental Performance, reporting of Environmental Audit and reporting of Closure Audit.
- O. Installers: All work shall be performed by trained and capable installers or craftsmen with sufficient experience to meet the quality and schedule requirements of the Project. All works shall be executed by specialist skilled craftsmen approved by the Contract Administrator. These craftsmen shall have a proven record of experience in workmanship for a minimum period of five (5) years in comparable quality projects. Any craftsmen not meeting these requirements will not be accepted.
- P. The requirements for key positions detailed in this section shall act as guidelines to the Contractor prior to proposing personnel for the Project.
- Q. All of Contractor's key personnel shall be approved by the Contract Administrator prior to assignment to the Project. The Contract Administrator and Contract Administrator have the authority to instruct the Contractor to remove any staff in the Contractor's organization if in the opinion of the Contract Administrator that the performance of the said staff is not satisfactory. The replacement of such staff shall take place within ten (10) days of the Contract Administrator's notice.
- R. The Contractor shall submit the CV's of his proposed Senior Personnel for approval by the Contract Administrator and any additional CV's as requested by the Contract Administrator.

2 PROJECT COORDINATION

- A. Depending on the contract, there may be a considerable amount of coordination required between other stakeholders, entities or trades. The Contractor shall be entirely responsible for the coordination and proper execution and completion of the Works as required in this document and the Conditions of Contract. This responsibility shall in no way be reduced by the employment of Sub-Contractors whether approved, nominated, assigned or otherwise. The Contractor shall coordinate the work and shall ensure that all trades cooperate to assure the required and steady progress of all work under the Contract. In the event the Contractor fails to perform his duties as stated above, the Contract Administrator reserves the right to employ additional staff for the purposes of coordinating works between necessary trades and any costs associated with the hiring of these additional staff will be deducted from the Contractor's subsequent payment applications. Prior to commencement for installation of the works, a Clash Detection coordination may be required with the Contract Administrator and Clash Detection Consultant.
- B. The Contractor shall take the lead position in maintaining an active role in the inter-active coordination of his work with that of all other Works Contractors, authorities or organizations performing works under separate contracts to ensure no delay, disruption or interference is caused to the Works under the Contract, and/or to such other contracts including works adjacent to the site perimeter.
- C. The Contractor shall actively coordinate including Clash Detection with other affected package contracts on an ongoing basis and it is the responsibility of the Contractor to make due allowance and provisions within his shop drawings for interfacing details based upon information and documents as and when they are received. When other packages are not represented due to the late award, then the Contractor must make allowance and provisions based on the Contract documents in his possession.
- D. The Contract Administrator will monitor the coordination efforts of the Contractor on Site and will set priorities as required should conflicts occur. Where the Contractor delays the coordination of the Works, he shall hold the Employer, the Contract Administrator or their representatives harmless for any claim and/or consequential claims received from any other Contractor or party resulting from such delays.
- E. The Contractor may be required to establish a coordination team charged with the responsibility to ensure coordination with his own activities, the activities of his nominated sub-contractors, and each of the other Works contractors and sub-contractors on the Project. The Contractor's personnel belonging to the coordination team shall establish daily/weekly planning and coordination meetings with their nominated sub-contractor or

the sub-contractor / the other direct Contractors employed on the Project to monitor progress, identify construction opportunities and redirect work efforts to avoid construction delays.

- F. As a part of the Contractor's coordination responsibility he shall prepare and/or cause to be prepared coordination drawings as described in Section SUBMITTAL PROCEDURES.

3 PROGRAMME AND SERVICES COORDINATION

- A. The Contractor shall, prior to commencement of the Works, prepare a time programme to be approved by the Contract Administrator in which he shall identify activities, procedures and measures to be followed and the date of completion of stages of work. Details required for Contractor's programming is included within and section PROGRAMME & SCHEDULES of this document.
- B. Within fourteen (14) days of the Commencement Date, the Contractor shall submit to the Contract Administrator for his review, comment and approval, his proposed preliminary programme of Works based on the Milestone Dates, Sectional Completion Dates, the Time for Completion forming part of the Tender Documents and the Contractor's programme submitted with his Tender showing the order of procedure, and method, in which he proposes to carry out the Works, in the form of a construction progress bar chart covering major work items, supplemented by a written narrative explaining the Contractor's arrangements for carrying out the Works, including a description of the Works, a description of the Plant and Temporary Works which the Contractor intends to supply, use, or construct, as the case may be. The proposed programme of Works shall be separated into sections as appropriate to show how different elements of work are to be integrated and details of resources required to achieve the proposed schedule. Within fourteen (14) days of review and approval of the Contractor's proposed preliminary programme of Works, the Contractor shall submit for the Contract Administrator's review and approval a "Programme of Works" (referred also as Schedule of Works or Contract Programme). Until such time the Programme of Works is approved, the Contract Administrator and/or the Employer has the right to consider, at their discretion, the Milestone Dates, Sectional Completion Dates, the Time for Completion and Programme included in the Tender Documents; or the tender works programme submitted by the Contractor with his Tender; or the preliminary programme of Works submitted by the Contractor; or any combination of the three programmes, as the governing programme for the construction of Works. The Programme of Works shall not be altered without the

approval of the Employer and/or the Contract Administrator. The Programme of Works and subsequent updates shall all be in accordance with the requirements of relevant sections of this specification.

- C. Commencement of onsite works will not be permitted until the preliminary programme has been received. The Contract Administrator reserves the right to delay commencement of onsite works until the preliminary programme has been approved if it does not meet the contract requirements. Any delay will not be considered valid extension of time request.
- D. The Contractor shall schedule their construction operations in the sequence required to obtain the best results where installation of one part of the work depends on installation from other parties, before or after its own works.
- E. Where availability of space is limited, the Contractor or each sub-contractor and each nominated sub-contractor shall coordinate installation of different sections of works and components with other Contractors to assure maximum accessibility for required maintenance, installation, service, and repair.
- F. If instructed by the Contract Administrator, the Contractor may use digital/computer based three dimensional models and other related functionality, generally referred to as building information modelling (such models and functionality are referred to herein as Clash Detection) as beneficial for use in facilitating coordination, sequencing, scheduling and/or production of as-built depictions of the Project and performance of the Work and as hereafter provided. The Contractor is responsible for all costs of such participation.
- G. The detailed procedures for utilizing Clash Detection (if applicable) on this project are outlined as per Section SUBMITTAL PROCEDURES.
- H. Any conflicts with affected contractors and sub-contractors are to be resolved before commencement of work by the Contractor.
- I. Drawings and specifications of other contracts and/or entities and subcontract packages will be made available and issued where appropriate for the Contractor's review in order to provide additional information regarding coordination requirements.
- J. In the event that any equipment to be supplied and installed by Third parties on or adjacent to works to be constructed by the Contractor is not available at the requisite time, the

provision for the later installation of same shall be made by the Contractor with no time or cost impact to the Employer.

4 COORDINATION DRAWINGS

A. Coordination drawings are described in Section SUBMITTAL PROCEDURES.

160.06 PROJECT MEETINGS

1 PRE-CONSTRUCTION CONFERENCE

A. The Contract Administrator will convene a Kick-off Meeting at a date to be determined, which shall be attended by the Contractor, his major sub-contractors and any other parties as requested by the Contract Administrator.

2 AGENDA

A. The Contract Administrator will provide the agenda for the Kick-off Meeting to the Contractor a minimum of seven (7) days prior to the meeting. The general outline of the agenda will be as follows.

1. The Construction Management Plan detailing procedures for safety management, security, quality control and assurance, environmental management, housekeeping etc.
2. Contractor's organisation arrangements.
3. Insurances
4. Channels and procedures for communication.
5. Programme, including sequence of critical Work and milestones.
6. Scope & Exclusions
7. Drawings (Construction and Shop/Fabrication Drawings) and Specifications, including distribution of required copies.
8. Processing of shop drawings and other data to be submitted to the Contract Administrator for review.
9. Processing of Contract Administrator's instructions and variations orders.
10. Rules and regulations governing performance of the Works.
11. Sustainability requirements
12. Procedure for reporting and monitoring progress, cost, materials, labour and equipment

13. Logistics Planning

- B. The above procedures, reviews, rules, policies, processes and requirements will be defined by the Contract Administrator and will be reviewed at the meeting.
- C. The Contractor shall comply with all aspects of the Contract Administrator's requirements and with any revisions that are made thereto during the progress of the Works.

3 PROGRESS, PROGRAMME AND COORDINATION MEETINGS

- A. The Contract Administrator will convene Progress Programme and Coordination Meetings on a weekly basis to review the Contractor's Programme. including, fourteen (14), thirty (30) and ninety (90) day look ahead programmes. Attendees at this meeting may include but not limited to the Contract Administrator, the contractor, his sub-contractors, nominated sub-contractors and other direct contractors as required. During the meeting, work progress and look ahead programmes will be reviewed to verify;
 - a. Actual start and finish dates of the completed activities during update period.
 - b. Remaining durations and percentage of completion for all activities not completed
 - c. Contractor's measures to rectify delays from the planned dates, such as increasing manpower, materials and equipment resources, working extended hours or additional shifts.
 - d. Contractor's safety report and tool box meeting records, equipment test certificates, accident reports, environmental incidents etc.
 - e. RFI (Request for Information), EWI (Employer's Work Instructions), NCR (Non Conformance Reports)
 - f. Contractor's Procurement of materials, plant and equipment and Submittals
 - g. Fabrication of materials
 - h. Contractor's Status Report on submittals and approvals of designs, shop drawings, materials, samples, etc
- B. The Progress Programme and Coordination Meetings will be chaired by the Contract Administrator.
- C. Relevant information from weekly reports in accordance with Section ADMINISTRATION OF PROJECT SITE may be used for the above as available.

- D. The Contractor shall attend all Progress Programme and Coordination Meetings, adequately prepared to discuss all of the items on the agenda and to report on follow-up actions required from previous meetings.
- a. In addition, the Contractor shall prepare and issue the following:
- i. A list of completed activities.
 - ii. A list of current activities, with an estimate of time required for completion.
 - iii. A list of any variation in starting dates and durations of outstanding activities from planned dates and times.
 - iv. Percentage of completion in every activity.
 - v. Activities the Contractor plans to start in the following period should be indicated.
 - vi. Other information as may be requested by the Contract Administrator
- E. Additional meetings as may be required by Contractor to comply with his obligations under this section shall be requested in writing by him to the Contract Administrator with full details of agenda and names of other contractors who are required to attend. Such meetings shall be chaired by the initiating Contractor and may be attended by the Contract Administrator and the Employer.
- F. The Contractor shall conduct a Monthly Safety Meeting along with all sub-contractors and Direct Contractors. The Employer and Contractor Administrator reserve the right to attend this meeting and as stated in this document.
- G. A detailed record of these meetings shall be prepared by the Contractor and circulated to attendees within 48 hours of the meeting.

4 SUB-CONTRACTOR'S SITE MEETINGS

- A. The Contractor shall hold weekly meetings with his appropriate sub-contractors, nominated sub-contractor's suppliers and the other Direct contractors before Site Progress Meetings to facilitate accurate reporting of progress. The Contract Administrator and Employer reserve the right to attend these meetings.
- B. The Contractor shall allow for sub-contractor's & direct contractors coordination meetings to be convened by the Contract Administrator as directed.

- C. Additional meetings between the Contractor and his Sub-Contractors / other Direct Contractors for coordination, progress, safety, environmental, trouble-shooting, procurement activities, etc., are the Contractor's responsibility.
- D. If required, the Contractor shall be available to attend meetings with surrounding stakeholders or any authority of the Republic of Fiji.

5. OTHER PROJECT MEETINGS

- A. Preconstruction Conference (This may be covered during the kick off meeting):
 - 1. A preconstruction conference shall be held by the Contractor for each major portion of the work after award of the subcontract.
 - 2. Attendees shall include the representatives from the Contract Administrator, Contractor, nominated sub-contractor, nominated sub-contractor's major suppliers and any other parties who may be required during the meeting.
 - 3. Review personnel assignments, roles and responsibilities, and points of contact.
 - 4. Review all the aspects of the Contractors scope of work.
 - 5. Agenda to include:
 - a. Review Contractors scope of work
 - b. Safety: Contractor's safety plan and any sub-contractor's safety plan. Special safety hazards and mitigation shall be addressed.
 - c. Quality:
 - 1) Review project documents for the Contractors scope of work and quality requirements
 - 2) Review project and Contractors quality assurance and quality control program.
 - 3) Review Contractors submittal list, mock-ups, checklists, and preconstruction and construction testing.
 - 4) Review required permits, codes, and specific requirements for permitting agencies
 - 5) Identify specific testing and inspection requirements, personnel, testing procedures, and reporting for both off-site and on-site work.

- 6) Review tracking and remediation procedures for deficient work.
- d. Schedule
 - 1) Review the Contractor's overall project programme.
 - 2) Review Sub-Contractor's material procurement, construction engineering, fabrication, shipping/delivery, and installation sequence and durations
 - 3) Identify critical long lead items and sequencing
- e. Project Procedures: Review procedures and review forms for payments, changes, submittals, requests for information
- f. Temporary facilities and controls
- g. Site Logistics
- h. Sustainability: Review any sustainable construction requirements and documentation. Review documentation required for international third party sustainability certification.
- i. Review closeout requirements:
 - 1) As-built drawings and specifications, submittals, operations and maintenance manuals, start-up, testing, and commissioning documentation, extra materials, keys, tools, and other items as required by the construction documents.
 - 2) Financial and contractual close-out
- j. Minutes: The Contractor will prepare minutes of each Pre-Construction Meeting and will distribute copies to the Contract Administrator. The Contractor shall make and distribute copies of the minutes to his sub-contractors and nominated sub-contractors. He may also make and distribute copies of the minutes to his fabricators as he wishes.

B. Pre-Installation Conference

1. Pre-Installation conference may be requested by the Contract Administrator for the review of the Contractor's scope of work just prior to the start of installation.
2. Attendees and agenda to follow Pre-Construction conference with emphasis on field activities.
3. Minutes: The Contractor will prepare minutes of each Pre-Installation Conference and will distribute copies to the Contract Administrator and sub-contractor. The Contractor shall make and distribute copies of the minutes to his Nominated sub-

contractors. He may also make and distribute copies of the minutes to his sub-contractors as he wishes.

- C. Daily Coordination Meeting: The Contract Administrator may, at their discretion, hold daily coordination meetings with all package Contractors. The purpose of this meeting is to provide the Contract Administrator with daily manpower counts, and works to be performed on that day. Also, any specific coordination issues with other package Contractors, related to the day's work, can be discussed.
- D. Coordination Meeting: From time to time, the Employer, Contract Administrator, Contractor, or the nominated sub-contractors may request coordination meetings. The Contractor shall participate fully in these meetings supplying proper personnel and sub-contractors with authorities to make commitments.

6. PROGRESS MEETINGS:

- A. The Contractor's Representative shall meet with the Contract Administrator to review progress and discuss general matters relating to the Works at least once every two weeks, unless otherwise agreed by the Principals Representative. The meeting shall be held at either the Contract Administrator office or the Contractor's site office and be chaired by the Principals Representative. Other Contractor's staff, subcontractors and Principals staff shall attend as appropriate.

7. SAFETY MEETINGS

- A. The Contractor shall host Safety meetings at least once a week at the Project site. Such meetings will be convened and conducted by the Contractor's Safety Manager. The Contract Administrator, all Safety Engineers, supervisors, foremen and appointed safety committee members are expected to be in attendance. The Contractor, sub-contractor and nominated sub-contractor shall have a responsible representative present to follow through on information and resolutions discussed and adopted at these meetings. Minutes of meetings shall be issued by the Contractor and distributed to the Contract Administrator and Supervision Consultants within 48 hours of the meeting.
- B. The agenda for the safety meetings will generally include:
 - 1. Review of the previous meeting minutes.
 - 2. Status of Safety Plan implementation.
 - 3. Review of incident reports from the previous week.
 - 4. Review of the Contractor's Safety Manager's inspections and violations reports from the previous week.

5. Identification of upcoming high-risk activities and status of hazard analysis reports.
6. Identification of potential safety hazards in the coming month and discussion and implementation of steps to be taken to avoid the same.
7. Review of evacuation procedures, firefighting training, etc.
8. Review of Site sanitary procedures with regard to toileting needs.
9. Development of timely topics for discussion and dissemination of safety bulletins, signs and notices.

160.07 PROGRAMME AND SCHEDULES

1 GENERAL

- A. This section consists of the programmes, scheduling and reporting procedures required to be carried out by the Contractor in conjunction with the progress of the Project. The Contractor shall develop the Programme demonstrating fulfilment of all Contract requirements.
- B. The contractual programme requirements herein thereafter stated as the “Programme” depicts in general the key activities and Milestones and the duration allotted for the same. The Contractor shall be required to plan, perform and coordinate his Works with that of other contractors to meet the time requirements of the Project.
- C. The Programme shall include details of the cost, resources and methods the Contractor proposes to adopt for achieving the objectives of the Project.
- D. The Contractor shall be responsible for submitting adequate planning data and acceptable cost and resource distribution information for the development and maintenance of the Contractor’s Programme, all for review by the Contract Administrator.
- E. The Contractor must coordinate with his sub-contractors, nominated sub-contractors and other affected Contractors in the preparation of the Schedule of Works.
- F. In case of monthly reports, the last calendar day shall be used as the closing day.
- G. The Programme shall be continuously updated and issued every 2 weeks or more frequently when required by the Contract Administrator.
- H. Each revision of the Programme shall be signed by the Contractor’s representative.

- I. All costs related to the preparation, computers, software, plotters, reproduction and presentation of programmes, reports, charts, photographs, transparencies, slides, internet connection and bandwidth etc. including the DVD's / storage device containing the relevant files, as required by this section shall be borne by the Contractor. Internet connection and appropriate bandwidth to handle large file uploads + downloads from the Employers Document Management website (if applicable) are to be borne by the Contractor.
- J. Within fourteen (14) days of the Commencement Date, the Contractor shall submit to the Contract Administrator in a format approved by the Contract Administrator, a complete schedule of all submittals required under this Contract, including shop drawings, Sustainability Documents, Quality Plan, Safety Plan, Environmental Plan, Schedule, samples, manufacturer's test certificate, testing, Commissioning documents, Test Reports, Survey reports, Closeout documents such as operation and maintenance manuals, etc., along with Planned submission dates and required on job dates.
- K. Within fourteen (14) days of the Commencement Date, the Contractor shall submit a complete and detailed Procurement Schedule detailing the source of all products, materials and articles proposed for use in the Works together with the names and addresses of manufacturers and suppliers. The Procurement Schedule shall indicate key dates in the procurement cycle.
- L. Method statements for execution of major elements of the Project shall be provided by the Contractor for the review and approval of the Contract Administrator and Consultants not less than fourteen (14) days prior to execution of the Works.
- M. Within fourteen (14) days of the Commencement Date, the Contractor shall submit to the Contract Administrator in a format approved by the Contract Administrator, a complete schedule of all material deliveries required under the Contract.

2 CONTRACTOR'S REPRESENTATIVE

- A. The Contractor shall designate a full-time qualified and experienced Senior Planning & Scheduling Manager who shall be responsible for the content and development of the Contractor's Programme, dedicated to CPM programming activity, time and cost control. The Senior Planning & Scheduling Manager shall have direct control and complete authority to act on behalf of the Contractor in fulfilling all schedule requirements and such authority shall not be withdrawn or abridged throughout the duration of the Contract. The

Contractor shall submit the CV and relative qualification documents of the designated Senior Planning and Scheduling Manager to the Contract Administrator for approval.

3 TENDER PROGRAMME

- A. The Tenderer shall submit with his tender a detailed programme (herein after referred to as the Tender Programme) in line with the Milestone Dates, Sectional Completion Dates, Priority Areas, the Time for Completion and Schedule requirements included in the Tender Documents, by elaborating and including all major activities in his scope of Works. The Tender Programme shall be prepared in line with the requirements under Clause 4 (below) and shall consist of:
1. Proposed execution programme.
 2. Schedule of Construction Equipment & Vehicles.
 3. Execution Method Statement.
 4. Support Data.
- B. The proposed execution Programme shall be prepared as per Section 4 (below) which shall be broken down to meet the schedule and milestones requirements provided in the Tender Documents. The proposed execution Programme shall address all elements of the scope of Works starting from award of Contract through various stages of execution till the completion of the Works. All constraints such as access requirements information requirement, etc. shall be clearly indicated.
- C. The Tenderer shall submit a Schedule of Construction Equipment & Vehicles; he proposes to use for the Project. This shall be in the form described under Clause 4 (below).
- D. All necessary support data details as applicable shall be provided by the Tenderer.

4 PROGRAMME OF WORKS

- A. Within four (4) days after the Commencement Date, the Contractor shall meet with the Contract Administrator to review the programming requirements of the Project. This review will include the specific requirements of the Contractor regarding restraints and milestones, including the interrelation with other contractors, as they relate to the Programme. Subsequently, within twenty-eight (28) days after the Commencement Date, the Contractor shall submit the Preliminary Programme, Cost Loaded Construction Programme, complete in all respects, to the Contract Administrator for review and approval.

- B. The outer cover of the Programme shall be titled with the following information:
1. The Name of the Project.
 2. The Package number and title.
 3. The Title “Programme” - “Rev.” [rev. no.] - “Data Date”” Date of Submission”
 4. The Name of the Employer.
 5. The Name of the Contract Administrator.
 6. The Name of the Contractor.
- C. The first page of the document shall be the contents page. The Programme shall comprise the following:

Section 1 Programme.

Section 2 Schedule of Values and Cost Loaded Construction Programme

Section 3 Manpower Loaded Programme.

Section 4 Schedule of construction Equipment & Vehicles.

Section 5 Critical Path Report and Sub-Critical Activity Report (activities with less than 3 weeks’ float).

Section 6 Execution of Method Statement.

Section 7 Support Data.

Section 8 Others if any requested by the Contract Administrator / Employer.

D. Programme

The sequence for execution of the Works (hereinafter called the “Programme”) shall be in a logic linked time-scaled bar chart format with the Work Breakdown Structure (detailed work activities in each major location of the project), to show the sequence and interdependence of activities required for complete performance of all items of work under the Contract or portion thereof. Further, this Programme shall reflect the Milestone Dates required by the Contract. The Contractor shall use a “Critical Path Method” (hereinafter referred to as CPM) technique in preparing his Programme. The software to be used by the Contractor for the CPM shall be the latest version of Primavera Project Planner (P6) unless otherwise agreed with the contract administrator. The Contractor may be required to provide a CPM network diagram and/or an analysis of the predecessor/successor relationships to explain and support the programme bar chart if requested by the Contract Administrator. The Contractor shall detail all activities within his scope of Works by identifying the durations of each of them and relationships between them. These activities shall be included within the milestone activities provided in the

tender documents and information. The Programme shall be developed as a coordinated programme with the programmes of other Contractors at Site where applicable. The Programme when accepted/approved shall be used as a baseline programme against which the Contractor shall work monitor and report his progress. In preparing the Programme, the Contractor shall ensure that the programme submitted shall serve as an effective means for controlling, monitoring and reporting the progress:

1. Exercise care to produce a clear, legible, and accurate diagram. Activities related to specific areas of the Project shall be grouped on the diagram for ease, understanding, and simplification. The diagram shall show the following for each activity, where applicable:
 - a. The programme shall be in bar chart format and shall show the following for each activity
 - b. Column for activity ID, Activity description, duration, early start and finish dates, late start and finish dates, total float, free float, weightage and in the case of progress reporting, percentage completion. All activity bars shall be shown using early dates.
 - c. All activities are logically linked and shall not be open ended. When the use of constraint is necessary, constraint type 'start on ', 'finish on', 'start on or after', and 'finish on or after' shall be used
 - d. Use a 6-day workweek calendar with public holidays.
 - e. Activity durations of greater than 1 week will typically not be allowed.
2. Include any trade or material restraints to indicate the movement of trades who are performing major work.
3. Show activities with open ends as not critical.
4. Consider the physical and technical inter-dependence between the activities, which may either be a part of the Contract scope or be the scope of other contracts.
5. Indicate the time when information is required for activities to commence or progress as planned.
6. Note that the submissions may not be approved at the first submission and therefore prepare the programme with suitable contingency.

7. Allow for sufficient contingency to mitigate the delays which may arise due to problems associated with shipment, clearance etc.
8. The Programme developed above shall not be changed throughout the duration of the Project without getting prior approval from the Contract Administrator.
9. Soft copies shall be provided in Primavera (P6) (or otherwise as agreed with Contract Administrator) and in PDF format and submitted via Document Management. The Contractor will provide 2 hard copies in a size and font approved by the Contract Administrator.
10. Depending on the specific contract, the Contractor may also need to develop a graphic representation of the project schedule utilizing 4D software and the 3D model developed for the 3D Clash Detection coordination, see Section SUBMITTAL PROCEDURES, or an independent model developed directly for the 4D schedule. This schedule shall be submitted and/or presented to the Employer and Contract Administrator within four (4) months after the Commencement Date. This schedule shall be maintained and modified by the Contractor throughout the duration of Project.

E. Schedule of Value & Cost Loaded Programme

Anticipated financial values of work (hereinafter referred to as Planned Cost) shall be assigned to all activities of the Programme in line with the schedule of rates (unless otherwise agreed with the Contract Administrator) on the basis of which an overall cost loading will be obtained.

Depending on the length of the contract, the Contractor may be required to submit a three-months look ahead programme within fourteen (14) days from Contract award. The bar chart programme shall be prepared to the level of details as per clause 1a, b & c for activities planned for the next three (3) months upon contract award.

The Contractor shall submit to the Contract Administrator for his approval a Cost Loaded Construction Programme with a fully detailed schedule of values report and all necessary supporting details of all activities in the cost loaded construction schedule based upon the priced schedule of rates and the Total Sum equal to the Contract Price.

The Cost Loaded Construction Programme shall be updated on a monthly basis, and shall be updated with actual value of work (hereinafter referred to as Actual Cost) as the

work proceeds. The programme shall be represented in graphical and tabular formats. In preparing the Cost Loaded Construction Programme, the Contractor shall:

- No single activity shall have a cost allocation too great in proportion to the overall activity quantities and approved by the Contract Administrator.
- Note that the amounts or values entered against the activities are as accurate as possible and the total amount tallies with the Contract Price.
- Present the programmes in graphical format with monthly Planned Cost histogram plotted on Y1-axis and cumulative to month values on Y2-axis (S-curve) with period on X-axis. The summary and break-down of cost against each month to be tabulated.
- Soft copy shall be provided in P6 and PDF File Format (unless otherwise agreed with the contract administrator).

F. Manpower Loaded Programme

The Programme shall be loaded with the manpower (in number of men) on a weekly basis, as proposed to be utilised (hereinafter referred to as Planned Manpower). The Manpower Loaded Programme shall be updated with actual expended manpower (hereinafter referred to as Actual Manpower) as the work proceeds. The Contractor shall provide an analysis of the manpower usage and productivity to explain and support the Manpower Loaded Programme. In preparing the Manpower Loaded Programme, the Contractor shall:

1. Note that Manpower shall be classified as Management Personnel (project manager, engineers, foremen, etc.) and workmen. The workmen shall be further broken down as direct workmen (skilled & unskilled labour) and indirect workmen (general drivers, watchmen, etc.).
2. Present the Manpower Loaded Programme in graphical format with weekly Planned Manpower plotted on Y1-axis (Histogram) and cumulative till end of week values on Y2-axis (S-Curve), with period on X-axis. The summary and breakdown of Manpower by discipline against each week shall be tabulated.

G. Schedule of Construction Equipment & Vehicles

The Contractor shall provide a schedule of all his construction equipment and vehicles he proposes to utilise for the execution of Project. This schedule shall list all major and

minor construction equipment indicating as a minimum, the make, model and capacity of each of them, a monthly distribution of the number of each anticipated to be used at Site till the end of the Project. This Schedule of Construction Equipment & Vehicles shall be presented in a tabular format and shall be updated with actual data as the work proceeds and include Off Site, Pre-fabrication, storage, workshops and logistics.

H. Critical Indicators

The major or critical items in the scope of the Contract shall be identified and presented in tabular and graphical formats, which can give progress details of each of these indicators over time. The Programme, Submittal Schedule and Procurement Schedule will be the basis for these. Depending on the scope of the Contract these will indicate the likes of:

- Submittal and Approval - Planned number of drawings per week (on Y1 axis) and Cumulative number of drawings (on Y2 axis) against time in weeks (on X axis).
- Submittal and Approval - Planned number of materials per week (on Y1 axis) and Cumulative number of materials (on Y2 axis) against time in weeks (on X-axis).
- Place Orders - Planned number per week (on Y1 axis) and Cumulative number (on Y2 axis) against time in weeks (on X-axis) for each of the major materials.
- Fabrication complete (where applicable) - Planned quantity of materials per week (on Y1 axis) and Cumulative quantity (on Y2 axis) against time in weeks (on X-axis).
- Delivered to Site - Planned quantity per week (on Y1 axis) and Cumulative quantity (on Y2 axis) against time in weeks (on X-axis) for each of the major materials.
- Installation complete - Planned quantity of items per week (on Y1 axis) and Cumulative quantity (on Y2 axis) against time in weeks (on X-axis) for major work activities
- Include any trade or material restraints to indicate the movement of trades who are performing major Works.
- Soft copy is required in P6 and PDF format (or in a format agreed with the contract administrator).

I. Support Data

The Contractor shall submit the following supporting data as a part of his Programme and any successive updates and revisions in an approved format as requested by the Contract Administrator:

1. The proposed number of working days per week.
2. National & Religious Holidays, (by date).
3. The planned number of shifts per day.
4. The number of hours per shift.
5. The average weekly manpower usage to be employed for the Works considering the activities, durations and production rates.
6. The planned procurement and delivery of materials on a monthly basis.
7. Any other relevant details as considered appropriate by the Consultant or Contract Administrator.

J. Execution Method Statement

The Contractor shall provide his Programme, in accordance with Section EXECUTION METHOD STATEMENTS, and detailed descriptive narration of the methods he proposes for execution of the Works. This shall be exhaustive and cover all major components of execution, all to the approval of the Contract Administrator and / or Employer, to clearly demonstrate the Contractors capabilities and expertise in executing the Works. The Contractor shall be required to provide details of methods specifically requested by the Contract Administrator.

- K. The Programme, when approved shall be the basis for proceeding with the Works at Site and the progress shall be monitored against this Programme.
- L. Failure to include any element of the Works required for the performance of the Contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase or the whole of the Project, notwithstanding the Employer's approval of the Programme.

5 SHORT-TERM & COORDINATION PROGRAMMES

- A. Dependent on the length of the contract, the Contractor may be required to submit for the Contract Administrator's approval, a detailed programme developed from the current approved Programme, covering a period of the next thirty (30) days and denoting the Contractor's daily work activities in relation to those of other Contractors. This may be required at monthly intervals.

- B. Every week, the Contractor shall submit to the Contract Administrator, a detailed programme of the current activities, covering the next four (4) weeks, as required by the Contract Administrator.
- C. The Contractor shall prepare programmes, as required by the Contract Administrator, from time to time, for the purposes of coordination between other stakeholders.
- D. These programmes may need to be plotted on to A0 or A1 or A2 or A3 size sheets with details, restraints, dates, etc. marked-up for clear understanding of all concerned. The Contractor shall also provide the Contract Administrator with the DVD(s)/ Storage devices containing the relevant files.

6 ADJUSTMENT AND REVISIONS

- A. Within Three (3) days after the receipt of notice (or as otherwise stipulated in the contract) from the Contract Administrator, the Contractor shall submit a revised Programme for any of the following reasons:
 - 1. When delays in submittals or deliveries or work stoppage are encountered, which make re-planning or reprogramming of the Works necessary.
 - 2. When the programme does not represent the actual execution and progress of the Works as being performed in the field.
- B. The revised Programme shall be a “catch-up programme”, to get the Works back to the original schedule. The Contractor shall ensure that such revised Programme indicates and conforms to the completion date or phase completion dates as per the approved Programme. The progress of Works shall be monitored against the revised Programme only after the revised “catch-up programme” is approved.
- C. Acceptance of the revised Programme and all supporting data is contingent upon compliance with all other articles of this Clause, Conditions of Contract and any other previous agreements or requirements made with or by the Employer or the Contract Administrator.
- D. The Time for Completion will be adjusted only in accordance with the provisions of the Conditions of Contract. In the event the Contractor requests an adjustment of the Time for Completion, he shall furnish such justification and supporting data as the Contract

Administrator may deem necessary for evaluation by the Employer as to whether or not the Contractor will be entitled to an extension of the Time for Completion. Submission of proof based on revised activity, logic, duration, and costs is obligatory with any request.

- E. The Contractor shall submit with every request, his revised Programme whenever the actual field progress of the work does not conform to the latest approved Programme in force at the time of the alleged delay.
- F. The Contract Administrator shall, after receipt of a request for extension of time (properly submitted in accordance with the Contract procedures), and, once confirmed to be fully compliant, after due consultation with the Employer, advise the Contractor of the determination, in accordance with the Conditions of Contract. For any requests for extension of time, the Contractor shall submit as a minimum the following items; critical path analysis, cause and effect analysis, revised manpower and preliminaries.
- G. Any revision in the Programme, if and when approved, shall be followed by a submittal of all associated Manpower Loaded Programme, etc. revised to correspond to the revision to the programme including explanation of all changes in logic, in duration's, manpower, and equipment. These revisions shall be shown against the original data contained in the Programme. The complete set of documents thus revised, shall be the revised Programme.
- H. The revised Programme shall be submitted if and when required by the Contract Administrator and/or Employer. The revised Programme shall be marked-up to show all of the revisions and changes to the original approved programme.

7 PROJECT TEAM ORGANIZATION CHART

- A. The Contractor shall submit the organisation chart of the project team. The line of reporting and responsibilities of all the key personnel and how they are to be supported must be clearly identified in the organisation chart. The Contractor shall submit resource planning throughout the whole contract period. The resource planning which shall include and not limited to resource histogram for each discipline and the overall manpower allocated for each work stage.

160.08 PROGRESS MONITORING AND REPORTING

1 PROGRESS MONITORING AND REPORTING

The Contractor shall update his current approved Programme with actual executed information and submit in the form of weekly & monthly reports which shall be verified and approved by the Contractor Project Manager prior to submission. This section describes the requirements, the form and content of such reports.

2 DAILY REPORT

The Contractor shall submit this report on a daily basis to be received by the Contract Administrator by 9AM the following day. The report shall describe the Contractors' work on Site, planned and actual progress of work activity, the labour force and its allocation, delivery of material type and quantity, construction equipment and work carried out during the day, status of weather morning, noon, evening and night and indication of any incidents. The format and the number of copies of this report shall be agreed with the Contract Administrator prior to use. Daily Contractor Report shall include Safety, Environmental & QA / QC Reports. Reports are not a valid vehicle for notification of and/or potential claims or delays. Any reports notifying any such claims and delays will be rejected and must be resubmitted strictly in accordance with the GCC.

3 WEEKLY REPORT

The Contractor shall prepare a weekly report in between issuance of the 2 weekly reports. A weekly report shall also be submitted via email by 5pm on the Friday of each week during the contract period. The cut-off date or data date for this report shall be the previous day. These reports shall consist as a minimum of the information below;

- Summary of Progress status
- Safety and Environmental Statistics
- Man-hours
- QA/QC Statistics

4 2 WEEKLY REPORT

The Contractor shall prepare 2 weekly reports and submit to the Contract Administrator by 9AM on Monday for the previous 2 weeks. The cut-off date or data date for this report shall be the Sunday of the previous week. The 2 weekly reports shall consist of, as a minimum, updates of actual progress information, actual utilisation of manpower and equipment,

updated material delivery schedule and status of submissions. The format for the 2 Weekly Report shall be as described in the following Sub-clauses.

The outer cover of the report shall be titled with the following information:

- The Name of the Project.
- The Package number and title
- The title: “2 Weekly Report No. (Subject week’s Monday) to (subject week’s Sunday)” and a report number in consecutive sequencing.
- The Name of the Employer
- The Name of the Contract Administrator
- The Name of the Contractor

The first page of the report shall be the contents page. This page shall have the following sections listed, whether or not any information is present under each section. If no information is presented under any section, then this shall be clearly stated under that section.

PART 1 – 2 Weekly Progress Report

- a) Executive summary on Project status
- b) Critical Issues and Action Plans (Environment, Construction, Design, Health and Safety, Public Relations)
- c) Summary of Progress status
- d) Design Issues, RFI Log update and Submittal Log update, Bulletin Log update
- e) Employer's works instruction - EWI Log update, NPC & VO Log update.
- f) Procurement status including all the material delivery status
- g) Master schedule update - Look ahead schedule, Updated Critical Indicators, Recovery / catch up schedule, Schedule showing Planned Vs Actual, Spread sheet / Graphical report.
- h) Sustainability update & Action Plan
- i) Progress Photos with clear title and key plan showing location / view of work progress. (Including providing photos in Power point slides with high resolution photos as directed by the Contract Administrator).

PART 2 – Safety Report

- a) Detailed Weekly Safety Report
- b) Safety Inspection checklist
- c) Safety Induction Log and schedule

- d) Safety Violation Log and action plan.
- e) Plant & Machinery Test Certificates and inspection reports.
- f) Safety Photos including House Keeping
- g) Visitors Record

PART 3 – Environmental Report.

- a) Average number of persons on site weekly.
- b) Number (if any) of Environment lost time incidents
- c) Number of Environmental accidents/incidents since last report.
- d) Environmental orientation statistics
- e) Environmental bulletins issued
- f) Environmental issues raised, closed out or pending for closure.
- g) Number of Environmental Inspections carried out
- h) Waste management weekly report.
- i) Lessons learnt (Good practice/bad practice)

PART 4 – QA / QC Report

- a) QA / QC Report including summary of QA / QC issues and Action Plan
- b) NCR – Non Conformance Report Log update & Action Plan
- c) WIR – Work Inspection Log Update and schedule for the week.
- d) Test Certificate / Reports Log including Test certificates / Report of work / material tested for the reporting week
- e) Laboratory Facility and Equipment Calibration Reports.

PART 5 – Traffic Management Report (TMP)

- a) TMP Inspection checklist
- b) Detailed Monthly report
- c) Number of incident/accident since last report
- d) Number of traffic personnel on site weekly
- e) Traffic Issues raised by internal and external parties, closed out or pending for closure
- f) Status of TMP – revision, submission and approval status.
- g) Submittal Status Report

This report shall include details of submittals such as transmittal number, date submitted, description and reference number of the submittal, date returned by the Consultant and / or

Contract Administrator, approval code, planned submission dates, approval required by date, etc. (which should be generated from the authorised Document Management system if applicable).

5 Procurement Status Report

This report shall indicate information regarding all materials for the Works such as description, quantity, name of supplier, expected and required delivery time, approval status, shipment status, etc.

- a) Status of Information Requests
- b) An updated list of RFI's (Requests for Information)
- c) Notice of Potential Change, Employer's Work Instructions and Variation Orders (Contractor Claims),
- d) Submit an updated report of NPC's, EWI's and VO's
- e) Updated Critical Indicators
- f) The Critical Indicators identified and included in the Programme shall be updated with actual information and presented in tabular and/or graphical, bar format. Updated progress of Works shall also be presented in "Excel" format identifying the activities, description, planned start / finish dates, target start / finish dates and clearly indicate the activities in delay.
- g) Safety Inspection Checklist
- h) This report shall include all information regarding the review of all men, materials, and equipment and job Site conditions from the safety point of view and shall be reported in the standard format of the Contract Administrator.
- i) Summary and Detailed status of progress
- j) The Summary status of progress shall include a narrative describing the actual reported status with reference to causes and measures taken to mitigate delays.
- k) The detailed status of progress shall include tabular report with actual status of items from look-ahead schedule compared to the planned progress as of weekly cut-off date.

6 SITE RECORDS

The Contractor shall maintain accurate records, in tabular form, of the actual start and finish dates of all activities and events under his Scope of Works. The records of any intermediate hand over and/or take over to and from other Contractors also shall be logged and maintained by the Contractor.

The Contractor shall maintain diagrammatic records by way of site sketches, marked-up drawings, and notations to represent various stages of work progress including dates as applicable.

Photographic records, taken by a high resolution digital camera and printed on purpose made photo quality paper, apart from those to be submitted as a part of the Monthly Report, shall be kept by the Contractor for reference.

The Contractor may be requested to provide and maintain time lapsed Cameras overlooking the project with location decided by the Contract Administrator.

7 WEATHER RECORDS

The Contractor shall have a Site weather station of approved quality and accuracy installed to record weather details.

The Contractor shall measure and keep an accurate record of daily weather parameters including Daily (24hrs) maximum and minimum air temperatures, shade temperatures, rainfall and humidity (including overnight) and shall provide maximum and minimum thermometers at locations relevant to the nature and stage of the work as approved by the Contract Administrator.

These records shall be available for inspection by the Contract Administrator, and the Employer.

Photographs are to be provided to the Contract Administrator and the Employer after significant rainfall and/or severe weather conditions (in the opinion of the Contractor or as otherwise directed by the Contract Administrator) within 48 hours after the event.

160.09 PROGRESS PHOTOGRAPHS AND VIDEO

1 PROGRESS PHOTOGRAPHS

The Contractor shall be responsible for taking high resolution digital photographs of the

Project and progress of works at Site using high resolution (minimum 12.1 mega pixels or more as approved by the Contract Administrator) digital cameras. The printed resolution of digital photographs shall not be less than 300 dpi that will enable high-quality printing on professional papers. The Contractor shall submit soft copies of these images in a compressed image format (jpeg) in DVD / Storage Device and the photos shall be arranged in Power point presentation slide with Title and explanation of the progress as required by the Contract Administrator, The Contractor shall also upload to the Project's document management system if one is being utilised.

Upon award of Contract, and prior to commencement of work at Site, the Contractor shall take sufficient number of high resolution digital photographs of site the and neighbouring area and buildings for record, and shall arrange the photos with necessary title and submit in pdf as well as in jpeg format to the Contract Administrator (uploading the document in Document Management System if one is being utilised).

The Contractor shall take colour high resolution digital photos of his Works, at the end of each week, or as directed by the Contract Administrator, covering as much as possible, the work executed during the month. These photos shall include not only the works at Site, but also those carried out at off-site fabrication yards, factories, models, etc. These photos shall also be included in the Bi-Weekly and Monthly Reports and shall be minimum 2 photos on 1 no. A4 page. The margin shall contain details of the Project, Contract Reference, Date of photographic record, point of view, etc. The Contractor shall submit soft copies of these images in a compressed image format (jpeg). The Contractor shall upload to the Project's document management system if one is being utilised.

The Contractor is required to take photos from the same/similar angle/ fixed points of view each week/month to record/document an overall progress of works. As the works progress, the number of views shall be increased to show progress of all the works.

The Contractor shall also submit progress photographs of Plant / Equipment / Materials being manufactured in The Republic of Fiji and overseas as a part of the Bi-Monthly report.

Upon request of the Contract Administrator and/or Employer, the Contractor shall provide soft and hard copies of High Quality digital images, the number, copies, and views of which shall be as required by the Contract Administrator and/or Employer, for their presentation and/or publication purposes.

When the Works are completed, and as directed by the Contract Administrator, the

Contractor shall take High Quality digital photographs as directed by the Contract Administrator.

The high quality digital photographs shall become the property of the Employer and shall not be reproduced or published or used anywhere by the Contractor without the consent of the Employer

The Contractor shall be responsible for all costs related to the provision of the above-mentioned high quality digital photographs and digital images.

160.10 SUBMITTAL PROCEDURES

1 GENERAL

This section addresses only the general requirements for submittals. Specific submittal requirements shall be as per the particular Specifications and other Sections in this document.

The review and approval of the Contractor's submittals, shop drawings & other requirements will be undertaken by the Contract Administrator. The Contract Administrator may delegate authority to other Consultants to liaise directly with the Contractor to review submittals.

All communications as identified below in item 2 Summary shall be issued in writing or via the Project Information Management System if used. Responses issued by the Contract Administrator, or the Employer shall likewise be issued in writing or via the authorised Document Management system if used. The Contractor shall submit Colour PDF copies in addition to the file in parent software where required by the Contract Administrator.

2 SUMMARY

In general, the submittals to be made by the Contractor shall be inclusive of and not limited to the following:

- a) Topographical and cadastral survey drawings
- b) Product Data
- c) Design Data
- d) Catalogues
- e) Calculations

- f) Construction drawings
- g) Samples and Mock-ups
- h) Certificates
- i) Test Reports (including geotechnical investigation reports)
- j) Manufacturer's Instructions
- k) Manufacturer's field reports
- l) Submittals for Temporary work
- m) Other Items as identified under Technical Specifications

Temporary Services drawings.

Programmes and Schedules (refer to this document).

Progress Monitoring and Reporting (refer to this document).

Progress Photographs and Videos (refer to this document).

Execution Method Statements (refer to this document).

3 PROJECT DRAWINGS

The drawings issued with the Tender and/or subsequently included in the contract are issued solely to show the basic principles on which Tenders are to be prepared. The drawings are not to be taken as coordination, shop, or working drawings which the Contractor is required to prepare and submit for the review and approval of the Contract Administrator.

Coordination, shop, or working drawings and design drawings are to be prepared and submitted by the Contractor in accordance with the Contract Documents. The drawings included in the Tender and/or subsequently included in the contract are for Contractor's guidance. The Contract Administrator may issue updated drawings or other coordination drawings if they become available during the course of the Project.

The Employer shall entertain no request for Contract Sum adjustment if the modifications do not materially change the original design intent.

Dimensions shall not be scaled from Drawings. The Contractor shall confirm from the Contract Administrator any dimensions required but not given in figures on the Drawings nor calculable from figures on the Drawings. Where the design is the responsibility of the Contractor, it shall obtain such information itself.

The Contractor shall note that it is the Contractor's responsibility to ensure the preparation of shop drawings and the like is complete with all relevant information and details prior to submission as detailed shop drawing or working drawing for the review of the Contract Administrator. The Contractor shall schedule the submittal of shop drawings in a timely manner to achieve the requirements of the Milestone Dates, Sectional Completion Dates and the Time for Completion.

The Contractor shall prepare shop drawings for all the areas with necessary sections, details, co-ordinates, levels, identification numbers, etc. for approval by the Contract Administrator. The Contractor may be required to provide additional shop drawings in 1:50, 1:25 scales as required for detailed coordination.

If requested by the Contract Administrator, the Contractor shall be responsible for the preparation of detailed bar bending schedules, to be tabulated alongside layout plans, and working drawings to detail the reinforcement as designed. The Contractor shall submit detailed equipment and materials schedules.

4 GENERAL

Contractor's Checking of Submittals: The Contractor shall thoroughly check all submittals for completeness and for compliance with the Contract Documents before submitting them for review of the Contract Administrator, and to mark them with the Contractor's stamp certifying that they have so been reviewed. Any submittal without such stamp shall be returned to the Contractor without review.

Design / Shop Drawing Coordination: In checking design and shop drawings, the Contractor is responsible to verify the dimensions and field conditions and check and coordinate the drawings of each section with the requirements of any other parties whose Work is related thereto, as required for proper and complete installation of the Work.

Identification of Submittals: The Contractor shall mark, tag, or otherwise properly label each submittal item with the name of the Contractor, name of the project, the date, and a reference to the applicable specification section number for identification of each item. Accompany each submittal with a letter of transmittal containing similar information, together with the purpose for which the submittal is being made. Each submittal item, or the label affixed thereon, shall have a clear space suitable to receive the electronically applied stamps of the Contractor and the Contract Administrator.

Numbering of Drawings: Consecutively number the shop drawings for each portion of the

Work, and retain the numbering system throughout all revisions. The Contractor shall use the numbering system as specified by the Contractor Administrator which is suitable for Document Management system.

Labelling of Samples: Identify each sample item with the source and the product name or number, in addition to the other information required on the tag or label.

Completeness of Submittals: The Contractor shall make complete submittals for each separate and definable section or sub section of the Work, and include in each submittal all the items necessary to completely define construction. Such items shall consist of the shop drawings, product data, supplementary product literature, samples, calculations, statement of manufacturer's review, or other information as required by the technical specification sections. Unless otherwise acceptable to Contract Administrator, combine the submittal items required for each section or subsection and furnish together at one time in a single submission as specified by the Contractor Administrator which is suitable for Document Management System.

Submittals to be Returned Un-reviewed: A submittal which, in the Contract Administrator's opinion, is incomplete or deviates significantly from the requirements of the Contract Documents, or contains numerous errors, or has not been checked or only checked superficially, will be returned without being reviewed by the Contract Administrator and the Contractor shall make a new submittal. A submittal which is not required by the Contract Documents will be returned without review.

5 SHOP DRAWINGS

Shop Drawings: The term "Shop Drawings" includes graphic representations which document the required component in the Work for construction purposes. Such drawings and other illustrations, including fabrication and layout drawings, diagrams, and related schedules, shall establish complete details and position, including in relation to adjoining work, amplify design details, and incorporate minor changes of design or construction to suit actual conditions. The Contractor shall lead all co-ordination with all the sub-contractors and the Employer's other contractors.

The Contractor shall be responsible for the preparation and timely provision of shop drawings which shall indicate proposed materials and methods of construction, fabrication, erection, layout and setting out, diagrams on various systems, equipment control, and other descriptive data, catalogues and brochures required to show that materials, equipment and system and position thereof shall conform to the Drawings and Specification. Shop drawings shall establish actual detail of all assembled, manufactured or fabricated items, coordinate

and indicate proper relation to adjoining work, amplify design details of mechanical and electrical equipment in proper relation to physical spaces within the structure and incorporate minor changes of design or construction to suit actual conditions. Shop drawings review by Contract Administrator is for general conformance only. The Contractor shall be solely responsible for interpretation and execution of such shop drawing documents.

The Contractor shall submit Design Drawings, Shop Drawings, Coordination Drawings, Catalogues, Brochures and Technical Data at his own cost and in such sequence so as to cause no delay in the Works or in the work of other contractors, sub-contractors or Employer's other Contractors or others. No extensions of time will be granted because of the Contractor's failure to have Design Drawings, Shop Drawings, Coordination Drawings, Catalogues, Brochures and Technical Data submitted in ample time to allow for processing and review. The Contractor's sub-contractors shall submit Shop Drawings, Coordination Drawings, Catalogues, Brochures, and Technical Data through the Contractor.

Shop drawings shall be taken to mean the same as detail drawings, fabrication drawings, working drawings, erection drawings, assembly drawings, or any drawing required to supplement the design drawings and/or the Contractor's coordination drawings.

The Contractor shall submit shop drawings following the distribution of the signed coordination drawings.

Any independent specialist required to sign-off shop drawings (and any other submittals) prior to submission must be approved by the Contract Administrator prior to submission of submittal. The Contractor is fully responsible to ensure that any submittals which require independent specialist sign-off are obtained. If any submittals are deemed to be required to be signed-off by an independent specialist where indicated by the Contract Administrator, the Contractor shall carry out this request at the Contractors cost.

All shop drawings shall bear the following certification (and stamped by a licensed professional engineer (PE) where directed by the Contract Administrator):

This drawing has been checked for completeness, accuracy, coordination, and compliance with the Contract Documents. All dimensions and field conditions have been verified.

Contractors' Representative	Date	Initials
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Shop drawings should include a title box that indicates the Project Name, Project Location, revision number and date, drafter's signature, checker's signature, and drawing description, signed off for co-ordination by any other required parties all as per format established by the

Contract Administrator.

The Contractor shall be responsible for the provision of all catalogues, Brochures and Technical data or any other descriptive data required by the Specifications or the Contract Administrator.

The shop drawings shall be submitted progressively and in advance for all of the works.

Unless otherwise noted, the Contractor shall submit all shop drawings and submittals in electronic format, i.e. in AutoCAD, Rivet, .ifc and .pdf via the Projects document management system as well as in One (1) hard copy of shop drawings in A1 size and distributed to the Contract Administrator for review and approval.

The Design Consultant's or Contract Administrators review, stamp (electronic) will be returned to the Contractor via the Document Management system or equivalent. Upon receiving approvals, the Contractor shall submit Two (2) Hard copies within 3 days, to the Contract Administrator office.

A consistent and logical numbering system has been used for design drawings and must be used for Contractor drawings and site drawings as directed by the Contract Administrator /Design Consultant.

The Contractor shall be responsible for producing, updating and issuing a drawing index within the bi-monthly report to the Contract Administrator in soft and hard copies in the approved format.

The Contractor shall be responsible for and shall pay for the preparation of all drawings necessary to provide those amplifications of drawings needed for completion of the construction, for those parts of the Works for which it has design responsibility.

6 PRODUCT DATA (CATALOGUES, BROCHURES, TECHNICAL DATA, ETC.)

Product Data: The term "Product Data" includes technical data which document the primary performance for each system and material component in the Work. Primary product data shall consist of a Material List, together with manufacturers' literature if any, which is necessary to clearly identify the primary function, quality and performance of the products. Product data shall be custom prepared for the project and made specific for the Work. Manufacturers' literature which does not document the primary performance characteristics shall be deemed to be supplementary data and "for information only".

Material List: With each submittal, furnish a Material List which stipulates the primary

performance characteristics of the materials as required by the Contract Documents. Arrange the Material List in a vertical schedule format. Specifically identify materials by manufacturer's name, product name or model number, reference to applicable section of the technical Specifications and any related shop drawings, specific location(s) of use in the Work, and the primary performance characteristics.

The Contractor shall be responsible for the provision of all product data such as catalogues, brochures, and technical data or any other descriptive data required by the specification or the Contract Administrator.

Unless otherwise noted, the Contractor shall submit all product data in electronic format, i.e. in pdf. via the Project Information Management System distributed to the respective Contract Administrator for review and approval.

Unless otherwise stipulated in the contract, Contract Administrator's review and approval shall be issued within fourteen (14) days. to the Contractor via the Document Management system.

7 CALCULATIONS

The Contractor shall be responsible for any design or design calculations which may be specified, or required by the Contract Administrator, in order to establish or demonstrate that his submittal conforms to the requirements of the Contract for quality, performance or in any other aspect. Any design or engineering consultant employed by the Contractor shall possess suitable professional qualifications. and be registered with the Board of Engineers, The Republic of Fiji (or international equivalent to be agreed with the contract administrator) and have five (5) year local experience Proof of such credentials shall be submitted for the Contract Administrator's review.

The Contractor shall provide for the design, engineering and calculations for temporary and permanent supports, miscellaneous bracing, scaffolding, props, temporary construction, leave-outs in structure, supports for construction equipment and machinery, including removal after permanent installation of the equipment if necessary.

The Contractor shall provide design and engineering for those works specified under performance-based specifications complying with stated requirements and as per established practices in the industry.

The Contractor shall provide for any design and engineering work associated with the builders' work and coordination with the Employer's other contractors.

Submittals for Temporary Work: When specifically required by governing code or local

authority, certain information relative to temporary construction systems, such as structural loading diagrams including specific points of load application, shall be submitted by the Contractor for the Contract Administrator's review. Each such submittal shall be prepared and sealed by the Contractor's qualified professional/structural Professional Engineer registered with the Board of Engineers, The Republic of Fiji (or international equivalent agreed with the contract administrator). The Design Consultant's review will be limited solely to the effects of the temporary construction systems upon any permanent building component. The design, installation, use, and maintenance of such temporary construction systems are solely the responsibility of the Contractor.

8 SAMPLES AND MOCK-UPS

Samples: The term "Samples" includes various natural materials, fabricated items, equipment, devices, appliances or components thereof, as may be required to verify visual appearance of such items for compliance with the Contract Documents.

Samples and/or Mock-ups of all materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the Employer or the Contract Administrator and are to be furnished by the Contractor without delay. The samples, when approved will be kept by the Contractor in a lockable stored area as agreed by the Contract Administrator. The Contract Administrator will reject all materials or workmanship not corresponding in quality and character with the approved samples. Suitably labelled boxes for the storage of samples shall be provided by the Contractor without additional charge.

Samples of materials shall be furnished in manufacturer's standard containers bearing manufacturer's descriptive labels and printed application instructions. Samples not submitted in manufacturer's standard containers shall be furnished with manufacturer's descriptive labels and application instructions.

Samples shall be properly identified with Contractor's tag or sticker, as directed by the Contract Administrator and submitted with approved transmittal form.

Samples for testing shall be taken at the place of origin, mixing plants or working site from the Works, as appropriate, and as required by the Contract Administrator. After inspection/approval the sample shall be marked for identification as shall be required by the Contract Administrator.

The transportation of samples to the various lead international consultants such as to the

USA, Australia, Europe or Asia/Oceania will be at the Contractor's cost.

Samples shall be submitted in three (3) sets. The Contractor shall be required to furnish additional samples at his own expense at the request of the Contract Administrator.

The Contractor shall make full provisions to store all samples and mock-ups within the Contractors area. All stored samples and mock-ups shall be stored within a locked area with access only available to the Contract Administrator.

Mock-ups: The term "Mock-ups" includes various assemblies of fabricated items, equipment, devices, appliances or components thereof, as may be required to verify visual appearance and operational functioning of such items for compliance with the Contract Documents and in accordance with the Contract Administrators requirements.

Mock-ups may be installed at the place of permanent works subject to the approval of the Contract Administrator. Any mock-ups which are rejected and/or require additional works shall be at the risk of the Contractor. Any time or cost impact for rejected mock-ups and/or amendments and alterations as directed by the Contract Administrator shall be borne by the Contractor.

Mock-ups shall be furnished with descriptive labels and shall be properly identified with Contractor's tag or sticker, as directed by the Contract Administrator and submitted with approved transmittal form.

The transportation of mock-ups to the project site as well as the transportation, where physically practical, to the various international consultants in the within Asia/Oceania or beyond Asia will be at the Contractor's cost.

Mock-ups shall be submitted in accordance with the project requirements.

The Contractor shall prepare Mock-ups for temporary works such as safety handrails, perimeter protection, openings protection.

Samples and Mock-ups shall conform to the requirements of the particular specification section as well as those in section QUALITY ASSURANCE AND QUALITY CONTROL.

9 OTHER SUBMITTALS

Supplementary Product Literature: Supplementary technical literature shall be used to document the characteristics of various products. Such literature may include manufacturer's catalogue information, product specifications, standard illustrations, diagrams, and standard details. The supplementary product literature shall describe physical characteristics such as size, weight, finish, material analysis, electrical requirements, and also furnish other information such as load tables, test results, and industry quality standards.

Certifications: Certified reports, prepared by the Contractor, verifying either a) the Contractor's review of certain existing conditions and/or existing information prior to commencing with the next phase of construction work, or b) the chemical and physical properties of various building materials, as noted. Materials reports shall state compliance of each item with respect to the technical requirements of the Contract Documents.

Preconstruction Testing Reports: Technical reports, prepared by the Contractor, which record the results of the Contractor's testing of certain products or materials, as required by the Contract Documents, prior to the installation of such systems and products. The report shall state compliance with the technical requirements of the Contract Documents.

Quality Control Testing and Inspection Reports: Technical reports which have been made in summary of quality control tests and inspections as performed by the Contractor's agencies for the production of various materials and other items as required by the Contract Documents. Such reports shall clearly state conformance or non-conformance with the technical requirements of the Contract Documents, for each respective item that has been tested and inspected.

Warranties/Guaranties: Specific warranties and guaranties for system and materials components verifying the technical performance, as required by the Contract Documents, for the time durations noted and as described in Section CONTRACT CLOSEOUT RECORD DOCUMENTS.

Record Documents: Documents prepared by the Contractor recording the as-built conditions of the systems and/or materials, and specifically defining the variations from requirements of the Contract Documents, as described in Section CONTRACT CLOSEOUT RECORD DOCUMENTS.

Operation & Maintenance Manuals: Manuals prepared by the Contractor, as described in Section CONTRACT CLOSEOUT RECORD DOCUMENTS and to be used by the Employer, for the Employer's maintenance and operations of various components.

Commissioning Reports: Technical testing and commissioning reports, prepared by the Contractor or approved independent testing agency, verifying that each component of the system, in each specific area served, has been tested and commissioned such as to obtain the technical performance required by the Contract Documents.

10 CONTRACT ADMINISTRATOR REVIEW OF SHOP DRAWINGS, CATALOGUES, PRODUCT DATA, CALCULATIONS, SAMPLES & MOCK-UPS, EXECUTION METHOD STATEMENTS, ETC.

Except for finish, colour and other aesthetic matters left to the Contract Administrator decision by the Contract Documents, the Contract Administrator review of shop drawings, catalogues, samples, mock-ups and method statements submitted by the Contractor is only for general conformance with the design concept and information given in the Drawings and Specification. The Contractor shall note that all materials', products' and equipment submittals require approval of the Contractor Administrator. The Contractor must take account of any variance in colour / finishes between Architectural / Interior Design and MEP schedules. Such review shall not relieve the Contractor from responsibility for any deviations from the requirements of the Drawings and Specification. Unless otherwise stated, the Contract Administrator may require "Custom Colours" beyond the manufactures standard range.

Certain materials, products and equipment submittals may be reviewed and approved by both the Contract Administrator and the Employer. The Contractor will be instructed accordingly by the Contract Administrator. The Contractor shall present such materials and samples as required by the Contract Administrator for review

The Contract Administrator's review and approval shall not be construed as a complete check nor shall it relieve the Contractor from responsibility for errors of any kind in shop drawings, method statements, or schedules, or from the necessity of furnishing any work required by the Drawings and Specification, which may have been omitted on the shop drawings.

The Contract Administrator will review shop drawings and samples with promptness and will return them to the Contractor with the Contract Administrator's stamp applied thereto through the Project's document management system. No acceptance or approval of shop drawings or samples, nor any indication or request marked by the Contract Administrator on any shop drawing, catalogue, sample or mock-up shall constitute an authorization for any increase in the Contract Sum or Time for Completion.

Notations on returned submittals by the Contract Administrator which may increase Contract Sum or Time for Completion shall be brought to the Contract Administrator's attention in accordance with the Conditions of Contract with adequate details and substantiation before proceeding with the works; otherwise any claim regarding this subject matter will not be considered. All specific information regarding cost and schedule impacts, if any, shall be provided at the time of notification. A general statement that there are cost and schedule implications shall not be admissible at any time and the Contract Administrator is not obligated to respond to such statements from the Contractor.

The Contractor shall clearly indicate on resubmitted shop drawings or method statements or product data, all revisions.

The Contractor shall remain responsible for any and all inaccuracies in the tabulation of quantities within the shop drawings and all such quantities shall correspond to the layout drawings submitted. and shall be computed from the layout drawings using computer software programs. The review and approval of such submittals by the Contract Administrator does not imply verification of quantities shown on drawings.

The shop drawings approved or otherwise, shall not be the basis for measurement of quantities for evaluation of cost variations, unless expressly agreed by the Contract Administrator.

Each submittal will be returned to the Contractor stamped or marked by the Contract Administrator indicating the appropriate action as follows:

“A” ACTION: The Contractor is advised that “A” action means “Approved”, and that fabrication, manufacture, supply, construction or installation may be undertaken, providing the work is in compliance with the Contract Documents.

“B” ACTION: The Contractor is advised that “B” Action means “Conditional Approval” and that the Contractor may:

Proceed with fabrication, manufacture, supply, construction or installation, providing the work is in compliance with the any notation's and the Contract Document. Concurrently, the Contractor is to re-submit the updated shop drawings amended as necessary. Re-submit amended or alternative shop drawings as necessary which shall then be subject to the Design Consultant's reconsideration in accordance with the provisions above. If a revised submission is made, fabrication, manufacture, supply, construction or installation shall not proceed until the relevant shop drawings have been approved.

“C” ACTION: The Contractor is advised that “C” Action means “Rejected” and that submittals do not comply with the Drawings and Specification and that fabrication, manufacture, supply, construction or installation shall not proceed. The Contractor shall re-submit amended or alternative shop drawings as necessary which shall then be subjected to the Contract Administrator’s reconsideration in accordance with the provisions above.

“D” ACTION: The Contractor is advised that “D” Action means “For Information Only” and that submittals do not necessarily require the review and approval of the Contract Administrator, but they have been duly received for information only.

The Contractor shall bear the cost of all reviews made by the /Employer and/or Contract Administrator for all submittals made after two (2) repeated reviews, unless they have been made due to reasons beyond the control of the Contractor.

Unless otherwise stipulated in the contract, fourteen (14) calendar days turn-around time for each submission for review by the Contract Administrator shall be allowed. After one re-submission, if the Contractor’s submittal is not approved, the Contract Administrator may instigate a workshop session with the Contractor to discuss and resolve the issue in an expeditious manner. The Contractor also may request for such a workshop session.

Minor submissions not involving detailed technical or method statement approval or approvals required through variations to the Works which are marked critical will be considered as such on a merit.

The Contractor shall submit an RFI – Request for Information to the respective Contract Administrator for any clarification required with respect the Construction Drawings issued to the Contractor sufficiently in advance so as to not to affect the schedule. Unless otherwise stipulated in the contract, the Contractor shall provide for fourteen (14) calendar days turn-around time for each RFI for review by Contract Administrator.

11 ADDITIONAL REQUIREMENTS

The Contractor shall submit all his submittals such as shop drawings, coordination drawings, catalogues, brochures, technical data, calculations, samples, mock-ups, asset database, etc., at his own cost and in such sequence so as to cause no delay in the Works or in the work of the Employer’s other contractors or sub-contractors. No extensions of time will be granted because of the Contractor’s failure to have these submitted in ample time to allow for processing and review. Sub-contractors shall submit shop drawings, coordination drawings, catalogues, brochures, technical data, etc., through the Contractor. All submittals

shall be sent to the Contract Administrator.

The Contractor shall be responsible for the correct location of his Works, irrespective of approval by the Contract Administrator and shall pay all costs and expenses incurred by the Employer as a consequence of the improper location of his Works.

The Contractor shall be responsible for and shall pay (at no extra cost to the Employer) for any alterations to the Works due to discrepancies, errors or omissions in the drawings and other particulars supplied by him whether such drawings and particulars have been approved by the Contract Administrator or not.

Following approval of the Contract Administrator, the shop drawings and samples shall not be departed from unless modified by variation order as provided under the Conditions of Contract.

160.11 CONSTRUCTION MANAGEMENT PLAN

1 CONSTRUCTION MANAGEMENT PLAN

The Contractor must submit a Construction Management Plan (CMP) to the Contract Administrator 14 days prior to project pre-start meeting. The CMP as a minimum should include the following:

- Site specific Environmental Management and Monitoring Plan (EMP)
- Site specific Social Management Plan (SMP)
- Site specific Traffic Management Plan (TMP); this includes pedestrians and any other form of transport.
- Health and Safety Management Plan (H&SMP)
- Quality Management Plan (QMP)
- Local Capacity Development Plan

No works should commence on site prior to CMP approval by the Principals Representative.

For full details of the Environmental Management and Monitoring Requirements See Section 17, in addition to these requirements:

The Contractor shall comply with the Environmental Management Laws of Fiji and FRA Codes of Environmental Planning, Design, Construction and Maintenance. Prior to the commencement of works an EMP must be prepared and submitted to the Contract Administrator for review. The Plan shall be finalised to incorporate any changes required by

the Contract Administrator and complied with for the duration of the Contract.

All works are to be programmed, constructed and maintained so as to minimise the impacts on the surrounding environment.

The EMP as a minimum must address the impacts and aspects highlighted in table 1 below. Any impact shown in table 1 not relevant to the nature of works of the Contract may not be included in the report. FRA is not obliged to provide an Environmental Impact Assessment Report for the site to the Contractor to facilitate the preparation of the EMMP.

- | | |
|--|---|
| (vi) Administrative procedures | (vii) Method of works and planning |
| (viii) Revegetation | (ix) Dust control |
| (x) Stockpiles and disposals | (xi) Slope stability |
| (xii) Drainage and water crossings | (xiii) Sediment and stormwater control |
| (xiv) Spill response and contamination control | (xv) Construction camps |
| (xvi) Erosion control | (xvii) Quarry development and operation |
| (xviii) River gravel extraction | (xix) Coastal protection and vegetation |

Table 1: Environmental Impacts /Aspects

Before beginning works on any site, the Contractor shall ensure that the appropriate environmental safety measures are implemented and operational. Furthermore, the Contractor shall have in place all contingency and emergency plans and procedures before starting work.

All incidents with possible significant environmental affects or outcomes shall be reported immediately to the Principals Representative

2 SOCIAL MANAGEMENT

The contractor is to prepare a social management plan on the following basis:

Best possible public relations are to be maintained at work sites where the general public or

any individuals who are affected prior to, during, and after works are completed. The Contractor's staff shall be courteous to the public at all times, and shall not offer an opinion to any member of the public on the works being carried out.

All reasonable steps shall be taken to ensure that all affected property owners and occupiers, public transport operators, and any other identifiable groups or individuals are notified of the effect that the Works will have on them, the proposed timeframe and the contact person and day and night telephone number(s), should they have any problems. This notification shall be carried out at a minimum of ten (10) days prior to the relevant work commencing. A courtesy visit to local chief is recommended at the Contractors expense.

With the aim of maintaining harmony and good relations, the Contractor must make itself aware cultural sensitivities, local practices, village bylaws and protocols in order to avoid giving offence to the occupants of any village or dwelling adjacent to the work site. The Principal expects the Contractor to treat local people with respect and to ensure that all activities are conducted in a manner that enhances the reputation of both the Principal and Contractor.

No public communication or announcement at any time to any third party, including any section of the media, about the Contract or the project shall be made by the Contractor without gaining written approval from the Employer beforehand

The Contractor shall supply a draft notification to the Contract Administrator for prior approval. The letter must include:

- Contractor Explanation of work;
- Date of disruption;
- Contract number;
- Contractors Name;
- Information pertaining to site specific controls;
- Access restrictions.

3 TRAFFIC MANAGEMENT

Further details of Traffic Management Planning can be found in appendix B.

The FRA Manual for Traffic Signs and Marking (MOTSAM) September 2015 shall apply. Where sections are not covered then PWD Interim Manual for Signage and Pavement Marking, Section E, Road works Signage and Management shall apply subject to the following changes:

- Replace all references to Department or PWD in the Manual with 'Contractor'
- The Contractor shall organise and carry out works in such a manner as to eliminate or at least minimise inconvenience or delay to road users (pedestrians, horse riders, cyclist, etc) while still providing safe conditions for both workers and the public.
- The Contractor shall take full responsibility for all actions taken by subcontractors engaged under this Contract including utility authorities.
- Sufficient restrictions and signs shall be used without being over restrictive. Warning signs and traffic control equipment shall be clearly visible to the road users.

Equipment shall comply with Section B Equipment of the Fiji adopted New Zealand Transport Agency Code of Practice for Temporary Traffic management, Third Edition: July 2015 Update.

A formal Traffic Management Plan shall be prepared and submitted by the Contractor to the Contract Administrator prior to commencement of work and shall demonstrate the Contractor's ability to manage the traffic such that the sites are safe at all times and disruption to traffic flow is kept to a minimum. This shall include for any temporary road diversions that the Contractor may require for the construction of the works.

The Contract Administrator shall review the TMP and provide sufficient feedback to the Contractor to allow finalisation and formal approval of the TMP.

The TMP must:

- be consistent with the general specifications and shall include diagrams or layouts of signs and delineation devices proposed for all the situations that may be encountered;
- include a layout diagram of the work site;
- Include temporary speed restrictions which must be authorised in writing by the Contract Administrator prior to commencement of the works. Temporary speed limits shall be the maximum that is consistent with the safety of the work, workers and road users. Unnecessarily low temporary speed restrictions shall not be used;
- be kept on site and made available for inspection when requested by the

Principals Representative.

In general, the following should apply in regards to traffic management:

The Contractor shall monitor the sign layout regularly and if necessary vary it to ensure that it meets the requirements of this specification;

Signs, barriers and safety delineation equipment shall be removed or covered immediately if it is no longer required;

Without causing damage the Contractor shall cover conflicting permanent signs until work is completed or there is not conflict with work site signs.

4 HEALTH AND SAFETY MANAGEMENT

Further details of Health and Safety management can be found in Section 12

The Contractor's responsibilities under this clause shall include but not limited to its obligations under the Health and Safety at Work Act 1996 (HSWA) of Fiji.

The Contractor must take all necessary precautions for the safety of the public, traffic and workers employed on or near the works and shall comply in all respects with the HSWA including the latest revisions and amendments.

The Contractor's health and safety plan shall include but is not limited to:

- Contractor's safety policy.
- Contractor's safety training procedures.
- Site safety management organisation.
- Site safety personnel.
- Schedule of known hazards on site and how these will be managed.
- Procedure for identifying and assessing hazards.
- Procedure for recording of accidents.
- Procedure for dealing with emergencies that may arise while employees are at work.
- Procedure for the evacuation of injured persons to an appropriate medical facility.
- Procedure for evacuation of the Site.
- Procedure for monitoring health and safety performance.
- Procedure for monitoring the health of employees where they are exposed to hazards.

A copy of the Health and Safety Plan shall be maintained on site at all times, updated as

necessary and made available to the Contract Administrator upon request.

Meeting these requirements and those set out in Section 12 shall not relieve the Contractor of any of its responsibilities to comply with the conditions of Contract or the Health and Safety at Work Act 1996.

5 QUALITY MANAGEMENT

Full details of Quality Management can be found in Section 14

A Contract QAQC Plan shall be prepared by the Contractor and submitted to the Contract Administrator for the approval prior to commencement of work. The QAQC Plan must demonstrate the Contractor's ability to meet all contractual technical and testing requirements using suitable work practices, in association with providing adequate quality, health and safety and environmental systems. The Contract Administrator must review the QAQC Plan and provide sufficient feedback to the Contractor to allow finalisation and formal approval.

In addition to the requirements in Section 14, the QAQC Plan shall include the following:

- The Contractor's key personnel and responsibilities;
- Material sources, in particular cement and concrete sand and aggregate;
- Hold Points - Points beyond which work shall not proceed until the Contractor can demonstrate that all work up to that point meets the requirements of the contract. This will demonstrate that the Contractor fully understands the methodology for completing the works;
- Schedule of Tests/Checks – a schedule of all testing/checking to be undertaken to verify the quality of the works, in particular concrete production and placement.
- It shall be the Contractor's responsibility to ensure that the construction of all precast and insitu concrete work complies in all respects with the Drawings and Specifications.

The Contractor must nominate and advise the Contract Administrator of a suitably experienced and qualified representative to be responsible for the quality control of all precast and insitu concrete.

All quality control testing shall be carried out in accordance with the quality assurance programme for the project by an IANZ or NATA Accredited laboratory.

160.12 REGULATORY REQUIREMENTS, CODES AND STANDARDS

1 CODES AND STANDARDS

All references to codes, specification and standards referred to in the Drawings and Specification shall mean, and are intended to be, the latest edition, amendment or revision of such reference standard in effect as of the date of the Drawings and Specification. The Contractor shall provide a copy, on the request of the Contract Administrator and/or the Contract Supervisor, of the latest edition of all codes and standards.

The Works shall be designed and constructed in accordance with the Project Specifications, The Republic of Fiji Standards relevant to the scope of works within this contract and international codes of practice where instructed by the contract administrator. Other codes, regulations and standards may be deemed applicable to the Works by the authorities having jurisdiction.

Other Codes and Standards may be prescribed for the fabrication, testing, safety, etc., for items, materials and components in the Specifications.

The standards and codes, in their latest edition unless specified otherwise, shall be applied to the works covered by this Specification. Where no such standard exists, as for example in the case of patents or special materials, all such materials and workmanship shall be of the best quality, and full details of the materials and any tests to which they are subjected shall be submitted to the Contract Administrator for approval.

Where the standards and codes conflict within themselves and/or with local codes, the Contractor shall be obligated to bring it to the attention of the Contract Administrator for a final resolution. The Contractor shall abide by the decision made by the Contract Administrator at no additional cost.

2 TECHNICAL LITERATURE

The Contractor shall have a copy of the latest technical literature referenced in the Drawings and Specification kept on the Project Site and maintained in good order and available to the Contract Administrator at all times.

3 CODES, STANDARDS, CERTIFICATE OF COMPLIANCE AND COMPLETION

The Contractor shall arrange for and give all necessary notices, submit plans and obtain written permission to commence Works. The Contractor shall inform the Contract Administrator, and arrange with the relevant Authorities for inspection of the Works during

commissioning and on completion. The Authorities are such bodies which have jurisdiction with regard to the carrying out of the Works including, but not limited to, the relevant government bodies, statutory bodies, local authorities, statutory undertakers, supply authorities, services providers and federal departments.

The Contractor shall do everything necessary in respect of the Works such that approval or acceptance by the Authorities can be obtained. Prior to the Employer's taking over the Works, the Contractor shall arrange for final inspections by all relevant Authorities which are required for any parts of the Works such that inspection for Certificate of Compliance and Completion can be arranged.

The Contractor shall do everything necessary, before and after the Employer's taking over, to assist the Employer and the relevant Consultants in arranging for the Certificate of Compliance and Completion to be issued, including (where applicable) completing, signing and submitting the appropriate documentation (with reference to the By-laws and the Works) to the Contract Administrator and/or causing its sub-contractors and nominated sub-contractors to do the same.

The Contractor shall comply with all regulations of relevant Authorities in respect of testing of all materials, goods and works. The Contractor shall allow in his programming of the Works for such testing (and any retesting as may be necessary) and shall pay all fees, charges and costs incurred.

160.13 TEMPORARY FACILITIES

1 GENERAL

The requirements of this Section apply to the Contractor, however certain paragraphs have been identified to apply to and be provided by the sub-contractors, nominated sub-contractors and Employer appointed contractors. In this case the provision of the requirements is by the identified contractor however this provision shall not relieve the other package Contractors from meeting the general requirements of those paragraphs.

Unless specifically indicated otherwise, the Contractor shall be responsible for providing all labour, materials, equipment and services as necessary to establish, relocate as required, operate and maintain the temporary facilities within and immediately surrounding the Project site. The facilities thus provided shall be as specified herein and shall include (if applicable) but not be limited to the following;

- Project Identification Signboard

- Perimeter Fencing and External Lighting if required.
- Any other temporary Fencing
- Site Security
- Site Access
- Traffic Regulation
- Temporary Utilities including Water Service, Sanitary Waste removal and Electric Power.
- Temporary Lighting Distribution
- Temporary Power Distribution
- Lightning Protection
- Temporary Toilets
- Temporary Ventilation
- Temporary Stairs, Ladders, Runways, Construction Openings
- Crane's
- Hoist
- Fire Protection
- Fire Alarm System
- Surface Water Control
- Pest Control
- Environmental Controls
- Permanent and Temporary Field Offices and Sheds
- Employer and Contract Administrator Project Site Office's
- First Aid Facilities with full time Qualified Nurse
- Waste Removal
- Canteen / Messing Facility
- Testing Lab

The equipment and facilities employed by the Contractor for the temporary construction facilities shall comply with pertinent local safety regulations and Project Safety procedures.

The Contractor shall also refer to the following documents and confirm compliance:

- The Republic of Fiji Government Standards
- Statutory Authority Standards
- The Republic of Fiji Electricity and Water Authority Rules and Regulations
- This document - Safety
- This document – Quality Control
- This document – Environmental Management

- National Fire Protection Agency (NFPA)
- British Standard IEE Regulations B.S.7671 1992 Section 604 “Construction Site Installation.”
- British Standard Code of Practice for distribution of electricity on construction and building sites (B.S.7375)
- Applicable codes of good practice
- Department of Environment

The Contractor shall also be responsible for the removal of all temporary installations provided by him as soon as possible after the completion of Contract as required or as instructed by the Contract Administrator, at no additional cost. The Contract includes for all associated earthworks, including plinths, cable ducts, trenching, bedding materials, excavation, backfill, compaction and final grading necessary for providing the temporary facilities. Unless otherwise specified, all areas affected directly or indirectly by temporary works are to be restored to equal or better than existing condition.

The Contractor shall be responsible for all temporary drainage measures and shall employ adequate equipment such as skimmers, trash pumps, vacuum cleaners, and/or other necessary elements as required to afford satisfactory working conditions for the execution and completion of the Project. Each sub-contractor and Employer appointed sub-contractor shall be responsible to install systems and work in a way that would prevent water from accumulating on the project site. Each sub-contractor and Employer appointed sub-contractor shall at all times avoid operations that cause water flow into excavated areas of the Project site. The Contractor shall assure himself that equipment to handle un-expected water influx emergencies is available for his use when required.

The Contractor shall submit shop drawings including any necessary calculations prepared by a Professional Engineer registered with the Board of Engineers, The Republic of Fiji, or equivalent, for all temporary services, temporary works and utilities in his scope of work to the Contract Administrator for review and approval within fourteen (14) days from the Commencement Date or as stipulated in the contract.

The Contractor shall develop his own logistics plan for the Contract Administrator’s approval and he shall submit the plan detailing any modifications to the layout which may become necessary during the course of his works. This plan shall (but not be limited to) provide clear, full details of location, capacity, etc., for the temporary facilities including the Contractors, the Contract Administrator’s and the Employer’s Site office’s, safety areas, plant, temporary utilities, sanitary facilities, materials storage areas, fabrication / assembly yards, concrete batching plant and wash out areas, canteens, trash sorting and temporary storage areas,

access routes, material deliveries and heavy lifts. The above information shall be submitted within fourteen (14) days after signed contract agreement or as stipulated in the contract. This logistics plan is required to show the site progress in monthly stages up on till the Contractors completion of work scope.

The Contractor shall not install any laydown areas, site offices, rest areas or alike on other plot development areas other than areas designated by him, and for which all necessary agreements, permissions etc have been obtained. At the Employer and/or Contract Administrators instruction, if the Contractor is requested to remove any laydown areas of any sought, the Contractor must remove all items within a period of one (1) months maximum from date of instruction. The Contractor shall bear all costs associated with relocation of such laydown areas and the Contractor shall not claim for additional laydown area in the event that previous laydown areas have been removed.

The Contractor shall maintain all temporary works as long as needed for the safe and proper execution of the work, not limited to the duration of the Contract, or until such time that the permanent facilities can support the remaining construction work or where the removal of temporary facilities is required to complete the permanent work, all as approved by the Contract Administrator.

Contractor shall remove and relocate any temporary facility herein specified if a change in location becomes necessary in order to progress the work properly. The Contractor shall remove and relocate as directed by the Contract Administrator without additional time or cost to the Employer. The decision of the Contract Administrator in this regard is final. The Contractor shall take into consideration any surrounding works and ensure relocation of temporary facilities (including fencing laydown areas) are executed in a timely manner.

The Contractor shall provide and maintain all temporary facilities in strict accordance with governing rules, regulations, codes, ordinances and laws of agencies and utility companies, and authorities having jurisdiction over work involved in the Project.

All temporary facilities provided by the Contractor for construction purposes shall comply with all National and Local Government Authority and Agency requirements.

The Contractor shall obtain and pay for any required permits or inspections pertaining to the installation, maintenance or removal of the temporary facilities and shall be responsible for all temporary work provided, and at his own cost, obtain necessary permits and inspections for such work for authorities having jurisdiction.

All temporary facilities including offices, stores, compounds etc., must comply with Fire

Department regulations and must be constructed with approved fire resistant materials.

2 SPECIAL PRECAUTIONS AND REQUIREMENTS

The Contractor shall not interfere with normal use of roads and highways in the immediate vicinity of Project site except as indicated or as absolutely necessary to execute required work, and then only after proper arrangements have been made with authorities having jurisdiction, including traffic control as applicable.

The Contractor is responsible, in the performance of his work, for protection of existing active utility services or utility lines installed under other phases, including both permanent and temporary systems.

Notification of any proposed interruption of services must be made two (2) weeks in advance, to the Contract Administrator. Accidental interruptions of services shall be reported to the Contract Administrator immediately. Any contractor causing any interruption shall be responsible to take all necessary action to restore the utility on an emergency basis including work on a twenty four (24) hour basis.

The Contractor shall take note that within FRA Project Site, other stakeholders may be carrying out construction works within the vicinity. The Contractor shall make full allowances for interface with each stakeholder that is adjacent to the Contractors work areas.

The Contractor is to review Appendix B; Temporary Works Traffic Management Planning Guidelines. This document is to be read in parallel with the General Requirement's and compliance with all Local Authority Regulations.

Specific obligations for protection requirements of the Contractor are as follows:

- Protection of Works until issuance of Taking Over Certificate
- Protection of work of others adjacent below and above during construction
- Protection of own personnel and other personnel
- Protection of own plant, equipment and tools
- Protection of existing facilities and personnel

3 USE OF PERMANENT SYSTEMS / WORKS

When the permanent works are in operating condition, they may be used during the construction period provided that the Contractor;

- Obtains the approval from the Contract Administrator

- Assumes the responsibility for each area the Contractor will be using
- Thoroughly cleans the entire area prior to final acceptance of the Works.
- Warranties for any such system/works are not to be reduced from the time of handover to the Employer.

4 PROJECT IDENTIFICATION SIGNBOARD

Within 14 days after Contract Award (or at such other time agreed by the Contract Administrator), the Contractor shall provide Project Signboard(s). The Contractor shall be responsible to keep clean and maintain the signboards throughout the duration of the Project, including making any necessary repairs using approved materials, reinforcing, supplementing as necessary to ensure that the signboard is sturdy and robust. In the event of the project sign board requiring to be replaced, the Contractor shall make full provision to replace as directed by the Contract Administrator.

The Contractor shall update the signage wording from time to time as instructed by the Contract Administrator using graphics and including any graphic illustrations of the Project as approved by the Employer.

If requested by the Contract Administrator, the Contractor shall ensure that adequate external illumination and maintenance is provided for the signboard including a continuous power supply for night time illumination of the signboard seven (7) days per week. The Contractor shall pay for all power consumption costs and fees in connection therewith.

The Contractor shall provide for any possible relocation of the signboard including its foundation and electrical service as and when instructed by the Contract Administrator for the duration of the Project.

The Contractor shall be responsible for the removal of the Project Signboard including its foundation and any electrical service as and when instructed by the Contract Administrator.

No signs or advertisements of any kind will be allowed to be displayed on the premises without the written approval of the Contract Administrator and the Employer.

5 TEMPORARY PERIMETER FENCE/HOARDING

At the request of the Contract Administrator adequate lighting will be provided by the Contractor along part or all of the perimeter hoarding. Such lighting will be spaced to ensure that there is no dark or shadowed areas along the perimeter fence/hoarding. The maintenance of the lightning and gates to be the responsibility of the Contractor.

Within 28 days after Contract Award, the Contractor shall provide perimeter fencing/hoarding/barrier protection to the approval of Statutory Authorities. The Contractor shall maintain all fencing/hoarding/barrier protection and gates in good condition during the entire duration of the Project including periodic repair, replacement of damaged components, touch up, painting etc. to the satisfaction of the Employer and/or Contract Administrator. Incidents of graffiti and vandalism are to be rectified immediately.

The Contractor shall ensure that his work areas shall be adequately secure and protected at all times to ensure that his works are not encroached by others and ensure no other party enters his areas of works.

Upon completion of the Project or as instructed by the Contract Administrator, the Contractor shall remove and properly dispose of the entire temporary perimeter fence and gates.

With the prior approval of the Employer and/or Contract Administrator, the Contractor may make modifications to the new fence and gates during the course of the Project's construction, including the relocation or addition of another gate for access to the Project site. In this regard, he will be responsible for the costs of such modifications.

The Contractor is responsible for all costs for providing hoarding / fencing / barrier protection around the contractor's assigned lay down areas and other facilities. Any damage caused to other contractor's hoarding/fencing by the Contractor shall be repaired at the Contractor's cost.

The Contractor shall make necessary arrangements to secure his belongings, materials and installations within the site. Any loss or damage of materials and/or installed works shall be replaced and/or rectified by the Contractor at his own cost.

The Contractor shall be responsible for the safety and security of his materials (permanent and temporary), equipment, personnel and other resources.

The Employer, and/or the Contract Administrator are not responsible for any stolen and or damaged equipment, materials or tools or any criminal or wanton acts in the Project site.

The Contractor shall liaise with the Contract Administrator and Employer and provide full assistance to install any advertisement by the Employer to the perimeter fencing and gates.

6 SITE SECURITY

The Contractor shall be responsible for providing security on the site. Within fourteen (14)

days after Contract Award, or as otherwise agreed with the Contract Administrator, the Contractor shall provide security to the Site (Areas of Works).

The Contractor shall submit a Project Security Plan for the Employer and Contract Administrator to approve prior to implementation. This Site Security Plan shall be required to be submitted within seven (7) days after Contract Award.

The Contractor shall employ a professional security services provider who shall be approved by the Employer and Contract Administrator. The professional security services provider along with the Contractor shall be responsible for managing and implementing a comprehensive security system during construction, for the entire duration of the Project. The agency providing the security services shall be appointed within fourteen (14) days of Contract Award. The security services provider must comply with the following conditions:

- Registered with the Fiji National Police
- Possess a valid Fiji Police security license for managing services
- In operation for a minimum of ten (10) years
- Has a hands on management team and organized structure
- Is not using a license belonging to another
- Will only employ local guards with appropriate qualifications
- Will comply with man-guarding rates as recommended by the Fiji Islands Security Employers Association.
- Is a registered member of the Fiji Islands Security Employers Association

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to:

Provide complete monitoring and control over the entry and/or exit of all equipment, machinery, vehicles, materials and personnel, directly or indirectly involved in the Project.

Install portable access control system (if required by the project, to be confirmed by the Contract Administrator) with the following characteristics:

- Based on a portable container cabin concept
- Cabin will be installed with portable vehicle arm barriers to cover the width of the access roads
- Cabin will be with half height turnstiles controlled by a photo ID system, ID Card printer and CCTV system
- All ID card readers to be integrated for Entry and Exit points for both pedestrian

and vehicle traffic

- Operating software to be the basis for manpower management and productivity reports recording company/contractor/worker group
- Number of cabins and turnstiles to accommodate peak movement of construction workers throughout the duration of the project
- Minimum queuing timing during peak worker movements
- There will be extended covered queuing areas provided to accommodate peak volume during start and change of shifts

Provide patrols of all areas, on all shifts of the Site and perimeter to ensure that the contractors, suppliers, lead and/or technicians, etc. maintain compliance with general safety and security requirements as prescribed under the general conditions of their particular contracts and dictated by good common practice.

A daily report shall be written up for all patrols and all incidents / events or defects to the security of the project will be brought to the attention of the contract administrator immediately. A similar log will be kept in the security cabin/cabins detailing the events of the shift. This log will be presented to the contract administrator each day.

Provide a manned, twenty-four (24) hour emergency information desk with personnel fluent in English.

Receive, collate, obtain authorizations, issue passes and monitor and inspect all personnel, plant, vehicles, materials and equipment entering and leaving the site.

Prevent entry of unauthorized personnel, plant, vehicles, materials and equipment to the site.

Supply, install, program, maintain and operate all telephone and wireless radio communication system as necessary between guard patrols, guard houses, guards and Contractor site offices as well as Emergency, Fire and Police stations.

Supply, install, maintain and operate all security and gate offices, any additional personnel, gates, vehicles, equipment, machinery, etc. necessary to manage, administer and execute the security works during the duration.

Gates provided at minimum two (2) locations along the full extent of the Site perimeter boundary. Security personnel shall be provided twenty-four hours per day/seven days per week (24/7) and including all public holidays at the entrance and exit of the site.

The Contractor shall allow for the provision of minimum two (2) gatehouses – one at each

gate. If the location is required to be relocated, then the contractor will cover all costs.

Provide CCTV system that covers all areas of the FRA Site and in particular, all pedestrian and vehicle main entrances must have recording retention of six (6) months before it is overwritten.

Provide an approved alarm system that covers all areas of the FRA Site.

Provide adequate floodlighting for all entrances/exits, perimeter fencing, office areas, compounds and work areas.

All Security Guards shall be in uniform whilst on duty.

The gate houses are to be equipped with Furniture, AC, etc.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to establish an ID card system that will include, as a minimum, the following:

All contractors, sub-contractors, Employer appointed sub-contractors' personnel requiring to go on and off the Project site will be issued with an ID card by the Contractor which is to be visible at all times. The Contractor shall also implement a finger printing/bar code system or eye retina system for all his workers, sub-contractors, Employer appointed sub-contractors, Direct contractors & Other contractors entering and leaving site. This system is to be reviewed and approved by the Contract Administrator.

Cards will only be issued after supplying the following information to the Contract Administrator, Safety Team and Security:

- National identification Card (The Republic of Fiji Citizens)
- Construction Safety Card (All Project Personnel)
- Passport/Immigration Card/Work Visa (Foreign Nationals)
- Operator Competency Certification (If Applicable)

The Contractor shall obtain all information necessary for the preparation of ID Cards, including fingerprints or retina readings and prepare and issue the same in a format acceptable to the Contract Administrator.

Cards marked with a "W" are meant for the workmen that will require the holders to go through the workmen's entrance. These cards shall hold encrypted data on magnetic strips

or bar codes that are machine readable.

Cards marked with an "S" are meant for the staff that will allow the holders into the Contract Administrator compound and on to Site by foot through the personnel gate or in an authorized vehicle.

Visitors and representatives of Contractors will be issued a "V" for visitor badge for entry to the Contract Administrator's compound. They can only be allowed on Site in the company of the Contractor or Contract Administrator through the personnel gate from the Contract Administrator's compound.

Passage of the workmen on and off Site will be automatically recorded at the entrance / exit points, and men are to ensure that their card is "read" properly by the reader as they pass through the barrier. It is mandatory that each entry / exit of all workmen is logged, and that Contractors ensure that their workmen observe such procedures, particularly under emergency situations / incidents / accidents.

Cards will be issued by the Contractor to all personnel before the men first enter site and after they have completed the site specific orientation induction. All lost or spoilt cards are to be reported immediately.

A charge will be made for the issuance of a new card to replace one lost or damaged.

When personnel arrive on Site without a card, they will have to stand to one side and wait for the crowd to disperse; a card will be issued after verification of identity by their supervisor and he will be allowed entry.

Only legitimate visitors having Contract Administrator's consent will be allowed entry to Site. Visitors are prohibited from taking photographs or videos.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to implement an effective access control procedure that will include, as a minimum, the following:

Access to Site for the workmen shall be scheduled through designated gates and during stipulated timing "windows" so as to prevent bottlenecks at the gateways, providing the men have up-to-date ID cards.

Access to Site for equipment and materials will only be possible during stipulated times so as not to interfere with the passage of men on to Site. Vehicles arriving un-announced, other than ready-mixed asphalt trucks, are not to be allowed on Site. All drivers are to carry delivery notes, one copy of which will be held by the security guard.

Vehicles with goods for sites other than the Project site will not be allowed on site.

Only site designated vehicles shall be allowed to enter the site, no personnel vehicles shall be allowed access.

Vehicles are to enter and leave the Site in an orderly manner, obeying all traffic rules for vehicles on site and no speeding will be tolerated.

Any vehicle carrying equipment or material, other than ready mixed asphalt, will need a pass out before leaving Site. This passage of all vehicles will be monitored through the gates, including the number of persons in the cab. Workmen may not enter Site inside a vehicle.

It will be the Contractor responsibility to maintain & repair all roads entering the site & neighbouring paved walk ways.

Towards the completion of each area, security guards shall be assigned on a progressive basis to secure the completed areas. Registers are to be maintained by the security guards where every visit by every person on the completed areas shall be recorded.

The Contractor shall ensure that the security system is audited on a monthly basis along with the Contract Administrator and that the findings are submitted to the Contract Administrator by no later than the first two (2) days of the previous month.

7 SITE ACCESS FROM PERIMETER ROADWAYS AND TEMPORARY ROADS WITHIN PROJECT SITE

Within 14 days after Contract Award, the Contractor shall provide site access, wheel wash areas, perimeter roadways and temporary roads within the project site work areas and in compliance with Local Authority regulations and requirements.

The Contractor shall be responsible for the upkeep and maintenance of the site access and wheel wash areas throughout the duration of the works.

The Contractor shall construct and maintain temporary access roads and entry gates and shall install manual control barricades at these access points. Vehicular entries and exits to the Project site shall be through these designated access roads and entry gates only and the Contractor shall be fully responsible for all access related issues as detailed in this document.

Where the site does not comprise existing public roadways, only authorized vehicles and

equipment are allowed entry to Site. Construction vehicles and equipment shall not enter areas designated for site offices.

The Contractor shall submit a layout drawing as part of his site logistics plan, showing any needed temporary roads and access routes for Contract Administrator review and approval prior to constructing same.

The Contractor shall be responsible to construct and maintain in good usable condition any required temporary roads and access routes within the Project site that may be needed to access the work areas, laydown/storage areas and site offices. Upon completion of the Contract Works, or at such time before completion as directed by the Contract Administrator the Contractor shall remove these temporary roads and access routes. All cost associated with providing and removing such temporary roads and access routes are the sole responsibility of the Contractor. The Contractor shall make all necessary arrangement with their sub-contractors and Employer appointed Contractors for temporary routes and access routes within the Project site to carry out their duties.

The temporary roads and access routes within the Project site shall be formed by proper roller compacted earth with compacted granular material topping. The granular course shall be at least 150mm thick and shall last for the period of construction of the Works

The Contractor shall submit to the Contract Administrator, a list of all vehicles and equipment he intends to use for construction purposes complete with the relevant required certification for such plant and equipment. Prior permission is to be obtained from the Contract Administrator for entry of all his vehicles and equipment.

Passenger vehicles are not allowed entry to the Project site without approval of the Contract Administrator and/or Employer.

All security procedures as detailed by the Contract Administrator shall be followed for entry, parking and exit of vehicles from and to the Project site, including the areas designated for site offices. Violation of security procedures shall result in barring future entry of the violating vehicle to the Site.

The Contractor shall provide for sufficient number of guards, flagmen (banksmen), barricades, etc. to direct traffic and public as required for carrying out works in his Contract. If the Contract Administrator deems that insufficient numbers of guards, flagmen (banksmen), barriers, etc. are provided at the Project site, then the Contractor shall provide additional resources as instructed by the Contract Administrator at the Contractor's expense.

The Contractor is responsible for avoiding any interference with the normal use of roads and highways in the vicinity of Project site except as indicated or as absolutely necessary to execute required work, and then only after arrangements have been approved by the Contract Administrator, including traffic control as applicable.

The Contractor shall familiarise themselves with traffic in the area and account for same via a Traffic Management Plan to be submitted to the Contract Administrator review and comment and periodically as requested by the Contract Administrator during the execution of the Works.

The Contractor shall maintain at all times, an uninterrupted use of the existing roads and sidewalks around the Site and the lay-down areas. Concrete Safety barricades will be provided as and where required. The Contractor will ensure that there is no disruption due to movement of workmen or transportation of material.

The Contractor shall provide all necessary labour, materials and equipment on a continuous basis to maintain and operate the wheel wash troughs and to enable the immediate removal of any mud and construction debris carried off the Project site and into the public roadways. All vehicles exiting the Project site are required to pass through the wheel wash troughs.

8 TRAFFIC REGULATION

The Contractor will provide a Traffic and Pedestrian Management Plan to indicate all temporary diversions, traffic signals, signs and the like as required. He shall ensure that all vehicles abide by the restrictions and regulations. The Contractor must pay particular attention to heavy traffic times in and around the project site, such as school drop off and pickup, the holding of special events in the area. The traffic management plan is a live document and must be updated as the project progresses and the traffic lay out changes. All Contractors/sub-contractors will be made aware of all and any changes to the traffic plan before the changes are put in place. Specific safety requirements for traffic management can be found in appendix B.

The Contractor with the Contract Administrator is to participate in meetings as required with management/administrators of surrounding schools and any areas of public concern in order to minimise impact on their operations. This will include traffic management as required.

The Contractor shall obtain at his cost all permits required for oversize loads, over-weight vehicles and arrange for all necessary police escorts.

Movements of materials and workmen into the Site shall be scheduled and co-ordinated with

the Contract Administrator in order to avoid traffic jams near the Site.

The Contractor shall provide flagmen (banksmen) for traffic control when delivery vehicles enter or leave the Project site.

9 TEMPORARY UTILITIES INCLUDING WATER SERVICE, SANITARY WASTE REMOVAL AND ELECTRIC POWER

The Contractor shall provide all temporary water service and sanitary waste removal service necessary for the completion of the entire Project's Works. In this regard, he shall make temporary connections to public utilities and services as required from locations and in a manner acceptable to the local authorities having jurisdiction thereof and he shall be responsible to pay all consumption costs for water used by the various sub-contractors, and his nominated sub-contractors, including sanitary waste fees to the concerned authorities.

The Contractor shall submit a Temporary Utilities Management Plan detailing the layout, installation relocation, operation and maintenance of all of the temporary utilities for the duration of the entire Project's Works.

The Contractor shall provide all temporary power service necessary for the completion of the entire Project's Works as required. In this regard, he shall make temporary connections to public Electric utilities and services (or other temporary methodology) from locations and in a manor acceptable to the local authorities having jurisdiction thereof and he shall be responsible to pay all consumption costs including any fees for electrical power used by the various contractors, sub-contractors and Employer appointed sub-contractors to the concerned authorities. Where is not readily available from Public Utilities, the Contractor shall supply, install, operate, maintain (including all costs for fuel consumption) any temporary generators that may be required to provide for temporary power service necessary for the completion of the entire Project's Works.

10 TEMPORARY LIGHTING

The Contractor shall provide a continuously operating temporary lighting system throughout the entire area of the Project to satisfy minimum requirements of safety and security.

All electrical works shall be carried out by competent, experienced and qualified electricians at all times. Works on electrical systems will be performed under a Lock Out-Tag-Out (LOTO) permit to work.

The Contractor shall provide and maintain general area lighting or flood lighting to all areas of the construction site as required by the Contract Administrator. Any further lighting for

craftwork or task lighting will be either from the common lighting transformer or from other sources, as available. Task lighting sources shall be fluorescent lamps on stands with wire guards. Incandescent sources such as tungsten or tungsten halogen shall not be used as they represent a fire risk.

Temporary lighting circuits shall be insulated PVC cables.

Light fixtures shall comply with the relevant International Standard and be of reputable quality and type. All light fixtures' installed in exposed areas shall be weather proof.

The lighting shall be evenly distributed over each phase of the electrical system.

All lighting circuits shall be provided with lighting switches in addition to circuit breakers. The circuit breakers shall be located adjacent to the power source. The Contractor shall also give consideration to means of egress when the general lighting is to be switched off shall be where switches shall be located.

Switches shall also be arranged to control lights in a logical manner/groups and shall be assigned to enable lights to be switched off when not required or daylight is adequate.

The Contractor shall be responsible for taking additional precautions where portable hand-lamps are used in damp and confined situations. In this event, the hand-lamps shall be powered at either 25 volts single-phase SELV or 50-volt single phase, centre-point earthed.

Temporary emergency lighting shall be provided by the Contractor to offer safe exit from the Construction site under mains failure conditions.

Floodlighting shall be the responsibility of the Contractor if required. Supplies for this lighting shall be derived from the dedicated sub distribution panels/boards.

11 TEMPORARY POWER DISTRIBUTION

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to meet power requirements of the Project as indicated below. Sufficient capacity shall be provided to ensure that ALL contractors, sub-contractors and Employer appointed sub-contractors working in the Project have power of sufficient rating and quantity for their construction tools and equipment as well as testing and commissioning needs.

Provide Power for;

- Project Site offices
- Temporary lay down areas, storage yards and similar
- Lighting Installation (general, access, task and emergency lighting)
- Tools, Compressors, Welding equipment
- Water pumps
- Temporary exhaust/fresh air fans
- Electric hoists, electric cranes
- External climbers, stages, etc.
- Winches and hoists
- Toilet blocks, canteen/messing areas, etc.
- Heavy lifting operations or similar
- Satellite field offices, toilets, canteen/messing, etc.
- Power required for testing and commissioning of all electrical, mechanical systems.

Other Facilities

Grounding for electrical devices and items that shall conduct lightning

Power Supplies: The recommended distribution voltages shall be as follows:

- | | |
|--|---|
| • Fixed and moveable plant above 3.75 kW | 380/400 V – 3 phase |
| • Fixed flood lights | 230 V – 1 phase |
| • Overhead secured general lighting | 230 V – 1 phase |
| • Small mobile plant up to 3.75kW | 110 V – 3 phase (centre point earthed) |
| • General or area lighting through mobile units | 110 V – 1 phase (centre point earthed) |
| • Portable hand-lamps | 110 V – 1 phase (centre point earthed) |
| • Portable hand-held tools | 110 V – 1 phase (centre point earthed) |
| • Local lighting up to 2 kW | 110 V – 1 phase (centre point earthed) |
| • Portable hand lamps in damp and confined areas | 25 V – 1 phase: SELV or 50 V – 1 phase centre-point earthed |

The Contractor shall ensure that all temporary electrical supply systems are installed in compliance with Local Regulations and Codes and IEE Regulations - BS 7671:1992 (Incorporating 1994 Amendment) Section 604 “Construction Site Installation” including references to BS / EN publications, supplies for welding equipment in accordance with BS 638.

All temporary wiring shall be routed, balanced and sized as to so as to produce a voltage drop of not greater than 5% at the extreme end of the line when operating at full load.

Dedicated sub distribution panels shall be provided for each major piece of equipment such as, Motors, Compressor, pumps etc. and provide remote emergency stops for all operating equipment

Dedicated sub distribution panels shall also be provided to serve hoists, welding equipment, compressors, external lighting, etc.

Dedicated sub distribution panels and distribution boards shall be provided to serve all welding equipment. The dedicated welding sub distribution panels shall be connected to the link boxes. A minimum of two (2) dedicated welding sub distribution panels shall be provided by the Contractor. Each panel shall comprise 400 amp TP MCCB isolator and at least four (4) 200 amp TP MCCB outgoing devices.

The Contractor shall provide the welding sub distribution boards comprising (if required):

- Incoming 200 TP+N isolator.
- six (6) 63A TP MCB outgoing ways.
- six (6) 63A 4 Pole 100 mA ELCB's.
- six (6) 63A 4P+E industrial IP44 plug and socket outlets mounted on the casing.

The Contractor shall make provisions for the use of generators in the event of not connecting to the temporary electricity.

Each Contractor requiring electrical welding services shall be responsible for picking up supplies from the welding distribution boards using the industrial plug and sockets provided.

The general lighting and power distribution boards shall be connected through a 220V to 240V power supply from the distribution units, and the panels shall be complete with integral isolator, protection devices (MCB's and RCD's) and industrial IP44 socket outlets and plugs. The sockets and plugs shall be industrial type to meet IEC. 309 and BS EN. 60309/BS.4343, the sockets and plugs shall be mounted on the side of the purpose made distribution panels and shall act as the final connection to power circuits and transformers.

All circuits should be protected by RCD's with a maximum sensitivity rating of 30ma.

The Contractor shall only use double insulated power tools suitable for purpose that have been safety tested with appropriate certification. Power operated tools shall be 400/230 volt only.

Small power in the construction areas shall be run using 400/230V. A mobile unit with the following configuration is recommended for this purpose:

- Size: 50 KVA
- Breaker Size: 63 A
- Capacity: 10 x 20 Amp outgoing
- Integral Fire Alarm bell, charger, break-glass and battery unit.

All local lighting and hand tools shall be supplied by a 400/2300V distribution sourced from centre tapped transformers in key locations such that trailing leads do not exceed 35m length

All Contractors' tools must be 400/230V and double insulated or earthed. All hand tools are to operate at 110V for safety requirements. All tools, transformers and cables shall be PAT tested before being delivered to site. Where temporary power is difficult to achieve or where associated power leads may cause safety hazards the Contractor shall use portable battery operated tools.

All Contractors shall be responsible for providing their own 400/230V transformers to power tools and equipment. Transformers shall generally be located adjacent to the temporary 400Volt 50 Hertz distribution panels and distribution boards. The distribution boards will be provided with industrial plugs and colour coded sockets (BS.4343type) to facilitate the connection to transformers and shall be regularly PAT tested every three (3) months.

All temporary electrical works shall be protected by a 100mA ELCB on main circuits and a 30mA ELCB on final circuits where applicable and shall be in accordance with the associated local rules and regulations and codes. All connections and installation shall be in compliance local code regulations.

3 Phase 400V and single phase 230V cables shall be PVC/PVC (SWA to be used if deemed necessary) and fastened to the structure above floor level and not obstructing corridors, escape routes or material transit routes

The Contractor shall be responsible for the maintenance of the temporary power distribution system and shall carry out thorough inspection and testing at regular intervals that will never exceed three (3) months. Conditional reports shall be issued to the Contract Administrator every three (3) months.

If portable generators are used to supply temporary power needs, the generators shall be grounded by the Contractor in accordance with local code and/or Contract Administrator

requirements and inspected on a regular basis for proper operation. Associated fuel tank installations shall be provided with tight bunds. All temporary electrical work is to be inspected on a weekly basis.

Battery charging of hand operated power tools shall take place in a well-ventilated charging room that is constructed to a one (1) hour fire rating, complete with suitable fire extinguishers.

12 LIGHTNING PROTECTION

The Contractor is responsible for installing and maintaining any temporary lightning protection of the permanent works that may be required.

13 AIRCRAFT WARNING LIGHTS

The Contractor shall arrange with his nominated (NSC) sub-contractor to provide and install temporary aircraft warning lights if required.

Any aircraft warning lights shall remain on at all times for day as well as night use.

14 TEMPORARY TOILETS

The Contractor shall install and maintain in a sanitary condition temporary toilet stations for the use of all package Contractors and Employer appointed sub-contractors throughout the entire Project duration. These temporary toilet stations shall be equipped with adequate lighting, ventilation, waste collection and water supply and shall be maintained in good condition throughout the entire Project duration.

The Contractor shall provide not less than one toilet station per fifty workers as per international regulations and shall locate these temporary toilets within the Project site limits in locations as directed and approved by the Contract Administrator. The Contractor shall provide and maintain toilets for Male & Female (if present at the project site) located at, works within the project site areas. There shall be separate toilet stations for male and female workers and staff. These toilet stations shall be maintained daily in a good sanitary condition throughout the entire Project duration.

The Contractor shall provide holding tanks and/or drainage facilities for all temporary toilet stations of sufficient capacity for sewage collection at each location and arrangements shall be made for emptying the same on a daily basis. Flushing of urinals and toilets is to be by the use of flush valves. Provide extract fans in each cubicle for ventilation.

Construction and installation of temporary toilet stations shall be in accordance with all

applicable codes and regulations of authorities having jurisdiction.

The Contractor shall be responsible for the maintenance and HOURLY cleaning of the toilet facilities and holding tanks for the duration of the Project. Include all costs associated with connections to potable water.

Upon completion of the entire Project, or at such time before completion as directed by the Contract Administrator and/or the Employer, the Contractor shall remove the temporary toilet stations.

15 TEMPORARY STAIRS, LADDERS, HANDRAILS, RAMPS AND RUNWAYS, CONSTRUCTION OPENINGS

The Contractor shall provide and maintain all equipment such as temporary stairs, ladders, ramps, runways, and chutes required for the proper execution of the work of the entire Project.

All such apparatus, equipment, and construction shall meet the, The Republic of Fiji HSAW (1996) requirements all local authority requirements and requirements applicable thereto.

The Contractor shall include in his Execution Method Statement the locations of all temporary openings.

The Contractor shall make provisions for temporary/permanent handrails and/or barricades for all openings and edges within the construction works.

The Contractor shall provide and install temporary/permanent edge protection at all times to any leading edges. At no time there shall be any open leading edge from any elevated areas.

The Contractor shall ensure that a competent person shall inspect and approve all equipment such as temporary stairs, ladders, ramps, runways and chutes prior to use and after any alterations.

16 CRANE

The Contractor shall provide all labour, material, equipment and services required for the supply, installation, maintenance and operation of any temporary Cranes and/or Mobile Cranes (if applicable) for his own use and for lifting the materials of his nominated sub-contractors and Employer appointed contractors on a 24-hour basis, 7 days per week during the time that the cranes are on-site for construction of the Contractor's Works. Any design, fabrication, installation, testing, commissioning, operation, maintenance and eventual removal of the temporary hoists and cranes shall be performed by the Contractor.

Crane operators must be physically fit, experienced, qualified, competent, and possess a third party certificate attesting to his/her competency.

All cranes which are to be used on site must have the required, valid up to date certification for the crane and all the lifting gear which will be used with the crane.

The Contractor shall provide at a minimum all labour, material, equipment and services required for temporary and/or Mobile Cranes foundations and tie-backs, all necessary temporary construction and modification with adequate protection. The Contractor is permitted to use only "Proprietary Pre-engineered" loading platforms if used.

The Contractor shall perform a structural analysis to confirm that the structure can withstand any loads imposed. This applies to both partially completed and completed structure. The Contractor shall submit his structural analysis to the Contract Administrator.

The Contractor shall allow in his Contract Sum for any additional structural support and modifications to the structure as may be required for the installation and positioning of Temporary and Mobile Cranes. It is the Contractor's responsibility for the design, engineering and installation of such modifications and support structure.

The Contractor shall submit shop drawings which include detailed information such as Mobile and/or Temporary Crane arrangements, platforms, loading deck, wiring diagrams, safety devices, overload protection, etc. Shop drawings shall indicate all load reactions at the base of the equipment, tiebacks, etc. All shop drawings shall be certified by a Professional Engineer registered with the Board of Engineers, The Republic of Fiji or international equivalent. All temporary crane shop drawings shall be reviewed and approved by the Contract Administrator.

The Contractor is responsible for any associated testing, of the Cranes, permits for operation, etc. as required by the local authorities as well as for the safety requirements of this Division 01 General Requirements document. Testing and certification of the same by internationally recognized agencies may also be required.

All warning lights and instructions for operation and routine maintenance of the equipment shall be in English and any other language that is used by the workforce.

Lifting plans and safe method of lifting for materials shall be submitted to the contract administrator before any lifts are conducted.

All contractors are responsible to provide their own competent labour for moving their

delivered or stored materials and equipment from the loading areas to their work locations

The Contractor is responsible to provide for the proper maintenance, operation, guards, signals, safety devices, etc., required for safe operation of Mobile Crane and Temporary Crane equipment.

Each crane shall be inspected daily by the crane operator to ensure it is fit for use. All and any defects will be reported immediately to the Contract Administrator.

No crane shall be operated which has been deemed to possess a fault. Any person who operates a crane under such condition will be removed from the project.

It is the Contractor's responsibility to ensure adequacy of the number, types and capacities of Cranes. The Contractor shall be responsible to install, operate and maintain sufficient Cranes to serve his requirements and that of other contractors, sub-contractors, nominated sub-contractors and suppliers.

The Contractor shall ensure that all Plant and Equipment shall be registered with the Land Transportation Authority prior to delivery to site.

17 FIRE PROTECTION

The Contractor shall meet all fire protection requirements by The Republic of Fiji Fire Department

The Contractor shall provide an emergency response plan to deal with any fires and preventative fire precautions within the works for approval by the Contract Administrator.

Any required connections for the Fire Department shall satisfy their requirements. Periodically, a review of the project site shall be made with Fire Department to familiarize them with the equipment and status of construction, as approved by the Contract Administrator.

The Contractor shall provide a minimum number of 10 Kg chemical and CO₂ fire extinguishers as specified by the contract administrator. Travel distance from any point of the construction area to the nearest fire extinguisher shall be specified by the Contract Administrator. The fire-extinguishers shall be of the (NFPA 2A) high pressure type complete with hose, mounted to theft-stopping devices that sound alarms when misused.

When more than twenty litres of flammable or combustible liquids or two kilograms of flammable gas are being used, a fire extinguisher rated not less than NFPA 10B shall be

provided within ten (10) metres unless required otherwise.

Portable fire extinguishers shall be inspected on a weekly basis and maintained in accordance with Maintenance and Use of Portable Fire Extinguishers as detailed in NFPA 10. Any fire extinguishers that are discharged or damaged shall be replaced with immediate effect.

Only Fire Extinguishers that are listed by an approved nationally recognized testing laboratory shall be used on this project to meet the requirements herein.

The Contractor shall ensure safety inspections are completed each week to replace any discharged, damaged or missing fire extinguishers. The Contractor will relocate fire extinguishers as necessary where they interfere with construction.

The Contractor shall make arrangements for periodical inspections of the temporary Fire Protection arrangements by Fire Department and local fire protection authorities and insurance underwriters. He shall cooperate with said authorities and promptly carry out their recommendations.

The Contractor when engaging in Hot Works shall adhere to the requirements of a hot work permit and shall provide a fire watchman and suitable fire extinguishers throughout the duration of the Hot Works and for 30 minutes after completion of the Hot Works.

The Contractor shall plan "just in time" deliveries to reduce the amount of material stored on site to a minimum. The Contractor shall provide all necessary facilities and equipment for fire protection of their material storage areas and areas of work.

Contractor shall ensure that his employees and staff have received training in the use of fire extinguishers and fire safety awareness.

Open fires, including for cooking or heating water for tea is NOT permitted within the building enclosure or on the Project site. No Smoking, No Cooking and No on-site accommodations.

The Contractor shall make full provision to maintain any project site offices from fire at all times and shall provide and maintain fire extinguishers with these offices and external areas.

The Contractor shall conduct fortnightly Fire Safety Audit Report if required by the contract administrator and to submit the report to the in timely manner.

18 TEMPORARY FIRE ALARM SYSTEM

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to install, operate and maintain (including testing on a weekly basis) a temporary manual fire alarm system on the Project site and in all areas where construction is underway. The temporary fire alarm system shall comply with The Republic of Fiji, Fire Department requirements and policies for Fire Alarms.

The Contractor shall provide full details of their design for the temporary fire alarm facilities to the Contract Administrator for review.

The fire-alarm system shall have a bell, charger, break-glass and a battery connected to an operating power supply. The fire-alarm shall be activated manually by break-glass. The fire-alarm shall also act as a warning bell when power supply to the fire-alarm device is cut off.

The Contractor shall have marshals or designated supervisors stationed in several areas of the project site who shall be responsible for emergency announcements and evacuation.

The supervisors shall have portable loud speakers in their possession for such announcements.

Evacuation of the workers and other project personnel shall take place only when the sounders operate continuously either manually from the control panel or automatically after a pre-determined time delay.

The Contractor shall conduct fire drills at regular periods to ensure that the employees and staff understand how to react in the event of a real time event.

The Contractor's workers shall be responsible for understanding and implementing the agreed Project fire policy and procedures during construction.

All Contractors shall have their site offices installed with building fire-alarm system consisting of automated fire alarm panels and smoke detectors.

19 SURFACE RUNOFF WATER CONTROL

Within 14 days after Contract Award, the Contractor shall provide surface runoff water control within the site. The Contractor shall keep all areas of the Project site free from the accumulation of water and throughout the period of his Contract Works.

The Contractor shall take responsibility for site drainage upon the commencement of the Works and is responsible to prevent any and all water and waste water run-off from the Project site and he shall maintain such site drainage until completion of the Works so as not

to adversely affect the adjacent areas. The prevention measures are to be documented for sustainability submission requirements.

The Contractor must maintain on Site sufficient portable water pumps and hoses to remove accumulated water from the work areas on a daily basis if required. On-site pumping equipment should be sized to handle heavy downpours of rainfall.

20 PEST CONTROL

Within 14 days after Contract Award, the Contractor shall provide the pest control within the site. The Contractor is entirely responsible for the pest control in all areas of the Project Site. Every effort shall be made by The Contractor to prevent vermin, rodents, domestic and wild animals, mosquitoes and other pests from entering the Project site. In this regard, the Contractor shall perform his work in a manner that is not conducive to proliferation of pests and animals at the Project site.

The Contractor shall be responsible to keep stray animals such as dogs and cats away from the Site.

The Contractor shall make provisions and be responsible to deal with any dangerous wildlife within the Laws of The Republic of Fiji.

The Contractor shall employ the duties of professional pest control companies to perform preventive work measures to avoid ingress of pests, vermin, rodents, etc. This shall be done at intervals to be approved by the Contract Administrator throughout the duration of the Works.

The Contractor shall be responsible to provide pest control services to the Project office of the Employer/Contract Administrators/Other consultants at intervals to be approved by the Contract Administrator throughout the duration of the Works.

The Contractor shall be responsible to provide pest control services to all areas of the site such as the canteen, messing area, toilets, first-aid centre, etc., and to his Site offices, laydown areas, storage yards and the like.

The Contractor shall be responsible for mosquito spraying and rodent prevention to be done on site through-out duration of Project at intervals to be approved by the Contract Administrator.

21 PERMANENT AND TEMPORARY FIELD OFFICES AND SHEDS

Depending on the contract, the Contractor shall at his own cost, provide, maintain in good condition and relocate as required in order to progress the work properly, a temporary site office at the Project site for his field operations and for the use of his sub-contractors, nominated sub-contractors and suppliers.

The Contractor shall set up his field office only in the location and space designated by the Contractor and approved by the Contract Administrator. The Contractor shall make his own arrangements for erecting their site office to satisfy the Project requirements.

The Contractor's temporary site office shall be constructed to a good standard, equipped with adequate ventilation, air-conditioning, light, power outlets, data/ telephones /fax /internet service, fire extinguishers, fire-alarm system consisting of automated fire alarm panels and smoke detectors and shall be well furnished as necessary to support the Contractor's construction process and day to day operations on the Project site. The temporary site office shall have adequate space and area for meetings to be held and shall have storage rooms of adequate sizes to store approved drawings, submittals and samples.

The Contractor is responsible for the cost for supply, installation, maintenance, operation and de-commissioning of all necessary services for his Site offices. Proper sanitation facilities shall be provided within the Site offices. All permits, fees, charges and monthly bills for water, electricity, telephone, internet and other services shall be borne by the Contractor.

Each contractor, whether they are Employer nominated or assigned sub-contractors shall pay the cost of actual power and water consumption in their respective field offices, lay-down areas and storage facilities to the Contractor. The Contractor shall bear the costs of water and energy consumed by his domestic sub-contractors and nominated sub-contractors

The cost of power and water consumed in the construction areas shall be borne by the Contractor.

The Contractor shall maintain in their site office a complete set of current Contract Drawings and specifications and maintain a file with all approved shop drawings, permits and other documents/data pertinent to the work.

The Contractor shall maintain their temporary site office and any temporary storage sheds in good condition and neat appearance. All temporary constructed facility's including offices, stores, compounds etc., shall comply with Fire Department regulations and be constructed with approved fire resistant materials.

The Contractor shall maintain their assigned space in good repair, free of mud, sand and

standing water.

The Contractor shall be responsible for constructing any required hoarding around their assigned space to prevent damage or loss of any stored materials. All materials stored within the Contractor's assigned space or elsewhere within the Project site are the responsibility of the Contractor.

Any additional hoarding/fencing which may be required around the Contractor's assigned lay down areas is the responsibility of the Contractor to supply and maintain. Any damage caused to other contractor's hoarding/fencing during the performance of the Contractor's work shall be repaired at the Contractor's cost.

Upon completion of Works, the Contractor shall remove his site office and facilities, clean the area, and reinstate the area to the satisfaction and acceptance of the Contract Administrator

The Contractor shall prepare and submit to the Contract Administrator for review and approval a site layout organization plan showing the Contractor's proposed layout of the area assigned to him by the Contractor and approved by the Contract Administrator for his site facilities. He shall resubmit the plan detailing any modifications to the layout which may become necessary during the course of his Works. This plan shall provide clear, full details of location, capacity, etc., for the temporary facilities including site office accommodation, plant, temporary utilities, sanitary facilities, material storage areas, fabrication/assembly yards and access routes.

The Contractor, sub-contractor, nominated sub-contractors shall be responsible for the cost of relocation and eventual removal of the temporary field office and any other temporary facilities installed by him as necessitated by ongoing construction or at such time before final completion as directed by the Contract Administrator. The Contractor shall be responsible to implement this requirement.

The Contractor shall not use any portions of the Project site or completed work areas as living, cooking (other than approved designated site canteen) or sleeping accommodation.

Within fifteen (15) days of receiving the Letter of Acceptance, the Contractor shall prepare and submit to the Contract Administrator for review and approval a site layout organization plan showing the Contractor's proposed layout of the area assigned to him for his site facilities. He shall resubmit the plan detailing any modifications to the layout which may become necessary during the course of his Works. This plan shall provide clear, full details of location, capacity, etc., for the temporary facilities including site office accommodation, plant, temporary utilities, sanitary facilities, material storage areas, fabrication/assembly

yards and access routes.

At the completion of his Works, the Contractor shall restore the space to its original condition, including the removal of any stone or gravel, and the replacement and re-grading of any removed topsoil.

22 SITE OFFICES FOR EMPLOYER / CONTRACT ADMINISTRATOR

When stipulated in the contract, the Contractor will make provision as noted below for the provision, furnishing and the maintenance etc. of an office facility for the use of the Employer and the Contract Administrator for the duration of the Works on site and up to the issue of the Final Account. The Contractor is to provide for the following items as noted below;

The Contractor shall allow for housekeeping / cleaning and complete maintenance of the Project Site offices not be limited to removal of trash, debris, periodic/weekly removal of sewage waste, day to day cleaning including office areas, toilets, wash rooms, and pantries, pest control and maintenance of office electrical, mechanical A/C, plumbing services and fire extinguishers.

The Contractor shall make allowance for the upkeep of internet connection within the Project Site Office.

The Contractor shall provide office consumables such as stationary and administrative items as requested by the Contract Administrator and Employer. The Contractor shall provide a detailed breakdown of all items prior to request by the Contract Administrator. A provisional sum shall be provided for this purpose in the payment schedules.

The Contractor shall provide continuous security personnel for 24 hours 7 days per week coverage to the Project Site Office.

The cost of power, water and any other utility of Local Authority bills consumed in the Project Site Office shall be borne by the Contractor.

Upon completion of Works, the Contractor shall remove the Site offices and facilities, clean the area, reinstate the area to the satisfaction and acceptance of the Contract Administrator / Employer.

23 DRINKING WATER STATIONS ON PROJECT SITE

The Contractor shall provide and maintain in good order, an adequate number of drinking water stations throughout the Project site for the use of all workers.

The location of drinking water stations shall be included on the Contractor's site logistics plan and approved by the Contract Administrator. The Contractor shall relocate as necessary as construction progresses.

24 ON SITE ASPHALT / GRAVEL TESTING LAB

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to retain and employ an independent 3rd party testing laboratory as approved by the Contract Administrator to conduct all required testing for the duration of the works. The testing lab must be one of the pre-approved companies listed in the specifications. All Asphalt / gravel testing conducted on site shall be within a testing laboratory on site to house the testing lab equipment as well as provide for storage of test materials.

160.14 MATERIAL AND EQUIPMENT

1 DELIVERY AND STORAGE OF MATERIALS

Generally, materials shall be delivered to the Site at the most suitable times for programme requirements and in advance of construction requirements. The Contractor shall carefully store them in order to prevent damage prior to incorporation into the Works.

2 SOURCE OF MATERIALS

The Contractor shall use locally sourced materials and products whenever possible providing they comply with the Contract Specifications.

There may be restrictions imposed by Government Authorities, etc. on the importation of certain products which are also manufactured locally or elsewhere. The Contractor shall be responsible for finding out what, if any, these restrictions are and for checking with the companies concerned to ensure that the Contract requirements can be satisfied.

The Contractor shall submit within thirty (30) days of the Commencement Date a complete and detailed list of the source of all materials and articles proposed for use in the Works together with the names and addresses of manufacturers and suppliers, inclusive of those utilized by sub-contractors. This list to be maintained and expanded upon for Sustainable material submission requirements.

Copies of the orders for imported materials and certificates of origin together with the supplier's confirmation of such orders shall be submitted to the Contract Administrator as

soon as they are available. The Contractor shall identify all long lead items of plant and/or equipment.

Where the source of a particular material is not stated, samples of the materials specified shall be submitted to the Contract Administrator for approval before placing orders.

The Contractor shall ensure that all proprietary articles and materials incorporated in the Works are fixed and used in strict compliance with the particular manufacturer's instructions.

The Contractor must ensure that all materials purchased will be from a reliable source which will ensure continuity of supply in case of additional work and if any damage occurs at all times throughout the period of the Contract to ensure regular supply and progress of the Works.

3 INSPECTION VISITS OUTSIDE THE REPUBLIC OF FIJI

The Contractor is deemed to have included in his Tender for any cost that may incur for arranging inspection visits outside of The Republic of Fiji.

The Contractor shall bear the actual costs of travel, appropriate hotel accommodation and boarding for the representatives of the Contract Administrator for such visits necessitated by the specifications.

The costs incurred by the Contractor for similar expenses for his personnel for such visits shall be borne by the Contractor.

The visits may include for inspection of materials, witnessing in-plant testing, fabrication facilities, etc.

Such visits by representatives of the Employer and/or the Contract Administrator shall not relieve the Contractor from meeting the Contract requirements.

4 QUALITY

Products shall be new, unless otherwise specified. The Contractor shall ensure that the whole quantity of each product and material required to complete the Works is of consistent kind, size, quality and overall appearance, comparable with the specifications, for the purpose intended. If requested, furnish evidence as to type and source and quality of products provided.

Defective products whenever identified prior to the completion of work will be rejected

regardless of previous inspections. Inspection does not relieve the Contractor of defective products, but is a precaution against oversight or error. The contractor must remove and replace defective products at no additional cost to the Employer and be responsible for delay and expense caused by rejection. Should any dispute arise as to the quality or fitness of products, the matter shall be decided by the Contract Administrator in accordance with the contract.

All materials shall be specifically designed for use in hot & humid climates. The Contractor shall provide full details of all materials proposed, including evidence that they have proved successful in use in conditions equal to those prevailing in The Republic of Fiji.

The Contractor must remove from the Site, without delay, all rejected and condemned Plant, Materials or structures of any kind. Should the Contractor fail to do so, or to make satisfactory progress in doing so, within 48 hours after the service of a written notice from the Contractors Administrators, the condemned materials or work may be removed by the Principal at the Contractor's cost. Once rejected or condemned, the Contractor shall not offer any such Plant, Material or structure for use under the Contract.

5 PROOF OF COMPLIANCE

Certifications and Test Data: Whenever the Contract Documents require that a product complies with certain published standard or specifications, such as ASTM, ANSI, EN, BS, DIN, MS or other published standard, the Contractor shall submit a statement from the manufacturer certifying that the product complies with such requirements. If further requested by the Contract Administrator, the Contractor shall also submit supporting test data to substantiate such compliance.

6 EXPEDITING

The Contractor shall be required to submit copies of agreements, sub-contracts and purchase orders for the materials and sources that he obtained from others after blanking out pricing information, as soon as such agreements are entered into.

The Contractor shall ensure that the representatives of the Employer and/or the Contract Administrator are given free access to the manufacturing, fabrication facilities of the various vendors to witness any test, of materials and to monitor the progress of work. The Contractor shall make all arrangements for such provisions.

The Contract Administrator may have expeditors or inspectors posted at various fabrication facilities of the Contractor, his Sub-Contractors or suppliers, either full-time or part-time

during the fabrication period. Such posting of expeditors, if in the opinion of the Contract Administrator, is necessitated to expedite delivery or to assist the Contractor in inspections, all costs incurred by the Contract Administrator shall be borne by the Contractor.

The Contractor shall be responsible for all additional costs incurred by the Contract Administrator and the Employer in expediting delivery of any material that falls behind schedule.

7 DELIVERY OF MATERIALS

Generally, materials shall be delivered to the Project site at the most suitable times for schedule requirements and in advance of construction requirements. They shall be carefully stored by the Contractor in order to prevent damage prior to incorporation into the Works.

The materials shall be delivered by carriers suitable for the type of product or equipment.

The Contractor shall conform with the procedures related to entry permits, authorization, etc., as prescribed in the contract, in accordance with relevant regulations and/or by the Employer or the Contract Administrator.

The time of delivery of materials to the Site shall not be disruptive to other ongoing works of the Contractor or other contractors employed on the Project.

The Contractor shall adopt a "Just in Time" approach with regard to delivery and storage of materials and shall be considerate with regard to limited space available at site.

The Contractor shall conform to the security procedures, rules and regulations prescribed by the Laws of Fiji.

Delivery of materials and equipment to occupied facilities shall be coordinated with the Contract Administrator and respective Security In-charge.

The Contractor shall arrange for off-site storage as required and schedule all deliveries with the Contract Administrator. For materials and/or Equipment stored off-site the Contractor shall use bonded and insured storage facilities. Payment for materials off-site shall be at the Employers discretion and as a minimum is subject to be insured storage facilities.

8 TRANSPORTATION AND HANDLING

The Contractor shall use extreme care in the transportation and handling of materials to and within the Project site. The materials shall be transported in a manner that does not hinder

progress of other Contractors' work at the site, and that inconvenience is avoided to any occupied tenants. Depending on the availability of storage areas within the site, it may be necessary for the Contractor to store his materials elsewhere, outside the Project limits, until they are needed for immediate use. The Contractor shall obtain prior approval of the Contract Administrator for arranging all storage areas on and off Site.

All Contractors, Sub-Contractors and his Nominated Sub-Contractors shall provide for their own craneage / forklifts, etc. for unloading /loading of their materials in their storage yards.

9 STORAGE AND PROTECTION

The Contractor shall use only the designated spaces as assigned and approved by the Contract Administrator for material storage. The Contractor shall arrange for any off-site storage and schedule deliveries of the materials on an as-needed basis. The mode, routing and time of delivery of materials shall be reviewed with the Contract Administrator, prior to actual deliveries.

The Contractor is responsible for marshalling and staging his materials. All costs associated with a storage yard including receiving, unloading shake-out, reloading and delivery to the Site are deemed to be included in the Contractor's rates and prices.

The Contractor shall provide covered and secured storage of samples as may be required on the Project from time to time. Should the Contractor's materials stored on Site interfere with the permanent construction, he shall promptly move these materials when directed by the Contract Administrator; all related costs shall be borne by the Contractor.

The Contractor shall handle, store and fix products to manufacturer's instructions with care to ensure that they are not damaged when incorporated into the work, to the Contract Administrator's approval.

The Contractor shall furnish the Contract Administrator with copies of manufacturing test certificates where applicable and quality control certificates.

The Contractor shall provide air-conditioned storage rooms for any materials that require storage in a controlled environment.

The Contractor shall be responsible for protection of stored materials from weather, negligence and other contractors, until their installation in the Works and hand over of the completed facilities to the Employer.

The Contractor's materials may require to be relocated from time to time as directed by the

Contract Administrator, to accommodate construction by other parties, at no additional cost to the Employer.

The Contractor shall take delivery of any Employer supplied materials, put them in proper storage and be responsible for protection of the materials.

Delivery and storage of all materials are required to comply with all Safety requirements as identified within this General Requirements document.

The Contractor must remove from site all Plant, Structures and Materials, utilised to facilitate construction at Practical Completion. Should the Contractor fail to do so, or to make satisfactory progress in doing so, within 7 days of Practical Completion, the Principal may remove the items at the Contractors cost.

160.15 SETTING OUT

1 GRADES, LINES, AND LEVELS

The Contractor shall be responsible for the establishment and maintenance of temporary survey benchmarks and coordinates on the Project site throughout the duration of the Contract. All permanent bench marks shall be adequately protected and shall be reinstated by a registered surveyor in accordance with the requirements of the Lands Department, if disturbed or damaged.

Where stipulated, site datum and coordinate system shall be related to the national grid system. Otherwise, the Contractor shall establish a local system of survey control. Irrespective of availability of any survey markers on the Site, the Contractor shall be responsible to perform his own survey and establish survey markers and/or verify the authenticity and accuracy of any existing survey markers. The Contractor shall establish a number of temporary setting out stations from which Works shall be set out. The details of the survey performed by the Contractor shall be submitted to the Contract Administrator for review and approval. The Contractor shall also verify his survey data with the local authorities as required.

The number and location of temporary benchmarks shall be such that the maximum distance from a temporary benchmark to any construction activity shall not exceed 50 metres. Temporary benchmarks shall be formed by fixed monuments with a standard detail to be approved by the Contract Administrator.

All baselines, coordinates etc. are to be detailed on a control drawing prepared by the

Contractor and the setting out shall be approved by Contract Administrator before the Contractor commences the Works. Such approval shall in no way relieve the Contractor of his responsibility for the correct execution of the Works.

The Contractor shall verify all measurements and be responsible for their correctness. No extra charge or compensation will be allowed on account of differences between actual measurements and the dimensions given in the Drawings and Specification. Any differences that may be found shall be submitted to the Contract Administrator in writing for consideration and directives before proceeding with the works.

2 SETTING OUT

The Contractor shall carry out as his own responsibility and at his own expense the setting out of the work, definition of levels and setting out lines, axes and slopes, all in accordance with the Drawings.

The Contractor shall be responsible for the true and proper setting out of the work in relation to original points, lines and levels of references given in the Drawings and for the accuracy of the positions, levels, dimensions and alignment of all parts of the work, and for any delay or loss resulting from errors made in completing the setting out of the work. The Contractor shall protect, preserve and be responsible for all existing bench marks, pegs and boundary marks and shall keep them in place or replace them when necessary or as directed by the Contract Administrator either in their original positions or in some other approved positions.

Two (2) ground marks (local bench mark) must be constructed to ensure stability, permanence, ready identification and ease of access. The mark must be a galvanised pipe with minimum diameter of twenty millimetres (20mm) driven into ground a minimum depth of one metre (1m) and grouted with concrete. The galvanised pipe must be extended to solid ground in fill areas.

Prior to commencement of any earthworks the Contractor must undertake topographic survey of twenty metre (20m) corridor along the alignment. Contract Administrator must be advised forty-eight (48) hours prior to commencement of survey pickup. Failure to undertake the topographic survey prior to commencement of earthworks will incur 10% penalty on the Contract Sum. The survey information must be submitted to the Contract Administrator within two (2) weeks of earthworks programme. The topographic survey must be provided on a paper and in dwg format.

The Contractor's survey crew shall co-operate with the Contract Administrator and/or those designated by the Contract Administrator and shall verify the survey control points,

benchmarks, existing ground levels, etc. The Contractor shall immediately notify the Contract Administrator of any disagreements or discrepancies.

Setting out shall be approved by the Contract Administrator before commencing the works, but such approval shall in no way relieve the Contractor of his responsibility for the correct execution of the work.

3 SYSTEM OF HORIZONTAL COORDINATES

The Contractor shall establish an internal Site grid of horizontal coordinates, based on the Contract drawings.

The grid shall be accurately set-out by transferring the coordinates from the approved benchmark(s) established at the Site by the Contractor.

4 APPEARANCE AND FIT

The Contractor shall arrange the setting out, erection, juxtaposition of components and application of finishes (working within the practical limits of the design and Specification) to ensure that there is a satisfactory fit at junctions and that the finished work has a well aligned true and regular appearance.

It shall be the responsibility of the Contractor to verify work installed by others that may have an impact on the appearance, quality and fit of his work or that of any sub-contractors or his nominated sub-contractors and notify the Contract Administrator sufficiently in advance of any potential problems or conflicts, so as not to impact the Schedule. The Contractor shall obtain resolution from the Contract Administrator in respect of such problems or conflicts prior to proceeding with further work. Failure to do so shall constitute acceptance of the installed work and the Contractor shall assume responsibility for any corrective work that may be required as a result.

5 NON-COMPLIANCE

Where work fails to meet the specified levels of accuracy the Contractor shall rectify such work as instructed by the Contract Administrator.

The Contractor shall:

- Submit proposals for such rectification and meet all costs arising, including effects on other work.

- Allow for the possibility that approval will not be given necessitating removal and replacement of the work.

160.16 EXECUTION METHOD STATEMENT

1 EXECUTION METHOD STATEMENT

The Contractor shall submit an Execution Method Statement as required by the tender documents. The method statement shall cover major aspects of construction and shall encompass the Tenderer's management and implementation plan for the Works including but not limited to, organisation, staffing, general approach to engineering, fabrication, delivery, installation, quality control, methodology of fabrication and completion of Works with particular attention to special details etc. and special site conditions and requirements. The Method Statement shall detail the sequence of operations and strategy to be utilised in order to achieve completion of the Tenderer's Scope of Work and this shall be used to demonstrate and evaluate the technical capabilities and expertise of the Tenderer.

Within 14 days of the Commencement Date and prior to commencement of any work at Site (or as stipulated in the contract), the Contractor shall prepare and submit a detailed method statement addressing all aspects of the work and the overall safety, access, storage, distribution and security measures to be implemented throughout the Works. The Method Statement shall be exhaustive and cover all major components of design and execution, for approval by the Contract Administrator.

Method Statements for tasks been performed on the project must cover all aspects of safety for the tasks for which it has been produced. This includes, but not limited to; description of the works, access and egress resources, risk assessments, certification for plant and equipment, competency of operators, PPE, housekeeping, competency of supervision, time scale for work permits and permits to work. Method statements must be explained to the team conducting the works in a language that is understood by all staff and workers and must be signed off as being understood.

2 DETAILS TO BE INCLUDED IN THE EXECUTION METHOD STATEMENT

The Contractor shall not be permitted to commence the Site work until he has submitted all details regarding the execution of work as listed below. Particular attention shall be paid to quality, safety and schedule requirements in the preparation of the detailed method statement. The Method Statement shall be clearly titled, with revisions numbered and dated, the format of which shall be as approved by the Contract Administrator.

The Contractor's Method Statements, as a minimum, shall:

- Describe the management and implementation methods for the procurement, engineering, fabrication, transportation, installation and testing of materials and workmanship.
- Describe the proposed methods of construction including construction equipment, trials, etc.
- Supplement the written information with drawings / diagrams as deemed necessary.
- Identify specific co-ordination/interface requirements with other contractors' work including preparation and submission of various technical submittals (drawings, sketches, calculations, material submittals).
- Address specific safety related precautions and measures proposed to be taken and describe emergency procedures.
- Address safety and security procedures.
- Identify the access routes and site logistics.
- Describe all temporary construction requirements including detailed locations of equipment, their capacities, clearances, etc. supplemented by relevant sketches.
- Identify areas for storage of materials and detail handling procedures.
- Identify existing services, structures, etc. in the proximity of the works to be carried out and detail the methods of execution.
- Detail how the works are to be set out.
- Describe the procedures for verification of construction and erection tolerances, and the stages at which checking of constructed works shall be done.
- Detail all proposed construction equipment and manpower to be utilised.
- Identify the person designated to be in-charge of the specific work being addressed.
- Include contingency plans to be implemented to mitigate the effects of identifiable risks.
- Production of contractor's shop and working drawings;
- Include detailed sketches, diagrams, calculations, etc., to render the method statements easily comprehensible.
- Relate to the approved Programme activities.
- Specific detailed Quality control procedures.
- Specific Safety requirements and implementation procedure.

The Construction Method Statement shall be submitted to the Contract Administrator for review and approval. The details such as site logistics, storage of materials, construction

equipment and manpower, security, safety precautions, etc., shall be reviewed and approved by the Contract Administrator.

In addition to the above method statement, the Contractor shall submit for the review of the Contract Administrator, when requested, more detailed method statements for specific portions where required.

In scheduling the Works, the Contractor shall allow a sufficient period for the review and approval of the Detailed Construction Method Statements.

The Contractor shall note that the methods proposed by the Contractor may not necessarily be approved in its entirety. The Contractor shall comply with any modifications or changes suggested by the Contract Administrator at no additional cost to the Employer.

3 ASSIGNMENT AND SUB-CONTRACTING

Unless otherwise provided in the contract, the Contractor must submit a request for approval for any proposed sub-contractor he intends to hire to carry out any portion of the Contractor's Works. Such sub-contractor shall be a specialist in his trade and the submittal shall include the minimum level of information to enable the Contract Administrator and/or the Consultant to review his capability and suitability to participate in the Project.

The Contractor's request for approval of any proposed sub-contractor shall include the following information at a minimum; copies of documents defining the constitution or legal status of the sub-contractor, the place of registration, and principal place of business of the sub-contractor; a written power of attorney of the signatory of the company management, a record of the general construction experience of the sub-contractor, total annual turnover in expressed as total of contracts in progress or completed in each of the last three years, particular construction experience records on works of a similar nature and complexity over the last five years, and details of work under way or contractually committed, names of employers who may be contacted for further information on the performance of the sub-contractor on those contracts, equipment capabilities expressed in list of the major items of construction equipment proposed to carry out the sub- contracted Works, qualifications and experience of key Site management and technical personnel proposed by the sub-contractor.

The Contractor at all times remains fully responsible for the executed works carried out by any of his sub-contractors as well as the behaviour and compliance with their staff and employees to all legal registration and compliance with law and regulations.

The Contractor shall be fully responsible to provide technical data, quality control services,

all other supports to his sub-contractors at all time.

The Contractor's sub-contractors shall fully adhere to the safety and health regulations stipulated in the Contract documents as well as the requirements of the General Requirement document and in particular Section - SAFETY. The Contractor shall keep the sub-contractors fully aware of their rules and the Site conditions and the conditions of Contract.

4 ADDITIONAL REQUIREMENTS

In programming the works, the Contractor shall allow a sufficient period in accordance with Section - SUBMITTAL PROCEDURE for the review and approval of the Detailed Execution Method Statements.

160.17 CONTRACT CLOSEOUT RECORD DOCUMENTS

1 GENERAL

This section includes only general requirements regarding contract closeout submittals. In addition, specific requirements are given in other sections of the General Requirements and the particular specifications.

The Contractor shall prepare and submit to the Contract Administrator a contract close out plan for his portion of the Project.

The close-out requirements from the Contractor include but are not limited to the following:

- Final cleaning/Snagging/Adjusting/Outstanding Works.
- Original Contractor Guarantee.
- Project Record Documents in a format approved by the Contract Administrator.
- Any Operation and Maintenance Data (incorporating Health and Safety information) in a format approved by the Contract Administrator.
- Any Spare Parts and Maintenance Products.
- Any Warranties / Guarantees.
- Maintenance Services and if called for elsewhere in the Contract Documents.
- Items 3, 4, 5, 6 and 7 above shall be submitted in the form of a bound report (3 copies) as well as in soft copy (pdf format).
- As-Built drawings in a format approved by the Contract Administrator.
- Any other hand over documents as requested by the Contract Administrator in a format approved by the Contract Administrator.
- Submittal list and its status (All the submittals shall be in A, B or E status).

- NCR's list and its status. (All NCR's must be closed).
- Licensed survey to survey all boundaries and alignment survey.
- Health and Safety File

2 AS BUILT DRAWINGS

As the Works progress the Contractor shall maintain a complete and accurate record of all changes and deviations from the Drawings, shop drawings and Specification, indicating the Works actually installed. This record set of prints of Drawings, shop drawings and Specification shall be kept at the Site for inspection by the Employer and the Contract Administrator.

Towards the completion of the Works the Contractor shall incorporate the as-built condition into a Record Copy of the electronic drawing format and certify that each of the revised record drawings and documents stated above is complete and accurate and shall submit them to the Contract Administrator for review and approval.

Prior to request for a Certificate of Practical Completion (CPC) or Taking Over Certificate for the Works, or for Sections thereof, the Contractor shall submit one (1) high quality reproducible drawing and five (5) printed sets of the record "As Built" (hereinafter referred to as As-Built) drawings. A comprehensive index of all As-Built drawings shall be included. A digital copy of all these documents shall also be provided.

As Built drawings should include updated construction drawings and show all approved changes. The As-Built drawings shall be in hard copies as well as electronic copies. As-Built drawings shall have all revision clouds and revision triangles removed and the words "As Built" shall be written in the revision box above the title block. The latest revision and date shall be indicated in the appropriate spaces.

The Contractor shall also supply three (3) full document sets on storage devices approved by the Contract Administrator, containing all drawings in ".dwg" (latest AutoCAD and software from AutoDesk, and/or as approved by the Contract Administrator) formats. In addition, all documents to be supplied in .pdf format.

Drawings shall be grouped as per the agreed structure of hard copy sets, each group contained within an appropriately named folder. No folder shall be split between Storage Devices. File structure and nomenclature system shall be submitted for separate approval.

3 OPERATIONS & MAINTENANCE MANUALS

Prior to request for a Certificate of Practical Completion (CPC) or Taking Over Certificate for

the Works, the Contractor shall submit for the Contract Administrator approval one draft copy of all operation and maintenance manuals which shall provide all necessary information for the proper upkeep of all the constructed works by the Contractor, including but not limited to:

- List of all shop-drawings with description.
- Relevant Specification number.
- Description of material or equipment including tag number, if applicable.
- Quantity and location.
- Catalogue cuts, if applicable.
- Manufacturer's preventive maintenance procedures.
- Methods and materials to be used in above (e.g. cleaning).
- Parts list.
- List of recommended spare parts.
- Name and address of supplier.
- Expiration date of warranty.
- Name and address of manufacturer.
- Maintenance Records.

After review and approval by the Contract Administrator, the Contractor shall submit a minimum of four (4) bound copies in a format acceptable to the Employer.

The Contractor shall also submit 2 electronic copies of Operations and Maintenance Data in a contemporary version of Adobe Portable Reader format (.pdf) or similar approved, including all graphics, catalogue cuts, etc., scanned at A4 / A3 size and included as high resolution '.jpg' (JPEG) files. Resolution of scan shall be minimum 300dpi.

Where specified, the Contractor shall undertake the training of the Employer's Maintenance teams to ensure that the Operations and Maintenance Manual, and the equipment are familiar and understood. Notes of the training sessions shall be incorporated into the final manuals.

4 WARRANTIES

The Contractor shall provide manufacturers, suppliers and installers warranties for the Works including equipment, material, product or system performed under the Contract in accordance with specification requirements. These warranties shall be in addition to and not in lieu of all other liabilities which the Contractor may have by law or by other provisions of the Contract and shall be made solely in favour of the Employer.

All materials, items of equipment and workmanship furnished shall carry the standard

warranty against all defects in materials and workmanship. Any faulty or defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, including all other damage done to areas, materials and other systems resulting from this failure.

Warranty period, as noted in the specifications, for any equipment, material, product or system shall be calculated to take effect from the day after the completion of the Defects Liability Period. Until the Defects Liability Period is complete, the Contractor shall hold necessary warranties from their sub-contractors, nominated sub-contractors, suppliers, and manufacturers. It is the Contractor's responsibility to obtain warranties that shall be valid throughout the duration and time as calculated in this clause.

Upon receipt of notice from the Employer of failure of any part of the Work during the Defects Notification Period or such other period as specified in the Conditions of Contract, the affected part or parts shall be replaced by the Contractor at no expense to the Employer.

The Contractor shall provide warranties with durations as indicated in the particular specification section. The Contractor's sub-contractors and nominated sub-contractors shall obtain and/or provide warranties under their scope as joint or multi-party warranties to the Contractor. The Contractor shall provide these warranties to the Employer wherein he shall be one of the parties, who shall be jointly and severally be obliged to provide the required assurance. All warranties shall be in the format provided by the Contract Administrator or the Employer.

The warranty for the Contractor shall cover the materials supplied and installed and the workmanship. The Contractor shall obtain samples of warranties from his sub-contractors, nominated sub-contractors and vendors immediately upon placement of orders with them for submission to the Contract Administrator for review and approval. The Contract Administrator shall verify the contents of the warranty seek modifications if required and return it back to the Contractor.

The Contractor shall then prepare the Final Warranty document in the same format and words as approved by the Contract Administrator. Payment for the completed work shall not be released completely without the approval of the Final "Original" warranties.

5 MAINTENANCE

Where maintenance of the Works is called for in the Contract documents, unless specifically detailed, all maintenance shall be comprehensive and shall include preventive maintenance, breakdown maintenance and emergency maintenance.

Maintenance period shall commence the day after the issue of the Certificate of Practical Completion (CPC).

6 AS CONSTRUCTED INFORMATION AND PROJECT SIGN BOARD

The Contractor must forward to Contract Administrator an as-constructed report together with the Practical Completion Claim. The report as a minimum must address the following:

- Geotechnical test results
- Crossing / culvert locations and treatment.
- Concrete test results
- Local survey bench marks
- Updated drawings – complete

7 HANDING OVER OF WORKS TO FOLLOW-ON CONTRACTORS

The Contractor shall handover his work areas in a clean, tidy and timely manner after a joint inspection with the Contract Administrator obtaining their approval and sign-off in writing.

Any follow-on contractor upon commencement of his Works shall ensure the adequate protection of the previous contractor(s) works and he shall be responsible for any damage to those works incurred during his occupation at the Site.

8 CERTIFICATION OF COMPLETION OF WORKS

When construction / erection of the Works is complete (or of any portion if requested by the Principals Representative), the Contractor must provide the Contract Administrator with a written certificate, signed by the Contractor's Construction Reviewer (Chartered Engineer) and the Contractor stating that the work has been carried out in accordance with the Terms of the Contract. The issuance of the Completion Certificate is dependent on satisfactory project close out and the following will be required:

- A3 size drawing of the actual areas being handed over, clearly indicating the limits and interfaces of this section of the Works.
- Snagging (Punch List) – All areas of work must be inspected and signed-off by the Consultant(s) and /or Contract Administrator.
- Sign-off of final inspection, testing and commissioning must be submitted, or if not completed then noted on the Outstanding Works List.
- Corrective Action Reports (CAR) detailing the satisfactory closure of all NCR's. All Non Conformance Reports (NCR's) must be closed within 28 days of being issued

and the Contractor will not be allowed to request completion until such time as all NCR's are signed off.

- A programme for completing all outstanding works must be provided.
- Contract close-out must also meet the requirements of the laws of The Republic of Fiji.

END OF SECTION

SECTION 161 – OCCUPATIONAL HEALTH AND SAFETY

161.01 GENERAL

As the Contractor responsible for the overall construction of the Project, it is entirely the responsibility of the Contractor to establish and implement all safety precautions and procedures to the requirement of each task performed on the Project site. Approval, agreement, endorsement or the like of the Contractor's Safety Plan if so provided by the Employer and/or the Contract Administrator shall not limit or absolve any responsibility of the Contractor and no other party except the Contractor is liable for any mishaps at the Site during the period of construction.

The Employer and Contract Administrator's safety goal for the Project is "NO LOST TIME ACCIDENTS". The Contractor, his sub-contractors, nominated sub-contractors and EACH Contractor on the Project site are required to do everything it takes to attain this Project goal. The Contract Administrator will issue Safety Fines as listed this document for safety violations witnessed by his staff or other designated Employer representatives.

Along with any requirements stipulated in the contract, this section defines the requirements for the Contractor to implement a proper safety program during the construction of the Works. This section describes certain minimum safety requirements for the Contractor to employ on the Project. The responsibilities of the Contractor are not limited to the provision of requirements identified in this document.

The Contractor shall strictly adhere to all safety rules, regulations and requirements of local authorities having jurisdiction. The Contractor shall follow all safety procedures prescribed in The Republic of Fiji Health and Safety at Work Act (1996) and all other local acts, codes and regulations. Contractor shall have printed copies of all applicable manuals on site.

Where any requirement explained in this section varies from that prescribed in any rules, regulations and requirements of authorities having jurisdiction, more stringent of the requirement shall apply.

The Contractor is required to familiarize himself with the requirements of these safety standards.

161.02 SAFETY

Within fourteen (14) days after the Commencement Date (or at such other time as may be stipulated in the contract), the Contractor shall submit, for the Contract Administrator's review

and approval, a “Project Specific Safety Plan” (hereinafter referred to as the Safety Plan), naming the key person in that organisation who will be responsible for administering the programme. This Safety Plan shall incorporate all the requirements for Project safety and accident prevention and in particular the safety requirements listed in the safety checklist. No works shall commence until the Project Specific Safety Programme is approved by the Contract Administrator.

The plan shall indicate the Contractor’s plan for protecting ALL workers, sub-contractor and nominated sub-contractor personnel and others working at the Project site as well as the general public in the surrounding area and how equipment and materials will be protected. The plan should include a site evacuation plan, weather plan, an injury evacuation plan and shall address, but not be limited to, organization, personnel, inspections, items such as protective barriers, personnel and safety equipment, netting, fire-watch, etc. The evacuation plan needs to be updated periodically (minimum every six months) in coordination with the site progress/layout and a full evacuation drill to be held once at least every 3 months.

The Contractor shall submit a crane lifting plan (if applicable) detailing procedures to be followed when lifting materials onto the various areas of the Project. The crane lifting plan shall include methodology for heavy lifts, general lifting procedures, and any tandem lifts will require a specific lifting plan. The crane lifting plan shall be submitted for the Contract Administrator’s review and approval, not less than fourteen (14) days prior to commencement of crane operation. No works shall commence until the Lifting Plans are approved by the Contract Administrator.

The Contractor shall integrate an overall Safety Plan incorporating all of his sub-contractors’ and nominated sub-contractors’ specific safety requirements. All sub-contractors and nominated sub-contractors shall support the Contractor by providing their input and requirements in full detail. The Safety personnel detailed in this section shall be provided by the Contractor and also by all sub-contractors and nominated sub-contractors.

The Contractor shall organize a “Site Crisis Management Team” that shall be headed by the Contractor’s Safety Manager. The Contractor’s Safety Manager shall be suitably qualified and shall have extensive experience (at least fifteen (15) years) in managing safety with specialization in construction projects. In the event of a second shift, the Contractor shall employ a safety manager for that shift of equal qualification. The Site Crisis Management Team shall comprise Safety Engineers from all sub-contractors, nominated sub-contractors and EACH contractor on the Project site. In addition, a number of foremen shall be identified, to liaise and coordinate with the Safety Engineers. The foremen shall be suitably trained by the Safety Engineers, who shall be responsible for clearly identified tasks, during emergencies.

The Contractor shall submit a detailed organization chart detailing the tasks of each individual forming the Site Crisis Management Team for the review of the Contract Administrator.

All employees shall be physically qualified for performing the duties to which they are assigned. Operators of equipment and vehicles shall be suitably trained in the operation of the particular equipment and vehicles and possess all licenses required by the Laws of the Republic of Fiji or other relevant international standards. They must also be able to read and understand the signs, signals and operating instructions in use.

The Contractor shall develop and submit an Emergency Preparedness and Response Plan (ERP) before any work commences at the Site. The Plan shall detail the arrangements for all potential emergencies associated with the Works. The ERP shall provide clear instructions to be followed in the event of emergency incidents and shall include the process of evacuation from any areas that incidents may occur in. The ERP shall specify the arrangements necessary to deal with all potential emergency incidents.

Prior to starting work on the Project, the Contractor shall establish contacts for ambulance service and medical assistance from medical services in the vicinity of the site.

The Contractor shall provide and maintain a manned (Nurse) first-aid facility on Site where over 50 workers are present. The First Aid facility shall include stretcher, bed (cot) hoisting cage to assist in safe transportation of any injured party if/as required. Nurses shall have credentials attesting to having been trained in First Aid/CPR/AED procedures. There shall be 1 trained first aid worker per every 50 workers on site.

Communication and transportation to effectively care for injured workers shall be provided by the Contractor. First aid kits, in the ratio of one (1) unit for each twenty five (25) persons or less, shall be provided on the Site. They shall be easily accessible to all the workers and personnel.

The Contractor shall comply with The Republic of Fiji Health and Safety at Work Act (1996) and all subsequent updates in respect of First Aid. First aid kits shall be easily accessible to all the workers and personnel.

161.03 SAFETY PLAN

The Safety Program established and maintained on the Project shall incorporate the requirements of The Republic of Fiji Health and Safety at Work Act (1996) and all other local codes and regulations.

The purpose of the Safety Plan is to elicit the interest and efforts of all personnel, both

management and supervisory, required for the prevention of injuries and accidents, through proper and thorough training and instructions to employees.

Within fourteen (14) days of issue of the confirmation of contract award (unless stipulated otherwise in the contract), the Contractor shall submit, for the Contract Administrator review and approval, his job specific Site Safety Plan, naming the key person in his organisation who will be responsible for administering the plan. This safety plan shall incorporate all the requirements for project safety and accident prevention and in particular the safety requirements listed in the safety checklist.

The Contractor and their supervisors/foremen are responsible for the administration of a comprehensive Safety Programme.

The Safety Plan shall embody the prevention of accidental injury, occupational illness and property damage. The Contractor shall provide and maintain a safe, hazard free workplace for their employees, for fellow workers, sub-contractors, nominated sub-contractors, other contractors, the employer, contract administrator, suppliers, inspectors, and the general public. As a minimum, the Contractor's Safety Programme shall incorporate all of the principles of this document. In addition, EACH contractor shall comply with safety regulations and requirements suggested by the Contract Administrator.

The Safety Plan shall ensure the involvement and active participation of all of the Contractor's employees on the Site as well as his sub-contractors on the Site by requiring safety training, which will promote recognition of unsafe acts, potential and actual hazards and the immediate corrective action to be taken. All employees shall be constantly aware of their responsibility to work in a safe manner.

The Contractor and his sub-contractors and his nominated sub-contractors, has a contractual obligation to perform their work using safe methods and to comply with the Project Safety Plan.

The Contractor's sub-contractors and nominated sub-contractors shall not have a separate safety plan. The Contractor's Safety Plan shall incorporate any special requirements of his sub-contractors and nominated sub-contractors' safety program. The Contractor shall fully coordinate such requirements with his sub-contractors and nominated sub-contractors.

Specific principles for protection requirements of EACH contractor are as follows:

- Protection of Works until issue of Taking Over Certificate
- Protection of work of others adjacent during construction
- Protection of own personnel and other personnel working in the surrounding area.

The Safety Programme shall include a comprehensive Hazard Communication Programme which includes container labelling and other forms of warning, material safety data sheets (MSDS) and employee training.

The Contractor is to review and comply with Appendix A; FRA Health, Safety, Security and Welfare System for compliance. This document is to be read in parallel with the General Requirement's. Pending any discrepancies, the General Requirement Document to take precedent.

161.04 MANAGEMENT ORGANIZATION

The Contractor shall employ a Safety Manager who shall have the overall responsibility to implement all safety measures on the Project site. He shall have full authority to direct work stoppages and to expend funds, as necessary, to eliminate hazards and imminent danger conditions on the site. For major contracts and where stipulated in the contract, the Safety Manager shall be full time position.

The Contractor shall employ trained Safety Officers for each Section of Works. The Safety Officer shall be deployed in full time basis where in the opinion of the Contract Administrator, this is required by the nature of the works. The Contractor is responsible to ensure sufficient shift of Safety Officers shall be deployed to cover Works that is required to be carried out beyond standard working hours.

The Contractor shall ensure each of his sub-contractors and nominated sub-contractors employs a Safety Officer and EACH contractor will designate a Safety Manager at the Project site. He will have full authority to direct work stoppages and to expend funds, as necessary, to eliminate hazards and imminent danger conditions on the site.

The Contractor's Safety Manager is responsible for the implementation and further development of the Safety Plan. His duties will include the following:

- Conduct regular safety meetings with Site personnel and equipment operators the frequency of which determined by the contract administrator.
- Inspect the Project daily, and record all visible safety hazards, including identification of violators and shall take immediate corrective action.
- Follow through on timely correction of safety hazards, making immediate corrections as necessary.
- Monitor on Site safety meetings and report same on the Daily Report.
- Foster 'Safety Awareness in all tradesmen and supervisors on the Project.

- Follow up all relevant safety reports.
- Check all areas at least once a day for housekeeping and clean-up. Take immediate action to ensure compliance with requirements.
- Submit job hazard analysis to the Contract Administrator for each major phase or element of work as necessary.

Post safety signs in English, (and other languages used), on the Project and ensure safety signage, lights, and barriers are provided throughout the project Site and take immediate corrective action to eliminate the unsafe condition.

Conduct safety training for all personnel prior to granting permission for personnel to enter the Site.

Ensure training is carried out for specific tasks, especially high risk activities. The Contractor shall provide evidence that workmen that will work on scaffolding have received scaffold training. Aerial lifts including scissor lifts are considered as scaffolding therefore training documentation is required for all workers using this type of equipment.

Conduct employee indoctrination for all new personnel.

Ensure training is carried out for specific tasks, especially work of a “non-standard” nature.

The Contractor shall provide for the training of all of his staff and workmen with regard to maintaining a safe and healthy project Site.

Ensure that all works are being carried out in accordance with all Local Authority rules and regulations and in accordance with Temporary Works Traffic Management Planning Guidelines.

The Contractor’s Safety Manager will be a member of the Site Crisis Management Team organized to deal with emergencies.

The Contractor’s Safety Manager shall have an experience of at least fifteen (15) years in the field and particularly within road works activities.

The Contractor’s Safety Manager shall as a minimum be a qualified engineer with additional qualifications and special training duly accredited to internationally recognized bodies pertaining to Safety implementation.

The Contractor’s Safety Manager shall report directly to the Contractor’s top management in the head office and in no case come under the hierarchy of the Contractor’s Project

Manager's team.

The Contract Administrator and the Supervision Consultant have the authority to ask the Contractor to remove any staff in the Contractor's Safety team if in the opinion of the Contract Administrator and/or the Supervision Consultant the performance of the said staff is not satisfactory. The replacement of such staff shall take place within ten (10) days of the Contract Administrator's notice.

The Contractor shall ensure that any sub-contractors adhere to the Safety Management arrangements.

The authority of the Safety personnel shall not be overruled by any of the Contractor's staff including the Contractor's Construction Manager and the Contractor's Project Manager. Violation of this rule shall have serious implications on the Contractor which may include removal by the CM/PM from the project.

161.05 SUBCONTRACTOR AND NOMINATED SUBCONTRACTOR PARTICIPATION

The officers and personnel of all sub-contractors and nominated sub-contractors shall be responsible for compliance with this Safety Plan. This will entail indoctrinating their site representatives with a working knowledge of the Safety Plan implemented on the Project site. They are further responsible to have their firms represented at all Project Safety Meetings.

161.06 SAFETY COMMITTEE

The Contractor shall establish a Safety Committee. The members of the committee shall be an equal representation of the employer (Contractor) and employees (Contractor's workers and Sub-Contractors). The Contractor shall submit the list of members to Contract Administrators for approval.

161.07 SAFETY MEETINGS

The Contractor shall host Safety meetings at least once a week at the Project site. as identified in this document.

Daily Safety Meetings shall be conducted by EACH contractor and each of his sub-contractors and nominated sub-contractors with all of their respective workmen before the start of each shift.

161.08 SAFETY REPORTS

The Contractor shall submit weekly Safety reports to the Contract Administrator. The format

and contents of the report shall be agreed with the Contract Administrator. As a minimum, the Safety report shall include:

- Average number of men / day during the week.
- Number of man hours during the week.
- Total number of man hours until the date of reporting
- Number of lost-time injuries
- Number of accidents
- Number of incidents
- Workmen indoctrination statistics
- Safety bulletins / topics issued
- Issues raised, issues closed out or pending closure.
- Inspections carried out
- Near Miss records
- Lessons Learnt (Good Practise/Bad Practise)

161.09 ACCIDENT PREVENTION RESPONSIBILITY

All supervisors and foremen are responsible to plan and accomplish their work with due regard for the safety of all individuals on the Site. They will be expected to eliminate all possible accident hazards when planning the work under their control. It is expected that all contractors and sub-contractors will observe and correct any accident producing practices before injury occurs. If an accident does occur, they will investigate to determine the cause and take the required corrective action to prevent a recurrence. All accidents shall immediately be reported to the Contractor's representative and to the Contract Administrator.

161.10 ACCIDENT REPORTING

All lost time injuries, property damage accidents (excluding off site accidents), material losses and "near misses" shall be notified to the Contract Administrator immediately of the accident, incident or "near miss". Such initial notification shall be followed by a written investigation report within seven (7) days for all significant incidents. The report shall include; type of accident, cause of accident, corrective actions taken to prevent future occurrence. Immediate notification will be provided in advance of the written report. The Contractor shall submit the report to the Contract Administrator for review. The Contractor shall implement all corrective and preventive actions identified in the accident investigation report at the Contractor's own cost to prevent any recurrence.

The Contractor shall comply with the relevant legislation or regulation on notification and

reporting of incidents. If any incidents occur at the Site resulting in injury, ill health or serious damage involving his employees or sub-contractors who are directly or indirectly involved with the Works they must be reported.

In the event of any employee being sent to a doctor for treatment, a release will be obtained from the doctor stating whether:

- the employee is fit to return to duty.
- the employee is fit to return for light duty; or
- the employee is not fit to return to duty;

A copy of this release will accompany the accident report submitted to the Contract Administrator. If the contractor fails to provide a release from the doctor as specified above, then the incident will be automatically treated as a lost time incident.

161.11 FIRST AID FACILITY

A First Aid Facility shall be provided and operated by the Contractor at the project Site where there are over 50 staff / workers present. The First Aid Facility shall be fully stocked, with medical supplies of quality approved by the The Republic of Fiji Health Department and any local emergency medical regulations, equipped, and qualified manned (Nurse) on a full time twenty four (24) hour, seven (7) days per week basis while construction activities are underway. Nurses shall have credentials attesting to having been trained in First Aid/CPR/AED procedures. A vicinity map indicating routing to emergency facilities shall be posted in the first aid station and on the project bulletin board, along with the list of designated emergency facilities, i.e. hospitals, doctors, ambulances, and fire departments.

The Contractor shall make arrangements for the removal by ambulance or by other suitable vehicle of injured or sick employees to local hospitals, if necessary.

All contractors, sub-contractors and nominated sub-contractors are responsible for providing at least one (1) fully stocked first aid station at his site office.

The Contractor shall provide and maintain a sufficient number of First-aid stations on the Project. These shall be under the responsibility of the Contractor's Safety Coordinator who shall have the overall responsibility to ensure the installation and maintenance of the first aid stations.

The Safety Coordinator and sufficient number of supervisory personnel shall be trained and

qualified first-aid personnel.

161.12 PERSONAL PROTECTIVE EQUIPMENT

Minimum requirements for Personal Protective Equipment (hereinafter referred to as PPE) shall include the wearing of Safety Helmets (Hard Hats), steel toe / steel shank safety work boots, and reflective vests by ALL personnel including visitors whilst on the Project site. Supplemental requirements for PPE shall be adopted for specific areas of the work for such items as eye protection, hand protection, hearing protection, protective clothing, fall protection, (full body harnesses, retractable lanyards (as primary means of fall protection in all situations and lifelines) as per the requirements of this safety specification and the Contractor's Safety Programme. All PPE shall bear the label of a recognised international safety testing/regulatory agency. Sandals or open-toe shoes are NOT permitted on the Project. Closed footwear with heavy-duty sole and steel toe cap must be worn by all personnel. EACH contractor is responsible to provide adequate protection to the personnel and equipment adjacent to the Contractor's area of work.

The Contractor shall provide, at his cost, all PPE to the workers under his employ, all sub-contractors and nominated sub-contractors and EACH contractor shall provide, at their cost, similar PPE to their workmen. It is the responsibility of the Contractor to strictly implement the PPE rules set out for all parties.

Each worker shall sign receipts indicating that he has received PPE from the Contractor's stores. Copy of these receipts shall be provided to the Contract Administrator if requested.

EACH contractor's and his sub-contractors', his sub-contractors' workmen of the contractor's company name to be inscribed on the High Visibility Vest. All hard hats shall also bear the identification of the Contractor.

The Safety Manager and other safety personnel shall wear Red coloured hard hats and OSHA Orange coloured safety jackets with the Contractor's identification. (Safety Jacket shall be constructed with a shell of windproof/water resistant/ fire-resistant cotton based material and shall feature 2" reflective tapes for high-visibility- shall meet ANSI/ISEA 107-1999 Standards, Class 3/Level 2). Other personnel wearing safety jackets, as required, such as banksmen, and workers performing road works, pipelines, etc., shall wear Lime Green coloured safety jackets.

161.13 FIRE PREVENTION

Smoking is not permitted on the Project site.

Burning of rubbish or debris is not permitted on the Project site.

Depending on the contract, a temporary fire alarm system may be required to be installed in appropriate locations, maintained & tested on a weekly basis by the Contractor.

Cooking of meals, heating of water for tea, etc. is not permitted on the Project site.

Any fuel storage tanks shall be properly grounded and vented, provided with proper type fire extinguishers, placed on posts, 3.00m to 5.00m from tanks. DANGER or NO SMOKING signs, and graphics, shall be prominently placed at these tanks. Storage tanks above ground shall be diked or kerbed for spill/leakage containment and the tanks shall be located at a safe distance from the construction area.

All compressed gas cylinders and acetylene cylinders shall comply with the requirements of The Republic of Fiji Health and Safety at Work Act (1996) and all other local requirements for construction, use and storage. All oxygen and acetylene cylinders shall be kept separately in the external area and in a caged storage area, stored upright, tied off, and capped. The storage area shall be designated as a NO SMOKING zone.

Flammable liquids and gases shall be stored in designated EXTERIOR areas and shall not be stored within the contractor's stores or concealed areas.

The Contractor shall operate a HOT WORK PERMIT system for all hot works including cutting, welding and brazing. Only qualified workers shall perform hot works with check list by the Contractor confirming the work to be undertaken and that screens, protection and suppressant devices are in place and workers assigned to the task are properly trained and qualified. The Safety Manager shall inspect the work area and affix his signature to endorse his satisfaction to the arrangements in place. A copy of such permit shall be issued to the Contract Administrator twelve (12) hours prior to work commencing. The Contractor and Contract Administrator shall endorse the permit reserving the right to inspect both the preparation and the work in hand. No work shall be carried out without a permit prepared by the responsible Foreman of the Contractor. Adequate fire extinguishing equipment shall be provided in the immediate vicinity of welding operations. The Contractor shall provide and use protective welding blankets at all welding locations. Smoke Eaters are required while doing Hot Work operations such as burning/welding/cutting in partially/fully enclosed areas of the Project. Workmen will be shielded from welding rays, sparks, slag and the like. Fire Watch is required at all hot work activities and shall extend 30 minutes beyond completion of hot work activities.

Fire protection is required for all materials and equipment on the site. Protection gear including suitably rated goggles, gloves & shields shall be used by each of the Contractor's personnel

carrying out operations such as welding, etc.

A special fire-watch is required during any cutting, burning and/or welding operation performed within the Project site. This will entail remaining at the work task area for thirty minutes after the completion of the works. If the works are completed at the end of shift the Contractor must inform security of the location of the works.

The Contractor shall provide and maintain adequate temporary lighting and identify escape routes for any enclosed structure while under construction.

The Contractor shall provide a minimum of 2 muster points at any 1 time throughout the site. These muster points must not defer from emergency service vehicles entering the site.

161.14 SCAFFOLDS AND ACCESS WAYS

Scaffolds shall be provided by the Contractor for any work that cannot be accomplished safely from the ground or other permanent and substantial footing. Contractor shall provide scissor lifts, rolling or electric powered scaffolds. Podium ladders may also be used for work at height but double extension ladders shall be used as a last resort and as access only. They must be footed and tied off at all times.

The Contractor shall ensure that safe and defined access is provided to all work areas. Ladders and scaffolding shall conform to The Republic of Fiji Health and Safety at Work Act (1996) and be inspected on a daily basis before the start of every shift and following the event of any adverse weather conditions, recorded and signed off by a competent person. Proper supports at base of scaffold poles shall be provided (Spreaders). Details for erection and use of scaffolds will be worked out by the Contractor and submitted to the Contract Administrator for review. The Contract Administrator's approval however, shall not remove any responsibility for scaffolding from the Contractor. Where Engineered Scaffolding systems are required calculations shall be prepared by the Contractor's employed Professional Engineer registered with the Board of Engineers, The Republic of Fiji (or international equivalent), and submitted to the Contract Administrator for review. The Contract Administrator review comments, if any, shall not remove any responsibility for scaffolding from the Contractor. Guardrails shall be installed on scaffolds when the height reaches 1.2 meters and above from the ground.

All scaffolds are to be designed to allow for adverse weather conditions.

Positive Fall Protection Systems shall be employed by EACH Contractor when workers of any trade are working on elevated platforms 1.2m or greater from the ground or other permanent and substantial footing. Workers involved in stripping concrete shuttering shall be tied-off with

a proper fall protection system if working at heights of 1.2m or greater. The same requirement applies to workers installing shoring or re-shoring. The Contractor shall employ a “zero-tolerance” policy with regard to ANY workers not being properly tied-off.

All scaffolds and elevated access ways shall be inspected by a competent person and with experience in scaffold and elevated works. Scaff Tags shall be provided and installed at each scaffold and elevated access either after erection, on a weekly basis and in the event of any adverse weather. If Scaff Tags are not updated as noted, then these areas shall not be permitted to be accessed.

161.15 FALL PROTECTION

The Contractor shall ensure that the required, approved and where the regulations dictate, certified Fall Protection Systems are in place throughout the Project site for the protection of all personnel on site.

Fall Protection Systems shall include: Coverings for openings, Safety Fences, Guardrails with Kick Plates, Fall Arrest Harnesses/Retractable Lanyards (as primary means of fall protection in all situations) and Lifelines, and any systems required to ensure that personnel are protected from falling from heights of more than 1.2m above the ground.

The Contractor shall be responsible for providing all perimeter protection, protection of work and workmen adjacent to and below his work and protection around openings until such time that their need is eliminated by permanent construction. The perimeter safety protection shall be installed at all times and at all floors including, roofs and setbacks and openings. Such protection shall be removed only after the installation of the permanent protection, in the form of parapets, walls, etc. Toe-boards shall be installed along with perimeter guard rails at all times.

The Contractor shall submit all information regarding the materials that he intends to use for the safety measures such as netting, railing, planking, etc., to the Contract Administrator who shall have the right to reject the proposed materials if they are found unacceptable, in which case the Contractor shall propose alternate materials.

Certificated and approved fall arrest equipment, under the fall protection regulations, will only be permitted on the project. This includes all shackles, lines, anchors, eyes bolts and any other component that makes up the fall arrest protection equipment.

Certificated fall arrest equipment will only be permitted on the project. This includes all shackles, lines, anchors, eyes bolt and any other component that makes up the fall arrest

protection equipment.

All slab penetrations less than 1 metre in the short direction and less than 2 metre in the long direction shall be securely covered so as not to be dislodged, clearly, marked, and designed to support a minimum concentrated load at centre of 210 kg. The wooden planking used for this shall be set on cleats sized to fit into the opening. Very small floor openings shall be protected with cleated plywood board and a sign marked "Danger-Floor Opening" permanently affixed to the board. Openings larger than 1m x 2m shall be protected with railings and toe boards. This is inclusive of openings for elevators, escalators, service shafts and other openings.

Fall protection for formwork scaffolding and systems scaffolding shall be installed in accordance with manufacturer's recommendations and instructions for installation. Anchorage points attached to the scaffolding structure shall be certified and verified by a Professional Engineer registered with the Board of Engineers of, The Republic of Fiji (or international equivalent), employed by the Contractor and the scaffold manufacturer must confirm acceptability.

Any safety cables or guard rails removed by the Contractor to facilitate construction shall be re-installed promptly after completion of the work.

The Contract Administrator must be informed and a request submitted for any removal of fall protection. Other trades must be notified as to the removal, before the works can be proceed, adequate signage and exclusion zone from the area to be in place.

The Contractor's Safety Plan shall include an emergency, response and crisis management sections which include the means and methods the Contractor will employ for rescuing a worker that has fallen and is being held aloft by their PPE Personal Fall Arrest System. A full fall arrest rescue plan for recovery must be submitted and approved by the Contractor Administrator before relevant works commence on the project.

161.16 EXCAVATIONS

Excavations shall comply with local regulations for trenching and shoring, as established by The Republic of Fiji safety requirements (or international equivalent standards) and as specified in the contract, with special attention to the following:

Excavations over 1.2 meters deep must have sides sloped to the angle of repose or be shored or battered back. Any shoring system design must be submitted to the Contract Administrator for approval.

Risk assessment and Job Safety Analysis (JSA) will be undertaken and reviewed by the Contract Administrator before any excavation works commence.

Close supervision, monitoring and control of the excavation will be put in place for the duration of the works.

Excavations will be inspected daily before entry and following adverse weather conditions to ensure the stability of the excavation to ensure the safety of those working the excavation and the inspection recorded.

Signage pertaining to the dangers of excavations (“danger excavation” “authorized entry only” etc.) are to be posted on the approach to the excavation and along the length of the excavation.

Excavated material must be stored at least 2 meters from the sides of excavations.

Engineered Guard rails or barricades must be provided around the excavation. robust enough for the protection of vehicles and people.

Access facilities must be provided to the excavation and clearly sign posted. Ramping access may be installed as access to excavations. Ladder access must be extended at least 0,9m above the trenches and spaced at maximum 7,6m horizontally. Ladder access points must be clearly marked and protected from collision from moving plant.

Wheel blocks for trucks must be installed correctly, pinned securely and inspected daily, before use, to ensure the fittings are secure and fit for use.

161.17 HAND TOOLS AND POWER TOOLS

All hand tools and portable power tools to be used by the Contractor shall be of good order and shall be used for the purpose intended. All electric power tools must be 110V and double insulated or earthed. Any deviation from this must be agreed with the contract administrator. All tools shall be Portable Appliance Testing (PAT) tested before being delivered to site and must be inspected and recorded on a monthly basis by the Contractor. Contractor shall ensure that all electrical tools are Ground Fault Circuit Interrupter (GFCI) protected or Residual Current Device (RCD) protected once permanent power is activated. This can be accomplished by using temporary GFCI devices. Where temporary power is difficult to achieve or where associated power leads may cause safety hazards, the contractors shall use portable battery operated tools.

Circular saws shall be equipped with guards that automatically enclose cutting edges. Radial arm power saws shall be equipped with automatic brakes. Modifications such as removal of safety guards is prohibited and any equipment found to have been modified shall be

immediately removed from the project site.

Explosive actuated tools must have prior written approval of the Contractor's Safety Manager BEFORE DELIVERY by the Contractor to the Project. Only trained operatives shall operate such tools to ensure safe and proper usage of the same. The Contract Administrator shall be informed prior to use of such tools.

Full-face shields shall be worn while cutting, welding or grinding any material.

161.18 MACHINERY & MECHANIZED EQUIPMENT

All machinery and mechanised equipment proposed by the Contractor for use on the Site shall be inspected for compliance with local safety requirements and proper reports, certifications, etc. shall be completed and submitted to the Contract Administrator prior to their use on the Project site.

The machinery and mechanised equipment are inclusive of and not limited to earth-moving machinery, graders, rollers, scarifiers, stabilisers, asphalt plant, cranes, derricks, hoists, mixing trucks, concrete pumps and the like.

Supplemental requirements covering operating rules shall be established prior to start of work using mechanised equipment and machinery.

All construction machinery, plant and equipment shall be fitted with spark arrestors and silencers. Air compressors shall be fitted with "whisperizers". Air hose couplings shall have safety ties (whip lashes/checks) on each coupling to prevent their separation.

All material handling equipment shall have rubber-tired wheel and rubber-tired protection at the front end, rear ends and protruding corners.

Wind velocity meter, aircraft warning lights and Lightning arrestors are to be included on cranes, and maintained in good working order until all cranes are removed

The Contractor shall perform all necessary engineering, have all the hoisting equipment inspected as required by local and government regulations as well as any agency having jurisdiction and obtain all required permits. Copies of all inspection reports and crane certifications must be transmitted to Contract Administrator as soon as possible. Weekly inspection of all hoisting equipment and cranes is necessary and the corresponding checklists shall be forwarded to the Contract Administrator.

The Contractor shall arrange with an independent testing company that is acceptable to the Contract Administrator for testing of all cranes, hoists and other lifting equipment, at frequencies dictated or suggested by the manufacturers or in shorter frequencies if required by regulations. In addition, the Contractor shall provide the following for cranes:

Torque crane masts. Forward inspection checklist to the Contract Administrator.

Adequate fire protection

Annual certification from manufacturer of crane and independent inspection firm.

All cranes, hoists and other major equipment shall have check sheets for Daily, Weekly, Monthly, Quarterly inspections.

The Contract Administrator reserves the right to have all hoisting equipment periodically inspected by an independent agency at the Contractor's cost. The independent inspector's findings will be binding. Corrections must be made within three days of receiving the report. Contract Administrator will not assume any responsibility for the safe operation of the cranes or any other equipment by exercising this right. The Contractor shall co-operate with the inspecting agency by allowing time for inspection. The Contractor will be notified 48 hours prior to the time of actual inspection.

Operators of equipment and vehicles shall be trained in the operation of the particular equipment and vehicles and possess all valid licenses and competent certification as required by the Laws of The Republic of Fiji (or other international certifications). They must also be able to read and understand the signs, signals and operating instructions in use. The operator must also be certified by an approved 3rd party certifying agency in the use of plant, equipment and vehicles.

The Contractor shall ensure that the loads placed on any structure do not exceed its design capacity. The Contractor shall investigate floor load capacities (if applicable) prior to loading materials on each level of the Project and provide a materials loading plan for Supervision Consultant and Contract Administrator review.

161.19 DELIVERY VEHICLES

All delivery vehicles either owned or leased by the contractor or his sub-contractors or nominated sub-contractors or third party vendors for use in making deliveries to the Project

site or taking materials, waste, etc. from the Project site shall be equipped with a reverse warning sound device (reversing alarm). Said alarm device shall be kept in full operating order at all times. Said Delivery Vehicles shall be inspected for compliance with local safety requirements and proper reports, certifications, etc. shall be completed and submitted to the Contract Administrator.

Contractor shall provide flagmen (banksmen) for traffic control when delivery vehicles enter or leave the Project site.

161.20 ELECTRICAL PANEL LOCK-OUT

The Contractor shall ensure that adequate electrical panel lockout procedures are adopted to ensure the safety of personnel working on or adjacent to electrical systems or devices.

A multiple-lock system shall be used on all electrical panels.

161.21 WORKER SAFETY INDUCTION

The Contractor shall provide Safety orientation and Site sanitation training to all personnel and visitors who enter the Site and shall issue wallet-sized ID cards certifying the individual has attended the course. The ID cards should be worn by all employees/workers at all times.

At a minimum the following items must be addressed in the Safety orientation and Site Sanitation Training:

- Minimum protective clothing for all personnel on the Site:
 - Safety Helmets (Hard Hats), safety work boots and reflective vests are required at all times.
 - Protective eye covering will be worn when welding, hammering metal, stone, or concrete, grinding or cutting metal units.
 - Ear and hand protection as required.
 - Fall arrest harness and lifelines are required when other fall protection systems are not in place (if applicable).

- Minimum safety observances:

Work areas and access ways are to be free of debris, materials, and all tripping hazards. Adequate housekeeping must be maintained by the Contractor at all times.

Temporary electrical wiring shall be protected from damage by traffic, be in good condition and protected by ground fault circuit interrupters.

All portable containers for fuel and other flammable liquids shall be appropriate for the liquid or fuel with self-closing lids. Plastic containers are NOT allowed on the Project site.

Emergency evacuation procedures and assembly points and first aid protocol.

All accidents are to be reported directly to supervisors, and the Contract Administrator. If serious injury is apparent or suspected, utilize pre-established emergency hospital service. The telephone number shall be prominently displayed at all bulletin board locations. For small cuts, scratches, etc. first aid kits are to be available from Contractor. In the event of fire, if it cannot be immediately contained, raise the fire alarm, notify the nearest local Fire Brigade and evacuate all personnel. The telephone number shall be prominently displayed at all bulletin board locations. Then attempt to put out the fire with available fire extinguishers and water hoses until help arrives. Do not endanger personnel in fighting the fire.

Heavy equipment operators must obtain clearance from the Contractor's Safety Manager and the Contract Administrator before commencement of their work.

All equipment must meet the appropriate safety standards of The Republic of Fiji Health and Safety at Work Act (1996) and more recent revisions as well as the Contractors Project Specific Safety Plan.

Site visits are not permitted during nights, weekends or holidays without prior permission from the Contractor and the Contract Administrator.

Site Sanitation Procedures:

The Contractor shall provide for the training of all of his staff and workmen with regard to maintaining a safe and healthy project Site. Contractor's staff and workmen shall be instructed in maintaining proper sanitary procedures with regard to toileting needs. If any of the Contractor's staff or workmen are found urinating or defecating in areas other than proper temporary toilet facilities, the Contractor shall be assessed a fine as listed at the end of this document and the violating staff or workman shall be immediately removed from the Project.

It is the Contractors responsibility to maintain and clean all toilets so that they are kept in a

sanitary condition for all workers. The Contract Administrator will periodically inspect the cleanliness of the toilet facilities and reserves the right to have others clean on the Contractors behalf if not maintained/cleaned to satisfactory level. Costs for same will be at the Contractors expense.

Safety Induction: The Contractor shall conduct safety induction for all persons entering to site including visitors.

The following will NOT be permitted on Site:

- Radios, Cassette players, CD/DVD players, iPods, video cameras, music systems, televisions.
- Alcohol or Tobacco.
- Firearms or Weapons
- Urinating or defecating in other than proper temporary toilet facilities.

161.22 WORKER TRAINING/Safety Instructions

The Contractor shall provide safety training to his operatives and shall issue wallet-sized cards certifying that the operative has attended the course. No employee will be permitted on site to operate any plant or equipment unless they have the relevant, validated and up to date certification for the equipment they are operating. This includes as a minimum:

- Crane operation, mobile and tower.
- 360 excavator
- 180 excavator
- Bull dozer
- Boom loader
- Scaffolders
- Trucks (Rigid, tipper and articulate)
- Tractors
- Bobcats
- Vibro rollers
- Welding and cutting operation
- Emergency Response Team (ERT)
- Lifting operations (banks man/rigger)

The above list is an inexhaustible list and other disciplines will also require certification of the equipment being used. All equipment or disciplines on the project will require operator

certification to perform works. This include:

- Project induction and orientation
- Confined entry and rescue (if applicable)
- Fire fighting
- First aid
- Safety Induction card (issued by contractor or third party as dictated by the contract administrator)
- Lock Out Tag Out (LOTO)

The following items must be included in the Contractor's safety training:

- Minimum protective clothing for all personnel on the site:
 - Hard hats, Safety Boots and Reflective Vests are required at all times.
 - Appropriate protective eye covering will be worn for all situations when there is a risk of eye injury.
 - Ear Protection is required when exposed under noise that exceeds 85 dB while using equipment that creates noise and for other workers within close proximity to the works being undertaken. This includes, but is not an exhaustible list, the use of grinders, jack hammers, concrete saw, heavy concrete drills etc.
 - Fall Arrest Harness, Lanyards and Lifelines are required when other fall protection systems are not in place. Only certified fall arrest equipment is to be purchased and the employees using the apparatus will be trained in the correct use and inspection of the equipment.
 - Proper anchor points for tying off when wearing a Fall Arrest Harness.

The Contractor shall provide adequate extraction and/or ventilation and the correct PPE including breathing apparatus during the installation of paint finishes and any other materials that provide toxic or harmful odors and fumes. Any such activities require a detailed method statement and risk assessment for the works commence.

Minimum safety observances:

Work areas and access ways are to be free of materials, debris and tripping hazards.

Adequate housekeeping must be maintained at all times.

All designated project access walkway and vehicle routes must be sign posted with clear visible signage which must also be understood by all. Signage must be kept clean and visible

for the duration of the project and changed when damaged or weather beaten.

Temporary electrical wiring shall be protected from damage by traffic, be in good condition and protected by ground fault circuit interrupters.

All portable containers for gas and other inflammable liquids shall be appropriate for the liquid or gas with self-closing lids and labelled showing the contents. No plastic containers are allowed to be used.

All empty hazardous containers are to be disposed of by an approved Department of Environment (DOE) waste management company in a correct manner. and tracking documentation provided to the Contract Administrator showing the route for disposal.

Maximum speed for vehicles on the Project site is five (15) kilometres per hour for site vehicles and five (5) Kilometres per hour for construction vehicles. This is a limit not a target.

All equipment must meet appropriate safety standards.

161.23 INDEPENDENT SAFETY AUDIT

Depending on the project, the Contractor shall engage an Independent Safety Auditor firm to conduct minimum once in every six (6) months independent safety audits of the Site when instructed by the contract administrator. This, in no way, shall detract from the Contractor's own Safety audit and inspection requirements. The Independent Safety Auditor shall be approved by the Contract Administrator.

It is the Contractor's full responsibility to keep work area free of hazards which could affect the worker's health and safety at all times. In addition to the ongoing monitoring of the site by the Contractor's management and supervisory personnel, the Contractor's safety manager shall perform a formal inspection and safety audit of the site at least once every week to identify any hazardous conditions noted and provide measures and recommendations for improving site safety and addressing unsafe conditions. A written record of all inspections and the results shall be submitted accordingly to the Contract Administrator by the Contractor.

The Contract Administrator will perform independent safety audits during construction and will hold periodic site safety meetings with the Contractor during the works. The Contractor's attendance to all site safety meetings held by the Contract Administrator is mandatory. The Contract Administrator will implement and enforce a Safety Fine Schedule per the contractual requirement accordingly.

The Contractor's independent safety auditor firm's qualifications shall be submitted to the Contract Administrator for review and approval.

161.24 SAFETY CHECK LIST

The Contractor shall, within twenty-eight (28) days after the Commencement Date (or as otherwise stipulated in the contract) prepare a checklist incorporating the following items and submit the same to the Contract Administrator after it has been signed off signifying completion of the related activities. The check list shall be updated monthly and be available for Contract Administrator's review every month as the Contractor's work area changes and additional sub-contractors, personnel and equipment are deployed:

Prepare Contractor Project Specific Safety Plan (within twenty-eight (28) days after Commencement Date or a duration specified by the contract administrator).

Establish procedure to obtain sub-contractor and nominated sub-contractor safety plan.

Commence Safety Training.

Post safety procedures on Site bulletin board.

Prepare and post Fire Prevention Programme.

Provide Fire Protection System.

Provide safety signage, barricades, and fences.

Analyse Site for potential hazards and hazardous procedures.

Establish plan for location of offices, sheds, material storage, personal facilities and traffic flow.

Arrange for drinking water and sanitary facilities.

Arrange for garbage and debris removal.

Establish a manned (Nurse) First Aid Facility on site, make arrangements for ambulance service and medical assistance from medical services in the vicinity of the Project site (where numbers of workers are in excess of 50 persons). First Aid facility shall include stretcher, bed (cot) for worker to lie down, hoisting cage to assist in safe transportation of any injured party if/as required. Nurse shall have credentials attesting to having been trained in First Aid/CPR/AED procedures.

Post phone numbers for police, fire, medical and ambulance service at each of the bulletin board locations.

Post chart to signify weekly checks of first aid kits.

Obtain insurance claim forms.

Contact loss prevention department of insurance carrier.

Arrange for exposure checks by insurance carrier.

Prepare and post at each of the bulletin board locations "Emergency Notification List" with telephone number to be used during work hours and after hours.

Arrange and implement Site security in accordance with FRA security requirements.

Obtain and post any required local authority notices in appropriate languages.

Verify own insurance coverage and that of sub-contractor, equipment, prior to starting work at the Site and also prior to execution of Sub-contracts.

Procure and issue PPE safety equipment appropriate to operations:

Hard hats

Safety harness

Goggles

Ear protection

Carbon monoxide tester

Safety shoes (steel toe caps)

Fall Arrest

Vests – High Visibility with Company Logo

Respiratory protective equipment

Protection against ionizing radiation if required

Post sketch and signs showing locations of fire alarm boxes, hydrants and first aid facilities.

Establish Daily toolbox safety talks.

Establish weekly safety meetings.

Arrange for and post, safety posters and warning signs.

Set up an accident control chart

Establish Assembly Points in the Site for EACH contractor, sub-contractor and nominated sub-contractor's personnel to meet in case of emergencies. Conduct fire drill and roll call to ensure all employees of EACH contractor, sub-contractor and nominated sub-contractor have been accounted for. This shall be done at least once every six (6) months or as required by the contract administrator.

161.25 NON-COMPLIANCE WITH SAFETY REQUIREMENTS

The Contractor's Safety Plan shall address at a minimum all points addressed in this document and ensure that the Site is safe and healthy for carrying out the works without risk to human life, injury, or damage.

Where the Contractor violates any of the safety provisions described within this document or his Safety Programme, the Contract Administrator and/or Employer shall take the appropriate remedial action, and all costs associated therewith shall be at the Contractor's expense.

On the occurrence of the first & second violation, the Contractor will be issued a written warning by the Contract Administrator, and shall be instructed to remedy the violation with immediate effect. Where the Contractor fails to remedy the violation within the time stipulated, the Contractor shall be prohibited from carrying out any further work within the affected area until the specific exposure has been corrected.

On the occurrence of all further violations Safety Fines will be issued in accordance with Section 29 below. Where the Contractor unreasonably ignores the Contract Administrator's instructions, then the foreman responsible for operations in the area where the safety violations are occurring shall be dismissed from the Site.

Where any of the Contractor's employees, or those of his sub-contractors or suppliers, violate any of the safety provisions within this category, the offending employee shall be warned and prevented from continuing working until the unsafe condition is corrected. Should the same employed person be caught a second time for the same violation, he shall be dismissed from the Site. In each case of a warning or dismissal, the responsible foreman shall be notified. Should more than two (2) employees be sent off the Site during any week, then the responsible foreman shall also be dismissed from the Site.

If the Contractor's staff or workmen or those of his sub-contractors or nominated sub-contractors persistently breach the Site safety and Site sanitation requirements, then the Principal of the Contractor shall be summoned to the Site and instructed to take the appropriate action to ensure that his employees comply with the safety and Site sanitation requirements of the Contract.

Where it is deemed that a gross safety violation has being committed, that person or persons shall be removed from the project immediately, regardless of the position that they hold within their company. A person or persons removed from the project will not be permitted to work on the project again.

161.26 NON-COMPLIANCE WITH EMERGENCY FACILITIES REQUIREMENTS

The Contractor shall provide all emergency facilities such as first aid equipment, fire-fighting equipment within work and material storage areas, and accessible sanitation facilities for employees in compliance with municipal requirements.

All these facilities are required prior to the commencement of work on Site by the Contractor. Should these facilities not be provided within the time specified by the Contract Administrator, then the Employer shall provide these facilities and the costs incurred by the Employer may be deducted by the Employer from any monies due or to become due to the Contractor or be recoverable as a debt.

161.27 SAFETY INCENTIVES

The Contract Administrator may provide incentives for workers to work safely. This may come in the form of rewards such as safety lunches for all of the workers, raffle prizes and other incentives in order to promote a safe work place. All contractors are expected to contribute to safety incentives.

161.28 SAFETY FINES

The below listed SAFETY FINES shall be assessed against the offending Contractor for violations of the Project Safety Programme and standards by the Contractor and his sub-contractor's personnel as follows:

VIOLATION	FINE	REMARK
Working on site without Safety Orientation	FJD 500	Person will be removed from site until Safety Orientation carried out
Working on site without health and safety training Card	FJD 500	Person will be removed from site with immediate effect
Not wearing a safety helmet (hard hat)	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Not wearing safety work boots	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Not wearing proper safety eyewear for working task	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Not wearing proper hearing protection for working task	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Not wearing reflective vests	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Not wearing proper fall prevention equipment if required	FJD 1000	Person will be removed from site with immediate effect
Not wearing appropriate PPE for specific tasks being undertaken	FJD 150 -1000	Dependent upon task being carried out
Urinating in areas other than proper temporary toilet facilities	FJD 500	Person will be removed from site with immediate effect
Defecating in areas other than proper temporary toilet facilities	FJD 500	Person will be removed from site with immediate effect
Remove guardrail or barricade protection	FJD 1000	Person removed from site immediately

Remove openings protection (floor, wall, other)	FJD 1000	Person removed from site immediately.
Unsecured compressed gas cylinders	FJD 300	Second offence RM900. Person to be removed from site for the third offence
Unprotected coring holes or openings in slab	FJD 150	Second offence FJD500. Person to be removed from site for the third offence
Faulty hand tools and extension cables i.e. broken cables, plug sockets not fitted correctly or not fitted at all	FJD 150	Faulty equipment to be removed from Project site
No hot works permit - all hot works (welding & cutting) must have a signed hot works permit for working in each area	FJD 150	Second offence FJD1500. Person to be removed from site for the third offence
No fire extinguisher during hot works	FJD 150	Second offence FJD1500. Person to be removed from site for the third offence
No Fire Watch during Hot Works	FJD 150	Second offence FJD900. Person to be removed from site for the third offence
Electric panels left open	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Use of damaged or improper Electric Cords	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Smoking in the site (other than designated areas permitted)	FJD 300	Violator to be immediately removed from Project site
Poor House Keeping	FJD 500	Second offence FJD1000
Eating food outside of designated areas	FJD 200	Second offence FJD600. Person to be removed from site for the third offence
Use of mobile phones when in operation of plant, machinery and/or tools	FJD 300	Person will be removed from site with immediate effect

Not Cleaning and maintaining Toilets	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Not having Inspection Tag on Scaffolds (if applicable)	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Altering a scaffold	FJD1000	Second offence FJD3000. Person to be removed from site for the third offence
Material not secured in open	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Scaffold being used when incomplete (Not signed off with Scaff.Tag)	FJD 500	Person will be removed from site with immediate effect
Operate Plant and/or Equipment without relevant Certification	FJD 300	Second offence FJD900. Person to be removed from site for the third offence
Riding in/on operational/moving Plant and Equipment as a passenger	FJD 300	Second offence FJD900. Person to be removed from site for the third offence
Plant and/or Equipment traveling over designated speed limits	FJD 300	Second offence FJD900. Person to be removed from site for the third offence
Failure to install vehicle barrier unit in accordance with approved traffic management plan	FJD 500	FJD 500 per barrier
Failure to install barricade panel to work zone in accordance with approved method statement	FJD 500	FJD 500 per barricade
Removal of barrier and/or barricade	FJD 500	FJD 500 per barrier/barricade
Working on electrical equipment or cables without correct certification for task	FJD 300	Second offence FJD900. Person to be removed from site for the third offence
Possession of alcohol at site and/or being under the influence of alcohol	FJD 1000	Person will be removed from site with immediate effect
Possession and/or use of non-	FJD 1000	Person will be removed from

prescription Drugs at site		site with immediate effect
Possession of firearms and/or weapons	FJD 1000	Person will be removed from site with immediate effect
Possession of Fireworks and/or illegal Explosives at Site	FJD 1000	Person will be removed from site with immediate effect
Fighting/Assault	FJD 1000	Person will be removed from site with immediate effect
Dangerous and/or unsafe behavior on Site	FJD 500	Person will be removed from site with immediate effect
Commencing works with no (agreed) Method Statement	FJD 500	Works shall be put on hold until Method Statement submitted and approved
Executing works not in compliance with approved Method Statement	FJD 500	Second offence FJD1500. Person to be removed from site for the third offence
Not complying in accordance with General Requirement specification	FJD 100 - 1000	At the Employers, and/or Contract Administrators discretion
Not carrying out works in compliance with Temporary Works Traffic Management Planning Guidelines	FJD 1000	Works shall cease until Contract Administrator approved otherwise and Person will be removed from site period
Construction of Works without an approved Traffic Management Plan where a Traffic Management is required	FJD 3000	Works shall cease until Contract Administrator approved otherwise
Non installation of each approved traffic and notification signages	FJD 3000	Works shall cease until Contract Administrator approved otherwise
Non installation of each approved hazard warning lights.	FJD 2000	Works shall cease until Contract Administrator approved otherwise
Non installation of each approved light point for general lighting.	FJD 2000	Works shall cease until Contract Administrator approved otherwise
Non Replacement of each damaged	FJD 3000	Works shall cease until

traffic and notification signage.		Contract Administrator approved otherwise
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No Contractor shall pass on a violation cost to any employee. The violation fines shall be used up in its entirety during the life of the project for such items as safety training, safety awards etc. The expenditure of the funds shall be determined by the Employer. All violation fines shall be withheld by the Contract Administrator from the monthly valuation payments and shall be utilized to promote safety training and safety awareness.

On the occurrence of the first violation, the Contractor shall be instructed in writing by the Contract Administrator to remedy the violation within a specified time. Where the Contractor fails to remedy the safety violation within the time stipulated, the Contractor shall be prohibited from carrying out any further work within the affected area until the specific exposure has been corrected.

On the occurrence of further violations, the severity of each violation shall be considered by the Contract Administrator and the Contractor will be instructed accordingly. Where the Contractor unreasonably ignores the Contract Administrator’s instructions, then the foreman and/or operatives responsible for operations in the area where the safety violations are occurring shall be dismissed from the Project.

Where any of the Contractor’s or sub-contractor’s or nominated sub-contractor’s employees or operatives violate any of the safety provisions, the offending employee or operative shall be warned and prevented from continuing working until the unsafe condition is corrected. Should the same employee or operative be caught a second time for the same violation, he shall be dismissed from the Project. The Contract Administrator reserves the right to require additional training or dismiss workers from the project immediately based on the nature of the violation. Notice will be given to the Contractors of specific conditions that will warrant additional training or immediate dismissal of a worker.

A person will be dismissed immediately, (regardless of their position in their company), from the project for committing a “gross safety violation”. Gross safety violation is a serious breach of the Safety rules and or regulations put in place for the protection of all on the project. Such an offence may put another employee/employees or the employee who committed the offence in a position that could lead to serious injury or fatality. Gross violations include:

- Tampering or altering traffic management safety equipment and barriers
- Using a scaffold that is not certified for use.
- Any tampering with Electrical equipment or Distribution boards

- Operating plant or equipment without the required qualification
- Performing lifting operations without certification
- Removing any protective cover without permission
- Starting a fire

If the Contractor persistently breaches the Project site safety requirements, then the principal of the Contractor shall be summoned to the Project site and instructed to take the appropriate action to ensure that his employees and operatives comply with the safety requirements.

END OF SECTION

APPENDIX A - OCCUPATIONAL HEALTH AND SAFETY

FRA Health, Safety, Security and Welfare System

I N D E X

1. HEALTH, SAFETY AND SECURITY POLICY
2. HEALTH, SAFETY AND SECURITY OBJECTIVES
3. HEALTH, SAFETY AND SECURITY ORGANISATION CHART
4. ROLES AND RESPONSIBILITIES
5. TRAINING AND COMPETENCE
6. RISK ASSESSMENTS FOR FRA SITE STAFF
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1 HEALTH, SAFETY AND SECURITY POLICY

The Fiji Roads Authority's (FRA) ultimate aim is to ensure the health, safety, security and welfare of our employees, the contractors and sub-contractors' employees, visitors, members of the public and any other third party who may be affected by our work activities on our projects. FRA is committed to ensure that the working environment across all areas of activity is such that all our staff and those of other entities working on projects go home healthy and safe at the end of each working day.

We consider the aforementioned to be a major part of our contribution to the people of The Republic of Fiji and FRA's goal of zero harm in the workplace.

To realise our goal of zero harm, we will implement a robust risk-based health, safety, security and welfare management system, based on ISO and OSHA Standards together with industry best practice to identify hazards and risks during the design, construction and contractual maintenance periods of FRA projects, with the ultimate aim of mitigating as many risks as possible through innovative design criteria and safe methods of working.

A register and copies of relevant The Republic of Fiji legislation and international standards will be maintained and made available for reference; their requirements will be adopted and implemented on our worksites and at our offices as appropriate to the work activities being conducted.

We will identify the development needs of our staff, from which we will provide applicable training to maintain and improve team member's competencies, with which to fulfil the requirements of new standards and new technology used on our projects to increase their knowledge.

We will provide a framework of objectives to fulfil our contractual obligations and to contribute towards their overall delivery of projects. All staff and employees will be provided with team, and where possible individual objectives, derived from our company objectives. Objectives will be reviewed and reported on during monthly meetings.

Monitoring of the health, safety, security and welfare performance will be undertaken utilizing a number of processes to measure the levels of compliance and implementation of all the above requirements.

We will disseminate copies of this Policy to all our staff, stakeholders, consultants,

contractors and subcontractors as well as including it in inductions for our employees, contractors and visitors.

Periodic reviews of this Policy and other Health, Safety and Welfare documentation will be undertaken every 6 months, during management reviews, following changes in legislation or whenever changes are required due to unforeseen circumstances or our contractual scope of work.

FRA CEO..... Date.....

2 HEALTH, SAFETY, SECURITY AND WELFARE OBJECTIVES

FRA reports against two Key Performance Indicators (KPIs) directly to the Board of Directors for FRA. The Key Performance Indicators KPIs are as follows:

KPI 1:

The number of reportable accidents per month, causing an employee to be off work for 4 days (excluding the day of the accident) or more, or a fatality involving employees and / or members of the public directly related the works (excluding road traffic accidents) compared to the total number of hours worked normalized by 100,000 for all works undertaken under the supervision of the FRA projects' delivery.

Objective: To confirm the effectiveness of health and safety management. To confirm continuous improvement in the working environment is being achieved through effective action plans.

KPI 2:

The number of work zone road traffic accidents per month, reported at road works in relation to the works.

Objective: To monitor road traffic accidents associated with road works and any resultant criticism of the Traffic Management. To confirm continuous improvement in the working environment is being achieved through effective action plans.

3 HSSW ORGANISATION CHART

Resident Engineers will provide a copy of the organisation chart, which indicates the Name and Designation of all HSSW team members covering their contract. This information will also be posted on Notice Boards in reception areas and at welfare facilities on the project worksite.

The FRA Organisation Chart showing the HSSW Team members is included in Appendix A.

4 ROLES AND RESPONSIBILITIES

FRA staff roles and responsibilities specific to Health, Safety, Security and Welfare are in addition to other roles and responsibilities found with Positional Job Descriptions and are clearly identified in an individual's HSSW Roles and Responsibilities matrix. An example is shown in Appendix B.

5 TRAINING AND COMPETENCY

All new and transferred employees will receive HSSW induction training on their first day at the project. The generic induction syllabus a separate document that can be utilized to provide information for the production of specific inductions and risk assessments.

An HSSW training matrix will be developed for the FRA projects that is dependent on the work activities to be undertaken and the competency and knowledge required by FRA personnel.

A generic HSW Training Matrix has been developed (Appendix C - HSW Form No. 3) from which role specific training programmes will be established.

6 RISK ASSESSMENTS FOR FRA SITE STAFF

Once the Contractor's Method Statements (that include risk assessments for site activity) are approved, FRA site supervision staff will work in accordance with these risk assessments. The risk assessments will be communicated to the FRA site supervision staff prior to the site commencement of the activity.

Risk assessments for specific activities carried out by FRA site supervision staff, that are not covered by the risk assessments in the Contractor's approved Method Statement, are:

- Lone Working - HSW Form No. 6 (Appendix D)
- Manual Handling – HSW Form No. 7 (Appendix E)

Periodic reviews will be carried out to ensure that the detail of the risk assessment is valid; these reviews will take place in the first week of June and the first Week of December each year. There will also be a review of pertinent risk assessments as the outcome of Lessons Learned following any incidents on site.

7 FIRST AID AND WELFARE

FRA will provide first aid and welfare facilities to their staff deployed at FRA offices and will train individuals to administer basic first aid at the site in the event of an incident.

Emergency contact details and a route map to the nearest hospital will be posted in the main

Reception Notice Board at the Site Office.

FRA will ensure that the Contractor deploys sufficient suitably qualified first aid professionals and suitable first aid and welfare facilities to the site in compliance with the requirements of the Republic of Fiji.

8 COMMUNICATIONS

FRA is responsible for ensuring open and on-going communications (both externally and internally) relating to HSSW to ensure that current issues, concerns, strategies, policies, procedures, lessons learned, causes of accidents, reports, knowledge, statistics, employee awareness, briefings, toolbox talks, posters etc. and many other HSSW aspects are provided to the required recipients in a timely manner.

FRA is the "the hub" for communications and must provide and receive current HSSW information through agreed channels, using agreed processes / procedures for such communications.

Communications are conducted using a number of mechanisms including provision of reports, letters, memos, e-mails, drawings, meetings, workshops, seminars, permits, safety alerts, posters, statistic reports, lessons learnt, toolbox talks, training, notice boards etc.

The Communications Process Map for Health, Safety and Security Information is included under Appendix F of this document.

Periodic Reports to be issued to FRA will be provided as follows:

- Summary HSW Information in the 'Weekly Project Summary'
- Health and Safety Statistics in the 'Monthly Progress Report'
- Complete Health and Safety Report
- Contractor's statistics and narrative, issue to FRA in the weekly contractors reports

9 MEETINGS

HSSW issues will be reviewed on a weekly basis, the detail of these meetings will be recorded in the form of meeting minutes distributed to attendees and assigned receivers.

The meeting schedule consists of:

Internal FRA HSSW issues discussed and recorded at the weekly FRA Progress Meeting chaired by the HSW Manager.

The HSSW performance of Contractors will be reviewed through a series of weekly meetings. The schedule for these meetings is:

(xx) MMeeting Name	(xxi) CChaired by	(xxii) AAttendees	(xxiii) PPeriodicity
(xxiv) GGovernance	(xxv) FFRA CEO	(xxvi) SSenior Managers	(xxvii) Monthly
(xxviii) Contractor Progress Meetings	(xxix) FRA GM or his nominated rep.	(xxx) FRA site team / Consultants /Contractor	(xxxi) Weekly
(xxxii) SSW Meeting	(xxxiii) RA HSW Manager	(xxxiv) Consultants / Contractor	(xxxv) Weekly

10 PROJECT CONTROLS

FRA supervisory teams are to manage processes and activities on the projects. To enable them to do this there are a number of processes that need to be put in place.

Initially there is a need to control the risks identified on the project prior to commencing work activities by identifying the potential hazards related to FRA personnel going onto site or visiting remote sites as part of their preparatory studies or surveying.

Each contractor has to supply FRA with their project HSSW Plan within 14 days from award of contract. FRA's HSSW Manager, and other members of the Delivery team will assess the contents of each plan using the 'Health and Safety Plan Review Document' (HSW Form No.2 – Appendix G) to record deficiencies and provide feedback for improvements to be made where required.

Prior to commencing any work on site, contractors will have to submit their method statements and combined risk assessments for review and approval by a team from the supervising Contract Administrator and present their evaluation to the FRA HSSW Manager.

Method Statements will include (but not be limited to) the scope of work, location(s), plant and equipment to be used, materials to be used, manpower and levels of supervision, training provided and proof of competence with certificates, a list of responsible persons with phone numbers, methodology, drawings, risk assessments with control measures, COSHH / hazardous product MSDS, PPE intended for use, manual handling and any other information relating to the work activities including protection of members of the public, visitors etc.

Contractors' HSSW personnel will be interviewed by the Contract Administrator prior to

commencement of work onsite to substantiate their experience and qualifications and then their performance will be monitored during the first 3 months' prohibition period on site. Similar monitoring of other key contractor personnel will also be carried out. The outputs from these interviews and checks will be presented to the FRA HSSW Manager and GM.

Emergency Response Plans will be developed by Contractors for all foreseeable emergencies, which will also be reviewed for their suitability and realism by the Contract Administrator. Emergency drills for each type of emergency plan will have to be carried out on site twice a year, to ensure employees are aware of their roles and actions to be taken and by whom. FRA personnel who may be affected by such emergencies need to participate in emergency drills to test their effectiveness.

11 MONITORING AND INSPECTION

Regular inspections of FRA project sites will be undertaken by FRA staff and specific issues related to HSSW non-conformances requiring improvement will be recorded using HSSW Form No. 1 (Appendix H). A HSSW report (Appendix I) will be completed and issued to the Contract Administrator to instruct the Contractor to undertake necessary improvements within 24 hours.

For any HSSW issues that requires immediate action, FRA staff will instruct all site personnel to clear the area and report the prohibition notice / stop work order to the FRA General Manager, HSSW manager, Contract Administrator and Contractor. FRA staff will remain onsite to ensure that no work is carried in the area until acceptable, safe plan of action is formulated and corrective action undertaken. Following the return to the site office a HSSW near miss form (HSW Form No. 15 – Appendix J) will be completed.

Regular inspections are also to be conducted FRA Delivery Team members, accompanied by other representatives of the Consultant's Site Supervision Team. Both inspections to be conducted using Form No. 1 and a HSSW improvement notice report submitted for any non-conformances found.

The contract administrator will conduct a HSW inspection of the FRA site under their overall management. The General Manager will generally conduct these inspections with the HSSW Manager and the Resident Engineer; the General Manager may also invite a senior representative from the Contractor to accompany the inspection. HSW Form No. 1 will be used for this inspection and a HSSW improvement notice report submitted for any non-conformances found.

The periodic HSSW Inspection Records will be reviewed by the FRA HSSW team and

recommendations provided to the Contract Administrator's Supervision Team. Close out of open actions will be monitored and verified by the HSSW Manager, or his authorised delegate.

Based on the HSSW report it is the Contract Administrator that is responsible for initiating corrective actions (and ensuring acceptable corrective action is taken) when the project HSSW performance falls below acceptable levels.

The HSSW manager in coordination with the aforementioned staff is responsible for gathering data and information relevant to HSSW compliance if possible. The HSSW manager is also responsible for reporting any incidents and general compliance evaluation to senior management.

Gathering data and information for compliance monitoring or verification purposes shall be accomplished by trained personnel (whether internal or external). When any data or other information indicates that there could be, or that there is either non-compliance, or a near miss then these shall be immediately reported to the HSSW manager through the "near miss" form (HSW Form No. 15) or HSSW Report.

The purpose of data gathering is to provide useful information that will be used in improving HSSW performance on the Project. FRA will review data to identify persistent occurrences of poor practice and trends in data, for example the trend analysis for Near Miss / HSSE report categories. The output from data gathering will be reviewed at the weekly Governance meeting. [Note: data output information and trend analysis will be exchanged once a sufficient volume of data has been acquired to permit interpretation].

12 CRISIS MANAGEMENT

Crisis and emergencies will be handled through the main contractor according to their Emergency Preparedness Procedures and Crisis Management Plan. FRA Delivery Team shall liaise with the main contractor and the authority during the crisis, and communicate with FRA management on the status of crisis.

The classifications or levels of emergency situations and crisis are defined in Table 1 and provide guidelines for escalation procedures. The Crisis management should include procedures that facilitate the management of incidents and emergencies when any threat occurs.

Table 1 - FRA CRISIS CLASSIFICATION

Type of Incidents	Emergency Level		
	Level 1	Level 2	Level 3**
Accident	Accident resulting in minor injury at project site. No 'Stop Work Order' issued by Authorities / Government Department	Accident resulting in major injury or involved public at project site. Short term stop work order (less than 5 says)	Accident resulting in major injury or fatality or multiple fatalities or involved public at project site. Long term stop work order (more than 6 says)
Fire	Fire discovered and quickly extinguished by project personnel.	Fire Dept. was called and extensive damage caused to constructed facilities / structure.	Fire Dept. was called and extensive damage caused to constructed facilities / structure/public/adjacent plot development.
Dangerous Occurrence Collapse of scaffold Collapse of structure Electrical Short Circuit Escape/leakage of a hazardous substance Lifting Machinery Failure	Dangerous occurrence arising out of or in connection with works but has not involved external parties or adjacent plot.	Dangerous occurrence arising out of or in connection with works and has involved external parties or adjacent plot.	Dangerous occurrence arising out of or in connection with works and has involved public or external parties or adjacent plot.
Chemical Spill	Chemical Spill from site boundary but has not reach nearest water way and adjacent plot.	Chemical Spill from the site boundary and interface with nearest water way and adjacent plot.	Chemical Spill from the site boundary, interface with and polluted nearest water way and adjacent plot.

Land Slide/Slope Failure	Incident occurring at construction site but has not caused inconvenience to adjacent plot.	Incident occurring at construction site has caused inconvenience to adjacent plot.	Incident occurring at construction site has caused inconvenience to adjacent plot and public.
Silt Trap Failure/Flood	Overflow from site boundary but has not caused damage to adjacent plot.	Overflow from site boundary and has caused damage to adjacent plot.	Overflow from site boundary and has caused damage to adjacent plot, residential, commercial area or any Environmental Sensitive Receptor Area (ESR).

****Level 3:**

Has attracted media attention or become national issue or involve minister level.

Potential of serious legal implication.

Incident that disrupt operations causing “Denial of Access” to site or site offices.

Table 2 – Crisis Communication & Persons in Charge

(xxxvi) (xxxvii)	(xxxviii) of Communication	Line	(xxxix) in Charge During Crisis	Person
(xi) Level 1	(xli) FRA Site representative		(xlii) FRA HSW Manager	(xliii) HSW Manager
	(xliii) FRA GM		(xliv)	
Level 2	FRA Site representative		HSW Manager	
	FRA HSW Manager			
	FRA GM			
	FRA CEO			
Level 3	FRA Site representative		CEO FRA	
	FRA HSW Manager			
	FRA GM			



FRA Director Corporate
Communication
FRA FRA
FRA Board Members

13 INCIDENT INVESTIGATION

All work-related injuries and incidents involving the public, regardless of severity, shall be reported to FRA immediately after they occur.

An Investigation Report must be completed by the main contractor and shall be submitted to HSSW Manager within 24 hours of the accident/incident for review and record. HSSW Manager shall then conduct the follow up on the control measures or procedures.

14 NON-CONFORMANCE TRACKING

Non-conformance issues identified in the Contractor's operation will be recorded through HSSW Report (and corrective action taken by the Contractor within 24 hours). The subject of non-conformance will be reviewed internally at the Weekly Progress Meeting where appropriate follow-up actions (those deemed necessary after the initial addressing of the issue) will be agreed. Non-conformance issues will be discussed and closed, where applicable at the Weekly meeting with the Contractor.

15 AUDITS

Internal audits of the HSSW elements will be conducted monthly as per the requirements of OSHA, following a programme to be developed by the Audit Manager and HSSW Manager, who will conduct the audits with assistance from HSSW staff and technical engineers where required. The aforementioned audit programme will include internal and external audits of our HSSW systems, implementation of HSSW plan together with the HSSW systems of our Contractors.

The 'Four Stage' Internal Audit Process and the processes for monitoring and closing out necessary corrective actions are identified in Appendix K of this document.

16 MANAGEMENT REVIEWS

Management reviews are to be conducted annually, or whenever there is a change in legislation or other circumstances that require a review of HSSW systems, plans or

documentation. The Management review team will consist of:

- General Manager
- Project Controls Manager
- HSSW Manager
- Project Person In Charge (P.I.C)
- The Management Review will focus on the Audit coverage requirements laid out in the FRA's Project Execution Plan utilising the Management Audit Checklist, HSW Form No. 19 (Appendix K).
- The findings and recommendations of the Management Audit will be presented to the FRA Board of Directors by the CEO. It is the HSSW Manager that will verify the close-out of any non-conformances or observations generated through the Audit.

17 LEGISLATIVE ISSUES

FRA will review the current legislation. To ensure that the information held is current the FRA HSSW Manager will write formally to the CEO, every 6 months, detailing the revision or version of all applicable legislation.

18 HEALTH AND SAFETY FILE

The HSSW file is to be produced by the Site Supervising Consultant (Contract Administrator).

The HSSW File should include information about all of the following topics, where these may also be relevant to the HSSW of any future construction works. The level of detail should be proportionate to the risks likely to be involved in such works.

A brief description of the works carried out and completed.

Residual hazards and how they have been dealt with (for example, surveys or other information such as buried services).

Key structural principles incorporated in the design of the structure (i.e. bracing, sources of substantial stored energy – including pre- or post-tensioned members) and safe working loads, particularly where these may preclude placing scaffold or heavy machinery there.

Any hazards associated with the material used (for example, hazardous substances, lead paint, special coatings that could be burnt off").

Information regarding the removal or dismantling of installed plant and equipment (such as

lifting arrangements).

Health and safety information about the equipment provided for cleaning or maintaining the structure.

The nature, location and marking of significant services, including firefighting equipment.

Information and as-built drawings of the structure, its plant and equipment (i.e. the means of safe access to and from service voids, fire doors and compartments)

It is the responsibility of HSSW Manager to ensure the accuracy and the completeness of the information included in the Health and Safety Files

SECTION 162 – ENVIRONMENTAL MANAGEMENT

162.01 GENERAL

As the Contractor responsible for the overall construction of the Works, it is entirely the responsibility of the Contractor to establish and implement all environmental management plan procedures to the requirement of each task performed on the Project site and to ensure all sub-contractors and his nominated sub-contractors under his control comply with the environmental management system.

Approval, agreement, endorsement or the like of the Contractor's Environmental Management Plan if so provided by the Employer and/or the Contract Administrator shall not limit or absolve any responsibility of the Contractor and that no other party except the Contractor is liable for any Environment issues at the Site during the period of construction.

This section describes certain minimum environmental requirements for the Contractor to employ on the Project. The responsibilities of the Contractor are not limited those identified in this document.

The Contractor shall strictly adhere to all environmental rules, regulations and requirements of local and national authorities having jurisdiction. The Contractor shall follow all environmental procedures prescribed in guidelines and codes of environmental practice of the Department of Environment of the Republic of Fiji (DOE), and its regulations and best industry practice pertaining to environment management.

Where any requirement explained in this section varies from that prescribed in any rules, regulations and requirements of authorities having jurisdiction, the more stringent of the requirement shall apply.

162.02 CONSTRUCTION ACTIVITY POLLUTION PREVENTION

Construction sites are responsible for significant environmental pollution. The objectives are to reduce the polluting effects of construction practices and workers at the construction site. The Contractor is required, among others, to comply with the following guidelines.

The Contractor shall create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the local standards and codes of environmental practice. The plan must describe the measures implemented to accomplish the following objectives:

To prevent loss of soil during construction by storm-water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.

To prevent carriage of sedimentation storm sewers or receiving streams.

To prevent pollution of the air with dust and particulate matter.

162.03 SUSTAINABLE SITE PLANNING & MANAGEMENT

The Contractor agrees to be fully aware of the sustainability requirements of the FRA at tender and will participate and cooperate with all FRA requirements, assessors and testing during construction.

Failed assessments or tests are to be immediately corrected by the Contractor until accepted and the minimum score goal is achieved.

Goals of FRA are meant to complement the full contract documents and are not to be used as a substitute or standard on its own. It is the responsibility of The Contractor to ensure that the quality of the construction works conforms to approved standards, practices, specifications and drawings. Comply also with all requirements in Section – QUALITY CONTROL, of these General Requirements.

162.04 STORAGE & COLLECTION OF RECYCLABLES

During construction, Contractor shall provide an easily accessible, dedicated area or areas on-site where sorted waste materials can be stored in separate skips for collection to recycling facilities. Only non-hazardous construction waste is to be included. The separate bins shall include for; paper, corrugated cardboard, glass, plastics, metals, wood, crushed concrete and mixed waste. Hazardous waste, domestic waste, excavation soils and land-clearing debris shall have their own designated bins.

Dedicated area for storage of recyclables.

Proper labelling for recyclable skips.

Proper instruction to all site workers to implement the practice.

162.05 CONSTRUCTION WASTE MANAGEMENT

The Contractor must develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on site or co-mingled. The Contractor shall liaise with sub-contractor/supplier regarding handling and recording the construction waste. The Contractor shall record and provide evidence (such as Delivery Orders, Invoices, Payment slips &etc.) regarding the construction waste. Quantify by measuring total tonnage of waste. Excavated soil and land-clearing debris do not contribute to calculations. The Contractor will also be required to report waste statistics through the online waste tracker tool by request of the Employer or must provide all information regarding waste to support this reporting and tracking tool on a monthly basis regularly.

162.06 RECYCLED CONTENT

If specified in the contract documents, the Contractor shall use materials with recycled content as identified by the project specifications.

162.07 REGIONAL MATERIALS

The Contractor shall follow specific contract instructions where there is a strict percentage of materials that have been extracted, harvested or recovered, as well as manufactured regionally.

162.08 ENVIRONMENTAL CONTROL

All contractors shall comply with all of the Republic of Fiji regulations and ordinances concerning the protection of the environment and minimisation of noise levels.

All contractors shall take all precautions, which, in the opinion of the Contract Administrator, are necessary to minimize nuisance arising from noise, dust, etc. Plans for nuisance control are to be developed and submitted to the Contract Administrator prior to starting the works.

The Contractor shall eliminate the potential for water pollution by engaging in effective control of sanitary facilities, proper storage of fuels and other potential contaminants, as well as prevention of siltation from land erosion.

The Contractor shall ensure that adequate silt traps are provided and maintained throughout the whole duration of the works and that no contaminated water enters within the public water

ways or external drainage system.

162.09 PROJECT MANAGEMENT AND COORDINATION - ENVIRONMENTAL

Details of the Contractor's Environmental Manager responsibilities and functions are detailed in this document.

Perform project quality control in accordance with requirements specified in Related Sections of this document, including:

- Outdoor Air Quality (IAQ) Management
- Noise & Acoustics Management
- Environmental Management
- Waste Management

Contractor's Environmental Training Program: Contractor shall provide environmental training for workers performing work on the project site. Training shall include the following (but not limited to):

Overview of environmental issues related to the construction industry.

Overview of environmental issues related to the Project.

Within 14 days after the Commencement Date (or as stipulated in the contract), the Contractor shall submit, for Contract Administrator's review and approval, documentation for environmental procedures as specified herein i.e. site specific Environmental Management Plan (EMP), Waste Management Plan (WMP), format for Monthly Environmental Performance Report and IAQ management Plan.

162.10 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan shall at minimum address the requirements as stipulated in the approved Environmental Impact Assessment (EIA) by DOE, and the following:

- Identification of Project.
- Identification and contact information for Environmental Manager.
- General site information.
- Summary of Plan.
- Procedures to address water resources.
- Procedures to address land resources.

- Procedures to address air resources.
- Procedures to address fish and wildlife resources. (if applicable)
- Monitoring procedures.
- Revise and resubmit Plan as required by the Employer or Contract Administrator.
- Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations.

162.11 ENVIRONMENTAL PROTECTION

Erosion and Sedimentation Control

Conduct all earthwork activity in accordance with the sequence of the approved method statement.

Transport and stockpile topsoil on site only to designated areas approved by the Contract Administrator. Transport and dispose of top soil, excavated earth and rock, excavated pavement, and unsuitable materials only at approved landfill sites. Provide temporary erosion protection for exposed slopes under construction until such time as the permanent measures are provided. Provide permanent protection and landscaping work to slopes immediately upon reaching their formation levels.

Construct berms and temporary earth drains for all slopes under construction. Construct permanent drains for slopes which have reached the required formation levels. Take all necessary precautions to prevent debris, rubbish, silt, waste materials and pollutants from entering existing waterways. Provide and maintain at site sediment control measures such as silt fences, silt traps, gabion walls, check dams at all times. Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to install a silt trap of proprietary mechanical type capable of treating the designed runoff to comply with DOE Standards before being discharged to waterways.

Reinstate the site including landscaping where silt traps were located and remove all other temporary measures for environmental control on completion of the works. Treat slurry, oil and grease from piling works before discharging residual water to watercourses.

Waste Management

The Contractor will be responsible for the management of waste on site and ensure that all waste removed from site is removed by an approved waste Contractor. The Contractor will ensure that as much waste as possible is recycled and the following system will be

implemented: Re-use, Recycle, Reduce, Recover, Dispose.

All types of wastes are to be segregated, stored and disposed in accordance with the EMP and the WMP. All excavated waste material shall be removed from the work site and legally disposed of on the day of excavation at the Contractors expense. Stockpiling or dumping of excavated material within the road reserve is not acceptable without prior approval of the Contract Administrator. Should any material be removed that potentially can be re-cycled, e.g. use culverts, riprap, etc the contractor is to seek direction from the Contract Administrator prior to disposal. The Contract Administrator may direct the contractor to save and stockpile any such recyclable materials Stockpile locations within road reserves shall be approved with the Contract Administrator prior to use.

Wastes with sharp edges are to be stored in specially designed containers that are specially manufactured for that purpose. Scheduled waste (as defined by the contract administrator) shall be kept in labelled containers drums and stored in designated areas which shall both be maintained and removed in accordance with the DOE requirements. Scheduled waste shall only be disposed of by the Contractor to an approved licensed service provider. Oil and grease from servicing of construction equipment, vehicles, machinery etc. shall be handled as scheduled waste. Fuel, grease, engine oil and workshop facilities shall be properly constructed and sited away from watercourses to avoid contamination.

Any water discharge from batching plants shall be treated in a water treatment pond system. All waste generated from the cleaning of asphalt hoppers will be collected and disposed of via approved methods. Wastewater (sullage and sewage) from site offices and site accommodation (if any) shall be collected and treated at a wastewater treatment plant prior to discharge into watercourses. Temporary toilets facilities with septic tanks or portable toilets shall be provided at the Site and they will be cleaned and maintained on a daily basis. Septic tanks and portable toilets shall be maintained and emptied by a licensed service provider.

The Contractor shall obtain approval from the relevant authority for his proposed disposal sites with regard to his management of spoil and slurry disposal. The Contract Administrator will confirm the types of waste removed from site that shall follow tractable processes.

Air Quality and Washing Facilities Control

Upon instruction of the Contract Administrator, vehicle washing facilities shall be provided at Site exits and shall be equipped with a motorized pump and jetting hose to ensure all vehicles are free of silt and mud prior to leaving the Site. The water in the wash through shall be

channeled into a silt trap. Vehicles transporting dusty materials shall have the load covered entirely by clean impervious sheeting, which extends over the edges of properly fitting side and tail boards and materials will be dampened before transportation. All vehicles, plant and equipment with internal combustion engines will be maintained in good working condition to ensure that exhaust emissions are controlled to acceptable standards.

Traffic controls such as speed limits and traffic volume restrictions shall be implemented to reduce dust churned up by vehicles, particularly attention will be paid at sensitive areas such as hospitals and schools. Open burning is prohibited at the Site.

The Contractor is required to obtain written approval from the DOE for fuel burning equipment, in particular generator sets used at the Site if the capacity of pulverized fuel or solid fuel consumption is 30kg or more per hour or any liquid or gaseous matter at 15 kg or more per hour.

The Contractor shall regularly spray access roads, haul roads, and other dry surfaces with water in order to control dust emissions such as to ensure compliance with air quality requirements, particularly earthworks activities.

Noise and Vibration Control

Movement of heavy vehicles shall be confined to daytime working hours and minimized during night time, weekends and public holidays. Overall noise levels arising from the movement of heavy vehicles shall be controlled by using routes that will cause minimum disturbance in the vicinity of the Site.

Activities that need to be carried out at night are subject to the permit or approval from the local authorities. No major disturbances are allowed near to the residential areas for night activities. Hoarding is recommended wherever required to isolate the unsightly construction activity from nearby sensitive residents/building if required. Noise generating equipment and machinery shall be inspected regularly and maintained in good working condition to reduce noise generation at source. All noise generating equipment and machinery shall be shut down when not in use. Where explosives are used on the construction process, controlled blasting method shall be used to reduce the noise and vibration.

Vibration levels shall be monitored and recorded for blasting operation conducted on the Site. Noise and vibration emitting construction equipment shall be placed away from sensitive receptors. Piling works should be confined to daytime hours and activities minimized during

night time, weekends and public holidays.

162.12 STORMWATER MANAGEMENT

Stormwater management design and construction works shall conform with the requirements of the Fiji Department of Environment.

162.13 ENVIRONMENTAL INCIDENTS

Any environmental incident caused by the Contractor or his nominated sub-contractors or occurring at the Site, the Contractor is responsible for informing all relevant authorities, the Employer and the Contractor Administrator.

For any environmental incident, the Contractor shall implement the site Emergency Response Plan.

The Contractor is responsible for rectification of all damages caused by the environmental incidents.

Should any environmental incident involve stakeholders the Employer shall be the spokesperson.

162.14 ENVIRONMENTAL MONITORING

The Contractor shall monitor any silt trap and effluent discharges. All samples taken must be tested by an accredited laboratory. The Contractor shall submit to the Contract Administrator and the Employer monthly environmental performance report consisting in-situ and laboratory results, sampling photographs with weather charts and analyses of the monitoring data in terms of environmental performance and summary of environmental inspection.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to engage an accredited laboratory or a laboratory approved by the Contract Administrator to monitor control measurement points proposed in the EMP namely river water quality, air quality, noise and vibration level and others stated in the EIA and associated approval conditions.

The Contractor shall carry out the necessary baseline monitoring to measure air quality, water quality, noise levels, and vibration levels at locations to be approved by the Contract Administrator prior to commencing the works at the site.

162.15 SITE INSPECTION

The Contractor shall conduct physical site environmental inspections on a scheduled basis and submit the summary of inspection status to the Contract Administrator and the Employer.

The Contractor shall take appropriate corrective and preventive actions for all identified deficiencies relating to environmental requirements at the Contractor's own cost.

Where inspections identify a particular person or groups of persons that repeatedly fail to achieve acceptable environmental standards then the Contractor will take action to remove such persons from the Site. Where the Contractor does not take such action the Contract Administrator may instruct the Contractor to do so.

The Contract Administrator and/or the Employer have the right to inspect the environmental performance of the Contractor at any time. The Contractor shall co-operate with such inspections and take action to correct any deficiencies observed at the Contractor's own cost.

The Contractor shall prepare, file and maintain all site inspection records, and which shall be made available to the Contract Administrator and the Employer for inspection upon request.

The Contractor shall adopt "Best Management Practices" for erosion and sedimentation control during earthworks, and the associated site inspections shall be carried out on a weekly basis. The Contractor shall prepare the inspection report and submit to the Contract Administrator and the Employer within twenty-four (24) hours of the inspection.

162.16 AUDITING

When stipulated in the contract, the Contractor shall engage an Independent Environmental Auditing firm to conduct once in every 6months environmental audits of the Site. This, in no way, shall detract from the Contractor's own Environmental audit and inspection requirements. The Independent Environmental Auditor shall be approved by the Contract Administrator.

The Contract Administrator and the Employer has the responsibility to conduct environmental audits at any time during the life of the project. Any such audits will be formally notified and subsequently reported to the Contractor. The Contractor shall co-operate with such audits and take action to correct any non-conformities reported at the Contractor's own cost.

162.17 MEETINGS

The Contractor shall ensure that environmental issues are discussed at all senior management meetings. They will also ensure that competent representatives are deployed to attend any environmental meetings with stakeholders that they are required to attend. The Contractor shall facilitate meetings on the environment with the Contract Administrator and/or the Employer and other stakeholders as required.

Contractor will comply with any directive or request received from the Department of Environment.

The agenda for the environmental meeting shall include the following:

- Review of the previous minutes
- Status of the Environmental Programme implementation.
- Review of environmental incident reports for the previous week
- Review of the Environmental Manger's Inspections and violation reports from previous week
- Identification of up and coming high-risk activities impacting on the environment and the hazard analysis report for same.
- Identification of potential environmental hazards in the coming month and discussion and planned implementation of the steps to be taken to avoid the same.

162.18 ENVIRONMENTAL REPORTS

The main Contractor shall submit weekly Environmental reports to the Contract Administrator. The format and contents of the report shall be agreed with the Contract Administrator. As a minimum the report shall include:

- Average number of persons on site weekly.
- Number (if any) of Environment lost time incidents
- Number of Environmental accidents/incidents since last report.
- Environmental orientation statistics
- Environmental bulletins issued
- Environmental issues raised, closed out or pending for closure.
- Number of Environmental Inspections carried out
- Waste management weekly report.
- Lessons learnt (Good practice/bad practice)

162.19 ENVIRONMENTAL FINES

The below listed Environmental Fines are in addition to the safety penalties and cover non-compliance with matters pertaining to Environment on the project.

VIOLATION	FINE	REMARK
Non segregation of waste materials	FJD 500	On second offence, removal from site
Noncompliance with environmental standards	FJD 500	Re-orientation on Environmental system
Chemicals not stored in chemical locker	FJD 1000	Second offence removal from site
Smoking on site	FJD 300	Plus removal from site
Poor housekeeping	FJD 500	Second offence double the fine
Unsecured materials stored in the open	FJD 300	
Spill Trays not being used	FJD 500	
MSDS not highlighted in store and/or on containers	FJD 300	
Containers not labelled adequately	FJD 300	
Hazardous materials spilt on the ground	FJD 500	
Poorly maintained plant and equipment	FJD 1000	
Urinating or defecating in areas other than in the facilities provided.	FJD 500	Removal from site.
Not carrying out works in compliance with Temporary Works Traffic Management Planning Guidelines	FJD 1000	Works shall cease until Contract Administrator approved otherwise and Person will be removed from site period

No Contractor shall pass on a violation cost to any employee. The violation fines shall be used up in its entirety during the life of the project for such items as environmental training etc. The expenditure of the funds shall be determined by the Contract Administrator. All violation fines shall be withheld by the Contract Administrator from the monthly valuation payments and shall be utilized to promote environmental training and awareness.

On the occurrence of the first violation, the Contractor shall be instructed in writing by the

contract administrator to remedy the offence within a specified time. Where the Contractor fails to remedy the offence within the time scale, the Contractor shall be prohibited from carrying out any further work within the affected area until the specific exposure has been corrected to the satisfaction of the Contract Administrator.

On the occurrence of further violations, the severity of each violation shall be considered by the Contract Administrator and the Contractor will be instructed accordingly. Where the Contractor unreasonably ignores the Contract Administrator instruction, then the foreman and/or operatives responsible for operations in the area where the violations are occurring shall be instructed to carry out the corrective actions required at the expense of the Contractor.

162.20 CLEANING AND WASTE MANAGEMENT

A) MAINTAINING A CLEAN PROJECT SITE

The Contractor is responsible for overall maintenance of a clean Project site at all times. In this regard he shall, at a minimum, ensure implementation of all measures detailed in this Section - CLEANING AND WASTE MANAGEMENT as well as Section - CONSTRUCTION WASTE MANAGEMENT by all contractors, his sub-contractors and nominated sub-contractors.

The contractor shall submit to the Contract Administrator a drawing and written explanation detailing the proposed logistics of debris removal. The drawing is to include areas for trash bin and/or skips storage and routes for disposal from all areas of the Project site.

The contractor shall have, at the minimum, the following number of workmen engaged on a daily basis exclusively for Site cleaning:

- 1 person for every 50 workmen.

The Contractor shall provide uniforms or overalls that are of distinctly different colour for the men engaged in cleaning operations.

The Contractor shall be responsible for cleaning and waste management of all areas within the Project site including all work areas, access roads, office areas, any canteen / messing area, toilets, first-aid facility, storage/ material laydown areas, etc.

The Contractor shall place designated skips around the construction areas and near the Project site offices at locations to be approved by the Contract Administrator. The Contractor shall regularly (at least 3 times per week) empty out the skips to waste separation areas in accordance with Section - CONSTRUCTION WASTE MANAGEMENT.

The Contractor shall provide 1-cubic meter heavy-duty mobile tilt trash carts and rubbish containers with a minimum thirty (30) cubic meters of capacity. The number and locations within project site will be specified by the Contract Administrator.

The Contractor shall be responsible for the general clean-up of the Project site including miscellaneous debris such as lunch boxes, cans, etc. and shall also provide for DAILY cleaning of debris generated from construction / construction personnel in/on the site and in the public roads around the Site.

As the work progresses, the Contractor, sub-contractor and his nominated sub-contractors shall be responsible for maintaining the whole area of his operations and work areas in a clean, tidy, pollution free and safe condition by arranging his materials in an orderly manner.

The Contractor, sub-contractor and his nominated sub-contractors are required to keep their work area clean on a daily basis and remove construction debris, crates, packaging material, miscellaneous cardboard, paper wraps, Styrofoam, etc. and place them in skips provided by the Contractor at designated locations for removal from the site by the Contractor as elaborated in Section - CONSTRUCTION WASTE MANAGEMENT. The Contractor, sub-contractor and nominated sub-contractor shall be responsible for any and all damage resulting from any debris blown from the construction site. All materials need to be secured/tied down to mitigate against this.

The Contractor, sub-contractor and his nominated sub-contractors shall be responsible for dust control and pollution control. The Contractor shall carry out regular cleaning of all areas of the Project site including all access roads within and around the Site. All areas shall be kept clear of dust, mud, water, silt and other materials.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to maintain a wheel washing facility to clean all vehicles and plant before they leave the Site to ensure that no earth, mud or other objectionable matter is deposited by them on public roads or private rights of ways.

If earth, mud or other objectionable matter is deposited on public or private rights of way as a

result of the Works, the Contractor shall provide sufficient labour, plant, equipment, etc., as is necessary and as required by the Contract Administrator to ensure that all deposits are immediately removed. The Contractor shall be responsible to pay fines imposed by local authorities for such deposit on public / local roads / R.O.W.s.

The Contractor shall ensure that all material is stored and kept in a manner that does not create any fire hazard or any other encumbrances. All rubbish, waste materials, debris, and the like shall be systematically cleared off the working areas as it accumulates. Disposal should be done in a timely manner, as a minimum, on a daily basis in order to maintain a clean and safe work area (refer to Section - CONSTRUCTION WASTE MANAGEMENT).

The Contractor shall be responsible for providing broom cleaning, machine vacuuming and/or street sweeping to ensure a safe and clean work environment.

The Contractor shall not dispose of any hazardous materials or substances or dump oil, diesel fuel or bury any toxic containers or contaminants on the Project site. All such materials shall be collected and stored in a separate skip for hazardous waste.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor may be required to establish, maintain, operate and decommission designated wash areas for asphalt transit mixer trucks within the Project site.

The Contractor is responsible to ensure that all material waste is properly covered prior to the waste removal trucks leaving the site.

The Contractor's safety engineer must complete a Housekeeping check list for all areas of the Works on a daily basis and submit this list to the Contract Administrator weekly.

The Contractor shall give particular attention to the requirements of protecting the environment related to the surrounding schools. In this regard, extra attention needs to be made by EACH Contractor in relation to dust control, noise control and traffic management during school operation hours. EACH Contractor will be required to formally submit a written nuisance avoidance plan to the Contract Administrator detailing the Contractor's plan for addressing the concerns of the neighbouring schools. EACH Contractor is also required to attend meetings as scheduled through the Contract Administrator with the responsible staff of the neighbouring schools to address their needs.

B) PROGRESSIVE CLEANING

The Contractor shall remove liquid spills promptly. Where sand or other debris would impair proper execution of work, broom-clean the entire work area, as appropriate. All substance or fuel spills must be reported to the Contract Administrator as soon as practically possible after the event.

The Contractor shall remove debris from concealed spaces before enclosing the space.

During handling and installation, the concerned Contractor shall clean and protect construction work in progress and adjoining materials already in place. He shall apply protective covering where required to ensure protection from damage or deterioration of the Works at the time of Completion of the Works.

The Contractor shall keep all installed works clean. He shall clean installed surfaces according to the written instructions of the manufacturer or fabricator of the product or products installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

The Contractor shall clean all exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at the time of Completion of the Works.

The Contractor shall clean and maintain cleanliness on completed Works as frequently as necessary through the remainder of his Contract period.

The Contractor shall ensure that the materials, products, assemblies and installed works and finishes are kept clean and protected, during the course of work. Non-conformance by the Contractor to the instructions of the Contract Administrator to clean the installed work items may result in those items being rejected from Site.

The Contractor shall dispose of all waste materials and debris in accordance with Section - CONSTRUCTION WASTE MANAGEMENT.

Burying or burning waste materials on Site is forbidden. Flushing waste materials into sewers or into waterways are forbidden. If the Contractor is found to be carrying out any of these infringements, then the Contractor shall be penalized.

If the Contract Administrator and/or the Employer find that cleaning is not satisfactory,

instructions will be issued to the Contractor for taking appropriate actions immediately. On failure to conform to the issued instructions, the Contract Administrator shall deploy an outside agency or third party to carry out the necessary tasks for which the costs shall be payable by the Contractor. The incurred costs shall be immediately deducted from the monies due to the Contractor.

C) FINAL CLEANING

Prior to requesting the Certificate of Practical Completion (CPC) for the Works / part of the Works, the Contractor shall submit for the Contract Administrator's approval, a thorough final cleaning plan which shall include but not be limited to a schedule indicating the planned cleaning activities by area, a list of all cleaning material recommended in writing by the different finishes manufacturers or suppliers for the various finished items, cleaning procedures for specially supplied items or as requested by the Contract Administrator and procedures required to protect finishes during remainder of the overall Project's construction period to ensure that surfaces will be without damage or deterioration at time of hand-over.

The Contract Administrator and/or the Employer will not issue the CPC for the Works / part of the Works until the Contractor has thoroughly cleaned all finished surfaces of the Contractor's works. This cleaning shall be carried out by a cleaning specialist engaged by the Contractor and includes but is not limited to the following:

Removal of stains, spots, marks, dust, paint, asphalt splashes and dirt from decorated work or finishes surfaces, including covered slab or spaces

Removal of all temporary protective coverings to any surfaces or hardscaping, including adhesive residue.

Clean all hardware and other metallic materials.

Cleaning of all finished surfaces using only cleaning material approved by the manufacturer or supplier of the item and in a manner approved by the Contract Administrator.

Damage done to any surfaces, fittings or equipment during the process of cleaning operations will be made good by the Contractor at his own expense.

Works will be inspected by the Contract Administrator upon receipt of a written request from the Contractor.

Dirt and debris shall be completely removed from the Site in accordance with the relevant section of the Specification.

The Contractor shall form dedicated teams comprising men from his employ and from his sub-contractors and his nominated sub-contractors to perform final cleaning operations under the responsible supervision of Contractor.

All locations, spaces and other areas will be inspected by the Contract Administrator upon receipt of a written request from the Contractor.

Dirt and debris shall be completely removed from the Site in accordance with the relevant section of the Specification.

It will be the responsibility of the Contractor to complete the final cleaning for all spaces in accordance with these requirements and to receive complete acceptance from the Contract Administrator regardless prior to work beginning from subsequent contractors. No claims will be accepted for any coordination with subsequent contractors work due to any delay by the Contractor in beginning and completing these requirements to full satisfaction of the Contract Administrator.

D) RUBBISH REMOVAL FINES

Refer to Section - SAFETY for Rubbish Removal Fines, which will be assessed against the Contractor for violations of the requirements of this Section by the Contractor and/or his sub-contractors or his nominated sub-contractors.

162.21 CONSTRUCTION WASTE MANAGEMENT

The Employer requires that all contractors comply with all National and Local regulations and ordinances concerning the protection of the environment.

The Employer requires that all contractors efficiently use resources and energy to the fullest extent possible in the completion of the Project. Resource efficient aspects to be considered in completing this project include the use of techniques that minimize waste generation, re-use of materials on site where possible and recycling of waste generated during the construction process.

Depending on the specific contract and as requested by the Contract Administrator, the Contractor

may be required to develop a Construction Waste Management Plan (CWMP) for the project. The plan shall include the following;

List of materials targeted for reuse, salvage, or recycling, and name(s) of receiving facilities/ companies that will be purchasing or accepting the recycled or salvaged materials.

Description of onsite and/or offsite sorting methods for all materials to be removed from the site.

If mixed construction and demolition wastes are to be sorted off site, provide a letter from the processor stating the average percentage of mixed construction and demolition waste they recycle.

Landfill information: Name(s) of landfill(s) where waste will be disposed, and applicable tipping fees.

Materials handling procedures; description of the means by which reused, recycled or salvaged waste materials will be protected from contamination.

Description of the means of transportation and destination for recyclable materials (whether materials will be separated on-site and self-hauled to designated centre, or mixed waste will be collected by a waste hauler and removed from the site).

Sample spreadsheet and description of how the plan will be documented on a monthly basis.

Waste hauling vendor shall register in accordance with local authority requirements.

END OF SECTION

SECTION 163 – QUALITY ASSURANCE

163.01 QUALITY CONTROL PLANNING

The Contractor's Quality Control (QA/QC) planning shall be based on ISO 9001 standards and identify the quality standards that are relevant to the Project and determine the ways to satisfy them. Quality Control planning shall identify the inspection and testing needs of materials and construction.

The Contractor shall meet with the Contract Administrator to discuss the QA/QC system prior to submittal of the QA/QC plan for formal acceptance. The meeting shall develop mutual understanding relative to details of the system, including the forms to be used for recording the QA/QC operations, inspection, administration of the system, and the interrelationship of Contractor inspection, Consultant's inspection, communication and Processing of requests for inspection, etc.

The Contractor's Quality Control planning shall establish processes for Quality reviews and audits that enable evaluation of the overall QA/QC plan's performance on a regular basis.

163.02 CONTRACTORS QUALITY CONTROL PLAN

The Contractor shall provide and maintain an effective Project Specific Quality Control plan hereinafter referred to as QA/QC plan that complies with the Conditions of Contract and as further described herein. The Contractor shall be responsible for ensuring that his sub-contractors, nominated sub-contractors and suppliers conform to the Quality Control plan requirements as provided in the Contract Documents.

The Contractors QA/QC plan shall establish a system to perform sufficient inspection and tests of all items of work, including that of his sub-contractors and nominated sub-contractors, to ensure construction, finish, functional performance, and identification meet or exceed the specified requirements. This control shall be established for all construction work performed pursuant to the Contract except where the technical provisions of the Contract provide for other specific control by inspections, test, or other means. The Contractor's QA/QC plan shall specifically include the surveillance and testing required in the technical provisions of the Specification.

The Contractor shall furnish to the Contract Administrator as soon as practicable and in no event later than fourteen (14) days after issuance of notification of the Commencement Date

(unless otherwise provided by the contract), a Project specific QA/QC plan which shall include the procedures, instructions, and records to be used. This document will include as a minimum:

The QA/QC organisation chart and Qualification requirements of personnel.

Authority and area of responsibilities of the QA/QC personnel. Depending on the scope of the contract, the Contractor's QA/QC Manager may not have any duties other than the implementation of the QA/QC programme. Where a dedicated QA/QC Manager is required, an instruction will be given by the contract administrator.

Plan for accomplishing quality control inspections including that for his sub-contractors and nominated sub-contractor's work. (How, what, where, when and why).

Detailed listing and designation of all tests to be performed list of Inspection and Test Plans to be generated to cover all inspection and test activities. (Include specimens of inspection and test formats). The Contract Administrator will indicate which tests may be performed by technicians employed by the Contractor and those that must be performed by an Employer approved independent testing laboratory. The Contractor, the sub-contractors and the Direct contractors shall provide necessary advanced equipment for inspection to measure the quality for their respective works.

Documentation procedures for Quality Control operations, inspections and testing.

Method of documenting QA/QC operations, inspections and testing. All the check lists for various works (for each stage of completion) shall be provided with this document for approval.

Close-out procedures and check lists.

A narrative discussion of how the Contractor's QA/QC staff will accomplish their assigned tasks.

An explanation as to how the QA/QC relates to other staff elements with regards to the shop drawing submittals, as-built drawings, revisions to the Contract and safety.

Sub-contractors and nominated sub-contractors shall not have a separate QA/QC plan. The Contractor shall include any specific requirement of his sub-contractors and nominated sub-contractors in his QA/QC Plan. In doing so, the Contractor shall ensure that he fully

coordinates QA/QC requirements with his sub-contractors and nominated sub-contractors.

Construction operations will not commence until the Quality Management plan has been accepted by the Contract Administrator. However, at the instruction of the Contract Administrator, the Contractor may be allowed to proceed on a specific phase of construction for which the plan has been submitted and accepted. Progress payments will not be processed for any portion of the Works that has a QA/QC requirement until that portion of the QA/QC plan has been submitted and accepted.

Should the Contract Administrator have reason to suspect that any materials, plant or workmanship used in any part or parts of the Works may not be in accordance with the requirements of the Contract, he may require the Contractor to carry out any type of testing which, in the Contract Administrator's opinion, is necessary to verify the quality of such material, plant or workmanship in such part or parts of the Works. The cost of any test, so required, shall be borne by the Contractor regardless of whether or not such test shows the materials, plant or workmanship are in accordance with the requirements of the Contract and to the satisfaction of the Contract Administrator. The Contractor shall not be entitled to claim any extension of the Time for Completion or additional costs as a result of having to carry out these tests.

163.03 IMPLEMENTATION OF QUALITY CONTROL PLAN

The Contractor's Quality Control plan shall be implemented by the contractor's QA/QC team whose duty will be to ensure conformance of the Contractor, his sub-contractor and nominated sub-contractors to the Project's Quality requirements.

The Contractor shall, within fourteen (14) days after issuance of notification of the Commencement Date, report to the Contract Administrator (or as stipulated in the contract), the names and qualifications of personnel assigned full-time to the QA/QC function. The named personnel shall prepare the QA/QC program and remain as the basis of the QA/QC staff until a QA/QC program has been submitted and accepted.

The Contractor's QA/QC team shall be sufficiently staffed to perform the following tasks:

Prepare detailed inspection and test plans for approval of the Contract Administrator.

Conduct phased inspections (preparatory, initial and follow-up) and approve inspection and test plans.

Perform all testing required under the technical paragraph QA/QC reports hereinafter.

Prepare daily QA/QC reports in accordance with paragraph QA/QC reports hereinafter.

Review and approve all shop drawing submittals.

Inspect materials as they are delivered on site to insure compliance with approved shop drawings and Contract Specification.

Conduct off-site inspections of supply items fabricated or assembled and services to be incorporated into the work. Provide monthly report of off-site QA/QC activities. The Contractor's QA/QC representative at the fabricating plant shall be responsible for the release of the fabricated items for shipment to the Project site.

Maintain record of all QA/QC activities that shall be available for the Contract Administrator's use.

QA/QC Reports: The Contractor shall provide a daily (or less frequently as agreed with the Contract Manager and depending on the specific requirements of the contract) QA/QC report not later than the end of the next working day. The report shall contain a record of inspections and tests for all work accomplished subsequent to the previous report and shall include the following information:

Phase(s) of construction underway during the time frame of the report.

Phase inspection (preparatory, initial, or follow-up), phase of construction and location of inspections and/or tests that were made.

Results of inspection, including nature of deficiencies observed and corrective actions taken or to be taken.

Report of tests performed, including those specified, with the results of the tests, including failures and remedial action to be taken. Test results, including all computations shall be attached to the report form. Where test results cannot be completed by the time the report is submitted, a notation shall be made that the test was performed and the approximate date test results will be available. Delayed test results shall be submitted with the report form on the date received.

Results of inspection of materials and equipment upon arrival at the Site and prior to incorporation into the work for compliance with submittal approvals, damage and proper storage.

Instructions received from the Contract Administrator's field representative or inspector.

In all cases, the report must be verified and signed by the one person delegated this responsibility by the Contractor. The verification is to contain the statement that all supplies and materials incorporated in the work are in compliance with the terms of the Contract except as noted.

163.04 CONTRACTOR'S QA/QC TEAM PERSONNEL

Qualifications of the QA/QC Manager's role and responsibilities are explained in this document.

The Contractor's QA/QC Manager shall have prior approval of the Contract Administrator.

The Contractor shall include staffing adequate within their staffing plan who are responsible for inspections, compliance with drawings and specification requirements and turnover of documentation to the Contract Administrator. QA/QC personnel shall be submitted and approved by the Contract Administrator prior to being deployed at site. The Contractor shall not remove or replace any of the QA/QC staff without the consent of the Contract Administrator.

The Contractor shall not remove, change out or relocate key QA/QC team staff without the Contract Administrator's written consent. The Contractor's and sub-contractors and nominated sub-contractor's senior Project site staff shall be fluent in technical English, spoken and written.

The Contractor shall have the full responsibility to ensure implementation of his sub-contractors' and nominated sub-contractors' Quality Control plan.

The QA/QC teams of the Contractor's sub-contractors and nominated sub-contractors shall perform their functions directly under the authority of the Contractor's QA/QC Manager.

163.05 QA/QC RECORDS FILING SYSTEM

The Contractor shall establish and maintain a Quality records filing system, which shall include, but is not limited to the following:

- Quality Control Plan
- Inspection and Test Plans
- Work and Material Inspection records
- Test certificates, Mill certificates, Calibration certificates etc.
- Earthworks tests, boring logs, pile reports, concrete records, asphalt records, reinforcement records and structural steel erection records (if applicable), welding reports and certifications
- Non-conformance reports, daily QA/QC reports
- Training records, on or off Site inspection records etc.
- Laboratories used to perform tests shall be accredited by a relevant authority and in accordance with specification and/or as approved by the Contract Administrator.

The Contract Administrator or Employer reserves the right to utilise the Contractor's material testing laboratory and equipment (if required) to make spot tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Employer.

If recurring deficiencies indicate that the QA/QC Plan, personnel, inspections, tests and/or records are not providing adequate control, the Contractor shall take corrective action as deemed necessary and directed by the Contract Administrator. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or his representative at the Site of the work, shall be deemed sufficient notice for the purpose. If the Contractor fails or refuses to comply promptly, the Contract Administrator may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject for extension of time or for excess costs or damages by the Contractor.

The Contractor shall notify the Contract Administrator in writing of any proposed change to the QA/QC system. No such change shall be implemented prior to concurrence in writing by the Contract Administrator.

The Contractor's quality control plan shall provide for inspection of all off-Site or on-Site stores. The Contractor's QA/QC Team shall ensure that no expired material is kept in the stores or on Site. All material delivery notes shall be copied to the Contract Administrator and shall be

inspected at the gate and prior allowing the material to pass into the store or to be stocked on Project Site unless the Contract Administrator has inspected and approved the items.

The Contractor shall detect / identify and remove from Project Site immediately any defective material or any material not approved for use in the project by the Contract Administrator.

163.06 LATEST DOCUMENTS

The QA/QC programme shall provide for procedures that will ensure that the applicable portions of the Contract (and any variations thereto made in accordance with the Conditions of Contract) and the latest and approved shop drawings and samples are used.

163.07 INSPECTION AND TESTING PLAN

The Contractor shall prepare an Inspection and Testing Plan that identifies the number and stages of each inspection and test on all items of work, including that of his sub-contractors and nominated sub-contractors and to identify which activity may not require inspection.

The plan shall include as a minimum at least three phases of inspection for all definable phases of construction as follows:

Preparatory Inspection: This inspection shall be performed prior to beginning any work on any definable phase of construction. It shall include a review of Contract requirements; a check to assure that all materials and/or equipment have been tested, submitted, and approved; a check to assure that provisions have been made to provide required control testing; and plan mock ups when appropriate; examination of work area to ascertain that all preliminary work has been completed; and a physical examination of materials and equipment to assure that they conform to approved shop drawings or submittal data and that all materials and/or equipment are on hand. The Contract Administrator's representative shall be notified at least twenty-four (24) hours in advance of the preparatory inspections and such inspections shall be made a matter of record in the QA/QC documentation as required.

Initial Inspection: This inspection shall be performed as soon as a representative portion of the particular phase of construction has been accomplished and shall establish the acceptable standard of workmanship, including a review of control testing for compliance with Contract requirements, review of mock up, use of defective or damaged materials, omissions, and dimensional requirements. The Contract Administrator's representative shall be notified at least twenty-four (24) hours in advance of the initial inspection and such inspection shall be

made a matter of record in the QA/QC documentation as required.

Follow-up inspections: These inspections shall be performed daily to assure continuing compliance with contract requirements, including control testing, until completion of the particular phase of construction. The Contractor shall give a notice period of at least twenty-four (24) hours in advance of each inspection. Such inspections shall be made a matter of record in the QA/QC documentation as required.

Upon receiving the Contract Administrator's approval, the Contractor's quality control staff shall adhere to the plan and provide Requests for Inspection for each activity or at each stage of work as per the agreed plan.

The Contractor shall give not less than one working day written notice to the Contract Administrator before covering up any works. All works are to be inspected by the Contractor's QA/QA/QC staff prior to Contract Administrator inspection.

163.08 TEST METHODS

The tests shall include typical, routine and sample tests as specified in the Specification. In addition, the Contract Administrator may direct special tests to be made to prove that the equipment and materials supplied comply with the Specifications. The methods of tests for equipment and materials not covered by a recognised standard and for which tests have not been specified herein shall be as directed by the Contract Administrator.

Materials shall be tested before leaving the manufacturer's premises (including quarries and aggregate production facilities) as well as after delivery to the Project Site and incorporation in the Works and the Contract Administrator shall be at liberty to reject materials after delivery and incorporation notwithstanding the preliminary test at the manufacturer's premises.

Should the Contract Administrator and/or Employer decide not to send an inspector to the manufacturer's premises, the Contractor shall obtain from the manufacturer certificates of test, etc., showing that the materials have been tested in accordance with the requirements of the Specification. The decision of the Contract Administrator and/or Employer to not send an inspector to the manufacturer's premises and the Contractor's submission of manufacturer's certificates of test as aforesaid shall not relieve the Contractor from his contractual responsibilities and commitments and shall not affect the right of the Contract Administrator and/or Employer to reject after delivery, any materials found to be not suitable or not in accordance with the Specification.

The Contractor shall pay all costs and expenses in connection with testing and inspection, including suitable transportation for the Contract Administrator and Employer as required to and from the manufacturer's premises. If inspections are required for manufacturer's premises at locations outside of The Republic of Fiji, the costs for flights, appropriate hotel accommodation, daily meals and local transportation for the Contract Administrator and Employer will be at the Contractor's cost.

Definitions

All references to;

“Tests” shall also refer to the inspection and selection of samples.

“Point of manufacture” shall include the point of origin or supply.

“Samples” shall include mock-ups and trials.

163.09 TESTING AND INSPECTION DEVICES

All measuring and testing devices shall be calibrated periodically against certified standard equipment. Copies of certified calibration reports issued by relevant authorities / agencies shall be available for review by the Contract Administrator.

163.10 PROJECT SITE SAMPLES AND MOCK- UPS

Samples of work may be requested by the Contract Administrator. If accepted, and allowed by the Contract Administrator or specifications such sample may be incorporated in and made part of the Work.

Prepare mock-up works as required by the different Sections of the Specifications. Remove mock-ups not suitable to be incorporated in the works as and when directed by the Contract Administrator.

The Contractor shall initiate mock-ups for typical installations for acceptance of visual and/or performance parameters prior to progressing with such installations in other areas. These mock-ups are intended to establish quality benchmarks, minimize abortive work and resolve coordination issues. The installation of mock-ups shall supplement the shop drawing and coordination drawing requirements and precede the continuous progress of such installations. Such mock-ups can be instructed by the Contract Administrator during the course of work progress, for which no additional cost shall be payable to the Contractor. A schedule and

matrix of mock-ups are to be developed and maintained to make all the team members fully aware in advance of these works for inspections.

Mock-ups shall be erected to full scale unless otherwise agreed with the Contract Administrator.

163.11 MANUFACTURER'S REVIEW

The Contractor and Installer shall review the Design Drawings and Specifications, the shop drawings, and product data, with qualified representative(s) of the materials manufacturers for the projects and systems to be used in the Works. The review of the documents and conditions shall confirm that all of the parties are in agreement the selected materials and systems are proper and adequate for the applications shown, especially with respect to compatibility with adjacent systems and materials.

163.12 NON-CONFORMANCE REPORTS

Work identified by Non-Conformance Reports (NCR's) generated by the Contract Administrator, must be remedied by the Contractor within seven (7) days of the date of issuance of the NCR or as otherwise agreed with the Contract Administrator. For each non-compliance, the Contractor shall supply the Contract Administrator within one day a written explanation for the variance and details of what remedial action is to be taken. Failure of The Contractor to take approved remedial action may result in a deduction from the Contractor's Payment for each unresolved NCR item. Any NCR's required for immediate resolution must be closed out within a maximum period of twenty-four (24) hours. Delayed rectification will not entitle the Contractor to any claim.

END OF SECTION

SECTION 164 – TRAFFIC MANAGEMENT

164.01 TRAFFIC MANAGEMENT OVERVIEW

The Contractor shall develop Traffic Management Plans and manage the traffic in accordance with FRA's Traffic Management Guidelines which are provided in this Section. The Guidelines cover:

- FRA HEALTH, SAFETY AND SECURITY POLICY
- TEMPORARY WORKS TRAFFIC MANAGEMENT PLANNING OBJECTIVES
- PRINCIPLES OF TEMPORARY TRAFFIC MANAGEMENT PLANNING
- RISK ASSESSMENT
- TRAINING AND COMPETENCE
- TRAFFIC MANAGEMENT PLANNING PROCESSES
- SAFE WORKING ZONES
- PEDESTRIAN SAFETY
- EQUIPMENT AND PPE
- INCIDENT DOCUMENTATION
- EMERGENCIES, INCIDENT RESPONSE AND CRISIS MANAGEMENT

164.02 FRA HEALTH, SAFETY AND SECURITY POLICY

The FRA ultimate aim is to ensure the health, safety, security and welfare of our employees, the contractors and sub-contractors' employees, visitors, members of the public and any other third party who may be affected by our work activities on our projects. FRA is committed to ensure that the working environment across all areas of the FRA development is such that all our staff and those of other entities working on the project go home healthy and safe at the end of each working day.

We consider the aforementioned to be a major part of our contribution to the people of The Republic of Fiji and FRA's philosophy of Zero Harm on the FRA project.

To realise our goal of Zero Harm, we will implement a robust risk-based health, safety, security and welfare management system, based on ISO and OSHA Standards together with industry best practice to identify hazards and risks during the design, construction and contractual maintenance periods of FRA, with the ultimate aim of mitigating as many risks as possible through innovative design criteria and safe methods of working.

A register and copies of relevant The Republic of Fiji legislation and international standards will be maintained and made available for reference; their requirements will be adopted and

implemented on our worksites and at our offices as appropriate to the work activities being conducted.

We will identify the development needs of our staff, from which we will provide applicable training to maintain and improve team member's competencies, with which to fulfil the requirements of new standards and new technology used on our projects to increase their knowledge.

We will provide a framework of objectives to fulfil our contractual obligations and to contribute towards their overall delivery of the project. All staff and employees will be provided with team, and where possible individual objectives, derived from our company objectives. Objectives will be reviewed and reported on during monthly meetings.

Monitoring of the health, safety, security and welfare performance will be undertaken utilizing a number of processes to measure the levels of compliance and implementation of all the above requirements.

We will disseminate copies of this Policy to all our staff, stakeholders, consultants, contractors and subcontractors as well as including it in inductions for our employees, contractors and visitors.

Periodic reviews of this Policy and other HSSW documentation will be undertaken at every 6 months, during management reviews, following changes in legislation or whenever changes are required due to unforeseen circumstances or our contractual scope of work.

164.03 TEMPORARY WORKS TRAFFIC MANAGEMENT PLANNING OBJECTIVES

A key component of the FRA projects scope includes the construction of connections to the road network and refurbishment of existing roads. In addition, projects often also provide an upgrade to the neighbouring streetscapes. These works will largely take place on public land and as such must be conducted in accordance with all legislation, health and safety best practices/policies and with all relevant approvals from Authorities.

To deliver projects whilst meeting the highest standard for these objectives all external works must have in place an approved Traffic and Pedestrian Management Plan (TMP) that sets out a methodology to provide a road environment that is safe for all road users and workers during construction, while maintaining access for pedestrians and traffic flow.

The FRA requires all contractors and subcontractors to adhere to Code of Practice for Temporary Traffic Management (CoPTTM) as issued by New Zealand Transport Agency. A copy of this code of practice can be found on the Fiji Roads Authority Website¹.

This guidelines document sets out a broad code of practice that shall be followed in addition

to the CoPTTM by all project management and site staff, as well as contractors or sub-contractors involved in the planning, approval, implementation, maintenance or removal of works on a public road. In case of any discrepancy the CoPTTM takes precedence.

FRA reports against two Key Health, Safety and Welfare Performance Indicators (KPIs) directly to the Board of Directors for FRA. The Key Performance Indicators KPIs are as follows:

KPI 1:

The number of reportable accidents per month, causing an employee to be off work for 4 days (excluding the day of the accident) or more, or a fatality involving employees and / or members of the public directly related the works (excluding road traffic accidents) compared to the total number of hours worked normalized by 100,000 for all works undertaken under the supervision of the FRA projects' delivery.

Objective: To confirm the effectiveness of health and safety management. To confirm continuous improvement in the working environment is being achieved through effective action plans.

KPI 2:

The number of work zone road traffic and pedestrian accidents per month, reported at road works in relation to the works.

Objective: To monitor road traffic accidents associated with road works and any resultant criticism of the Traffic Management. To confirm continuous improvement in the working environment is being achieved through effective action plans.

1 <http://www.fijiroads.org/activities-on-the-road/code-of-practice-fo-temporary-traffic-management-copttm/>.

164.04 PRINCIPLES OF TEMPORARY TRAFFIC MANAGEMENT PLANNING

The TMP must establish a safe system of work for all temporary external roadworks. The safe system must include methodologies to ensure work zones are managed such that the potential for harm can be eliminated or reduced. Communication of approaching work zones must be provided to all road users in an appropriate timeframe that includes what to expect and clear instructions of action required.

Safety must be maximised approaching and within all work zones.

Access must be maintained that minimizes disruption and inconvenience.

All workers and pedestrians must be segregated from vehicular traffic. A lateral buffer must

be present between all works and pedestrians/vehicles.

Instructions and advice clearly communicated to all road users, residents, businesses and workers in a timely, unambiguous and accurate manner.

In addition to these principles, all stakeholders affected by the proposed works must be engaged to ensure appropriate information is communicated to reduce the disruption to essential services. Stakeholders will/may include the land transport authority, police and emergency services, utility companies, land owners, public transport operators and the general public.

164.05 RISK ASSESSMENT

Included with all TMP's for external construction works must be a risk assessment. This purpose of the risk assessment is to identify, assess and mitigate/eliminate/reduce the associated risk to ensure that the risk is broadly acceptable/tolerable. In assessing risks using a risk matrix approach, consideration must be given to the likelihood of a risk occurring and the severity of the consequences.

Mitigation and control measures will be employed to reduce risks to acceptable levels that may include revision of the temporary road layout or speed restrictions, communication and hazard warning, diversions, construction methodology amendments or restrictions to working hours (programming).

164.06 TRAINING AND COMPETENCY

All contractor / subcontractor staff involved with the generation of TMP's shall be trained and accredited to the approved standards stipulated by the Land Transport Authority of the Republic of Fiji and the FRA. Staff involved with Traffic Management planning must have completed a relevant Traffic Management Certificate of Competency. In addition, all staff involved in Traffic Management Works must complete the Traffic Controller and Flagmen training course.

164.07 TRAFFIC MANAGEMENT PLANNING PROCESSES

All TMP's and associated works must follow the process detailed below:

- Planning
- Approval
- Implementation

- Inspection, Enforcement and FRA Audit
- Clearance and Reopening
- Continuous Traffic Management Improvements

Planning

The purpose of the planning stage is to ensure that the TMP associated with temporary roadworks is properly designed and documented to ensure that the safety of the road worker, road user and pedestrian is maximised. An appropriate planning methodology would include the instigation of planning activities, development of the TMP, a review of the TMP together with a road safety audit before submission to the authorities for approval.

Approval

Approval of the TMP from the FRA must be granted prior to any works commencing on public roads. The approval process will likely involve a thorough review and analysis workshop with the FRA to ensure safe systems will be employed and that there will be zero/minimal impact to the surrounding road network.

Implementation

Once approved, the TMP will be implemented with works commencing with the installation of safe working zones in accordance with safe working practices included in the temporary traffic diversion as set out in the TMP.

The implementation of safe working zones is a high hazard work activity. As such within the TMP, the implementation of the safe working zone must have a dedicated method statement and risk assessment developed especially for the work to be carried out that takes all risks and safe working best practices into consideration.

During the implementation process the contractor will comply with all elements of the approved TMP, method statement and risk assessment whilst communicating appropriately with required stakeholders. Any variations to the TMP required during implementation shall be included in an updated revision of the TMP that is issued to the FRA at least 1 month prior to work commencement for approval. During the approval process of any updated revisions of the TMP no works shall be carried out.

Inspection, Enforcement and FRA Audit

The Contract Administrator will be primarily responsible for ensuring that the approved TMP is strictly followed throughout the construction works at the designed and implemented standard. The TMP will include a programme of inspections that will be followed and a record must be kept by the Contract Administrator that documents deficiencies and non-conformance. Inspections will be completed by the Contractor Administrator and will often

include representatives from the local authorities as well as FRA personnel. All deficiencies and non-conformances will be rectified and closed out within the timeframes specified in the contract or as soon as practically possible depending on the nature of the issue. Periodically throughout the works FRA will conduct an audit to ensure that the mandatory elements in this document are being adhered to in addition together with all requirements of the TMP and FRA stipulations.

Clearance and Reopening

This stage ensures that temporary road diversions and traffic management restrictions are removed in a safe manner and in accordance with the TMP upon completion of the works to enable the road to be returned to normal operation. Upon completion of works, the contractor will notify the Contract Administration who will in turn communicate the status to the FRA and other relevant stakeholders that works are suitable for reopening. Following a pre-opening inspection/audit any restrictions and diversions shall be removed in accordance with the methodologies specified in the TMP to ensure safety to road users and workers. All permanent signs and road markings must be reinstated prior to the road reopening for normal traffic operations.

Continuous Traffic Management Improvements

Throughout the entire Traffic Management process, regular meetings will be held involving FRA, Contract Administrators, Contractors, Authorities and other relevant stakeholders to review the planning and works carried out to date, identify potential improvements to the traffic management plan and implement these changes either directly with site works or included in future TMP's.

164.08 SAFE WORKING ZONES

A work zone typically comprises of the area of road directly affected by the construction works and additional areas of road in advance of the works for warning signs, barriers, safety buffers etc. All work zones must be highly visible and properly lit especially at night. Some operations may involve multiple work zones working in concurrence and special attention must be given to ensure that clear, accurate and appropriate warning signs are used to instruct traffic. The initiation, operation and removal of ALL safe working zones must comply with all relevant the statutory Authority. Electronic and hard copies of both documents are held at the FRA Site Office.

All works area is defined as the area taken up by the works themselves including space required for accommodate the workforce whilst they carry out construction and any required movement of plant and equipment.

Lateral Safety Buffers

Adjacent to the works area must be a lateral safety buffer that separates the works area from the moving traffic. The boundary should be designated by channeling devices like cones and concrete barriers. The size of lateral safety buffers will depend on factors such as road conditions, layout and speed of approaching vehicles. Figure 1 demonstrates this principle:

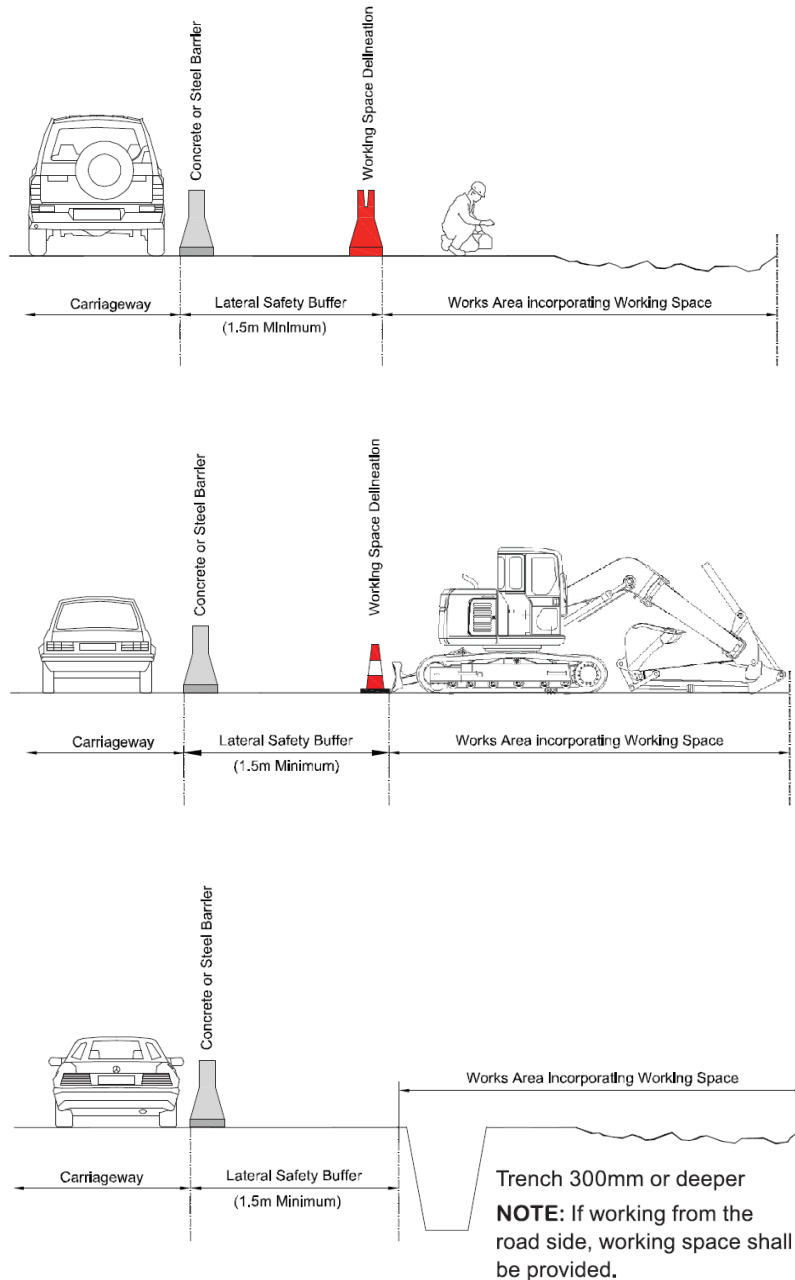


Figure 1: Lateral safety buffers required for all works

Advance Warning Zones Approaching Works

When considering a the temporary TMP from plan view, a typical work zone will have five specific areas as shown in Figure 2:

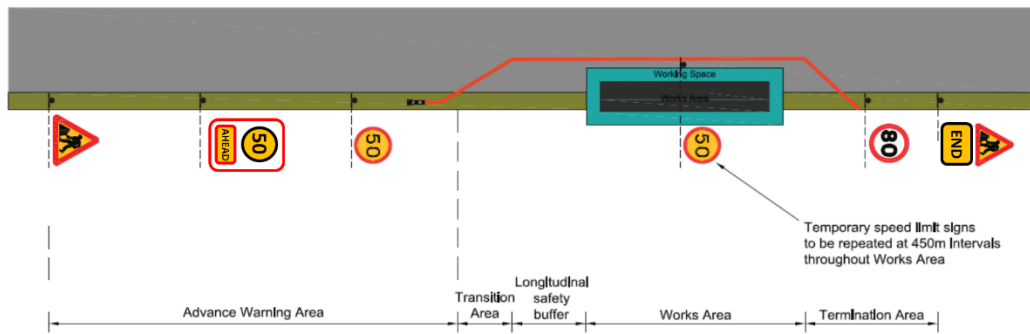


Figure 2: Longitudinal typical work zone and safety areas

It is important to note that appropriate speed limits approaching and within the diversion must be enforced to protect workers and road users. Average speed cameras and point speed cameras may be used to enforce temporary speed restrictions. All works carried out by contractors and/or sub-contractors on public highways will need to adopt the above principles and allocate sufficient space for each of the five areas based on factors such as vehicle speed, anticipated traffic, road conditions and the type of road. An example of an advance warning area is shown in Figure 3:

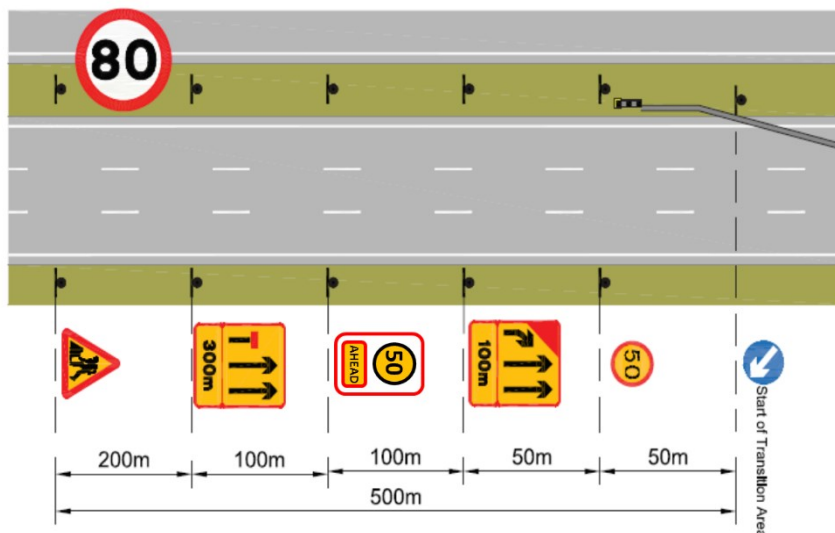


Figure 3: Example 500m advance warning area

Lane Reduction on Divided Carriageways

When work zones occur on requiring a reduction of the number of lanes on a divided carriageway, the works will be implemented such that the vehicles travelling at slower speeds are not required to speed up to merge with faster traffic. If works are located in a lane with slower then all traffic should be diverted into the slower lane before the single lane being diverted away from the works. Any lane closure of a divided carriageway will result in a reduction in the road capacity and as such the designer must develop a strategy for minimizing the effect of this loss of capacity.

164.09 PEDESTRIAN SAFETY

The safety of all pedestrians is of paramount importance for all stages of the construction works and they must be protected from both the works and passing traffic. A suitable fencing system is required to provide safe passage free of hazards for all pedestrians. Wherever possible, diverted pedestrian routes shall be located away from live carriageways. An example is shown below in Figure 4:

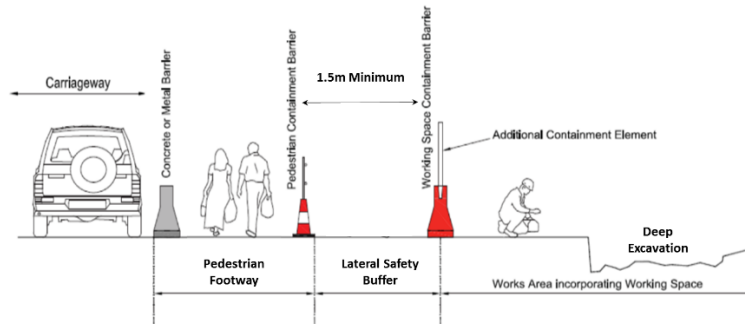


Figure 4: Appropriate Pedestrian Footway

164.10 EQUIPMENT AND PPE

Appropriate equipment, signs, PPE and concrete barriers must be employed and used throughout all public carriageway works. The selection of equipment, signs and barriers will be determined by factors such as the type of road, speed of traffic, and nature of works being undertaken. All equipment and PPE must be detailed in the TMP and reviewed by the authorities prior to use.

164.11 INCIDENT DOCUMENTATION

To facilitate continuous improvement of TMP safety standards, the contract administrator / contractor will notify FRA immediately following the occurrence of any incident or “near-miss” and provide a brief report. The report must detail the nature, location, date, time and severity of the incident together with a sketch detailing the occurrence, the response taken, any contributing factors, the effectiveness of TMP and recommendations to implement.

164.12 EMERGENCIES, INCIDENT RESPONSE AND CRISIS MANAGEMENT

The TMP process to be implemented and followed as outlined in this document has the intention of eliminating or mitigating the risk of any incidents occur. However, in the event that

the TMP fails to prevent an incident or if an unforeseen event occurs the Contract Administrator, Contractor and any subcontractor must have an emergency and incident response plan that has been approved by FRA. This plan must be activated, monitored and reported against. As soon as the incident or emergency occurs the Contractor must notify the Contract Administrator who in turn informs FRA and any other the Authorities. FRA has a crisis management plan covering the FRA development that will be activated and followed in addition.

END OF SECTION

SECTION 165 – QUALITY CONTROL AND TESTING

165.01 GENERAL

The onus is on the Contractor to produce work of quality and accuracy of detail to the requirements of the Specifications and Drawings. The Contractor must provide experienced engineers, foremen, surveyors, materials technicians and other technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the Works at all times.

The Contractor shall be responsible for carrying out all examination and testing of materials and work under the Contract in accordance with the requirements of the specification.

The cost of all testing shall be met by the Contractor.

Unless otherwise specified, all tests and sampling shall be undertaken in accordance with the described standards, test methods, codes of practice as current at the time of performance of the tests.

Current VicRoads Codes of Practice and Test Methods are available online at the VicRoads website (www.vicroads.vic.gov.au). Australian Standards are available online at the SAI Global website (www.saiglobal.com).

a) Laboratory Accreditation

Laboratories that perform tests required under this contract shall meet the requirements of AS ISO/IEC 17025. All test reports/certificates shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025.

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

NOTE: To conform with ILAC requirements, any additional tests may need to be covered by the terms of the accreditation or, if this is not the case, the testing may need to be reported such that it is clear the testing is not covered by accreditation. A separate report may be necessary.

If requested by the Engineer, the Contractor shall submit documents that allow materials to be traced to their point of origin.

b) Calibration

All test equipment used for tests, carried out in accordance with Clause 163.E5(d) above, shall be calibrated by a laboratory meeting the requirements of AS ISO/IEC 17025 for the particular calibration method.

c) Sampling

All construction materials sampling shall be undertaken by either:

- (i) personnel from a laboratory accredited to AS ISO/IEC 17025 for the appropriate sampling methods; or
- (ii) personnel who have successfully completed an accredited course in sampling of construction materials delivered by a registered training organisation, and as necessary, have taken a refresher course in sampling of construction materials every three years.

The sampler shall be identified on the test report

165.02 METHODS OF TESTING

All tests shall be made in accordance with the standard methods prescribed.

In order to interpret which test methods are to be selected, the following is the hierarchy of documents to be used. The highest documents in the list having precedence over any lower documents:

Contract Specific Clauses

Standards and Specification Sections

Australian Standards

Australian Standards Test Methods

Austroads Test Methods

Other Standards and Test Methods such as

New Zealand Standards

American Society for Testing and Materials (abbreviation ASTM).

British Standards Institute Specifications (abbreviation BS).

American Association of State Highway and Transportation Officials (abbreviation AASHTO).

Precedence in test methods is established by

- (a) Higher order method(s), that may call on other test methods, have precedence in reporting accuracies and procedures;
- (b) Lower order method(s) that require certain information to be reported, such information shall be included in the report.

Where test methods include statements in the reporting clause such as

- as required;
- where (as) applicable; or
- where relevant;

such details shall be included in the report wherever possible. The applicability, relevance, etc., is based on whether that part of the test is performed or such information was obtained in accordance with the method requirements.

If the Contractor proposes materials complying with other Standards the Contractor must supply sufficient documentation to enable the Engineer to examine and rule on the suitability of such standards.

In all cases the latest amendment or revision current at the closing date of the tender is implied when reference is made to one of the above standards in the Specification.

165.03 ALLOWANCE FOR TESTING IN PROGRAMME

The Contractor shall make allowance in the construction program for the time necessary to arrange for and to carry out examination and testing of materials and work.

The Contractor shall also make allowance in the construction program for the time necessary for the Engineer to undertake additional testing and examination of works.

165.04 NOTIFICATION

Where inspection or testing of materials or work is required by the Engineer or his representative, at least 24 hours' notice shall be given to the Engineer.

165.05 TESTS

Unless otherwise specified, all tests shall be undertaken in accordance with the appropriate Australian Standard (AS) test method or method as described within the specification.

165.06 LOT TESTING

Unless otherwise specified, acceptance of material and work will be based on testing of the material or work in lots. A lot will consist of a single layer, batch or area of like work which has been constructed or produced under essentially uniform conditions and is essentially homogeneous with respect to material and appearance. Unless otherwise specified, the extent of each lot shall not exceed one day's production. Discrete portions of a lot which are non-homogeneous with respect to material and appearance shall be excluded from the lot and shall be either treated as separate lots, or reworked. Where the areas excluded from a lot as non-homogeneous exceed 10% of the total lot area or at other specified percentages of the total lot area, the whole of the lot shall be rejected.

165.07 TAKING AND SUBMISSION OF SAMPLES

Where it is required in these Specifications that the Contractor shall submit samples of materials or mixtures to the Engineer for approval prior to their use in the Works. The use of these materials or mixtures without the Engineer's written approval shall constitute default on the part of the Contractor for the consequence of which default shall be liable. All samples shall be submitted in sufficient time for proper testing. The Engineer's approval of any materials or mixture shall in no way relieve the Contractor from his obligation to provide materials, mixtures and workmanship in accordance with the Specifications.

All samples for testing shall be taken in a random pattern as defined in the Specification. Where specified the random sampling procedures shall be followed and where no specified random sampling is specified the sampling procedure shall be as ordered by the Engineer. The method of taking samples shall be as specified in the applicable sampling and testing methods.

The Engineer shall have free access to the Works for the taking of samples. The Contractor shall render any assistance necessary for the taking of samples and shall be responsible for the reinstatement of pavement layers or other structures at the positions where samples have been taken. Full compensation for rendering assistance with sampling reinstatement where samples are taken shall be included in the rates tendered for the various items of work tested and no additional payments will be made in this respect.

Table 165.071 below shall serve as a guide to the submission of materials in respect of the

time and quantity required for testing, approval and mix design. As the time stated in this schedule makes no allowance for possible rejection and re-submission of alternative materials the Contractor shall submit any doubtful material at an early stage or together with alternative materials in order to minimise any delays in final approval.

These requirements are in addition to the specific test requirements required in each specification section.

Table 165.071 Schedule showing quantities and times for the submission of materials for approval and mix designs

Submission for quality approval only				Submission for quality approval and mix design	
Material submitted	Proposed use	Minimum time to be allowed for testing and approval	Minimum quantity to be submitted	Minimum time to be allowed for testing, approval and mix design	Minimum quantity to be submitted
	Coarse aggregate for concrete	2 weeks	50 kg of each size of stone	10 weeks	150 kg of each size of stone for each class of concrete
Aggregate	Bituminous sprayed / chip seal	2 weeks	50 kg of each size of stone	N/A	N/A
	Asphalt mix	2 weeks	50 kg of each size of stone	6 weeks	100 kg of each size of stone
	Crushed stone base or subbase	3 weeks	50 kg of each size of stone	N/A	N/A
	Fine aggregate for concrete	2 weeks	50 kg of each size of chart	10 weeks	150 kg of each type proposed

Submission for quality approval only				Submission for quality approval and mix design	
			fraction		for use for each class of concrete
Crusher dust and/or sand	Asphalt mix	2 weeks	15kg of each size of chart fraction	6 weeks	150kg of each type proposed for use
	Slurry seal or sand seal	2 weeks	15kg of each type proposed for use	6 weeks	50kg
Crushed Rock/ Gravel	Subbase and/or base	4 weeks	200 kg of each sample	N/A	N/A

Other materials as specified or as directed by the Engineer e.g. paint, cement, additives etc.

165.08 FURTHER EXAMINATION AND TESTING

Notwithstanding anything to the contrary herein, the examination and testing of materials and work by the Engineer and any consent to proceed resulting from such examination and testing shall not be taken as preventing the Engineer from carrying out further examination and testing of the materials and work and subsequently rejecting the materials and work if shown by such examination and testing to not comply with the Contract.

165.09 COMPACTION AND MOISTURE CONTENT TESTING

- For the purpose of control of moisture content of material and for determination of compaction procedure the following definitions shall apply:
 - (i) material of nominal size 40 mm or less is material which has 20% or less (by wet mass) retained on a 37.5 mm AS sieve
 - (ii) material of nominal size greater than 40 mm is material which has more than 20% (by wet mass) retained on a 37.5 mm AS sieve.
- Density ratio is defined for asphalt materials as the percentage ratio of the field bulk

density to the bulk density of the job design mix when compacted in the laboratory. For concrete pavement, the density ratio is the percentage ratio of the field bulk density to the mean bulk density of cylinder specimens taken from the same lot.

- Characteristic Value of Density Ratio or Moisture Ratio

The characteristic value of density ratio or moisture ratio of the lot shall be calculated as $\bar{x} - 0.92S$ for six tests per lot where \bar{x} and S are respectively the mean and the standard deviation of the individual density ratio or moisture ratio test values respectively for the lot.

The mean of density ratio or moisture ratio is defined by:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

The standard deviation of density ratio or moisture ratio test values is defined by:

$$S = \sqrt{\frac{\sum_{i=1}^n (\bar{x} - x_i)^2}{n-1}}$$

where x_i , $i=1, 2, 3, \dots, n$, is the individual density ratio or moisture ratio test value and n is the number of tests per lot.

- Testing Small Areas

For earthworks and pavement construction any lot which has a surface area less than 500 m² may be treated as a small area. When testing a small area as a lot and where test requirements are based on characteristic values of density ratio and/or moisture ratio, acceptance of the lot shall be based on the mean values of 3 individual tests. In this case the lot will be accepted as far as compaction is concerned if the mean value of the individual tests exceeds by 2.0% or more the appropriate compaction scale requirement for the characteristic value of density ratio for a lot of six tests.

- Samples Containing Oversize Material with a Nominal Size Greater than 40mm

- (i) Assessment Based on Characteristic Density Ratio

If the set of six samples includes no more than two samples having more than the permitted amount of 40 mm nominal size material, the lot will be accepted as far as compaction is concerned if the mean value of the individual tests exceeds the specified characteristic value of density ratio by 2.0% or more. If there are less than 4 valid samples, acceptance shall be

based on the adoption of an acceptable compaction procedure and test rolling carried out in accordance with the requirement of this Specification.

(ii) **Assessment Based on Mean Density Ratio**

If the set of three samples includes one or more samples having more than the permitted amount of material exceeding 40 mm in nominal size, assessment shall be based on the adoption of an acceptable compaction procedure and test rolling carried out in accordance with the requirement of this Specification.

- **Refilling Test Holes**

The Contractor shall backfill test holes with material of similar quality to that removed from test holes during testing. The backfill material shall be compacted in the holes in layers with a suitable compaction device.

- **Moisture Ratio Determination**

For material of nominal size greater than 40 mm, moisture ratio shall be determined on that fraction of the material which passes the 19.0 mm AS sieve. For material of nominal size 40 mm or less, moisture ratio shall be determined on the whole material, taking into account any adjustment for oversize material as detailed in the relevant test method.

165.10 ACCEPTANCE TESTING

All compaction testing of work carried out under this Contract shall be deemed to be testing for acceptance unless written advice is provided to the Engineer prior to the commencement of the test, that such testing is for in-process monitoring only. Where the Contractor provides prior written advice to this effect, the results of such testing will not be allowable as testing for acceptance.

165.11 CONTINUATION OF WORKS

The Contractor is required to demonstrate to the Engineer, that any earthworks or pavement layer placed has met specification requirements e.g. material quality, compaction results, test rolling, conformity to drawings etc. before the placement of the next overlying earthworks or pavement layer can commence. Placement of the next overlying earthworks or pavement layer shall not proceed without the approval of the Engineer.

165.12 COST OF TESTING**(a) Process control**

The cost of testing undertaken by the Contractor in respect of process control including the taking of samples, reinstating where samples have been taken, and all testing equipment, labour, materials, etc., shall be included in the rates tendered for the various items of work supplied and will not be paid for separately.

(b) Provision of certificates

Where the properties of materials or manufactured products have been specified by reference to Clause 814.02, the Contractor shall produce when called upon to do so, certificates from the manufacturer that the materials or products supplied comply with the relevant specifications. The cost of providing such certificates shall be borne by the Contractor.

(c) Testing of materials and products covered by certificate

The Engineer shall have the right to take samples of and order tests to be made on products and materials in respect of which certificates of compliance may be required as described in Clause 814.03(b). The Contractor shall be paid at the applicable rates, if the cost of such tests are itemised in the Schedule of Quantities or if no applicable rates exist such tests shall be classed as extra work under the General Conditions of Contract, always provided that such tests indicate compliance with the Specifications otherwise the cost shall be borne by the Contractor.

END OF SECTION

SECTION 201 – CLEARING AND GRUBBING

201.01 DESCRIPTION

This section covers the requirements for site clearing and grubbing and for the management of the materials generated.

201.02 DEFINITION

(a) *Clearing and Grubbing*

Clearing and grubbing is the removal within specified limits of:

- Vegetation such as trees, trees stumps, tree roots, logs, brush, noxious weeds and decayed vegetable matter; and
- Refuse such as pole stumps, rubbish dumps and sawdust piles resting on or protruding from the ground surface; and
- Obstruction such as concrete paving, concrete edgings, drainage pits, foundations, fences and disused structures but not underground obstructions such as drainage pipes, service conduits and fuel tanks.

201.03 LIMITS OF WORK

Unless otherwise specified, the limits of clearing and grubbing shall be:

- the whole length between the following chainages refer to Contract Specific Condition
- the width between the outside edges of any batters, including any rounding, together with a further horizontal distance of 1m beyond the outside edges of the batters but not beyond the road reserve boundary or, where catch drains are required, to the outside edges of coach drains
- not more than the width required for completion of the work under the Contract

201.04 CLEARING

Unless otherwise specified or directed by the Engineer, the area within the specified limits shall be cleared of all vegetation, refuse or obstructions down to the natural surface. The Engineer may direct that any tree or shrub designated shall be retained. The Contractor shall not undertake any clearing work or any type of disturbance outside of the specified limits of work unless approved by the Engineer.

Trees shall be brought down in such a manner as to avoid danger to personnel and traffic or

damage to other trees, shrubs, structures or property outside the area being cleared or designated to be retained within the area being cleared.

Tree branches extending over the carriageway shall be trimmed to provide a clearance of at least 6 m above the carriageway surface. Where whole branches are to be removed, the Contractor shall use the three cut method which requires:

- (i) the under cut
- (ii) the upper cut (further away from the trunk than (i) above) to remove the branch
- (iii) the final trim cut which is to be cut close to the main trunk but outside the branch collar.

201.05 GRUBBING

Except as otherwise specified the cleared area shall be grubbed free from vegetation, refuse or obstructions.

In areas where excavation will be made, all vegetation, refuse and obstruction shall be grubbed to a depth not less than 0.6m below the stripped surface. In areas to be covered by embankments exceeding 1m in height, foundation may remain if located or cut off not more than 0.4m above the natural surface but not less than 1m below the finished surface of the subgrade. No extra cost will be paid to the Contractor if ground improvement work is required at the foundation after grubbing to provide a trafficable surface for construction plant.

Pits which are no longer required shall be removed or broken back to a depth not less than 0.3 m below the finished surface of the subgrade. Remaining pipe openings shall be sealed with concrete. Any remnants of pits shall be backfilled with material and compacted to a density ratio of not less than 95%. The calculation of density ratio shall be based on Standard compactive effort.

Holes resulting from grubbing shall be backfilled with materials similar to the surrounding material and compacted to the same degree as the surrounding material.

201.06 CLEARING AND GRUBBING AT BRIDGE AND CULVERT SITES

Unless otherwise shown on the drawings or directed by the Engineer, trees and stumps within 10m of any portion of a proposed bridge or proposed culvert having a waterway area greater than 6m², shall be cleared and grubbed.

Clearing and grubbing at bridge and culvert sites shall conform to the other requirements of this section.

201.07 DISPOSAL OF MATERIALS

All materials resulting from clearing and grubbing shall be disposed of by the Contractor.

Works under the Contract shall be carried out to wherever possible re use materials generated from clearing and grubbing operations within the works area. Any materials which cannot be re used on site shall be removed from the site. Disposal of material by burning on site or burying of materials on site shall only be carried out when permitted and approved by the Engineer. Where burning of material is approved by the Engineer, materials to be burned shall be stacked in neat heaps well clear of standing timber. No materials shall be stacked or burned on private property without written consent of the owner. Residue from burning shall be removed from the site unless otherwise approved by the Engineer.

All burning shall be done at such a time and in such a manner as to prevent fire from spreading to areas adjoining the road reserve and to prevent smoke which might obscure the visibility of motorists. Where required, suitable arrangement shall be made for the control of traffic during this operation.

The Contractor shall observe the requirements of the local fire brigade local government, Department of Environment and the Ministry of Forests or other government department concerning stacking and burning of materials and shall hold all necessary permits before any burning is commenced. Burning shall not commence until all necessary permits have been obtained and provided to the Engineer for record. Where, due to fire restrictions, the Contractor is unable to start the burning operations, materials intended to be burned which interferes with subsequent construction operations shall be moved to approve locations clear of the construction work and later burned. Where it is not practical or not permitted by relevant authorities to dispose of material by burning, the material shall be removed from the site or buried at approved locations, shall observe the requirements of the local government and Department of Environment or equivalent.

201.08 SURVEY MARKS

During clearing and grubbing operations, care shall be taken not to disturb any survey marks.

201.09 DAMAGE TO FENCES

Any damage to fences shall be repaired immediately by the Contractor to a condition at least equal to that existing before damage and no additional payment will be made for this work.

201.10 PROTECTION AND REMOVAL OF EXISTING VEGETATION

(a) Protection of Existing Vegetation

Prior to commencement of any work, the Contractor and the Engineer shall conduct a joint inspection of the site to identify vegetation to be retained and protected.

Existing trees, shrubs, native grasses and groundcovers and other areas of existing vegetation marked as 'to be protected and/or retained' on the Drawings or as directed by the Engineer shall be protected by temporary fencing and incorporated into the works by the Contractor.

No earthworks, travel of equipment or storage compounds shall be established within 5 metres of the drip line of mature trees of trunk diameter greater than 200 mm.

Construction of table drains within the drip line of roadside trees shall be undertaken with no disturbance beyond the line of the table drain and no damage to the canopy of the trees.

(b) Protective Fencing

Protective fencing shall consist of, as a minimum, star pickets with three strands of wire (top, middle and bottom) and para-webbing.

201.11 SALVAGE OF VEGETATION

The Contractor shall cooperate with the Engineer by co-ordinating works under the Contract with activities involving the salvage of plants and the collection of cuttings and available seed from areas of native vegetation on the site.

SECTION 202 – EARTHWORKS

202.01 DESCRIPTION

This section covers the requirements for forming and grading of earthworks including excavation, placement and compaction of topsoil, Type A, Type B, Type C, permeable, oversize and unsuitable materials, disposal of surplus materials, the trimming of batters, surface drains and formation, and the preparation of the final earthwork surfaces and subgrade.

202.02 DEFINITIONS

(a) *Formation*

Formation is the finished surface after completion of the earthworks, excluding any cut or fill batters. The completed formation includes selected material, verges, batters, batter roundings and table drains.

(b) *Subgrade*

Subgrade is the trimmed or prepared portion of the formation on which the pavement and shoulders are constructed.

(c) *Batter*

Batter is the uniform side slope of a cut or fill.

(d) *Batter Point*

The intersection of the batter with the natural surface disregarding any batter rounding.

(e) *Boxing*

The space above the subgrade to be occupied by the pavement bounded by the subgrade level and the inside faces of the constructed verges, or unsealed shoulders.

(f) *CBR*

California Bearing Ratio.

(g) *Cut*

Excavation below the natural surface level after removal of topsoil.

(h) *Cut Floor Level*

The theoretical level of the formation in a cut after completion of excavation to the underside of any Type A material. Where Type A material is required, the cut floor level

is subgrade level and the underside of pavement.

(i) *Catch Drain*

An open cut surface drain above a cut batter or below a fill batter to intercept surface water and divert surface water to drainage outlets.

(j) *Fill*

The compacted embankment placed above natural surface level after removal of topsoil.

(k) *Fill Material*

Fill material includes:

- (i) Type A material – a superior quality material complying with the requirements of Table 202.041 and used as selected material, structural material and/or verge material.
- Type B material – a medium quality material that does not meet the requirements of Type A material, and is usually specified with a minimum CBR value.
- Type C material – a lesser quality material that does not meet the requirements of Type A or Type B material, which may be used in Type C material zones of embankments as indicated on the drawings.
- Rock Fill material – a material comprised of larger rock and rock fragments which may be used within Type B and Type C material zones at lower levels of high embankments in accordance with Section 203.
- Permeable Fill material – self draining material, typically sand or aggregate.

(l) *Formation*

The horizontal and vertical extent of the surface of the formed earthworks. The completed formation includes selected material, verges, batters, batter roundings and table drains.

(m) *Rock Subgrade*

The surface prepared at or below subgrade level by trimming the otherwise undisturbed in situ floor for the full width of the cutting in consistent, medium to high or higher strength rock, as defined in Table 19 of AS 1726 (2017) – Geotechnical Site Investigations, and which is free of soil and loose material. Areas shall not be considered as a rock subgrade where they do not extend the full width of subgrade and for a continuous length of at least 200 m of a carriageway.

(n) *Selected Material*

A Type A material layer placed immediately below pavement subbase to provide greater strength to support the pavement.

(o) *Silt*

A material classified as SILT (ML, OL or MH) in accordance with Figure 5 in AS 1726 (2017) Structural Material

(p) *Structural Material*

A zone of Type A material that is placed at a bridge or a culvert structure or in other areas as specified and/or as shown on the drawings.

(q) *Subgrade Level*

The level of the prepared subgrade defined as follows:

- On Fills – subgrade level is the level of the top of Type A material or where no Type A material is to be placed, the top of Type B material.
- In Cuts – subgrade level is the level of the top of Type A material or where no Type A material is to be placed, the cut floor level and the underside of pavement.

(r) *Surface Drain*

An open drain to collect and drain surface water to drainage outlets

(s) *Surplus Material*

Material which is surplus to the total quantity of material required.

(t) *Topsoil*

The layer of fertile, organic soil immediately below natural surface or placed to the finished formation level outside areas to be paved.

(u) *Table Drain*

A longitudinal surface drain located adjacent to and at the bottom of cut slopes or the top of fill slopes. A surface drain adjacent to the shoulder with an invert level designed to be lower than the top of the Type B material or the Cut Floor Level wherever possible.

(v) *Unsuitable Material*

Material that is soft, excessively wet, unstable or otherwise not suitable for the specified use.

(w) *Verge*

The portion of the formation between outer edge of the shoulder and the start of the batter

slope, or as detailed on the drawings.

(x) *Nominal size of material*

For the purposes of control of moisture content of filling and determination of compaction procedure, material of nominal size 40mm or less is material which has 20% or less by weight retained on a 37.5mm AS sieve and material of nominal size greater than 40mm is material which has more than 20% by weight retained on that sieve.

(y) *Pavement*

Pavement shall consist of subbase, base and surfacing courses.

202.03 CONFORMITY WITH DRAWINGS

Earthworks shall be finished to conform limits to the levels, lines, grades and cross sections specified or shown on the drawings or directed by the Engineer.

(a) *Formation width and alignment*

The widths measured on each side from the specified centreline or design line to the toes of cut batters and/or the tops of fill batters shall not be less than the widths shown on the drawings.

(b) *Boxing width and alignment*

The boxing width shall not be less than specified or shown on the drawings and the edges of boxing shall not deviate by more than 50 mm from the designed offset from the centreline or design line.

(c) *Formation level and shape (outside subgrade width excluding batters)*

Verges shall be constructed such that they match the finished surface level at the outer edge of shoulder or pavement, or where installed the level of kerb and channel or concrete edgings.

Both prior to and after completion of placement of topsoil, the level at any point on the finished surface outside those areas to be paved shall not differ by more than 50 mm from the specified level and the surface shall be free from depressions capable of retaining water. Unless otherwise permitted by the Engineer, no point on the surface shall lie more than 25 mm below a 3m straightedge laid on the surface.

(d) *Subgrade level and shape*

The level at any point on the finished surface shall not differ by more than 25 mm from the specified level. The Engineer may require that the shape be checked by means of a

3 m straightedge laid parallel to the centreline of the road or, except on crowned sections, laid at right angles to the centreline in which case no point on the surface shall lie more than 20 mm below the straightedge. Water shall not pond at any point.

(e) *Batter slope and shape*

At any cross section the batter slope shall not be steeper than the slope specified. The batter faces shall be finished to uniform shape.

(f) *Batter line*

Cut batters shall be constructed so that the batter point is not more than 10% of the batter height outside the calculated batter line.

Fill batters shall be constructed so that the toe of the batter is not more than 10% of the batter height outside the calculated batter line.

The dimensions of batter rounding shall be within 10% of the dimensions shown on the drawings.

On all sections beneath bridges, and on other sections where it becomes necessary to confine the lateral spread of the earthworks to closer limits due to site constraints, the tops of cut batters and the toes of fill batters shall be not more than 300 mm outside the calculated batter lines

(g) *Type A Material*

The thickness, width and shape of placed Type A material shall not be less than the specified thickness, width and shape at any point.

(h) *Type B Material immediately below the Selected Material*

Where selected material is to be placed on Type B material to subgrade level, the level at any point on the surface of Type B material immediately below Type A material shall not differ by more than 15 mm above or 30 mm below the specified level,

(i) *Cut Floor Level*

Where Type A material is to be placed above the Cut Floor Level to subgrade level, the level at any point on the surface of the Cut Floor Level immediately below Type A material shall not differ by more than 15 mm above or 30 mm below the specified level,

Where Type A material is not required, the Cut Floor Level shall be prepared to the appropriate tolerance for the subgrade.

(k) *Surface Drains*

Surface drain invert levels and side slopes shall be finished to within 50 mm of the specified level at any point and shall be free from depressions capable of retaining water.

(l) Type A Material

The thickness, width and shape of placed Type A material shall not be less than the specified thickness, width and shape at any point.

(m) Type B Material immediately below Type A Material

The level at any point on the surface of Type B material shall not differ by more than 15 mm above or 30 mm below the specified level,

202.04 MATERIALS

Materials used for fill construction shall be subject to the approval of the Engineer, and except for topsoil, shall be free from perishable matter. Materials conforming to the following descriptions shall be used for purposes as and when specified or directed by the Engineer.

Testing of materials shall be undertaken in accordance with VicRoads Code of Practice RC 500.20- *Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials* and VicRoads Code of Practice RC 500.16 Code of Practice - *Selection of Test Methods for the Testing of Materials and Work*.

Unless otherwise specified in Table 202.201 or as agreed to by the Engineer, the following Assessment Scales, based on road classification as defined in the FRA Austroads Design Guide Supplement Parts 1 to 8, shall apply in determination of the Assigned CBR and Swell in accordance with VicRoads Code of Practice RC 500.20:

- Scale A: M1, M2, and Arterial roads
- Scale B: S and Collector Roads
- Scale C: Local Streets, C and R

(a) Topsoil

Topsoil is fertile, friable soil containing organic matter and is free from subsoil, refuse, tree roots, rubbish, noxious weeds, contaminants, clay lumps, pathogens and toxic levels of any element with a pH in the range of 5 to 8.

(b) Type A Material

Type A material shall comply with the requirements of Table 202.041 and shall be free of topsoil, deleterious and/or perishable matter.

Material classified as silt, either before or after compaction, is not acceptable as Type A material without stabilisation to the satisfaction of the Engineer.

Table 202.041 Type A Material Requirements

Location and Use of Type A Material				Limits of Grading (% passing by mass) Post					PI x % passing 0.425 mm Post Compaction(max)	PI Range Post Compaction
	Assigned CBR (min) (1)	Swell % (1)	Permeability (max) m/s(2)	75.0	37.5	4.75	0.425	0.075		
Selected Material	8	≤ 1.5	Not Applica	100	-	40-	-	10-40	1000	6-25
Verge Material	8	≤ 1.0	5 x 10 ⁻⁹	100	-	40-	-	10-40	1000	6-25
Structural Material	8	≤ 1.5	Not Applica	100	-	40-	-	10-40	1000	6-25

Notes to Table 202.041

- (1) The Assigned CBR and percentage swell values are to be determined in accordance with VicRoads Code of Practice RC 500.20. Sampling for CBR testing shall be undertaken after field compaction.
- (2) The permeability value is to be determined in accordance with VicRoads Code of Practice RC 500.16. *Code of Practice - Selection of Test Methods for the Testing of Materials and Work* The permeability value is to be determined on specimens manufactured from that fraction of material which passes a 19.0mm AS sieve, compacted at optimum moisture content and 98% of maximum dry density as determined by testing using standard compactive effort for CBR and swell.

(c) *Type B*

Type B material shall be totally free of organic content, topsoil, deleterious and/or perishable matter such as bricks, concrete, glass, plastic, timber, steel or steel by-products. Type B material is material from site or borrow excavation which is free of perishable matter and after compaction has a maximum particle dimension of not more than:

- 150 mm within 400mm of the top of Type B material
- 400mm at depths greater than 400mm below the top of Type B material.

Type B material shall have a minimum Assigned CBR of 4% which has been determined in accordance with VicRoads Code of Practice RC 500.20 Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials.

Material classified as expansive or silt, either before or after compaction, shall not be used as Type B material without stabilization or modification to the satisfaction of the Engineer.

Where the highest quality Type B materials are available they shall be reserved for placement in higher levels of the fills being constructed.

Materials with Assigned Swells of 2.5% or greater are not permitted unless otherwise approved by the Engineer.

Sampling for CBR testing shall be undertaken after field compaction.

Material classified as silt, either before or after compaction, shall not be used as Type B material.

(d) Type C Material

Type C material shall be capable of being spread in layers of not more than 500 mm and compacted as specified to achieve a stable condition.

(e) Permeable Fill Material

Permeable fill material shall be a mixture of hard, durable, clean sand, gravel or crushed aggregate complying with the requirements of Table 202.042, which is free of clay balls and perishable matter. The material shall be free draining.

Table 202.042 Permeable Fill Material

Location	Type of Permeable Fill Material
Against Structures	Grade A4, A5 or A6 (1)
Backfill for Open Jointed Pipes	Grade A4, A5 or A6 (1)

Drainage Blanket Material	Grade A6, B4 (1)
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Note to Table 202.042

(1) Grading requirements are specified in Standard Section 502.

Material not meeting the requirements of Table 202.042 may be considered for approval by the Engineer where the Contractor can demonstrate the proposed permeable filling is hard, durable, and free from clay balls and organic matter and capable of providing the desired permeability requirements.

(f) Oversize Material

Oversize material shall have a maximum particle dimension after compaction not greater than that specified for the type of material and depth of layer being placed.

202.05 MANAGEMENT OF EARTHWORKS

The Contractor shall manage the earthworks in such a way that:

- Materials are maintained in a condition suitable for their intended use;
- The earthworks are kept well drained;
- The trimming and final grading of the surface is completed as work proceeds; and
- The work is executed in safe, neat and workmanlike manner.

202.06 STRIPPING OF TOPSOIL

Topsoil shall be stripped for the full width of the formation:

- (i) defined by the line through batter points extended to include any rounding and any surface and catch drains;
- (ii) by a means which avoids contamination with subsoil and does not increase the extent of unstable areas
- (iii), to a depth of 150mm from the cleared and grubbed surface unless directed by the Engineer; and
- (iv) placed in stockpile or prepared areas unless otherwise approved by the Engineer.

Unless there is an excess of topsoil to be removed from site, topsoil shall not be removed from the site.

The Contractor shall treat and manage site topsoil before stripping, and after spreading, to remove and/or minimise the spread of weeds and other pathogens and pest organisms throughout the site. Stockpiles shall be maintained in a neat, well-shaped state capable of shedding water.

Stripped surfaces shall be graded to an even self-draining surface

Topsoil shall be re spread as soon as practicable.

202.07 SITE EXCAVATION

(a) General

Site excavation shall be excavation within the limits of the batters, open and underground drainage, approved borrow areas from within the Site and other minor excavation outside these limits and shall include placement and compaction of excavated material into the formation or to the point of disposal. Site excavation shall include material excavated and placed as Type B, rocky material, Type A structural material, Type A selected material or Type C as defined in Clause 202.08. The Engineer shall classify each type of material in the cut and approve its nominated use.

(b) Catch drains and Batter Rounding

The Contractor shall construct catch drains where shown on the drawings or where required for the temporary collection and diversion of surface runoff or as otherwise agreed to by the Engineer.

Permanent catch drains and batter rounding at the top of cut batters shall be constructed at the commencement of the cutting excavation.

(c) Excavation Operations

The Contractor shall so conduct the operations that the area outside the limits of the excavation is not unduly disturbed. Any falls or slips of material that occur due to the Contractor's negligence or use of inappropriate methods shall be removed and the area reinstated by the Contractor and no additional payment will be made for this work. Loose and unstable rock on cut batters shall be removed immediately.

If any area on cut batters becomes unstable or unsafe, the Contractor shall install suitable measures to restrict access to the area, e.g. the erection of warning signs and fencing. The affected area shall be inspected and assessed by an appropriately qualified geotechnical engineer, and made safe prior to excavation proceeding in the affected area.

Where unrippable rock has been encountered, the Contractor shall be permitted to use

explosives to break up the work in accordance with Clause 101.24. All costs associated with the excavation of unrippable rock will be at the Contractors expense.

Oversize material shall be treated in accordance with Clause 202.09.

(d) Treatment of Subgrade

Unless otherwise specified, where the excavation at subgrade level is rocky material, the subgrade shall be loosened and rocks or boulders removed to a depth of at least 150 mm below subgrade level in areas on which pavement is to be placed. Any resulting depressions shall be backfilled with suitable material similar to the surrounding in situ material and such backfilling together with the loosened material shall be reworked and compacted as specified.

Where removal of material below subgrade level is not required the surface shall be loosened to a depth of 150 mm and re-compacted to specified requirements.

(e) Cut to fill zones

The excavation in cut to fill zones shall be continued, in the form of transverse benching, across the cut/fill interface for a distance sufficient to ensure that a minimum thickness of fill of 600 mm is achieved across the full width of the formation except that such distance shall not exceed 30 m on each side of the interface;

In sideling country the cut shall be excavated to a depth of 600 mm below subgrade level for the full cut width of the subgrade.

All pavement and verge areas at cut to fill zones shall be excavated to a minimum depth of 600 mm below the Cut Floor Level or top of Type B material, for a distance of not less than 15 m into the cut and 30 m under the fill from the cut-fill line at the upper surface of Type B material. In sideling cut areas, the cut shall be excavated to a depth of 600 mm below the Cut Floor Level for the full cut width to be occupied by pavement and verge material. The excavations shall be backfilled in layers with Type B material.

(f) Surface finish of cut batters

Cut batter surfaces to be topsoiled shall be roughened or otherwise grooved horizontally. No additional payment will be made for any work required to comply with this sub-clause.

(g) Treatment of Rock Subgrade

Where rock exists in a cut below subgrade level but within the designed selected material layer, the material shall be excavated to a depth of not less than 150 mm below subgrade level in all areas on which pavement is to be placed and all loose material and soil shall be removed from the rock floor. Any resulting depressions lower than 150 mm below

subgrade level shall be cleaned of loose material and backfilled with 3% cement treated Size 40 mm Crushed Rock Base or Size 40 mm Crushed Rock Subbase and compacted as specified.

A regulating layer of Size 40 mm Crushed Rock Base or Size 40 mm Crushed Rock Subbase shall then be placed above the rock to subgrade level in lieu of the specified selected material, in layers not exceeding a compacted thickness of 150 mm in accordance with Section 302.

Prior to construction of the regulating layer, the areas of rock subgrade shall be presented to the Engineer for acceptance.

The Contractor shall submit details of any necessary amendments to the subsurface drainage design including transverse subsurface drainage at the interfaces to the Engineer for review.

No adjustment to the Contract Sum will be considered for the treatment of a rock subgrade, or for the construction of the regulating layer in lieu of selected material, or for any modifications to the subsurface drainage.

(h) *Groundwater*

Where groundwater or seepage is encountered the Contractor shall notify the Engineer and submit the proposed action to be taken to the Engineer for review.

The Contractor shall submit any necessary approvals from relevant authorities for the treatment and disposal of this groundwater.

(i) *Surface Finish of Cut and Fill Batters*

The surface of cut and fill batters to be topsoiled shall be textured by scarifying or horizontal grooving.

(j) *Treatment of Cut to Fill Zones*

All pavement and verge areas at cut to fill zones shall be excavated to a minimum depth of 600 mm below the Cut Floor Level or top of Type B material, for a distance of not less than 15 m into the cut and 30 m under the fill from the cut-fill line at the upper surface of Type B material earthworks.

In sideling cut areas, the cut shall be excavated to a depth of 600 mm below the Cut Floor Level for the full cut width to be occupied by pavement and verge material.

The above excavations shall be backfilled in layers with Type B material.

202.08 UNSUITABLE MATERIAL*(a) General*

Unsuitable materials include those materials which are specified as such or which are soft, excessively wet or unstable or otherwise not suitable for the specified use. Material used to replace excavated unsuitable material shall be Type B material.

Excavation of unsuitable material shall be undertaken such that the extent of unstable areas is not increased

(b) Cuts

In cuts, unsuitable materials which exist or develop during construction immediately below subgrade level, or the level of the bottom of any selected subgrade filling shall be treated in situ or excavated and replaced with approved material spread and compacted as specified in layers not exceeding a compacted thickness of 150 mm.

Where material has become unsuitable to any depth due to the Contractor's negligence or use of inappropriate methods it shall be treated in situ or excavated and replaced and no additional payment will be made for this work.

Other unsuitable materials below the subgrade level on which pavement subbase or selected material is to be placed shall be either treated in situ or excavated and replaced with Type B material. All treated areas or replacement material shall be spread and/or compacted to the specified density in layers not exceeding a compacted thickness of 200 mm.

Where material:

- (i) is unsuitable and does not exceed 150 mm in depth, it shall be treated in situ or excavated and replaced and no additional payment will be made for this work;
- (ii) is unsuitable and exceeds 150 mm in depth, it shall be treated in situ or excavated and replaced.

Separate payment, if applicable, (i.e. if the work is itemized in schedule of rates or the work is covered by a Provisional Item under a lump sum Contract) will be made for the volume of material below the Cut Floor Level so treated or excavated and replaced.

- (iii) has become unsuitable to any depth due to the Contractor's negligence or use of inappropriate methods it shall be treated in situ or excavated and replaced and no additional payment will be made for this work.

(c) *Areas upon which filling is to be placed*

After completion of clearing, grubbing and stripping of areas upon which filling is to be placed any unsuitable material immediately below these areas shall be treated in situ or excavated to depths as directed or authorized and replaced with approved material which shall be spread and compacted as specified.

Payment will be made for the full volume of material so treated or excavated and replaced except that where material has become unsuitable due to the Contractor's negligence or use of inappropriate methods, no additional payment will be made for this work.

(d) *Treatment of Unsuitable Materials*

Where unsuitable material is encountered the Contractor shall submit the proposed in situ treatment or extent of excavation to the Engineer for review.

(e) *Fills*

Unsuitable materials in fills shall be treated in situ or excavated and replaced. No additional payment will be made for this work.

(f) *Disposal*

Further to the requirements of Clause 202.09, excavated material conforming to the requirements of Type C and unsuitable material may be used as Type C material within the formations outside the 1.5 to 1 Type B material batters but within the design batter lines of the formations as shown on the typical cross sections, or within such flatter batter profile as may be agreed with the Engineer.

Type C material shall not be placed within 30 metres of a culvert. Where the drawings show Type C material within 30 metres of a culvert this material shall be replaced with Type B material.

202.09 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

No material shall be transported offsite, where such material can be used within the designed earthworks under the Contract.

The Contractor shall, subject to approval by the Engineer and any such conditions as may be imposed by the Engineer, dispose of surplus excavated material by uniformly widening the formation or flattening fill batter or by stockpiling on site or by removing from the site.

Surplus material shall be disposed of offsite at the Contractor's cost.

202.10 BORROW EXCAVATION

Borrow excavation shall be excavation other than site excavation and shall be defined as excavation of Type B from an off-site source for the purpose of placement and compaction into the road formation.

Borrow excavation shall be limited to the quantity of material necessary to complete the work under the Contract and will not be permitted where sufficient suitable material is available from within the limits of site excavation. The Contractor shall obtain all necessary permits and approvals for borrow areas outside the road reservation.

202.11 GEOTEXTILES AND PERMEABLE FILL

(a) General

This clause covers the requirements for the replacement of geotextile fabrics at locations shown on the drawings or as directed. The geotextile fabric shall be supplied in accordance with Section 608.

(b) Preparation of underlying surface

Unless otherwise specified, prior to placing the geotextiles the Contractor shall excavate the surface material to the depth shown on the drawings. The area shall then be trimmed to provide a uniform surface freely draining to points clear of the formation.

The Contractor shall not commence placing the geotextile on the trimmed surface until the Engineer has inspected the area and has given consent to proceed. Where the surface to be trimmed becomes unstable for whatever reason, the Contractor shall treat insitu or remove and replace the unstable material to the condition that the surface has the required strength to support the weight of construction traffic and plant and no additional payment will be made for this work.

(c) Placing Geotextile Fabric

The Contractor shall place the specified geotextile to the limits shown on the drawings or as specified. The geotextiles shall be subject to a visual inspection by the Contractor's geotechnical consultant to verify that the coverage and ground preparation for placement of the geotextile have been executed in accordance with the drawings and this specification.

The geotextile shall be placed without punctures or tears and, if these occur, they shall be rectified or the entire roll of geotextile replaced prior to covering. Any rolls with imperfections shall not be used. All joints shall be overlapped or sewn in accordance with requirements specified in Table 202.111. Geotextiles shall be covered by filling within 48

hours of placement.

Table 202.111 Requirements of overlapped or sewn joints

CBR*	MINIMUM OVERLAP
>2	300- 450 mm
1-2	600- 900 mm
0.5-1	900 mm or sewn
<0.51	Sewn
All roll ends	900 mm or sewn
* CBR at time of construction	

(d) *Type B*

Unless otherwise specified, the Contractor shall supply and place over the geotextile Type B of maximum particle size of not more than 150 mm and moisture ratio of not less than 85% of Optimum Moisture Content as determined by test using the Standard compactive effort.

Where approved by the Engineer the initial layer of Type B filling shall be placed and compacted to the maximum density practicable without causing further instability in the underlying materials upon which the geotextile has been placed. The Engineer may permit subsequent layers of Type B filling to also be placed to the maximum density practicable until stability is achieved and a layer satisfies the test rolling requirements specified in Clause 202.14.

(e) *Permeable Filling*

Where shown on the drawings or specified, the Contractor shall supply and place permeable fill material of the depth specified over the geotextile. The geotextile shall be of the type of filtration and separation classification. The permeable filling shall comply with the requirements of Clause 202.04(e) and have a moisture content compatible with achieving maximum density practicable without causing further instability or loss of shape to the trimmed surface upon which the geotextile has been placed. Any subsequent layers of permeable filling shall also be placed to the maximum density practicable until the full depth of permeable fill specified has been placed.

Following placement of the specified depth of permeable filling, a second layer of geotextile shall be placed as specified to completely enclose the permeable filling before placement of Type B material commences.

202.12 FILL CONSTRUCTION

(a) *General*

Fill construction includes the preparation of areas upon which fills are to be constructed and the selection, placement, and compaction of filling material.

(b) *Areas upon which Fills are to be constructed.*

Areas upon which fills are to be constructed shall be prepared for test rolling by the Contractor. The surface of the prepared area shall be test rolled in accordance with Clause 202.14. Any unstable areas detected by test rolling shall be rectified in accordance with the requirements of Clause 202.08.

Existing pavements which are not required to be salvaged shall be scarified to a depth of not less than 150 mm and compacted as specified. The Contractor shall not commence placing any filling on the prepared areas until the Engineer has inspected these areas and has given consent to proceed.

Where the height of fill to be placed to top of Type B material level over the stripped surface is less than 1.0 m, material immediately below the surface exposed after stripping of topsoil or removal of existing pavements shall be scarified to a depth of not less than 150 mm and re-compacted to the specified density ratio for the location and type of material being placed.

Existing pavements under areas upon which fills are to be constructed, that are not required to be salvaged shall be scarified to a depth of not less than 150 mm and compacted as specified.

If groundwater is encountered, the requirements of Clause 202.07(h) shall apply.

The Contractor shall not commence placing any fill on the prepared areas until the area has been reviewed by the Engineer.

(c) *Benching*

Where a fill is to be constructed on sideling ground or against an existing fill, surfaces on or against which the fill is to be constructed which have a slope steeper than 4 horizontally to 1 vertically shall be cut progressively in the form of benches over the full area to be covered by new filling. The width of each bench shall be such as to permit safe and effective operation of plant but shall not be less than 1m. Each bench shall be sloped inward at a slope not flatter than 10 horizontally to 1 vertically. The new filling shall be placed and compacted in layers as specified face of each bench, and then a new bench shall be cut; this process shall continue for the full height of the fill. Material excavated

during benching may be used in the fill if it meets the requirements specified in Clause 202.04 for the type of material being placed. No additional payment will be made for any work required to comply with this sub-clause.

(d) Moisture content of filling

(i) Material of nominal size 40mm or less

Filling which will have a nominal size after compaction of 40mm or less shall have during compaction a minimum moisture content of 85% of the optimum moisture content as determined in the Standard compaction test. After completion of compaction of a layer the moisture content of the material in the layer shall be maintained within 70% of optimum moisture content until the subsequent layer is placed or, when no subsequent layer is to be placed until the layer has been test rolled in accordance with Clause 202.14. Material within 150 mm of subgrade shall be maintained such that its moisture content is not less than 70% of optimum moisture content prior to the placement of any pavement layer.

(ii) Material of nominal size greater than 40mm

In case of filling which have a nominal size after compaction greater than 40 mm the Engineer will determine the Standard optimum moisture content to the fraction of filling passing the 37.5 mm AS sieve and during compaction of filling the moisture content of that fraction shall be a minimum of 85% of the optimum moisture content.

(e) Placing of filling

(i) General

Filling shall be placed and spread in uniform layers and shall be compacted to meet the specified requirements for the location and type of material being placed. Each layer of fill shall be keyed into the layer above by creation of a textured surface. The Contractor shall ensure that an adequate bond will develop between each layer of filling. Any rocky material present in in a layer of fill shall be uniformly distributed within the layer and the whole shall be compacted as specified.

During the placement of fill material the surface of each layer shall be kept generally parallel to the surface of the subgrade. Prior to the cessation of work each day, the top of the fill shall be shaped and compacted to minimise damage resulting from wet weather.

The Contractor shall establish a procedure to verify that compacted layers do not exceed the specified maximum thickness. Verification records must provide

evidence of measurements taken at least every three layers in consistent locations across the filled areas, and must be retained with the lot records.

(ii) Type A Material

Type A Selected material shall be placed in locations shown on the drawings or, if surplus Type A material is available, it may be used in locations specified for Type B material. Type A material shall be spread and compacted in layers not exceeding a compacted thickness of 200 mm. and shall be placed in accordance with the requirements of Clauses 202.13 and Clause 202.15.

(iii) Type B Material

Type B material shall be placed in locations shown on the drawings, or if surplus Type B material is available, it may be used in locations specified for Type C material. The highest quality Type B materials available shall be reserved for placement in the higher levels of Type B fills being constructed.

The compacted thickness of each layer shall not exceed 200 mm.

Where Type B material contains 25% or more of rock by volume, which will not break down during compaction to meet the maximum particle dimension required for a 200 mm thick layer, the loose thickness of each layer may equal 125% of the typical maximum particle dimension of the rock up to a maximum layer thickness of 500 mm. Any rock with a maximum particle dimension greater than 80% of the loose thickness of the layer shall be removed. The material shall be placed and compacted such that voids are completely filled with fine material.

Prior to placement of the first layer of rock fill (rocky fill material), a geotextile fabric G>3500 shall be placed as a separation layer. Rock fill (rocky fill material) shall be placed and compacted to ensure rock particle to particle contact between coarser rock particles is maintained and to achieve stability of the layer.

Interlock between successive rock fill layers shall be ensured by limiting the placement of finer particles over the surface of the rock fill layer to that necessary to achieve interlock between the courser rock particles.

The material shall be placed and compacted such that voids are completely filled with fine material.

Type B material containing rock with a particle dimension greater than 150 mm after compaction shall not be placed within 400 mm of the top of Type B and/or Type C material zones.

(iv) Type C Material

Type C material shall be placed in locations shown on the drawings or in other areas approved by the Engineer.

Type C material shall be spread and compacted in layers not exceeding a compacted thickness of 300 mm.

Where Type C material contains 25% or more of rock by volume, which will not break down during compaction to meet the maximum particle dimension required for a 300 mm thick layer, the loose thickness of each layer may equal the maximum particle dimension of the rock up to a maximum layer thickness of 500 mm.

Rocks with a maximum particle dimension of less than 800 mm may be placed in Type C material zones as specified, with sufficient spacing between larger rocks to enable full compaction of the Type C material.

The material shall be placed and compacted such that voids are completely filled with fine material.

202.13 FILLING AT STRUCTURES

(a) *General*

This clause covers the requirements for the placement and compaction of fill material adjacent to, or preparatory to the construction of structures such as bridge abutments, retaining walls, wing walls, crown units and large culverts with an opening height greater than 1200 mm. Such filling shall be placed at locations as specified or shown on the drawings. At structures, including abutments, retaining walls, wingwalls and culverts, rock fill and rock fill cover material shall not be placed within 2 m of any structure.

(b) *Filling at existing structures*

No filling shall be placed within 3 m of an existing structure until any foundation of the fill has been reviewed by the Engineer. Unless otherwise specified or approved by the Engineer no filling shall be placed against concrete within 14 days of casting.

In addition to the placement of Type A material at bridge abutments as structural material, embankment material or backfilling within 3 metres of retaining walls, wing walls, all crown units, and culverts with an opening height greater than 1200 mm, shall be material of at least Type A material quality.

Unless a geocomposite drainage mat is specified as a drainage medium, material to be placed within 300mm of bridge abutments, retaining walls, wing walls or large culverts shall consist of permeable filling which meets the requirements of Clause 202.04. The

permeable fill material shall be placed in conjunction with the adjacent filling in layers not exceeding 150mm compacted thickness and compacted to refusal using hand held mechanical equipment. The bottom of the permeable filling or any geocomposite drainage mat shall be connected to a suitable drainage outfall by subsurface drainage pipes as shown on the drawings or as otherwise specified.

Type A Structural material fill shall be placed between the permeable filling or geocomposite drainage mat and 3m from the face of such structures. Such material shall be spread and compacted as specified in horizontal layers not exceeding 150 mm compacted thickness and compacted as specified in Table 202.131.

Compaction plant shall not operate within the minimum distances of structures as shown in Table 202.131 These minimum distances apply until the fill reaches the level above the top of the structure corresponding to the relevant specified minimum cover.

The difference in level of any fill being placed on opposite sides of a structure or structural component shall not exceed $H/4$ or 500 mm, whichever is the lesser, where H is the height of the structure.

Table 202.131 Minimum distance of compaction plant to structures

Non Vibrating Rollers - Static Weight * (tonne)	Vibrating Rollers - Total Applied Force ** (kN)	Minimum Distance from Compaction Plant to Side of Structures (m)	Minimum Distance from Compaction Plant to Abutments, Retaining Walls and Wing Walls (m)	Minimum Cover over Top of- Culverts (m)
Less than 2	Less than 20	0.15	0.15	0.15
2 – 5	21 - 50	0.3	0.3	0.15
6 – 10	51 - 100	1.2	1.2	0.4
11 – 20	101 - 200	2.4	1.2	0.4
21 – 35	201 - 350	2.4 or height of structure (whichever is greater)	1.2 or height of structure (whichever is greater)	0.7

* Includes vibrating rollers operating in non-vibrating mode.

** Total Applied Force is the sum of the static weight and the vertical component of the centrifugal force.

(c) *Fill Placed Prior to Erection of Structures*

Material placed within 3 m of any future structure shown on the drawings shall be Type A structural material.

202.14 TEST ROLLING

(a) *General*

Areas upon which fills are to be constructed, all layers of filling, and material within 150 mm of cut floor level in cuts, shall be test rolled and capable of withstanding test rolling, without visible deformation or springing. Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- Steel smooth wheeled rollers shall have a mass not less than 12 tonne mass with a load intensity under either the front or rear wheels of not less than 6tonne per metre width of wheel;
- Pneumatic tyred plant shall have a mass not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

The Contractor shall submit a test rolling procedure to the Engineer including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours' notice of the location and commencement time for the test rolling to the Engineer. The Contractor shall provide for the Engineer to be present during all test rolling.

Each layer shall be test rolled immediately following completion of compaction. Where, with the approval of the Engineer, test rolling is carried out at a later time the surface of the layer shall be watered and given a minimum of three passes with the test roller prior to commencement of test rolling

The Engineer reserves the right to direct the Contractor to undertake further test rolling on any layer prior to it being covered by a successive layer. No additional payment will be made for any requirement to carry out such further test rolling.

(b) *Compliance*

Compliance with the test rolling requirements shall be when an area withstands test rolling without visible deformation or springing.

202.15 REQUIREMENTS FOR TESTING & ACCEPTANCE OF COMPACTION

(a) *General*

The Contractor shall not commence work on any layer until the Engineer has tested the preceding layer and has given consent to proceed.

Unless otherwise specified in Table 202.201, fills shall be compacted to either Compaction Scale A, Scale B or Scale C as follows:

Scale A: M1, M2, and Arterial roads

Scale B: S and Collector Roads

Scale C: Local Streets, C and R

Road classification is as defined in the FRA Austroads Design Guide Supplement Parts 1 to 8.

Testing for compaction shall be undertaken in accordance with VicRoads Code of Practice 500.05.- *Acceptance of Field Compaction*.

(a) *Test Lots*

A test lot shall be as defined in Clause 165.06. The lot size for Type A, Type B and Type C material shall be as specified in Table 202.172.

The calculation of density ratio and moisture ratio shall be based on laboratory values determined using standard compactive effort and as specified in Clause 165.09.

For work to be tested for compliance with Scale A or Scale B compaction requirements, the number of tests per lot shall be six, unless the lot is to be treated as a small lot.

For earthworks a small lot has a surface area less than 500 m² and may be treated as a small area. When testing a small area as a lot and where test requirements are based on characteristic values of density ratio and/or moisture ratio, acceptance of the lot shall be based on the mean values of 3 individual tests. In this case the lot will be accepted as far as compaction is concerned if the mean value of the individual tests exceeds by 2.0% or more the appropriate compaction scale requirement for the characteristic value of density ratio for a lot of six tests.

For work to be tested for compliance with Scale C compaction requirements, the number

of tests per lot shall be three.

(b) *Material of nominal size 40mm or less after compaction*

Filling, and material within 150 mm of subgrade level in cuts, which will have a nominal size after compaction of 40 mm or less shall be compacted to comply with the following requirements.

Fill material, and material within 150 mm of the Cut Floor Level having a nominal size after compaction of 40 mm or less shall be compacted to comply with the requirements of Table 202.151.

Each lot to be tested for compaction shall be test rolled in accordance with Section 202.14. Any unstable areas shall be excluded from the lot and shall be rectified by the Contractor and assessed separately. If the total area of the excluded areas exceeds 20% of the area of the lot, the whole of the lot shall be rejected.

Table 202.151 Compaction Requirements

Material Type and Location	Scale A	Scale B	Scale C
	Minimum Characteristic Value of Density Ratio (%)	Minimum Characteristic Value of Density Ratio (%)	Minimum Mean Value of Density Ratio (%)
All Type A Material	99.0	98.0	100.0
Type B Material placed within 400 mm of top of Type B Material			
Ripped and re-compacted material below Cut Floor Level			
Type B Material placed more than 400 mm below top of Type B Material	97.0	95.0	95.0
The top 150 mm of areas where fill is to be constructed			
Type C Material	95.0	93.0	92.0

(c) *Material of nominal size greater than 40mm after compaction*

All fill material and ripped and re-compacted material in cuts below Cut Floor Level with a nominal size after compaction greater than 40 mm shall be compacted using a grading, mixing, watering and rolling procedure as agreed by the Engineer.

The Engineer may require that trial sections be constructed to verify that the proposed compaction routine is acceptable. No additional payment will be made for any requirement to construct trial sections.

All fill material and material below the Cut Floor Level shall be compacted at minimum moisture ratio of 80%. The moisture ratio shall be determined using the material which passes the 37.5 mm sieve, where the material contains less than 20% oversize material. If the material contains more than 20% oversize material, the moisture ratio shall be determined using an alternative method in accordance with the appropriate test method or VicRoads Code of Practice RC 500.05 *Acceptance of Field Compaction*

Acceptance of work for compaction will be based on compliance with the accepted placement and compaction procedure and test rolling carried out in accordance with Clause 202.14.

Any unstable areas detected by test rolling shall be rectified. Where unstable areas exceed 20% of the area being test rolled, the whole of the area shall be ripped, re compacted as specified above, and re-presented for test rolling.

202.16 TESTING OF SURFACE LEVEL OF EARTHWORKS

The surface level of the finished earthwork formation including table drains, verges, the top of Type B material in fills, the Cut Floor Level in cuts where Type A material is specified and the prepared subgrade shall be checked longitudinally for conformity with the specified requirements at intervals not exceeding 20 m. Level measurements shall be taken and recorded at all changes in gradient, at the edges of prepared earthworks surfaces, designated lane lines and at intervals not exceeding 2 m transversely across the prepared surfaces prior to placing Type A material or pavement material.

202.17 FREQUENCY OF TESTING

The Contractor shall carry out testing at a frequency which is sufficient to ensure that the materials and work supplied under the Contract complies with the specified requirements. Notwithstanding this requirement, testing shall be undertaken at either Scale A or Scale B level of testing, at a frequency not less than that specified below. Where the scale of testing has not been specified, Scale A shall apply.

Unless otherwise in Table 202.201, or as agreed to by the Engineer, the following Scales shall apply in relation to the determination of the frequency of testing:

- Scale A: M1, M2, and Arterial roads, S and Collector Roads
- Scale B: Local Streets, C and R

(a) Material Properties Testing - Scale A

(i) CBR and Percentage Swell

Materials shall be tested to demonstrate compliance with the material property requirements specified in Clause 202.04. Where Scale A is specified, the following frequency of testing shall apply.

The initial lot of each material type shall be tested to determine the Assigned CBR (strength) and percentage swell of the material and shall be carried out in accordance with VicRoads Code of Practice RC500.20 *Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials*. Unless otherwise approved by the Engineer sampling for CBR testing shall be undertaken after field compaction of the initial lot. If either the Assigned CBR value or percentage swell value does not meet the requirements specified in Clause 202.04, the lot shall be rejected and all subsequent material from that source will be considered as non-conforming for that use.

Where both the Assigned CBR and percentage swell values meet the requirements of Clause 202.04 the material will be considered to be conforming subject to it complying with other specified requirements,

The continued acceptance of Assigned CBR and percentage swell will be assessed against the CBR and percentage swell values of a single CBR test and a single percentage swell test. Provided that the single CBR test value is greater than the specified Assigned CBR value and that the percentage swell value is less than the specified percentage swell value, the lot shall be accepted for CBR and percentage swell.

Should either the single CBR value be less than the specified Assigned CBR or the percentage swell value be greater than the specified swell value, the lot shall be retested for Assigned CBR and percentage swell values.

The values obtained from the new Assigned CBR and percentage swell tests shall comply with the requirements of Clause 202.04 and shall be considered to be the new Assigned CBR and percentage swell values.

Should the verification tests for the Assigned CBR and/or percentage swell value not comply with the requirements of Table 202.041, the material from that source will be considered as non-conforming and the lot rejected.

(ii) Gradings, PI, LL, Permeability and Particle Dimension

Testing for grading, PI, LL, permeability and maximum particle dimension shall be undertaken at the initial testing frequency specified in Table 202.171

Table 202.171 Frequency of Testing for Material Properties

Material Properties	Material	Testing
CBR and percentage swell	Type A Material	1 Lot Test to determine Assigned CBR and swell. Single CBR test every lot to confirm CBR and swell.
	Type B Material	1 Lot Test to determine Assigned CBR and swell. Single CBR test every lot to confirm CBR and swell
	In situ material in cuts within 400 mm below Cut Floor Level	1 Lot Test to determine Assigned CBR and swell. Single CBR test every lot to confirm CBR and swell
Grading	Type A Material	Every Lot
	Permeable Fill Material	Every Lot
PI and calculation of PI x % Passing 0.425 mm	Type A Material	Every Lot
LL and comparison of PI against LL, (identification of silt)	Type A Material Type B Material	Every Lot
Permeability	Capping and Verge Materials and Other Type A Material	1 Test per 3 Lots

Maximum Particle Dimension ¹	Type A Material,	Every Lot
	Type B and Type C Material containing rock greater than 150 mm	Every Lot
Note: 1 Visual inspection, assessment and measurement of larger rock particles.		

(b) Material Properties Testing - Scale B

For Scale B the first lot of each material type shall be tested to demonstrate compliance with the material property requirements specified in Clause 202.04.

Where the first lot of each material type satisfies the material property requirements in Clause 202.04 as applicable to that material type, no further testing will be required for that material except where changes to the physical properties of the material are observed or where directed by the Engineer.

Where the first lot of each material type does not satisfy the material property requirements in Clause 202.04 as applicable to the material type, the lot will be rejected.

(c) Compaction and Moisture Content Testing Frequency

Every lot shall be tested to demonstrate compliance with the requirements for compaction and moisture content.

Table 202.172 Minimum Frequency of Testing for Compaction and Moisture Content

Material	Acceptable Lot Size in a Single Layer of Work	Testing Frequency
Type A Material	One day's production or 2,500 m ² , whichever is the lesser	Every Lot
Type B Material		
• ripped and re-compacted below Cut Floor Level	One day's production or 5,000 m ² , whichever is the lesser	Every Lot
• placed within 400 mm of top of Type B Material	One day's production or 5,000 m ² , whichever is the lesser	Every Lot
• placed more than 400 mm below top of Type B material	One day's production	Every Lot

Type C Material	One day's production	Every second Lot of like material and work
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202.18 TOPSOILING

Topsoiling shall not be placed over cut and fill areas until the Contractor has verified that such areas comply with the requirements in Clause 202.03.

All unpaved cut and fill areas within the limits of the batters, including batter roundings but excluding cut batters steeper than 1.5 to 1 (horizontal to vertical), and any other area disturbed by the Contractor's operations, shall be topsoiled to the following thicknesses measured normal to the slope:

- (i) batters with slopes of 2 to 1 (horizontal to vertical) or steeper 50 mm minimum
- (ii) tree and shrub plantation bed areas other than (i) above - 100 mm minimum
- (iii) verges: In areas without kerb and channel or concrete edging strips the depth of topsoil shall vary uniformly from 50 mm deep at the outside edge of verge to 20 mm deep within 100 mm of the edge of seal or asphalt surface treatment
- (iv) all other areas 75 mm minimum.

Topsoil shall be placed and levelled but not compacted except for verge areas, which shall be compacted.

Topsoil on batters shall be placed so as to prevent rilling.

The surface level of topsoil shall match the finished surface level, or level of back of kerb or concrete edging, as appropriate.

202.20 SCHEDULE FOR MATERIALS TESTING, COMPACTION TESTING AND FREQUENCY OF TESTING

Clauses 202.04 and/or 202.15 and/or 202.17 shall apply unless otherwise stated in the Contract Specific Conditions.

SECTION 203 – ROCK FILL

203.01 DESCRIPTION

This section covers the requirements for the use of rock fill in embankment construction. This section should be used taking into account the requirements of Section 202.

203.02 DEFINITIONS

(a) *Fill*

The compacted embankment placed above natural surface level after removal of topsoil.

(b) *Rock Fill*

A material comprised of larger fragments of hard, sound durable rock containing only a small amount of fine particles, which when placed and compacted produces an embankment deriving its stability from the mechanical interlock of the coarser rock particles and not from the compaction of finer material.

203.03 MATERIALS

(a) *Rock Fill Material*

Rock fill shall be comprised of sound rock fragments having not less than two broken or angular faces. Not less than 10 individuals, randomly selected, rock samples, with dimensions greater than 100 mm, shall be tested for each nominated point load test. Not less than 90% of rock fragments with dimensions greater than 100 mm shall have a Point Load Strength ($I_{S(50)}$) of 2.0 MPa or greater.

Prior to placement, rock fill material shall have no particle dimension exceeding 500 mm and minimal fine material. After placement and compaction, rock fill material, including Rock Fill cover layer material, shall comply with post-compaction gradings in Table 203.031.

Table 203.031 Post-Compaction Grading of Rock Fill Material

Rock Fill Type (mm)	Limits of Grading (% passing by mass) Post Compaction AS Sieve Size (mm)				
	500	300	150	75	37.5
Maximum Particle Size 500	100	10-25	0-10		

Maximum Particle Size 300		100	10-25	0-10	
Maximum Particle Size 150			100	10-25	0-10
Maximum Particle Size 75				100	10-25
Maximum Particle Size 37.5					100

(b) *Geotextile Fabric*

Geotextile fabric required for the construction of rock fills shall have a G robustness rating of greater than 3000 and shall be supplied, handled and placed in accordance with the requirements of Section 608.

203.04 SITE EXCAVATION

(a) *General*

Site excavation of rock fill material shall be within the limits of batters, open and underground drainage and approved borrow areas from within the Site, and shall include the handling of excavated material to the point of disposal.

(b) *Material Category*

Prior to the use of excavated rock material as rock fill, the Engineer and the Contractor shall inspect the material encountered and subject to verification by appropriate testing, agree on the suitability of the material for rock fill as described in Clause 203.03.

(c) *Excavation Operations*

If excavated rock is to be used in the construction of rock fill embankment, the working methods employed in the excavation of cuttings must be adjusted to produce rock fill material of the size and grading and rock strength specified in Clause 203.03. Such working methods generally must include screening and, if necessary, secondary processing.

(d) *Oversize Rock*

Oversize rock produced as a consequence of rock fill production shall be used or disposed of only in areas specified or shown in the drawings or approved by the Engineer.

The Engineer's approval shall be obtained to the use or disposal of oversize rock with a maximum particle dimension greater than the requirements for Type B fill material in Type C fill areas in accordance with Section 202.

203.05 ROCK FILL EMBANKMENT CONSTRUCTION

(a) Areas Upon Which Rock Fills are to be Constructed

Areas upon which fills are to be constructed shall be prepared in accordance with the requirements of Section 202. Topsoil and material classified as silt shall be removed prior to construction of any rock fills.

Where a rock fill is to be constructed on steep sideling ground or against an existing embankment with a side slope steeper than 4 horizontally to 1 vertically, benches shall be progressively cut over the full area to be covered by new fill. The width of each bench shall be such as to permit safe and effective operation of plant but shall be not less than 1 m.

Material excavated during benching may be used in construction of earthworks in accordance with Section 202.

Foundations under rock fills must be shaped to ensure that drainage is maintained and treated to ensure that erosion of the foundation will not occur.

(b) Placement and Compaction of Rock Fill

Prior to placement of the first layer of rock fill, a geotextile fabric shall be placed as a separation layer.

The rock fill material shall be placed and compacted in layers in accordance with the accepted placement and compaction procedure and Table 203.051.

Rock fill shall be placed and compacted to ensure rock particle to particle contact between coarser rock particles is maintained and to achieve stability of the layer.

Interlock between successive rock fill layers shall be ensured by limiting the placement of finer particles over the surface of the rock fill layer to that necessary to achieve interlock between the coarser rock particles.

Where earthworks fill material is to be placed over or adjacent to a rock fill, cover layers of rock fill material shall first be placed in accordance with Table 203.051. A geotextile separation fabric with a G robustness rating of greater than 3000 shall then be placed over the top of the rock fill layers, and extended to cover the longitudinal edge of the top layer. A minimum layer of 200 mm of Type B fill material with a maximum particle

dimension of 75 mm shall then be placed on top of the geotextile fabric, above which the earthworks fill layer can then be constructed.

Table 203.051 Thickness of Rock Fill Material Layers

Rock Fill Type	Maximum Thickness of each Compacted Layer (mm)	Minimum Distance Below Subgrade Level (m)	Thickness of Rock Fill Cover Layers (mm)			
			Bottom Layer Maximum Particle Size 150 mm	Middle Layer Maximum Particle Size 75 mm	Top Layer Maximum Particle Size 37.5 mm	Total Thickness of Rock Fill Cover Layers
Maximum Particle Size 500 mm	600	2.0	300	200	100	600
Maximum Particle Size 300 mm	400	1.2	Not Required	200	100	300
Maximum Particle Size 150 mm	300	800	Not Required	Not Required	100	100
Maximum Particle Size 75 mm	200	400	Not Required	Not Required	100	100

(c) Rock Fill around Structures

At structures, including abutments, retaining walls, wingwalls and culverts, rock fill and rock fill cover material shall not be placed within any specified Type A fill zone or within 2 m of any structure.

(d) Level Control

Each layer of rock fill including cover layers shall be surveyed to confirm that placement

is in accordance with the following:

- Intermediate layers of rock fill shall be placed to a tolerance of +/- 100 mm.
- The surface level of the top of final layer of rock fill or zone shall be finished to a tolerance of: +0 mm / -100 mm.

203.06 ACCEPTANCE OF PLACEMENT AND COMPACTION

The first lot shall be placed as a trial section for review by the Engineer. The Contractor shall then develop a material grading, mixing, watering and rolling routine based on the construction and testing of trial section for review by the Engineer.

As a minimum, trial sections shall be carried out both for the initial layer of rock fill over in situ material and then for the subsequent (second) layer of rock fill and each trial section shall:

- have an area of not less than 1000 m²
- be thoroughly watered prior to applying roller passes and be compacted by the application of not less than 15 roller passes or more, if consolidation is still occurring be surveyed for level changes in surface levels after each roller pass at not less than 20 pre-determined monitoring points be assessed to determine the point at which effective refusal occurs be inspected and tested for compliance with this Section 203.

Where any monitoring point has been, in the opinion of the Engineer, destroyed or significantly damaged by crushing or rock break down, the survey level result for that point shall be disregarded for that roller pass and a replacement monitoring point established for monitoring of subsequent roller passes.

The accepted compaction routine shall provide not less than three additional passes of the compaction plant above the number of passes identified from the compaction trials as having no further consolidation of rock particles and the compactive effort shall be not less than the equivalent of 6 passes of a vibrating pad foot roller which can transmit a minimum force to the ground through the surface of the drum of 50 kN per metre of drum length, when operated at the maximum frequency of vibration. The frequency of vibration of the roller shall be between 16 and 25 Hz, and the travel speed shall not exceed 1 m for every three seconds.

The Engineer may require that further trial sections be constructed to verify that the proposed placement and compaction routine is acceptable where there is a change in the type or quality of the material being placed. Assessment of placement and compaction will include visual inspection of inspection trenches excavated to the full depth of the rock fill layer and test rolling carried out in accordance with Clause 203.07.

Assessment of placement and compaction shall also include monitoring the level of rock particles at

the surface of the layer to identify the point at which no further consolidation of the rock particles occurs when subject to three additional passes of the compaction plant. The number and location of monitoring sites shall be to the satisfaction of the Engineer but shall not be less than 12 locations for each lot monitored.

Acceptance of work for compaction will be based on compliance with the accepted placement and compaction procedure, testing and inspection as specified and the confirmation by survey level monitoring that effective refusal has been achieved for the rock fill layer. For the purpose of this clause, effective refusal is where the average cumulative deflection over the last three roller passes is no greater than 5 mm.

203.07 TEST ROLLING

All layers of rock fill shall be test rolled in accordance with Clause 202.14.

Prior to any layer being covered by a successive layer, the Engineer may require further test rolling to confirm that the layer is stable. Any unstable areas detected by test rolling shall be rectified.

203.08 MINIMUM FREQUENCY OF TESTING

(a) Material Properties

Materials shall be tested to demonstrate compliance with the material property requirements specified in Clause 203.03. Testing shall be undertaken at the frequency specified in Table 203.081.

Table 203.081 Minimum Frequency of Testing for Material Properties

Material Properties	Minimum Frequency of Testing
Rock Strength – Point Load Index – I _{S(50)}	Each source prior to the commencement of work and every 500 m ³ of production.
Grading Prior to Compaction	Prior to the commencement of work and at other times when in the opinion of the Contractor or the Engineer, the nature and/or physical properties of the material have changed.

After Compaction Grading	For each trial section and for every third lot, and at other times when in the opinion of the Contractor or the Engineer, the nature and/or physical properties of the material have changed.
Consolidation Measurement of Rock Fill Layers	Survey monitoring for all trial sections and each layer of rock fill including cover layers.
Test Rolling	All layers of rock fill including cover layers.

(b) *Compaction*

The Contractor shall initially test each trial section to verify the adequacy of placement and the compaction procedure to the satisfaction of the Engineer. Once a placement and compaction routine is established, each lot shall be placed in accordance with this procedure.

Every layer shall be tested for stability by test rolling and every third lot shall be monitored to verify that no further consolidation is occurring. Should the rock fill in any layer be found to be continuing to consolidate within the past three roller passes, the placement and compaction procedure shall be reviewed to the satisfaction of the Engineer.

SECTION 204 – LIME STABILISATION OF EARTHWORKS MATERIALS

204.01 DESCRIPTION

This section covers the requirements for lime stabilisation of earthworks materials within the formation. The requirements relate to preparation of the formation to be stabilised, quality of lime, spreading, mixing, and compaction of the stabilised earthworks material.

This section is not applicable for lime pre-treatment of pavement layers. For lime pre-treatment of pavement layers, Standard Section 304 – Insitu Stabilisation of Pavements with Cementitious Binders shall be used.

204.02 DEFINITIONS

(a) *Available Lime*

The amount of Calcium Oxide (CaO) or Calcium Hydroxide (Ca(OH)₂) contained in Quicklime or Hydrated Lime respectively.

(b) *Available Lime Index (ALI)*

The Calcium Oxide or Calcium Hydroxide content of quicklime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS4489.6.1.

(c) *Design Distribution Rate of Available Lime*

The spread rate of pure Calcium Oxide or Calcium Hydroxide.

(d) *Lime*

Lime is either Hydrated Lime (Calcium Hydroxide) or Quicklime (Calcium Oxide).

(e) *Hydrated Lime*

Hydrated lime is a powdered form of lime consisting primarily of calcium hydroxide, also referred to as slaked lime.

(f) *Lime Spreading Rate*

The required spread rate of lime determined from the Design Distribution Rate of Available Lime corrected for the ALI of the lime to be used.

(g) *Quicklime*

Quicklime is a fine granulated powder consisting primarily of Calcium Oxide that can be readily slaked by the application of water after it has been evenly spread to form Calcium

Hydroxide.

204.03 CONFORMITY WITH DRAWINGS

Lime stabilised layers shall be finished to conform within the following limits to the levels, lines, grades, thicknesses and cross sections specified or shown on the drawings:

(a) Surface Level

Surface level measurement shall be undertaken in lots not exceeding 4000 m² to check longitudinally for conformity with the specified requirements at intervals not exceeding 20 m. Level measurements shall be taken and recorded at all changes in gradient, at the edges of prepared earthworks surfaces, designated lane lines and at intervals not exceeding 2 m transversely across the prepared surfaces.

Unless otherwise specified, the surface level of the lime stabilised layer at subgrade level at any point shall not differ by more than 15 mm above or 25 mm below the specified level.

(b) Depth of Stabilisation

The depth of lime stabilised material as specified in Clause 204.15(a) or (b) shall not at any point be less than the depth as specified in Clause 204.15 by more than 15 mm and the average depth of the lot shall be not be less than the specified depth.

(c) Alignment

Lime stabilised earthworks carried out in a boxed formation shall extend to the full width of the boxing. Where there is no boxed formation, the edges of the lime stabilised material shall not be more than 50 mm inside the specified offset from centreline or design line.

(d) Width

The width of the lime stabilised material shall not be less than that specified width by more than 50 mm.

(e) Shape

Where the finished surface of the lime stabilised material is at subgrade level, no point on the surface of the lime stabilised material shall lie more than 15 mm below a 3 m straightedge placed in any direction on the surface except on the part of the cross-section designed with a crown.

204.04 MATERIALS

Materials supplied under the Contract shall comply with the following properties:

(a) *Lime*

Quicklime and hydrated lime shall meet the requirements of AS1672.

All quicklime and hydrated lime supplied to the job shall be provided with delivery docket showing an assigned ALI at the start of each production week. The assigned ALI shall be determined by averaging the six most recent test results for ALI. A test certificate for determination of the ALI shall be made available on request

Lime shall be stored in a moisture free environment and shall be re-tested for compliance with AS1672.1 *Limes and limestones Part 1 Limes for building* if stored for more than 14 days after receipt from the manufacturer.

(b) *Water*

Water added to the material shall be clear and substantially free from sediments and detrimental impurities such as oils, salts, acids, alkalis and vegetable substances.

204.05 INVESTIGATION AND DETERMINATION OF DESIGN LIME SPREADING RATE

Where the Design Distribution Rate of Available Lime is not specified in Clause 204.15(b), the Contractor is required to carry out the site investigation and perform laboratory testing to determine the Design Distribution Rate of Available Lime in accordance with VicRoads Code of Practice RC 500.23 *Code of Practice for Lime Stabilised Earthworks Materials-Available lime content, assignment of CBR and % swell*. The Design Distribution Rate so determined shall satisfy all the requirements for the stabilised material as specified in Clause 204.15(a).

204.06 COMMENCEMENT OF WORK

The Contractor shall not commence work until the Lime Spreading Rates have been presented to the Engineer for review. If the Contractor is required to determine the Design Distribution Rate of Available Lime, evidence shall be produced to show that the material properties specified in Clause 204.15(a) have been met.

204.07 CONSTRUCTION PLANT

The Contractor shall provide construction plant meeting the following requirements and capability.

(a) *Lime Spreader*

A purpose built mechanical spreader capable of accurately regulating the discharge of lime directly to the roadbed shall be used such that the Design Distribution Rate of Available Lime is uniformly met in accordance with the requirements of Clause 204.12.

(b) *Mixing Machine*

A purpose built machine mixing machine designed for insitu stabilisation of roadworks shall be used to pulverise and uniformly mix the earthworks formation material with water and lime for the specified depth of stabilisation. Rotary hoes and other types of agricultural machinery shall not be used.

After pulverisation and mixing, all stabilised material other than isolated hard rock particles up to a nominal size of 75 mm shall be capable of passing a 37.5 mm sieve.

(c) *Watering Plant*

Watering plant or any purpose designed watering system incorporated within the mixing machine shall be capable of uniformly distributing sufficient water to hydrate quicklime and if required add more water to increase the moisture content to aid compaction.

(d) *Compaction Plant*

Compaction plant shall be of such mass as to be capable of compacting the stabilised layer to the minimum density ratio throughout the depth of the layer.

204.08 CONSTRUCTION

(a) *General*

Construction includes the preparation of the earthworks formation, spreading of lime, slaking of quicklime, mixing, compaction, trimming and curing of the stabilised material.

(b) *Pre-treatment of Earthworks*

The material to be stabilised shall be pre-treated by scarifying or pulverising to the specified depth to provide an even surface capable of being trimmed to meet the requirements of Clause 204.03. Any hard rock particles larger than 75 mm shall be removed from the scarified soil.

(c) *Spreading of Lime*

Spreading of lime shall not be carried out at times when lime could become airborne or dispersed in such a way as to become a nuisance or a hazard to persons, property or livestock.

Lime shall be spread uniformly over the prepared surface at the Lime Spreading Rate calculated using the appropriate formula (i) or (ii) below.

- (i) Where hydrated lime has been used in the laboratory testing to determine the Design Distribution Rate of Available Lime and it is proposed to use quicklime at

the job site, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = 0.76 \times \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

- (ii) Where the same type of lime (hydrated lime or quicklime) is to be used at the job site as has been used in the laboratory tests to determine the Design Distribution Rate of Available Lime, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

Under no circumstances shall the Design Content of Available Lime be less than 1.5% by mass as determined under VicRoads Code of Practice RC 500.23 *Code of Practice for Lime Stabilised Earthworks Materials-Available Lime Content, Assignment of CBR and % Swell*.

Immediately following completion of spreading of lime, the Contractor shall check and record the Average Lime Spreading Rate and the Uniformity of Spreading Rate in accordance with Clause 204.12.

If the required Lime Spreading Rate exceeds 15 kg/m² it shall be spread in two equal spreading runs with material from the first spread run being fully mixed into the earthworks material prior to the second spreading run being undertaken.

(d) *Slaking of Quicklime*

Quicklime shall be slaked with sufficient water to allow full hydration to take place. Full hydration will be deemed to have been achieved when all quicklime that has been spread has changed from a cream coloured granulate to a fine white powder and there is a cessation of rising vapours.

(e) *Mixing*

Where quicklime is used, mixing shall not commence until full hydration has been achieved.

All lime shall be mixed to the specified depth within 6 hours of spreading regardless of the number of spreading and mixing runs required. If lime stabilised material contains non-friable wet clay lumps with a nominal size more than 75 mm after the initial mixing run,

the lime stabilised material shall be allowed to stand for up to 72 hours to allow sufficient time for clay lumps to dry out and react with the lime.

Once the lime stabilised material is friable it shall be remixed prior to compaction. Remixing shall proceed until all stabilised material other than isolated hard rock particles up to a nominal size of 75 mm, is capable of passing a 37.5 mm AS sieve and a minimum of at least 60% is capable of passing a 9.5 mm sieve when shaken without forcing material through the openings. The stabilised material shall be visually inspected for uniform mixing by excavating test holes for the full depth of the loose material at six random locations within each compaction test lot as defined in Clause 204.11(a).

The number of mixing runs undertaken after spreading of lime shall not be less than two.

(f) Final Trimming

The surface may be further trimmed before or during compaction to meet the requirements of Clause 204.03(a) and (e).

(g) Compaction

Compaction shall not commence until the requirements of Clause 204.08(e) are met. Prior to compaction, additional moisture may be added if required to achieve the specified density ratio.

Compaction shall commence within 2 hours and be completed within 8 hours after completion of mixing.

204.09 PRELIMINARY TRIAL

If specified in Clause 204.15(c), the Contractor shall carry out a preliminary trial of the proposed stabilising operation. The trial shall determine the:

- (i) effectiveness of the construction plant;
- (ii) number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing;
- (iii) field moisture content required to achieve specified compaction requirements;
- (iv) rolling routine required to meet specified compaction requirements.

The trial section shall be located within the Works area. The length of the trial section shall be between 100 and 200 metres over the full width of the area proposed for stabilisation.

Lime stabilisation shall not proceed outside the trial section until the Engineer has reviewed all aspects of the work. The outcome of the Engineer's review will be provided to the Contractor within

three working days after completion of the trial. If the Specification requirements are not met for the trial, the Engineer may direct that another trial be undertaken or that the work be re-stabilised and presented for re-assessment.

204.10 TEST ROLLING

All lime stabilised material shall be test rolled and capable of withstanding test rolling, without visible deformation or springing. Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- Steel smooth wheeled rollers shall have a mass not less than 12 tonne mass with a load intensity under either the front or rear wheels of not less than 6 tonne per metre width of wheel;
- Pneumatic tyred plant shall have a mass not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

The Contractor shall submit a test rolling procedure to the Engineer including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours' notice of the location and commencement time for the test rolling to the Engineer. The Contractor shall provide for the Engineer to be present during all test rolling.

Each layer shall be test rolled immediately following completion of compaction but if test rolling is carried out at a later time the surface of the layer shall be watered and given a minimum of three passes with the test roller prior to commencement of test rolling

If the Engineer considers that a completed stabilised earthworks layer has been affected by rain or damaged in some way before a successive layer is placed, further test rolling shall be carried out by the Contractor on the layer immediately prior to being covered by a succeeding layer. No additional payment will be made for any requirement to carry out such further test rolling.

204.11 REQUIREMENTS FOR ACCEPTANCE OF COMPACTION

(a) General

Density testing shall be undertaken within 12 hours after completion of compaction. Remoulding of compacted specimens for determination of the laboratory reference density at each test site shall be completed within 24 hours after extraction of samples of stabilised material.

The work shall be assessed for compliance with Scale A or Scale B requirements for

acceptance of compaction of the lot as specified in Clause 204.15. The calculation of the characteristic or mean density ratio shall be based on Standard compactive effort.

The following assessment Scales shall apply:

- i) For work on M1, M2, and Arterial roads (as defined in the FRA Austroads Design Guide Supplement Parts 1 to 8) Scale A requirements are applicable
- ii) For roads other than M1, M2, and Arterial roads, Scale B requirements shall apply

A lot shall consist of a single layer of like material and work compacted on the same day up to a maximum area of 4000 m².

For work to be tested for compliance with Scale A requirements, the number of randomly selected test sites per lot shall be six. For work to be tested for compliance with Scale B requirements, the number of randomly selected test sites per lot shall be three.

If the depth of stabilisation or any compacted layer exceeds 200 mm, the Contractor shall measure and assess the field density in two sub-layers in accordance with VicRoads Code of Practice 500.05 *Acceptance of Field Compaction*.

(b) Scale A Requirements for Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio of the lot is not less than 99.0%. If the characteristic density ratio is less than 99% the material shall be immediately reworked and/or re-compacted as specified in Clause 204.08(g) to meet specification requirements.

(c) Scale B Requirements for Lot Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the mean density ratio for the lot is not less than 99.0%. If the mean density ratio is less than 99% the material shall be immediately reworked and/or re-compacted as specified in Clause 204.08(g) to meet specification requirements.

204.12 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF LIME SPREADING RATE

(a) Mat or Tray System

The average Lime Spreading Rate shall be ascertained by dividing the mass of lime used by the area over which the lime has been spread. Where the average Lime Spreading Rate is less than specified, additional lime shall be spread over the surface to bring the average Lime Spreading Rate up to at least the specified rate.

The Contractor shall check the uniformity of the spreading of lime at the frequency

specified in Table 204.131 by placing a minimum of three mats or trays with a plan area not less than 1 m² in the path of the spreading vehicle at an equal spacing of not less than 25% of the length of the spreading run. The Lime Spreading Rate over each mat or tray shall be calculated by dividing the mass of lime deposited on each mat or tray by the plan area of the mat or tray. Where the Lime Spreading Rate so determined for any mat or tray is less than the specified rate by more than 10%, additional lime shall be spread over the part or all of the area over which the lime has been spread.

(b) Continuous Weighing System

The mass of lime spread over the pavement surface may be measured and recorded by a spreader fitted with a fully calibrated computerised electronic weigh scale system capable of continuously measuring and recording the mass of lime at intervals of not more than 100 m of forward travel. If requested by the Engineer, the Contractor shall produce the print out of the actual Lime Spreading Rate.

The Contractor shall have a current certificate of calibration for the computerised spreading equipment and shall produce evidence of the actual running spread rate when requested by the Engineer.

204.13 MINIMUM TESTING FREQUENCY

(a) General

The Contractor shall carry out testing at a frequency which is sufficient to ensure that the materials and work supplied under the Contract complies with the specified requirements but which is not less than that shown in Table 204.131.

(b) Frequency of Density Testing for Assessment of Compaction

The Contractor shall test every lot for acceptance of compaction in accordance with the requirements of the Specification.

Table 204.131 Frequency of Testing

Test	Minimum Frequency of Testing
Available Lime / Available Lime Index	One test per production day at the point of manufacture.

Uniformity of Spreading Rate	A mat or tray test (minimum of three mats or trays as specified in Clause 204.12(a) for each separate continuous spreading run except where calibrated load cell computerised spreading devices are fitted with a system to continuously monitor the lime spreading rate every 100 m.
Average Lime Spreading Rate	Each continuous spreader run with no breaks or pauses in spreading.
Uniformity of Mixing	For each compaction lot – Visual inspection of six random test holes excavated for the full depth of the loose material after mixing of the binder prior to commencement of compaction.
Characteristic or Mean Density Ratio	Every lot

204.14 CURING AND PROTECTION OF COMPACTED LAYERS

The surface of the compacted layer shall be kept continually moist, and free from contamination until the succeeding layer is placed.

204.15 SCHEDULE OF DETAILS

(a) *Job Details and Design Requirements refer to Contract Specific Conditions*

SECTION 301 – MATERIALS FOR PAVEMENT CONSTRUCTION

301.01 DESCRIPTION

This section covers the requirements for natural gravels, crushed gravels and crushed rock including mixtures thereof for use as pavement base and subbase. The requirements relate to the source rock and properties of the product as supplied.

301.02 DEFINITIONS

(a) *Crushed Rock Base*

A size 20 or 40 mm crushed rock material on which the bituminous surfacing is applied.

(b) *Crushed Rock Subbase*

A size 40 or 75/65 mm crushed rock material on which the crushed rock base is placed.

(c) *Remote Location Basecourse*

A size 40 mm basecourse used for unsealed roads considered by the FRA to be located in remote areas where the supply of crushed rock base is not economically and reasonably available and where approved for use by the Engineer. *suthe*.

(d) *Sealed Rural Roads Basecourse*

A size 40 mm crushed rock material suitable for very low traffic sealed pavements located along rural village frontages, schools and health centres.

(e) *Running Course*

The uppermost layer of an unsealed pavement with the primary purpose is to provide a stable smooth tightly bound surface to reduce aggregate loss, vehicle wear and provide adequate road user comfort.

(f) *Natural Gravel*

Gravel is a naturally occurring mixture of angular or rounded rock fragments substantially retained on a 4.75mm AS sieve.

(g) *Crushed Rock*

Crushed rock is composed of rock fragments produced by the crushing, scalping and screening of igneous, metamorphic or sedimentary source rock which conforms to the requirements of this specification, produced in a controlled manner to close tolerances for grading and plasticity.

(h) *Unsound Rock*

Unsound rock is that material whether in the source or crushed particles, which:

- i) is soft, friable or composed of clay or weathered rock, or which contains matter which degrades when alternatively wetted and dried; or
- ii) in the case of igneous (except basic igneous) and metamorphic rock, has a Degradation Factor Source Rock less than the minimum value of 35 determined in accordance with AS 1141.25.1 Methods for sampling and testing aggregates – Degradation factor – Source rock
- iii) in the case of basic igneous rock, has a Secondary Mineral Content greater than the maximum value of 30% or an Accelerated Soundness Index value less than the minimum value of 90
- iv) for sedimentary rock, has a Ball Mill value greater than the maximum value of 40 (Argillaceous) and 55 (Arenaceous) Sediments as determined using AS 1141.28 Ball mill value

(i) *Los Angeles Value*

The Los Angeles Value (LAV) is a hardness rating derived from Los Angeles Abrasion test. The Los Angeles Value is based on test results for samples from current production. Bulk samples obtained for testing shall represent the typical product available at the site with regard to stone quality. The preferred gradings for use in the Los Angeles Value test are J or K, as detailed in AS 1141.23, Methods for sampling and testing aggregates – Los Angeles Value, which correspond to the common sizes of aggregate for pavement surfacing.

(j) *Material Type*

Rock from a particular source and which is distinguishable on the basis of colour, texture, hardness, the degree of weathering and test properties.

(k) *Non Quarry Rock*

Rock obtained from a location other than a quarry, or within a construction site. Non quarry rock is usually processed by an onsite portable plant but may also be taken to a nearby quarry for processing.

(l) *Quarry Rock*

An in situ rock mass located in an operating quarry or a part of a quarry.

(m) *Rock Type*

Rock is classified as igneous, metamorphic or sedimentary on the basis of the classification scheme detailed in AS 1726:2017 Geotechnical Site Investigations.

(n) *Source Rock*

The rock mass which is used or proposed to be used in the production of crushed rock or aggregate. The rock mass can be igneous, metamorphic or sedimentary rock.

(o) *Polished Stone Value*

The Polished Stone Value as determined in accordance with VicRoads Test Method RC374.01.

301.03 SOURCE ROCK

(a) *General*

Prior to the commencement of work, the Contractor shall nominate the source from which the crushed rock and aggregate will be obtained. The Engineer's approval shall be obtained prior to changing the source of material.

(b) *Properties*

The source rock shall meet the following requirements:

- (i) Shall not be unsound as defined in Clause 301.02 (h)
- (ii) durability criteria as specified in Table 301.031.
- (iii) a crushing resistance greater than 100 kN and a wet/ dry test strength ratio greater than 60% (both wet and dry strengths tested to NZ 3111 section 14
- (iv) the hardness of the source rock shall be measured by a Los Angeles Abrasion test on the product and the Los Angeles Value shall comply with the test values shown for the different product applications in Table 301.032 and tested in accordance with AS 1141.23: - Los Angeles Value

Sedimentary source shall not be used for production of crushed rock base course material.

Table 301.031 - Durability Requirements

Rock Type	Degradation Factor ⁽¹⁾ (min.)	Secondary Mineral Content ⁽²⁾ (%)	Accelerated Soundness Index ⁽³⁾
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		(max.)	(min.)
IGNEOUS (INTRUSIVE)			
Granodiorite	45		
Diorite	45		
Gabbro	45		
Tonalite	45		
Monzonite	45		
IGNEOUS (EXTRUSIVE)			
Basalt		25	94
Andesite			

Notes to Table 301.031

1. AS1141.25.1 Degradation factor source rock
2. AS 1141.26 Methods for sampling and testing aggregates – Secondary minerals content in igneous rocks
3. AS 1141.29 Methods for sampling and testing aggregates – Accelerated soundness index by reflux

Table 301.032 Requirements of LA Abrasion loss for Various Rock Types

Rock Type	Los Angeles Abrasion Loss (max.)	
	Base	Subbase
Granodiorite	40	45
Diorite		
Gabbro		
Tonalite		
Monzonite		

Other Acid Igneous		
Basalt	30	35
Andesite		
Sedimentary - River Gravel Pebble	Not Permitted	35

If a source rock type proposed is not described in Table 301.031, the Engineer will determine whether the rock type is acceptable and will set appropriate limits.

301.04 PRODUCT

(a) General

The aggregate shall consist of naturally occurring or processed material originating from crushed river gravel, ripped or crushed rock, or combinations of these, together with sand, silt and clay elements. All dirt and organic matter shall be removed. Pavement materials shall be free from vegetable matter, lumps or balls of clay or other deleterious matter. For crushed rock base and subbase the product shall be sourced from sound rock and meet the requirements of Section 301.03. The products shall meet the following requirements:

(i) For natural gravel base and subbase products:

- shall meet the properties shown in Table 301.041.

(ii) For crushed rock products:

- shall meet the properties shown in Table 301.042.

CBR testing shall be undertaken at optimum moisture content and 98% of maximum dry density as determined by test using Modified compactive effort, but then soaked for four days prior to the CBR test in accordance with AS1289.6.1.1.

Plasticity Index shall be determined in accordance with AS 1289.3.3.1: Methods of testing soils for engineering purposes - Soil classification tests - Calculation of the plasticity index of a soil

Table 301.041 Requirements for natural gravel base and subbase

Property	Base	Subbase
Liquid Limit % (max.)	35	35

California Bearing Ratio % (min.)	50	50
Ball Mill (Sedimentary Rocks)		45

Table 301.042 Requirements for crushed rock base and subbase

Property	Base	Subbase
Sand Equivalent (min.) ⁽¹⁾	50	-
Liquid Limit (% max.)	30	40
Plasticity Index (max.)	2 – 6	2 – 12
California Bearing Ratio (% min.)	80	80
Flakiness Index (max.) ⁽²⁾	35	35

Notes to Table 301.042

1 Sand Equivalent test shall be undertaken in accordance with Test method for Sand Equivalent is AS 1289.3.7.1

2 As determined in accordance with AS 1141.15 Methods for sampling and testing aggregates Method 15: Flakiness index

For Remote Location Basecourse and Subbase for unsealed rurals the product shall comply with the properties shown in Table 301.043.

Table 301.043 Remote Location Basecourse and Subbase for Unsealed Rural Roads

Property	Base
Crushed Aggregate	At least 70% by mass of the aggregates in the product that are retained on the 4.75 mm sieve shall have two or more faces produced by crushing.
California Bearing Ratio % (min.)	50
Crushing Resistance	Less than 10% under 100 kN load

(b) Sulphide Mineralisation

Crushed rock manufactured from sources containing sulphide/sulphate mineralisation shall not be used unless the fraction of the crushed rock passing the 2.36 mm sieve complies with the pH and conductivity test requirements specified in Table 301.044.

Table 301.044 pH and Conductivity Test Requirements

Sieve Size (mm)	Target Grading	Limits of Grading % Passing	Target Grading	Limits of Grading % Passing
37.5	-	-	100	95 – 100
26.5	100	100-	85	80 – 90
19.0	100	95 – 100	74	66 – 82
13.2	85	78 - 92		
9.5	73	63 – 83	54	44 – 64
4.75	54	44 – 64	39	29 – 49
2.36	39	30 – 48	29	21 – 37
0.425	18	14 - 22	13	10-17
0.075	8	7 -11	6	5-8

Table 301.052 Grading Requirements for Size 40 and 75 mm Crushed Rock Subbase (Igneous - Extrusive)

Grading				
Sieve Size (mm)	40mm Subbase		75/65 mm Subbase	
	Target Grading	Limits of Grading % Passing	Target Grading	Limits of Grading % Passing
75	-	100-	100	90-100
37.5	100	95-100	77	64-90
26.5	85	75-95	67	50-84
19.0	77	64-90	60	42-78
9.5	60	42-78	48	30-66
4.75	46	28-64	36	20-52
2.36	35	20-50	27	12-42
0.425	17	10-23	14	4 –24
0.075	9	6 -12	6	2 -10

Table 301.053 Grading Requirements for Size 20 and 40 mm Crushed Rock Base (Igneous – Intrusive)

Grading

Sieve Size (mm)	20mm Base		40 mm Base	
	Target Grading	Limits of Grading % Passing	Target Grading	Limits of Grading % Passing
37.5	-	-	100	90-100
26.5	100	100-	85	80-90
19.0	100	95-100	74	66-82
13.2	85	78 - 92		
9.5	73	63-83	54	44-64
4.75	54	44-64	39	29-49
2.36	38	29-48	29	22-35
0.425	16	13 - 21	11	8-13
0.075	7	5 - 9	3	2-5

Table 301.054 Grading Requirements for Size 40 and 75 mm Crushed Rock Subbase (Igneous - Intrusive)

Grading				
Sieve Size (mm)	40mm Subbase		75/65 mm Subbase	
	Target Grading	Limits of Grading % Passing	Target Grading	Limits of Grading % Passing
75		100	100	90-100
37.5	100	95-100	77	64-90
26.5	85	75-95	67	50-84
19.0	77	64-90	60	42-78
9.5	60	42-78	48	30-66
4.75	46	28-64	36	20-52
2.36	35	20-50	26	12-42
0.425	15	7-23	12	4-- 24
0.075	6	2-9	4	2-10

(b) *Sealed Rural Roads Basecourse*

For Sealed Rural Roads Basecourse, the product grading prior to compaction shall comply with the requirements shown in, Table 301.055, The crushed rock shall not be graded from near the coarse limit on one sieve to near the fine limit on the following sieve or vice versa. At least 70% by mass of the aggregates in the product that are retained on the 4.75 mm sieve shall have two or more faces produced by crushing.

Table 301.055 Grading and Plasticity Index Requirements for Sealed Rural Roads Basecourse

Grading and Plasticity Index	
Sieve size (mm)	% Passing
53	100
37.5	100
26.5	
19.0	66 - 81
9.5	43 - 57
4.75	28 - 43
2.36	19 - 33
1.18	12 - 25
0.75	
0.6	7 - 19
0.425	
0.3	3 - 14
15	0 - 10
0.075	0 - 7
Plasticity Index Range	0 - 5

(c) Remote Location Basecourse and Subbase

For Remote Location Basecourse and Subbase for unsealed rural roads, the product grading prior to compaction shall comply with the requirements shown in, Table 301.056, The material shall not be graded from near the coarse limit on one sieve to near the fine limit on the following sieve or vice versa.

Table 301.056 Grading and Plasticity Index Requirements for Remote Location Basecourse and Subbase For Unsealed Rural Roads

Grading and Plasticity Index			
40mm Material		75/65 mm material	
Sieve size (mm)	% Passing	Sieve Size (mm)	% Passing
53	100	75	100
37.5	95 - 100		
26.5	75 - 95		
19.0	64 - 90	19.0	45 - 90
9.5	47 - 78	9.5	30-60
4.75	27 - 64		
2.36	20-50		
0.425	10-23		
0.075	6-12	0.075	0-10
Plasticity Index Range	5 - 12	Plasticity Index Range	Less than 12

(d) *Running Course*

The Running Course product grading prior to compaction shall comply with the requirements shown in, Table 301.057,

Table 301.057 Grading and Plasticity Index Requirements Running Course

Grading and Plasticity Index	
Sieve Size (mm)	% Passing
55	100
37.5	
26.5	85 – 100
19.0	
13.2	
9.5	65 - 100
4.75	50 - 85
2.36	
0.425	25 - 45
0.075	15 - 28

Plasticity Index Range	5 - 12
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301.06 WATER

Water added to the material prior to delivery, such water shall be clean and substantially free from detrimental impurities such as oils, salts, alkalis, acids, and vegetables substances.

Where payment is made on the basis of mass, the average moisture contents of crushed rock at the plant shall not exceed 4.0 % by mass unless the Contractor has, at the time of tendering, nominated an upper limit of average moisture content greater than 4%. In the latter case the difference between the nominated value and the specified value will be taken into account when tenders are being considered

The average moisture content of crushed rock supplied on any one day will be determined from three samples taken at random on that day

301.07 MATERIAL SUPPLIED TO STOCKPILE

Where the Contractor supplies crushed rock to stockpile prior to delivery to the roadbed the following requirements apply:

- the product, after recovery from the stockpile, complies with this specification;
- the stockpile site is clean, adequately paved, and well drained;
- if a stockpile is constructed in more than one layer, each layer is fully contained within the area occupied by the upper surface of the preceding layer;

301.08 HANDLING OF CRUSHED ROCK PRODUCTS

Handling of crushed rock including stockpiling and loading of trucks shall be undertaken to minimise segregation.

301.09 FREQUENCY OF TESTING

The Contractor shall undertake testing at the minimum frequency specified in Clause 301.10. . . .
 Production Testing of Source Material: Material shall be tested at the source of production, from samples which are intended for use and are representative of the processing method. Initial production source testing must be carried out immediately prior to commencement of supply, and material shall not be brought to site until source tests have been submitted to, and accepted by the Engineer. Any change of source or processing method, or any noticeable change in the materials properties during the construction process will require that the full suite of tests be carried out again..

Representative samples of the aggregate shall be obtained by qualified and experienced technicians in accordance with. AS 1141.3.1 Methods for sampling and testing aggregates –Sampling – Aggregates

All tests are to be carried out in an appropriately accredited laboratory.

On site Testing: Aggregate samples shall be collected for testing from the stockpiles intended for use on site and from the completed layers of pavement to ensure that the material complies with the grading requirements of this specification.

Additional tests may be requested by the Engineer. If the results of these show non-compliant material the cost of such tests shall be borne by the Contractor. If the tests show compliance in all tests asked for by the Engineer, then the cost of such tests shall be borne by the Engineer.

301.10 MINIMUM TESTING REQUIREMENTS

The Contractor shall test crushed rock products at such a frequency to ensure that the supplied material consistently complies with the specified requirements.

The minimum test frequency shall not be less than that shown in Table 301.101.

Table 301.101 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Grading and Atterberg Limits	On each production day - One per 750 tonnes or part thereof.
Moisture Content	On each production day - One per 750 tonnes.
California Bearing Ratio	One per 2000 tonnes
Degradation Factor	One per 2000 tonnes on each production day
Los Angeles Value	One per 2000 tonnes on each production day
Sand Equivalent	One per production fortnight
Flakiness Index	One per production fortnight
Crushed Particles	One per production fortnight
Polished Stone Value	Not used

SECTION 302 – CONSTRUCTION OF BASE AND SUBBASE PAVEMENT COURSES

302.01 DESCRIPTION

This section covers the supply, delivery, spreading and compaction of screened or crushed gravel, sand and soft or ripped rock, including mixtures thereof and materials broken to size on the roadbed, for the construction of pavement courses including shoulders.

302.02 DEFINITIONS

(a) *Unbound Flexible Pavement*

A pavement consisting of an unbound granular base and subbase materials, with a thin asphalt or sprayed bituminous seal surfacing.

(b) *Pavement Course*

For the purpose of this specification, the pavement base and subbase shall each be termed a pavement course. A pavement course may comprise one or more layers.

(c) *Base*

One or more layers of material usually constituting the uppermost structural element of a pavement on which the surfacing may be placed, which may be composed of crushed rock, or other materials as specified. .

(d) *Subbase*

The pavement material constructed on the subgrade to the underside of the base either for the purpose of making up the additional pavement thickness required, or to provide a working platform.

(e) *Subgrade*

Subgrade is the trimmed or prepared portion of the formation on which the pavement including shoulders is constructed.

(f) *Segregated Area*

An area of a pavement layer, which does not comply with the grading requirements of the specification. Typically this is where the finer material is either not present or has settled to the bottom of the layer leaving the coarser materials at the surface.

302.03 SUBGRADE PREPARATION

Prior to placing subbase material, the subgrade shall meet the requirements of Section 202.

302.04 CONFORMITY WITH DRAWINGS

All pavement courses shall, after compaction, be finished to smooth and uniform surfaces, free of segregated areas, and conforming to the limits for level, line, grade, thickness and cross section shown on the drawings or as specified or directed by the Engineer.

(a) *Surface Level of Pavement Courses*

The surface level of each completed pavement course shall be checked longitudinally and transversely for conformity with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- (i) at the edges of the pavement
- (ii) at all changes of gradient across the pavement
- (iii) at intervals not exceeding 2m across the pavement.

The surface level of the pavement courses shall comply with the requirements of Table 304.041.

Table 304.041 Level Tolerances at the Surface of Pavement Courses

Lower Subbase (mm)	Upper Subbase (mm)	Base (mm)
+ 15 to – 25	+ 10 to - 25	± 15

The maximum lot size for measurement and assessment of surface level shall be 4000 m² unless otherwise approved by the Engineer.

Where base course is to be constructed to the lip level of kerb and channel it shall be constructed flush with the lip of the channel or not more than 5 mm above.

(b) *Thickness of Pavement Layers*

In addition to complying with pavement layer surface tolerances specified in Clause 302.04 (a), the following tolerances shall apply to the thickness of any pavement layer:

- (i) the subbase course shall be not less than the specified thickness by more than 15 mm;

- (ii) the base course shall be not less than the specified thickness by more than 10 mm and the average thickness of base over every 100 m section, over the full carriageway width, shall be not less than the specified thickness;
- (iii) the combined thickness of subbase and base courses shall be not less than the specified thickness by more than 15 mm.

Where the Contract does not require design finished surface level control but specifies a pavement composition or a minimum overlay / resheet thickness only, the Contractor shall construct the pavement to comply with the requirements of thickness of each pavement layer as specified in this sub-clause. The tolerance requirements of Table 302.041 shall not apply. The Contractor shall determine the thickness of pavement courses or overlay / resheet by taking the difference between the surface level measurements at locations as described in Clause 302.04 (a).

(c) Alignment

The edges of the bottom of pavement not placed against an edging shall be not more than 50 mm inside, nor more than 100mm outside, the designed offset from centreline or design line. Within these tolerances, the rate of change of offset of the edge of the layer shall be not greater than 25 mm in 10 m.

(d) Width

The width at the bottom of pavement not placed between edging shall be not less than the design width by more than 50mm, nor greater than the design width by more than 10mm, and the average width at the bottom over any 300m shall be not less than the design width, when measured at right angles from the centre line or design line. The face of the boxing shall be vertical or slope outwards at approx. $\frac{1}{4}$ to 1.

(e) Shape

No point on the surface of each layer of base or subbase shall lie more than 8 below a 3 m straightedge or 10 mm from a 6 m straight edge, placed in any direction.

At no location shall water pond on the surface of any pavement layer.

302.05 SPREADING AND FINISHING PLANT

(a) Pavers

Where the crushed rock is supplied as a wet mixed product, a self-propelled paver can be used. The pavers shall be equipped with hoppers and distributing screws of the counter-rotation type to place the material evenly in front of the screen. The screen shall

be adjustable to the required cross section and shall produce a surface of uniform texture within the specified tolerances for line and level.

(b) *Graders*

Graders shall be self-propelled and have a mass of not less than 12 tonne. They shall be capable of producing a surface of uniform texture within the specified tolerance for line and level.

302.06 WATERING PLANT

Watering plant shall have spray bars capable of uniformly distributing water on the road and shall be fitted with rapid acting positive shut-off valves. Water may be added to the pavement material at the pit, stockpile or roadbed and then be uniformly mixed, but no water shall be added to material in delivery vehicles.

302.07 COMPACTION PLANT

Compaction plant shall be either steel or pneumatic tyred rollers in good condition free from any leakage and shall be capable of compacting the pavement to the specified level of density. The size and number of rollers shall match the rate at which the pavement material is delivered each day, and shall be able to produce a surface at the end of each day that is capable of shedding water.

302.08 MATERIALS

The Contractor shall be responsible for the procurement of sufficient specified material to complete the work

Materials may be obtained from one or more sources provided that the quality is maintained as specified in Section 301 and that:

- i. Delivery does not commence from any source until the sample that source has been approved for use by the Engineer.
- ii. Material from one source of supply and of the same nominal grading is used full width on any carriageway for continuous lengths of not less than 300 m unless otherwise permitted by the Engineer.

Water added to the pavement material shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances.

302.09 DELIVERY

The methods of loading and unloading material shall be such that segregation will be minimised. Material which does not comply with the Specification shall be removed from the site. Delivery to separate stockpiles for testing prior to placement on the roadbed may be directed by the Engineer if variability in the pavement material occurs. No additional payment will be made for the cost of rehandling the stockpiled material.

302.10 SETTING OUT

Unless otherwise approved by the Engineer the Contractor shall establish setting out stakes at no more than 15 m intervals positioned 300 mm outside the edge of the shoulder, before any pavement material is placed. Marks shall be positioned on the stakes to provide a plane, parallel to but at least 300 mm above the finished level of the road.

Unless otherwise approved by the Engineer, control of the depth of pavement layers shall be maintained by measuring down from a string line pulled taut between the marks on the stakes. The dipping records shall be retained by the Contractor and be made available at all times during the work. The survey stakes shall be maintained and used at all times that work is proceeding.

302.11 SPREADING

Spreading shall include running material from delivery vehicles and, as necessary, breaking to size, mixing and watering to produce material of uniform grading & moisture content.

Construction of a new layer shall not commence until the previous layer has been compacted and accepted. The previous layer shall be kept in good condition before and during the spreading of the subsequent layer.

Care shall be taken to minimise segregation of material. If segregation occurs the segregated material shall be mixed and re-spread. Unless otherwise specified or shown on the drawings, the compacted thickness of any layer of any course shall not exceed 100 mm except where the nominal size of material is such that 2.5 times the nominal size exceeds 100 mm. Where this occurs the maximum layer depth shall be the minimum allowable compacted thickness plus 50 mm.

Minimum allowable compacted layer thickness shall be 2.5 times nominal size of the material.

302.12 JOINTING

The layout of joints shall conform to the following requirements:

- (i) material shall be spread in such a manner as to minimise the number of joints;
- (ii) for all pavement layers, transverse joints in adjoining paver runs shall be offset by not less than 2 m;

- (iii) transverse joints shall be offset from one layer to the next by not less than 2 m;
- (iv) longitudinal joints shall be offset from one layer to the next by not less than 150 mm;
- (v) longitudinal joints shall be located within 300 mm of the planned position of traffic lanes lines or within 300 mm of the centre of a traffic lane.

The exposed end of each lot and the exposed edges of any part width construction shall be kept moist until spreading and compaction has been completed over the entire layer.

302.13 COMPACTION PROCEDURE AND REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION

(a) General

Compaction shall commence promptly after spreading, and all material spread each day shall be compacted sufficiently to provide a dense surface to minimise the entry of water in the event of rain.

Pavement lots shall be tested for compliance in accordance with the appropriate test methods as described in VicRoads Code of Practice RC500.05 *Acceptance of Field Compaction*.

Material during compaction shall have a moisture content of not less than 85% of optimum. After completion of compaction of a layer, the moisture content of the material in the layer shall be maintained at a moisture content of not less than 85% of optimum until test rolling has been completed. All segregated areas shall be rectified as construction proceeds, prior to the completion of compaction and in such a way as to mitigate the potential for segregation to re occur.

For the purpose of control of moisture content of material and for determination of compaction procedure the following definitions shall apply:

- (i) material of nominal size 40 mm or less is material which has 20% or less (by wet mass) retained on a 37.5 mm AS sieve
- (ii) material of nominal size greater than 40 mm is material which has more than 20% (by wet mass) retained on a 37.5 mm AS sieve.

(b) Material of nominal size 40mm or less

Material shall be spread and compacted such that the material is properly mixed both transversely and longitudinally to produce a homogeneous material for each lot.

Material having a nominal size after compaction of 40 mm or less shall be compacted to

comply with the following requirements:

- (i) The calculation of density ratio per lot, unless otherwise approved by the Engineer, shall be based on tests performed using Modified compactive effort. The work shall be assessed for compliance with Scale A, Scale B or Scale C requirements for testing and acceptance of compaction as specified in Clause 302.15 and as provided in Tables 302.131 and 302.132.

Unless otherwise specified in Clause 302.15, the following Scales, based on road classification as defined in the FRA Austroads Design Guide Supplement Parts 1 to 8, shall apply:

- Scale A: M1, M2, and Arterial roads
- Scale B: S and Collector Roads
- Scale C: Local Streets, C and R

- (ii) A lot, as defined in Clause 165.06, will consist of a single layer of work and shall not exceed 4000 m² or one day's production, whichever is the lesser, or as otherwise approved or directed by the Engineer. The bounds of each lot to be tested will be defined by the Engineer.
- (iii) For work to be tested for compliance with Scale A or Scale B requirements, the number of tests per lot shall be six. For work to be tested for compliance with Scale C requirements, the number of tests per lot shall be three. For each lot, sites for density testing will be selected on a random basis in accordance with AS1289.1.4: *Methods of testing soils for engineering purposes - Sampling and preparation of soils - Selection of sampling or test sites - Stratified random number method* or as determined by the Engineer.
- (iv) Every lot shall be tested for acceptance of compaction in accordance with the requirements of the Specification for the required scale of testing, provided in Tables 302.131 and 302.132.
- (v) Any lot that has a surface area less than 500 m² may be treated as a small area and tested in accordance with Clause 165.09. For small lots, every lot shall be tested separately for compliance with the specified requirements.
- (vi) All pavement layers shall be compacted to withstand rolling and shall be test rolled in accordance with Clause 302.14 to acceptance of the layer.

The Contractor shall provide for the Engineer to be present during all test rolling.

- (vii) The maximum and minimum thickness of any pavement base and subbase layer

shall be in accordance with Clause 302.11.

Table 302.131 Acceptance Limits for Scale A and Scale B Standards of Compaction

Compaction Scale	Characteristic Density Ratio % (six tests)		
	Subbase Layers	Base Layers	
		Layer directly beneath the Bituminous Surfacing	Other Layers
A	Not less than 98.0	Not less than 100.0	Not less than 99.0
B	Not less than 97.0	Not less than 98.0	Not Less than 98.0

Table 302.132 Acceptance Limits for Scale C Standard of Compaction

Compaction Scale	Mean Value of Density Ratio % (three tests)	
	Subbase Layers	Base Layers
C	Not less than 98.0	Not less than 100.0

(c) *Material of nominal size greater than 40 mm*

Unless otherwise specified, material which will have a nominal size after compaction greater than 40mm shall be compacted using a grading, mixing, watering and rolling routine proposed by the Contractor and reviewed by the Engineer. The Engineer may require that trial sections be constructed to verify that the proposed compaction routine is acceptable. No additional payment will be made for any such request.

Following acceptance of the trial section, the Contractor shall then confirm the moisture control and compaction procedure and submit the procedure to the Engineer for review and record.

Acceptance of work as far as compaction is concerned will be based on compliance with the accepted compaction routine and test rolling carried out in accordance with Clause 302.14. During compaction, the moisture content of that fraction of material passing the 37.5mm AS sieve shall be within the range 85 to 115 percent of the optimum moisture content determined in the Modified compaction test.

Any unstable areas detected by test rolling shall be rectified and re-presented for test rolling. Where the total unstable areas exceed 10% of the area being test rolled the whole

of the area shall, unless otherwise approved or directed by the Engineer, be ripped, re-compacted and re-presented for test rolling.

The Contractor shall provide for the Engineer to be present during all test rolling.

Unstable areas identified by test rolling shall be rectified by the Contractor.

Prior to any layer being covered by a successive layer, the Engineer may require further test rolling to confirm that the layer is sound.

302.14 TEST ROLLING

(a) General

Pavement layers shall be compacted to be capable of withstanding test rolling without visible deformation or springing. Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- Steel smooth wheeled rollers shall have a mass not less than 12 tonne mass with a load intensity under either the front or rear wheels of not less than 6 tonne per metre width of wheel;
- Pneumatic tyred plant shall have a mass not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

Test rolling shall be carried out by the Contractor in the presence of the Engineer prior to the placing of the next layer of pavement material.

Each layer should be test rolled immediately following completion of compaction but if test rolling is carried out later the surface of the layer shall be watered and given a minimum of three passes with the test roller prior to commencement of test rolling.

The Engineer reserves the right to direct the Contractor to undertake further test rolling on any layer prior to it being covered by a successive layer. No additional payment will be made for any requests to carry out such further test rolling.

The Contractor shall submit a test rolling procedure to the Engineer including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours' notice of the location and commencement time for the test rolling to the Engineer.

(b) Compliance

Compliance with the test rolling requirements shall be when an area withstands test rolling without visible deformation or springing.

302.15 CLAUSE NOT USED

302.16 PROTECTION OF COMPACTED LAYERS

The surface of any compacted pavement layer or prepared subgrade shall be maintained in such a way as to minimise dust, prevent ravelling, erosion, deformation or any other damage to the layer resulting from environmental conditions, traffic or construction activities. The layer shall be kept free from contamination until any subsequent pavement work under the Contract is commenced or the Engineer accepts and takes responsibility for that part of the Works.

302.17 PREPARATION FOR SEALING

(a) General

The Contractor shall prepare for bituminous surfacing the lengths, widths and areas specified or shown on the drawings for bituminous surfacing plus an additional 0.3 m on sides where there is no concrete edging, unless otherwise indicated on the drawings. The surface of the shoulders and verges shall be matched to the finished surface of the prepared pavement.

Construction practices that produce a slurry or pasting of fine material at the surface are not permitted.

The addition of fine material to the surface is not permitted.

Where the Engineer considers the prepared surface to have excessive fines, the pavement layer shall be rectified to a condition acceptable to the Engineer.

The pavement shall be prepared to produce a surface that is:

- (i) constructed to meet specified shape and level requirements
- (ii) homogenous and consistent with the material in the pavement base layer
- (iii) uniform in texture
- (iv) free of tearing and scabbing
- (v) free of lamination on or within 75 mm of the finished surface
- (vi) level with adjacent sealed areas and edgings at the joints
- (vii) a hard dense and tight surface capable of being swept with a rotary road broom or

similar

- (viii) free of loose and foreign materials
- (ix) dried back to the moisture content as specified in Clause 302.17 (b), where required by the Engineer

Any imperfections as listed above shall be corrected in a manner acceptable to the Engineer. Where this involves the re-working of the material, the full layer depth shall be re-worked.

The total area of the work shall be presented to the Engineer for acceptance for surfacing as one lot.

(b) Pavement Dryback

The pavement shall be allowed to dryback to a moisture content which will not adversely affect the performance of a bituminous surfacing when applied and trafficked. Premature surfacing of the pavement prior to achieving dry back and opening to traffic can lead to poor surfacing performance.

The Engineer may request the Contractor undertakes testing to confirm that the pavement has dried back. Where this occurs the uppermost pavement layer after preparation of the surface and prior to priming or primersealing shall have a moisture content of the layer which meets the requirements of Table 302.171 for each test lot. The Contractor may undertake testing to confirm pavement dry back has been achieved.

The mean Moisture Ratio shall be determined from six randomly selected sites as a percentage of the optimum moisture content based on Modified compactive effort unless otherwise approved by the Engineer.

Table 302.171 Requirements for Pavement Dryback and Embedment

AADT	Pavement Dryback	
	Mean Moisture Ratio	Maximum of any individual result
> 2,500	Less than 60%	65%
<2,500	Less than 60%	70%
Shoulder widenings/ untrafficked areas etc.	Less than 65%	70%

The maximum lot size to be presented for testing under this provision shall be 4000 m², and testing shall be undertaken no more than 24 hours before priming or primersealing (initial seal).

Where the pavement moisture content has increased during the period between dryback testing and the proposed time of bituminous surfacing, the Engineer may require pavement dryback to be reassessed in accordance with this clause.

302.18 MAINTENANCE PRIOR TO BITUMINOUS SURFACING

Following the acceptance of the prepared surface and until bituminous surfacing is completed, the Contractor shall maintain the pavement in the accepted condition until surfacing works are completed. Should the pavement condition deteriorate before surfacing works are completed, the Contractor shall re prepare the pavement and represent the pavement for acceptance.

SECTION 303 – SUPPLY AND DELIVERY OF ROADMAKING MATERIALS**303.01 GENERAL**

This section covers the supply and delivery of roadmaking materials. For supply only contracts, “supply” includes the loading of the material into delivery vehicles supplied by others.

303.02 MATERIAL QUALITY

Except where otherwise specified all materials supplied shall comply with the requirements of the following sections as relevant:

- i. Section 301 Materials for Pavement Construction
- ii. Section 401 Aggregates for Sprayed Bituminous Surfacing

Material may be obtained from one or more source provided that the following conditions are adhered to:

- i. Delivery shall not commence from any source until the sample from that source has been approved by the Engineer.
- ii. The specified quality is maintained.
- iii. Materials from separate sources are not mixed but retained in separate stockpiles.

Any material which does not comply with the specification will not be paid for, and shall be removed from the place of delivery by the Contractor at his expense.

303.03 PROCUREMENT AND TRANSPORT OF MATERIALS

The procurement and transport of materials shall comply with requirements of Section 101.

303.04 DELIVERY

Delivery shall commence within 4 weeks of the date of a written notice from Engineer to commence delivery.

Unless otherwise specified delivery to the roadbed shall be made within the following times:

- Monday to Thursday 7.00am to 4.00pm
- Friday 7.00am to 2.30pm

Delivery to stockpile shall only be carried out in the approved working hours unless otherwise directed. Saturday work may be approved by the Engineer on written application by the Contractor.

There shall be no delivery on Sundays or any Gazetted Public Holiday.

Delivery shall be directly to the roadbed following acceptance of the material, or placed in stockpile by the roadside as directed by the Engineer.

All materials shall be delivered in vehicles fitted with approved bodies.

Pavement materials to be delivered direct to the roadbed shall be spread in even layers. Material shall not be dumped in heaps on the area to be paved without the prior approval of the Engineer.

The methods of production, loading and unloading of pavement materials shall be such as to minimise segregation.

303.05 STOCKPILING OF DELIVERED MATERIAL

Where delivery of material into stockpile is specified or directed by the Engineer because of the variability in the material, clearing and preparation of nominated stockpile sites will be done by the Fiji Roads Authority unless otherwise specified.

Any other temporary stockpile sites required by the Contractor for his own purpose shall be constructed by the Contractor at his own expense.

Stockpiles shall be so located and constructed that they do not unduly reduce sight distance at locations such as intersections and curves. Stockpiles shall not be located under or immediately adjacent to overhead electric power lines or elsewhere where the overhead clearance from the surface for dumping is less than 6m. Stockpiles shall be located clear of the road formation, drains, entrances, trees and side tracks and the toes of the stockpiles shall not impede the operation of mechanical loading equipment. Where material is supplied from more than one source, material from each source shall be stockpiled separately. Stockpiles shall be constructed in such a way that segregation of the material is minimised.

303.06 CLAUSE NOT USED

SECTION 304 – IN SITU STABILISATION OF PAVEMENTS WITH CEMENTITIOUS BINDERS**304.01 DESCRIPTION**

This section covers the requirements for in situ stabilisation of existing pavements by addition of cement, blended cement, lime, or other supplementary cementitious materials. The requirements relate to mix design, preparation of existing pavement materials, lime pre-treatment of pavement materials with high plasticity, supply of cementitious binders, construction plant, and spreading, mixing, and compaction of pavement layers.

304.02 DEFINITIONS*(a) Available Lime*

The amount of Calcium Oxide (CaO_2) or Calcium Hydroxide ($\text{Ca}(\text{OH})_2$) contained in Quicklime or Hydrated Lime respectively

(b) Available Lime Index (ALI)

The Calcium Oxide or Calcium Hydroxide content of quick lime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS 4489.6.1

(c) Cementitious Binder

A cementitious material capable of being uniformly mixed into a granular pavement material to bind the particles together to increase its strength. Cementitious binders include Portland cement (AS3972) Type GP or blended cement Type GB, or a blend of ground granulated blast furnace slag (GGBFS, AS3582.2), hydrated lime (AS1672.1), fly ash (AS3582.1), alkali activated slag or other pozzolanic material supplied in accordance with this specification.

(d) Density Decay Correction Factor

A factor derived to calculate the field density ratio from a laboratory determined reference density where compaction of the test sample has occurred after the maximum allowable working time has expired.

(e) Design Distribution Rate of Available Lime

The spread rate of pure Calcium Oxide or Calcium Hydroxide.

(f) Fly Ash

A fine powder of pozzolanic material extracted from the flue emissions produced from the

burning of black coal.

(g) *Hydrated Lime*

Hydrated lime is a powdered form of lime consisting primarily of calcium hydroxide, also referred to as slaked lime.

(h) *Lime*

Lime is either Hydrated Lime (Calcium Hydroxide) or Quick Lime (Calcium Oxide).

(i) *Lime Spreading Rate*

The required spread rate of lime determined from the Design Distribution Rate of Available Lime corrected for the ALI of the lime to be used.

(j) *Maximum Allowable Working Time*

The maximum allowable working time for the cementitious binder as specified or as determined in accordance with the relevant Test Method or Code of Practice.

(k) *Pozzolan*

A siliceous or aluminosiliceous material when finely ground can be mixed with lime or Portland cement to form a cementitious material.

(l) *Quicklime*

Quicklime is a fine granulated powder consisting primarily of Calcium Oxide that can be readily slaked by the application of water after it has been evenly spread to form Calcium Hydroxide.

(m) *Reference Density*

The reference density is the maximum dry density or the peak converted wet density determined in accordance with the appropriate test method, but adjusted for oversize material as appropriate.

(n) *Slag (Ground Granulated Blast Furnace Slag)*

Ground Granulated Blast Furnace Slag (GGBFS) is a pozzolan produced by fine grinding of slag produced as a by-product from the smelting of iron ore.

(o) *Working Time*

The time required to mix, fully compact and trim the stabilised pavement layer after the addition of cementitious binder.

304.03 CONFORMITY WITH DRAWINGS

Completed stabilised base and subbase layers shall conform within the following limits to the levels, lines, grades, thicknesses and cross sections shown on the drawings, or specified, or directed by the Engineer.

(a) *Surface Level*

The surface level of any pavement course shall be checked longitudinally and transversely for conformity with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- (i) at the edges of the pavement
- (ii) at all changes of gradient across the pavement
- (iii) at intervals not exceeding 2m across the pavement.

The surface level of the pavement courses shall comply with the requirements of Table 304.031.

Table 304.031 Level Tolerances at the Surface of Pavement Courses

Subbase (mm)	Base (mm)
+ 10 to - 25	± 15

The maximum lot size for measurement and assessment of surface level shall be 4000 m² unless otherwise approved by the Engineer.

(b) *Subbase*

If the cementitious stabilised material forms a subbase for an unbound flexible pavement or an asphalt pavement, the level tolerances as specified in Table 304.031 shall be met.

(c) *Base*

Unless otherwise specified in other specification sections or elsewhere if the cementitious stabilised material forms a base on which bituminous surfacing is to be applied, the level tolerances as specified in Table 304.031 shall be met.

Where base course is to be constructed to the lip level of kerb and channel it shall be constructed flush with the lip of the channel or not more than 5mm above.

(d) *Depth of Stabilisation*

The depth of cementitiously stabilised material as specified in Clause 304.16(a) shall not at any point be less than the specified thickness by more than 15 mm and the average thickness of the lot shall be not be less than the specified thickness. Maximum permitted stabilisation depth is 250 mm.

(e) *Alignment*

The edges of the stabilised layer shall be not more than 50 mm inside, and not more than 100 mm outside, the specified offset from centreline or design line.

(f) *Width*

The width of the stabilised material shall not be less than the specified width by more than 50 mm.

(g) *Shape*

No point on the surface of the stabilised layer shall lie below a 3 m straightedge placed in any direction on the surface by more than 10 mm for the base and 15 mm for subbase.

304.04 MATERIALS

(a) *Cementitious Binders*

(i) Cement

Blended cement Type GB or for special purposes, General Purpose Portland Cement Type GP complying with AS 3972 shall be supplied by the Contractor.

The Contractor shall nominate the type, brand and source of cement proposed.

(i) Lime

Quicklime and hydrated lime shall meet the requirements of AS 1672.

All quicklime and hydrated lime supplied to the job shall be provided with delivery docket showing the manufacturers reference number for the production lot and an Assigned ALI for each production week. The Assigned ALI shall be determined by averaging the six most recent test results for ALI. Test certificates for determination of the ALI shall be made available on request.

Lime shall be stored in a moisture free environment and shall be retested for compliance with AS1672.1 if stored more than 14 days after receipt from the manufacturer.

(iii) Slag / Lime Blends

Slag and hydrated lime may be used in blended combination to produce a slow setting cementitious binder. The requirements for hydrated lime shall be as specified in Clause 304.04(a)(ii). Slag used shall be Ground Granulated Blast Furnace Slag (GGBFS) meeting the requirements of AS 3582.2. The Contractor shall nominate the type, brand and source of the GGBFS to be used.

Unless otherwise specified, slag/lime shall be blended uniformly in the ratio of 85% slag to 15% hydrated lime. If the blend is to be varied, the proportion of lime shall not be less than 10% but may be increased above 15% for materials with high plasticity provided that the minimum UCS requirements are met as specified in Table 304.053. The Contractor shall provide evidence that the blend ratio has been met for all material supplied to the job. An 85% slag to 15% lime blend shall have a mortar bar 7 day compressive strength of 10 MPa and 28 day mortar bar compressive strength of 16 MPa. The test shall be the same test specified in AS 3972 except that the cement to water ratio shall be adjusted to match the consistency of mortar produced for the compressive strength test for GB cement in accordance with the relevant Australian Standard Test Method.

(b) Water

Water added to the material shall be clear and substantially free from sediments and detrimental impurities such as oils, salts, acids, alkalis and vegetable substances.

(c) Pavement

The in situ pavement material to be stabilised shall be the existing surfacing and pavement material and any additional material placed over the existing pavement for mixing with the pavement below.

304.05 PAVEMENT MATERIALS INVESTIGATION AND MIX DESIGN

(a) General

Unless otherwise specified in Clause 304.16(c) and (d), the Contractor shall produce a mix design for the in situ stabilised pavement material in accordance with Section 10(a) of VicRoads Code of Practice RC 500.16 *Selection of Test Methods for Testing of Materials and Work* and referenced VicRoads Test Methods. The aim of the mix design procedure is to improve the material grading if necessary, reduce the plasticity and to optimise the type and amount of cementitious binder required having regard to the chemical and physical properties of the in situ material. The in situ stabilised pavement material is required to meet the specified grading, plasticity and strength requirements, and contain a cementitious binder which will allow sufficient working time to mix, place,

compact and trim the material before the initial set takes place.

(b) Grading and Plasticity Index

The final grading of the material to be stabilised after addition of any additional granular material, to correct the grading or to increase the thickness of the pavement shall be within the limits specified in Table 304.051.

If the Plasticity Index (PI) exceeds the limits specified in Table 304.051 the material shall be pre-treated with lime or modified with additional granular material using the design procedure described in the Test Method. If the material is to be pre-treated with lime to lower the PI, the quantity of lime additive used shall not be less than 1.5% by mass.

Table 304.051 Grading and Plasticity Index Requirements

Sieve Size (mm) (% passing by mass)	53	37.5	19	4.75	0.425	0.075	PI (Max.)
Base	100	85-100	60-100	40-70	20-40	5-25	10
Subbase and Sealed Shoulders	90-100	75-100	50-100	30-80	15-45	3-30	15

(c) Maximum Allowable Working Time

The type of cementitious binder added shall be selected on the basis of the maximum allowable working times specified in Table 304.052 and the minimum working time considered necessary to properly mix the material, trim and shape the surface to level and fully compact the layer to the specified density ratio.

Table 304.052 Maximum Allowable Working Times for Various Cementitious Binders

Cementitious Binder	Maximum Allowable Working Time After Mixing (hours)
Slow Setting Slag/Lime blends,	8

Medium Setting Type GB Cements Cement/Slag blend (50% to 60% cement content) Cement/Fly Ash blend (70% to 80% cement content) Cement/Slag/Fly Ash blend (55% to 65% cement content)	3
Rapid Setting Type GP Cement	2
Hydrated Lime and Quicklime	12

(d) *Cementitious Binder Content and Unconfined Compressive Strength (UCS)*

Table 304.053 specifies the limits for the minimum and maximum content of cementitious binder and the target UCS to be used to select the optimum cementitious binder content from test specimens prepared at a minimum of three different binder contents varying by not less than 0.5% by mass in accordance with referenced test methods.

Table 304.053 Target UCS to Select the Optimum Content of Cementitious Binder (7 days)

Type of Work	Cementitious Binder Content (% by mass)		Target 7 day UCS at modified compactive effort (MPa)		
	Min	Max	Slow Setting	Medium Setting	Rapid Setting
Material Modification	1.5 *	3.5	1.0	1.4	1.8

*The Engineer may agree to a cementitious binder content of less than 1.5% but at least 1% by mass if the UCS requirement at a binder content of 1.5% is more than 50% above the target UCS. If less than 1.5% by mass of cementitious binder is permitted, a minimum of two mixing runs shall be undertaken after spreading of cementitious binder and the minimum density ratio specified in Clause 304.13 shall be increased by one percentage point.

304.06 COMMENCEMENT OF WORK

The Contractor shall not commence work until all mix design details have been presented to the Engineer showing compliance with the requirements of Clause 304.05 and approval has been given for stabilisation work to proceed.

304.07 CONSTRUCTION PLANT

The Contractor shall provide construction plant meeting the following requirements and capability.

(a) Spreader for Cementitious Binder

Mechanical equipment specifically designed for the spreading of cementitious binder directly on to the prepared roadbed shall be used. The spreader shall be capable of accurately regulating the discharge of the cementitious binder such that the requirements of Clause 304.14 are met.

(b) Mixing Machine

A purpose built mixing machine designed for in situ stabilisation of roadworks shall be used to pulverise the existing pavement material and uniformly mix the material together with water and cementitious binder to the specified depth of stabilisation. Rotary hoes and other types of agricultural machinery shall not be used.

After pulverisation and mixing, all base material shall be capable of passing a 37.5 mm sieve and all subbase material shall be capable of passing a 53mm sieve.

(c) Watering Plant

Watering plant or any purpose designed watering system incorporated within the mixing machine shall be capable of uniformly distributing sufficient water to hydrate any quicklime used for lime pre-treatment and if required, add more water to increase the moisture content to aid compaction.

(d) Compaction Plant

Compaction plant shall be of such mass as to be capable of compacting the stabilised layer to the minimum density ratio throughout the depth of the layer.

Where compaction is to be accepted on a procedural basis rather than by lot testing, the Engineer and the Contractor shall agree on the number and minimum mass of rollers and the compaction routine to be used. If the compacted depth of layer exceeds 150 mm, the following items of compaction plant shall be used as a minimum requirement:

- a vibrating pad foot roller for initial compaction;
- a vibrating steel flat roller for densification;
- a multi wheel roller for finishing and sealing off the surface prior to trafficking.

304.08 CONSTRUCTION

(a) General

Construction includes the pulverisation of any seal or asphalt surfacing, premixing of in situ materials, supply and spreading of any additional granular material, supply, spreading and mixing of cementitious binder into the in situ pavement material, and compaction, trimming and curing of the stabilised layer.

Unless otherwise specified, stabilisation work undertaken each day shall be completed across the full pavement width.

Stabilisation operations may continue during light rainfall if the moisture content of the in situ pavement material can be maintained below modified optimum moisture content.

Only sufficient area of pavement is to be pulverised that can be mixed and fully compacted in one day. For stabilised patching work, which is to be trafficked or sealed immediately after completion of compaction, only sufficient pavement area shall be opened up to enable work to be completed within the maximum allowable working time specified in Table 304.052.

(b) Preparation of the Existing Pavement

The existing pavement shall be pulverised and mixed to the proposed depth of stabilisation prior to spreading of the cementitious binder. If significantly different in situ materials are present across the width of pavement to be stabilised, the Contractor shall use a system for cross blending materials as necessary, to produce a uniform material prior to addition of cementitious binder.

In locations where a pavement has been pre-treated with lime to dry the material out or lower the Plasticity Index, addition of further cementitious binder and remixing shall not commence until the following day.

The Contractor shall remove or re-pulverise lumps of asphalt or seal which would otherwise be retained on a 53 mm sieve. The volume any large size material removed from the site shall be replaced with an equivalent volume of suitable granular pavement material.

(c) Lime Pre-treatment

If the material to be stabilised is to be first pre-treated with lime to lower its plasticity, lime shall be spread uniformly over the prepared surface at the Lime Spreading Rate calculated using formula (i) or (ii) below.

- (i) Where hydrated lime has been used in the laboratory testing to determine the Design Distribution Rate of Available Lime and it is proposed to use quicklime at the job site, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = 0.76 \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

- (ii) Where the same type of lime (hydrated lime or quicklime) is to be used at the job site as has been used in the laboratory tests to determine the Design Distribution Rate of Available Lime, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

If quicklime is used it shall be slaked with sufficient water to allow full slaking to take place prior to mixing. Full slaking will be deemed to have been achieved when all quicklime that has been spread has changed from a cream coloured granulate to a fine white powder and there is a cessation of rising vapours.

Mixing of quicklime into the pavement material shall not commence until full slaking has been achieved.

(d) Spreading of Lime or Cementitious Binder

Spreading shall not be carried out at times when lime or cementitious binder could become air borne or dispersed in such a way as to become a nuisance or a hazard to persons, property or livestock.

Immediately following completion of spreading, the Contractor shall check and record the Average Spreading Rates and the Uniformity of Spread in accordance with Clause 304.15. If the required Spreading Rate for lime or cementitious binder exceeds 15 kg/m², it shall be spread in two equal spreading runs with material from the first spread run being fully mixed into the pavement material prior to the second spreading run being undertaken.

The prepared pavement shall not be trafficked until the cementitious binder has been mixed into the pavement material.

(e) Mixing in Cementitious Binder

Mixing shall commence as soon as practical after spreading of the cementitious binder and shall continue until all pavement materials and cementitious binder are uniformly blended throughout the full depth of the stabilised layer.

The moisture content of the pavement material prior to addition of the cementitious binder

shall be within the range 80% to 100% of the Modified optimum moisture content. Additional water shall be added to hydrate the cementitious binder.

A minimum of two mixing runs shall be carried out.

(f) Compaction

Compaction of the stabilised layer shall commence immediately after mixing. Compaction equipment shall work as close as practicable behind the mixer to maximise the time available for compaction. Compaction and trimming shall be carried out in a continuous operation.

All compaction shall be completed within the times specified in Table 304.052 after addition of the cementitious binder.

Where necessary during compaction, the Contractor shall water the material to maintain the moisture content within 80% to 100% Modified optimum moisture content.

(g) Trimming

On completion of initial rolling, the stabilised material shall be trimmed to the specified surface tolerances. Light applications of water may be applied during this operation to replace evaporated moisture and to assist in rapid achievement of a tightly knit surface.

All surface irregularities which do not conform to the requirements of Clause 304.03 shall be rectified by the Contractor within the maximum working time for the cementitious binder used as specified in Table 304.052. Rectification beyond the maximum working time for the cementitious binder shall be carried out by replacing material with freshly stabilised material as necessary.

The material trimmed off shall be either cut to waste and if necessary, removed from site or, alternatively it may be transported to another location to be incorporated into a stabilised layer.

304.09 JOINTING

Longitudinal joints shall be avoided by completing a full carriageway width each day. If a longitudinal joint is required, because of rain or traffic control requirements, it shall be located at a lane line or in the centre of the carriageway. Transverse joints shall be formed where stabilisation operations have been halted for more than the time specified in Table 304.052 and at the end of each day's work.

Joints shall be formed by cutting back into the fully compacted previously stabilised material by a minimum of 300 mm which shall be remixed into the new work. Additional stabilising agent shall be added to the area of previously stabilised material to be remixed. Placement of additional

cementitious binder shall be deemed to be part of the joint construction.

The level and shape of the surface at all joints shall be within the limits specified in Clause 304.03.

304.10 TEST ROLLING

Stabilised layers shall pass test rolling. prior to acceptance of the layer. Pavement layers shall be compacted so as to be capable of withstanding test rolling without visible deformation or springing. Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- Steel smooth wheeled rollers shall have a mass not less than 12 tonne mass with a load intensity under either the front or rear wheels of not less than 6 tonne per metre width of wheel;
- Pneumatic tyred plant shall have a mass not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

Test rolling shall be carried out by the Contractor in the presence of the Engineer prior to the placing of the next layer of pavement material.

Each layer should be test rolled immediately following completion of compaction

The Engineer reserves the right to direct the Contractor to undertake further test rolling on any layer prior to it being covered by a successive layer. No additional payment will be made for any requests to carry out such further test rolling.

The Contractor shall submit a test rolling procedure to the Engineer including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours' notice of the location and commencement time for the test rolling to the Engineer.

304.11 MAINTENANCE OF THE STABILISED SURFACE PRIOR TO SURFACING OR OVERLAY

The Contractor shall keep the stabilised pavement surface moist and protected from damage by traffic or construction activities until either a further pavement layer or the bituminous surfacing is applied.

304.12 PRELIMINARY TRIAL

If directed by the Engineer, the Contractor shall carry out a preliminary trial of the proposed stabilising operation.

The trial shall determine:

- the effectiveness of the construction plant;
- the number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing;
- the field moisture content required to achieve specified compaction requirements;
- the rolling routine required to meet specified compaction requirements.

The trial section shall be located within the Works area.

The length of the trial section shall be between 100 and 200 metres over the full width of the area proposed for stabilisation.

Stabilisation work shall not proceed outside the trial section until the Engineer has reviewed all aspects of the stabilising operation. The Engineer's review of the stabilising plant and procedures will be provided to the Contractor by the end of the next working week day after the trial's completion. If the Specification requirements are not met for this trial section, the Engineer may direct that another trial section be stabilised or the rejected section be re-stabilised and presented for re-assessment.

304.13 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION AND STRENGTH

(a) General

(i) Lot Testing Requirements

For Scales A1, A2 or B, compaction is to be accepted by density testing in lots of similar material and work. Unless otherwise specified, the maximum lot size shall be the area of work completed on the same day up to 4,000 m² provided that the whole of the lot is essentially a uniform material similar to material used for the relevant mix design applicable to the lot. If the maximum binder working time requires the area or work to be completed in one day to split into sub-sections, each sub-section shall be treated as a separate lot.

If the material is too variable to be able to assign a single maximum dry density for the lot, a separate reference density shall be determined for each test site.

The calculation of density ratio shall be based on Modified compactive effort of the

laboratory prepared sample containing the design rate of cementitious binder.

The work shall be assessed for compliance against Scales A1, A2, B and C requirements for testing and acceptance of compaction. Unless otherwise specified the following Scales shall apply, based on road classifications as defined in the Fiji Roads Authority Austroads Design Guide Supplement Parts 1 to 8:

- Scale A1, A2: M1, M2, and Arterial roads
- Scale B: S and Collector Roads
- Scale C: Local Streets, C and R

(ii) Determination of the Density Ratio

If it is not possible to transport extracted samples of mixed material to an established laboratory for determination of the reference density within the maximum working time of the cementitious binder, and the Engineer agrees that establishment of a site laboratory for this purpose is not warranted, the following procedure shall be used to determine the Density Ratio:

1. measure field density on completion of compaction;
2. extract samples and transport to an offsite laboratory;
3. determine the reference density for the laboratory compacted samples as soon as practicable but not exceeding 24 hours;
4. determine the Density Ratio (DR) from -

$$DR = DR_t \times DDCF$$

Where:

DR_t = Density Ratio calculated using the reference density determined at time (t)

$DDCF$ = Density Decay Correction Factor determined from Table 304.131 corresponding to time (t), the binder type and the time of year construction is being undertaken.

Table 304.131 Density Decay Correction Factors

Time (t) from Addition of	
----------------------------------	--

Binder to Completion of Laboratory Compaction (hours)	Slow Setting	Medium Setting	Rapid Setting
1 to 2	1	1	1
2 to 4	1	1	0.994
4 to 6	1	0.994	0.990
6 to 8	1	0.991	0.985
8 to 12	0.998	0.988	0.978
12 to 18	0.993	0.981	0.965
18 to 24	0.987	0.973	0.951

For individual jobs more than 10000 m² where the material to be stabilised is of a similar nature throughout, the Engineer may request the Contractor to determine and apply a job specific DDCF determined in accordance with VicRoads Test Method RC 330.03 as specified in VicRoads Code of Practice RC 500.16.

(b) Scale A1 and A2 Requirements for Testing and Acceptance of Compaction

- (i) Scale A1 assessment shall be used where the in situ material is sufficiently consistent to be assigned a Maximum Dry Density for the lot.

If a single maximum dry density can be assigned to the lot the work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio obtained from six randomly selected test sites within the lot is not less than 95.0%.

- (ii) Scale A2 assessment shall be used where in situ material is too variable to assign a Maximum Dry Density to the lot.

If the material is too variable to assign a single maximum dry density to the lot and requires separate maximum dry densities to be determined for each test site, the work represented by the lot will be accepted, as far as compaction is concerned, if the mean value of the density ratio obtained from three randomly selected test sites within the lot is not less than 97% with no individual value being less than 93%.

(c) Scale B Requirements for Testing and Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the

mean of the individual density ratio test values from three randomly selected test sites for the lot is not less than 95.0%.

(d) Scale C Requirements for Acceptance of Compaction

The Engineer may direct the Contractor to construct a trial section of stabilised pavement as specified in Clause 304.12.

Acceptance of work will be based upon on compaction plant to be used, compaction routine and a density monitoring procedure using a nuclear gauge and proof rolling as specified or agreed between the Engineer and the Contractor.

Any unstable areas within limits of work and depth of stabilisation detected by test rolling shall be rectified by the Contractor and re-presented for test rolling.

304.14 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF SPREADING RATES

(a) Mat or Tray System

The average spreading rate of lime or cementitious binder shall be ascertained by dividing the mass of cementitious binder spreading by the area over which the cementitious binder has been spread. Where the average spreading rate is less than the specified or design spread rate, additional cementitious binder shall be spread to bring the average rate up to at least the design spread rate.

The Contractor shall check the uniformity of spreading rate of lime or cementitious binder at the frequency specified in Clause 304.15 by placing a minimum of three mats or trays with a plan area not less than 1 m² in the path of the spreading vehicle at an equal spacing of not less than 25% of the length of the spreading run. The spreading rate over each mat or tray shall be calculated by dividing the mass of lime or cementitious binder deposited on each mat or tray by the plan area of the mat or tray. Where the spread rate so determined for any mat or tray is less than the specified rate by more than 10%, additional cementitious binder shall be spread over the part or all of the area over which the lime or cementitious binder has been spread.

(b) Continuous Weighing System

The mass of lime or cementitious binder spread over the pavement surface may be measured and recorded by a spreader fitted with a fully calibrated electronic weigh scale system capable of continuously measuring and recording the mass of lime or cementitious binder at intervals of not more than 100 m of forward travel. The Contractor shall have a current certificate of calibration for the computerised spreading equipment and shall

produce evidence of the actual running spread rate when requested by the Engineer.

304.15 MINIMUM TESTING FREQUENCY

The Contractor shall test the materials and the stabilised pavement layer at a frequency which is sufficient to ensure that the materials and work under the Contract comply with the specified requirements but not less than the frequency specified in Table 304.151.

Table 304.151 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Available Lime / Available Lime Index	One test per production day at the point of manufacture.
Uniformity of Spreading Rate of Lime or Cementitious Binder	A mat or tray test (minimum of 3 mats or trays as specified in Clause 304.14(a)) for each separate continuous spreading run except where calibrated load cell computerised spreading devices are fitted with a system to continuously monitor the spread rate every 100 m.
Average Spread Rate of Lime or Cementitious Binder	Each continuous spreader run. Based on the total tonnage used for the run (kg) divided by the area covered (m ²).
Uniformity of Mixing	For each compaction lot – Visual inspection of six random test holes excavated for the full depth of the loose material after mixing of the binder and prior to commencement of compaction.
Characteristic or Mean Density Ratio	Every lot as defined in Clause 304.13(a)

304.16 SCHEDULE OF DETAILS – NOT USED

SECTION 305 – IN SITU STABILISATION OF PAVEMENTS WITH FOAMED BITUMEN BINDER**305.01 DESCRIPTION**

This section covers the requirements for in situ stabilisation of existing pavements by the addition of foamed bitumen and other supplementary binders. The requirements relate to mix design, preparation of existing pavement materials, supply of bitumen and supplementary binders, construction plant, and spreading, mixing, and compaction of pavement layers.

305.02 DEFINITIONS*(a) Available Lime*

The amount of Calcium Oxide (CaO) or Calcium Hydroxide (Ca(OH)₂) contained in Quicklime or Hydrated Lime respectively.

(b) Available Lime Index (ALI)

The Calcium Oxide or Calcium Hydroxide content of quicklime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS 4489.6.1.

(c) Expansion Ratio

The expansion ratio is the ratio of the maximum volume of the bitumen in its foamed state to the final volume of bitumen once the foaming has subsided.

(d) Foamed Bitumen

Foamed bitumen is a mixture of air, water and hot bitumen. When hot bitumen comes in contact with cold water the mixture expands to greater than ten times its original bitumen volume forming a fine mist or foam.

(e) Half-life

Half-life is the time taken (measured in seconds) for the maximum volume of foamed bitumen to dissipate to half of the maximum expansion volume.

(f) Hydrated Lime

Hydrated lime is a powdered form of lime consisting primarily of calcium hydroxide, also referred to as slaked lime.

(g) Quicklime

Quicklime is a fine granulated powder consisting primarily of Calcium Oxide that can be

readily slaked by the application of water after it has been evenly spread to form Calcium Hydroxide.

(h) *Initial Working Time*

The time required to mix, fully compact and trim the stabilised pavement layer after the addition of foamed bituminous binder.

(i) *Reference Density*

The reference density is the maximum dry density or the peak converted wet density determined in accordance with the appropriate test method, but adjusted for oversize material as appropriate.

(j) *Supplementary Binder*

Foamed bitumen stabilisation may incorporate a supplementary binder comprising either hydrated lime or quicklime.

(k) *Target Depth*

The target depth is the cutting depth required by the reclaimer/stabiliser to achieve the lower reference level (LRL). To achieve the LRL, the cutting depth (target depth) should take into account the bulk height. Refer to Figure 1 *Diagrammatic Representation of Foam Bitumen Stabilisation's Key Terms*. In establishing the target depth the following should be noted.

- Pulverisation/secondary additive incorporation

Preliminary pulverisation and incorporation of supplementary binder is mixing to 50 mm less than the design depth.

- Bulking after secondary additive incorporation

After surface compaction and trimming, the volume of materials change due to incorporation of the supplementary binder. The bulking height above the finished surface level (FSL) needs to be identified and added to the design depth.

- Target depth/final foam bitumen stabilisation pass

The cutting depth required on the final pass by the reclaimer/stabiliser to reach the LRL will need to account for the additional bulking above the FSL.

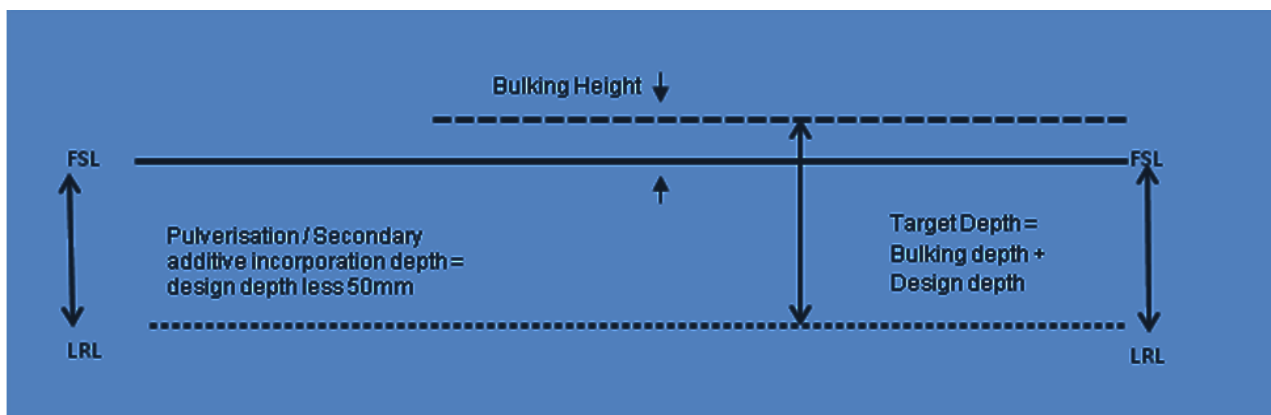


Figure 1 Diagrammatic Representation of Foam Bitumen Stabilisation's key terms

305.03 CONFORMITY WITH DRAWINGS

Completed stabilised base and subbase layers shall conform within the following limits to the levels, lines, grades, thicknesses and cross sections shown on the drawings, as specified, or as directed by the Engineer.

(a) Finished Surface Level

The level of the top of the stabilised layer shall not differ from the specified level and shall be in accordance with Table 305.031. The surface level of any pavement course shall be checked longitudinally and transversely for conformity with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- (i) at the edges of the pavement
- (ii) at all changes of gradient across the pavement
- (iii) at intervals not exceeding 2m across the pavement.

Table 305.031 Finished Surface Levels Tolerances for Stabilised Layers

Road Category*	Base	Subbase
Scale A M1, M2, Arterial Roads	-5 to +10 mm	-5 to +15 mm
Scale B S, Collector Roads	-5 to +15 mm	
Scale C Local Streets, C, R		

Note to Table 305.031

* Road classification defined in Fiji Roads Authority Austroads Design Guide Supplement Parts 1 to 8:

(b) *Thickness*

The thickness of the stabilised layer at any point shall be not less than the thickness specified by more than 15 mm. The average thickness of the layer over any 100 m section for the full carriageway width shall be not less than the specified thickness

(c) *Alignment*

The edges of the stabilised layer shall be not more than 50 mm inside, and not more than 50 mm outside, the specified offset from centreline or design line.

(d) *Width*

The width of the stabilised layer shall be not less than the specified width by more than 50 mm and not greater than the specified width by more than 100 mm. The average width of the layer determined from measurements at six sites selected randomly over any 300 m shall be not less than the specified width.

(e) *Shape*

No point on the surface of the stabilised layer shall lie more than the shape tolerances shown in Table 305.032 below a 3 m straight edge placed in any direction on the surface.

Table 305.032 Shape Tolerances for Stabilised Layers

Road Category*	Base	Subbase
Scale A M1, M2, Arterial Roads	5 mm	8 mm
Scale B S, Collector Roads	8 mm	15 mm
Scale C Local Streets, C, R.	15 mm	15 mm

Note to Table 305.032

* Road classification as defined in Fiji Roads Authority Austroads Design Guide Supplement Parts 1 to 8:

305.04 MATERIALS

Materials supplied under the Contract shall comply with the following properties.

(a) *Bitumen*

Bitumen shall comply with the requirements of AS 2008 Bitumen for pavements.

The Contractor is permitted to incorporate bitumen foaming additives to the bitumen provided a test certificate is produced confirming that the half-life and expansion ratio as specified in Clause 305.14(c) are met at the bitumen foaming temperature. The test certificate shall include:

- (i) the form of the foaming additive i.e. solid, liquid or paste
- (ii) chemical and physical properties of the additive
- (iii) method of handling and mixing
- (iv) dosage rate for bitumen used
- (v) mixing time and effective life in the bitumen
- (vi) shelf life
- (vii) half-life in seconds and expansion ratio of bitumen with additive and the specified bitumen temperature
- (viii) Materials Safety Data Sheet.

(b) *Lime*

Quicklime and hydrated lime shall meet the requirements of AS 1672.

At the time of spreading, the supplementary binder shall not be more than 3 months old, measured from its date of manufacture.

All quicklime and hydrated lime supplied to the job shall be provided with delivery docket showing an assigned ALI at the start of each production week. The assigned ALI shall be determined by averaging the six most recent test results for ALI. A test certificate for determination of the ALI shall be made available on request.

Lime shall be stored in a moisture free environment and shall be re-tested for compliance with AS 1672.1 *Limes and limestones - Limes for building* if stored for more than 14 days after receipt from the manufacturer.

(c) *Cement*

Blended cement Type GB or for special purposes, General Purpose Portland Cement Type GP complying with AS 3972 shall be supplied by the Contractor.

(d) *Water*

Water added to the material shall be clear and substantially free from sediments and detrimental impurities such as oils, salts, acids, alkalis and vegetable substances.

(e) *Pavement*

The in situ pavement material to be stabilised shall be the existing surfacing and pavement material and any additional material placed over the existing pavement for mixing with the pavement below, unless otherwise specified.

305.05 PAVEMENT MATERIALS INVESTIGATION AND MIX DESIGN

(a) *General*

Unless specified in Clause 305.16(c) and (d), the Contractor shall produce a mix design for the in situ stabilised pavement material in accordance with Austroads Guide to Pavement Technology Part 4D: Stabilised Materials. The in situ stabilised pavement material is required to meet the specified grading, plasticity and strength requirements, and contain a bituminous binder which will allow sufficient working time to mix, place, compact and trim the material before the initial set takes place. The mix design procedure shall ensure that the bituminous stabilised material is a flexible cohesive pavement material capable of withstanding ravelling under traffic prior to sealing.

The design is to provide a modified material with the following properties:

- (i) Initial modulus > 700 MPa;
- (ii) Three day cured modulus >2500 to 4000 MPa;
- (iii) Three day soaked modulus >1500 to 2000 MPa; and
- (iv) Retained modulus > 0.5 (ratio wet modulus to dry modulus), a foam bitumen stabilised pavement that does not lose greater than 50% of strength when inundated.

(b) *Grading*

The final grading limits for the material to be stabilised after addition of any granular additive, if required to correct the grading shall be in accordance with Table 305.051.

Table 305.051 Grading and Plasticity Index Requirements

Sieve Size (mm)	Base (% passing by mass) with ≤ 1000 ESA/day	Base (% passing by mass) with > 1000 ESA/day
53.0	100	
26.5	73 - 100	100
19.0	64 - 100	80 - 100
9.5	44 - 75	55 - 90
4.75	29 - 55	40 - 70
2.36	23 - 45	30 - 55
1.18	18 - 38	22 - 45
0.600	14 - 31	16 - 35
0.425	12 - 29	12 - 30
0.300	10 - 27	10 - 24
0.150	8 - 24	8 - 19
0.075	5 - 20	5 - 15
Plasticity Index (max)	10	10

Notes to Table 305.051

Materials with a Plasticity Index (PI) between 10 and 20 may be used if they are pre-treated with lime or appropriate alternative to reduce the PI to a maximum of 10.

305.06 COMMENCEMENT OF WORK

The Contractor shall not commence work until all mix design details have been presented to the Engineer showing compliance with the requirements of Clause 305.05 and approval has been given for stabilisation work to proceed.

305.07 CONSTRUCTION PLANT*(a) General*

The Contractor shall provide and operate sufficient spreading, mixing, watering and compaction plant to complete the work in accordance with the requirements of this section.

(b) *Spreader for Supplementary Binder*

Mechanical equipment specifically designed for the spreading of supplementary binder directly on to the prepared roadbed shall be used. The spreader shall be fitted with calibrated load cells and be capable of accurately regulating the discharge of the supplementary binder at various widths such that the requirements of Clause 305.14 are met. When hydrated lime is used as a supplementary binder it is preferable to use a reclaimer with an integrated spreader to minimise binder loss due to wind.

(c) *Stabilisation Machine*

The pulverisation and mixing of pavement material together with water and bituminous binder shall be carried out using a purpose designed machine for bituminous stabilisation of road pavements.

The stabilisation machine shall satisfy the following requirements:

- (i) a minimum engine power capacity of 315 kW to ensure adequate mixing of materials
- (ii) a computer controlled bitumen flow meter to determine binder application rate for process control
- (iii) a bitumen injection system linked to the ground speed to ensure an accurate application throughout runs, irrespective of the speed of the equipment
- (iv) each jet on the bitumen injection bar shall have separate on and off controls to maintain uniform transverse control in the overlapping runs
- (v) bitumen temperature gauges to verify bitumen temperature in the injection system
- (vi) bitumen injection bar and supply lines shall be equipped with a heating system to maintain the bitumen temperature
- (vii) self-cleaning bitumen jets
- (viii) an inspection or test jet fitted to allow for sampling
- (ix) water spray bars located in the mixing hood to control moisture.

Rotary hoes and other types of agricultural machinery, including skid steer machines with attachments shall not be used. The stabilising machine shall be capable of pulverising the existing pavement and mixing the bituminous and/or supplementary binder uniformly throughout the layer within its enclosed mixing chamber. After pulverisation and mixing, all material shall be capable of passing a 53mm sieve.

When mixing tools are damaged they shall be replaced to maintain mixing efficiency.

(d) Watering Plant

Watering plant shall be capable of uniformly distributing water in a fine spray and coupling to the stabilising machine to ensure correct addition of water.

(e) Compaction Plant

Compaction plant shall be of such mass to be capable of compacting the stabilised layer to the minimum specified density ratio uniformly throughout the depth of the layer.

Where compaction is to be accepted on a procedural basis rather than lot testing, the Engineer shall approve the number and minimum mass of rollers and the compaction routine to be used.

Otherwise, the following items of compaction plant shall be used:

- a vibrating pad foot roller for initial compaction, minimum of 18 tonnes for compacted thicknesses up to 200 mm, or minimum of 21 tonnes for compacted thicknesses up to 300 mm
- a vibrating steel flat roller for densification, minimum of 18 tonnes for compacted thicknesses up to 200 mm, or minimum of 21 tonnes for compacted thicknesses up to 300 mm
- a multi wheel roller, minimum of 12 tonnes, for finishing and sealing the surface prior to trafficking.

305.08 CONSTRUCTION

(a) General

Construction includes the pulverisation of any seal or asphalt surfacing, premixing of in situ materials, supply and spreading of any additional granular material, supply, spreading and mixing of bituminous and/or supplementary binder into the in situ pavement material, and compaction, trimming and curing of the stabilised layer.

Stabilisation work undertaken each day shall be completed across the full pavement width.

(b) Climatic Conditions

Stabilisation shall not be undertaken:

- (i) when the wind is sufficiently strong to cause particles of the supplementary binder to become air-borne

- (ii) during conditions that in the opinion of the Engineer are a hazard and may cause nuisance to people, livestock, property or the environment
- (iii) during rain or when rain appears imminent
- (iv) when the pavement temperature prior to the commencement of work and measured at a depth of 50 mm below the surface of the road is below 10°C
- (v) when the air temperature, measured in the shade, exceeds 40°C.

Details of procedures for measuring pavement temperature and ceasing operations in the event of rain or strong wind shall be submitted to the Engineer for review.

(c) Preparation of the Existing Pavement, Primary Pulverisation

One (1) pass of a reclaimer/stabiliser or profiler shall be used to pulverise the material to be stabilised to a depth that is 50 mm less than the target depth of the stabilised layer.

Preliminary pulverisation shall occur:

- (i) after the removal and replacement of material identified as material not suitable for stabilisation;
- (ii) prior to the addition of shape correction material, and
- (iii) prior to the application or addition of either bituminous or supplementary binders.

The Contractor shall remove or pulverise lumps of asphalt or seal which would otherwise be retained on a 53 mm sieve. The volume of any large size material removed from the site shall be replaced with an equivalent volume of suitable granular material.

If the existing pavement material is not suitable for stabilisation, granular material that complies with the requirements of Standard Section 301 shall be used to replace this material prior to stabilisation.

The Contractor shall be responsible for the procurement of sufficient specified material to complete the work. The Contractor shall supply details demonstrating compliance of the materials meeting Crushed Rock Base and Crushed Rock Subbase (maximum nominal size of 40 mm).

(d) Spreading of Supplementary Binder

Spreading of the supplementary binder shall be carried out in accordance with the mix design rate or as specified in Clause 305.16(b).

If quicklime is used it shall be slaked with sufficient water to allow complete hydration such that the material remains friable after slaking. Water shall be applied by spraying over the

quicklime spread over the road surface.

(e) *Foaming of Bitumen*

At the start of each stabilisation operation the Contractor shall confirm that all bitumen foaming nozzles are operating by conducting a foaming test adjacent to the site. The foamed bitumen from the test shall not be incorporated in the pavement material and the Contractor is responsible for the management of this waste. At the start of each tanker load of bitumen, the half-life and expansion ratio of the foamed bitumen shall be determined and reported.

(f) *Initial Mixing*

Initial mixing shall commence as soon as practical after spreading of the supplementary binder. The supplementary binder shall be incorporated into the pavement materials to 50 mm less than the specified pavement depth. Water may be added during the mixing process to meet the target moisture content envelope which is required for compaction following the mixing of the foamed bitumen.

Incorporation of the supplementary binder shall be achieved using a reclaimer/stabiliser before the foamed bitumen is added to the pavement material.

Where indicated by visual inspection that the resultant mix is not uniform and/or the moisture distribution throughout the layer is variable, the Contractor shall carry out additional passes with the mixing equipment to improve the uniformity of the:

- (i) material
- (ii) distribution of the supplementary binder
- (iii) distribution of the added moisture.

The mixed material is to be lightly compacted prior to the addition of the foamed bitumen.

(g) *Foamed Bitumen Mixing*

The incorporation of the bitumen is to be carried out to the specified thickness in one or more mixing passes. Foamed bitumen stabilisation should not proceed if the bitumen temperature does not comply with the specified bitumen temperature included in the test certificate required in Clause 305.04(a).

Where indicated by visual inspection that the foamed bitumen is not uniformly mixed and/or the moisture distribution throughout the layer is variable, the Contractor shall carry out additional passes with the mixing equipment to improve the uniformity of the:

- (i) material being stabilised; and/or

- (ii) distribution of the bitumen; and/or
- (iii) distribution of moisture.

Mixing shall cease if bitumen streaks, blotches or bitumen rich masses form in the mixed material.

The relative moisture ratio (RMR) prior to incorporation of the foamed bitumen shall be not less than 55% or greater than 75% of optimum moisture content (OMC) of the material.

(h) Compaction

Compaction of the stabilised layer shall commence immediately after mixing of foam bitumen. Compaction equipment shall work as close as practicable behind the mixer to maximise the time available for compaction. Compaction and trimming shall be carried out in a continuous operation until completed.

(i) Trimming

The material trimmed off shall be cut to waste and, if necessary, removed from site.

On completion of trimming and final rolling compaction equipment marks shall be removed if a sprayed sealed surfacing is to be applied to the foamed bitumen stabilised layer.

305.09 JOINTING

Longitudinal joints shall be avoided by completing a full carriageway width each day. If a longitudinal joint is required, because of rain or traffic control requirements, it shall be located at a lane line or in the centre of the carriageway. Transverse joints shall be formed where stabilisation operations have been halted and at the end of each day's work.

Joints shall be formed by cutting back into the fully compacted previously stabilised material by a minimum of 100 mm.

The level and shape of the surface at all joints shall be within the limits specified in Clause 305.03 except when a sprayed sealed surfacing is to be applied to the stabilised layer where a 5 mm maximum tolerance shall be adopted.

305.10 TEST ROLLING

Stabilised layers shall pass test rolling, prior to acceptance of the layer. Pavement layers shall be compacted so as to be capable of withstanding test rolling without visible deformation or springing. Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- Steel smooth wheeled rollers shall have a mass not less than 12 tonne mass with a load intensity under either the front or rear wheels of not less than 6 tonne per metre width of wheel;
- Pneumatic tyred plant shall have a mass not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

Test rolling shall be carried out by the Contractor in the presence of the Engineer prior to the placing of the next layer of pavement material.

Each layer should be test rolled immediately following completion of compaction

The Engineer reserves the right to direct the Contractor to undertake further test rolling on any layer prior to it being covered by a successive layer. No additional payment will be made for any requests to carry out such further test rolling.

The Contractor shall submit a test rolling procedure to the Engineer including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours' notice of the location and commencement time for the test rolling to the Engineer.

305.11 MAINTENANCE OF THE STABILISED SURFACE PRIOR TO SURFACING OR OVERLAY

Water curing shall commence immediately after the completion of compaction.

The Contractor shall keep the stabilised pavement surface moist and protected from damage by traffic or construction activities until either a further pavement layer or the bituminous surfacing is applied. Where the pavement is opened to traffic within 3 hours of compaction being completed the initial modulus measured after 3 hours of air drying at 25°C ($\pm 5^\circ\text{C}$) shall be a minimum of 700 MPa.

The Contractor shall maintain drainage of all stabilised areas throughout the period of construction to ensure run-off of rainfall without ponding.

305.12 PRELIMINARY TRIAL

If directed by the Engineer, the Contractor shall carry out a preliminary trial of the proposed stabilising operation.

The trial shall determine:

- (i) effectiveness of the construction plant

- (ii) effectiveness of spreading lime and slaking of quicklime, and mixing to the required depth
- (iii) number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing or the combined work of a profiler and stabilisation machine to achieve the specified requirements
- (iv) field moisture content required to achieve specified compaction requirements
- (vi) visual observation of the full depth of the mixed material to ensure no bitumen streaks and uniform incorporation of the foamed bitumen and supplementary binder
- (vii) jointing of the mixing runs
- (viii) the rolling routine required to meet specified compaction requirements
- (ix) preliminary and final trimming of the surface to the specified levels and tolerances.

The trial section shall be located within the works area.

The length of the trial section shall be between 100 and 200 metres over the full width proposed to be stabilised.

Stabilisation work shall not proceed outside the trial section until the Engineer has reviewed all aspects of the stabilising operation. The Engineer's review of the stabilising plant and procedures will be provided to the Contractor by the end of the work on the trial day. If the specification requirements are not met for this trial section, the Engineer may direct that another trial section be stabilised or the rejected section be re-stabilised and presented for re-assessment.

The payment for all costs associated with the direction of the Engineer to carry out a preliminary trial or re-trial shall be made under the relevant scheduled item for the construction of the foam bitumen stabilised layer.

305.13 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION AND STRENGTH

(a) General

(i) Lot Testing Requirements

Where a Scale A or Scale B compaction standard is specified, compaction is to be accepted by density testing in lots of similar material and work. The maximum lot size shall be the area of work completed on the same day up to 4,000 m² provided that the whole of the lot is essentially a uniform material similar to material used for the relevant mix design applicable to the lot.

If the material is too variable to be able to assign a single maximum dry density for the lot, a separate reference density shall be determined for each test site.

The calculation of density ratio shall be based on Modified compactive effort of the laboratory prepared sample containing the design rate of bituminous and supplementary binder.

The work shall be assessed for compliance with Scale A, Scale B or Scale C requirements for testing and acceptance of compaction as specified in Clauses 305.13(b), (c) and (d).

Unless otherwise specified in Clause 305.16(d), the following Scales shall apply, based on road classifications as defined in the Fiji Roads Authority Austroads Design Guide Supplement Parts 1 to 8:

- Scale A: M1, M2, and Arterial roads
- Scale B: S and Collector Roads
- Scale C: Local Streets, C and R

(ii) Determination of the Density Ratio

Field density shall be measured at the completion of compaction of the foamed bitumen stabilised pavement. Material shall be sampled from the site to enable three samples to be prepared in the laboratory, for determination of the reference density, before three hours have elapsed after foam bitumen stabilisation. The Density Ratio shall be determined in accordance with 165.09.

(b) Scale A Requirements for Testing and Acceptance of Compaction

If a single maximum dry density can be assigned to the lot the work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio obtained from six randomly selected test sites within the lot is not less than 98%.

If the material is too variable to be able to assign a single maximum dry density for the lot, a separate reference density shall be determined for each test site. The work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio obtained from six randomly selected test sites within the lot is not less than 98%.

(c) Scale B Requirements for Testing and Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the mean of the individual density ratio test values from three randomly selected test sites for the lot is not less than 100%.

(d) Scale C Requirements for Acceptance of Compaction

The Engineer may direct the Contractor to construct a trial section of stabilised pavement as specified in Clause 305.12.

Acceptance of work will be based on compaction plant to be used, compaction routine and a density monitoring procedure using a nuclear gauge and proof rolling as specified or approved by the Engineer.

Any unstable areas within limits of work and depth of stabilisation detected by test rolling shall be rectified by the Contractor and re-presented for test rolling.

305.14 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF BINDER CONTENT

(a) Mat or Tray System for Supplementary Binder

The average spreading rate of the supplementary binder shall be ascertained by dividing the mass of binder spreading by the area over which the binder has been spread. Where the average spreading rate is less than 95% of the specified or design spread rate, additional binder shall be spread to bring the average rate up to at least the design spread rate. Lots where the binder is spread at an average rate less than 95% design spread rate will be rejected.

The Contractor shall check the uniformity of the spreading of the supplementary binder at the frequency specified in Clause 305.15 by placing mats or trays with a plan area not less than 1 m² in the path of the spreading vehicle and dividing the mass of the supplementary binder deposited on each mat by the plan area of the mat or tray. Where the spread rate so determined for any mat or tray is less than the specified rate by more than 10%, additional supplementary binder shall be spread over the part or all of the area over which the binder has been spread.

(b) Continuous Weighing System

The mass of the supplementary binder spread over the pavement surface may be measured and recorded by a spreader fitted with a fully calibrated electronic weigh scale system capable of continuously measuring and recording the mass of the supplementary binder at intervals of not more than 100 m of forward travel. The recorded measurements of spread rate shall be made available to the Engineer on request.

(c) Bituminous Binder Application

The binder shall be uniformly incorporated by a controlled device that provides calibration to the application rate in litres/m² of residual bitumen. The rate of application shall be such as to provide the specified binder content in the compacted material. In addition, for

foamed bitumen the minimum expansion ratio shall be 10 and the minimum half-life shall be 20 seconds.

Mixing uniformity shall be continuously inspected by the Contractor and work shall stop when bitumen streaks or blotches are observed.

305.15 MINIMUM TESTING FREQUENCY

The Contractor shall test the materials and the stabilised pavement layer at a frequency which is sufficient to ensure that the materials and work under the Contract comply with the specified requirements but which is not less than that shown in Table 305.151.

Table 305.151 Frequency of Testing

Test	Minimum Frequency of Testing
Bitumen Application Rate	One test per continuous spraying run ascertaining the quantity of bituminous binder sprayed per m ² by either: (i) dipping the bituminous binder supply tanker at the start and end of each spraying run; or (ii) a calibrated computerised measuring device which continuously monitors the bitumen spray rate per continuous spray run, recorded on a daily report sheet. The Contractor shall have a current certificate of calibration for the computerised bituminous spray monitoring device and shall produce evidence of actual running spray rate when requested by the Engineer.
Bitumen Foaming Characteristics	Test the half-life and expansion ratio of the bitumen from the test inspection nozzle on the stabilisation machine before the bitumen is used in the mixer and with the tanker connected to the stabilisation machine for every tanker load supplied.

Uniformity of Spreading of Supplementary Binder	<p>After the spread rate is confirmed using three trays or mats not less than 1 m² as per Clause 305.14, three randomly selected supplementary binder spreader runs are to be tested per lot as per Clause 305.14 unless the forward speed of travel of spreader or the rate of spread of the spreading unit is changed, then the above process shall be repeated for the new forward speed of travel or new rate of spread.</p> <p>Except where calibrated load cell computerised spreading devices are fitted with a system to continuously monitor the spread rate every 100 m, recorded on a daily report sheet. The Contractor shall have a current certificate of calibration for the computerised spreading equipment and shall produce evidence of the actual running spread rate when requested by the Engineer.</p>
Average Spread Rate of Supplementary Binder	Each day's production.
Pavement Temperature	At the commencement of the shift the pavement temperature shall be measured at a minimum of ten random places at a depth of 50 mm.
Characteristic or Mean Density Ratio	Every lot as defined in Clause 305.13(a).
Relative moisture ratio (RMR)	The ratio of the in situ moisture content at each compaction sample location prior to the incorporation of the foamed bitumen and material OMC as a percentage.
Resilient Modulus	Each day's production. The Contractor shall produce evidence that the laboratory design modulus has been achieved in the field.

305.16 SCHEDULE OF DETAILS – NOT USED

SECTION 401 – AGGREGATES FOR SPRAYED BITUMINOUS SURFACING

401.01 DESCRIPTION

This section covers the requirements for aggregates produced by crushing and screening, for use in sprayed bituminous surfacing. The requirements relate to the quality and properties of the rock and the supply and delivery for the aggregates. Should the quality of the aggregates supplied fall below that specified, the Engineer may either reject the aggregate or accept them at a price determined in accordance with the General Conditions of Contract.

For the purposes of this section the terms aggregate and chip are equivalent.

401.02 DEFINITIONS

(a) *Aggregates*

An aggregate consists of substantially one-sized mineral particle produced by crushing and screening. It is used as cover material applied to a layer of bituminous binder.

(b) *Unsound Rock*

Unsound rock is the material, whether in the source or as spalls or as crushed or natural particles, which is soft, friable, or composed of clay, or weathered rock, or which contains matter which breaks up when alternately wetted and dried, or fails to meet the requirement of clause 401.03

(c) *Los Angeles Value*

The Los Angeles Value (LAV) is a hardness rating derived from Los Angeles Value test results.

(d) *Polished Stone Value*

The Polished Stone Value as determined in accordance with. NZTA M6: 2011 Section 3.5.

(e) *Average Least Dimension*

The Average Least Dimension (ALD) is the average height of the aggregate particles when they are spread as a single layer with their least dimension vertical.

(f) *Crushed Aggregate*

An aggregate produced by crushing and screening of rock spalls or other material approved by the Engineer which has fully (or 100%) crushed faces.

(g) *Partly Crushed Aggregate*

An aggregate produced by washing, crushing and screening of a suitable material (e.g. coarse gravel), which may not have fully crushed faces.

401.03 SOURCE ROCK

Source rock for crushed aggregates shall be in accordance with Clause 301.03 (b) excluding the requirements of Clause 301.03(b)(iv). The Source rock for crushed aggregates shall have LA values in accordance with Table 401.041.

Source rock which does not comply with the specified durability and hardness requirements but from which aggregates of proven satisfactory performance have been produced may be accepted for use subject to the written approval of the Engineer.

401.04 AGGREGATES

(a) *General Requirements*

- Crushed aggregates shall consist of clean, hard, durable, angular fragments of igneous, or metamorphic rock produced by crushing rock from a source acceptable to the Engineer, and shall be free from clay organic matter and elongated particles.
- Aggregates shall meet the following requirements:
 - (i) LA Values listed in Table 401.041

Table 401.041 LAV For Aggregates

Rock Type	Los Angeles Abrasion Loss (max.)	
	Surfacing Aggregates	
	Class A	Class B
	M1, M2, Arterial Roads	S, Collector Roads Local Streets, C, R
Granodiorite	30	35
Diorite		
Gabbro		
Tonalite		
Monzonite		

Other Acid Igneous		
Basalt	25	30
Andesite		

(ii) A Polished Stone Value of the source rock as measured by a Polished Stone Value test on the product shall have a minimum PSV for the minimum PSV requirement based on specific location e.g. road, intersection, chainage etc. if required refer to the Contract Specific Condition

- The contractor shall nominate the Quarry from where materials are to be supplied and nominate the location within the quarry or river bed from where the source rock will be obtained. The Engineer may request the contractor to undertake additional testing of the source as is appropriate to confirm specification requirements will be met.
- Source rock which does not comply with specified requirements but from which aggregates of proven satisfactory performance have been produced may be accepted for use subject to the written approval of the Engineer. The contractor will be required to provide supporting information including relevant test data and documentary evidence of aggregate usage.

(b) Unsound and Marginal Rock

Unsound and marginal rock in that fraction of a sample retained on a 4.75 mm AS sieve shall not exceed the values specified in Table 401.042.

Table 401.042 Marginal and Unsound Rock Content Limits

Class of Aggregate	Total of Marginal and Unsound Rock (max % by mass)	Unsound Rock (max % by mass)
	Individual Test	Individual Test
A	10	3
B	18	5
C	24	10

(c) Flakiness Index

Flakiness Index tests shall be undertaken on aggregate sizes of 10 mm or above.

- (i) For all source rock with an assigned Los Angeles Value of 25 or less, the Flakiness Index of aggregate shall not exceed the values specified in Table 401.043.

Table 401.043 Flakiness Index Requirements (LAV ≤25)

Class of Aggregate	Flakiness Index (max % by mass)
	Individual Test
A	25
B	30

- (ii) For all source rock with an assigned Los Angeles Value of more than 25, the Flakiness Index of aggregate shall not exceed the values in Table 401.044.

Table 401.044 Flakiness Index Requirements (LAV >25)

Class of Aggregate	Flakiness Index (max % by mass)
	Individual Test
B	25

(d) Grading

The grading by mass of one sized aggregate shall conform to the relevant requirements of Tables 401.045.

Table 401.045 Grading Envelopes and Minimum ALD Requirements for Class A and B Aggregate

Sieve Size (mm)	Percentage Passing AS Sieve (by mass)				
	Nominal Size of Aggregate				
	20 mm	14 mm	10 mm	7 mm	5 mm
26.5	100				
19.0	85-100	100			

13.2	0-35	85-100	100		
9.50	0-5	0-30	85-100	100	
6.70	0-2	0-5	0-40	85-100	100
4.75			0-5	0-35	85-100
2.36				0-5	0-35
0.075	0-1.0	0-1.0	0-1.0	0-1.0	0-1.0
Minimum ALD	10.0	7.0	5.0	3.5	

(e) Average Least Dimension

For 7 mm aggregate and larger, testing of ALD values is required for each lot of aggregate supplied under the Contract in accordance with the relevant ALD test methods contained. Refer VicRoads Codes of Practice 500.09 and 500.16.

401.04 PRECOATING OF AGGREGATE

Aggregate shall be precoated with suitable precoating material and each particle shall be uniformly coated to the satisfaction of the Engineer.

Precoating material shall be in accordance with Clause 402.07

401.05 TESTING

Unless otherwise specified, testing of aggregate shall be based on lot testing. A lot shall consist of not more than 30 m³ of aggregate of the same class and size, and which is uniform in appearance and has been produced under the same conditions. Each lot shall be assigned a unique identification number. Three samples shall be taken essentially at random from each lot prior to delivery to stack sites. The samples shall be taken not more than 30 days prior to delivery of material in the lot and tested for compliance with the specified requirements in accordance with both the individual test results and the mean of the individual test results for each lot. Any aggregate which appears not to comply with the specification shall be excluded from the lot before sampling commences and where necessary shall be tested separately.

A representative sample shall be taken at random from each lot and tested for compliance with the specified requirements.

The Contractor shall not proceed or continue with the sealing until tests on the samples have been performed and the Engineer has given permission to proceed.

401.06 DELIVERY

Aggregate shall not be delivered directly from stockpiled lots at the quarry to the stacksites unless the aggregate has been tested and meets the acceptance of all test requirements to the satisfaction of the Engineer.

Where delivery of aggregate is made to stacksites at or near the site of the sealing works, delivery shall be made to separate identifiable stacks for each lot of aggregate tested. Once delivery is commenced the Contractor shall continue to promptly complete the delivery of the entire lot.

401.07 AGGREGATE STACKS

Aggregate shall not be delivered directly from stockpiled lots at the quarry to the stack sites unless the aggregate has been tested and meets the acceptance of all test requirements to the satisfaction of the Engineer.

Aggregates stacks shall be so placed at locations such as intersections and curves so that they do not unduly reduce sight distance. Stacks shall not be placed under or immediately adjacent to electric power lines or, where the overhead clearance is less than 6m, under trees or structures. Stacks shall be placed clear of the road formation, drain, gateways and side tracks and the toes of the stacks shall not be less than 1 m from any obstructions which could impede the operation of mechanical loading equipment. Aggregates shall be stacked on prepared surface that is free from vegetation and large stones, is self-draining and can take the weight of construction vehicle without wheel rutting.

Where delivery of aggregate is made to stacksites at or near the site of the sealing works, delivery shall be made to separate identifiable stacks for each lot of aggregate tested. Once delivery is commenced the Contractor shall continue to promptly complete the delivery of the entire lot.

SECTION 402 – PRIMING, PRIMERSEALING AND SEALING

402.01 DESCRIPTION

This section covers the equipment for priming, primersealing and sealing. The requirements relate to quality of bituminous materials, cleaning of the surface to be treated and supply, delivery and application of bituminous materials, cleaning of the surface to be treated and supply, delivery and application of bituminous materials and aggregates.

Unless otherwise specified, sprayed seal treatments shall be designed in accordance with Austroads Guide to Pavement Technology – Part 4K Selection and Design of Sprayed Seals (2018 or latest version).

402.02 DEFINITIONS

(a) *Priming*

An initial treatment comprising of the application of a bituminous primer to a prepared granular pavement base without cover aggregate.

(b) *Primersealing (initial seal)*

An initial treatment comprising of the application of a bituminous primerbinder and covered with sand or aggregate to a prepared basecourse which has not been primed to provide a temporary bituminous surfacing.

(c) *Sealing*

The sprayed application of bituminous binder to a previously primed or sealed surface followed by an application of aggregate. Types of sprayed seals include:

- Conventional (C), where the bituminous binder is Multigrade 500/170 (M500/170) bitumen or suitable alternative as approved by the Engineer.
- A Geotextile Reinforced Seal (GRS) where the bituminous binder is reinforced with a geotextile fabric to treat extensively cracked pavements.

(d) *Cutting back*

The addition of cutter to bitumen.

(e) *Binder*

Bitumen, cutback bitumen or emulsified bitumen.

(f) *Residual Binder*

Binder which includes bitumen but not cutter or other additives. In the case of bitumen emulsion, it is binder which remains after water has separated.

(g) *Geotextile*

A synthetic fabric used to reinforce spray seals to improve water proofing and resistance to reflection cracking.

(h) *Adhesion Agent*

A wetting agent designed to promote adhesion of binder or primerbinder to stone

402.03 BITUMINOUS MATERIALS

(a) *Supply*

- Bituminous materials shall be provided by the Contractor.
- For the purpose of this section bituminous materials shall be include binders, cutters and adhesion agents.
- Any offer to supply a material which is subject to approval by the Engineer or which does not comply with the requirements of 402.03 (b) to 402.03 (f) inclusive shall be accompanied by a statement setting out the properties of the material and the suppliers recommend application method.

(b) *Primer*

The primer to be used shall be one of the following:

- Cutback bitumen complying with AS 2157 'Cutback Bitumen'
- Proprietary grades of special cutback bitumen provided that the proprietary product is approved for the Contract by the Engineer.
- Field produced medium curing cutback bitumen primers manufactured by blending Class 170 bitumen and cutter in accordance with Table 402.031.

The primer shall be of a suitable class to ensure penetration into the pavement surface and when cured, be waterproof, of uniform appearance and capable of providing a strong bond between the bituminous surfacing and the pavement. Primer classification and its viscosity shall be in accordance with AS 2157

Table 402.031 Field produced medium curing cutback bitumen primers

Classification	Parts by volume at 15°C		Equivalent % of Cutter in Mixture
	Class 170 bitumen	Cutter	
Light	100	100	50

(c) Primer binder

The prime binder to be used shall be one of the following:

- Proprietary grades of special cutback bitumen or bitumen emulsion provided that the proprietary product is approved by the Engineer.
- AMC 5 or AMC 6 grade of cutback bitumen complying with AS 2157
- Field produced cutback bitumen manufactured by blending Class 170 bitumen and cutter in accordance with Table 402.032. Adhesion agent when directed shall be added to field produced primer binder in the proportion of one part by volume of adhesion agent per 100 parts of bitumen measured at 15°C.
- The primerbinder shall be waterproof and capable of penetrating into and adhering to the pavement surface while retaining sufficient binder on the surface to hold the aggregate in place.

2 Field produced medium curing cutback bitumen primer binder

Primer binder Classification	Field Produced Primer binder [Parts by Volume at 15°C]		
	Class 170 Bitumen	Flux	Cutter Oil
Heavy	100	0	13
Very heavy	100	0	8

(d) Bitumen

Bitumen shall be Class 170 complying with the requirements of Australian Standard 2008 –Bitumen for pavements, or equivalent, with the additional requirements that the minimum time to reach the specified apparent viscosity level shall be 9 days when tested in accordance with Australian Standard 2341.13 – Determination of Durability

of Bitumen.

(f) *Cutter*

Cutter shall be kerosene, Jet A1 aviation fuel or other similar product approved by the Engineer. Cutter shall comply with the current Australian Standard for Oils for reducing the viscosity of residual bitumen for pavements.

(g) *Adhesion Agent.*

Adhesion agent may be added to the aggregate precoat, binder or primerbinder to promote adhesion to the cover aggregate and/or pavement surface. The type of adhesion agent and the percentage to be used shall be subject to the Contractor providing evidence that the proprietary product has satisfactory field performance. When adhesion agent is added to the binder or primerbinder, the total volume of adhesion agent and diluent shall not exceed 1% by mass of the binder.

(h) *Geotextile*

The geotextile fabric used for a geotextile reinforced seal shall be a non-woven needle punched fabric. The mass of the fabric shall be a minimum of 135 g/m² for seals of nominal maximum size of 14 mm and under, and 175 g/m² for seals of nominal maximum size of larger than 14 mm. The geotextile fabric shall have a melting point at least 10°C above the maximum binder spraying temperature.

402.04 AGGREGATES

Aggregates shall be supplied by the Contractor and shall comply with the requirements of Section 401.

402.05 PLANT

All plant and equipment shall be supplied by the Contractor and shall be in sound mechanical condition and shall comply with the following requirements:

(a) *Rotary road brooms*

Rotary road brooms shall be drawn, tractor mounted or self-propelled and shall have a broom core width of not less than 1.5m.

(b) *Sprayers*

All sprayers must meet the performance requirements as described in Austroads Publication No. AP-T181/11 Performance Requirements for Bitumen Sprayers

Sprayers used for application of bituminous materials shall have a current of calibration showing compliance with Austroads Test Methods for Calibration of Bitumen Sprayers AGPT-T530 and AGPT-T533, AGPT-T535 or E2 certification Civil Contractors New Zealand. Calibration shall be renewed every 12 months or whenever any sprayer has its spray equipment overhauled or replaced. Only sprayers that have been checked and calibrated to the satisfaction of the Engineer and for which spraying tables that have been issued shall be used.

(c) *Aggregate loading equipment*

Equipment for loading aggregates shall be a loader with minimum bucket capacity of 1 m³.

(d) *Aggregate spreaders*

Aggregate spreaders shall be capable of uniformly spreading aggregates in a single layer from the rear of a tipping truck to a width up to the full width of the truck.

(e) *Drag brooms*

Drag brooms shall be capable of evening outspread aggregates without damaging the work and shall be so constructed that the pressure on the broom bristles can be controlled.

(f) *Rollers*

Rollers shall be self-propelled pneumatic tyred multi-wheeled rollers having a mass not less than 8 tonnes and tyres of equal size. Rear wheels shall be offset relative to front wheels to give overlapping tyre paths and complete coverage for the effective width of the roller. Tyres shall be capable of being inflated to 700kPa.

(g) *Watering Plant*

Watering plant shall have spray bar capable of uniformly distributing a fine spray water on the road and shall be fitted with rapid acting shut off valves.

402.06 COMMENCEMENT OF WORK

(a) *Periodic Resurfacing and Maintenance Works*

Within 2 weeks of the Date of Award of Contract the Contractor shall submit to the Engineer for review the sealing program for the whole of the works. During the period

of the Contract, the Contractor shall submit by the preceding Thursday a detailed program of planned sealing jobs for the following week for review by the Engineer, including planned dates for each sealing job.

(b) Construction Projects

The Contractor shall include details of all sprayed bituminous surfacing works on the Construction Program.

During the period of the Contract, the Contractor shall submit by the preceding Thursday a detailed program of planned sprayed bituminous surfacing works for the following week for review by the Engineer, including the planned sprayed bituminous surfacing works for each day.

402.07 PREPARATION OF BITUMINOUS MATERIALS

(a) Temperature and heating

Except as otherwise provided below, the temperatures of bituminous materials shall not exceed the upper limits specified in Table 402.071 and, at the time of spraying, shall be within the range specified in that table. Higher temperatures will be permitted for freshly blended field produced cutback bitumen primer binders provided that the temperature of Class 170 bitumen prior to blending does not exceed 185°C and that the Primer binder is not reheated to a temperature higher than that specified in Table 402.071.

For cutback bitumen binder, the spraying temperature shall be determined from the Table 402.072. Materials shall be continuously circulated at a rate not less than 1000 L/min during heating. Circulation shall continue for at least 20 minutes after heating has stopped.

Materials shall not be heated at a rate more than 40°C(100°F) per hour.

Table 402.071 Temperature and heating properties of bituminous materials

Material	Temperature °C	
	Minimum	Maximum
Very Light Primer (AMC 00)	10	30
Medium (AMC 0)	35	55
Heavy cutback bitumen Primer binder (AMC 5)	120	135

Very heavy cutback bitumen Primer binder (AMC 6)	135	160
Class 170 bitumen, Multigrade Bitumen	175	190
Cutback bitumen	Table 402.072	

Table 402.072 Spraying Temperatures of Fluxed and/or Cutback Bitumen Binder

Cutter, Parts by Volume per 100 parts of Class 170 Bitumen at 15°C	Flux Oil, Parts by Volume per 100 parts Class 170 Bitumen at 15°C					
	0		2		4	
	Temperature at °C					
	Min	Max	Min	Max	Min	Max
0	175	185	170	183	165	180
2	170	183	165	180	162	177
4	165	180	162	177	159	174
6	162	177	159	174	157	172
8	159	174	157	172	154	169

(b) Cutting back of binder

Cutting back of binder for sealing shall be done in the sprayer, located near the job site, and in the presence of the Engineer Representative. The proportions of cutter shall be as directed by the Engineer. The Engineer may direct that an adhesion agent be added to the binder at a rate of one part by volume of adhesion agent per 100 parts of bitumen based on the volume of bitumen at 15°C. The mixture shall be circulated in the sprayer tank for not less than 20 minutes after all materials have been added.

(c) Blending of primer binder

Where primer binder is blended in a sprayer, the mixture shall be circulated at a rate of not less than 1000 L/min. After all materials have been added circulation shall continue for a period at least 20 minutes.

(d) Precoating Material / Fluid

Precoating fluid shall consist of diesel fuel oil or cutter mixed with between 20 to 30 parts of C170 bitumen or suitable alternative as approved by the Engineer.

A typical precoating material shall have a viscosity in the range 0.003 to 0.020 Pa.s at 60°C and contain a bitumen residue of between 25% and 40% by mass and an adhesion agent of 1% by volume at normal concentration.

402.08 PRE-COATING OF AGGREGATES

The Contractor shall either supply plant precoated aggregate from the aggregate supplier or field precoated aggregate from the stacksite.

402.09 RATES OF APPLICATION

Rates of application of primer, primer binder and binder will be expressed in terms of hot volume per unit area (L/m²). In the case of binder, rates of application refer to binder including cutter. Where it is necessary to apply correction factors for temperatures the multipliers shown in Table 402.091 shall be used.

Table 402.091 Temperature Correction Factors

Product Temperature (°C)	Hot to Ambient	Ambient to Hot
190 – 170	0.90	1.11
169 – 140	0.92	1.09
139 - 120	0.93	1.08

402.10 PROVISION FOR TRAFFIC

The Contractor shall make provisions for traffic in accordance with Clause 101.16. Traffic shall be stopped while spraying is in progress.

402.11 PRELIMINARY WORK

The surface to be sprayed shall be swept, clean and free of dust, dirt, clay and deleterious materials. Sweeping shall be done using a rotary road broom, or hand broom or other means approved by the Engineer. The Engineer may require that concrete shall be clean using compressed air and primed with light emulsion (CRS60 as per Australian Standards or suitable approved proprietary emulsion) or cutback. All such work shall be done to the satisfaction of the Engineer.

402.12 AMBIENT CONDITIONS FOR SPRAYING*(a) Primer*

The surface on which the primer is to be applied shall be hard, tight, homogenous and free of tearing, scabbing, laminations and dried back to the required moisture content.

(b) Binder

The surface on which binder is to be applied shall be dry

(c) Primer binder

The surface on which the Primer binder is to be applied shall be dry prior to a light application of water being applied just before the application of primerbinder

Unless otherwise approved by the Engineer, spraying shall not be carried out when the air temperature is less than that specified in Table 402.121.

Table 402.121 Ambient Conditions for Spraying

Type of Work	Air Temperature °C (Min)
Priming/ Primersealing	15
Sealing	20

402.13 SPRAYING AND COVERING*(a) Setting Out*

Setting out of edges and/or centreline will be done to the satisfaction of the Engineer. Markers such as stones or other objects shall not be used. Guideline marks shall be placed at about 10m intervals.

(b) Application of primer, Primer binder and binder

Primer, Primer binder and binder shall be applied uniformly to the specified areas at the design rate of application. Except where the surface to be primed abuts an existing concrete edge or bituminous surface, the primer shall be applied 100mm wider than the design seal width. Each sprayer run shall overlap any adjacent run by 150mm or 50 mm when end jets are used.. The work shall be so planned as to minimise spraying

by hand. Hand spraying in wheel paths shall not be permitted unless approved by the Engineer.

Spraying of any load of Primer binder or binder shall not commence unless rollers are operational and at the start of the run and sufficient aggregates to cover the area to be sprayed are at the work site and loaded in spreader trucks. The work shall be planned to minimise the number of cold joints. All longitudinal joints shall be located at the traffic lane lines.

(c) *Papering and other protection*

The Contractor shall have sufficient paper at the start and finish of each paper sprayer run to ensure clean cut on and cut off. The paper shall be heavy duty craft paper or an equivalent approved by the Engineer. Edgings and adjoining structures shall be protected by papering or by a method approved by the Engineer Representative and all necessary precautions shall be taken to protect traffic and parked vehicles. Paper for cut-ons, cut-offs and protection of edgings and structures shall be held in place by weighing down with small quantities of aggregates from the same stock-pile as used for the work

(d) *Geotextile Reinforce Seal*

Geotextile fabric shall be fixed to the pavement surface free of wrinkles and/or folds. Transverse joins shall be butt jointed. Longitudinal joins in geotextile fabric shall be overlapped by approximately 150 mm and be located along lane lines. The Contractor shall make an allowance for additional binder to be applied along the join so that both geotextile layers are adequately saturated with bitumen. This allowance shall be included in the Contractor's seal design.

(e) *Spreading of aggregates*

Spreading of aggregates shall commence immediately after the start of spraying of the Primer binder or binder and shall continue without delay until all the Primer binder or binder has been covered. Before rolling the surface shall be inspected and any bare areas shall be covered by hand brooming and/ or spreading and any spillage or overlapping of aggregate shall be removed.

(f) *Rolling*

Rolling shall commence as soon as practicable after the aggregate have been spread and shall continue uniformly over the whole area until aggregate has adhered to the binder sufficiently that it will not be dislodged by traffic and to the satisfaction of the Engineer.

(g) *Drag brooming*

Drag brooming or hand sweeping shall be done in conjunction with rolling to ensure that a uniform distribution of aggregate is achieved.

(h) *Removal of Loose Aggregate*

Loose aggregate shall be removed, within 48 hours of completion of the seal. This includes loose aggregate on all trafficked areas, and areas where loose aggregate has been swept, or moved by traffic onto sealed shoulders or non trafficked areas, or into other areas such as concrete channels, traffic islands, medians, open drains, drainage pits, footpaths, nature strips, or verges.

402.14 TOLERANCES

The width of any prime, primerseal or seal shall not be less than the design width of prime, primerseal or seal nor more than 0.1 meters beyond the design width at any point. Priming or primersealing against kerb and channel shall extend to the channel by no more than 50mm.

402.15 ACCEPTANCE

The Contractor shall forward a record of the spraying application rate, temperature of binder and the spread rate of the aggregate within 24 hours of completion of the bituminous surfacing.

The spray application rate must be within 0.1 litres/m² of the design application rate; and the aggregate spread rate must be within ±10% of the design spread rate.

402.16 REMOVAL OF SURPLUS AGGREGATE

The Contractor shall remove surplus aggregate immediately when the aggregate spread rate exceeds 10% of the design spread rate. Following trafficking of the sealed surface, the Contractor shall remove any other surplus aggregate within 7 days of a direction by the Engineer to do so.

402.17 MAINTENANCE OF SEALS

The Contractor shall be responsible for the monitoring and maintenance of seals from the time of application until the end of the Defects Liability Period. Monitoring of seals shall include regular and timely inspection of work, management of traffic, and monitoring of any deterioration in the surface condition.

The Contractor shall carry out any work necessary to protect and maintain the seal or to effect repairs to any seal failure. Such failures include but are not limited to, potholing, emulsification, flushing, bleeding, fatty areas, significant areas of bitumen on kerb and channel, excess bitumen

without aggregate cover at the start/finish of runs, aggregate stripping, non-uniform aggregate spreading and streaking of aggregate but do not include pavement failures or events beyond the reasonable control of the Contractor.

The Contractor shall undertake the protection or repair work within 48 hours of notification by the Engineer.

For urgent repairs, the Contractor shall take action to preserve the work and make the road safe within 2 hours of being notified or becoming aware of the problem.

Payment will be made for the cost of repairs undertaken by the Contractor and approved by the Engineer for damages that are the result of incidents outside the Contractor's control, including but not limited to, damage caused by others involving oil spills, accidents, vehicle fire or tearing due to heavy braking and skidding.

SECTION 403 – REMOVAL OF PAVEMENT BY COLD PLANING

403.01 GENERAL

This section covers the requirements for removal of pavement by cold planing including the cleaning up, removal and disposal of the excavated materials.

403.02 COLD PLANING

Cold planing shall be carried out in a manner as to leave a uniform surface on a plane parallel with the ultimate finished surface of the pavement as shown on the drawings.

Cold planing machines shall have a standard cutting drum with cutting tool spacing of a maximum of 15 mm horizontally.

The nominal depth and width of pavement to be removed shall be as specified in the Contract Specific Conditions. After planing, no point on the planed surface shall lie more than 15 mm below a 3 m straightedge placed on the planed surface in any direction.

In locations where removal and replacement of asphalt or pavement is required on the same day, the rate of cold planing including clean up shall be at a rate consistent with the asphalt replacement process to minimise the pavement area closed to traffic.

403.03 CLEANING UP AND DISPOSAL OF EXCAVATED MATERIAL

The planed surface shall be swept clean of all loose material prior to either diverting traffic onto the planed surface or placing asphalt.

The excavated material removed from the road shall either become the property of FRA, or the property of the Contractor, as specified in Clause 403.06.

If the material becomes the property of FRA, the Contractor shall load, transport and stockpile material into a neat pile at the nominated stockpile area as specified in Clause 403.06(d).

If the material becomes the property of the Contractor, the Contractor shall remove all such material from the site.

Prior to opening to traffic, placing asphalt, or leaving the site, the Contractor shall present a clean planed surface.

403.04 ASPHALT REPLACEMENT

Where work under the Contract includes replacement of excavated material with asphalt supplied and placed under Section 404, the following requirements shall apply:

- (i) Exposed granular pavement material shall be watered, re-compacted and, where specified, primed or heavily tack coated, or for larger areas, given a bitumen emulsion primerseal prior to placing asphalt.
- (ii) Prior to opening to traffic, excavated areas shall be filled with hotmix asphalt. All transverse and longitudinal joints shall be constructed as cold joints and new asphalt shall be compacted flush with the existing pavement in accordance with the requirements of Clause 404.17.
- (iii) In the event of a breakdown in the supply or placing of asphalt in areas to be opened to traffic, the Contractor shall temporarily backfill or ramp down the cold planed area with cold mix asphalt or other suitable material which will support traffic loading and provide for the safe passage of traffic. Material so placed shall be removed prior to placing new asphalt as specified and the placing and removal of temporary backfilling shall be at the expense of the Contractor. Temporary ramping shall be carried out to the standards specified in Clause 403.05.

403.05 TEMPORARY RAMPING

(a) Longitudinal Edges

Any exposed longitudinal edges within the trafficked area shall be ramped down at a slope no steeper than 5 horizontal to 1 vertical by constructing a temporary wedge of hot mixed or cold mix asphalt.

(b) Transverse Edges

Any exposed transverse edges within the trafficked area shall be ramped down by constructing a temporary wedge of hot or cold mix asphalt. Temporary ramping shall not be steeper than 20 horizontal to 1 vertical for traffic speeds of more than 75 km/h or 10 horizontal to 1 vertical for traffic speeds of 75 km/h or less.

(c) Removal of Temporary Ramping

Before asphalt replacement, all temporary ramping shall be removed by cutting back along a straight line to expose a vertical face of fully compacted asphalt at the specified layer depth.

403.06 SCHEDULE OF DETAILS

(a) Type of Work

- (i) Cutting of tapered longitudinal chases against kerb and channel, median openings, and side streets

- (ii) Cutting of tapered transverse chases
- (iii) Excavation of granular pavement material
- (iv) Profiling of concrete pavement
- (v) Removal and replacement of asphalt in accordance with Section 404 of this specification

(b) *Not used*

(c) *Not used*

(d) Not used

(e) Planed material shall become the property of FRA and be stockpiled at nominated location as stated in the Contract Specific Conditions.

SECTION 404 – ASPHALT

404.01 GENERAL

This section covers the requirements for the manufacture and placing of dense graded hot mix asphalt. The requirements relate to quality of materials, mix design, supply and placing of the asphalt.

404.02 DEFINITIONS

(a) *Asphalt Base Course*

Asphalt base course is that part of an asphalt pavement supporting the intermediate and wearing courses. It rests directly on the subgrade or subbase pavement.

(b) *Asphalt Course*

An asphalt course comprises one or more layers of a single asphalt type.

(c) *Asphalt Intermediate Course*

Asphalt intermediate course is that part of the asphalt pavement immediately under the wearing course. It rests on the asphalt (or granular) base course.

(d) *Asphalt Layer*

An asphalt layer comprises a single paving run of uniform asphalt.

(e) *Asphalt Pavement*

Asphalt pavement comprises the combined thickness of all asphalt courses as defined in Clause 404.24 or as otherwise specified.

(f) *Asphalt Regulating Course*

Asphalt regulating course is an asphalt course of variable thickness applied to the road surface to adjust the shape prior to the wearing course or any other bituminous surfacing.

(g) *Asphalt Wearing Course*

Asphalt wearing course is the final part of the pavement upon which the traffic travels.

(h) *Asphalt Types*

Asphalt Sizes 7, 10 and 14 are primarily used for wearing and regulation courses. Size 20 mixes are primarily used as structural mixes for intermediate and base courses. Asphalt mixes shall contain Multigrade bitumen (M1000/320) unless otherwise specified or as approved by the Engineer.

Mixes containing polymer modified binder are used when specific asphalt properties are required to be enhanced beyond that provided by the default binder (Multigrade bitumen). Where polymer modified binder and Multigrade bitumen is used it shall meet the requirements of Austroads Specification Framework for Polymer Modified Binders and Multigrade Bitumen (AGPT/T190) or superseding Austroads publication. Other bitumen types shall meet the requirements of AS 2008 - Bitumen for Pavements.

Asphalt types shall be designated by mix size and bitumen type e.g. "Size" "(binder type)".

(i) *Polished Stone Value*

The Polished Stone Value as determined in accordance with. NZTA M6: 2011 Section 3.5.

(j) *Binder*

Binder is bitumen, Multigrade bitumen or polymer modified binder (PMB) used to hold a mixture of aggregates together as a cohesive mass. Alternative binder types may be considered subject to the approval of the Engineer.

(k) *Binder Film Index*

An empirical calculation of theoretical thickness of the binder film around each aggregate particle within the asphalt mix having regard to the aggregate grading, surface area of the aggregates and binder content.

(l) *Bulk Density*

Bulk density is the mass per unit volume of the compacted mix where the volume is the gross volume of the mix including the air voids.

(m) *Coarse Aggregates*

Coarse aggregates are aggregates retained on a 4.75 mm AS sieve.

(n) *Cold Joints*

A cold joint is where asphalt is placed against the exposed edge of an existing asphalt mat where the existing mat has cooled to less than 80°C for bitumen and multigrade binders or to less than 100°C in the case of PMBs.

(o) *Filler*

Filler is that portion of the aggregates passing the 0.075 mm sieve. It includes the combined mass of crusher dust, any added recycled fines from asphalt plant dust extraction filters and any added filler required to enhance the mix properties.

(p) *Fine Aggregates*

Fine aggregates are aggregates passing a 4.75 mm AS sieve.

(q) *Asphalt*

Asphalt is a designed and controlled mixture of coarse and fine aggregates, filler and binder which is mixed, spread and compacted to a uniform layer while hot. Asphalt types are designated by the use of symbols.

(r) *Manufactured Sand*

Manufactured sand is a material passing the 4.75 mm sieve produced by crushing igneous or metamorphic rock spalls or washed gravel.

(s) *Mineral Matter*

Mineral matter includes coarse and fine aggregates, plus filler.

(t) *Placing*

Placing is the spreading and compacting of asphalt, including operations necessary for preparation of the surface.

(u) *Reclaimed Asphalt Pavement (RAP)*

Asphalt removed from an existing asphalt pavement, and re-processed by crushing and/or screening for recycling into new asphalt.

(v) *Asphalt Mix Design*

An asphalt mix design that shows the mix complies with the mix design requirements specified in Clause 404.06.

(w) *Void Free Bulk Density (VFBD)*

The maximum theoretical density of an asphalt mix if it were possible to compact it to zero air voids.

404.03 AGGREGATES

(a) *General*

Aggregates shall consist of clean, hard, durable, angular rock fragments of uniform quality.

The combined aggregate mixture shall consist of crushed rock or a mixture of crushed rock and sand or any RAP permitted under Clause 404.10.

(b) *Source Rock*

Source rock for crushed aggregates shall be in accordance with Clause 301.03 (b) excluding the requirements of Clause 301.03(b)(iv). The Source rock for crushed aggregates shall have LA values in accordance with Table 404.030.

Table 404.030 LA loss values of crushed aggregates

Rock Type	Los Angeles Abrasion Loss (max.)
Granodiorite	35
Diorite	
Gabbro	
Tonalite	
Monzonite	
Other Acid Igneous	
Basalt	25
Andesite	
Sedimentary - River Gravel Pebble	Not Permitted

Source rock which does not comply with the specified durability and hardness requirements but from which crushed rock and aggregates of proven satisfactory performance have been produced may be accepted for use subject to the written approval of the Engineer.

(c) *Crushed Aggregate Products*

The Flakiness Index of each separate sized coarse aggregate, with a nominal size of 10 mm or larger, shall be 35% (max.).

(d) *Crusher Fines and Manufactured Sand*

Crusher fines and manufactured sand shall:

- (i) consist of a uniformly graded product of separate particles from the crushing of

rock which complies with the requirements of Clause 404.03(b) appropriate to the asphalt type being produced

- (ii) be free from lumps and aggregations
- (iii) comply with the grading limits specified in Table 404.031.

Table 404.031 - Grading of Crusher Fines and Manufactured Sand

Sieve Size AS (mm)	Crusher Fines Percentage Passing (by mass)	Manufactured Sand Percentage Passing (by mass)
6.70	100	100
4.75	70 – 100	80 – 100
0.600	20 – 55	30 – 70
0.075	5 - 23	0 – 10

- (iv) comply with the relevant requirements specified in Table 404.032.

Table 404.032 - Quality of Crusher Fines and Manufactured Sand

Test Value	
Degradation Factor-Crusher Fines (min.)	Plasticity Index (max.)
60	3

(e) *Natural Sand*

Natural sand extracted from natural sand deposits shall consist of clean, hard, durable grains free from lumps, clay, mica and organic or deleterious matter.

Where natural sand is accepted as a washed sand for the registered mix, the Sand Equivalent Value of any such sand supplied for asphalt production shall not be not be less than 45.

Where natural sand is accepted as an unwashed sand for the registered mix, the Plasticity Index of any sand supplied for asphalt production shall not be more than 3.

(f) *Aggregates for Asphalt Used as Wearing Course*

- (i) Coarse aggregates shall be a mixture of separate one-sized aggregates blended

together.

- (ii) Not used
- (iii) Fine aggregates shall be a mixture of one or more sands and crusher fines.

For mixes designed by the Marshall method, the fraction passing the 4.75 mm AS sieve shall contain not less than 20% of natural sand.

No mix shall contain more than 65% by mass of natural sand unless otherwise approved by the Engineer.

(g) Aggregates for Asphalt Used as Intermediate or Base Course

The combined aggregates shall consist either of crushed material or a mixture of crushed material and natural sands. The fraction of the mix passing the 4.75mm AS sieve shall contain not more than 50% by mass of natural sands.

404.04 FILLER

Mineral filler shall comply with the requirements of Tables 404.041 and 404.042.

If any of the following added fillers are specified or required, they shall comply with the corresponding additional requirements below:

- (i) hydrated lime complying with AS 1672 - Lime and Limestone (Lime for Building) and the requirements of Table 404.042
- (ii) cement kiln dust complying with the requirements of Tables 404.041 and 404.042
- (ii) ground limestone complying with the requirements of Tables 404.041 and 404.042
- (iv) ground granulated blast furnace slag (GGBFS) complying with AS 3582.2 and the requirements of Table 404.042
- (v) Portland Cement complying with AS 3972
- (vi) fly ash produced from the combustion of black coal complying with Tables 404.041 and 404.042.

Table 404.041 - Grading Limits (Fillers other than Hydrated Lime, Cement and GGBFS)

AS Sieve Size (mm)	Percentage Passing by Mass
0.600	100

0.300	95 – 100
0.075	75 – 100

Table 404.042 - Test Requirements for Filler

Filler Type	Test	Test Limit (%)
Total Combined Filler ¹	Dry Compacted Voids	38 (min.)
All Added Fillers	Moisture Content	3 (max.)
Cement Kiln Dust	Water Soluble Fraction	20

Note on Table 404.042

¹The total combined filler is the total amount of all filler in the mix including any added filler.

404.05 BITUMINOUS MATERIALS**(a) Binders**

Unless otherwise specified, the class of binder for each asphalt type shall be Multigrade bitumen M1000/320. Class 320 bitumen may be used where approved by the Engineer.

(b) Multigrade Bitumen and Polymer Modified Binder (PMB)

The Contractor shall comply with the following requirements in regard to supply and handling multigrade binder and PMB:

- (i) material shall be handled in accordance with the manufacturer's requirements
- (ii) a product quality certificate and test report from the manufacturer shall be obtained for each delivery of material
- (iii) material shall be transported and stored in such a manner to avoid contamination and/or deterioration of the product to the extent that it no longer complies with specified test properties.

(c) Bitumen Emulsion

Bitumen emulsion used for tack coating shall be a cationic rapid setting type complying with Australian Standard 1160, Bitumen Emulsions for Construction and Maintenance of Pavements. Emulsion diluted with water shall have a bitumen content of not less than

30%.

404.06 MIX DESIGN

(a) General

The Contractor shall design all required asphalt mixes. All mixes shall be designed in accordance with VicRoads Code of Practice RC 500.16 - *Selection of Test Methods for the Testing of Materials and Work* and referenced Test Methods, specifically VicRoads Test Method RC 201.01 *Design of Asphalt Mixes (Marshall Method)* noting the criteria for selection of a design mix as described in this specification apply unless approved otherwise by the Engineer

Approval to use of the asphalt mix design under the Contract does not guarantee the handling properties or performance of the mix nor relieve the Contractor from contractual obligations in regards to rectification of defects.

(b) Mix Submission

All asphalt mixes proposed for use on the works shall be submitted to the Engineer, at least two weeks prior to the proposed date for the commencement of supply of the asphalt and shall be accompanied by the information listed in part (c) of this clause demonstrating specification requirements have been met.

(c) Information Required for Mix Submission.

The following information shall be submitted for each new mix design:

- (i) Grading test results for each component
- (ii) Proportion of each component in the mix
- (iii) Grading of the mix
- (iv) Flakiness Index of each separate coarse aggregate of size 10 and above
- (v) Degradation Factor and Plasticity Index for the crusher fines component
- (vi) Sand Equivalent Value of washed sand and Plasticity Index of unwashed sand as applicable
- (vii) Supplier and class of binder and certificate of compliance, which includes viscosity value, that binder meets all requirements of this specification
- (viii) Source of added filler and certificate of compliance for added filler and the Dry Compacted Voids of total combined filler
- (ix) Test information shown in Table 404.061.

Table 404.061 – Test Information to be Submitted for each Mix for Registration

Test Property
Marshall Stability (Clause 404.07(b))
Marshall Flow (Clause 404.07(b))
Air Voids at Design Binder Content (Clause 404.07(b))
Voids in the Mineral Aggregate (Clause 404.07)
Marshall Bulk Density at the design binder content for use as the reference density for compaction determined in accordance with VicRoads Code of Practice 500.16 and referenced Test Methods.
Voids Free Bulk Density
Binder Film Index (Clause 404.07(e))

(d) Sieve Analysis and Binder Content of RAP

Where RAP is used, the sieve analysis after extraction of binder, and binder content of RAP shall be provided to the Engineer.

404.07 MIX DESIGN REQUIREMENTS

(a) Grading of Aggregates

The grading of aggregates including any added filler and the proportions of aggregates and binder in the mix after mixing but before compaction, shall lie within the limits specified in Table 404.071 and 404.072 for each size of asphalt unless otherwise approved by the Engineer.

Table 404.071 - Grading Limits for Aggregates (including any filler)

Sieve Size	Percentage Passing (by mass)				
	AS (mm)	Size 7 Mix	Size 10 Mix	Size 14 Mix	Size 20 Mix
37.5					

26.5				100
19.0			100	90 – 100
13.2		100	85 - 100	75 - 88
9.5	100	90 – 100	70 - 84	61 - 75
6.70	80 - 100	70 – 86	59 - 73	49 - 64
4.75	70 - 88	58 – 73	48 - 65	41 - 55
2.36	46 - 65	38 – 55	32 - 48	27 - 41
1.18	31 - 51	25 – 44	22 - 37	18 - 33
0.600	20 – 40	16 – 34	14 - 28	12 - 25
0.300	13 – 29	10 – 24	10 - 22	8 - 19
0.150	8 - 17	6 – 16	6 - 14	5 - 13
0.075	5 - 8	4 – 7	4 - 7	3 - 6

Table 404.072 - Proportions of Aggregates and Binder for Trial Mix Designs

Material	Percentage (by mass)			
	Size 7 Mix	Size 10 Mix	Size 14 Mix	Size 20 Mix
Aggregates and Filler	95.0 - 92.5	95.5 - 93.0	95.5 - 93.5	96.0 - 93.5
Trial Binder Content Range	5.0 – 7.5	4.5 – 7.0	4.5 – 6.5	4.0 – 6.5

(b) *Volumetric Test Properties and Minimum Binder Film Thickness (Marshall Mix Design Method)*

The test properties for asphalt mixes shall comply with Table 404.074. Mix design shall be based on using Class 170 bitumen and the binder content of all other mixes may be derived from these mixes if they are the same in every respect other than binder grade and content. All derived mixes must pass all other relevant test requirements for the mix.

Table 404.074 - Asphalt Marshall Properties and Voids in Mineral Aggregate

Mix Size (mm)	Minimum Stability (kN)	Flow (mm)		Air Voids Range (%)	Minimum Voids in Mineral Aggregate (%)
		Min.	Max.		
7	5.5	1.5	3.5	4.9 – 5.3	17
10	6.5	1.5	3.5	4.9 – 5.3	17
14	6.5	1.5	3.5	4.9 – 5.3	16
20	6.5	1.5	3.5	-4.9 – 5.3	-15

(d) Added Filler for Wearing Course Asphalt

Wearing course asphalt shall contain a minimum of 1% added filler. Added filler shall be any one of the fillers listed in Clause 404.04 except for crusher dust, and/or plant recycled fines. Any asphalt containing aggregates of coarse or medium grained acid igneous rocks (e.g. granite) shall contain not less than 1% hydrated lime filler unless otherwise approved by the Engineer

(e) Binder Film Index

The binder film index shall be a minimum of 8.0 micron.

404.08 TOLERANCES ON MIX PRODUCTION

The production tolerances on the grading aim of the mix before compaction shall be as specified in Table 404.081. The tolerance on the binder content in the mix shall be $\pm 0.3\%$ of the total mix by mass.

Table 404.081 - Production Tolerances for Mix Grading

Sieve Size AS (mm)	Tolerance on Percentage Passing (% by mass)			
	Size 7	Size 10	Size 14	Size 20
37.5	Nil	Nil	Nil	Nil
26.5	Nil	Nil	Nil	Nil
19.0	Nil	Nil	Nil	± 6

13.2	Nil	Nil	±6	±6
9.5	Nil	±6	±6	±6
6.70 - 4.75	±6	±6	±6	±6
2.36 - 0.600	±5	±5	±5	±5
0.300 - 0.150	±3	±3	±3	±3
0.075	±1.0	±1.0	±1.0	±1.0

Note on Table 404.081

If post compaction grading is checked by binder extraction and sieve analysis after placement, the positive tolerances shall be increased by one percentage point.

404.09 PRODUCTION OF ASPHALT*(a) Temperatures*

The temperature of binder and aggregates at the mixing plant and the temperature of the asphalt as it is discharged from the mixing plant shall not exceed the limits specified in Table 404.091. Asphalt manufactured at temperatures in excess of the limits specified in Table 404.091 shall not be used.

Table 404.091 - Maximum Mixing Temperatures

Material	Temperature °C (max.)
Binder plant storage	185 *
Aggregates before binder is added	200
Asphalt at discharge from mixing plant	175

Note on Table 404.091

*This limit may vary for PMBs in accordance with the supplier's recommendation

(b) Mixing

The mixing period shall be such that at least 95% of the coarse aggregate particles are fully coated with binder.

After completion of mixing, the moisture content of the mix shall not exceed 0.5%.

(c) Hot Storage of Mixed Asphalt

Asphalt types with PMB, Multigrade bitumen and Class 600 binders shall not be stored in hot bins for more than 8 hours prior to use. All other asphalt types shall not be stored in hot bins for more than 18 hours prior to use. Asphalt that is deemed unsuitable for use may be recycled by re processing adding it to a new mix at a proportion not greater than 5% by mass of the total aggregates. Alternatively, it may be added to the RAP stockpile and re-processed to comply with the requirements of Clause 404.10.

404.10 ASPHALT RECYCLED FROM RECLAIMED ASPHALT PAVEMENT

Unless otherwise specified, Reclaimed Asphalt Pavement (RAP) may be re-cycled by adding it to new asphalt during the mixing process subject to the following requirements:

- (i) all asphalt containing RAP shall comply with all relevant test requirements specified in Clause 404.07 for the size and type of asphalt specified for use;
- (ii) RAP shall consist of milled or excavated asphalt pavement free of foreign material such as unbound granular base, broken concrete or other contaminants and shall be crushed and screened to a maximum size not exceeding the size of asphalt produced;
- (iii) the manufacturing process shall provide for addition of RAP to a batch plant pug mill or drum mixer separately from other mix components by a method that avoids damage to the mix by overheating;
- (iv) Asphalt may contain up to 10% RAP provided that all relevant specification requirements are met for each mix type:

404.11 FREQUENCY OF INSPECTION AND TESTING AT THE MIXING PLANT

The frequency shall not be less than that shown in Table 404.111, except that the Engineer may agree to a lower frequency where the Contractor has implemented a system of statistical process control and can demonstrate that such lower frequency is adequate to assure the quality of the product.

Table 404.111 - Frequency of Inspection and Testing

Checks Required	Minimum Frequency
Particle size distribution of each aggregate and sand component including processed RAP	On each production day: One test on each component unless certification of specification compliance is received for each delivery to the mixing plant.

Degradation Factor of crusher fines	At fortnightly monthly intervals.
Plasticity Index of crusher fines and natural sand supplied as unwashed sand	At fortnightly monthly intervals.
Sand Equivalent of natural sand supplied as washed sand	At fortnightly intervals.
Flakiness Index of coarse aggregate 10 mm and larger	At fortnightly y intervals.
Viscosity of bitumen and multigrade binder at 60°C	<p>Certification of specification compliance for each delivery of bitumen supplied to the mixing plant.</p> <p>At weekly intervals: where bitumen has been stored above 150°C for more than 14 days without the storage tank being topped up by more than 50% of its capacity.</p> <p>In cases where two or more bitumen classes are blended together to correct the viscosity, a viscosity test at 60°C shall be taken prior to use and at weekly intervals thereafter.</p>
Viscosity at 165°C, Torsional Recovery, and Softening Point of PMB	At weekly intervals: For PMB that has been stored above 165°C for more than 3 days or between 140°C and 165°C for more than 7 days without the storage tank being topped up by more than 50% of its capacity.
Scrutiny for segregation, uncoated particles, separated binder, excess binder or overheating before dispatch from the plant	Each loaded truck.
Temperature of asphalt before dispatch from the plant	Each loaded truck or at intervals of 15 minutes if more than one truck is dispatched in 15 minutes.
Binder Content and Full Sieve Analysis of Asphalt (full extraction test)	On each production day: One test per 75 tonnes or part thereof of the asphalt plant production on a representative sample taken from a delivery truck.
Moisture Content, Binder Content and Full Sieve Analysis of RAP (full extraction test)	At weekly intervals: One test on a representative sample of each 75 tonnes of RAP prior to use.

Notes to Table :404.111

- Sampling of loose asphalt shall comply with AS/NZS 2891.1.1 *Methods of sampling and testing*

*asphalt**Method 1.1: Sampling—Loose asphalt.*

- Binder Content and Particle Size Distribution shall be performed in accordance with AS/NZS 2891.3.3

Methods of sampling and testing asphalt Method 3.3: Binder content and aggregate grading—Pressure filter method.

- Moisture Content of asphalt shall be determined by drying to constant mass in accordance with AS/NZS 2891.10 *Methods of sampling and testing asphalt, Method 10: Moisture content of asphalt*
- Bituminous Products - Australian Standards and Austroads Test Methods shall be used.

The Contractor shall make available all completed work sheets, check lists and test reports for inspection at the mixing plant.

404.12 RATE OF DELIVERY

Asphalt shall be placed at the highest practicable rate in order to minimise the time traffic is disrupted and to avoid intermittent paving.

404.13 AMBIENT CONDITIONS FOR PLACING

The surface on which asphalt is to be placed shall be essentially dry and free from puddles.

Asphalt wearing course mixes with polymer modified binder shall not be placed when the majority of the area to be paved has a surface temperature less than 15°C.

404.14 SURFACE PREPARATION

Prior to tack coating and placing of asphalt, the Contractor shall remove all deleterious material and sweep clean the area upon which asphalt is to be placed.

404.15 TACK COAT

A tack coat shall be applied to the cleaned asphalt or sealed surface on which asphalt is to be placed unless the unsealed surface has been primed in which case a tack coat is not required unless otherwise directed or specified.

Tack coat shall consist of cationic bitumen emulsion and shall be applied only to a clean, essentially dry surface, free from puddles.

Tack coat shall be sprayed in a uniform film over the entire road surface.

Unless otherwise directed, the application rate for bitumen emulsion tack coat shall be 0.15 to 0.3 litres/m² (60% Bitumen content) or 0.3 to 0.6 litres/m² (30% bitumen content) except for joints and chases where rates shall be doubled.

Before asphalt is placed, sufficient time shall be allowed for the free water to evaporate and for the tack coat to set up and change in colour from brown to black.

Any tack coat not covered by asphalt shall be covered with clean grit or sand before the road is opened to traffic.

Where asphalt is to be spread over clean, freshly laid asphalt, or over a clean, primed surface, or where the depth of the layer exceeds 60 mm, the Contractor may omit the tack coat unless otherwise directed or specified.

404.16 DELIVERY

(a) General

Delivery shall only be made during the hours listed for possession of site. Asphalt delivered to the site, which is segregated, has been overheated, is too cold, contains separated binder or uncoated particles which does not comply with the Specification shall be removed from the site at the Contractor's expense.

(b) Delivery Dockets

Delivery docket shall show

- (i) name of supplier and location of plant
- (ii) docket number
- (iii) name of user
- (iv) project name and location (or contract number)
- (v) registered number or fleet number of the vehicle
- (vi) date and time of loading
- (vii) size and type of asphalt
- (viii) empty and loaded mass of the vehicle, or the total of the electronically measured batch weights printed on the docket
- (ix) class of binder, and proprietary name of modified binder
- (x) temperature of load at mixing plant when measured.

Where asphalt is scheduled for measurement by mass, a copy of the delivery docket for each load shall be given to the Engineer's representative at the point of delivery, or delivered or mailed to the Engineer at the end of each day's work.

Where asphalt is measured by other means and for Lump Sum Contracts, the Contractor shall make delivery dockets available for inspection on request by the Engineer.

404.17 JOINTS AND JUNCTIONS

(a) General

The location of all joints shall be planned before work commences to achieve the specified offsets between layers and the final position of joints in the wearing course.

The number of joints shall be minimised by adopting good asphalt paving practices. If requested by the Engineer, the Contractor shall produce drawings showing the location of longitudinal joints of asphalt layers in respect to the traffic lane lines.

All joints shall be well bonded and sealed and the surface across the joint shall meet the requirements of Clause 404.23(b).

All cold joints and abutting concrete edges shall be heavily tack coated.

Where cold joints are constructed, any loose or poorly compacted existing asphalt on the exposed edge shall be trimmed back to produce a face of fully compacted asphalt along the exposed edge before fresh asphalt is placed.

(b) Transverse Joints

All transverse joints shall be offset from layer to layer by not less than 2 m.

(c) Longitudinal Joints

- (i) Longitudinal joints in the wearing course shall coincide with the location of intended traffic lane lines.
- (ii) Longitudinal joints in intermediate and base courses shall be offset from layer to layer by not less than 150 mm and shall be within 300 mm of the traffic lane line or the centre of traffic lane. Where new pavement abuts an existing pavement, the existing pavement shall be removed in steps to achieve an offset from layer to layer of not less than 150 mm.
- (iii) Longitudinal joints shall be parallel to the traffic lanes unless otherwise specified.
- (iv) Cold joints shall be avoided either by matching up all longitudinal joints over the full width of the carriageway each day or such lesser period depending on the rate

of cooling of asphalt placed in the preceding run or by paving with two or more pavers in echelon.

Subject to approval by the Engineer, a longitudinal joint in the wearing course may be located up to 300 mm from the traffic lane line, or 300 mm from the centre of a traffic lane.

(d) Junctions

At junctions where the new asphalt mat is required to match the level of existing pavement surface at the limits of work, chases shall be cut into the existing pavement by cold planing as specified in Section 403.

The chase shall be cut by removal of a wedge of asphalt tapering from zero to a depth of 2.5 times the nominal size of the asphalt from the existing pavement to the minimum width as follows:

- at side streets and median openings - 600 mm
- on through carriageways with a speed limit of 80 km/h or less - 3 m.

(e) Treatment of Exposed Edges under Traffic

On completion of each day's work and prior to opening to traffic, the following treatment of exposed edges shall be adopted for asphalt work.

(i) Longitudinal Edges

All longitudinal joints within the trafficked area shall be matched up between paver runs except for a short section required to achieve the minimum offset between transverse joints. Any exposed longitudinal edges within the trafficked area shall be ramped down at a slope of not steeper than 5 horizontal to 1 vertical by constructing a temporary wedge of hot mixed or cold mixed asphalt. In unusual situations, such as the sudden onset of inclement weather, a longer length of longitudinal joint may be exposed provided it is ramped down as specified.

(ii) Transverse Edges

At the end of the paving run in the transverse direction, the new asphalt mat shall be squared up to a straight line and ramped down by constructing a temporary wedge of hot mixed or cold mixed asphalt. Temporary ramping shall not be steeper than shown in Table 404.171.

Table 404.171 – Maximum Grade of Temporary Ramping

Posted Speed Limit (km/hr)	Speed	Maximum Ramp Grade (Horizontal to Vertical)
40		20 to 1
60		30 to 1
80		40 to 1

(iii) Removal of Temporary Ramping

Before commencement of each day's work, all temporary ramping shall be removed by cutting back along a straight line to expose a vertical face of fully compacted asphalt at the specified layer depth.

404.18 COMMENCEMENT OF PLACING

The placement of asphalt on the sub-base or granular base for a new pavement or for an overlay of an existing bituminous surfaced pavement shall not commence until the consent to proceed is obtained from the Engineer.

404.19 REGULATING COURSE

A regulating course of asphalt of the type and size specified shall be placed for correction of longitudinal and transverse pavement shape so that the resulting surface is parallel with the finished surface.

404.20 SPREADING

(a) *General*

Asphalt shall be spread in layers at the compacted thicknesses shown on the drawings or specified.

All asphalt shall be spread with an asphalt paver except for small areas where use of a paver is not practicable.

(b) *Level Control*

Asphalt shall be spread in layers at the compacted thickness specified or shown on the drawings.

All asphalt shall be spread with an asphalt paver except for small areas where use of a paver is not practicable.

Unless otherwise specified asphalt paver screed levels shall be controlled by a suitable combination of manual and automatic controls operating from fixed or moving references.

(c) Spreading

All asphalt shall be spread with a purpose designed asphalt paving machine to form a uniformly smooth asphalt mat complying with the requirements of Clause 404.23 without segregation, tearing or gouging.

The Contractor shall conduct spreading operations to ensure that the paver speed matches the rate of supply so that stoppages are minimised.

If the paver is required to stop and asphalt in front of the screed cools to below 120 C, a transverse joint shall be constructed.

For asphalt work carried out on a road to be opened for traffic at the completion of work each day, each layer of asphalt shall cover the full width of the trafficked area. The requirements of Clause 404.17(e) shall be followed in respect of the treatment required for exposed edges.

(d) Spreading by Hand

Hand spreading shall only be used for small awkward areas where it is not practical to use a paver.

(e) Asphalt layer thickness shall be in accordance with Table 404.21

Table 404.21 Selection of Asphalt Size and Layer Thickness

Nominal Size	Courses where Used	Thickness Range
7	Wearing and regulation	15 to 25 mm
10	Wearing and regulation	25 to 35 mm
14	Wearing, intermediate and regulation	35 to 50 mm
20	Base, intermediate regulation	50 to 100 mm

404.21 COMPACTION

Asphalt shall be uniformly compacted to the standards specified in Clause 404.22 as soon as the asphalt has cooled sufficiently to support the rollers without undue displacement.

404.22 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION

(a) *General*

Work shall be tested and accepted for compaction on either a test lot basis as provided in Clause 404.22(b) or on an approved procedural basis as provided in Clause 404.22(c). Where the total quantity of the particular size and/or type of asphalt supplied under the contract exceeds 200 tonne, compaction shall be tested and accepted on a test lot basis. Unless otherwise specified or agreed by the Engineer, acceptance of compaction for all other asphalt work, will be on a procedural basis.

Procedures to be followed when carrying out acceptance testing of field compaction of asphalt shall be in accordance with VicRoads Code of Practice RC 500.05. *Acceptance of Field Compaction*

(b) *Testing and Acceptance of Compaction on a Lot Basis*

For small lots, the test procedure specified in Clause 165.09 shall apply.

The density of extracted cores for the purposes of determining the bulk density for acceptance purposes or to check or assign offsets to a nuclear gauge shall be undertaken in accordance with VicRoads Code of Practice RC 500.05 *Acceptance of Field Compaction* and RC 500.16 *Selection of Test Methods for the Testing of Materials and Work*.

A lot presented for testing consists of that part of a particular layer of asphalt which is placed in one day under uniform conditions and is essentially homogeneous in respect to material and appearance.

Sites for density testing shall be selected on an essentially random basis provided that no site shall be selected within 200 mm of a joint constructed against a cold edge.

For core sample tests, the layer thickness is the mean thickness of the core samples and for nuclear gauge tests, the layer thickness is the nominal layer thickness.

Asphalt Density Ratio is defined as the percentage ratio of the field bulk density to the assigned bulk density of the approved laboratory mix design.

The assigned maximum density of the asphalt shall be calculated from the 6point rolling average maximum density of the production mix. Should a single maximum density of the production mix vary by more than $\pm 0.5\%$ of its rolling average then a check design or

redesign should be initiated.

The Characteristic Value of Density Ratio is the calculated value of $x - 0.92S$ for six tests per lot where x and S are respectively the mean and standard deviation of the individual density ratio test values for the lot.

The work represented by a lot of six tests shall be assessed as shown in Table 404.221.

Table 404.221 - Limits for Characteristic Density Ratio (Six Tests)

For layers less than 50 mm thickness		For layers 50 mm thickness or greater	
Characteristic Value of the Density Ratio (Rc)	Assessment	Characteristic Value of the Density Ratio (Rc)	Assessment
94.0% or more	Accept lot	96.0% or more	Accept lot

(Rc) is the Characteristic Value of the density ratio for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.

Where one or more individual core thicknesses are less than the relevant values shown in Table 404.222, they shall be discarded and the acceptance assessment modified in accordance with Table 404.223 provided that there remain at least 4 test values.

Table 404.222 - Minimum Thickness of Cores Extracted from the Pavement

Size of Asphalt	Individual Core Thickness (mm) min
7	14
10	20
14	28
20	40

Table 404.223 - Mean Density Ratio (less than six cores)

For layers less than 50 mm thickness		For layers 50 mm thickness or greater	
Mean Value of the Density Ratio (R _m)	Assessment	Mean Value of the Density Ratio (R _m)	Assessment
95.5% or more	Accept lot	97.0% or more	Accept lot

(R_m) is the mean of the individual density ratios for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.

(c) *Acceptance of Compaction on a Procedural Basis*

Acceptance of work as far as compaction is concerned shall be based on the adoption of approved placing procedures and a density test check plan that provides for a minimum test frequency of 5% of relevant lots to be tested. The test check plan shall provide for additional testing to demonstrate correction of non-conformance. If not otherwise agreed, placing procedures shall be in accordance with Australian Standard AS 2150 – Hot-Mix Asphalt.

404.23 SURFACE FINISH, AND CONFORMITY WITH DRAWINGS

(a) *General*

For all asphalt works the following requirements shall apply for conformance with location, shape, alignment, and width.

(i) Surface Finish

The finished surface of asphalt wearing course shall be of uniform appearance, free of dragged areas, cracks, open textured patches and roller marks.

(ii) Kerb and Channel

Where asphalt is placed against kerb and channel the surface at the edge of the wearing course shall be either flush with or not more than 5 mm above the lip of the channel unless otherwise specified or shown on the Drawings.

(iii) Shape

No point on the finished surface of the wearing course shall lie more than 4 mm below a 3 m straight edge laid either parallel to the centreline of the pavement or,

except on crowned sections, at right angles to the centreline. For intermediate and base course layers, the distance below the straight edge shall not exceed 6 mm and 10 mm respectively.

(iv) Alignment

Where asphalt pavement is not placed against a concrete edging, the edge of asphalt layers shall not be more than 50 mm inside nor more than 100 mm outside, the designed offset from centreline or design line. Within these tolerances, the rate of change of offset of the edge of layer shall not be greater than 25 mm in 10 m.

(v) Width

Where asphalt pavement is not placed against a concrete edging, the width of asphalt layers shall not be less than the design or specified width of layer by more than 50 mm or greater than the design or specified width by more than 100 mm. The average width over any 300 m shall not be less than the design or specified width.

(b) Conformity with Drawings for New Pavements and Major Pavement Rehabilitation Projects.

This clause is applicable to new construction or rehabilitation works where drawings are available showing new surface levels. The level of the top of each asphalt course shall not differ from the specified level by more than 15 mm for intermediate and base courses and 10 mm for wearing course.

Where a uniform thickness of new asphalt pavement construction is specified, the mean thickness of a lot of asphalt shall be not less than the combined thickness of all asphalt courses specified in Clause 404.24 or shown on the Drawings. For the purpose of this clause, the maximum lot size shall be not more than 2000 m² of pavement area.

The surface level of each completed pavement course shall be checked longitudinally and transversely for conformity with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- at the edges of the pavement
- at all changes of gradient across the pavement
- -at intervals not exceeding 2 m across the pavement.

404.24 SCHEDULES OF DETAILS – NOT USED

SECTION 501 – UNDERGROUND STORMWATER DRAINS

501.01 DESCRIPTION

This section covers the requirements for supply, delivery, transport and installation of underground storm water drains, herein after referred to as culverts, together with the construction of inlet and outlet structures (endwalls, catchpits, basins, etc.), erection of marker posts, and the removal and/ or relaying of existing culverts, as shown on the drawings, or as specified.

501.02 DEFINITIONS

(a) *Culvert*

An underground stormwater drain consisting of pipes, arch or box sections.

(b) *Precast reinforced concrete pipes*

Pipes manufactured from Portland cement-based concrete

501.03 MATERIALS

(a) *Culvert Sections*

Unless otherwise specified, and where an individual culvert unit shall have a maximum width of 1.2m, materials, design and construction of underground stormwater drains shall comply with the requirements of relevant Australian Standards including:

AS 1597 Part I Precast reinforced concrete box culverts

AS 1646 Elastomeric seals for waterworks purposes

AS 1683 Methods of testing for elastomers

AS/NZS 2041 Buried corrugated metal structures

AS 4058 Precast concrete pipes (pressure and non-pressure)

AS 4139 Fibre-reinforced concrete pipes and fittings

AS 3972 General purpose and blended cements

(i) Precast reinforced concrete box culverts

Precast reinforced concrete box culverts shall comply with the requirements of AS 1597 Part 1.

Box culverts shall be designed for a minimum exposure classification specific to

the site in accordance with AS 5100.5 and AS 1597.1. Box culverts used in saltwater applications shall be designed for exposure classification C1 or C2 as specified in accordance with AS 5100.5 and AS 1597.1.

(ii) Precast reinforce concrete pipes

Precast reinforce concrete pipes shall comply with the requirements of AS 4058.

Precast reinforced concrete pipes covered by this section shall be used for drainage not subject to internal pressure and the required sizes and load classes shall be as shown on the drawings.

Rubber ring joints shall comply with the requirements of AS 1646.

The clear cover to steel reinforcement shall be based on normal environments and shall not be less than shown in Table 3.1 of AS 4058.

The design diameter as defined in AS 4058 shall not be less than 95% of the nominal size shown on the drawings for all classes of pipes up to and including Class 4.

(b) *Bedding and Backfill Materials*

Materials used for bedding and selected backfill shall be free from perishable matter and lumps and shall conform to the requirements of Table 501.031.

Ordinary backfill shall be free from perishable matter and shall conform with the requirements of Table 501.031.

Table 501.031 Grading of bedding and backfill materials

Material	Sieve Size – AS (mm)					Plasticity Index (max.)
	75.0	37.5	19.0	2.36	.075	
	% passing by mass					
Bedding	-	-	100	-	5 - 40	20
Select backfill	-	100	-	-	5- 40	20
Ordinary backfill	100	-	-	40 – 100	-	-

(c) *Testing Requirements*

Prior to commencement, the Contractor shall test the bedding and selected backfill

material at a frequency shown in Table 501.032 to ensure that all materials supplied under the contract comply with the specified requirements.

Table 501.032 Testing requirement for bedding and selected backfill

Test	Minimum Frequency of Testing
Grading	One per 5000 tonnes or part thereof
Plasticity Index	One per 51000 tonnes or part thereof

(d) *Concrete*

Cast-in-place concrete concrete edgings, paths and other surfacings shall comply with the requirements with the requirements of Section 603.

(e) *Mortar*

Mortar used in the laying of box culvert sections or as jointing for pipes shall consist of three parts of sand to one part of cement, by mass, with sufficient water to produce a mix of consistency appropriate to the intended use. The cement shall comply with the requirements of Australian Standard AS 3972 General purpose and blended cement.

(f) *Buried Corrugated Metal Culverts*

Buried corrugated metal structures (BCMS) are:

- bolted steel plates or sheets in accordance with AS/NZS 2041
- long-span corrugated steel structures in accordance with AS/NZS 2041.

All BCMS shall be designed and constructed in accordance with AS 2041:2011 the Australian Standard for Buried Corrugated Metal Structures.

All BCMS shall be provided with a reinforced concrete invert lining. Lining concrete shall comply with Section 804.

Reinforcement for use with concrete linings shall be galvanised in accordance with AS/NZS 4680.

Concrete lining shall not be cast until 28 days has elapsed following the completion of backfilling and road construction.

The lining together with its attachments to the culvert walls shall be of sufficient strength to enable the culvert to support the design loads in the event that the steel loses its load-carrying capacity.

On completion of the concrete invert lining, construction vehicles or plant shall not pass

over the culvert until at least 28 days has elapsed following casting of the concrete invert lining; or seven days has elapsed following casting, provided that the cylinder strength of the concrete has achieved 20 MPa.

Attachment of reinforcement to the culvert walls shall be by welding. The temperature of the steel components during welding must not exceed 450°C. Galvanised surfaces which have been damaged by heat must be repaired by the application of two coats of a proprietary zinc-rich coating which complies with Clause 8 of AS/NZS 4680.

Welding must be in accordance with AS/NZS 1554 using a qualified welder together with appropriate welding materials and welding procedures.

Threaded fasteners may be used for attachment to the culvert walls provided that a continuous structural connection between the concrete lining and the culvert wall can be achieved.

Fasteners for attachment shall be hot-dip galvanized. Holes for fasteners shall be drilled, de burred and treated with two coats of zinc-rich paint.

BCMS made from continuous helically-wound galvanised steel strips with lock-seams or other proprietary helically-wound profiles are not permitted.

BCMS are not permitted if the culvert will be permanently inundated and water will be in constant contact with the galvanised steel structure.

BCMS shall have a design life of 100 years. At the end of the design life the structure shall have a residual thickness of steel with sufficient capacity to safely support the design dead and live loads current at the time of design in accordance with the relevant Australian Standard.

BCMS of less than 1200 mm diameter are not permitted.

Where the required design life cannot be achieved using steel, consideration must be given to the use of alternative materials for example aluminium or pre-cast concrete pipes and box culverts.

Materials shall comply with the requirements of the relevant Australian Standard.

Steel plates shall be hot-dip galvanised in accordance with AS/NZS 4680.

Materials shall be tested for conformity with the specified requirements.

Testing of materials shall be conducted by a NATA-accredited laboratory or an equivalent testing establishment that meets with the approval of the Engineer.

The Contractor shall submit to the Engineer for each lot of steel plate material used in the

fabrication of the culvert a test certificates for the required material properties in accordance with the relevant Australian Standard and the manufacturer's certificate of compliance of the material with the relevant Australian Standard.

Test certificates for other materials shall be supplied to the Engineer on request.

All materials shall be traceable from the point of manufacture to the point of use and appropriate supporting documentation shall be supplied to the Engineer on request

BCMS shall be designed in accordance with AS/NZS 2041 and shall be made from galvanised steel with a minimum wall thickness of 5 mm which shall be shown on the drawings.

Design calculations shall ignore the effect any concrete lining.

Fill material shall be Type A to Section 202, graded in accordance with Table 2.4.1B of AS/NZS 2041.2:2011 with a pH in the range of 6 to 8 and a minimum resistivity of 10,000 ohm.cm.

The levels of chloride and sulphate ions in the fill material shall not exceed 200 ppm and 1000 ppm by weight respectively in accordance with AS/NZS 2041.1:2011.

Filling and installation shall comply with the requirements of AS/NZS 2041.2:2011. Fill shall be laid progressively to both sides of the culvert and shall be compacted by mechanical means with the appropriate level of energy to achieve the required density without permanent distortion or damage to the culvert.

To avoid permanent distortion or damage to the culvert, fill over the structure shall be compacted with low-energy devices until the depth of fill is to the lesser of half the culvert diameter or 600 mm.

Internal bracing shall be provided during filling as necessary to prevent distortion or damage to the culvert.

501.04 CONFORMITY WITH DRAWINGS

The Contractor shall set out the drainage work in accordance with drawings, or as specified by the Engineer.

Prior to commencement of excavation for the culverts the Contractor shall confirm the position of all culverts with the Engineer.

The culverts constructed shall be constructed true to line and level true to line and level.

Where it is necessary to modify the line or levels of drainage lines shown on the drawings the Engineer shall be notified of the proposed design change prior to excavation for the drainage lines. The design change notice shall include certification by the designer that the change complies with the design requirements.

Unless specified otherwise the tolerance on location of pipes compared to the design or a change to the design notified in accordance with this clause shall be:

- (i) offset of entry pits required to match lines of kerbs or barriers ± 20 mm
- (ii) plan location of pits other than offsets to kerb lines or barriers ± 100 mm
- (iii) invert level of pipes at pits ± 50 mm
- (iv) departure from design grade of pipe runs ± 10 mm in 10 m provided minimum grade is not less than 1:250

The location of each run of underground drainage shall be verified by a survey prior to backfilling the culverts and shall be recorded progressively on the Contractor's as constructed drawings.

501.05 PROVISION FOR DRAINAGE DURING CONSTRUCTION

The Contractor shall provide for safe discharge of seepage, drainage and storm water at all times during the construction of any culvert, and for the effect de-watering of excavations. Before obstructing any waterway, channel, culvert, or pipe, the Contractor shall make provision for temporary diversion of flow and obtain prior written approval from the relevant waterway authority.

501.06 INSTALLATION OF CULVERTS IN FILLS UNDER CONSTRUCTION

Before laying any single row or multiple rows culvert in a fill, the fill shall first be constructed and compacted to subgrade level or to a level 0.3 m above the top of the proposed culvert; whichever is the lower, for a distance of not less than 6m clear on either side of the proposed trench. The trench shall then be excavated through this fill as provided in Clause 501.08 and the culvert installed.

501.07 CONSTRUCTION LOADING ON CULVERTS

Until the minimum compacted thickness of cover specified in Table for a particular range of axle or track loading has been provided over any culvert, construction traffic of loading within or greater than the range shall not be permitted to cross that culvert. A temporary embankment extending not less than 15 m both sides of the culvert may be used to provide the necessary cover.

Table 501.071 Construction loading on culverts

Range of Axle or Track Loading (tonne)	Required Cover Thickness (Metre) (min.)							
	Type, Size, and Class of Culvert							
	Pipe						Corrugated Metal D 1.2 - 3.6 m	Box Culvert 90 kN Proof Load
	Pipe Class							
	2		3		4			
	D<1.2m	D>1.2m	D<1.2m	D>1.2m	D<1.2m	D>1.2m		
0 – 9	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.1
9 – 20	0.4	0.4	0.4	0.4	0.4	0.4	1.2	0.6
20 – 35	0.7	0.4	0.4	0.4	0.4	0.4	1.5	0.9
35 – 50	0.9	0.7	0.6	0.5	0.5	0.4	1.8	1.2
50 – 60	#	#	0.8	0.8	0.7	0.7	2.1	1.5

Notes to Table 501.071

This range of loading not permissible.

D Nominal Pipe diameter

D less than 1200 mm not permitted, D more than 3600 mm as directed by the Engineer.

501.08 EXCAVATION

Excavation for installation of culverts shall include all excavation necessary to prepare the culvert foundation and to provide the full specified depth of culvert bedding. Where necessary the foundation shall allow for pipes with protruding sockets. Where practical, trench walls shall be vertical. The sides of excavation shall be supported by satisfactory means to ensure the safety of workmen and traffic. For trenches deeper than 1.2m in depth the Contractor shall submit to the Engineer for approval his proposed method for supporting the trench. No work shall commence without the Engineers approval.

For box culverts the width of the trench shall be such that the clearance from the outside of the culvert to the wall of the trench or to the inside of sheeting is in the range 0.5 to 1.0 times the overall height of the culvert. For pipe culverts the width of trench at and below the level of the top of the

pipe shall be such that the horizontal clearance from the outside of the pipe to the wall of the trench or to the inside of sheeting is within the limits shown in Table 501.081.

Table 501.081 Horizontal Clearance to Wall of Trench

Pipe Type	Nominal Pipe Diameter or Width (mm)	Horizontal Clearance to Wall of Trench	
		Minimum (mm)	Maximum (mm)
Corrugated Metal Culvert	All	300	1,000
Other	All	300	600

The base of the trench shall be compacted to refusal using mechanical plant.

The Contractor shall treat or replace all soft, wet or unstable material below the level required to provide the minimum specified thickness of culvert bedding, as specified below. Replacement material if used shall be compacted in accordance with Clause 501.12.

501.09 CULVERT BEDDING

Bedding material shall be provided and placed for the full width of the trench or, where the culvert is to be placed without trenching, to a width 0.8m greater than the overall width of the culvert. The compacted thickness of bedding material following any shaping necessary shall be not less than:

- 100 mm where $D < 1500$ mm
- 200 mm where $D > 1500$ mm

where D is the nominal pipe diameter or culvert width.

When the sections are in position, an additional layer of bedding material shall be placed to a height equal to 30% of the pipe diameter or culvert height. This material shall be placed between the pipe and the outer limits of the lower layers of bedding, and shall be compacted as specified in Clause 501.13.

501.10 LAYING

(a) General

Laying of all culverts shall commence at the downstream end.

Laying of pipes or box culverts shall not commence until the Contractor has verified that culvert bedding complies with the specified lines and levels and compaction requirements, and that pipes or box culverts are not damaged and comply with the requirements of Clause 501.04.

(b) Pipe Culverts

- Rebate and socket ends of pipe sections shall be placed facing upstream. The ends of the rebate and socketed pipes shall be fully entered.
- The lower portion of the pipe circumference shall be in contact with the bedding for the full length of each section. The compacted bedding shall be shaped to accommodate the joint collar and ensure that the pipe is supported along its full length.
- Where applicable, the top of the pipe as marked shall be set within five degrees of the vertical axis of the culvert.
- Corrugated metal culverts shall be assembled and laid as specified in Clauses 501.14
- The spacing for multiple row culverts shall be as shown in Table 501.101.

Table 501.101 Spacing for multiple row culverts

Pipe Type	Corrugated Metal		Corrugated Metal Pipe Arch		Other		
	Less than 2,400	Over 2,400	Less than 3,600	Over 3,600	Less than 600	600 to 1,800	Over 1,800
Nominal Diameter (D) or Width (mm)							
Clear space between rows	D/2	1.2 m	D/3	1.2 m	0.3 m	D/2	0.9 m

(c) Precast Box Culverts

Consecutive sections of box culverts shall be firmly butted together. The top sections shall be matched to the bottom sections and shall not be lapped over adjoining bottom sections. The contact area between the top and bottom sections shall be mortared. Multi row box culverts shall be laid with the sections in each row in contact with the sections in the adjacent rows

(d) Cutting of Culverts

Where it is necessary to cut any culvert section to length or to create a penetration, cutting shall be done by machine to achieve a clean vertical face and any exposed reinforcement shall be coated with an approved epoxy treatment to prevent corrosion

501.11 JOINTING

All interlocking (flush) joint reinforced concrete pipes shall be mortar joined or wrapped with a 200mm wide external joint rubber band. External rubber bands shall be manufactured from natural rubber and have a minimum tensile strength of 18 MPa and a minimum elongation of 400% at break as determined in accordance with AS 1683, Method 11. Rubber band thickness shall not be less than 2 mm. In the case of internally jointed pipes, 600mm diameter and larger, the mortar shall be struck off flush with the bore of the pipe.

Rubber rings shall be kept undisturbed, clean, and free from dirt and other foreign materials and shall be stored undercover if pipes are not to be installed immediately. Rubber ring joints shall be assembled and prepared in accordance with the manufacturer's recommendations. Where rubber rings are disturbed they shall be cleaned and re-assembled prior to refitting.

501.12 PLACEMENT OF FILLING

Unless the culvert is installed through an existing paved area, selected and ordinary backfill shall be placed around and above the culvert sections after the sections are bedded and compacted as specified in Clause 501.13.

(i) Culvert Under Area to be paved

Where the trench has been excavated from design subgrade level or above, the trench shall be backfilled to design subgrade level with selected backfill material and above that level with appropriate pavement material.

Where the trench is excavated from below design subgrade level the trench shall be filled with selected backfill material.

(ii) Culvert Under Area not to be Paved.

The trench shall be backfilled with selected backfill material to a level 0.3 m above the top of the culvert and with ordinary backfill above that level.

Where written permission is provided by the Engineer to install culverts in non-trench conditions the following requirements shall apply:

- Selected backfill material shall be placed for the full width of the previously placed bedding material to a height of 0.3 m above the top of the culvert or to subgrade level, whichever is the lower. To provide support for the selected backfill material, ordinary backfill material

shall be placed simultaneously with the selected backfill material to a distance two culvert diameters clear of the culvert.

- During filling, the maximum difference between fillings placed on opposite sides of the culvert shall not exceed the lesser of one quarter the height of the culvert or 0.5 m. Filling shall not be placed within 2 m of an exposed culvert end where further sections are to be placed.

Where approved by the Engineer, culverts in trenches may be backfilled to half the pipe diameter or box culvert height with 3% cement stabilised sand with a water content sufficient to ensure penetration beneath the pipe or box culvert invert without leaving free surface water.

501.13 COMPACTION STANDARD

Bedding and backfill materials shall be placed and compacted in layers not exceeding 150 mm loose

Bedding and backfill shall be assessed for compaction and or moisture in lots. The number of tests per lot shall be three. A lot shall consist of one layer of bedding or backfill for a culvert length between adjacent pits or endwalls. A minimum of 20% of all lots for each culvert shall be tested. The calculation of density and moisture ratios shall be based on standard compactive effort.

Where the nominal size of bedding or backfill material after compaction is greater than 40 mm, the moisture ratio shall be determined on material that passes the 19.0 mm sieve.

(a) Bedding

Bedding shall be compacted to refusal using hand held mechanical equipment. Bedding material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

(b) Backfill

(i) Material of nominal size 40 mm or less after compaction

Backfill material which will have a nominal size after compaction of 40 mm or less shall be compacted to a mean value of density ratio of not less than 97%. Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

(ii) Material of nominal size greater than 40 mm after compaction

Backfill material which will have a nominal size after compaction greater than 40 mm shall be compacted using a grading, mixing, watering and rolling procedure.

Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

501.14 ASSEMBLY OF CORRUGATED METAL PIPES

All corrugated metal culvert sections supplied by the Contractor shall be assembled in accordance with the manufacturer's assembly instructions.

Where culvert sections supplied free to the Contractor, the following will be provided:

- Manufacturer's Assembly Drawings
- Schedule of Parts Supplied
- General Assembly Instructions

501.15 INSTALLATION OF CULVERTS THROUGH EXISTING PAVED AREAS

The Contractor shall install culverts through existing paved areas in such a manner and at such times as to minimise disruption to traffic. Existing pavement shall be saw-cut prior to excavation.

Unless otherwise specified or shown on the drawings, the trench shall be backfilled to the existing subgrade level with selected backfill material and the pavement restored using materials approved by the Engineer. If the existing pavement has a bituminous or concrete surface, the uppermost 40 mm shall be size 10 asphalt.

501.16 REMOVAL OF EXISTING CULVERTS

(a) General

Where specified the Contractor shall remove culverts from existing paved areas.

The Contractor shall remove culverts from existing paved areas in such manner and at such times as to minimise interference to traffic.

Except where the pavement under which the culverts passes is to be abandoned, the trench shall be kept to the minimum width to allow removal of the culvert or laying a replacement.

(b) Salvage and Stacking

Salvaged culvert sections shall be cleaned and unless otherwise specified or they are to be relayed, they shall be neatly stacked.

(c) Treatment of Residual Excavation

Where a culvert has removed and the excavation is not to be backfilled, the excavation shall be neatly trimmed to slopes not exceeding 1.5 to 1 and the ends of the trench shaped to facilitate the smooth flow of water.

Where the trench is to be backfilled, this shall be done in accordance with the provisions of Clause 501.13 the final surface shall be shaped to conform to the adjoining profile.

(d) Pavement Restoration

Unless otherwise specified or shown on the drawings, pavement restoration shall be carried out using materials approved by the Engineer and, if the existing pavement has a bituminous, the uppermost 50mm shall be size 14 asphalt or at least the depth of the existing asphalt, whichever is the greater.

Where excavation is undertaken in a concrete pavement, the restoration shall be undertaken to the equivalent depth as the existing concrete unless deemed inadequate by the Engineer. Prior to placement of the concrete, the subbase depth shall be at least 150 mm of crushed rock meeting crushed rock subbase requirements as described in Section 301.

501.17 INLET AND OUTLET STRUCTURES

Inlet and outlet structures and endwalls shall be constructed in accordance with the drawings and specification.

Concrete used for the construction of inlet and outlet structures shall comply with the requirements of Section 804.

Footings shall extend to the depths shown on the drawings or as necessary to achieve a satisfactory foundation. If backfilling to the specified level is required, selected backfilled material shall be used.

When the proposed foundation is unsatisfactory due to neglect or the use of inappropriate methods by the Contractor, no payment will be made for the work and materials necessary to provide a satisfactory foundation at the specified level.

501.18 EXIT AND ENTRY CHANNELS

Where shown on the drawings or otherwise specified by the Engineer, channels shall be excavated to facilitate the flow of water. They shall be of regular shape and of sufficient area to take the flow of water without any low spots that might retain water. Any low areas shall be filled with suitable excavated material and firmly compacted.

501.19 FLUSHING OF CULVERTS

All culverts shall be flushed clean from end to end on completion and maintained in proper working order.

501.20 REPAIRS TO DAMAGED PIPES AND BOX CULVERTS

(a) Steel reinforced concrete pipes

Any steel reinforced concrete pipes that have cracks wider than 0.2 mm or are damaged prior to laying and backfilling shall be rejected. Where inspections after backfilling identify any of the following defects they shall be notified as a non-conformance:

- cracks wider than 0.5 mm
- spalling of concrete
- exposed reinforcement
- joints that are not fully engaged.

Any pipes with defects greater than the following limits shall be removed and replaced:

- longitudinal cracks greater than 2 mm
- circumferential cracks around the full circumference with width greater than 3 mm or with lateral displacement of the cracked sections exceeding 3 mm
- circumferential cracks around part of the circumference with width greater than 4 mm
- penetrations with area greater than 400 mm²
- pipe joints that are separated.

The Engineer may agree to accept pipes with defects as noted above subject to demonstration that repairs will ensure that pipes will operate effectively for their design life. Consideration will only be given to products and procedures with proven performance and to the following types of treatments:

- hot sprayed epoxy coatings for cracks not wider than 4 mm with no lateral displacement
- fibre glass reinforced epoxy sleeving for cracks not wider than 4 mm with lateral displacements up to 3 mm
- spalled concrete, exposed steel reinforcement and penetrations shall be treated as patch repairs and repaired with polymer modified cementitious repair

The Contractor shall submit details of proposed rectification treatments including

manufacturer's product specifications and warranties, the area and thickness of repair treatment, detailed repair procedures, and inspection and test plans.

No repairs shall be undertaken without the Engineer's approval of the repair materials and procedures.

(b) Other types of pipes

Other types of pipes which exhibit defects or are otherwise damaged prior to laying and backfilling shall be rejected.

Where inspections after backfilling identify any defects, such pipes shall be removed and replaced, unless the Engineer approves repairs to be undertaken in accordance with the manufacturer's repair procedures and materials.

(c) Box culverts

Box culverts which do not comply with the requirements of the specification prior to laying and backfilling shall be rejected and removed from the site unless the Engineer approves repairs to be undertaken.

501.21 MARKER POSTS

At all locations specified the Contractor shall supply and erect guide posts at the edges of the formations on the side of the culvert nearer approaching traffic.

SECTION 502 – SUBSURFACE DRAINAGE

502.01 DESCRIPTION

This section covers the requirements for the supply, delivery and installation of subsurface drainage pipes, prefabricated drains and filter materials as shown on the drawings or as specified.

502.02 DEFINITION

(a) *Pervious Pipe System*

A pervious pipe system comprises drainage pipes which permit the entry of water from surrounding material and convey it to a discharge point. Such pipes may be perforated, slotted or porous pipes or impervious pipes laid with open joints.

(b) *Sub surface Drain*

A subsurface drain is a pervious pipe system laid in a trench and surrounded by granular filter material or geotextile.

(c) *Prefabricated Drain (also referred to as Geocomposite drain)*

A prefabricated drain comprises a highly permeable core material wrapped in a geotextile. The core shall be non-crushable and flexible and shall completely support the geotextile fabric. The geotextile shall have the filtration and separation properties to perform the functions of a single or second stage filter

(d) *Single Stage Filter*

Single stage filter is granular filter material placed in contact with the trench sides and surroundings the pervious pipe system.

(e) *First Stage Filter*

First stage filter is granular filter material or geotextile placed in contact with the trench sides and surrounding a second stage filter.

(f) *Second Stage Filter*

Second stage filter is granular filter material or geotextile placed in contact with the pervious pipe system and surrounded by a first stage filter.

502.03 CONFORMITY WITH DRAWINGS

Subsurface drains, whether pipe or prefabricated systems, shall be constructed true lines, depth or levels as shown on the drawings.

The invert of the subsurface drainage pipe or the prefabricated drain shall be not more than 25mm from the specified level and not more than 50mm from the specified line. Changes of grade shall not be abrupt, or occur at a rate exceeding 10mm in any 3m length, or lead to ponding of water within the drainage pipe to a depth exceeding 25mm.

502.04 DRAINAGE PIPES AND PREFABRICATED DRAINS

Unless otherwise specified, subsurface drainage pipes and fabricated drains shall be supplied by the Contractor.

For the purpose of this section, subsurface drainage pipes and prefabricated drains are grouped into three categories as follows:

- Category 1: Perforated plastics Class 1000
 Precast concrete Class "Y"
- Category 2: Perforated plastics Class 400
- Category 3: Prefabricated drains

Pipes supplied shall be of the category and diameter shown on the drawings and shall comply with the following Standards or approved equivalent:

- Perforated plastics - AS 2439 (except for perforation dimensions)
- Perforated concrete pipes - Section 501
- Perforated corrugated steel - AS 2041

Category 1 pipes may be substituted for category 2.

Geotextiles used for the outer covering of the prefabricated drain shall comply with the requirements of Section 608.

Perforated plastics pipes and prefabricated drains supplied in coils shall be free from any permanent curved set when uncoiled.

Plastic pipes and prefabricated drains shall be stored away from sunlight and shall not be exposed unnecessarily to sunlight during delivery and placement.

502.05 GRANULAR FILTER MATERIALS

(a) General

Granular filter material shall consist of hard, durable and clean sand, gravel or crushed rock, free from clay balls and organic matter, and shall have a pH value greater than 4. and less than 10. The portion of granular filter material passing a 4.75mm AS sieve shall

have a Sand Equivalent value not less than 80 when tested in accordance with AS 1289.3.7.1. The grading of granular filter material shall comply with the requirements of 502.051

Table 502.051 Grading Requirements for Granular Filter Material.

Sieve Size AS (mm)	Limits of Grading (% passing) (by mass)									
	Single and First Stage Filters						Second Stage Filters			
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4
37.5	-	-	-	-	-	100	-	-	-	-
26.5	-	-	-	-	-	-	-	-	-	100
19.0	-	-	-	-	100	85-100	-	100	100	70-100
13.2	-	-	-	-	90-100	-	-	90-100	90-100	0-30
9.5	-	100	100	100	70-100	65-100	100	70-100	40-70	0-10
4.75	-	90-100	90-100	70-100	28-100	48-82	70-100	28-100	0-15	-
2.36	100	75-100	70-100	0-50	0-28	30-60	0-50	0-28	0-5	0-5
1.18	95-100	50-98	40-65	0-10	0-8	15-40	0-10	0-8	-	-
0.0600	70-98	30-80	12-40	-	-	5-25	-	-	-	-
0.300	30-60	10-40	0-16	0-5	0-5	0-10	0-5	0-5	-	-
0.150	0-12	0-7	0-4	-	-	1-5	-	-	-	-
0.075	0	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3

(b) Crushed Rock Components

Source rock for crushed rock components of granular filter material shall comply with the material requirements for 'sound' rock as specified in Section 301 and the Los Angeles Value (LAV) subbase requirements of Table 301.032.

(c) No Fines Concrete

No fines concrete should consist of B4 filter as defined in Table 502.051 and mixed with

4.0% by mass of cement and 3.5% by mass of water in a mixing plant.

502.06 GEOTEXTILE FILTER

A geotextile filter shall consist of a fabric manufactured from synthetic fibres of a long chain polymer such as polypropylene, polyethylene, polyester or similar material and shall be stabilised against deterioration due to ultraviolet light. After forming, the geotextile shall be processed so that the fibres retain their relative positions with respect to each other. The geotextile shall be free from defects or flaws which significantly affect its physical and/or filtering properties.

A geotextile filter may be non-woven or knitted fabric and shall comply with the requirements of Table 502.061.

Continuous knit seamless sleeve geotextile filter may be used as a second stage filter.

Table 502.061 Geotextile Requirements

Geotextile Filter Type		Minimum Robustness G ⁽¹⁾	EOS ⁽²⁾ (microns)	Minimum ⁽³⁾ Elongation (%)
1.	First Stage Filter	900 (moderately robust)	85 - 230	45
2.	Second Stage Filter (non-woven)	600 - 900	125 - 350	20
3.	Second Stage Filter (knitted seamless sleeve)	N/A	125 - 350	50

(1) G = Geotextile strength rating

(2) EOS= Equivalent Opening Size using AS 3706.7

Determination of Pore Size Distribution - Dry Sieving Method.

(3) Elongation at break as determined by AS 3706.2

Determination of Tensile Properties - Wide Strip Method.

Geotextiles shall be stored away from sunlight and shall not be exposed unnecessarily to sunlight during delivery and placement.

502.07 MINIMUM TESTING REQUIREMENTS

The Contractor shall test the granular filter material at the minimum frequency in accordance with

Table 502.071.

Table 502.071 Minimum testing requirement

Test	Minimum Frequency of Testing
Grading	One per 100 tonnes or part thereof
Unsound Rock	One per 100 tonnes or part thereof
pH	One each production month or part thereof

502.08 DRAINAGE SYSTEM AT STRUCTURES

The geotextile drainage system at structures may be either prefabricated drains placed vertically or a geocomposite drainage material made up of a permeable drainage layer with one or both faces bonded to a geotextile filter fabric. The geotextile filter used in such drains shall be a non-woven product conforming to the requirements of Section 608.

Where a prefabricated material is made up of a permeable drainage layer with one or both faces bonded to a geotextile filter fabric, such a system shall be placed over the full height of fill which is in contact with the structure. The geotextile filter used in such drains shall be a non-woven product conforming to the requirements of Clause 502.06.

The geocomposite drainage layer shall have the following minimum hydraulic properties under unit hydraulic gradient.

Permeability perpendicular to the geocomposite under 0.2KPa normal pressure – 0.5 cm/sec

Transmissivity in the plane of the geocomposite – Normal

<u>Pressure</u>	<u>Transmissivity</u>
10 kPa	$350 \times 10^{-6} \text{ m}^2/\text{sec}$
100 kPa	$250 \times 10^{-6} \text{ m}^2/\text{sec}$
200 kPa	$150 \times 10^{-6} \text{ m}^2/\text{sec}$
399 kPa	$100 \times 10^{-6} \text{ m}^2/\text{sec}$

Material supplied should be in accordance with the manufactures specification.

Prefabricated drains shall be connected to a collector pipe with an outlet to a fitting immediately adjacent to the structure or as shown on the drawings. The collector pipe shall be fitted with a flush-out riser connected to an inspection opening in the verge adjacent to the structure or as shown on the drawings.

Preformed PVC fittings shall be used for all connections between the prefabricated drains and the collector pipe and all connections shall be sealed and protected to prevent displacement during backfilling.

502.09 EXCAVATION

The width of the trench shall be not less than the diameter of the pipe plus 250mm and not greater than the diameter of the pipe plus 350mm. Where a geotextile is to be used as a first stage filter in contact with a trench wall, the trench wall shall be excavated to allow the geotextile to be in close contact with the wall when the granular filter material is placed against the geotextile.

Where prefabricated drain is to be used, the trench walls shall be excavated to allow the drain to be in close contact with the wall when the granular filter material is placed against the geotextile.

The bottom of the trench shall be compacted and shall be not more than 50mm below the specified level of the invert for the pipe. There shall be no departures from the grade of the base of the trench that would allow ponding of water. Excess trench excavation shall be made good by filling back to grade with compacted material of permeability similar to that of the surrounding material and any loose material shall be removed.

The base of the trench shall be inspected to verify compliance with the requirements in this clause prior to placing bedding in completed excavations. The Engineer shall be notified at least 24 hours prior to the inspection.

502.10 INSTALLATION

(a) Depth

Subsurface drainage pipes or fabricated drains shall be laid to the depth or levels shown on the drawings. Unless otherwise specified or shown on the drawings, the tops of pipes shall be at least 300mm below subgrade level.

(b) Grade

Unless otherwise specified, or shown on the drawings, the grade of pipes or prefabricated drains shall be not flatter than 1 to 250.

(c) Bedding for Drainage Pipe System

Unless otherwise specified, a bedding of granular filter material of thickness between 25 mm and 50 mm shall be placed across the bottom of the trench. The bedding shall be tamped and screened or graded to level. Bedding is not required for prefabricated drains.

(d) Placing of Pipes

Pipes shall be placed centrally in the trench on the prepared bedding and held firmly in place. Slotted pipes shall be laid with the openings in the lower half of the pipes.

(e) *Placing of Prefabricated Drains*

Prefabricated drains shall be placed such that the drain stands vertical and is centrally located within the trench.

(f) *Jointing*

Preformed pipe joints and fittings may be used. Splice joints in prefabricated drains and pipes shall be made either with preformed prefabricated drain joints or fittings, or by putting together the sections of drain to be joined and wrapping the joint area with geotextile. Joints made by putting and wrapping with geotextile shall be secured to prevent separation during installation. The minimum width of geotextile used for wrapping shall be 450mm.

Lap joints in geotextile used as first stage filters shall consist of an overlap of not less than 900mm longitudinally and 150mm transversely.

Lab joints in geotextile used as second stage filters shall consist of an overlap of not less than 300mm.

(g) *Placing Granular Filter Material Around Pipes*

Filter materials shall be placed moist and with a minimal disturbance to pipes or prefabricated drains, geotextiles and trench walls. The loose thickness of layer shall not exceed 300mm. Each layer shall be compacted by means of at least three coverage of a vibrating plate or other compaction unit approved by the Engineer.

No fines concrete shall be placed and compacted within 1 hour of mixing

(h) *Backfilling for Prefabricated Drains*

Unless otherwise specified or shown on drawings, narrow trenches excavated for installation of prefabricated drains may be backfilled with granular filter material excavated from the trench as specified.

(i) *Flushing*

A flushing test shall be carried out on each subsurface drainage line after completion of subsurface drains, flushers and outlets, and after completion of all adjacent kerb and channel, barriers and road furniture. The test shall be witnessed by a representative nominated by the Engineer. Each drain shall be flushed in the presence of the Engineer with sufficient water to remove material that has entered the pipes during construction and to ensure that the pipes are free from obstruction.

The Contractor shall maintain a record of flushing tests for every sub-surface drainage line including the date and time of notification to the Engineer, the date and time of flushing, and witnesses to the flushing

502.11 ACCESS POINTS AND INSPECTION OPENINGS

Unless otherwise specified, or shown on the drawings, subsurface drainage pipes and/or prefabricated drains shall have access points at the beginning and end of the drainage run and shall have inspection openings at intervals of between 100m to 150m along the drainage run.

Where storm water drainage pits are used as access points, the invert at the beginning of each drainage runs shall be located above the top of the pit outlet and the invert and the end of each drainage run, when not shown on the drawings, shall be located not less than 100mm above the invert of the pit outlet.

Flushout risers for drainage pipes shall have the same diameter as the pipe. Flushout risers for prefabricated drains shall consist of a preformed riser fitting, or a pipe of diameter not less than 100mm. Flushout risers shall have surface fittings as shown on the drawings.

Unless otherwise specified or shown on the drawings, the outlet point at the end of each drainage runs shall be located at a drainage pit, culvert endwalls, or outlet in a fill batter or drain.

Inspection openings as shown on the drawings shall consist of pits having a diameter not less than 600mm. Pits shall be fitted with concrete or cast iron frame covers as shown on the drawings.

502.12 MARKER POST

At all fill batter and drain outlets the Contractor shall supply and erect marker posts as shown on the drawings.

SECTION 503 – DRAINAGE PITS

503.01 DESCRIPTION

This section covers the requirements for the supply of materials and construction of drainage pits including the associated excavation, backfilling, culvert connections, and supply and fitting of covers and associated components.

503.02 MATERIALS

Pits shall be constructed of concrete to the thicknesses shown on the drawings.

The supply of concrete and construction of items covered by this section shall comply with the requirements of Section 804. The concrete shall have a minimum 28 day compressive strength of 32 MPa

Cement used shall comply with the requirements of AS 4058.

Covers, grates, lids and lintels shall be as shown on the drawings

All steel reinforcement shall comply with the requirements of Section 803.

503.03 EXCAVATION

(a) General

Excavation shall be to the depth indicated on the drawings or as necessary in order to obtain a satisfactory foundation. Backfill material conforming to the requirements of Section 501 shall be supplied, placed and compacted in layers not exceeding 300 mm loose thickness and compacted to refusal using hand held mechanical equipment.

(b) Pre-Cast Pits

For pre-cast pits the excavation shall provide a clearance from all external faces of pits to each face of the excavation of not less than 400 mm. Bedding conforming with the requirements of Section 501 shall be supplied, placed and compacted to a thickness not less than 150 mm on a clay foundation or 80 mm on a rock foundation.

Where the Engineer considers that the proposed foundation is unsatisfactory due to neglect by the Contractor or the use of inappropriate methods, no payment will be made for the work and materials necessary to provide a satisfactory foundation at the specified level

503.04 CAST-IN-PLACE PITS

Pits shall be constructed at the locations and to the dimensions shown on the drawings. Walls and

floor thickness shall not be less than the dimensions shown on the drawings.

Cast in place pits shall be constructed in accordance with the requirements of Section 804.

503.05 PRE-CAST PITS

Where the Contractors propose to use pre-cast pits, they shall be supplied and installed in accordance with the following requirements.

(a) General

Pits shall be installed at the locations and to the dimensions shown on the drawings.

(b) Provisions for Stormwater Drainage Connections

Provision shall be made for the connection of all stormwater drainage, culverts and subsurface drains as shown on the drawing. Holes for subsurface drains shall be 150mm diameter, unless otherwise specified or shown on the drawings. Weep holes of 50mm diameter shall be provided in all pits and shall be placed between the midpoint and top of the stormwater drain in those walls which have openings for drains.

Reinforcement exposed by the cutting of holes shall be coated with an approved epoxy treatment to prevent corrosion prior to rendering around the pipes.

(c) Segments

If a pit is cast in segments, each section of the pit shall be rebated to ensure correct alignment and to prevent horizontal movement. A minimum rebate of 15mm shall be used.

(d) Completion on Site

Where pre-cast pits are to be completed on site, the provision of cuts outs and protruding reinforcement shall be as specified or in accordance with the drawings.

(e) Joints

Joints in precast concrete shaft sections shall be sealed from the inside with an epoxy compound in accordance with the manufacturer's instructions to produce watertight joints.

503.06 STORMWATER DRAINAGE CONNECTIONS

All stormwater drainage connections to pits, drains, and the like shall be neatly made, and where necessary the ends of all drains be trimmed off and finished with cement mortar as stated in Clause 503.11.

Openings into drainage pit walls to facilitate stormwater drainage connections shall be neatly saw cut to the required size.

Weepholes or holes installed on site shall be cut. Breaking out of holes is not permitted. Pits shall be replaced if circumferential or longitudinal cracking occurs as a result of installing holes or if the hole exceeds the pipe diameter by more than 50 mm.

Openings for culverts shall be cored out of the shaft sections during manufacture or carefully broken out to avoid shaft fractures. Minimum gaps of 25 mm shall be provided all around between connecting culverts and shaft sections.

Reinforcement exposed by the cutting of holes shall be coated with an approved epoxy treatment to prevent corrosion prior to rendering around the pipes

503.07 STEP IRONS

Pits greater than 600 mm deep shall be fitted with steps irons as shown on the drawings in accordance with AS 1657 on one internal wall for the full depth of the structure. Steps shall be so located that they do not obstruct openings other than subsurface drainage openings and that water does not discharge onto them. Steps shall be set into a wall which has no openings, or besides an opening, or across a corner of the pit.

Step irons shall be installed horizontal, vertically in line and shall project uniformly from drainage pit walls.

Where drainage pits are extended in height from the lowest pit, step irons shall be located such that an equidistant spacing between step irons is still maintained.

The top of the uppermost rung must not be more than 600 mm below the top of the pit. The top of the bottom rung must not be more than 500 mm or less than 300 mm above the invert of the pit. Rung spacings must be 300 mm \pm 50 mm.

Step irons shall be manufactured from steel to AS/NZS 3679.1 Grade 250, or AS/NZS 4671 Grade N500 and after fabrication shall be prepared, pre-treated and hot dip galvanized in accordance with the requirements of AS/NZS 4680 with a minimum average coating thickness equivalent to 600 g/m² or manufactured from 13 mm steel bar covered with polypropylene plastic to a design and sample approved by the Engineer. Step irons of an approved proprietary type shall be installed in accordance with the manufacturer's instructions.

503.08 SHAPING OF FLOOR

Pit floors shall be smoothly shaped from the inlets to the outlet for a height of one-third of the diameter of the outlet pipe with cementitious mortar, to provide a profile that will ensure smooth flow conditions between inlet and outlet pipes and prevent any snagging of debris.

503.09 FITTING OF COVERS

Frames for pits covers shall be cast into the top of the pit or bedded on fresh mortar, 5 mm thick, consisting of two parts of sand, one part of cement and sufficient water to produce a mix of suitable consistency.

The level at every point of the perimeter shall be within 10 mm of the design level for that point, and the line of the cover shall be within 10 mm of the design kerb line.

503.10 BACKFILLING AROUND PITS

All backfill materials shall be free of soluble salts, organic matter and other deleterious matter.

Backfilling around pits shall be placed in layers not exceeding 300mm loose thickness and compacted to a refusal using hand held mechanical equipment. Backfill material shall be supplied, placed and compacted in accordance with Section 501.

503.11 JOINTING

The ends of components shall be free of any foreign matter at the time of jointing and shall be arranged to give best fit.

The joints between various components such as drainage pits, access chambers and pipes shall be made watertight using a cementitious mortar. The joint areas shall be thoroughly cleaned and wetted just prior to filling. The cementitious mortar shall be used within its allowable application time and shall not be retempered.

The joints shall be finished to provide smooth surfaces, uniform with the inner surfaces of pits and access chambers.

Mortared joints and recesses shall be cured for a period of not less than 48 hours. Backfilling operations against end structures shall not be carried out during the curing period.

SECTION 504 – OPEN CONCRETE LINED DRAINS

504.01 DESCRIPTION

This section covers the requirements for the construction of open concrete lined drains at location shown on the drawings or as directed by the Engineer.

504.02 MATERIALS

The concrete lining shall be cast in situ or precast concrete. All materials shall be supplied by the Contractor.

Unless shown on the Drawings, proprietary products may only be used with the approval of the Engineer in accordance with the manufacturer's instructions

The concrete lining shall comply with the requirements of AS 1379, and shall have a minimum compressive strength at 28 days (MPa) of 25 MPa as specified in Section 601.

504.03 SUPPLY OF PRECAST UNITS

All precast units shall conform to the profiles shown on the drawings and shall have a dimensional tolerance of 10mm. Precast units shall be constructed from concrete complying with requirements of Section 601.

The surface of all sections shall be consistently smooth and of uniform colour. Any section damaged during handling, storing and transporting shall not be used.

504.04 CONSTRUCTION

All soft, wet or unstable material shall be removed up to 150mm below the underside of bedding and backfilled with Type A fill, sand or crushed rock of a quality that when moistened and compacted will form a stable foundation.

All excavation shall be neatly trimmed to levels specified so as to permit accurate construction of concrete linings. All loose material shall be fully compacted to the specified level.

For cast in situ works, formwork shall be accurately set to line and level and shall be firmly held in position during placing of concrete. All concrete work shall be carried out in accordance with the requirements of Section 601. Wherever mortar is used for bedding and jointing purposes, the mixture shall have a 6 to 1 sand to cement ratio.

Backfilling behind the concrete lined drains shall be with Type A material compacted to a relative compaction of 95% standard compaction.

All excavation shall be neatly trimmed to levels specified so as to permit accurate construction of concrete linings. Before placing any concrete the foundation material shall be shaped and compacted to form a firm base.

Contraction joints shall be provided at a maximum spacing of 3 m. Joints shall be formed or cut through the full cross-section of the drain lining using an approved template and the edges finished with a suitable grooving tool.

Expansion joints shall be provided at maximum 20 m intervals throughout, be 15 mm wide and filled with a pre-moulded filler extending over the full cross-section of the drain. The filler shall be placed in position before adjoining concrete is poured and shall be firmly held in position during construction.

The Contractor shall adjust the batter for a distance of 1 metre above the lip of the lined table drain by trimming or by placing fill so that the batter face matches the line and level of the top inside edge of the lined table drain.

504.05 TOLERANCES

Concrete lined drains shall be constructed to within the following tolerances.

- (i) The concrete lining shall be constructed with a smooth, uniform appearance
- (ii) For horizontal and vertical alignment, 25mm and 10mm respectively from the required levels and position.
- (iii) For exposed surfaces, when tested with a 3m straight edge, surface irregularities shall not be more than 10mm.
- (iv) All cross-sectional dimensions shall be within 10mm of the specified dimensions.

SECTION 601 – CONCRETE FOR INCIDENTAL CONSTRUCTION

601.01 DESCRIPTION

This section covers the requirements for concrete incidental construction. The requirements relate to quality of materials manufacture, supply and placing in conformity with the lines, grades and dimensions shown on the plans, or specified or directed by the Engineer.

601.02 MATERIALS

Unless otherwise specified, the Contractor shall make his own arrangements to obtain all materials required to complete the work covered by this section.

(a) *Concrete Materials*

Concrete materials shall comply with the requirements of the following Australian Standards as applicable:

AS 3582.1 Supplementary cementitious materials for use with portland and blended cement – Part 1: Fly ash

AS 3582.2 Supplementary cementitious materials for use with portland and blended cement – Part 2: Slag - Ground granulated iron blast furnace

AS 3582.3 Supplementary cementitious materials for use with portland and blended cement – Part 3: Amorphous silica

AS 3799 Liquid membrane-forming curing compounds for concrete

AS 3972 – General purpose and blended cement

The water used shall be free from all substances harmful to concrete and its reinforcement.

(b) *Ready Mix Concrete*

The mix and delivery of ready mix concrete or concrete mixed in central plant shall comply with:

AS 1012 Methods of testing concrete

AS 1411 Methods of sampling and testing aggregates

AS 1379 Specification and supply of concrete

(c) *Reinforcement*

Unless otherwise specified or shown on the drawings or directed by the Engineer

reinforcement for concrete shall comply with the requirements of the following:

AS/NZS 4671 Steel reinforcing materials

AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

The reinforcement shall be free from any coating which will reduce or prevent bonding of the concrete to the steel.

(d) *Formwork*

Unless otherwise specified or shown on the drawings or directed by the Engineer formwork shall comply with the requirements of the AS 3610 Formwork for concrete

601.03 STRENGTH

Expect as specified below, concrete shall develop the cylinder strengths in accordance with Table 601.031.

Table 601.031 Cylinder strength for concrete used in incidental construction

Portland cement concrete character strength (MPa)	Minimum cylinder compressive strength (MPa)	
	7 days age of cylinder	28 days age of cylinder
N20	15	20
N25	17-18	25
N32	20	32

Unless otherwise specified, concrete used in kerb extrusion machines will not be subject to these compressive strength requirements but shall have a minimum cement of 280 kg/m³.

601.04 MIXING OF CONCRETE

Concrete shall be mixed with mechanically operated mixers in sound mechanical condition which discharge concrete with such degree of uniformity that when samples taken at the one-quarter and three-quarter points of the batch volume are tested, the difference between the two slumps shall not exceed 25mm.

The volume of concrete mixed in any mixer shall not exceed the manufacturer's rated capacity of that mixer.

The interior of the drum and the mixer blades shall be kept and free of hardened concrete or mortar by cleaning at frequent intervals. The first batch mixed in a cleaned mixer shall contain an excess of cement, sand and water over the normal batch volume sufficient to coat the inside of the mixer without adversely affecting the properties of the batch.

Each batch shall be completely discharged from the mixer before any materials are placed therein for the next batch.

601.05 PLACING OF CONCRETE

Concrete shall not be placed until the Engineer has examined both formwork and reinforcement in place and given his consent to proceed. Consent to proceed will not be given when the shade temperature is below 5°C or above 40°C or when the temperature of the concrete is less than 10°C or more than 30°C.

After mixing concrete shall be placed in the forms without delay and in the case of ready mixed concrete or concrete mixed at a central mixing plant within 1 and half hours of the addition of cement to the aggregates. The methods of transport handling and placing concrete shall be such as to minimise segregation or loss of ingredients.

Concrete shall not be under water or dropped through distance greater than 2 m without consent of the Engineer. Depositing a large quantity of concrete at any point and moving it or working it along the forms will not be permitted. Concrete which has developed its initial set or which has not been placed in the forms and compacted within 20 minutes after discharge from the agitator or on-site mixer shall not be used.

Concrete shall be placed in one continuous operation between ends of members and construction joints and within such intervals of time that the contact surface of the preceding concrete is still in a plastic condition.

601.06 COMPACTION OF CONCRETE

During and immediately after the placing operation concrete shall be thoroughly compacted by means of continuous tamping and internal vibration or other means approved by the Engineer.

During compaction, neither reinforcement nor formwork shall be displaced. Care shall be taken to fill every part of the forms to force the concrete under and around the reinforcement to work coarse aggregate back from surfaces and to eliminate voids to produce a dense concrete free from voids, honeycombing, segregation or surface defects. Vibration shall be supplemented by such hand tamping as is necessary to achieve these aims.

Vibrators shall be of type and design approved by the Engineer and shall have a minimum frequency of vibration of 100 Hz. The intensity of vibration shall be such as to visibly affect a mass of concrete having a slump between 20 and 30mm over radius of at least 0.5m.

Vibration shall be applied to freshly deposited concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued so as to cause segregation or produce

localized areas of grout. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly affected. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distance so great as to cause segregation.

601.07 MINIMUM CONCRETE COVER TO REINFORCEMENT

The minimum concrete cover to steel reinforcement and other steel embedment shall be as shown on the drawings. The dimensional tolerance of concrete cover shall be 0 to +5mm. The curing of concrete shall be continuous and uninterrupted in accordance with Clause 601.09 to ensure the effectiveness of the minimum concrete cover. Where the minimum cover required for concrete placement and the minimum allowable steel reinforcement spacing within a concrete member shall not less than 1.5 times and the maximum size of aggregate in the concrete mix or the reinforcement bar diameter whichever is greater to ensure that the concrete can be satisfactorily placed, flow and compacted around the steel reinforcement.

601.08 CONSTRUCTION JOINTS

Construction joints shall be constructed where shown on the drawings. Where it is necessary to construct such a joint in a position not shown on the drawings it shall be constructed at a location and in a manner approved or directed by the Engineer. Joints in the concrete due to stopping work shall be avoided as far as possible. Before placing new concrete against concrete which has set, the forms shall be re-tightened if necessary and the surface of the set concrete shall be roughened and cleaned for foreign matter laitance and loose material. Immediately prior to placing further concrete and contact surface shall be covered uniformly with a thin coat of cement-water paste of creamy consistency. This surface preparation work shall be completed to the satisfaction of the Engineer before concreting proceeds.

601.09 CURING

Until hard set has occurred, freshly finished surfaces shall be effectively protected from rain or injury from other sources. Concrete surfaces exposed to conditions which might cause premature drying shall be protected for a period of not less than 24 hours after placing the concrete. The surface shall be kept moist in a manner approved by the Engineer, either by flushing or sprinkling or by covering with impermeable material or permeable material kept moist for a minimum period of 7 days after placing the concrete. Curing compounds shall comply with AS 3799 and may be used only with the consent of the Engineer.

When in the opinion of the Engineer, frosts or freezing temperature are likely special precautions

shall be taken to maintain the concrete temperature at the surface of the setting concrete above 5°C.

601.10 REMOVAL OF FORMS

The materials, design, construction and remove of formwork shall comply with the relevant requirements of AS 3610. Forms shall not be removed until the concrete has the required strength to resist any formwork suction forces and with the permission of the Engineer.

601.11 FINISH OF EXPOSED SURFACES

Exposed surfaces shall be true and free from depressions or projections. Rough or porous areas and holes shall be filled with mortar. Bolts wires and other items passing through the concrete to hold the forms shall be cut off or set back 25mm below surface and any resultant holes shall be filled with mortar.

601.12 DEFECTIVE CONCRETE

The Contractor shall be fully responsible for the adequacy of forms, and for employing effective methods of mixing placing protecting and curing concrete. Approval of any such work or methods by the Engineer will not relieve the Contractor of this responsibility. Concrete not placed and completed in accordance with this specification or which in the opinion of the Engineer, is defective shall be removed within the limits assigned by the Engineer and replaced by the Contractor at his expense.

601.13 SAMPLING AND TESTING

Sampling and testing of the strength of concrete shall be carried out in accordance with Clause 6.2 of AS 1379. The frequency of sampling and testing shall provide at least one sample at the point of discharge to be tested of each 50 m³ or part thereof of each strength grade placed on any one day. Where less than 50 m³ is provided for any one day then one sample shall be tested of each strength grade.

The consistency of the concrete shall be determined by a slump test of each concrete strength sample in accordance with AS 1012.3 and Clause 5.2 of AS 1379. The concrete represented by the samples shall be deemed to comply with the nominated concrete slump if the measured slump is within the limits given in Table 5.1 of Clause 5.2 of AS 1379.

601.14 CRACKING OF CONCRETE

The concrete shall have no surface cracks at any stage after construction of width greater than 0.3 mm. Where such cracks exist, the cracked sections of concrete shall be removed and replaced or repaired.

SECTION 602 – ROAD OPENING FOR UNDERGROUND SERVICES AND MANAGEMENT OF UTILITIES

602.01 DESCRIPTION

This section covers the requirements for the excavation, backfilling and surface reinstatement of road openings, on or across road reserves associated with the installation inspection, maintenance or replacement of underground utility services as shown on the drawings, or as directed by the Engineer, or as authorised in a Road Opening Permit.

602.02 SERVICES UNDER CARRIAGEWAYS

Where pipelines or carrier conduits are placed under carriageways, the cover from the top of the pipe or carrier conduit to the pavement surface shall be not less than 1.2m and to the invert level of open drains shall be not less than 750 mm.

The Contractor shall be responsible for obtaining approval for the location of each new service from the appropriate service authority, as well as obtaining approval from all other service authorities that have services that could be affected by the installation of the new service or by the construction of the road opening.

Aerial services shall have a minimum height clearance of 5.5 m above the finished road surface level or the natural surface. Poles for aerial services shall have a minimum lateral clearance of 3 m from the edge of carriageway in urban areas and 9 m in rural areas, except where frangible poles are used

602.03 PROVISION FOR TRAFFIC

Provision for traffic shall be made in accordance with the requirements of Section 101.16

Except in an emergency or unless approved by the Engineer, no work shall be carried out on the road reserve outside daylight hours.

Where traffic lanes on heavily trafficked roads must be closed to enable excavations to be made, such closures shall be made only between the hours of 9.00am and 3.30pm unless otherwise approved by the Engineer.

Deliveries of material to the site and work on the site shall be arranged in such manner as to minimise interference to traffic. Materials shall not be dumped or stored on any carriageway or footpath without the consent of the Engineer.

602.04 BORING UNDER CARRIGEWAYS

Approval to detailed proposals for boring under carriageways shall be obtained from the Engineer before commencing work. Proposals for undertaking the work shall be submitted at least two weeks before carrying out the work.

Boring by water jetting will not be permitted.

Unless otherwise specified, the annulus between the bore and the pipe or carrier-conduit shall be filled by pressure grouting

602.05 EXCAVATION

Where it is necessary for asphalt or concrete pavements to be cut, they shall be sawn full depth. Where it is necessary to excavate a trench across a carriageway, approval to detailed proposals shall be obtained from the Engineer before commencing work. Excavation shall be carried out in a safe and work manlike manner.

Wherever practical the line of trench shall be straight and form the shortest link between terminals. The line and depth of trench shall be as approved by the Engineer. The width of trench shall be not greater than is necessary to carry out the work. Trench walls shall not slope into the Trench towards the top. Any trench greater the 1.2m of depth shall be supported to the satisfaction of the Engineer. Any drains disturbed as a result of the work shall be reinstated promptly to the satisfaction of the Engineer.

Any infrastructure located within the road reserve that is disturbed as a result of the work shall be reported immediately to the Engineer and shall be reinstated promptly in consultation with the relevant infrastructure manager.

602.06 MATERIALS

Unless otherwise specified or approved by the Engineer, materials used for bedding and backfilling shall be uniform in composition and free from perishable matter and shall comply with the requirements specified in Table 602.061.

Table 602.061 Requirements for materials used for bedding and backfilling

Material	AS Sieve Size (mm)					Plasticity Index	
	Percentage Passing (by Mass)					Min.	Max.
	75.0	37.5	19.0	2.36	0.075		
Bedding	-	-	100	-	10 - 40	2	12
Selected Backfill	-	100	-	-	10 - 40	5	20
Ordinary Backfill	100	-	-	40 - 100	-	-	-

Pavement material shall comply with the requirements of Section 301 and 302 as applicable. Bituminous cold mix or asphalt shall comply with the requirements of Section 404. Where these sections are not included in this copy of the Specification they will be supplied on request.

For the purposes of control of moisture content of the material and for determination of compaction procedure, material of nominal size greater than 40 mm is material which has more than 20% retained on that sieve.

602.07 BEDDING

Bedding shall be placed below, around and above the pipe or carrier conduit for the full width of the trench and unless otherwise approved by the Engineer, not less than 50 mm compacted depth of bedding shall be placed below, and not less than 150 mm compacted depth of bedding shall be placed above the pipe or carrier conduit. Bedding shall be placed in layers not exceeding 150 mm compacted thickness and shall be compacted as specified in accordance with Clause 501.12

602.08 BACKFILLING

Unless otherwise specified or shown on the drawings, selected backfill and ordinary backfill material shall be placed and compacted as follows under, around, and above the conduit after the sections are bedded:

(i) Conduits under Area to be Paved, including Shoulders and Verges

Where the trench has been excavated from the nominated or designed subgrade level or above, the trench shall be backfilled up to the nominated or designed subgrade level with selected backfill placed and compacted in layers not exceeding 150 mm loose thickness, and above that level with ordinary backfill material.

Where the trench is excavated from below the nominated or design subgrade level, the trench shall be filled with selected backfill material placed and compacted in layers not exceeding 150 mm loose thickness.

(ii) Conduits under Area not to be Paved

The opening shall be backfilled with common backfill placed and compacted as specified in layers not exceeding 200 mm loose thickness.

(ii) Conduits through Existing Paved Areas including Shoulders and Verges

Unless otherwise specified or shown on the drawings, the opening shall be backfilled to the existing subgrade level with selected backfill material placed and compacted in layers not exceeding 150 mm loose thickness and the pavement material placed and compacted in layers not exceeding 100 mm loose thickness using materials.

Where a sealed surface is to be reinstated, a bituminous cold mix 75 mm compacted thicknesses, or 40mm of size 10 or Size 14mm asphalt, shall be placed above the pavement material and shall be compacted flush with the road surface to the satisfaction of the Engineer to a density of 96% of the modified Maximum Dry Density. Cold mix asphalt may only be used as a temporary measure. All cold mix asphalt shall be removed and replaced with hot mix asphalt within two weeks

602.09 COMPACTION STANDARD

Unless otherwise specified, bedding and backfilling shall have uniform moisture content within the range 85% to 115% of the optimum moisture content during compaction as determined in the standard compaction test. For backfilling of material greater than 40 mm, the fraction of material passing the 37.5 mm sieve shall have uniform moisture content within the range 85% to 115% of the optimum moisture content during compaction as determined for that fraction in the Standard Compaction test.

Bedding and backfill shall be compacted to refusal using hand held mechanical equipment.

Backfilling beneath areas to be paved shall be assessed for compaction in lots as defined in Clause 165.06. The number of tests per lot shall be three. Backfill, the whole of which passes the 37.5 mm AS sieve, shall be compacted to a mean value of density ratio of not less than 97%. The calculation of density ratio shall be based on Standard compactive effort. A lot shall consist of a single layer of work. A minimum of 30% of all lots constructed shall be tested.

Detailed proposals for the compaction of backfill materials of nominal size greater than 40 mm shall be submitted to the Engineer for review before commencing work.

For existing paved areas, unless otherwise specified, pavement material shall have during compaction a uniform moisture content within the range 85% to 115% of the optimum moisture content as determined in the Modified compactive effort.

Pavement material shall be assessed for compaction in lots as defined in Clause 165.06. The number of tests per lot shall be three.

602.10 CLEANING OF SITE

Surplus excavated material shall be removed from the road reserve. Areas affected by the work shall be restored to a condition similar to that which existed prior to the commencement of the work.

602.11 MAINTENANCE

After completion of backfilling, the reinstated surface shall be maintained in a trafficable condition in accordance with the provisions of the Contractors or Road Opening permit as applicable. In paved areas, additional pavement material may be placed in the trench and compacted as specified where

settlement or loss of material is expected. Regular inspections shall be made to ensure that settlement of the trench does not exceed 20 mm below the level of the existing seal, where after maintenance action shall be undertaken.

602.12 INSPECTIONS

Notwithstanding anything to the contrary herein contained, the inspection and the examination of materials and work by the Engineer, and any consent to proceed resulting from such inspections and examinations shall not be taken as preventing the Engineer from making a further inspection and examination of the materials and work and subsequently rejecting the materials and work if shown by such further inspection and examination to be in non-compliance with the Specification.

602.13 JOINTS

- Footpaths and Surfacing

Expansion Joints

Expansion joints shall be placed at intervals not exceeding 10 m, on either side of vehicle crossings, and at junctions with existing footpaths and bridges. The expansion joint shall be 15 mm wide and filled with cork or bituminous impregnated particle board strip extending for the full width and full depth of the paving. The filler shall be placed in position before concrete is placed, and shall be held firmly in position during the placing of the concrete.

Dummy Joints

Unless otherwise specified, dummy joints at least 20 mm deep and 5 mm wide shall be formed with a cutting tool at 2.5 m intervals.

- Between Edgings and Footpaths and Surfacing

Except on narrow medians (less than 2.0 m wide) surfaced full width, bonding between the surfacing and the edging with bitumen, or by using a strip of bituminous felt material between the edging and the surfacing.

602.14 MARKING OF CONDUIT POSITIONS

The positions of any existing conduits passing under edgings shall be marked by a chase in the edging immediately above the conduit together with a suitable identification mark designated by the Engineer or as specified.

602.15 BACKFILLING AND PAVEMENT RESTORATION

Unless otherwise specified, as soon as the concrete has cured sufficiently, topsoil material, free from perishable matter, lumps or balls of clay or other deleterious matter, shall be placed and firmly compacted behind the edging to the level of the top of the edging and to a width not less than 300 mm.

Where edging has been constructed alongside an existing pavement part of which has been excavated to permit the construction of the edging and unless otherwise specified or shown on the drawings, the excavated space shall be used for this work.

SECTION 603 – CAST-IN-PLACE CONCRETE EDGINGS, PATHS AND OTHER SURFACINGS**603.01 DESCRIPTION**

This section covers the requirements for the construction of cast-in-place concrete edgings (i.e. kerbs, channels, edge strips, and vehicle and perambulator crossings), footpaths, and median and other surfacing, together with the necessary excavation and backfilling.

The use of a precast kerb and cast-in-place channel, in lieu of a fully cast kerb and channel, will be permitted provided that the kerb is supplied in accordance with Section 604. The tolerance specified in this section for cast-in-place kerb and channel will apply to the use of precast kerb and cast-in-place channel.

Kerb and channel and other edgings shall comply with the requirements of AS 2876 Concrete kerbs and channels (gutters) Manually or machine placed.

603.02 THICKNESS AND STEEL MESH REQUIREMENTS

The following thickness and steel mesh requirements shall apply:

- (i) Concrete paving including footpaths, edgings and other surfacings shall be 125 mm thick, and when steel reinforcement is specified, they shall be reinforced with SL72 steel mesh.
- (ii) Median surfacings within 2 m of the edges of medians and bays of footpath adjacent to intersecting kerb and channel shall be 150 mm thick and reinforced with SL72 steel mesh.
- (iii) Private entrance vehicle crossings shall be 150 mm thick and when steel reinforcement is specified, they shall be reinforced with SL72 steel mesh.
- (iv) Commercial vehicle crossings shall be 170 mm thick, and when steel reinforcement is specified, they shall be reinforced with SL82 steel mesh.

603.03 MATERIALS**(a) Concrete**

Concrete shall comply with the requirements of Section 601 and AS 1379 Specification and supply of concrete.

(b) Steel Reinforcement

Steel reinforcement shall comply with the relevant requirements of AS/NZS 4671 Steel reinforcing materials.

The minimum cover of any steel reinforcement to the nearest concrete surface shall be

50 mm unless shown on the drawings.

Reinforcement shall be supported using either concrete or plastic chairs. Wire chairs with or without plastic tips, bricks or pieces of timber or coarse aggregate shall not be used to support steel reinforcement.

(c) *Aggregates*

Concrete aggregates shall comply with the requirements as set out in Section 601.

603.04 SETTING OUT

The Contractor shall set out the work in accordance with the drawings and as specified.

The Engineer will review and confirm the set out. The work shall be constructed in accordance with the confirmed set out to the line and level specified by the Engineer.

603.05 PROVISION FOR DRAINAGE DURING CONSTRUCTION

Before obstructing any waterway, channel or culvert, the contractor shall make appropriate provision for its temporary diversion. The Contractor shall make provision for the safe discharge of drainage and storm water at all times during the construction of the works.

603.06 HOUSEHOLD DRAINAGE CONNECTIONS

Unless otherwise specified, existing household drains which are not connected to underground storm water drains shall be altered as necessary and connected through the kerbing to drain into the channel. Provision shall be made for connection of future household drains as specified or shown on the drawings or as directed by the Engineer.

603.07 EXCAVATION

The contractor shall carry out any necessary to excavations and disposal of excavated material off site.

The Contractor shall box out to a sufficient depth to allow for the required compacted thickness of bedding material under the full width of concrete paving.

Where it is necessary to excavate existing pavement in order to construct the section, the excavation shall not extend more than 150 mm from the edge of the adjacent section face. Existing asphalt or bituminous surfacing shall be saw cut for a sufficient depth to produce a neat vertical face.

603.08 BEDDING PREPARATION

Bedding of crushed rock, gravel or concrete, or other specified material shall be provided by the contractors as follows:

- Edgings – Where edgings are constructed over pavement layers, bedding shall be provided between the pavement layer and the underside of the edging, or the edging thickened to match the pavement layer. Where edgings are not constructed over pavement layers, bedding shall be not less than 75 mm compacted thickness.
- Foot paths and Surfacing – Unless otherwise specified or shown on the drawings not less than 50 mm compacted thickness.

Bedding shall be trimmed to the appropriate levels, moistened as necessary, and firmly compacted.

For footpaths and surfacing the foundation shall be brought true to grade and cross section as shown on the drawings by filling and excavating as necessary. All soft wet or unstable material shall be removed to a depth of not less than 100 mm below the design level of the underside of the bedding and the resulting space filled with bedding material moistened and compacted to form a stable foundation. Immediately before concrete is placed, the bedding shall be trimmed to the appropriate levels, moistened but shall have no free water on the surface.

All bedding material used for cast in place concrete paving works shall be compacted size 20 mm crushed rock.

603.09 PROVISION FOR PERMANENT SIGNS

Unless otherwise specified sign post sleeves shall be supplied and placed by the Contractor to provide for erection of permanent signs in the areas to be paved. Sleeves shall be placed at the locations shown on the drawings or where directed by the Engineer.

Unless otherwise specified or shown on the drawings, sign post sleeves shall be 100mm nominal diameter 500mm long, plugged at one end. They shall be placed vertically in the ground, with the plugged end at the bottom, and with the top of the sleeve 15-20 mm above the finished level of the footpath or surfacing and shall be installed before concreting is commenced. Any concrete which falls into the sleeve shall be removed.

603.10 MACHINE EXTRUSION

Where an extrusion or slip form machine is used the datum for grade and alignment of the section to be extruded shall be established by the Contractor.

Concrete shall be fed to the machine at a uniform rate. The machine shall be so operated as to produce a satisfactory compacted mass off concrete. Surfaces shall be substantially free from surface pitting larger than 5 mm diameter.

Where work using fixed forms is combined with extruded work and similar concrete mixes are used for both, the concrete in the fixed form sections shall be compacted with internal vibration to produce a satisfactory compacted mass of concrete.

603.11 PROFILE TRANSITIONS

Where it is necessary to join to an existing section of profile different from that being constructed, the change of profile, unless otherwise specified shall be made at a constant rate between 10 and 20 mm per meter. Transitions between different profiles being constructed under the Contract shall be made in accordance with drawings.

Matching of new to existing concrete paving shall be such that it appears identical to the existing section. When replacing damaged sections of concrete paving or footpaths, the damaged section shall be removed completely to the nearest construction joint and replaced with identical material to the existing.

603.12 FORMWORK

The materials, design, construction and stripping of formwork shall comply with the relevant requirements of AS 3610. Joints in formwork shall be constructed such that loss of mortar is prevented.

Prior to placing concrete in an earth excavation, formwork shall be erected so that fresh concrete is not placed directly against the sides of the excavation.

Formwork shall not be stripped until the minimum times specified in AS 3610 Formwork for concrete Table 5.4.1 have elapsed from the time of completion of the placing of concrete. The minimum time shall also not be less than:

- 2 days for vertical formwork on external surfaces; and
- 1 day for vertical forms on permanently hidden surfaces\

603.13 SUPPLY OF PREMIXED CONCRETE

(a) Portland Cement-based Concrete

Portland cement-based concrete shall be either N20, N25 or N32 standard strength grade, as specified for concrete paving complying with the requirements of AS 1379 Specification and supply of concrete.

(b) Kerb and Channel

Concrete used in kerb extrusion machines will not be subject to compressive strength

requirements but shall have a minimum cementitious material content in the finished concrete as follows:

- Arterial Roads, Collector Roads M1, M2, S, – a minimum of, or equivalent to, 320 kg of cementitious material
- Local Streets, C, R – a minimum of, or equivalent to, 280 kg of cementitious material

Where kerb and channel is placed and compacted with internal vibration between previously placed formwork, concrete shall be:

- Arterial Roads, Collector Roads M1, M2, S – N32 portland cement-based concrete complying with the requirements of AS 1379 Specification and supply of concrete.
- Local Streets, C, R – N25 portland cement-based concrete complying with the requirements of AS 1379 Specification and supply of concrete.

As defined in the FRA Austroads Design Guide Supplement Parts 1 to 8

603.14 PLACING, COMPACTING AND SURFACE FINISH

Concrete shall be transported, handled and placed to prevent segregation, loss or leakage of materials. Fresh concrete shall not be placed against concrete which has taken its initial set, except at properly formed construction joints. Concrete shall be thoroughly compacted by means of continuous tamping and internal vibration and shall be worked around any embedments and into corners of formwork or excavations to produce a dense concrete free from voids, honeycombing, segregation or surface defects.

Unformed surfaces shall be hand tamped to ensure a smooth surface with a uniform colour and appearance, and screeded to achieve the specified level, dimensions, falls and tolerances.

Exposed surface shall be treated as follows:

(a) Edgings

All edgings shall be rendered and have a steel trowel finish. Rendering shall be applied within 30 minutes of placing or extruding concrete in the forms. The mortar used shall consist of two parts of fine aggregate, one part of cement, and sufficient water to produce a mix of suitable consistency. The thickness of rendering shall not exceed 3 mm. Exposed surfaces shall be given a steel trowel finish and have a smooth surface with a uniform colour and appearance

(b) Footpaths and Surfacing

Fresh concrete shall be compacted with internal vibration and worked until all the coarse aggregate is below the surface and the mortar comes to the top. It shall then be struck off and finished to grade and cross section with a wooden float to produce a lightly textured non skid surface. All outside edges of slabs and all joints shall be finished with a suitable tool.

After finishing, the whole of the work shall present a consistently neat appearance of uniform colour. All arises shall be sharp and clean, no ragged edges shall be left, and bullnoses shall be regular and of uniform radius. All discoloured concrete shall be cleaned or replaced by the Contractor at his cost.

Permanently hidden concrete surfaces of concrete paving including footpaths, edgings, other concrete surfacing, and shared use paths shall have a Class 4 surface finish in accordance with AS 3610.

All other concrete elements constructed with reference to Section 603 shall have a Class 3 surface finish for external surfaces and a Class 4 surface finish for permanently hidden surfaces in accordance with AS 3610 Formwork for concrete.

603.15 CURING OF CONCRETE

The curing of exposed concrete surfaces shall commence immediately after finishing operations are progressively completed and shall continue uninterrupted for a period of not less than 7 days after placing the concrete, with the exception of concrete edgings which shall be cured for a period of not less than 3 days after placing the concrete.

Concrete shall be cured either by water curing, wet hessian, polyethylene sheeting which is adequately sealed, curing compound or a combination of these. Freshly finished exposed concrete surfaces shall be effectively protected from rain or damage from other sources, until hard set has occurred.

Curing compounds shall comply with AS 3799 Liquid membrane forming curing compounds for concrete. The curing compound shall be applied in two coats using a fine spray at the rate stated on the certificate of compliance. The curing membrane shall be maintained intact for not less than the specified period of curing. Any damage to the curing membrane during the period of curing shall be repaired immediately at the original rate of application.

At the end of the curing period, concrete paving shall provide a dense, hard wearing surface.

603.16 JOINTS

Unless otherwise specified, transverse joints shall be constructed at right angles to both the back of edgings and the edge of surfacing. Joints in surfacing shall be opposite joints in adjacent edgings

(a) Edging

i) Transverse Joints

Transverse joints shall be constructed at regular intervals not exceeding 2.5 m. For extruded edgings this shall be done by a method which does not damage or distort the adjacent surfaces. For edging constructed using fixed forms, templates shall be removed as soon as practicable after finishing the work. The guillotine (for extruded work) or template (for fixed form work) shall cut between 40% and 70% of the area of the section. In both cases the resultant slot in the edging shall be tooled to a depth of 20 mm to produce a neat groove not less than 5 mm wide on the exposed surfaces, following which a vertical cut shall be made through the base of the groove to a depth not less than 50 mm from the surface of the section.

ii) Expansion Joints

Expansion Joints shall be placed at junctions with bridges shall be 15 mm wide and filled with cork or bituminous impregnated particle board strip extending for the full width and full depth of the edging. The filler shall be placed in position before concrete is placed, and shall be held firmly in position during the placing of the concrete.

(b) Footpaths and other Surfacing

i) Expansion Joints

Expansion joints shall be placed at intervals not exceeding 10 m, on either side of vehicle crossings, at junctions with existing footpaths and shared use paths, at junctions with bridges and around all abutting structures such as pits, utility services, power poles, kerbs and other such features. The expansion joint shall be 15 mm wide and filled with cork or bituminous impregnated particle board strip extending for the full width and full depth of the paving. The filler shall be placed in position before concrete is placed, and shall be held firmly in position during the placing of the concrete.

Where required dowelled expansion joints shall be installed in accordance with the details and locations as shown on the drawings.

ii) Control Joints

Control joints at least 25% of the paving thickness deep and 5 mm wide shall be

formed with a cutting tool at 2.5 m intervals along the full width of footpaths and other surfacings within four hours of placing the concrete where the air temperature measured at the time of placement is between 20°C and 35°C and within 24 hours of placing the concrete where the air temperature measured at the time of placement is less than 20°C.

603.17 TOLERANCES ON LINE, LEVEL, AND SHAPE

All surfaces shall be finished in conformity with the lines, grades, thicknesses and cross sections shown on the drawings or as specified, within the following limits:

- Footpaths and surfacing shall be shaped to match existing fixtures, e.g. pit covers, edgings and driveways, within 5 mm.
- The departure of the finished work from line or level shall not exceed to 10 mm at any point, and the rate of change of deviation from line or level shall not exceed 10 mm in 10 m. Except on curves or in shape areas, the deviation of the finished work from a 3 m straightedge shall not exceed 5 mm at any point.
- Kerb and channel shall be constructed to the level of the adjoining pavement with a tolerance of 0 to +10 mm.
- Section dimensions shall not differ from those shown on the drawings by more than 5 mm except that overall width shall not exceed the specified width by more than 15 mm; and on dimensions less than 25 mm the tolerance shall be ± 3 mm.
- Where median surfacing is to be constructed between edge sections of substantially the same level, the paving shall be crowned to produce a cross fall towards the edges not exceeding 3% nor less than 1 %.

603.18 PROTECTION OF CONCRETE

All concrete shall be protected from damage from early loading by pedestrians, animals, vehicles and from rain or any other cause.

The Contractor shall ensure that no vehicles are permitted to cross over private entrance or commercial vehicle crossings a minimum of four days after completion of casting of the concrete. Vehicles equal to or less than 1.5 tonnes in weight may be permitted to cross after 4 days, vehicles greater than 1.5 tonnes may be permitted to cross after 7 days.

603.19 MARKING OF CONDUIT POSITIONS

The positions of any existing conduits passing under edgings shall be marked by a chase in the edging immediately above the conduit together with a suitable identification mark designated by the Engineer or as specified.

603.20 BACKFILLING AND PAVEMENT RESTORATION

Unless otherwise specified, as soon as the concrete has cured sufficiently and not earlier than 3 days after placing, topsoil material, free from perishable matter, lumps or balls of clay or other deleterious matter, shall be placed and firmly compacted in layers not exceeding 150 mm in thickness behind the edging to the level of the top of the edging and to a width not less than 300mm.

Where edging has been constructed alongside an existing pavement, part of which has been excavated to permit the construction of the edging, the excavated space shall be backfilled to the surface level of the existing pavement. Size 7 or Size 10 asphalt shall be used for this work and firmly compacted in layers not exceeding 100 mm in thickness.

603.21 CONFORMANCE TESTING FOR CONCRETE STRENGTH AND CONSISTENCY

The minimum compressive strength requirements for each strength grade shall be as shown in Table 603.211.

Table 603.211 Concrete Strength Requirements

Portland Cement Concrete Strength Grade	Minimum Compressive Strength at 28 days (MPa)
N20	20
N25	25
N32	32

Sampling and testing of the strength of concrete shall be carried out in accordance with Clause 6.2 of AS 1379. The frequency of sampling and testing shall provide at least one sample at the point of discharge to be tested of each 50 m³ or part thereof of each strength grade placed on any one day. Where less than 50 m³ is provided for any one day then one sample shall be tested of each strength grade.

The consistency of the concrete shall be determined by a slump test of each concrete strength sample in accordance with AS 1012.3 and Clause 5.2 of AS 1379. The concrete represented by the samples shall be deemed to comply with the nominated concrete slump if the measured slump is within the limits given in Table 5.1 of Clause 5.2 of AS 1379.

Compressive strength testing and slump testing shall not be required for concrete used in extruded kerbs and channels and other edgings.

603.22 CRACKING OF CONCRETE

The concrete shall have no surface cracks at any stage after construction of width greater than 0.3 mm. Where such cracks exist, they shall be identified as a non-conformance.

Cracked sections of concrete shall be either removed and replaced, or repaired as approved by the Engineer.

For damaged kerb and channel and edgings, a length of at least 1 m shall be removed and the replacement section shall be:

- (i) constructed on compacted bedding;
- (ii) dowelled into the adjoining sections with 12 mm diameter hot dip galvanised dowels embedded at least 100 mm each side of the joint; and
- (iii) shaped and finished with curved trowels to match the profile and surface finish of adjoining sections.

SECTION 604 – PRECAST CONCRETE KERB

604.01 DESCRIPTION

This section covers the requirements for the supply and placing of precast concrete kerb as shown on the drawings or at locations as specified.

604.02 SUPPLY OF KERBS

All kerbs required under this Contract shall be supplied by the Contractor and shall conform to the profiles shown on the drawings. Precast kerbs shall be constructed from concrete complying with the requirements of Section 601. The surface of all sections shall be consistently smooth and of uniform colour.

Unless otherwise specified or shown on the drawings, concrete shall be N20 standard strength grade complying with the requirements of Section 601.

Kerbs shall be cast in sufficient lengths to ensure a smooth alignment of the kerb, and in order to ensure that all sections butt together neatly, holes for placing dowels or interlocking joints shall be provided in each section.

Any section damaged during handling, storing and transporting shall not be used.

The surface of all sections shall be consistently smooth and of uniform colour.

604.03 PLACING OF PRECAST KERBS

(a) Preparation of Base

Where the kerb is not being placed on a compacted pavement layer, the foundation for the kerb shall be excavated or filled to a level 75 mm below the underside of the kerb. All soft, wet or unstable material shall be removed to at least 150mm below the underside of bedding level and backfilled with selected filling, sand or gravel of a quality that when moistened and compacted will form a stable foundation. Bedding material consisting of sand, gravel or crushed rock shall then be placed and fully compacted to the specified level.

b) Placing

The kerb shall be set so that the top conforms to the line and grade specified within a tolerance of = 10 mm. All sections shall be firmly butted together.

604.04 PLACING OF PRECAST SPIKPED KERBS

Where precast kerbs are to be pinned to existing pavements, they shall be placed true to line with adjoining sections firmly butted together. Where necessary, the sections shall be added on 6 to 1 cement mortar in order to maintain an even grade along the top of the kerb.

The kerb section shall be held in position by 12 mm diameter steel spikes 300 mm long driven into the pavement so that the tops are at least 10 mm below the tops of the kerbs. The holes in the tops of the kerbs shall then be filled level with the top with 3 to 1 cement mortar.

604.05 BACKFILLING

Backfilling behind the kerb shall be Type A material having a maximum size of 40 mm The fill shall be thoroughly compacted behind and up to the level of the top of the kerb..

SECTION 605 – BLOCK PAVING

605.01 DESCRIPTION

This section covers the requirement for paving driveways, parking areas, medians, verges, footpaths and traffic islands using manufactured paving blocks.

605.02 MATERIALS

Unless otherwise specified, the contractor shall supply all materials necessary to construct the paving including paving blocks, bedding crushed rock or gravel, bedding sand, jointing sand, and concrete or timber edging. Paving blocks shall meet the requirements specified in Clause 605.13 and have a crushing strength of 45 MPa.

Bedding and jointing sand shall consist of clean, hard, durable, naturally occurring grains free from clay, dust, soft or flaky particles, shale, salt, alkali, organic matter, soil or other deleterious substances.

Bedding and jointing sand shall be maintained at uniform moisture content.

Bedding sand shall comply with the grading requirements shown in Table 605.021.

Table 605.021 Requirements for bedding sand used in block paving

AS Sieve	9.50 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
% Passing	100	95-100	80-100	50-85	25-60	10-30	5-15	0-10

Jointing sand shall be dry, free flowing and shall all pass the 1.18 mm sieve with 10-20% passing the 0.075 mm sieve. Bedding sand shall not be used for joint filling.

605.03 CONFORMITY WITH DRAWINGS

All surfaces shall be finished in conformity with the lines, grades, thicknesses and cross sections shown on the drawings or specified within the following limits:

- (i) Paving shall be shaped to match the level of existing fixtures, (e.g. pit covers, edgings and driveways) to within 5 mm. Elsewhere the deviation of the finished work from line or level shall not exceed 20 mm at any point, and the rate of change of deviation from line or level shall not exceed 20 mm in 10 m or 2 mm between adjacent blocks. Except on curves or in shaped areas, the deviation of the finished work from a 3 m straightedge shall not exceed 15mm at any point.
- (ii) Unless otherwise specified all paving shall be shaped to shed surface water from the entire paved area in the direction of natural slope or towards constructed surface drains.

The slope at any point on the paving except on a ridge shall be not less than 1%.

- (iii) Where median or other surfacing is to be constructed between edge sections of substantially the same level, the paving shall be crowned to produce a crossfall towards the edges not exceeding 3% and not less than 1%.

605.04 SETTING OUT

The work shall be set out by the Contractor in accordance with the drawings.

605.05 PROVISION FOR TRAFFIC

The Contractor shall make provisions for traffic in accordance with Section 101 as provided for in this specification. Deliveries of material to the site shall be made in such a manner as to minimise interference to traffic and material shall not be placed on any carriageway or footpath.

If a traffic lane closure is required, the Contractor shall submit details of the proposed signing to the Engineer for review.

605.06 TEMPORARY WORKS AND PROTECTION OF PROPERTY

Before obstructing any waterway, channel, culvert, or pipe, the Contractor shall make provision for temporary diversion and submit the proposal to the Engineer for review. The Contractor shall make provision for the safe discharge of drainage and storm water at all times during the construction of the Works. The Contractor shall take every precaution necessary to protect property, including fences, buildings, poles, hedges, shrubs, gardens, and the like on or adjacent to the Works.

605.07 TRIMMING AND BEDDING

The areas on which block paving is to be placed shall be trimmed by the Contractor to an even and stable surface to allow a layer of bedding material not less than the minimum specified thickness to be placed.

Lower bedding shall consist of graded crushed rock or natural gravel, watered as necessary and compacted to form a hard, dense surface.

Upper bedding shall consist of bedding sand complying with the requirements of Clause 605.02 placed in accordance with the following requirements:

- (i) Sand shall be spread loose in a uniform layer of 20 mm nominal thickness and shall be screened in a loose condition to achieve a layer of uniform thickness, to the specified

design level, following compaction of the paving.

- (ii) The spread sand shall be carefully maintained in a loose condition and protected against precompaction both prior to and following screeding. Sand shall be lightly screened in a loose condition to the predetermined depth just ahead of the laying of the paving units. Under no circumstances shall the sand be screened in advance of the laying face to an extent to which paving will not be completed on that day.

605.08 EDGE TREATMENT

Where it is specified that paving shall match concrete edgings any protrusions on the line of the edging shall be removed to allow paving blocks to be placed abutting a straight edge. Chamfered blocks shall be placed adjacent to all concrete edgings with the lower edge of the chamfer set at the level of the top of the edging.

Following installation of the edge strip the ground surface not to be paved adjacent to the strip, shall be reinstated or filled with soil to match the finished level of the edge strip. Part width paving blocks at the edge of the paved area with or without concrete edgings, shall be saw-cut along the line of the edge.

605.09 PROVISION FOR PERMANENT SIGNS

Where shown on the drawings or specified, sign post sleeves shall be placed by the Contractor to provide for erection of permanent signs in the areas to be paved. Sign post sleeves will be not greater than 500 mm long and they shall be placed vertically with the top of the sleeve 5-15 mm below the finished level of the paving and shall be installed before paving is commenced. Any sand or debris which falls into the sleeve shall be removed.

605.10 LAYING PAVING BLOCKS

Unless otherwise specified, paving shall be laid in a stretcher bond pattern commencing at the longest straight edge with the long sides of the pavers parallel to that edge. Paving blocks shall be placed with gaps nominally 2 to 4 mm wide between adjacent blocks such that all joints are correctly aligned.

In each row, all whole blocks shall be laid first. Closure blocks shall be cut and fitted subsequently. Such closure blocks shall consist of not less than 25% of a whole block. Spaces less than 25% of a full block shall be filled with a mortar consisting of four parts sand and one part cement and coloured to match the colour of the paving blocks.

Except where it is necessary to correct any minor variations occurring in the laying pattern the paving blocks shall not be hammered into position. Where adjustment of position is necessary care shall

be taken to avoid premature compaction of the sand bedding. Any foot or barrow traffic shall use boards overlying and raised above the paving to prevent disturbance of blocks prior to compaction. No other construction traffic shall be allowed on the paving at this stage of construction

605.11 COMPACTION AND JOINT FILLING

As soon as practicable after laying the paving blocks, the paving joints shall be filled with joint filling sand and the paving shall be compacted. Joint filling sand shall be spread over the paving and broomed into the joints and not less than two passes of a plate compactor shall be used with compaction and brooming continuing until lipping has been eliminated between blocks and the joints completely filled with sand. Any blocks that are cracked or broken during compaction shall be immediately removed and replaced. All paving shall be fully compacted on the day of laying, provided that compaction shall not proceed closer than 1 m from any face where paving will be continued.

605.12 CLEAN UP

At the completion of work all unused materials and trimmed material shall be removed from the site and the paving shall be swept clean.

605.13 SCHEDULE OF DETAILS

- (i) Type/shape of block
- (ii) Colour of block
- (iii) Size of block
- (iv) Thickness of block
- (v) Thickness of bedding
- (vi) Upper bedding
- (vii) Lower bedding

SECTION 606 – BEACHING (ROCK LINING)

606.01 DESCRIPTION

This section covers the requirements for the supply and placing of rock, stone or manufactured block beaching (rock lining) for the protection of batter slopes, drainage channels and culvert endwalls as shown on the drawings. Three types of beaching are covered by this section:

- Type 1: Riprap
- Type 2: Grouted rock beaching
- Type 3: Butted paving block beaching

606.02 CONFORMITY WITH DRAWINGS

The finished surface of the beaching shall conform to the levels, lines and grades as shown on the drawings as specified. Perimeter and toe walls shall be constructed where shown on the drawings.

606.03 MATERIALS

Unless otherwise specified, the Contractor shall supply all materials necessary to construct the beaching as specified, including rock or paving blocks, bedding materials, filter materials, geotextile, concrete, mortar, reinforcement and drainage pipes.

Prior to the commencement of work, the Contractor shall nominate the source of the proposed materials, supply specified test results and provide a representative sample for approval by the Engineer.

Materials used for rock beaching shall be resistant to weathering action of air, wind and water and shall be free from staining, laminations, cracks and other structural defects which may reduce its mechanical strength.

All rock materials used for beaching shall comply with the material requirements for 'sound' rock as specified in Section 301 and the Los Angeles Value (LAV) subbase requirements of Table 301.032. The rock shall have a minimum apparent particle density of 2.5 t/m³ when tested in accordance with the requirements of the current Australian Standard - Method for sampling and testing of aggregates- Particle density and water absorption of coarse aggregate-Weighing-in-water method. In addition, the rock beaching shall have a minimum wet strength of 100 kN and a wet/dry strength variation not exceeding 45% when tested in accordance with the requirements of the current Australian Standard – Methods for Sampling and Testing Aggregates-Wet/Dry Strength Variation.

(a) Beaching Material

(i) Type 1 Beaching - Riprap

Rock for Type 1 beaching shall consist of sound, dense field or quarry rock. Sedimentary rock shall not be used. The required size of stone will be determined by the 'critical masses specified. At least 50% of the material comprising the riprap shall consist of stones having a mass heavier than the critical mass and not more than 10% by mass of the material shall not consist of stone having a mass than 20% of the critical mass. No rock shall be more than 2 times greater than the critical mass.

(ii) Type 2 Beaching - Grouted rock beaching

Rock for Type 2 beaching shall conform to the same general requirements as for Type 1 beaching except that the rocks shall be of such size that the layers of beaching shall be at least 150mm thick and of mass between 10 kg and 40 kg with at least 60% by number having a mass of over 25 kg. The rocks shall be reasonably uniform in colour. Width of joints may vary between 10 mm and 60 mm, with an average not exceeding 40 mm. Level difference between edges of adjacent rocks shall not exceed 40 mm. The joint pattern shall be random and the joints kept free from debris before grouting.

(iii) Type 3 Beaching Butted paving block beaching

Paving blocks (masonry units) shall be of a type, face size, thickness and colour as specified. All masonry units used for Type 3 beaching shall be solid units and shall comply with the requirements for masonry units in AS/NZS 4455.1. Masonry units shall be sampled to AS/NZS 4456.1 and tested in accordance with AS/NZS 4456.4, and shall have a minimum unconfined compressive strength for masonry units in AS/NZS 4455.1. The blocks shall be placed on the specified bedding sand and laid in accordance with the manufacturer's recommendation. Edge blocks shall be neatly cut to establish straight edges. Dry sand shall be broomed into joints on completion and lightly watered. The sand used in this mixture shall all pass a 1.18mm AS sieve and 10 - 20% shall pass a 0.075mm AS sieve.

(b) Bedding

- Type 1 beaching shall not require a granular bedding. However a needle-punched non-woven, "very robust (G=2000-3000)" geotextile (mass >250 g/m²), shall be laid over the trimmed surface where beaching is to be placed. Geotextiles used shall comply with and be placed in accordance with Section 608. The geotextile shall be buried to a depth of 300 mm at the edges of beaching and placed under and around the excavation for the toe wall and for any other

perimeter walls provided. The geotextile shall be laid evenly with no kinks or folds, and joints shall be formed by overlapping the geotextile by not less than 300 mm and not more than 500 mm.

- Type 2 beaching shall not require bedding unless otherwise specified or shown on the drawings.
- Bedding for Type 3 beaching shall consist of a 50mm minimum layer of bedding sand or stabilised sand with a slow setting binder.

606.04 PREPARATION OF UNDERLYING SURFACE

Areas on which beaching is to be placed shall be compacted and trimmed as required to provide a finished surface level of beaching in accordance with the drawings. Any scours or hollows in the surface shall be filled with compacted crushed rock.

Trimmed material shall be removed from the site.

606.05 BEACHING PLACEMENT

(a) General

Beaching materials shall be firmly bedded on the prepared embankment and/or bedding if required and laid in courses commencing from the bottom of any slope.

Un-grouted beaching when placed shall form a tight 'interlocking grid', which shall prevent the removal of individual rocks.

The general surface of the finished beaching shall not vary from a 3 metre straight edge laid across the surface of the beaching by more than:

- 100 mm for Type 1 Beaching
- 75 mm for Type 2 Beaching
- 20 mm for Type 3 Beaching

Finished surface levels of rock beaching placed in open drains shall be flush with adjacent soil levels. Rock beaching shall not protrude more than 50 mm above the surrounding ground levels.

(b) Type 1 Beaching

Gaps between rocks shall be as narrow as practicable and not exceed 60 mm on average. Voids shall be filled to at least mid-height of the rocks with topsoil.

The level of the topsoil shall be increased where planting is required within Type 1 rock

beaching. The topsoil depth shall be increased to finish flush with the general rock surface and adjacent ground level.

(c) Type 2 Beaching

Width of joints may vary between 10 mm and 60 mm, with an average not exceeding 40 mm. Level difference between edges of adjacent rocks shall not exceed 40 mm. The joint pattern shall be random and the joints kept free from debris before grouting.

(d) Type 3 Beaching

The blocks shall be placed on the specified bedding sand and laid in accordance with the manufacturer's recommendation. Edge blocks shall be neatly cut to establish straight edges. Dry sand shall be broomed into the joints on completion and lightly watered. The sand used in this mixture shall all pass a 1.18 mm AS sieve and 10 - 20% shall pass a 0.075 mm AS sieve.

606.06 GROUTING

Grouting with mortar shall be kept moist for 3 days after grouting. Joint mortar shall consist of once part Portland cement, three parts sand by volume, thoroughly mixed with water to produce grout of suitable consistency. Propriety cementitious mortars with equivalent performance may be used if approved by the Engineer.

Grouted rock beaching (Type 2) shall be initially placed on a bed of mortar which infiltrates joints and final grouting shall ensure that mortar is firmly tamped into joints to fill the joints to 20 mm below the general top of beaching level.

The joints shall neatly be finished by filling with mortar. Care shall be taken to keep the exposed rock face clean. Brooming of mortar across the face of the rocks will not be permitted.

606.07 PERIMETER AND TOE WALLS

Perimeter and toe walls shall be constructed where shown on the drawings.

For Type 1 Beaching, toe walls 600 mm wide by 600 mm deep shall be constructed. They shall be lined with geotextile fabric and filled with hand packed rock, the larger voids between rocks being filled with smaller stones. Where Type 1 beaching is used in streams, similar walls 600 mm wide by 600 mm deep shall also be constructed across the upstream end of the beaching.

For Types 2, 3 Beaching, concrete perimeter walls shall be constructed around exposed edges of the beaching. Concrete is to be provide in accordance with Section 804.

Toe walls shall be 300 mm wide by 400 mm deep at the front face and reinforced with L8TM trench

mesh top and bottom. The upper surface of the toe wall shall slope upwards at either the slope of the rock beaching or the adjacent verge as shown on the drawings. Side walls and other perimeter walls shall be 150 mm wide by 250 mm deep. The top of the walls shall be continuous with the beaching.

Perimeter and toe edge rocks may require a granular bedding and an underlying geotextile filter layer, if warranted by the site and hydraulic conditions. All rocks shall be carefully placed into position, rather than dumped directly, so as to avoid segregation of the rock sizes.

606.08 DRAINAGE

Where specified, or shown on the drawings, a 100 mm diameter PVC pipe shall be laid down the batter in a trench beneath the bedding to discharge immediately above the top of toe wall. The pipe shall be securely bedded within the backfilled compacted crush rock or natural gravel trench.

Weepholes consisting of 75 mm diameter PVC pipes shall be placed through the beaching at 2 m centers immediately above the top of the concrete toe wall and cut off flush with the face of beaching. Weepholes and other drainage lines shall not directly discharge onto areas of public access.

606.09 CLEANING

On completion of the work, the beaching shall be cleaned to remove all foreign materials and discolouration from the beaching surface. Any joint mortar adhering to the surrounding rock surfaces shall be removed.

SECTION 607 – GABIONS AND ROCK MATTRESSES

607.01 DESCRIPTION

This section covers the requirements for the supply of materials, assembly, installation and filling of rock filled gabions and rock mattresses.

This section also covers specific requirements for gabion retaining structures, and specific requirements for the use of gabions and rock mattresses in waterways and coastal waters.

607.02 DEFINITIONS

(a) *Gabion*

A container manufactured from hexagonal mesh wire netting or square welded mesh, partitioned into maximum 1 m³ cells, interconnected with other units and filled with rock. Gabions may be used for landscaping, erosion control, noise attenuation walls, facing panels for reinforced soil structures and retaining structures.

(b) *Gabion fill material and rock mattress fill material*

Rock used to fill gabions and rock mattresses.

(c) *Gabion retaining structure*

A mass retaining structure constructed from gabions, 1.5 m or greater in height and steeper than 0.66(H):1(V), or which would result in a traffic or pedestrian hazard or damage to neighbouring property upon failure.

(d) *Prefilled gabion*

A gabion assembled and filled with gabion fill material, and then lifted and transported prior to installation.

(e) *Rock mattress*

A container manufactured from hexagonal mesh wire netting, partitioned into maximum 2 m² cells with a maximum height of 300 mm and filled with rock, used for landscaping and erosion control.

607.03 GABIONS

a) Hexagonal mesh wire netting shall have the following properties:

- (i) wire and selvedge wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 2.7 mm and 3.4 mm respectively

- (ii) wire and selvedge wire shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to netting manufacture
- (iii) netting shall be manufactured by winding two wires around each other through three 180 rotations to form a tight, helical twist with a nominal mesh size of 80 mm x 100 mm.

Gabions manufactured from hexagonal mesh wire netting shall be partitioned into maximum 1 m³ cells, and selvedge wires shall be provided on all edges.

b) Square welded mesh shall have the following properties:

- (i) wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 5.0 mm
- (ii) welded mesh shall be manufactured with a minimum weld shear strength of 7.5 kN and a maximum mesh size of 75 mm x 75 mm
- (iii) welded mesh shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy, after mesh manufacture.

Gabions manufactured from square welded mesh shall be partitioned into maximum 1 m³ cells, and shall not be used in noise attenuation walls, facing panels for reinforced soil structures and retaining structures.

c) Fasteners shall have the following properties:

- (i) wire shall have a minimum tensile strength of 1500 MPa and a minimum diameter of 3.0 mm
- (ii) wire shall be stainless steel wire.

Fasteners shall be able to be folded around four selvedge wires with a minimum overlap of 25 mm.

d) Braces shall have the following properties:

- (i) wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 3.4 mm
- (ii) wire shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to brace forming.

Braces shall be formed by folding one wire to form a U shape with strands of nominal length 1000 mm and a span of nominal length 200 mm; returns of nominal length 100 mm shall also be provided at the open end of the brace.

e) Certificate of compliance

Prior to the commencement of work, the Contractor shall supply a certificate of compliance from the manufacturer confirming that the gabions, fasteners and braces comply with this specification, for approval by the Engineer.

607.04 ROCK MATTRESSES

a) Hexagonal mesh wire netting shall have the following properties:

- (i) wire and selvedge wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 2.0 mm and 2.4 mm respectively
- (ii) wire and selvedge wire shall be coated with a minimum of 210 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to netting manufacture
- (iii) netting shall be manufactured by winding two wires around each other through three 180 rotations to form a tight, helical twist with a nominal mesh size of 60 mm x 80 mm.

Rock mattresses manufactured from hexagonal mesh wire netting shall be partitioned into maximum 2 m² cells, and selvedge wires shall be provided on all edges.

b) Fasteners shall have the following properties:

- (i) wire shall have a minimum tensile strength of 1500 MPa and a minimum diameter of 3.0 mm;
- (ii) wire shall be stainless steel wire.

Fasteners shall be able to be folded around four selvedge wires with a minimum overlap of 25 mm.

c) Certificate of compliance

Prior to the commencement of work, the Contractor shall supply a certificate of compliance from the manufacturer confirming that the gabions and fasteners comply with this specification, for approval by the Engineer.

607.05 GABION FILL MATERIAL AND ROCK MATTRESS FILL MATERIAL*(a) General*

Gabion fill material and rock mattress fill material shall consist of rock with not less than two broken or angular faces. The rock shall be resistant to weathering action of air, wind

and water and shall be free from staining, laminations, cracks and other structural defects which may reduce its mechanical strength.

All rock used for gabion fill material and rock mattress fill material shall comply with the material requirements for 'sound' rock as specified in Section 301 and the Los Angeles Value (LAV) requirements for base material as specified in Section 301. The rock shall have a minimum apparent particle density of 2.5 t/m³ when tested in accordance with AS 1141.6.1. In addition, the rock shall have a minimum wet strength of 100 kN and a wet/dry strength variation not exceeding 35% when tested in accordance with AS 1141.22.

Prior to the commencement of work, the Contractor shall nominate the proposed source of rock and supply the specified test results for approval by the Engineer.

(b) Dimensions

The dimensions of gabion fill material and rock mattress fill material shall comply with the relevant requirements of Table 607.051.

Table 607.051 Dimensions of Gabion Fill Material and Rock Mattress Fill Material

Material	Minimum Dimension (mm)	Maximum Dimension (mm)
Gabion fill material	100	250
Rock mattress fill material	75	Two-thirds the thickness of the rock mattress, or 200 mm, whichever is the lesser.

(c) Testing

The Contractor shall sample and test gabion fill material and rock mattress fill material at a frequency of at least one test per 75 tonnes or part thereof to ensure that the material consistently complies with the dimensions shown in Table 607.051. Samples shall be obtained from stockpiles in accordance with AS 1141.3.2. Tests shall be undertaken by passing the samples through rigid screens with round holes with a diameter of the relevant dimension.

607.06 GABION ASSEMBLY, INSTALLATION AND FILLING

(a) Foundation preparation

Areas upon which gabions are to be installed shall be prepared specified in Section 202. Test rolling shall be undertaken in accordance with Clause 202.14. Any unstable areas detected by test rolling shall be rectified as specified in Section 202. Any unstable areas detected by test rolling shall be rectified as specified in Section 202.

The Contractor shall request the Engineer to be present during all test rolling.

(b) Assembly

Gabions shall be laid out on a hard, flat surface and stretched to remove all kinks and bends. Individual gabions shall be assembled by raising the sides and partitions and connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Gabions may be cut into two segments and spliced by a minimum length of 200 mm to form nonstandard dimensions. Fasteners shall be installed at both edges of the splice at maximum 150 mm horizontal and vertical intervals.

(c) Installation

Gabions shall be installed in the positions shown on the drawings and each gabion shall be connected to all adjacent gabions by connecting all abutting edges with fasteners at maximum 150 mm intervals. Temporary supports, permanent supports consisting of galvanized star pickets or galvanized steel structural sections, or tensioning shall be used as required to ensure the sides of the installed gabions do not vary by more than 50 mm from a 3 metre straight edge laid across the surface prior to, during and after filling with gabion fill material.

(d) Filling

Gabions shall be filled with gabion fill material by mechanical means aided by hand sorting to ensure that exposed surfaces are free from excessive bulges and depressions. Gabions shall be one third filled and braces installed at evenly distributed nominal 330 mm horizontal centres. Gabions shall then be two thirds filled and additional braces installed at evenly distributed nominal 330 mm horizontal centres. Gabions shall then be fully filled, the selvedge wires on the lids connected to selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals, and any temporary supports or tensioning removed.

Where bulges and depressions greater than 50 mm are present after filling, the gabions shall be refilled. Square welded mesh that is buckled by impacts during filling shall be replaced.

(e) Prefilled gabions

The use of prefilled gabions is not permitted without the prior written approval of the Engineer.

The Contractor shall submit a procedure for filling, lifting and transporting prefilled gabions for approval by the Engineer. The procedure shall demonstrate that the prefilled gabions will not vary by more than 75 mm from a 3 m straight edge laid across the surface after installation. Where required by the Engineer, a test prefilled gabion shall be filled, lifted, transported and lifted again to confirm the suitability of the procedure.

Prefilled gabions shall be installed in the positions shown on the drawings and each prefilled gabion shall be connected to all adjacent prefilled gabions by connecting accessible abutting edges only with fasteners at maximum 150 mm intervals. The exposed sides of the prefilled gabions after installation shall not vary by more than 75 mm from a 3 metre straight edge laid across the surface after installation. Where bulges and depressions greater than 75 mm are present after installation, the prefilled gabions shall be replaced.

607.07 ROCK MATTRESS ASSEMBLY, INSTALLATION AND FILLING

(a) Foundation preparation

Areas upon which rock mattresses are to be installed shall be prepared specified in Section 202.

Test rolling shall be undertaken in accordance with Clause 202.14. Any unstable areas detected by test rolling shall be rectified as specified in Section 202.

The Contractor shall request the Engineer to be present during all test rolling.

A separation/filtration geotextile layer shall be placed on the prepared surface. The geotextile shall comply with the requirements of Section 608, and shall have a classification of very robust, an overlap of 300 mm, and shall be a non-woven type geotextile. The geotextile shall be placed as specified in Section 608, and shall be buried to a depth of 300 mm at the edges of the areas upon which rock mattresses are to be installed.

(b) Assembly

Rock mattresses shall be laid out on a hard, flat surface and stretched to remove all kinks and bends. Individual rock mattresses shall be assembled by raising the sides, ends and partitions and connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Rock mattresses may be cut into two segments and spliced by a minimum length of 200 mm to form nonstandard dimensions. Fasteners shall be installed

at both edges of the splice at maximum 150 mm horizontal and vertical intervals.

(c) *Installation*

Rock mattresses shall be installed in the positions shown on the drawings. Rock mattresses installed on slopes shall be arranged with the longest dimension of the rock mattress in the direction of the slope. Each rock mattress shall be connected to all adjacent rock mattresses by connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Permanent anchors consisting of galvanized star pickets shall be installed on a minimum 1 m by 1 m centre grid. The galvanized star pickets shall be driven into the foundation to a minimum depth of 500 mm and shall be connected to the base of the rock mattress with a fastener.

(d) *Filling*

Rock mattresses shall be filled with rock mattress fill material by mechanical means aided by hand sorting to ensure that exposed surfaces are free from excessive bulges and depressions. Rock mattresses shall be fully filled and the lids connected to all abutting edges with fasteners at maximum 150 mm intervals. The lids of the rock mattresses shall not vary by more than 50 mm from a 3 metre straight edge laid across the surface. Where bulges and depressions greater than 50 mm are present after filling, the rock mattresses shall be refilled.

607.08 GABION RETAINING STRUCTURES

(a) *General*

Gabions manufactured from square welded mesh and rock mattresses shall not be used in gabion retaining structures.

(b) *Design*

Gabion retaining structures shall be designed in accordance with AS 5100.3, and the following requirements:

- (i) the design life shall be 100 years
- (ii) the gabions shall lean backward into the retained material and the base of the gabions shall have a slope of 10(H):1(V)
- (iii) the gabion fill material design source rock unit weight shall be 24.5 kN/m^3 , unless demonstrated otherwise by nominating the source rock and supplying apparent particle density test results in accordance with Clause 607.05(a)
- (iv) the gabion fill material design porosity shall be 20% for design for bearing failure

and global failure ultimate limit states, and shall be 40% for design for sliding, rotation and structural failure ultimate limit states, unless demonstrated otherwise by determining the porosity using a sacrificial test gabion

- (v) the Type A structural material, permeable fill material or no fines concrete design effective cohesion shall be 0 kPa, the design effective friction angle shall be 40, and the design unit weight shall be 20 kN/m³.

In addition, for gabion retaining structures with a retained height of 6 m or more:

- (i) the gabion fill material design source rock unit weight shall be determined by nominating the source rock and supplying test results demonstrating the minimum apparent particle density
- (ii) the gabion fill design porosity shall be determined by preparing a sacrificial test gabion and measuring the mass of gabion fill material in the test gabion, in tonnes to the nearest 0.1 tonne, and the volume of the test gabion, in m³ to the nearest 0.1 m³. The gabion fill design porosity shall then be determined using:

$$1 - \frac{\text{(mass of gabion fill material in test gabion, t) / (apparent particle density, t/m}^3\text{)}}{\text{volume of test gabion, m}^3}$$

- (iii) the design shall be proof-engineered by an appropriately qualified engineer.

(c) Foundation preparation

In addition to the requirements of Clause 607.06(a), the prepared surface shall have a slope of 10(H):1(V).

(d) Installation

In addition to the requirements of Clause 607.06(c), temporary supports, permanent supports or tensioning shall be used as required to ensure the top of the first layer of gabions has a slope of 10(H):1(V) prior to filling with gabion fill material. For subsequent layers of gabions, the placement of a screed layer of gabion fill of nominal dimension 70 mm on the underlying layer may also be used as required to ensure the top of the gabions has a slope of 10(H):1(V) prior to filling with gabion fill material.

In addition, for gabion retaining structures with a retained height of 6 m or more:

- (i) in addition to the requirements of Clause 607.06(d), internal braces shall be installed at evenly distributed nominal 250 mm horizontal centres
- (ii) gabions shall be installed in a stretcher bond pattern, so that the ends of the gabions

are staggered vertically from the ends of the gabions in the layers above and below

- (iii) the Contractor shall request the Engineer to be present during the installation of gabions to ensure the top of the gabions have a slope of 10(H):1(V) prior to filling with gabion fill material.

(e) Material placed behind gabion retaining structures

Prior to placing material behind gabion retaining structures:

- (i) a separation/filtration geotextile layer shall be placed on the rear of the gabion retaining structure. The geotextile shall comply with the requirements of Section 608, and shall have a classification of very robust, an overlap of 300 mm, and shall be a non-woven type geotextile;
- (ii) a subsurface drainage pipe shall be placed at the base of the rear of the gabion retaining structure. The subsurface drainage pipe shall comply with the requirements of Section 502, and shall be a category 2 pipe, shall have a minimum diameter of 100 mm, shall have a perforation size of 2 mm and shall be fitted with a knitted seamless sleeve.

Material placed behind gabion retaining structures shall consist of:

- (i) Type A structural material, consisting of 20 mm Crushed Rock Base, complying with the requirements of Section 301 and with a minimum permeability of 1×10^{-8} m/s, shall be placed and compacted as specified in Section 202 Clause 202.12, Testing and acceptance of compaction and moisture content shall be undertaken as specified in Section 202 Clause 202.15 Scale A compaction requirements and Test rolling shall be undertaken in accordance with Clause 202.14. Any unstable areas detected by test rolling shall be rectified as specified in Section 202;
- (ii) permeable fill material, consisting of Grade A4, A5, A6, B1, B2, B3 or B4 granular filter material which shall comply with the requirements of Section 502. Permeable fill material shall be placed and compacted as specified in Section 202 Clause 202.11;
- (iii) no fines concrete, which shall comply with the requirements of Section 502. Permeable fill material shall be placed as specified in Section 202 Clause 202.11.

607.09 GABIONS AND ROCK MATTRESSES IN WATERWAYS

Gabions and rock mattresses shall not be installed below the 1:50 annual recurrence interval flood level of waterways with a permanent flow of water without the prior approval of the Engineer.

The Contractor shall submit a proposal for protecting gabions and rock mattresses from damage from debris impact, and written consent from the relevant Catchment Management Authority, for approval by the Engineer.

607.10 GABIONS AND ROCK MATTRESSES IN COASTAL WATERS

Gabions and rock mattresses shall not be installed below the highest astronomical tide level of tidal waterways or coastal waters, or within the splash zone of coastal waters.

SECTION 608 – GEOTEXTILES

608.01 GENERAL

This section covers the requirements for the supply and handling and placing of geotextiles as a separation and filtration layer, in earthworks at locations shown on the drawings or specified.

608.02 SUPPLY OF MATERIALS

The Contractor shall supply the geotextiles specified in accordance with the requirements of this section of the specification. After delivery of the geotextiles to site, the Contractor shall ensure that the geotextiles are kept clean and undamaged and stored away from direct sunlight until covered. Any damaged or improperly stored geotextiles shall be replaced by the Contractor. The Contractor shall provide evidence to the Engineer that the geotextile supplied under the Contract conforms with the appropriate requirements of this section of the Specification, prior to its use.

608.03 PROPERTIES OF GEOTEXTILES

(a) General

The geotextile shall consist of woven or non-woven fabric manufactured from synthetic fibres of a long chain polymer such as polypropylene, polyethylene, polyester or similar. Woven geotextiles shall have filaments interlaced in two sets, mutually at right angles. One set shall be parallel to the longitudinal direction of the geotextile.

Non-woven geotextiles shall have filaments bonded by needle punching, heat or chemical bonding processes.

After forming, the geotextiles shall be processed so that the fibres retain their relative positions with respect to each other. The geotextiles shall be free from defects or flaws which significantly affect its physical and/or filtering properties.

(b) Robustness

The geotextile shall have a robustness (Geotextile Strength Rating – G) complying with the requirements of Table 608.031

Table 608.031 Requirements for robustness of geotextiles

Classification	Robustness (G)
Moderately Robust	900 - 1350
Robust	1350 - 2000

Very Robust	2000 - 3000
Extremely Robust	> 3000

Determination of robustness (G) shall be in accordance with VicRoads Test Method RC 381.01 *Calculation of Robustness of Geotextile Material*.

(c) *Equivalent Opening Size*

Where specified in Clause 608.07 as a separation/filtration material, both woven and non-woven geotextiles shall have an equivalent opening size between 85 and 230 microns. The equivalent opening size determination shall be carried out in accordance with AS 3706.7 *Determination of pore size distribution - Dry sieving method*,

(d) *UV Radiation Stabilisation*

The geotextile shall be stabilised against deterioration due to ultra-violet radiation such that when tested in accordance with AS 3706.11, the geotextile must have retained strength of at least 50% after 28 days of test exposure. After forming, the geotextile shall be processed so that the fibres retain their relative positions with respect to each other. The geotextile shall be free from defects or flaws which adversely affect its physical and mechanical properties.

(e) *Testing*

All testing shall be performed by laboratories with third party accreditation to ISO/IEC 17025 by a signatory to the International Laboratories Accreditation Cooperation (ILAC) scheme, e.g. by NATA (National Association of Testing Authorities, Australia), or by a laboratory accredited to ISO/IEC 17025 through NATA's Mutual Recognition Arrangement (MRA) Network process.

Test certificates shall be in the English language.

Sampling shall be in accordance with AS 2490, and testing shall be in accordance with the relevant part of AS 3706.

Test certificates shall be submitted for each delivery of geotextile supplied to the works. Test certificates for the same material produced and tested within 12 months prior to the proposed use will be accepted, except for geotextile material used in structural applications, as detailed in Table 608.032, below.

Where no test certification is provided, test samples from each roll of geotextile shall be selected and the test results reported in accordance with the relevant part of AS 3706. Tests shall include the determination of the material properties specified in Clause 608.03(b), (c) and (d) of the geotextile for the consignment delivered.

Table 608.032 Frequency of Testing for Geotextile Material Properties

Geotextile Use	Test	Test frequency
General use	AS 3706.1 AS 3706.2 AS 3706.3 AS 3706.4 AS 3706.5 AS 3706.7 AS 3706.9 AS 3706.11 RC 381.01	Annual
Geotextile used in structural fill applications	AS 3706.1 AS 3706.2 AS 3706.3 AS 3706.4 AS 3706.5 AS 3706.7 AS 3706.9 RC 381.01	Test results on the test certificate shall include at least one set of results for each month of geotextile manufacture.
	AS 3706.11	Annual

608.04 PREPARATION

Prior to placing any geotextiles the Contractor shall excavate the surface material to the depth shown on the drawings or specified. The area shall then be trimmed to provide a uniform surface freely draining to points clear of the road formation.

Where the surface having been trimmed becomes unstable for whatever reason, the Contractor shall treat in situ or remove and replace the unstable material to the condition that the surface has the required strength to support the weight of construction traffic and plant and no additional payment shall be made for this work.

608.05 PLACING GEOTEXTILES AND BACKFILLING

The placement of geotextile is not permitted without the written approval of the Engineer.

(a) General

The Contractor shall place the specified geotextile to the limits as shown on the drawings or specified. The geotextile shall be subject to a visual inspection by the Contractor's geotechnical consultant during placing. A certificate of compliance shall be provided by the Contractor's geotechnical consultant to verify that the coverage and ground preparation for placement of the geotextile have been executed in accordance with the drawings and this specification.

The geotextile shall be placed without punctures or tears and, if these occur, they shall be rectified or the entire roll of geotextile replaced prior to covering. Any rolls with imperfections shall not be used. Geotextiles used in subsurface drains shall be placed to conform approximately to the shape of the excavation. The geotextile shall fully envelop the drainage material in the excavation. All joints shall be overlapped or sewn in accordance with requirements specified in Clause 608.07. Geotextiles shall be covered by filling within 48 hours of placement.

(b) Type B Material

The Contractor shall supply and place over the geotextile Type B material of maximum particle size of not more than 150 mm and moisture ratio of not less than 85% as determined by test using the Standard compactive effort. The initial layer of Type B material shall be placed and compacted to the maximum density practicable without causing further instability in the underlying materials upon which the geotextile has been placed. Subsequent layers of Type B material shall also be placed to the maximum density practicable until stability is achieved and a layer satisfies the test rolling requirements specified in Section 202 as applicable. Any remaining layers of fill to be placed above the stable layer shall be placed and compacted in accordance with the requirements of Section 202 as applicable.

(c) Permeable Fill Material

Where shown on the drawings or specified, the Contractor shall supply and place permeable fill material of the depth specified in Clause 608.07 over the geotextile. The geotextile shall be of the type of filtration and separation classification. The permeable fill material shall comply with the requirements of Clause 608.06 and have a moisture content compatible with achieving maximum density practicable. The initial layer of permeable fill material shall be placed and compacted to the maximum density practicable without causing further instability or loss of shape to the trimmed surface upon which the geotextile has been placed. Any subsequent layers of permeable fill material shall also be placed to the maximum density practicable until the full depth of permeable fill material specified has been placed.

Following placement of the specified depth of permeable fill material, a second layer of

geotextile (filtration and separation) shall be placed as specified to completely enclose the permeable fill material before placement of Type B material commences.

608.06 SUPPLY OF PERMEABLE FILL MATERIAL

For the purpose of this section, permeable fill material shall:

- (i) comply with the requirements of Section 202 or;
- (ii) consist of hard, durable and clean sand or gravel, or crushed stone from a source rock with a Los Angeles Abrasion Loss of not more than 45 or;
- (iii) have maximum particle size not exceeding 19 mm and a permeability not less than 10^{-4} m/sec when compacted to a density ratio value of 100% based on Standard compactive effort.

608.07 SCHEDULE OF DETAILS – NOT USED

SECTION 609 – CONCRETE BASE AND LEAN MIX CONCRETE SUBBASE**609.01 GENERAL**

This section covers the requirements for the supply and quality of materials and for the construction of lean mix concrete subbase and plain (unreinforced), reinforced and continuously reinforced concrete base pavement courses.

Paving shall be carried by a mechanical paver with the exception of odd shapes and difficult to access areas, anchors and subgrade beams which shall be constructed by manual methods.

609.02 STANDARDS*(a) Australian Standards*

AS 1012	Methods of testing concrete
AS 1379	Specification and supply of concrete
AS 3679	Hot rolled structural steel bars and sections
AS 3799	Liquid membrane - Forming curing compounds for concrete
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings

(b) VicRoads Codes of Practices

RC 500.16	Code of Practice for Selection of Test Methods for the Testing of Materials and Work
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(c) Additional Test Methods

ASTM C 603	Extrusion Rate and Application Life of Elastomeric Sealants
ASTM C 679	Tack-free Time of Sealants
ASTM C 793	Weathering of Sealants
ASTM C 794	Peel Adhesion of Sealants
ASTM D 792	Density of Plastics
ASTM D 2240	Rubber Hardness
ASTM D 2628	Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

RTA T1192 Adhesion of sealant

RTA T1193 Sealant accelerated ageing

609.03 CONFORMITY WITH DRAWINGS

The pavement base and subbase courses shall be finished to a smooth and uniform surface and shall conform within the limits to the levels, lines, grades, thicknesses and cross sections shown on the drawings.

Conformity within the limits shall be assessed for every test lot as defined in Clause 609.05(a), for a minimum of three survey points across the width of the cross section at intervals of no greater than 5 metres for the whole length of the test lot.

(a) Alignment

The edge of the base and subbase shall be within 15 mm and 25 mm of the plan location, respectively. The horizontal alignment of the edges shall not deviate by more than 5 mm and 10 mm from a 3 metre straight edge placed along the edge of the base and subbase, respectively.

(b) Surface Level

The level at the top of the base shall not be less than the specified level nor exceed the specified level by more than 10 mm except against kerb and channel where the surface shall be flush with or not more than 5 mm above the lip of the channel.

The level of the top of the subbase shall not exceed the specified level or be more than 15 mm below the specified level.

(c) Shape

No point on the finished surface of the base shall lie more than 5 mm below a 3 metre straight edge laid on the surface at any location, and in any direction, including across joints. The surface shape of the base shall be such that water cannot pond at any point.

No point on the surface of the subbase shall lie more than 5 mm below a 3 metre straight edge laid on the surface in any direction.

(d) Width

The width of the base and subbase shall not be less than the design width and not greater than the design width by more than 50 mm.

(e) Thickness

The thickness of the subbase and base at any point shall not be less than the specified

thickness by more than 15 mm and 10 mm, respectively.

609.04 CONCRETE MIX DESIGN

(a) General

The Contractor shall be responsible for the mix design of all concrete, including any other nominated requirements, so that the specified durability, strength and other requirements of the hardened and plastic concrete are achieved.

The concrete used for the construction of the base and subbase pavement courses, anchors and subgrade beams shall comply with the requirements of Section 804 unless specified otherwise in this section.

(b) Requirements for Lean Mix Concrete Subbase Course

The mean 28 day compressive strength of the concrete mix used for the construction of the lean mix concrete subbase course shall be 6 MPa to 15 MPa. The lean mix concrete shall be sampled and tested in accordance with the requirements of Clause 609.05, except that each sample shall consist of four specimens tested in accordance with AS 1012. The mean compressive strength shall be the average of at least three individual results within a range of 2.0 MPa.

The minimum cementitious material content in the lean subbase course mix shall be 150 kg/m³ of concrete.

(c) Requirements for Concrete Base Pavement Course

Base course concrete shall have a 28 day characteristic compressive strength ($f'c$) of 30 MPa to 40 MPa for use in continuously reinforced concrete pavements and greater than 30 MPa for jointed concrete pavements. This characteristic strength shall be calculated to the nearest 0.1 MPa as follows:

$$f'c = \bar{x} - 1.35s$$

where: $f'c$ = characteristic compressive strength of the mix

\bar{x} = mean 28 day compressive strength determined from a sample of three specimens of concrete sampled and tested in accordance with the requirements of Clause 609.05 and AS 1012.

s = standard deviation of the compressive strength results of the concrete plant determined in accordance with AS 1379.

The minimum cementitious material content in the base course mix shall be 300 kg/m³ of

concrete.

609.05 ASSESSMENT OF CONCRETE

(a) General

Assessment of concrete shall be based upon the following criterion:

- (i) 28 day compressive strength values of cylinder specimens cast on site with strengths adjusted for in situ density
- (ii) thickness determined from subbase and base surface level measurements.

The concrete shall be assessed in lots and all lots shall be tested. A lot shall consist of work constructed under essentially uniform conditions and is essentially homogeneous with regard to material and appearance. A lot shall normally consist of one day's work unless there has been a change in materials or mix proportions which could affect the uniformity of the lot, or there has been a substantial interruption to the casting process requiring a construction joint to be made. In such cases the work shall be split into more than one lot and each lot shall be assessed separately for compliance with the specification.

(b) Sampling and Testing of Cylinder Specimens

The Contractor shall sample, prepare, cure and compression test the cylinders cast on site in accordance with AS 1012.

The concrete shall be sampled at the point of discharge to the roadbed. Each sample shall consist of two cylinder specimens for testing at age 28 days.

The number of samples in each lot shall be related to the expected volume of concrete placed in that lot according to Table 609.051.

Table 609.051 Number of Samples for Testing of Cylinder Specimens

Number of Samples	Volume of Concrete (m ³)
2	Less than 50
3	50 - 100
4	101 - 250
5	More than 250

The Contractor shall develop and implement a site sampling procedure to ensure the concrete quality for the day's production. Samples shall be taken at approximately equal portions of the volume cast in one continuous operation. If the casting process is unexpectedly interrupted or terminated the samples taken to that time shall represent the lot.

(c) *Concrete Cores*

Density and compaction testing shall be based on cores taken from the concrete pavement at seven days. The bounds of each base course lot for density and thickness testing, and the bounds of each subbase course lot for density testing only shall be selected to coincide with the lots selected for compressive strength testing and, within the lot, sites for testing shall be selected on a random basis except that no site shall be selected within 300 mm of a joint or slab edge.

For each base course lot six cores shall be taken.

For each subbase course lot six density tests shall be performed using either cored samples or a nuclear gauge.

Cored specimens taken for density testing shall not be used if they are damaged during the coring operation or during transport. Rejected specimens shall be replaced with other specimens from the same lot.

The Contractor shall reinstate core holes within 24 hours of cores being taken. Core holes shall be reinstated with shrinkage compensating polymer modified cementitious material having a compressive strength not less than that in the base or subbase.

The surface of the reinstated hole shall be similar to the surrounding concrete surface in texture and colour and shall be covered with a curing compound.

Prior to trafficking or placement of the subsequent concrete layer the cementitious material in the core shall be cured sufficiently to achieve an estimated compressive strength of 4 MPa.

Reinstatement of the cored holes shall be completed prior to the application of any surface debonding treatment.

(d) *Concrete Base Course*

(i) *Density of Cylinder Specimens*

The saturated surface dry density of cylinder specimens (C_c) of a lot shall be determined in accordance with AS 1012 Part 12 at the same age at which the density of cores of the lot are determined. The mean cylinder density (C_c) of a

lot shall be calculated using all the compressive test cylinder specimens in that lot.

(ii) Density of Concrete Cores

The saturated surface dry density of cores shall be determined in accordance with AS 1012 Part 12 and the mean core density (C_f) of the lot determined using all density test values from the cored samples in that lot.

(iii) Assessment of Compressive Strength (Cylinder Specimens)

(1) Unadjusted Characteristic Strength (D_u)

Where six or more test values of 28 day compressive strength of a lot are available the characteristic strength of the lot shall be calculated to the nearest 0.1 MPa as follows:

$$D_u = \bar{x} - ks$$

where:

D_u = unadjusted characteristic strength of the lot

\bar{x} = average cylinder strength of all specimens from the lot

s = standard deviation of cylinder strength of all specimens from the lot

k = a factor which depends on the number of specimens in the lot as shown in Table 609.052.

Table 609.052

n	8	9	10
k	1.42	1.40	1.38

Where less than eight test values of 28 day compressive strength of a lot are available the characteristic strength of the lot shall be calculated to the nearest 0.1 MPa as follows:

$$D_u = \bar{x} - 3s$$

(2) Adjusted Characteristic Strength (D_a)

The unadjusted strength of the lot shall be adjusted for compaction as

follows.

Calculate the density ratio of the lot (R_c) defined as:

$$R_c = \frac{100 C_f}{C_c}$$

If R_c is greater than or equal to 100.0% then D_a , the adjusted characteristic strength of the lot, shall equal D_u , the unadjusted characteristic strength of the lot.

If R_c is less than 100.0% but is greater than or equal to 97.0%, the unadjusted characteristic strength of the lot D_u shall be adjusted as follows:

$$D_a = D_u \left[6.94 \frac{R_c}{100} - 5.94 \right]$$

If R_c is less than 97.0% the lot shall be rejected.

Lots shall be assessed for strength in accordance with Table 609.053 or Table 609.054, as appropriate.

Table 609.053 Continuously Reinforced Concrete Pavements

D_a (MPa)	Assessment	Payment %
Greater than 40.0	Accept	180 - 2 D_a
30.0 to 40.0	Accept	100
27.0 to 29.9	Accept	10 D_a - 200

Table 609.054 Jointed Concrete Pavements

D_a(MPa)	Assessment	Payment %
Greater than 30.0	Accept	100
27.0 to 30.0	Accept	10 D_a - 200

(iv) Assessment of Base Thickness

The thickness of a lot shall be determined as follows:

Within the lots defined for assessment of compressive strength the surface levels of the subbase shall be checked longitudinally and transversely for conformity

with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- at the edges of the pavement
- at all changes of gradient across the pavement
- at intervals not exceeding 2 m across the pavement.

Levels of the base surface shall be taken at the same locations as taken on the subbase. For each lot the measured differences (Xi) at each location shall be calculated to the nearest 1 mm as follows:

$$X_i = (\text{base level})_i - (\text{subbase level})_i$$

The departure of the lot thickness from the design thickness shall be calculated to the nearest 1 mm as follows:

$$T = D - \bar{x}$$

where:

T = departure of the lot (mm)

\bar{x} = mean thickness determined from the level differences (Xi) for the lot (mm)

D = design thickness (mm)

Lots shall be assessed for thickness in accordance with Table 609.055.

Table 609.055

T (mm)	Assessment	Payment %
Less than 0.0	Accept	100
0.0 to 10.0	Accept	100 - 3T

(e) Concrete Subbase Course

(i) Assessment of Compressive Strength (cylinder specimens)

The 28 day compressive strength of each sample shall be calculated as the mean of the values from the pair of specimens comprising that sample, providing the strength values do not differ by more than 3.5 MPa. If the values differ by more

than 3.5 MPa then the higher of the two values shall represent the compressive strength of the sample. Where one specimen of the pair has been rejected for testing the remaining specimen shall represent the strength of that sample.

The mean 28 day strength (A) of a lot shall be calculated to the nearest 0.1 MPa using all cylinder specimens for that lot. Concrete shall be accepted or rejected in accordance with Table 609.056.

Table 609.056

Mean 28 Day Compressive Strength of Lot (MPa)	Assessment	Payment %
Greater than 15.0	Accept	130 - 2A
6.0 to 15.0	Accept	100
5.0 to 5.9	Accept	30A - 80

(ii) **Compaction of Subbase**

The mean field density of a lot (C_f) shall be calculated using all field density test values from the cored samples or nuclear gauge sites in that lot.

The mean density of the cylinder specimens of a lot (C_c) shall be calculated using all the compressive test cylinder specimens in that lot.

The density ratio of the lot (R_c) is defined by:

$$R_c = \frac{100 C_f}{C_c}$$

If the density ratio of the lot is greater than or equal to 98.0%, the lot will be accepted as far as compaction is concerned provided that if the density ratio of the lot is less than 98.0% but greater than or equal to 97.0% payment for such work will be made at a rate of 70% of the rate for supply and placement of subbase concrete.

609.06 MANUFACTURE AND DELIVERY OF PREMIXED CONCRETE

(a) *General*

The Contractor shall be responsible for the manufacture and delivery of all concrete which

shall comply with the requirements of Section 804 and AS 1379.

(b) Methods of Production and Transport

The Contractor's production and transport shall be as follows:

- (i) limit segregation or loss of materials;
- (ii) supply a homogeneous product;
- (iii) result in concrete workability, at the time of incorporation, which is compatible with the capacity of the placing equipment to achieve the specified compaction and surface finish.

Concrete shall be supplied from the Contractor's nominated production plant for the duration of the daily paving operations.

609.07 CONCRETE PLACEMENT

Unless otherwise specified, concrete shall be spread using a paver except for small areas where use of a paver is not practical in which case concrete shall be placed by manual methods between fixed forms.

(a) General

The Contractor shall give the Engineer seven days written notice of its intention to commence construction of any section of the works or carry out a trial of the concrete subbase or base course.

Concrete shall not be placed until the proposed method of placement, spacing of planned transverse construction joints and the provision of dowels, constructed formwork, reinforcement and embedments conforming to the requirements of this specification and the drawings, has been reviewed by the Engineer.

For the subbase course loose material shall be removed from the surface of the subgrade and the subgrade shall be wetted to ensure a uniformly moist surface at the time of placing.

Where required, the Contractor shall provide concrete sawing equipment at the paving site before concrete is placed.

Concrete shall not be placed when the temperature is below 5°C or above 35°C and the temperature of concrete, when placed, shall be not less than 10°C nor more than 32°C. Concrete shall not be placed when rain is falling or when rain is expected within one hour of placing. The Contractor shall have available on site sufficient waterproof covers to

protect the freshly placed concrete against the effects of unexpected rain. Covers when required shall be installed in such a manner to not disturb the surface of the subbase or base slab.

The methods of concrete placement shall minimise segregation by placement at a uniform rate with a minimum of rehandling. The face of freshly placed concrete shall be generally vertical, full width of the slab and normal to the direction of placing.

(b) Trial Concrete Subbase and Base Courses

Prior to commencing paving of the respective full scale works the Contractor shall construct a trial section, unless otherwise approved by the Engineer, of both the concrete subbase and base using the same materials, concrete mix and equipment as proposed for the construction of the full scale works, to satisfy the specification requirements. The methods proposed for finishing, texturing, application of curing compound, sawing of joints, placement of dowels, tie bars and reinforcement shall be demonstrated and documented as part of these trials.

For a mechanical paver a trial length of between 50 and 100 metres at the maximum width proposed to be laid shall be constructed in one continuous operation. Separate trials are required for each mechanical paver.

For manual paving a trial length of between 15 and 50 metres at the maximum width proposed to be laid shall be constructed in one continuous operation to a minimum of 25 m³ of concrete.

The Engineer shall require a new trial section at any stage of the full scale works if the Contractor makes any changes to the equipment, materials, mix, plant or rate of paving or when concrete as placed and jointed does not comply with the Specification.

In the event of deficiencies in the trial concrete the Engineer may require a new length of trial concrete subbase or base, using a modified procedure to rectify such deficiencies. Any delays caused through deficiencies in the trial sections shall not constitute justification for extension of time.

If the trial sections conform to the specification requirements, they will be accepted as part of the works.

The Contractor shall not proceed with full scale works until the trial has been reviewed by the Engineer.

(c) Placement by Paver

The paver shall be operated such that a concrete slab having the specified alignment

profile, ride quality, density and compaction is achieved.

Concrete feed shall be arranged such that the paver is operated in a continuous forward motion and stoppage of the paver is avoided. Should an essentially continuous rate of progress not be maintained, paving operations shall cease until appropriate remedial action has been taken.

In addition to the paver, the Contractor shall have available at the paving site equipment to carry out the following works:

- (i) completion of concreting work to a construction joint in case of paver breakdown;
- (ii) remedial work to any slab when the paver has not finished the work to a satisfactory standard;
- (iii) construction of odd shaped areas which cannot be done by a paver.

(d) Manual Placement of Concrete (between Fixed Forms) and Replacement Base Slabs

Replacement slabs and concrete placed manually (between fixed forms) shall comply with the base course requirements of Clauses 609.04 and, 609.05.

Forms shall be of sufficient size and rigidity and positioned such that the geometry of the compacted and finished concrete satisfies the requirements of Clause 609.03. Forms shall be mortar tight and debonded to ensure non-adhesion of the concrete to the forms.

Concrete shall not be placed until the Engineer has reviewed the proposed method of placement, compaction, and curing of concrete.

During compaction no formwork or reinforcement shall be displaced. Care shall be taken to fill every part of the forms to force the concrete under and around any reinforcement and any dowels and tie bars and to work coarse aggregate back from form surfaces.

(e) Compaction

Base and subbase concrete shall be compacted to meet the requirements of Clause 609.05. Concrete placed around dowel bars shall be carefully vibrated without the vibrators touching the dowels.

(f) Screeding and Finishing

The concrete shall be finished to provide a dense and homogeneous concrete surface satisfying the requirements of Clause 609.03.

The subbase concrete shall be finished to a uniform non-textured surface. The base concrete shall be finished to a textured surface as specified.

(g) Rate of Evaporation

The Contractor shall be responsible for measuring concrete temperature and wind velocity at the point of concrete placement and for measuring and recording air temperature and relative humidity at the site throughout the course of the work.

When the value of the Rate of Evaporation as determined from Figure 609.071 exceeds 0.50 kg/m² per hour the Contractor shall take precautionary measures to prevent excessive moisture losses in the form of an evaporative retarding compound in accordance with the requirements of Clause 609.18(b). If these measures prove unsatisfactory in reducing moisture losses or damages the finished surface the Contractor shall cease concreting whilst the evaporation rate is in excess of the abovementioned rate or satisfactory measures are implemented.

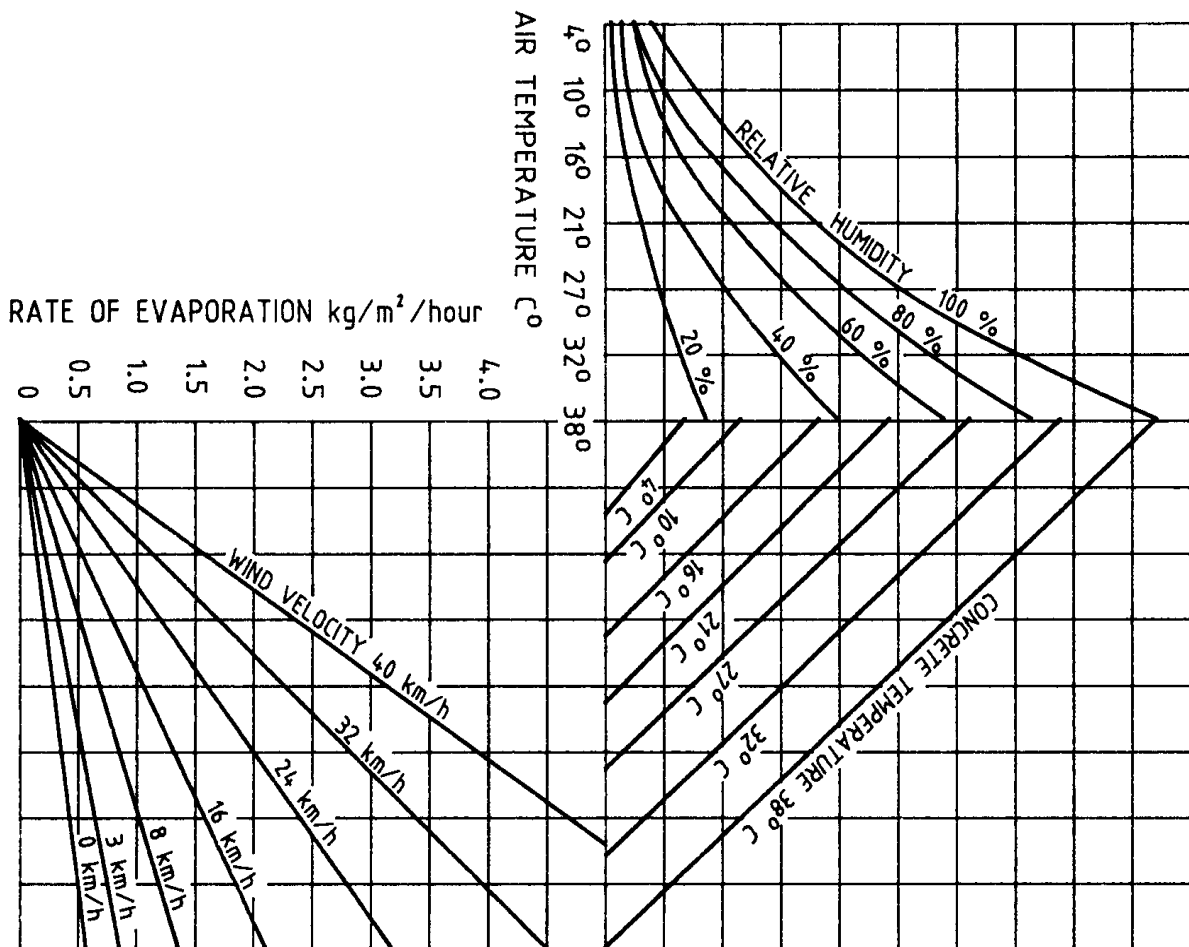


Figure 609.071 - Evaporation of Water from Freshly Placed Concrete

The graph shows the effects of air temperature, humidity, concrete temperature and wind velocity together on the rate of evaporation of water from freshly placed and unprotected concrete.

Example:

- * *with air temperature at 27 °C*
- * *with relative humidity at 40%*
- * *with concrete temperature at 27 °C*
- * *with a wind velocity of 26 km/h the rate of evaporation would be 1.5 kg/m²/hour.*

To determine the evaporation rate from the graph, enter the graph at the air temperature (in this case 27 °C), and move vertically to intersect the curve for relative humidity encountered - here 40%. From this point move horizontally to the respective line for concrete temperature - here 27 °C. Move vertically down to the respective wind velocity curve - in this case interpolating for 26 km per hour - and then horizontally to the left to intersect the scale for the rate of evaporation.

609.08 APPLICATION OF DEBONDING LAYER

If a bituminous seal has not been applied to the subbase, a third application of wax emulsion curing compound shall be applied to the subbase at a rate of 0.2 l/m² between 48 and 72 hours prior to placement of base concrete. The curing compound shall comply with the requirements of Clause 609.18.

609.09 STEEL REINFORCEMENT

(a) General

Reinforcement placed in the pavement shall consist of deformed round reinforcing bars complying with the requirements of AS/NZS 4671 and plain round bars and hard-drawn steel wire fabric complying with the requirements of AS/NZS 3679 and AS/NZS 4671.

Where specified or shown on the drawings galvanizing shall be undertaken in accordance with AS/NZS 4680 and shall consist of a uniform layer of commercially pure zinc, free from abrasions, cracks, blisters, chemical spots or other imperfections, and so applied that it adheres firmly to the surface of the steel. The rate of zinc application shall be 600 g/m², equivalent to a thickness of 84 microns.

The Contractor shall make appropriate allowances when preparing its reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of reinforcement or other fitments, taking into account the practical variations in the tolerances noted and other margins normally applied by reinforcement suppliers.

Steel reinforcement shall be supplied cut to length, bent to shape, free from loose mill

scale, loose or thick rust, or any other coating. Steel reinforcement shall not be bent or straightened in a manner that will damage the material or heated for the purposes of bending.

Steel reinforcement, tie bars, dowels and other steel fitments shall be placed as shown on the drawings and within a tolerance of ± 5 mm.

(b) *Tie Bars*

The diameter, grade, length and location of tie bars shall be as shown on the drawings.

(c) *Dowels*

Dowels shall be hot dipped galvanized plain rod bars, manufactured from AS/NZS 3679 Grade 250 steel and shall be straight, clean and free from burrs, mill scale and oil. The ends of the bars shall be cut off square.

Dowel assemblies shall be manufactured from structural steel complying with AS/NZS 3679.

609.10 JOINT SEALANTS

(a) *General*

Permanent seals shall be either a neoprene compression seal or an in situ cast silicone sealant.

A full technical description of the proposed sealant and method of installation recommended by its manufacturer shall be submitted for approval by the Engineer at least four weeks prior to installation.

(b) *Neoprene Compression Seals*

Neoprene compression seals shall conform to the requirements of ASTM D 2628.

The size of the seal shall be selected to suit the width of the sealant reservoir. The sealant shall be installed in accordance with the manufacturer's written recommendations.

The seal shall be dimensioned such that its maximum operating width does not exceed 80% of its uncompressed width.

(c) *Silicone Seals*

Silicone seals shall be formed from a silicone joint sealant conforming to the requirements of Table 609.101.

Sections of material prepared for testing in the cured state shall be cured seven days at

25 ±1°C and 50% ±5% Relative Humidity. The silicone joint sealant shall be grey in colour and shall be stored and installed in accordance with the manufacturer's recommendations.

Table 609.101

Test Method	Attributes	Requirements
ASTM D 792 (Method A)	Specific gravity	1.1 - 1.55
ASTM D 2240 (Standard Curing)	Durometer hardness	10 - 25
ASTM C 603	Extrusion rate	90 – 250 g/min
ASTM C 679	Tack free time	30 0 70 mins
ASTM C 793	Accelerated weathering	No chalking, cracking or bond loss at 5000 hrs
ASTM C 794	Adhesion to concrete	Minimum 35 N average peel strength
RTA T1193	Accelerated aging	
RTA T1192	Adhesion to concrete	Pre-treatment as per RTA T1193 Extension to 70% Compression to 50% No more than 10% failure over the cross-sectional area
(Not applicable) Visual	Colour	Grey compatible with pavement concrete

609.11 CONSTRUCTION PLANT

Pavers shall include the following features:

- an operating mass of not less than 10 tonne and the capability to form the slab widths, or combinations of slab widths, shown on the drawings and slab depths as specified;
- an automatic control system with a sensing device to control line and level from guide lines placed parallel to the edges of the concrete slab being placed;
- they shall be capable of spreading, compacting, screeding and finishing the freshly placed concrete in such a manner that a minimum of finishing by hand will be required and dense and

homogeneous concrete with a surface finish complying with the specified requirements will be produced.

609.12 JOINTS FOR SUBBASE

(a) Transverse Construction Joints

Transverse construction joints shall be constructed as shown on the drawings.

Transverse construction joints shall be constructed normal to the pavement centreline and shall not be placed closer than 500 mm to a planned transverse joint in the concrete base. Where a mechanical breakdown occurs in the paver, or paving operations are interrupted for any other reasons, the subbase shall be placed by hand methods to a construction joint location agreed with the Engineer.

(b) Longitudinal Joints

Longitudinal joints shall be constructed as plain butt construction joints and the proposed location shall be reviewed by the Engineer prior to commencement of paving.

The joints shall be located within the bounds shown on the drawings and shall be located 250-300 mm offset from proposed joints in the concrete base.

609.13 JOINTS FOR BASE

Joints shall be constructed as specified and shown on the drawings. Joints shall be straight and vertical. Transverse joints shall be continuous from edge to edge of the pavement. Tie bars shall be installed such that anchorage strength of at least 85% of the yield strength of the bar is developed upon hardening of the base.

(a) Sawn Joints

Sawing shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without excessive ravelling, regardless of time or weather conditions.

The line of the joint shall be without any discontinuities. Neither edge shall deviate from a 3 metre straight edge by more than 10 mm.

The joint surface shall not exhibit more than 5 mm of vertical or horizontal edge ravelling. The length of edge ravelling shall not be more than 300 mm in any one (1) metre length of joint on each edge. Saw debris shall be washed from the joint and pavement immediately after sawing.

Immediately after cleaning a continuous UV-stabilised PVC spline seal 5 ± 1 mm in diameter shall be installed in the saw cut, and where transverse joints cross longitudinal

joints the transverse seal shall pass under any seal inserted in longitudinal sawn joints. The seal shall not be stretched in order to fit into the groove. Any increase in length of the seal after installation shall not exceed 10% of the original length. Joints in the seal shall be kept to a minimum and shall be cemented together by a suitable adhesive. The top of the seal shall not be less than 5 mm nor more than 7 mm below the surface of the base.

(b) *Transverse Contraction Joints*

(i) *Forming Joints*

Transverse contraction joints shall be sawn. To prevent uncontrolled cracking in the base sawn transverse contraction joints shall be constructed either skewed or normal to the centreline of the pavement as shown on the drawings. The joints shall be constructed to the dimensions and details shown on the drawings and initially formed as a sawn groove 3 mm wide to a depth not less than 1/4 the slab depth, but not exceeding 1/4 the slab depth plus 10 mm. When the concrete can be cut without excessive ravelling the spline seal shall be pushed to the bottom of the initial saw cut and the initial groove widened to accommodate the permanent seal. Joints shall be sawn in the sequence of concrete placement. Before sawing a joint, the base concrete shall be examined closely for cracks and the joints shall not be sawn within 1 metre of a crack. In pavements with dowelled joints, sawn transverse contraction joints shall be constructed normal to the pavement and the joint shall be sawn to coincide with the centre of the dowel assemblies. The centre of dowelled assemblies shall be suitable referenced prior to concrete placement.

Skewed joints shall commence from the right side of the pavement and cross in the direction of the design traffic flow at a 1 in 6 skew, unless otherwise specified. The joints shall be spaced by repeating the subgroup spacing of 4.3 m, 3.7 m, 4.6 m and 4.0 m. The distance between the first and last joint of each subgroup shall be $16.6 \text{ m} \pm 250 \text{ mm}$ and each joint within the sequence shall not vary from its designated position by more than $\pm 250 \text{ mm}$. Sawn contraction joints specified normal to the pavement centreline shall be sawn at 4.5 m intervals. Each joint shall not vary from its designated position by more than $\pm 250 \text{ mm}$. The line of any sawn joint shall not deviate by more than 20 mm from a 3 metre straight edge.

Sawing of transverse contraction joints shall be carried out in such a manner that no more than five unplanned cracks, each with a width not exceeding 0.5 mm, occur per successive kilometre of pavement.

Where unplanned cracking occurs, the Contractor shall cease paving operations until all the joints have been completed and the paving operation altered so that further unplanned cracking is prevented.

(ii) Temporary Sealing

After the second saw cut is made to form the sealant reservoir and the joint thoroughly cleaned of all sawing debris, a continuous closed-cell polyethylene backer rod of diameter shown on the drawings shall be inserted into the joint.

The top of the seal shall be 0 to 10 mm below the concrete surface. The backer rod shall pass over any longitudinal joint seal already in place.

The backer rod shall be maintained by the Contractor until the joint is sealed permanently. Damaged or disturbed backer rods shall be removed, the joint recleaned and a new backer rod inserted.

(iii) Permanent Sealing

Within 10 days of initial sawing the permanent seal shall be placed in the joint.

The permanent seal shall be either a neoprene compression seal or an in situ cast silicone seal complying with the requirements of Clause 609.10.

(1) Neoprene Seals

The joint grooves into which the neoprene compression seal is to be inserted shall be clean and dry immediately prior to the installation of the seal. The sides of the neoprene seal shall be coated with an appropriate clear or concrete coloured lubricant-adhesive compound complying with ASTM D-2835 *Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements*. The seal shall not be over-stretched in order to fit into the groove and the maximum increase in length of the seal after installation shall be 5%. Any seal exceeding 5% extension shall be removed. The seal shall be continuous between longitudinal joints and where a discontinuity occurs the seal shall be butt jointed. The top of the seal shall not be less than 5 mm nor more than 7 mm below the surface of the base and shall overlay any longitudinal seals.

(2) Silicone Seals

The joint grooves into which the silicone sealant is to be inserted shall be clean and dry at the time of installation of the seal. The backer rod shall be depressed such that the bottom of the silicone seal shall be at the planned location and of the correct shape.

(c) *Transverse Construction Joints*

(i) General

Transverse construction joints shall be installed at the end of each day's operation and at any other stage when concrete placement is interrupted for 30 minutes or longer. Construction joints shall be normal to the pavement and constructed to the dimensions and details shown on the drawings. The aggregate on the face of the joint shall be exposed prior to casting against the exposed face. Care shall be taken to ensure that the concrete immediately adjacent to the joint is fully compacted.

The line of the joints shall not deviate in from a 3 metre straight edge placed along the joint by more than 20 mm.

(ii) For Plain Base

Construction joints shall not be constructed closer than 1.5 m to a transverse contraction joint. Construction joints shall be tied using steel bars as shown on the drawings.

(iii) For Jointed Reinforced Base

Construction joints shall be located at planned transverse contraction joints and the joints shall be dowelled as shown on the drawings. Construction joints formed at locations other than planned contraction joints shall not be within 1.5 m of a contraction joint and shall be tied using steel bars as shown on the drawings.

(iv) For Continuously Reinforced Base

Construction joints shall be tied using steel bars as shown on the drawings.

(d) *Expansion Joints - For All Types of Base*

Expansion joints are generally formed around structures and features which project through, into or against the pavement and at other locations as specified. Transverse expansion joints shall not be constructed within 2 metres of a sawn contraction joint. Where necessary the spacing and/or skew of the adjacent transverse contraction joints may be changed to ensure sufficient clearance is obtained.

Expansion joints shall be continuous across the full width of the base normal to the control line and constructed in accordance with the drawings.

The Engineer may require a trial joint installation up to 2 metres in length of any proposed sealant, to be carried out prior to approval being given. The top of the sealant shall be between 3 mm and 6 mm below the surface of the pavement.

(e) *Longitudinal Joints - For All Types of Base*

Where shown on the drawings longitudinal joints shall be constructed as a construction joint or induced by sawing.

Longitudinal joints shall be constructed parallel to the centreline of the pavement by the slip formed edge, by fixed formwork or by sawing a 3 mm wide cut to a depth not less than one-third the slab depth but not exceeding one-third the slab depth plus 10 mm.

Tie bars of 1 metre long deformed steel bars Grade 410Y 12 mm diameter spaced at 500 mm centres located at half the slab depth and placed perpendicular to the line of the joint shall be placed in each longitudinal joint. If placed by paver, the tie bars shall be inserted automatically. For fixed form construction the bars may be placed in the forms but in either case tie bars shall not be vibrated into freshly placed concrete. For longitudinal joints between the base slab and any kerbs, kerbs and channels and open spoon drains, tie bars 600 mm long of 12 mm diameter spaced at 500 mm centres shall be installed at half slab depth except within 0.5 metre of a transverse contraction joint.

For sawn longitudinal joints, the joint shall be thoroughly cleaned of all sawn and foreign matter and an approved UV-stabilised PVC spline seal or equivalent shall be inserted in the joint within 24 hours of sawing. The seal shall not be stretched in order to fit into the groove. Any increase in length of the seal after installation shall not exceed 5% of the original length. Joints in the seal shall be kept to a minimum and shall be cemented together by a suitable adhesive. The top of the seal shall not be less than 5 mm nor more than 7 mm below the surface of the base, except where depressed to lie under the transverse joint sealant.

609.14 ODD SHAPED AND MISMATCHED SLABS - FOR ALL TYPES OF BASE

A slab shall be considered to be odd-shaped if the longer side dimension exceeds the shorter by more than 50% or if the joint pattern produces an angle of less than 80° between two adjacent sides. A slab shall be considered mismatched if it has one transverse joint out of alignment with the transverse joint on the adjacent slab.

Concrete placed in odd shaped and mismatched slabs shall comply with the base course requirements of Clauses 609.04 and 609.05,

Odd shaped and mismatched slabs shall be reinforced with a single layer of SL82 welded wire mesh fabric placed with 50 to 60 mm cover from the top of the concrete surface. Fabric shall be clear of

all transverse and longitudinal joints by 50 to 100 mm. Odd shaped or mismatched slabs which are not specified and result from matters within the Contractor's control, shall be the Contractor's responsibility.

Joint arrangements for odd shaped and mismatched slabs shall be designed by the Contractor and submitted to the Engineer for review at least four weeks prior to the work commencing.

Odd shaped and mismatched slabs shall be cured in accordance with the requirements of Clause 609.18.

609.15 SLAB ANCHORS - FOR ALL TYPES OF BASE

Concrete placed in slab anchors shall comply with the base course requirements of Clauses 609.04 and 609.05, and with the requirements of Section 804.

Slab anchors shall be constructed normal to the pavement centreline, to the dimensions and at the locations shown on the drawings prior to placing the base.

Anchors shall extend over the full width of the pavement. A transverse expansion joint shall be provided between the anchor and the abutting slab and shall not be placed closer than 1.5 metre to a sawn contraction joint.

Slab anchors shall be cured in accordance with the requirements of Clause 609.18.

609.16 SUBGRADE BEAMS

Subgrade beams shall be provided below the subbase at expansion joints and isolation joints in the concrete base as shown on the drawings.

Concrete placed in subgrade beams shall comply with the base course requirements of Clauses 609.04 and 609.05, and with the requirements of Section 804.

Subgrade beams shall be constructed prior to construction of the subbase. The top of the beam shall be level with the subgrade. Any loose subgrade material shall be removed or re-compacted to the correct level.

Steel reinforcement shall be the type and size shown on the drawings.

The top surface of the subgrade beam shall be a smooth surface. This surface shall be cured in accordance with Clause 609.18.

The top surface of the subgrade beam shall be treated with a bond breaker which shall consist of a further application of curing compound at a rate of 0.2 l/m², 24 to 72 hours before placing of subbase concrete.

609.17 TEXTURING OF SURFACE

Texturing of the concrete surface shall be carried out to the standard of surface specified in Clause 609.21 using a hessian drag or steel tines. The textured surface shall extend across the full width of the base and shall be uniform in appearance.

(a) *Texturing of Surface for No Asphalt Overlay*

(i) Light Texturing

Concrete surface shall be textured using a hessian drag.

The hessian drag shall consist of a minimum of two layers of material each having a nominal mass of 0.34 kg/m² and shall have a length of at least 1 metre of material in contact with the concrete surface.

(ii) Medium Texturing

The concrete surface shall be finished to achieve an average texture depth between 0.40 mm and 0.70 mm. The texture depth shall generally be achieved using steel tining equipment which shall comprise of rectangular-shaped tines of flat spring steel, approximately 0.6 mm thick. The width of the tines shall be 2 mm.

(iii) Heavy Texturing

The concrete surface shall be finished to achieve an average texture depth between 0.50 mm and 1.00 mm. The texture depth shall generally be achieved using steel tining equipment which shall comprise of rectangular-shaped tines of flat spring steel, approximately 0.6 mm thick. The width of the tines shall be 3 mm.

For texturing with steel tines, the tines shall be spaced between 10 and 21 mm with a mean spacing between 13 and 14 mm in a random pattern as depicted below:

. 10 14 16 11 10 13 15 16 11 10 21 13 10 .

and the tining shall be done transversely.

Should the Contractor wish to use an alternative method to achieve the texture depth, details of the proposed method shall be submitted to the Engineer for approval. The Engineer may require the Contractor to cast a sample test panel of size 3 m x 3 m of textured concrete prior to approval.

Acceptance of the surface texture shall be based on testing of randomly selected areas of the surface by the sand patch method to determine the average texture depth of that area. Sand patch testing shall be undertaken at a frequency of not

less than one test per 400 m² of concrete base surface. Areas found to have an average surface texture depth of less than that specified shall be saw grooved parallel to the line of the texturing to achieve the specified average texture depth by sawing grooves at 20 mm centres.

(b) Texturing of Surface for Asphalt Overlay

The surface of the concrete shall be lightly textured.

The concrete surface shall be textured using a hessian drag. The hessian drag shall consist of a minimum of two layers of material each having a nominal mass of 0.34 kg/m² and shall have a length of at least 1 metre of material in contact with the concrete surface.

609.18 CURING AND PROTECTION

(a) Curing Compounds

Curing of the base and subbase concrete shall be undertaken by the use of a curing compound sprayed onto the freshly laid concrete at the application rates specified in this clause. Curing compound shall not be sprayed when bleed water is present.

Prior to the use of curing compounds, the Contractor shall submit to the Engineer for review not less than four weeks prior to placement of concrete, full details of the proposed curing method, including the time and rate of application, documented evidence of the effectiveness of the compound as a curing agent supported by test certificates from a NATA accredited laboratory, or approved equivalent, and method of removal where required. The test certificates of compliance shall relate only to the formulation on which the tests were made and shall be valid for not more than three years from the date of issue.

The exposed surfaces of the concrete including the sides of the slab shall be treated for curing protection immediately surface finishing has been completed. Where any side forms have been used the concrete sides shall be treated after stripping of the forms.

Curing protection for base and subbase concrete shall be achieved by the application of a chlorinated rubber curing compound and a pigmented wax emulsion curing compound respectively, complying with the requirements of AS 3799. Two coats shall be applied at the full rate. The compound shall be sprayed onto the concrete surface at a rate of 0.2 l/m² per coat.

The curing compound shall be applied by a pressurised sprayer to give a uniform cover except that, for the sides of slabs and for small areas where spraying equipment cannot be used, the compound shall be sprayed with a hand lance at a rate 25% higher than the

rate for mechanically sprayed areas. The pressurised sprayer shall incorporate a device for continuous agitation and mixing of the compound in its container during spraying. The application rate shall be checked by calculating the amount of curing compound falling on felt mats, each approximately 0.25 m² in area, placed on the concrete surface.

The time between the first and second coat shall be in accordance with the manufacturer's recommendation, or on the basis of a trial application.

Notwithstanding the requirements of Clause 609.07(g) an evaporative retarding compound shall be used for the base and subbase concrete in accordance with the requirements of Clause 609.18(b).

For the base course no traffic or construction equipment other than that associated with testing, saw cutting and joint sealing shall be allowed on the finished base concrete until the in situ strength of the concrete is at least 60% of the target 28 day compressive strength. Notwithstanding the above, any damage caused to the base by the Contractor's operations shall be rectified by the Contractor.

For the subbase course the curing membrane shall be maintained until the base concrete is placed and any damage to the curing membrane during that time shall be repaired. No traffic or construction equipment shall be allowed on the finished concrete until the in situ strength of the subbase is at least 4 MPa. Any damage caused to the subbase by the Contractor's operations shall be rectified by the Contractor.

The Contractor shall take necessary measures to ensure that the temperature of the concrete does not fall below 5°C during the first 24 hours after placing.

Curing compounds shall not be applied to concrete surfaces which are to be subsequently asphalted, unless they are compatible with the asphalt layer or surfacing system or provision is made for removal of the compound from these surfaces prior to the application of the asphalt layer or surfacing system.

(b) Application of Evaporative Retarding Compound

The evaporative retarding compound, when required, is to be applied immediately after initial screeding. The remaining finishing operations can be carried out after application of the compound.

Application of the evaporative retarding compound shall be implemented in accordance with the manufacturer's instructions.

Details of the proposed compound and its application procedure shall be submitted to the Engineer for review not less than four weeks prior to the commencement of concreting works.

609.19 TRAFFICKING OF BASE AND SUBBASE*(a) General*

Any damage caused to the base or subbase as a result of the Contractor's construction activities shall be rectified to produce a dense, homogeneous base and subbase with the specified surface finish. Any damage to the debonding treatment or to the applied curing compound shall be rectified immediately.

Two additional test cylinders or two concrete cores per sample shall be taken for the assessment of compressive strength where early trafficking of the bases or subbase is proposed.

Upon determination of the in situ strength of any lot, all concrete placed prior to that lot using the same mix may be assumed to have achieved the equivalent compressive strength.

(b) Concrete Subbase Course

With the exception of inspection and testing equipment and personnel the concrete subbase course shall not be trafficked until the in situ compressive strength has reached at least 4 MPa based on concrete cylinder testing or at least 3.5 MPa based on core testing. Construction equipment and personnel may traffic the subbase for the purpose of applying the debonding treatment, construction of the concrete base and undertaking remedial works when the subbase in situ compressive strength is at least 4 MPa based on concrete cylinder testing or at least 3.5 MPa based on core testing.

(c) Concrete Base Course

With the exception of concrete saws and coring machines and personnel the concrete base course shall not be trafficked until the in situ compressive strength has reached at least 20 MPa based on concrete cylinder testing or at least 17 MPa based on core testing. Construction equipment and personnel may traffic the base when the base in situ compressive strength is at least 20 MPa based on concrete cylinder testing or at least 17 MPa based on core testing and provided that all sealing of joints has been completed.

Other loadings shall not be applied onto the base course concrete until the in situ compressive strength is at least 30 MPa based on concrete cylinder testing or at least 26 MPa based on core testing.

Backfill material shall not be placed against the edge of the base until the in situ compressive strength is at least 20 MPa and provided that all sealing of joints has been completed.

609.20 REMEDIAL WORK*(a) Concrete Base Course**(i) General*

Rejected slabs shall be removed and replaced.

Replacement slabs shall be formed using hand methods and the surface of replaced concrete shall be textured to the same standard as the adjoining undisturbed concrete.

Tie bars placed in hardened concrete shall develop an anchorage strength of at least 85% of the yield strength of the bar.

Rejected slabs shall be removed and replaced without damage to the adjacent slabs. Over sawing into the subbase shall be avoided.

(ii) Localised High Areas

Where a slab fails to meet the requirements of Clause 609.03 due to localised high areas, the surface shall be ground to remove the high areas. Surface grinding shall not commence until the in situ strength of the concrete is at least 4 MPa

*(iii) Removal and Replacement of Rejected Concrete**(1) For Plain and Reinforced Base*

Dowel bars shall be installed at the existing transverse contraction joint at lateral spacings of 300 mm. Any damaged tie bars shall be replaced. A groove shall be formed in the top of the contraction joint to accommodate a cast in situ silicone seal and shall be of such depth and width to suit the proposed sealant.

(2) For Continuously Reinforced Bases

A construction joint shall be constructed in accordance with Clause 609.13 at the junction of the existing concrete and replaced concrete.

(iv) Unplanned Cracking of Slabs

The Contractor shall undertake an assessment of the cracked slabs to establish the cause(s) of the cracks, crack width, the moisture condition of the crack and whether a crack is active or inactive, and submit a crack repair procedure for the Engineer's approval prior to any repair works being undertaken in accordance with the requirements of Clause 804. The assessment of the cracked concrete slab shall be undertaken by a technical specialist with a minimum of five years

practical experience in the diagnostic assessment and investigation of concrete structures.

If the crack repairs are unsuccessful or if in the Engineer's opinion the slabs are irreparable the slabs shall be rejected and replaced.

(b) Concrete Subbase Course

(i) General

Rejected areas shall be replaced. Unless otherwise agreed, rejected concrete shall be disposed off site.

(ii) Localised High Areas

Where an area fails to meet the acceptance criteria of Clause 609.03 due to one or more localised high areas, the surface shall be ground to remove the high areas to allow a reassessment of the slab's surface level. Surface grinding shall not commence until the in situ strength of the concrete is at least 4 MPa. The texture of all machined surfaces shall be similar to the surrounding undisturbed surface.

(iii) Deficient Thickness

Where an accepted subbase area is deficient in thickness the deficiency shall be corrected by placing a thickened base area.

(iv) Surface Treatment of Joints and Cracks

The Contractor may either apply a size 7 mm bituminous seal over the entire subbase or treat the cracks and joints individually as specified below between 48 and 72 hours prior to placement of base concrete. The seal shall be applied in accordance with the requirements of Section 402.

All joints shall be covered with a bitumen impregnated proprietary product which shall be at least 250 mm wide and shall be firmly adhered to the concrete slab. The surface of the material after placement shall be even and free from ripples.

Cracks of width greater than 0.3 mm but less than 1 mm when measured between 7am and 9am shall be treated with an application of 0.5 litres/square metre minimum of the pigmented wax emulsion curing compound. The wax emulsion shall be applied uniformly to a cleaned surface for a distance of 300 mm each side of the cracks and shall be applied between 7am and 9am.

Cracks of width greater than 1 mm when measured between 7am and 9am shall

be treated as joints.

609.21 SCHEDULE OF DETAILS

Medium texturing should be specified for roads with speed limits of 75 km/hr or less and heavy texturing specified for roads with speed limits greater than 75 km/hr.

SECTION 701 – GUIDE POSTS

701.01 DESCRIPTION

This section covers the requirements for the supply, delivery and installation of guide posts including delineators.

701.02 DEFINITIONS

(a) *Delineator*

Small retro reflective panel or sheeting attached to guide posts to provide a consistent pattern of delineation of the edges of road carriageways to aid road users during night time driving.

(b) *Guide Post*

Posts used to mark the edge of the road carriageway and give road users an indication of the approaching alignment and geometry of the road.

(c) *Rigid Guide Post*

A guide post which fractures or remains intact and horizontal when impacted.

(d) *Semi-Flexible Guide Post*

A guide post which fails by bending when impacted and can be reinstated to vertical position with maintenance intervention.

(e) *Flexible Guide Post*

A guide post which deflects when impacted and then returns to a vertical position, without maintenance intervention

701.03 SUPPLY OF POSTS

All posts shall be supplied and delivered by the Contractor.

701.04 POSTS

(a) *General*

Guide posts shall be between 90 mm and 100 mm across the face visible by traffic. The tops of guideposts shall be flat, the bottom ends made to suit the method of installation as recommended by the manufacturer.

Guide posts shall be straight, smooth, and structurally sound and of a shape that allows delineators to be permanently and securely attached. The above ground section of each guide post shall be free of sharp edges and burrs and discoloration or other defects that may affect its appearance and/or serviceability.

(b) *Timber Posts*

Posts shall be of timber dried to equilibrium moisture content, sawn from *vesi*, *yasi*, *kaudamu*, or of pine timber pressure treated. All timber should be sawn from the sound truewood of mature trees and shall have the grain parallel to the length of the piece. Timber shall be free from insect life (white ants, borers, grubs, etc.) dead timber, cracks, gum veins and pockets, wavy edges and other defects. No knots shall be exposed on the 50mm face, and any knots exposed on the 100mm face shall be round, tight, well-shaped and shall not exceed 20mm in size.

Posts shall be of rectangular 100mm x 50mm nominal with all faces sawn plane and square. The top of post shall be cut off an angle at 30 degrees.

Post dimensions shall be within the following limits:

Width	90 – 100mm
Thickness	45 – 50mm
Length	1.65 – 1.70m

The deviation from straightness of any face shall not exceed 10mm

(c) *Other Posts*

Posts other than timber posts shall be of a type approved by the Engineer

The supplier shall state the type of material used in manufacture of the guide posts as well as recommended methods of installation, anchoring depth, cleaning, removal, and disposal. Test certification shall be submitted to the Engineer, addressing post strength, flexibility, impact performance, durability, heat resistance, fire retardant ability, corrosion resistance and cold resistance. The supplier shall provide a performance guarantee statement clearly indicating the nature of the guarantee and the service life expectancy. Where a product is a FRA approved guide post product the above shall not be required.

All types of guideposts shall respond in a safe manner when struck, and not present a further danger in their damaged condition.

701.05 PAINTING OF TIMBER POSTS

Before erection, each timber post shall be completely painted with a minimum of two coats of white

paint to meet the performance requirements of Clause 701.06 the Contractor shall submit details of the paint to be used for approval by the Engineer. After erection, the exposed portion of each timber post shall be cleaned and painted with final coat of all-weather white paint.

701.06 PERFORMANCE REQUIREMENTS

The finished surface of guide posts shall be uniform and free from discontinuities, areas of discoloration, blisters, runs and other surface defects which affect appearance and serviceability. Guide post surfaces shall be durable gloss or semi-gloss opaque white capable of being repeatedly cleaned. All materials used shall retain 85% of the original colour, appearance and physical properties and be resistant to ultraviolet radiation for at least 10 years when exposed to all weather conditions experienced in Fiji.

Guide posts shall be designed to resist bending, twisting and displacement due to wind. They must be effective in resistance to vertical displacement of +5 mm for the life of the guidepost, with the exception of any displacement associated with impact or physical force. Flexible guide posts shall return to within +5 mm of the original vertical position following impact or physical force application for the life of the guide post.

701.07 INSTALLATION OF POSTS

Installation of guide posts includes setting out, excavation, supply, placement, backfilling, erection, driving, removal and disposal of guide posts.

Guide posts shall be, as shown on the drawings, or as specified by the Engineer. Guide posts shall be placed at a uniform distance from the road pavement edge with the widest face presenting to oncoming traffic. Posts shall be set into the ground so that the posts are vertical and the tops present a uniform profile.

Guide posts shall be installed such that the exposed length above ground is nominally 1000 mm and minimum anchoring depths recommended by the manufacturer to achieve the specified performance requirements under service conditions. Allowance shall be made in the height of guide posts above the ground for the effects of super elevation and other road geometry in order to keep guide posts within the range of the beam of vehicle headlights.

Timber posts shall be set approximately 600mm into the ground in dug or drilled holes with the backfilling well rammed so that posts are vertical and the tops present a uniform profile. Spacing of posts shall be as specified in AS 1742.2 and FRA Manual of Traffic Signs and Markings, Part 1 Section 1 Introduction.

Non timber guideposts shall be installed as per the manufacturer's recommendation.

Where guide posts are to be set in the ground they shall be erected in excavated holes which are

subsequently backfilled and compacted to a density that is not less than that of the adjacent undisturbed ground.

Guide posts shall be installed such that they effectively resist removal by persons other than personnel using recommended removal tools.

Where guide posts are to be installed directly onto concrete, asphalt or any other hard wearing surface, the Contractor shall submit to the Engineer the details of the proposed installation method.

i) Wire Rope Safety Barrier Installations

Where new installations of Wire Rope Safety Barrier (WRSB) are proposed on the edge of shoulder, and will conflict with guide post installation locations, WRSB posts shall be converted into guide posts in accordance with the above product requirements. Posts shall be spaced in accordance with the Drawings or the requirements of Traffic Engineering Manual Volume 2. The Contractor shall submit to the Engineer the details of the proposed installation.

ii) Underground Services

Underground service locations shall be determined prior to installation of posts.

iii) Tolerances

Maximum installation tolerances are as follows:

- within 3 degrees of true vertical position
- within +5 mm across the face visible by traffic
- within +50 mm of the uniform profile height (nominally 1000 mm)
- within 200 mm longitudinally of the design spacing requirement and 100 mm transversely of the plan position with reference to the design line for the road.

iv) Removal and Disposal of Existing Guideposts

Existing guide posts where required, are to be removed as directed by the Engineer.

All holes left after removal shall be backfilled and compacted to a density that is not less than that of the adjacent undisturbed ground, or the same characteristics of the shoulder material from where they were removed. All existing guide posts removed by the Contractor shall be disposed of offsite. Existing guideposts manufactured from recyclable materials shall be recycled.

701.08 DELINEATORS

Delineators shall be fixed on guide posts on both sides of the carriageway, to expose to approaching traffic a red delineator on the left and a white delineator on the right.

Delineators shall be either:

- (i) circular 80 mm diameter Type A corner cube retro reflectors conforming with Type 'A' delineator in AS 1906.2; or
- (ii) Class 1A retro reflective sheeting having a total minimum reflective output equivalent to 100 cm², as defined in AS/NZS 1906.1. The nominal dimension of retro reflective material shall be 50 mm x 200 mm. Delineators made from retro reflective sheeting shall be installed such that the sheeting manufacturer's preferred orientation for optimum performance is followed.

Delineators shall be placed centrally between the edges of posts, with the top of the delineator 50 mm below the top edge. Delineators shall be attached to posts following completion of final protective coatings by a vandal proof and weatherproof means so they can be replaced if necessary without damaging the post.

701.09 MARKINGS – NON TIMBER POSTS

To enable traceability of the manufacturer, each post shall be legibly and indelibly marked with the manufacturer's name, date of manufacture and warranty period with lettering no greater than 10 mm high. The markings shall be placed at the bottom of the guide post just above recommended ground level installation depth. Guide posts shall be clearly marked to show the recommended ground level installation depth. Markings shall be installed on one side of the guide post only, and remain visible for the full life expectancy of the guide post.

SECTION 702 – GUARD FENCE

702.01 GENERAL

This section covers the requirements for the supply and/or installation of steel beam guard fence including proprietary guard fence systems and guard fence terminals.

702.02 STANDARDS

Australian Standards are referenced in an abbreviated form (e.g. AS 1012).

AS 1012	Methods of testing concrete
AS 1111.1	ISO Metric hexagon bolts and screws
AS 1112.1	ISO Metric hexagon nuts
AS 1214	Hot dip galvanized coatings on threaded fasteners
AS/NZS 1365	Tolerances for flat-rolled steel products
AS 1379	Specification and supply of concrete
AS 1391	Metallic materials - Tensile testing at ambient temperature
AS/NZS 1554.1	Welding of steel structures
AS/NZS 1594	Hot rolled steel flat products
AS 1627	Metal finishing
AS 1720.2	Timber structures – Timber properties
AS 1742	Manual of Uniform Traffic Control Devices
AS/NZS 1906.2	Retroreflective materials and devices for road traffic control purposes - Retroreflective devices (non-pavement application)
AS 3569	Steel wire ropes – Product specification
AS/NZS 3750	Paints for steel structures
AS/NZS 3845	Road safety barrier systems
AS 4100	Steel Structures
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles

Other Documents

Manufacturer's recommendations and any applicable requirements for each proprietary end treatment.

702.03 DEFINITIONS

(a) Manufacturer's recommendations

The specification, installation manual and drawings for a specific proprietary safety barrier device, prepared by or for the manufacturer, detailing the components, the device, and the methods and/or procedures for installation.

(b) Nested w-beams

Two or more steel w-beams erected together (one inside the other) to increase stiffness. Nested w-beams share bolts.

(c) Definition of terms

The meaning of terms and definitions in this section shall be as defined in AS/NZS 3845.

(d) Snug-tight

Is the tightness attained by at least two impacts of an impact wrench or by the full effort of a person using a standard podger spanner in accordance with AS 4100.

702.04 ACCEPTED PRODUCTS

Only safety barrier products approved by the FRA shall be used.

Unless specifically noted within the relevant sub clause, the requirements of this specification apply to public domain and proprietary guard fence systems equally.

Products which are discontinued and in this case including legacy products, or the manufacturer has identified as to be discontinued shall not be used.

New guard fence installations shall not be connected to any products which have been discontinued or identified for discontinuance unless approved by the Engineer.

All materials shall be supplied by the Contractor

702.05 GUARD FENCE COMPONENTS

(a) Identification

Mark on any steel w-beams, posts at both ends and all plastic components of proprietary end treatments unobtrusively and permanently in text not more than 20 mm high, the following information:

- i) name of the manufacturer
- ii) batch number, or date of manufacture
- iii) strength grade and base metal thickness of the steel w-beams.

(b) *Material test certificates*

The properties of all steel for the Works shall be evidenced by test certificates.

The Contractor shall submit to the Engineer all test certificates related to the supply of steel for the Works at least 14 days prior to commencement of installation.

All tests shall be carried out in accordance with the appropriate Australian Standard by officers experienced in the test methods described in the Contract, in a laboratory accredited by the National Association of Testing Authorities (NATA) for those test methods or recognised equivalent. All tests shall be endorsed in accordance with the NATA registration or recognise equivalent for that laboratory.

For steel sourced outside of Australia, all tests shall be carried out in a laboratory accredited by and with endorsement of the relevant national accreditation authority which has mutual recognition arrangements with NATA. Where the certification of the steel is incomplete, the Contractor shall arrange for the adequate testing to be carried out by a NATA accredited laboratory, or satisfactory equivalent as approved by the Engineer, to demonstrate compliance of the material, at the rate of one test per 1000 lineal metres of material.

For galvanised steel components, the Contractor shall include a manufacturer's certificate of compliance certifying that the zinc coating mass is in accordance with the requirements of AS/NZS 4680, or, for components of proprietary end treatments, the manufacturer's recommendations and any specified requirements.

(c) *Metal components*

Metal components supplied by the Contractor shall be new and conform to the dimensions shown on the drawings.

- (i) W-beams

The w-beams shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA350.

The mechanical properties of the base metal shall conform to the following requirements when tested in accordance with AS 1391:

- Minimum yield strength: 350 MPa

- Minimum tensile strength: 430 MPa
- Minimum elongation in 80 mm: 16%

The base metal shall comply with the following tolerances when measured in accordance with the methods of AS/NZS 1365:

- Base metal thickness: 2.7 mm -0.10 mm, +0.21 mm
- Mill tolerance on strip width: +2.5 mm, -0.0 mm
- Mill camber tolerance on 2500 mm length: 10.0 mm maximum

(ii) Steel Posts and Blocks

Steel posts and blocks shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA250.

The base material thickness shall be 6.0 mm \pm 0.27 mm.

(iii) Terminal sections

Terminal sections and stiffener plates shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA350.

(d) *Protective treatment*

Unless stated otherwise in the manufacturer's recommendations, the surfaces of all ferrous metal components including posts, blocks, beam elements, anchor plates, connectors and end treatment pieces must, after fabrication, be treated in accordance with the requirements of AS 1627 – Parts 1 and 4, and finished by hot-dipped galvanising in accordance with AS/NZS 4680.

All galvanised coatings shall be smooth, adherent and free from stains, gross surface imperfections, markings, brand names and/or inclusions. Appearance is of prime importance and colour shall be uniform.

Hot-dipped galvanised coating on bolts, nuts and washers shall comply with AS 1214.

Where the galvanising on guard rail or associated fittings has been damaged, the coating shall 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.

Where curved w-beam of less than 45 m curve radius is specified, the curving operation shall be carried out off site in a manner that will not result in damage to the galvanising.

(e) *Timber*

Timber posts and blocks shall be supplied to the dimensions shown on the drawings.

Timber posts and blocks shall be seasoned timber dried to equilibrium moisture content and sawn from species complying with Class 1 or 2 durability and stress grading as specified and in accordance with AS 1720.2.

(f) Wire rope

Wire rope in anchor assemblies for post and w-beam end treatments shall comply with the requirements of AS 3569 and the details shown on the Drawings.

Wire rope used in proprietary devices must comply with the manufacturer's recommendations.

(g) Concrete

Concrete for guard fence maintenance strips shall comply with the requirements of AS 1379, and shall have a minimum compressive strength at 28 days (MPa) of 20 MPa as specified in Section 601.

702.06 MATERIAL HANDLING AND STORAGE

The Contractor shall ensure that loading, transport, unloading, stacking and handling operations before and after fabrication, are carried out in such a way that items are protected from distortion and that galvanised surfaces are protected from damage.

All materials and components shall be stored in such a manner that damage and corrosion are prevented. Generally, storage at least 200 mm above the ground on platforms, slabs, or other supports under cover will be satisfactory. Rusted or bent or damaged steel shall be rejected.

The Contractor shall store components in such a manner that the freshly galvanised surfaces are protected from the attack of 'white rust', which can occur on freshly galvanised articles that are transported or stored under damp or badly ventilated conditions (including contact stacking).

If stacks are located behind a serviceable road safety barrier system, the clear space between the road safety barrier system and the stack must allow for the dynamic deflection of the system and be at sufficient distance from the ends of the system to allow the proper functioning of the end treatments.

702.07 CONSTRUCTION

(a) General

Construction of guard fence includes supply, delivery, handling and assembly of component and devices, setting out, and supply and installation of delineation.

The Contractor shall plan and execute the work in a manner that prevents damage to underground and above ground facilities such as utilities, services, structures, pavements, vegetation, etc.

The Contractor shall construct the guard fence to form a smooth line vertically and horizontally, when viewed along the line of the installation, free of humps, sags, or other irregularities, within tolerances.

Any component of a guard fence must not be welded or flame cut in the field under any circumstances. Welding and flame cutting in a workshop may be undertaken only where shown on the Drawings or in accordance with the manufacturer's recommendations.

(b) Damage

Where the galvanising on guard fence components or associated fittings has been damaged, the coating shall 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.

(c) Sequence of work

Where the guard fence is being constructed on a road open to traffic, the Contractor shall carry out the work so end treatments and transitions can be commissioned at the earliest practicable time, desirably on the day of installation. Where this cannot be achieved on the day, temporary end treatments to the satisfaction of the Engineer shall be provided until the permanent treatment is complete.

(d) Removal of redundant safety barrier systems

Removal of an existing installed safety barrier system includes:

- (i) dismantling or demolition of safety barriers, transitions and end treatments;
- (ii) extracting all posts, anchors and other in-ground components and materials;
- (iii) removing all components and waste materials from the site;
- (iv) cleaning, backfilling and mechanically compacting all excavations and holes formed by the extraction of posts, anchors and other in-ground components and materials; and
- (v) stacking or disposing of components and waste materials.

Following the removal of all redundant posts, anchors and other in-ground components by extraction or excavation, the holes shall be cleaned and backfilled. Backfilling and compaction of holes shall proceed in 150 mm layers using similar materials to existing surrounding layers. The backfill shall be compacted to not less than the density of the surrounding layers.

702.08 INSTALLATION

Prior to installation the Contractor shall confirm with the Engineer the required location and length of all guard fence.

The guard fence shall be installed at the positions so confirmed and shall be constructed true to line and level.

(a) Posts

Posts shall be installed to the depth, line and spacing shown on the drawings, and to the tolerances in Clause 702.08(d).

Posts shall be orientated to the direction of traffic as shown on the drawings.

Posts shall be installed by driving, provided there is no distortion or damage which may reduce their effectiveness. The installation must not cause any damage to the pavement beyond 100 mm from any part of any post, including any soil plate attached to the post.

If site conditions dictate that the posts cannot be driven, then the posts shall be installed in holes. The bottom of the holes shall be adequately compacted to achieve the same density as the surrounding soil. The posts shall be supported to true line and level while the holes are backfilled with clean, well-graded, non-cementitious subbase or base course granular material and compacted to achieve the same density as the surrounding soil.

All post holes in rock shall have a 75 mm minimum clearance from the back of the post to the face of the hole.

Except for anchorage posts, post holes in rock shall be backfilled with granular material. Other post holes shall be backfilled with selected earth, free of rock. The backfilling shall be firmly compacted in layers not exceeding 100 mm compacted thickness. Where posts are located in areas to be paved with concrete or premixed bituminous material, the backfilling of the post holes shall be finished 50 mm below the underside of such paving and the remaining depth of the holes shall be filled and compacted with material similar to the surrounding material.

The foundation of any post shall be deemed complying when the displacement at ground level does not exceed 3 mm when a 1 kN force is applied 200 mm below the top of the post in any direction. For any posts failing the test, the Contractor shall take remedial measures and retest the rectified post plus one other similar post within 5 m.

Prior to the installation of any w-beam barrier system where non-standard post lengths are required or other special measures (e.g. shallow concrete foundations) are proposed to be used, the Contractor shall provide details of the measures proposed and evidence that the effectiveness of the barrier system will be maintained, for consideration by the Engineer

Alternative methods of support are not permitted. For proprietary systems requiring alternative arrangement, the Contractor shall consult with and implement the requirements of the licensed product supplier. The Contractor may submit proposals for extending the guard fence to a location where installation of the end treatment is feasible, or proposals for a different end treatment.

Surplus excavated material remaining after the guard fence has been constructed shall be disposed of offsite by the Contractor.

(b) W-beams

The w-beam sections shall be lapped so that the exposed ends face away from near-side approaching traffic. The edges of the w-beam section or backing plate adjacent to posts shall be fixed in contact with the post or post blocks and all bolts shall be fully tightened.

End treatments of the types specified shall be constructed in accordance with the details shown on the drawings.

Posts attached to bridges and culverts shall be bolted to supporting members and/or set on mortar pads as shown on the drawings.

All bolts used in guard fence construction, other than nuts on wire rope assemblies, shall be tightened to a snug-tight condition.

All bolts on the traffic side of w-beam installations shall be flush with the w-beam.

(c) End treatments

During installation of wire ropes in the end treatments of w-beam, the Contractor shall ensure that no twisting of the rope occurs. When rope assemblies are used, the nuts at each end of the rope shall be tightened to a minimum torque of 50 Nm on the assemblies or as per the manufacturer's requirements.

The Contractor shall maintain tension in the wire ropes in end treatments until the Date of Completion, by keeping the nuts at both ends tightened to 50 Nm or to manufacturer's requirements.

(d) *Tolerances*

W-beam guard fence shall be erected to the following tolerances:

- (i) Variation from true plan position of posts: ± 20 mm
- (ii) Variation of line of w-beams from specified vertical profile: ± 10 mm
- (iii) Variation of w-beams from specified horizontal alignment ± 20 mm
- (iv) Variation of posts from vertical (measured at top of the post) ± 15 mm
- (v) Orientation of block and/or post to w-beam: +0 mm, -15 mm (measured at the point of greatest offset between the block or post to the w-beam)
- (vi) Dimension of holes: -0 mm, +50 mm
- (vii) Top of bolt head relative to w-beam: -0 mm, +5 mm

After installation, the top of the rail shall be within 25 mm of the specified level and 50 mm of the specified line. Variations from specified line and level shall not occur at a rate exceeding 15 mm in any 5 m length.

Notwithstanding these requirements, the line and level of the guard fence shall be adjusted where necessary to provide a smooth and even vertical and horizontal alignment.

For proprietary systems refer to manufacturer requirements.

(e) *Barrier offsets to kerb and channel, traffic lanes and batters*

Guard fence shall be installed at the offsets shown on the drawings. The desirable level shall be adopted unless otherwise approved by the Engineer.

Where practicable, w-beam guard fence should not be installed behind kerb and channel.

Posts shall be installed such that the back of post is not less than 500 mm from hinge point. This also applies where a manufacturer's proprietary system allows for installation at less than 500 mm from the hinge point.

(f) *Height of guard fence*

Where the face of the guard fence is erected within 0 to 1 m behind the back of kerb, the mounting height (vertical dimension from ground surface to centre of w-beam) shall be measured from the lip of kerb. Where the face of the guard fence is erected within 1.5

m from edge of carriageway without kerb, the mounting height shall also be measured from that edge of carriageway (typically the edge line). For distances beyond 1.5 m, the mounting height shall be measured from the nominal ground surface at the guard fence location.

702.09 PROTECTION OF GUARD FENCE POSTS FOR MOTORCYCLIST SAFETY

Where specified, steel rub rail or other proprietary under-run systems, as listed in RDN 06-04, shall be attached below the w-beam in accordance with the manufacturer's recommendations and the following:

- installation shall only be on nominated sections of barrier as shown on the drawings
- rails are to be placed in line with the face of w-beam
- rails shall be placed in accordance with the requirements for steel guard fence
- a 50 mm gap shall be provided between the rub rail and the ground to allow for passage of water, litter and leaves.

702.10 CERTIFICATE OF COMPLIANCE

Further to Clause 702.08 Installation, and prior to the issue of the Certificate of Practical Completion, the Contractor shall arrange for a safety barrier compliance audit on all proprietary guard fence end treatments constructed under the Contract. The audit shall be undertaken and a report prepared by an appropriately qualified engineer. The Contractor shall in writing certify that the products have been installed in accordance with the manufacturer's Installation Manual and this specification. The certification shall be provided for each end treatment installed.

In addition, the Contractor shall complete and submit to the Engineer a signed copy of the Checklist / Inspection and Test Plan as per the manufacturer's Product and Installation Manual.

702.11 DELINEATORS

The Contractor shall supply and fasten delineators to the top of the w-beam, comprising flexible plastic mounting brackets fitted with 100 cm² of Class 1A retro-reflective material, as defined in AS/NZS 1906.2. Delineators shall be installed in accordance with AS 1742.2 Clause 4.2.5.4(b).

The Contractor shall arrange delineators so that vehicles approaching from either direction at night will only see:

- red delineators on the left side of one-way and two-way roadways;
- white delineators on the right side of two-way roadways; and

- yellow delineators on the right side of one-way roadways.

Delineators shall not be installed on guard fence when the barrier offset is greater than 4 m from the traffic lane. White guide posts with delineators shall be installed in accordance with AS 1742.2 Clause 4.2.4 – Guide Posts.

Where guard fence delineators are required to be installed as part of the Works, they shall be installed in accordance with the requirements of AS 1742.2.

702.12 MAINTENANCE STRIPS FOR GUARD FENCE

The Contractor shall provide maintenance strips beneath the guard fence and terminals as indicated on the drawings and/or as nominated in Table 702.121.

Table 702.121 Maintenance Strip Locations

Location	Start	End	Direction	Strip Type
Refer to Contract Specific Conditions				
Road Name			North Bound	Concrete

The concrete maintenance strip shall be placed parallel to the barrier, such that it extends a minimum of 300 mm clear of the rear of the post and 300 mm clear from the face of w-beam. It shall be constructed with minimum 2% crossfall away from the road and shall be flush with the adjacent ground level so the finished level does not impede road runoff.

The concrete maintenance strip shall be placed between and around the posts to not affect the performance of the guard fence.

All bedding material used for cast in place concrete construction works shall be in accordance with Section 301 Size 40 mm Crushed Rock Subbase.

The concrete maintenance strip shall consist of 75 mm depth concrete. The concrete shall comply with the requirements of AS 1379, and shall have a minimum compressive strength at 28 days (MPa) of 20 MPa as specified in Section 601.

The edges of the infill area shall be boarded up prior to placing concrete to ensure smooth edges are produced. Alternatively, the expansion joints may be sawcut to 75% of the concrete depth. The infill area may utilise low strength concrete (< 0.85 MPa).

The edge board shall be placed parallel with the steel beam guard fence. The surface of the maintenance strip shall be finished with a wooden float to produce a lightly textured surface.

Where the concrete maintenance strip is adjacent to kerb or pavement, separation from the kerb or pavement by the use of a cork expansion joint (or approved alternative) shall be produced. Full depth expansion joints shall be provided perpendicular to the line of the steel beam guard fence 200 mm each side of every post.

The Contractor shall topsoil and grass all disturbed areas as necessary to ensure that the concrete maintenance strip is flush with the adjacent ground surface level.

702.13 INTERACTION OF GUARD FENCE WITH EXISTING ASSETS

The Contractor shall install the guard fence to provide for its dynamic deflection that does not interfere with any existing roadside furniture.

The Contractor shall remove any existing guard fence located between existing assets, such as gantry legs, variable speed signs and bridge piers. The Contractor shall allow for the interaction between all roadside furniture, including slip base light poles, and the guard fence by providing for the dynamic deflection zone or providing reduced post spacing as per the Drawings.

The Contractor shall integrate the guard fence with any existing lengths of safety barriers protecting ends of bridge parapets as shown on the drawings and in accordance with Clause 702.13.

The Contractor shall remove and dispose of existing guide posts that conflict with a new guard fence, including any in front of a new guard fence located within a 4 m offset from the traffic lane and any behind a new guard fence greater than 4 m offset from the traffic lane, as well as bollards or other roadside furniture affected by the Works or where shown on the drawings or instructed by the Engineer.

702.14 MODIFICATION TO THE GUARD FENCE AT THE INTERFACE WITH WRSB

The Contractor shall be responsible for any alteration and/or relocation of any existing WRSB, including the removal and disposal of existing redundant WRSB, dismantling and reinstating existing WRSB (including terminals) and extension of existing WRSB (including the provision of a concrete maintenance strip where specified) where required and as shown on the drawings.

The Contractor shall terminate the guard fence at the interface with the WRSB ensuring sufficient overlapping of systems as detailed on the drawings.

Any variations to the interface of the guard fence with the WRSB shall be reviewed for acceptance by the Engineer prior to installation of the guard fence.

The Contractor shall be responsible for the supply of all materials and labour necessary to undertake the modification works as specified above and as shown on the drawings.

702.15 ASSOCIATED PAVEMENT (SHOULDER) WIDENING

Where specified, the Contractor shall widen the existing shoulder on the median or outer verge applications adjacent to locations where guard fence is to be installed, in accordance with the FRA Austroads Design Guide Supplements Parts 1 to 8, or as shown on the typical cross section, drawings or specification.

The Contractor shall provide additional pavement between the edge of existing pavement and the guard fence. The Contractor shall adopt the nominated pavement design. Where a nominated pavement design has not been specified the Contractor shall construct the widening with a pavement that matches the existing.

The edge of shoulder shall be saw-cut to provide a neat straight edge against which the additional pavement can be placed.

Pavement layers shall be stepped a minimum 150 mm horizontally to enable new widening to be keyed into the existing pavement.

702.16 CONCRETE

Unless otherwise specified, and any applicable requirements for proprietary barrier systems, the placement of concrete shall comply with the requirements of Section 601.

702.17 EXISTING SIGNS AND MARKINGS

All existing signs that are temporarily removed or relocated during the execution of the works shall be reinstated to their original location as soon as practicable to ensure that adequate information is provided to road users. In all cases the Contractor shall provide continuity of regulatory and warning signs.

The Contractor shall reinstate all signs to a standard not less than the pre-existing condition and to the satisfaction of the Engineer.

The Contractor shall reinstate any existing painted edge lines and reinstate or replace any missing Raised Reflective Pavement Markers (RRPMs) along the length of the Works, including RRPMs damaged by the installation process for the guard fence.

702.18 MEDIAN CROSSINGS

Where a median crossing is removed, the Contractor shall reinstate the median with a treatment consistent with the surrounding area. Any redundant median crossing signs within the Limit of the Works shall be removed and delivered to a storage area nominated by the Engineer.

Median crossings within the Limit of the Works shall be retained by the Contractor.

Where detailed on the drawings, new median crossing points shall be constructed in accordance with the pavement details specified, to provide for adequate access for emergency vehicles and shall be integrated with the guard fence installation.

702.19 EXISTING VEGETATION

The Contractor shall ensure that the existing vegetation within the Limit of Works is not affected by the Works. Areas where no works are required shall not be disturbed. Any damage to existing vegetation shall be rectified immediately to the satisfaction of the Engineer.

702.20 GRASSING OF DISTURBED AREAS

(a) General

All disturbed areas shall be topsoiled and grassed.

All areas are to be cultivated to a minimum 50 mm depth, and moistened prior to the application of grass seed and fertiliser.

Grass seed shall be applied at a rate of not less than 200 kg/Ha. Fertilizer shall be applied in accordance with the manufacturer's recommendations.

A joint inspection of all grassed areas shall be carried out between the Contractor and Engineer three months after sowing has taken place.

Areas with less than 90% cover shall be re-sown by the Contractor.

Any remedial works required are to be performed within two weeks of the date of inspection.

(b) Maintenance of grassed areas

The Contractor shall be responsible for the maintenance of grassed areas, including mowing, for the duration of the Defects Liability Period for the Whole of the Works.

SECTION 703 – ERECTIONS OF PERMANENT SIGNS

703.01 DESCRIPTION

This section covers the requirements for the handling, storage and erection of signs and supply, and erection of sign supports.

703.02 SUPPLY OF MATERIALS AND COMPONENTS

All signs as scheduled shall be supplied by the Contractor

All materials, equipment and labour necessary to erect the sign, including post and fittings and cement or concrete for post hole backfill shall be supplied by the Contractor.

703.03 TRANSPORT, HANDLING AND STORAGE OF SIGNS

The Contractor shall collect signs and sign components from the specified storage location and transport them to the specified sign location.

Signs shall be transported, handled stored in a manner that prevents damage to and deterioration of sign components.

If any damage or deterioration should occur to sign components, the Contractor shall repair or replace the affected item. Repairs shall restore the sign to the original condition using proprietary materials obtained from the sign manufacturer or alternative materials compatible with the original.

703.04 CONFORMITY WITH DRAWINGS

The sign installation shall be as described in the sign schedule and as shown on the contract drawings.

If the Contractor proposes to use an alternative method of installation, the Contractor shall submit full details to the Engineer for approval not later than four weeks before the commencement of sign installation.

703.05 TOLERANCES

(a) Foundations

The finished surface of concrete foundations shall be between 50 mm and 100 mm above the finished surface at the base of the sign and shall be shaped to ensure free drainage of water away from the base of the post.

(b) Posts

- i) Posts shall be straight
- ii) Posts shall be vertical with a maximum deviation of 1 in 100
- iii) Post tops shall be 50 mm \pm 10 below the top edge of the sign

(c) *Signs*

- i) Signs shall be mounted level with a maximum deviation of 1 in 100.
- ii) Signs shall be mounted symmetrically on their posts unless the drawings indicate that an offset is required or if directed by the Engineer.
- iii) Where the sign comprises two or more signs above each other, the individual sign faces shall be mounted with the adjacent edges touching unless otherwise shown on the sign drawings.
- iv) Sign faces shall present an even surface free from twists, cracks, indentations or any other faults after erection.

703.06 POSTS AND FOUNDATIONS

The required positions of all posts and signs shall be as directed by the Engineer who shall confirm the positions before the erection of posts commences.

Post details shall be as shown on the Sign and Post Schedule or equivalent.

If the Contractor proposes the use of an alternative post and sign installation, full details of the proposals shall be supplied to the Engineer for review not later than four weeks before installation.

a. Steel and Timber Posts

The Contractor shall conform to the requirements of Clause 703.04 and the Sign and Post Schedule (or equivalent).

Where posts are to be mounted in sockets, the post shall be securely fixed into the socket by an approved vandal-proof method.

Signs to be mounted on two or more posts shall have posts positioned such that the sign face is rotated away from the approaching traffic to avoid direct reflection. Posts shall be positioned such that the sign is rotated away from the cross section by an amount equal to one tenth of the width of the sign (approximately 5°).

Posts specified as frangible hardwood shall be set at a level such that the centre of the lower hole of each post is 75 mm above the finished surface at the base of the post.

b. Coatings for Sign Supports

Steel posts shall be hot-dip galvanized in accordance with the Australian Standard for Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

c. Foundations

All posts shall be set in concrete foundations to the depths shown in the Sign and Post Schedule or equivalent and with the foundation hole diameters provide in Table 703.061:

Table 703.061 Foundation Hole Diameter Requirements

Foundation Hole Diameter	
Post size and type (mm)	Diameter (mm)
32 mm and 50 mm nominal bore steel	225
80 mm to 150 mm nominal bore steel	300
180mm x 100 mm frangible hardwood	300

Concrete shall comply with the requirements of AS 1379, and shall have a minimum compressive strength at 28 days (MPa) of 20 MPa as specified in Section 601.

d. Posts in Sockets

If a sign is located in a paved area or in a location where the sign may be struck by a vehicle, e.g.at the end of an urban median or where it may be necessary to remove the sign to accommodate the swept path of over-dimensional vehicles, the post should be inserted into a socket cast into concrete foundation. Suitable socket sizes for posts as provided in Table 703.062 shall be met.

Table 703.062 Foundation Hole Diameter Requirements

Socket Size	
Post size (mm)	Socket Size (mm)
32 mm nominal bore tube	50 mm nominal bore tube
50 mm nominal bore tube	65 mm nominal bore tube

The depth of the socket should be the same as the depth in ground nominated in AS

1742.2:2009.

The socket should protrude 50 mm above an earth surface or 25 mm above a paved surface.

The sign post must penetrate a minimum 450 mm into the socket.

The sign post should be securely fixed into the socket by an approved vandal-proof method.

e. Backfilling of Post Holes

- i) 32 and 50 mm Nominal Bore Steel Posts
- ii) posts holes shall be back-filled with concrete with a nominal strength of 10 MPa.
- iii) 180 mm x 100 mm Frangible Hardwood Timber Posts
- iv) frangible Hardwood Posts shall be erected in accordance with the drawings
- v) post-holes for frangible hardwood posts shall be filled with a mixture of gravel and cement (4% by weight).

f. FRA Approved Sign Support Systems

Other FRA approved proprietary supports systems may be used and shall be installed in accordance with the manufacturer's specifications.

703.07 INSTALLATION OF SIGNS

Installation of signs shall be in accordance with the Sign and Post Schedule.

Fittings shall be appropriate to the size and type of sign and shall ensure that the sign face is securely connected to the post.

Signs shall be attached to the post(s) or structures using the type and number of fittings as specified in the schedule or as Table 703.071.

Table 703.071 Number of Fittings per Post

Size of Sign	Number of Fittings per Post
Signs up to 200 mm in depth	One
Signs 201 to 900 mm in depth	Two
Signs 901 to 1200 mm in depth	Three

One extra fitting shall be provided per post for each 400 mm increment or part thereof above 1200 mm.

For braced signs, the sign shall be attached to the post at every intersection point between the sign bracing member and the post.

Where a sign assembly consists of two or more signs, the signs shall be mounted in accordance with the sign assembly drawings.

Signs shall be positioned in accordance with the following tolerances:

- ± 40 mm of the height specified in the Sign and Post Schedule measured from the bottom of the sign or sign assembly to the lip of the kerb or edge of shoulder nearest the sign;
- ± 100 mm of the pegged sign location or specified location.

When a sign is to be mounted on frangible posts on a cut batter having a slope steeper than or equal to 2:1, the mounting height at the shorter post may be reduced providing that:

- the uphill corner of the sign is a minimum of 800 mm above the ground;
- the sign at the longer post is 2200 mm minimum above the ground.

If required on the drawings sign faces shall be mounted on existing roadside poles, lighting columns, traffic signal pedestals. Where a sign is to be mounted with stainless steel straps, the brackets shall be attached to the pole using stainless steel straps of 12 mm minimum width and a minimum tensile strength 6.5 kN.

Small signs with an area of not exceeding 0.3 m² shall be attached to steel or concrete electricity distribution poles, tramway poles, lighting columns and signal pedestals or mast arms by banding or other proprietary fittings.

Signs exceeding 0.3 m² in area may be attached to existing poles (other than electricity distribution poles) provided that the pole has sufficient strength to support the additional loading due to the sign and that special joint-use supports are used.

If the Contractor proposes to mount a sign on an existing pole, the strength of the pole and any other effects of mounting the sign in this way such as fatigue and durability shall be checked by an experienced structural engineer. Evidence of the structural checking shall be submitted to the Engineer for review. The Contractor shall obtain permission shall for use of structures which are not FRA property.

Minimum lateral and vertical clearances adjacent and under the sign shall be maintained.

Where the drawings indicate that a sign is to face oncoming traffic, it shall be mounted on posts

which have been rotated in accordance with the requirements of Clause 703.06(a), with the exception of signs mounted on structures over traffic lanes.

Where signs are to be removed or relocated, as specified in the schedule, the Contractor shall dismantle and transport the signs, posts and fittings to the specified new location or as directed by the Engineer. Post holes shall be backfilled and compacted to the finished surface. Relocated signs shall be erected in their new position as specified.

After erection of each sign all stiffening bars are to be removed.

Single post mounting for large signs shall be provided if required on the drawings and the schedule. Such supports are not to be made as breakaway supports.

Installation of proprietary signs approved by FRA shall be in accordance with the supplier's recommendations as modified by FRA conditions of approval.

703.08 MASKING OF SIGNS

Signs, where indicated in the schedule, or where signs that have been erected but are not appropriate to current traffic usage, shall be masked, The Contractor shall mask the sign(s) by placing a porous cloth or similar covering that conceals the sign text under both wet and dry conditions and does not void the sign material warranty. The masking material shall be held in position by wire mesh over the sign.

Adhesive material shall only be applied to the masking material and not be applied to either the front or rear face of the signboard.

The size of the masking material and its method of attachment shall be such that the sign is:

- effectively and securely covered;
- wholly or partly covered, as required;
- covered at all times and under all conditions.

SECTION 704 – RAISED PAVEMENT MARKERS

704.01 DESCRIPTION

This section covers the supply, delivery and the fixing of both reflective and non-reflective raised pavement markers to asphalt, concrete or sealed pavements using epoxy adhesive or hot melt bitumen adhesive.

704.02 SUPPLY

All pavement markers shall be supplied by the Contractor

704.03 TOLERANCES ON POSITION

Markers shall be affixed to the pavement at the position shown on the drawings, or specified or directed by the Engineer within the following limits, unless otherwise specified.

(a) Markers in Line with Broken Line Segments

- Transverse position within 25mm of the centreline of the segments.
- Longitudinal or position within 0.5m of the specified position.

(b) Markers in a Longitudinal Group

- Transverse position of the centre of each marker within 25mm of the specified position and within 10mm of a line joining the centres of the end markers of the group.
- Longitudinal position of the end markers of the group within 0.5m of the specified position.
- Spacing of markers within the group within 50mm of the specified position.

(c) Markers Adjacent to Unbroken Line

- Clearance to the edge of line within 5mm of that specified.
- Longitudinal mismatch between markers in transverse pairs at barrier line not more than 25 mm.
- Longitudinal position of markers within 0.5 m or 10% of the specified spacing's whichever is the less.

(d) Orientation of Reflective Markers

- Lower edge of the reflective face of 85° to 95° to the centreline of the roadway or any adjacent line.

704.04 MATERIALS

The Contractor shall supply all materials required to complete the work covered by his section, unless otherwise specified.

(a) Marker

Markers shall comply with the relevant requirement of AS 1906 Part 3

Only markers approved for use by the FRA shall be used and all raised non reflective pavement markers shall be of the ultra-hard plastic type unless otherwise directed. Glass faced raised reflective pavement markers shall be used as indicated on the drawings unless specified otherwise

(b) Adhesive

Epoxy adhesive shall be Standard Set or Rapid Set Adhesive complying with the relevant requirement of AS 3554. Hot melt bitumen adhesive shall be approved by the Engineer.

Only adhesives approved for use by the FRA shall be used

704.05 MIXING EPOXY ADHESIVE

Adhesive components shall be batched so that the mixed adhesive contains not less than 45% nor more than 55% by volume of either component. Before starting work each day, or when changing to a different batch of adhesive, a hand mixed colour standard shall be prepared for reference during the day.

When machine mixing is used the mixing equipment shall use positive displacement pumps which proportion the two components in the specified range. At the beginning of each day and at any other time ordered by the Engineer, the Contractor shall check the proportion in the presence of the Engineer. Adhesive which has remained in the mixing head for longer than 90 seconds for rapid set adhesive or 180 seconds for standard set adhesive shall be discharged to waste.

When hand-mixing is used not more than 500 g each component shall be mixed at any time. The components shall be mixed on a flat surface and the mixed adhesive shall be used within 10 minutes of the time the two components are brought together.

Only standard adhesive shall be mixed by hand, unless the Engineer comments otherwise.

704.06 PREPARING HOT MELT ADHESIVE

The hot melt bitumen adhesive shall be heated in accordance with the manufacture's specification in a heater designed specifically for the purpose. It shall be regularly stirred in the heater during the laying operation to maintain uniformity of the component proportions.

704.07 PAVEMENT PREPARATION

The Contractor shall sweep or air blast each marker site as necessary to remove loose material before placing markers. Markers shall only be placed at locations where the pavement is free from dirt, oil, grease, paint or any other material which would adversely affect the bond of the adhesive to the pavement, unless otherwise specified.

Unless specified otherwise, the Contractor shall clean the pavement to remove oil or grease at every marker site by sand blasting, chipping or burning of bitumen as appropriate to ensure that the surface is clean and sound

Locations at which markers have not been placed because the pavement cannot be cleaned effectively shall be reported to the Engineer each day in writing who will direct the course of action to adopt.

704.08 PLACING MARKERS

Markers shall not be placed in any of the following circumstances:

- When the pavement is wet
- When the relative humidity is greater than 80% when the ambient temperature or the temperature of the road surface is less than 15 degrees centigrade.

Epoxy adhesive shall be placed on the base of the marker in such quantity and manner is to completely cover the base of the marker and extrude slightly all round when the marker is placed on the road. The marker shall be then positioned correctly on the pavement and pressure shall be applied until the adhesive is uniformly extruded from each edge of the base of the marker shall be approximately 1mm. The orientation and position of the marker should then be visually checked and if necessary immediately corrected.

Hot melt bitumen adhesive shall be placed on the road in the correct position and the marker quickly placed correctly oriented and pressed into adhesive.

Adhesive of either type on the exposed surfaces of the marker shall be removed using soft rags moistened with kerosene, petrol, or mineral turpentine. Any adhesive on the pavement which might be obscure the reflective faces or aspect of the marker shall be removed using a square ended spatula or similar.

Where a marker is not positioned correctly within 10 seconds for hot melt bitumen adhesive, 2 minutes for rapid set machine mix adhesive, 4 minutes for standard set machine mix or 10 minutes for standard set hand mix from the time mixing commences, it shall be discarded and a new marker placed.

Similarly, any marker dislodged by traffic after these times up to the end of the maintenance period shall be removed and replaced with a new marker.

On concrete and asphalt pavements, wherever possible markers shall be placed clear of longitudinal or transverse joints and on all pavements markers shall be placed clear of any surface cracks or positions from which markers have been removed and the surface is damaged.

704.09 PROTECTION FROM TRAFFIC

Markers shall be protected from the traffic after placing for periods not less than those shown in Table 704.091.

Table 704.091 Markers Protection from Traffic

Ambient Temperature (°C)	Standard Set Adhesive (Hours) (Min.)	Rapid Set Adhesive (Minutes) (Min.)	Hot Melt Adhesive (Minutes) (Min.)
35	1.25	25	4
30	2	30	4
25	3.5	35	3
15	6	40	3

SECTION 705 – PAVEMENT MARKINGS

PART 705.A - GENERAL

PART 705.B - PAVEMENT MARKINGS FOR NEW WORKS

PART 705.C - PAVEMENT MARKINGS FOR MAINTENANCE WORKS

PART 705.D - PAINTED PAVEMENT MARKINGS

PART 705.E - LONG LIFE PAVEMENT MARKINGS

PART 705.A – GENERAL

705. A01 GENERAL

This section covers the requirements for materials and application of pavement markings including:

- (i) supply and application of pavement marking paint and glass beads, longitudinal lines, intersection markings and other markings on the road surface for all new installations and maintenance of pavement markings;
- (ii) supply and application of thermoplastic or cold-applied plastic material and glass beads, and pliant polymer tape for all new installations and maintenance of pavement markings;
- (iii) fixing of both reflective and non-reflective raised pavement markers to asphalt, concrete or sealed pavements using epoxy adhesive or hot melt bitumen adhesive.

705. A02 DEFINITIONS

(a) Pavement Marking

The term used to define all linemarking, roadmarking and raised pavement markers.

(b) Linemarking

The term used to define all longitudinal lines such as centre, lane, edge, turn and continuity lines.

(c) Roadmarking

The term used to define all transverse lines and markings applied by hand such as Stop/Give Way lines, pedestrian lines, arrows, and legends.

(d) Maintenance of Pavement Markings

Refers to the refreshing or replacement of an already existing pavement marking.

(e) *New Pavement Markings*

Refers to applying pavement markings to a new surface where no pavement marking exists i.e. after reseals, asphalt resurfacing, newly constructed pavements, and modifications to existing pavement markings.

(f) *Initial Coat*

The term used to define initial coat of painted markings placed prior to the final coat.

(g) *Final Coat*

The term used to define the final application of paint.

(h) *Raised Pavement Marker*

A device placed on a pavement which may be a:

(i) *Non Reflective Marker*

A device to provide a degree of delineation during daylight owing to the contrasting colour, reflection and profile with respect to the pavement surface. Also a device which reflects ambient light during the day-time and to a limited degree when illuminated at night.

(j) *Reflective Marker*

A device which produces an effective point source of light at normal highway viewing distances by reflecting incident light in directions close to the direction from which it came. Also a device to provide a degree of delineation during daylight owing to the contrasting colour, reflection and profile with respect to the pavement surface.

(k) *Temporary Reflective Marker*

A temporary device performing the same function as a Reflective Marker but with an intended life of not more than two weeks under average traffic conditions.

(l) *Retroreflectivity*

A property of some materials, such as solid glass beads, to reflect incident light in directions close to the direction from which it came. Retroreflectivity is the value of reflected light measured in millicandella / lux / square metre and is used as a measure of light reflected by pavement markings.

(m) *Retro reflectometer*

A device used to measure retro reflectivity. For the purpose of this contract the geometry of the retro reflectometer shall be based on 30 m observation geometry.

(n) *Urban Area*

An area in which:

- (i) a speed limit of 60 kilometres per hour or less applies and is not a speed limit which applies only because of a temporary reason such as roadworks or a street event; or
- (ii) there are buildings on land next to the road or where the street lighting poles are not more than 100 m apart for -
 - a distance of at least 500 m; or
 - if the length of the road is less than 500 m, over the full length of the road.

(o) *Rural Area*

An area that is not an Urban Area.

705. A03 STANDARDS

The dimensions and colour of pavement markings shall conform to the following standards:

- (i) FRA Manual of Traffic Signs and Markings: Part 2 Linemarking;

705. A04 INCLUSION AND DELETION OF JOB ITEMS

(i) The Engineer may delete any work, subject to notice of deletion being given one month prior to the proposed programmed date. The Contractor will be notified in writing of such deletion and the contract sum adjusted by the price tendered in Schedule 1 for the job item(s) deleted.

(ii) No additional payment will be made as a result of the deletion of any work or job item. However, where the deletion of job items results in a contract sum reduction of more than 20 per cent of the original contract sum, the deletion of job items in excess of this amount will be treated as a variation in accordance with the General Conditions of Contract.

(ii) The Engineer may request the Contractor to undertake additional pavement marking works at sites not listed in Schedule 1. These works will be treated as a variation in accordance with the General Conditions of Contract, except that the work shall be valued using Schedule 2 – Rates for Variation Purposes.

705. A05 MATERIALS

Pavement marking materials shall conform to the following standards.

(a) *Raised Pavement Markers*

- (i) Raised pavement markers shall comply with the relevant requirements of AS 1906, Part 3
- (ii) Temporary raised reflective pavement markers shall comply with the relevant requirements of AS 1906, and shall be at least 100 mm in width and to a height of 50 mm with white reflective material on both sides and include protective covers for the reflective material.

(b) *Adhesive*

The Contractor shall provide evidence (test results, history of satisfactory performance etc.) that the proposed hot melt bitumen adhesive will permanently bond raised pavement markers to bituminous and concrete surfaces and perform its intended purpose.

Other types of adhesive materials shall only be used with the approval of the Engineer.

(c) *Linemarking and Roadmarking Paint*

All paints shall be approved under the Australian Paint Approval Scheme (APAS). Paint shall comply with the requirements of AS 4049.1 for solvent-borne paint or AS/NZS 4049.3 for water-borne paint.

(d) *Glass Beads*

- (i) Glass beads shall be used on all applications of material and for all pavement markings and shall conform to the requirements in AS/NZS 2009 and the Australian Paint Approval Scheme (APAS) Specification 0042.
- (ii) Intermix glass beads for use in long life material applications shall conform to AS/NZS 2009 and the Australian Paint Approval Scheme (APAS) Specification 0042.
- (iii) The amount of heavy metals in the beads shall not be greater than that specified in Specification 0042.
- (iv) Pristine glass beads (Type B-HR)

Type B-HR glass beads shall comply with the properties of Type B (AS 2009:2006) drop-on glass beads, with an additional high performance retroreflectivity requirement, requiring the delivery of a minimum 450 mcd/lux.m², when tested in accordance with a modified Appendix M* of AS

2009:2006 (described below).

Section M4 Apparatus clause a) Dry film thickness of paint will be 200-250 μm

Section M5 Procedure clause b) Weigh 24 +/- 0.5 grams of glass beads

Section M5 Procedure clause e) Wet film thickness of paint will be 375 μm
+/- 25 μm .

(e) Thermoplastic Pavement Marking Material

Thermoplastic pavement marking material used under this Contract shall comply with the requirements of Clause 705.A13 and shall provide a functional service life of a least six years allowing for fair wear and tear.

(f) Cold-applied Plastic Pavement Marking Material

Cold-applied plastic pavement marking material used under this Contract shall be a Poly Methyl Methacrylate resin based pavement marking material conforming with the colour, luminance and bead content requirements of Clause 705.A13 and shall provide a functional service life of at least six years allowing for fair wear and tear.

(g) Pliant Polymer Pavement Marking Tape

Pliant polymer pavement marking tape intended for use under this Contract shall be approved by the Engineer.

705. A06 SITE PREPARATION

Site preparation shall be the sole responsibility of the Contractor as part of the works, including:

- (i) the removal of existing unsound, obsolete or redundant pavement markings
- (ii) the removal of any foreign materials and debris within reasonable limits.

705. A07 PLACING RAISED PAVEMENT MARKERS

Markers shall be placed in accordance with the manufacturer's specification for pavement markers and the adhesives used shall be in accordance with Clause 705.A05 (b).

Adhesive on the exposed surfaces of the marker shall be removed.

Where a new or replacement marker is not positioned correctly it shall be removed and a new marker placed.

Markers shall be protected from traffic after placing and any marker dislodged by traffic shall be removed and replaced with a new marker.

On concrete and asphalt pavements, wherever possible, markers shall be placed clear of longitudinal or transverse joints and on all pavements markers shall be placed clear of any surface cracks or positions from which markers have been removed and the surface is damaged.

705. A08 REMOVAL OF PAVEMENT MARKINGS

Where required the Contractor shall remove existing pavement markings to the standard approved by the Engineer and appropriate to the marking being removed.

Any pavement damage caused by the installation or removal of pavement markings included in the works shall be the Contractor's responsibility. Rectification of any pavement damage to line and level shall be completed on the same day in accordance with the Engineer's requirements.

On sections of road on which the Contractor has been directed to replace or remove raised pavement markers, the Contractor shall also repair damage to the pavement caused by the loss of pavement markers.

705. A09 LAYOUT OF MARKINGS

The Contractor shall be responsible for the layout of and spotting out for markings in accordance with the FRA Manual of Traffic Signs and Markings: Part 2 Linemarking.

705. A10 TOLERANCES ON PAVEMENT MARKINGS

The Contractor shall comply with the tolerances as shown in Table 705.A101 when installing pavement markings.

Table 705.A101 Tolerances on Pavement Markings

Markings	Tolerance
(A) Pavement Markings ⁽¹⁾	
Distance between the centreline of the marking and the centreline of the set out mark	<30 mm
Distance between the centreline of the completed marking and the centreline of the previous marking	<15 mm
Width of completed painted markings	±10 mm of the specified dimensions
Width of completed markings for long life materials	0 mm to +10 mm
Length of completed stripes and blocks	0% to +10% of the specified length
Gap between double lines	-10 mm to +0 mm of the required 100 mm gap (2)
(B) Raised pavement markers	
(i) Markers in line with broken segments	
Transverse position	±25 mm of the centreline of segments
Longitudinal position	±0.5 m of the specified position
(ii) Markers in a longitudinal group	
Transverse position	±25 mm of specified position and ±10 mm of a line joining the centres of the end markers
Longitudinal position	±0.5 m
Spacing of markers within the group	±50 mm of specified spacing
(iii) Markers adjacent to an unbroken line	
Clearance to edge line	±5 mm of the specified dimensions

Longitudinal mismatch between markers in transverse pairs	<25 mm
Longitudinal position	Lesser of: 0.5 m or 10%
(iv) Orientation of reflective markers	Lower edge of the reflective face at 85° to 95° to centreline of roadway or adjacent line
(C) Thermoplastic profiled lines	
(i) Tolerances on dimension	
Line width	+20 mm, -5 mm
Line height	+2 mm, -0 mm
Extrusion breadth	+10 mm, -0 mm
Extrusion spacing	±15 mm
Extrusion shape	±25 mm at any point from rectangular shape
(ii) Tolerances on position	
Distance between the centreline of the marking and the centreline of the set out	<30 mm
Length of the completed lines	-0% to +5% of the specified length
Longitudinal position of individual extrusions	±50 mm of any previously applied profiled lining
<p>(1) Apparent line of the markings is a smooth, continuous alignment when viewed in the direction of the line.</p> <p>(2) Maintenance of pavement markings: If the gap between the existing lines is 90 mm or less the gap shall not be reduced by the maintenance application.</p>	

705. A11 PROTECTION OF WORK

The Contractor shall be responsible for protecting the work by an appropriate means until the work

can be trafficked without the glass beads being disturbed from their embedded position, or the paint being picked up and/or spread by passing traffic. If paint pick-up or glass bead disturbance does occur, the Engineer may direct that the marking be re-applied, and paint or long life material spread by traffic be removed.

705. A12 ACCEPTANCE OF WORK

Pavement marking shall comply with the specified requirements as detailed in the following clauses:

- 705.A05 Materials
- 705.A10 Tolerances on Pavement Marking
- 705.A13 Acceptance of Retroreflectivity
- 705.A14 Acceptance of Colour
- 705.D02 Minimum Requirements (for painted markings)
- 705.E02 Minimum Requirements (for long life markings)

Where a particular item fails to satisfy any of the above requirements:

- (i) the Contractor shall rectify the failed sections within 4 weeks of testing at the Contractor’s expense

Where removal of unsuitable pavement marking is required, the method of removal shall be subject to the approval of the Engineer before removal works commence.

705. A13 ACCEPTANCE OF RETROREFLECTIVITY

The Contractor shall measure the level of retroreflectivity using the procedure set out in the current revision of VicRoads Test Method RC 424.01 – Determination of Retroreflectivity of Pavement Markings. Acceptance of the retroreflectivity of any line or road marking will be based on a lot basis.

The average of the six test site Site Retroreflectivity Values (SRV) shall be calculated for each lot. Each lot shall achieve an average minimum level of retroreflectivity as specified in Table 705.A131 Acceptance of Retroreflectivity.

Table 705.A131 Acceptance of Retroreflectivity

	Initial Measurement	Additional Measurement
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Testing Period ⁽¹⁾	3 – 5 weeks	5 – 6 months
Minimum level of retroreflectivity on sprayed seal surfaces	350 mcd/lux/m ²	220 mcd/lux/m ²
Minimum level of retroreflectivity on asphalt and all other surfaces	350 mcd/lux/m ²	250 mcd/lux/m ²
⁽¹⁾ Measured after application of the second/final coat of material.		

Measurements shall be forwarded to the Engineer no later than five days from when the measurements were taken.

705. A14 ACCEPTANCE OF COLOUR

White markings - the colour match test for white materials shall be based on luminance factor and conducted in accordance with AS 4049.4, using Field Method 2 of AS 4049.4 Appendix H4.3. All markings shall have a colour difference detected as whiter than Natural Colour System (NCS) swatch S 2000-N, at all times during the Defects Liability Period.

Yellow markings – the colour match test for non-white (yellow) materials shall be conducted in accordance with AS 4049.4 using Field Method 2 of AS 4049.4 Appendix H4.3, using the reference swatch sample NCS S 1070-Y20R. All yellow markings shall be an approximate match to Natural Colour System (NCS) swatch S 1070-Y20R, at all times during the Defects Liability Period.

Measurements shall be forwarded to the Engineer upon request no later than five days from when the measurements were taken.

PART 705.B – PAVEMENT MARKINGS FOR NEW WORKS

705. B01 GENERAL

This section covers the requirements for new pavement markings.

705. B02 SCOPE OF WORK

The scope of work includes the supply of all materials and placement of pavement markings in accordance with this specification.

For new pavement marking the following works shall be undertaken as part of the works:

- (i) immediately prior to resurfacing, removal of any existing reflective and non-reflective markers

- (ii) placement of temporary reflective pavement markers including removal of protective covers after surfacing works
- (iii) initial placement of pavement markings, including reinstatement of any adjoining pavement markings blackened but not necessarily covered by the surfacing activity, comprising –
 - reinstatement and/or placement of initial coat of painted pavement markings
 - reinstatement and/or placement of other long life pavement markings
 - reinstatement and/or placement of raised pavement markers and removal of temporary raised reflective pavement markers
- (iv) final coat of all painted pavement markings
- (v) reinstatement and/or placement of profiled lines after the final coat of paint.

705. B03 LIMIT OF WORK

For new pavement markings the limit of pavement marking works shall be the same as the limit of the new surfacing or as shown the drawings.

705. B04 PROGRAM

For new pavement markings the Contractor shall undertake pavement marking works in accordance with the following requirements.

- a) After surfacing works the initial coat of paint, long life pavement markings (other than profiled linemarking) and raised pavement markers (reflective and non-reflective) on newly surfaced pavements shall be installed in accordance with the following timeframes:

AADT ≥5,000 and M1, M2 roads within 24 hours of opening to traffic

AADT ≥1,000 and ≤4,999 within 3 days of opening to traffic

AADT < 1000 within 5 days of opening to traffic

- b) All new painted pavement markings shall receive two applications of paint. The second/final application shall be applied between 2-6 weeks after the initial application.
- c) The Contractor shall apply profiled linemarking between 2–6 weeks after the final coat.
- d) For new works constructed clear of traffic, all pavement markings shall be completed prior to opening of traffic.

705. B05 POSITION OF MARKINGS

All markings are to be set out in accordance with the dimensions and spacings as required by the appropriate standard in Clause 705.A03.

Painting/application of material shall not commence until the Engineer has inspected the set out and given consent to proceed, unless an exemption has been granted in writing by the Engineer.

a) New pavement markings shall be positioned in accordance with the following requirements:

(i) set out by the Contractor in conformance with the appropriate standard required by Clause 705.A03

(ii) applied within the tolerances listed in Table 705.A101.

b) Temporary Reflective Markers

Temporary reflective markers for new works shall be placed at the following minimum spacings on all longitudinal lane lines, except that on any curve less than 500 m in radius the spacing shall not be more than 12 metre centres:

AA DT ≥5,000 and M1, M2 Roads	12 metre centres
AA DT ≥1,000 and <5,000	24 metre centres
AA DT <1,000	48 metre centres

705. B06 RECORDS AND REPORTING

(a) *Job Completion Report*

For New Markings the Contractor shall complete and forward to the Engineer a Job Completion Report (Pavement Markings).

(b) *Retroreflectivity Report*

The Contractor shall complete and forward to the Engineer a Retroreflectivity Report in a form approved by the Engineer showing the level of retroreflectivity determined for each test lot in accordance with the requirements of Clause 705.A12.

PART 705.C – PAVEMENT MARKINGS FOR MAINTENANCE WORKS

705. C01 GENERAL

This section covers the requirements for maintenance of pavement markings.

705. C02 SCOPE OF WORK

The scope of work includes the supply of all materials and placement of pavement markings in accordance with this specification.

Maintenance works shall entail preparing the site in accordance with Clause 705.A06 and refreshing the existing pavement markings with the same material as the existing markings in accordance with this specification.

Existing markings which are in 'Long-life' i.e. thermoplastic, cold-applied plastic, pliant polymer roadmarking tape, or other long durability non-paint product shall not be maintained in paint, unless prior approval has been given by the Engineer. Missing or badly worn long life markings shall be reported to the Engineer who may direct the Contractor to maintain the markings in paint.

705. C03 LIMIT OF WORK

For the maintenance of existing pavement markings the works shall include all existing tapers, bell mouths at intersecting roads, pavement widening and traffic lanes. The limits of work at typical intersections are shown in the Drawings.

705. C04 EXCLUSION OF ROADWORKS

For works involving the maintenance of pavement markings, the Contractor will not be responsible for maintaining pavement markings unless otherwise directed by the Engineer where it is evident that roadworks are taking place or will shortly take place which will interfere with the installation of the markings or which will damage the completed markings.

The Contractor shall record the location of any road lengths not maintained and notify the Engineer. The Contractor shall state the reason as to why the location is not maintained prior to the pavement marking work being undertaken.

Long Life Pavement Markings that could result in thicknesses greater than 5 mm shall not be applied and shall be brought to the attention of the Engineer.

705. C05 PROGRAM

- a) For the maintenance of pavement markings the Contractor shall submit the following programs as specified for review by the Engineer as part of the works.
 - (i) Within two weeks of the Date of Award of Contract, a pavement marking program for the whole of the works that complies with contract requirements for Road Inventory Information. This program shall be reviewed and updated at least annually.
 - (ii) Based on the list of jobs requested by the Engineer, the Contractor shall submit a monthly detailed program of planned pavement marking jobs at least five working days in advance of the following month.

The detailed program shall be in bar chart form or other suitable form approved by the Engineer, including specific jobs to be undertaken with a time scale shown in days. The

program shall be in sufficient detail to identify dates covering the following activities:

date of linemarking

date of roadmarking

dates of placement of raised pavement markers

date of retroreflectivity testing.

- (iii) The Contractor shall submit a weekly program confirming the crew locations for work that will be undertaken in the following week.

All pavement markings on individual Job Items shall be completed in the programmed month as specified in Contract requirement.

705. C06 INSPECTION AND REPLACEMENT REQUIREMENTS FOR MAINTENANCE OF RAISED PAVEMENT MARKERS

For maintenance of raised pavement markers, the Engineer will conduct a routine program of inspections of the condition of raised pavement markers.

From the routine program of inspections, requests for replacement of raised pavement markers will be made. For the purpose of replacing raised pavement markers, the Contractor may program this based on a minimum run of 250 markers on urban road sections and M1 and M2 and Arterial class roads, and a minimum run of 125 markers on other road sections. Valuation of these works will be based on rates submitted in Schedule 2 - Rates for Variation Purposes. The Contractor shall replace these markers within one month of the issue of a request from the Engineer.

705. C07 RECORDS AND REPORTING

(a) Job Completion Report

For maintenance of pavement markings the Contractor shall complete and forward to the Engineer a Job Completion Report (Pavement Markings) using the proforma included as Attachment A to this Section 705, for each job item in Schedule 1.

The Contractor shall hold all records on electronic media in a form approved by the Engineer. One electronic and one hard copy of each month's completed work shall be forwarded to the Engineer together with the statement for payment under the Contract.

(b) Retroreflectivity Report

For both new work and maintenance of pavement markings, the Contractor shall complete and forward to the Engineer a Retroreflectivity Report in a form approved by the Engineer showing the level of retroreflectivity determined for each test lot in

accordance with the requirements of Clause 705.A12.

PART 705.D - PAINTED PAVEMENT MARKINGS

705. D01 GENERAL

Linemarking shall be applied by a self-propelled machine, and stencils shall be used with all roadmarking.

All work must be undertaken by an appropriately qualified and experienced contractor.

Completed markings shall be uniform in appearance from all angles of observation, texture, width and thickness and the surface shall be free from streaks, overlaps, unbeaded areas, tyre marks, stencil breaks or other defects. Edges and cut-offs should be neat and sharp, and there shall be no visible run-off, overspray, dribbles, splash or spillage on to the surrounding area, or on to parked or passing vehicles. The Contractor shall be responsible for the cost of removal of paint from such vehicles.

Glass beads shall be applied to the paint to produce a uniform coverage and be properly embedded and bonded over the whole painted surface. Glass beads shall be applied to all markings.

The Contractor shall be responsible for any spillage on to the surrounding area, and cost of any remedial action required.

705. D02 MINIMUM REQUIREMENTS

The minimum requirements of paint and glass beads shall be as shown in Table 705.D021. The Contractor shall allow for any extra material required when placing on coarse chip seals. This includes the retained quantity of glass beads, to counter the phenomenon of reduced retroreflectivity due to road surface texture and directional visibility limitations.

Table 705.D021 Minimum Requirements – Paint and Glass Beads

	Paint ⁽¹⁾	Glass Beads ⁽²⁾
Linemarking		
New Markings (initial application only)	0.22 mm dft on sprayed seals 0.22 mm dft on asphalt and all other surfaces	Type D-HR ⁽³⁾

Re-marking (including second application on new markings)	0.38 mm dft on sprayed seals 0.35 mm dft on asphalt and all other surfaces	Type D-HR ⁽³⁾
Roadmarking		
All Marking	0.35 mm dft on sprayed seals 0.30 mm dft on asphalt and all other surfaces	Type B-HR
<p>⁽¹⁾ The minimum dry paint film thickness (dft) specified above shall be the end product thickness measured on a 200 mm x 100 mm sheet metal test plate without beads. Consideration shall be given to the texture of the road surface and the method of application used to achieve the requirements of this section.</p> <p>⁽²⁾ A minimum of 400 g/m² shall be retained in the painted marking for all glass beads.</p> <p>⁽³⁾ An alternative glass bead application rate shall be 300 g/m² of D-HR with a separate drop of 200 g/m² of B-HR provided that 75% minimum of the D-HR beads is retained at the 5 to 6 month testing undertaken Table 705.A131. Retention of the D-HR beads shall be demonstrated by photographs at each test site.</p>		

PART 705.E – LONG LIFE PAVEMENT MARKINGS

705. E01 GENERAL

Long life pavement marking materials shall be prepared and used in accordance with the manufacturer's specification.

All linemarking shall be applied using a self-propelled ride-on machine including Statcon marking unless otherwise recommended by the marking manufacturer and approved by the Engineer.

Glass beads shall be applied to all long life markings. Glass beads shall be sprinkled or sprayed on to the long life material while it is in a fluid state immediately after it has been applied to the pavement to ensure that the beads are embedded by a nominal 60%. The surface beads shall be distributed to give a uniform coverage over the whole surface of the long life material.

Completed markings shall be uniform in appearance, texture, width and thickness and the surface shall be free from blisters, air bubbles, tears, lumps, streaks, overlaps, unbeaded areas, tyre marks or other defects. Edges and cut-offs shall be neat and sharp, and there shall be no visible

run-off, overspray, dribbles, splash or spillage on to the surrounding area, or on to parked or passing vehicles. The Contractor shall be responsible for the removal of pavement marking material from such vehicles.

705. E02 MINIMUM REQUIREMENTS

The minimum requirements of long life materials and glass beads shall be as shown in Table 705.E021. The Contractor shall allow for any extra material required when placing on coarse sprayed / chip seals. This includes the retained quantity of glass beads, to counter the phenomenon of reduced retroreflectivity due to road surface texture and directional visibility limitations.

Table 705.E021 Minimum Requirements – Long Life and Glass Beads

Material	Applied Minimum Thickness, Glass Bead and Other Requirements
Thermoplastic	
sprayed markings	2.0 mm minimum thickness on longitudinal lines containing intermix beads and with a minimum of 400 g/m ² of Type D-HR or Type B-HR ⁽³⁾ drop-on glass beads retained on the marking surface
extruded line markings ⁽¹⁾	2.0 mm minimum thickness on longitudinal lines containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
extruded road markings ⁽¹⁾	3.0 mm minimum thickness on intersections containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
preformed markings	2.3 mm with a minimum skidding resistance value of 45 BPN (British Pendulum Number) and retroreflective properties agreed with the Engineer.
profiled lines ⁽¹⁾	8.0 mm minimum thickness with a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface

(Table 705.E021 Minimum Requirements – Long Life and Glass Beads (continued))

Material	Applied Minimum Thickness, Glass Bead and Other Requirements
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Cold-applied Plastic	
sprayed line markings ⁽²⁾	1.0 mm minimum thickness for longitudinal line markings only with a minimum of 400 g/m ² of Type D-HR or Type B-HR glass beads retained in and on the marking surface
sprayed road markings ⁽²⁾	2.0 mm minimum thickness for all road markings containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
trowelled, screeded, or extruded markings ⁽¹⁾	2.0 mm minimum thickness of markings containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
Pliant Polymer Tape	as approved by the Engineer
<p>⁽¹⁾ The minimum thickness specified shall be the height above the upper road surface level or above the existing marking as appropriate.</p> <p>⁽²⁾ The minimum thickness specified shall be the height of the material between the glass beads on a metal test plate. All other thicknesses shall be as measured on a metal test plate including glass beads.</p> <p>⁽³⁾ Pristine drop-on Type B glass beads (Type B-HR), as per Clause 705.A05.</p>	

705. E03 ADDITIONAL REQUIREMENTS FOR PROFILED LINES

The Contractor shall provide measurements of rib height, length, width, and spacing of profiled lines at a minimum of 10 evenly spaced readings per kilometre or part thereof. For lengths of less than 500 metres, a minimum of 2 evenly spaced readings per 100 metres shall be provided.

The Contractor shall carry out remedial work to rectify defective sections of profiled lines where they:

- (a) were not installed to specified dimensions, or distorted in shape or lost shape, such that the height of individual extrusions is less than 8 mm above the top of adjacent road surface aggregate particles, over more than 10 per cent of the profiled edge lining job item; or
- (b) have shattered or no longer adhere to the road surface over more than 1 per cent of the profiled edge lines job item; or
- (c) have shattered or no longer adhere to the road surface over a continuous length exceeding 5m.

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Job No.			
Road Name		Map Reference From	
From		Map Type	
To		Map Reference To	
Lane kilometres		Carriageway kilometres	
Responsible Region		Other Region(s)	
Municipality(ies)		Connect Equipment No. FRA Use Only	
MABC No. FRA Use Only		Road Category	
Comments			

Pavement Marking Maintenance

Paint Maintenance

Treatment	Material	Date of Marking	FRA Use Only
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			Next Schedule Date	Next Program Date

RPM, Including RRPM Maintenance

Treatment	Material	Date of Marking	FRA Use Only	
			Next Schedule Date	Next Program Date

Long Life, RRPM Special and other Special Treatments Including Part Treatments and other RPM Treatments

Treatment	Material	Date of Marking	FRA Use Only	
			Next Schedule Date	Next Program Date

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Performance Reporting

Treatment	Performance Criteria	Date of Testing	FRA Use Only Next Schedule Date	FRA Use Only Next Program Date
Painted Markings	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			
	Skid Resistance			
Raised Pavement Marker	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			
Long Life Markings	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			

	Skid Resistance			
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The Contractor shall include in the Job Completion Report the actual status of the item compared to the specified requirement for that item, including:

- tolerances on pavement markings;
- retroreflectivity;
- daylight visibility;
- colour; and
- skid resistance.

I, certify the above details as correct.

(Print Name)

(Signed)

ATTACHMENT A TO SECTION 705

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

<p>Painted Marking Detail</p>
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Pattern	Material	Unit of Measure	Quantity
Standard Stripe 100 mm		km	
Semi Barrier 100 mm		km	
Double Barrier 100 mm		km	
Edgeline 100 mm		km	
Single solid lane line 100 mm		km	
Edgeline 150 mm		km	
Single solid lane line 150 mm		km	
Single solid centreline 150 mm		km	
Continuity line 150 mm		km	
Turn lines 100 mm		m	
Lane lines 100 mm		m	
Chevron, diagonal bars or pedestrian crossing stripes, 600 mm		m	

Straight ahead arrow 1.4 m ² including 150° angle arrow		each	
Turn arrow 1.6 m ²		each	
Combination turn/straight arrow		each	
Double turn arrow 2.7 m ²		each	
Combination straight/double turn arrow 3.6 m ²		each	
U turn 2.7 m ²		each	
Pedestrian lines 150 mm		m	
Stop lines 600 mm		m	
STATCON holding bars 150 mm wide 600/600 line/gap		Per block	
STATCON stop line 300 mm		m	
STATCON give way 300 mm wide 600/600 line/gap		Per block	
STATCON centreline 100 mm wide, usually 30 m long		m	
Freeway exit ramp block 1.5 m wide, usually 6 m long		m	
STATCON Roundabout blocks 400 mm wide 600/600 line/gap		Per block	
Special Legends			
KEEP CLEAR, including 150 mm long clearance bars		each	

Small Bicycle Symbol		each	
Large Bicycle Symbol		each	
Transit Lane TL		each	
Bus Lane		each	
Other			

ATTACHMENT A TO SECTION 705

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

<p>Raised Pavement Marker Detail</p>

Marker Type	Material	Unit of Measure	Quantity
Raised retroreflective pavement marker white mono or bi-directional		each	
Raised retroreflective pavement marker white mono or bi-directional (glass faced)		each	
Raised retroreflective pavement marker, yellow, red or green, mono or bi-directional		each	
Raised non-reflective pavement marker (ceramic)		each	
Raised non-reflective pavement marker (ultra-hard plastic alloy)		each	

Long Life Markings Detail

Pattern	Material	Unit of Measure	Quantity
	ST sprayed thermoplastic		
	ET extruded thermoplastic		
	SCT screeded thermoplastic		
	CA cold applied plastic		
Standard Stripe 100mm		km	
Semi Barrier 100 mm		km	
Double Barrier 100 mm		km	
Edgeline 100 mm		km	
Single solid lane line or centreline 100 mm		km	
Continuity line 100 mm		km	
Edgeline 150 mm		km	
Single solid lane line 150 mm		km	
Single solid centreline 150 mm		km	
Continuity line 150 mm		km	
Profiled lines		km	

Turn lines 100 mm		m	
Lane lines 100 mm		m	
Chevron, diagonal bars or pedestrian crossing stripes, 600 mm		m	
Straight ahead arrow 1.4 m ² including 150° angle arrow		each	
Turn arrow 1.6 m ²		each	
Combination turn/straight arrow		each	
Double turn arrow 2.7 m ²		each	
Combination straight/double turn arrow 3.6 m ²		each	

ATTACHMENT A TO SECTION 705

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

<p>Long Life Markings Detail ... continued</p>

Pattern	Material	Unit of Measure	Quantity
U turn 2.7 m ²	ST sprayed thermoplastic	each	
Pedestrian lines 150 mm	ET extruded thermoplastic	m	
Stop lines 600 mm	SCT screeded thermoplastic	m	
STATCON holding bars 150 mm wide 600/600 line/gap	CA cold applied plastic	Per block	
STATCON stop line 300 mm		m	
STATCON give way 300 mm wide 600/600 line/gap		Per block	
STATCON centreline 100 mm wide, usually 30 m long		m	
STATCON Roundabout blocks 400 mm wide 600/600 line/gap		Per block	
KEEP CLEAR including 150 mm long clearance bars		each	
Small Bicycle Symbol		each	
Large Bicycle Symbol		each	
Transit Lane TL		each	
Bus Lane		each	
Other			

Traffic Signal Site

Job Item No.			
Employer Road Name			
Intersecting Road			
Other intersecting Road			
Map Reference From		Map Type	
Responsible Region		Other Region(s)	
Municipality(ies)		Connect Equipment No. FRA Use Only	
MABC No. FRA Use Only		Road Category	
Comments			

ATTACHMENT A TO SECTION 705

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

**Pavement Marking
Maintenance**

Paint Maintenance

Treatment	Material	Date of Marking	FRA Use Only	
			Next Schedule Date	Next Program Date

RPM, including RRPM maintenance

Treatment	Material	Date of Marking	FRA Use Only	
			Next Schedule Date	Next Program Date

Long Life, RRPM Special and Other Special treatments including Part treatments and Other RPM treatments

Treatment	Material	Date of Marking	FRA Use Only	
			Next Schedule Date	Next Program Date

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I, certify the above details as correct.

(Print Name)

.....

(Signed)

SECTION 801 – FOUNDATIONS FOR STRUCTURES

801.01 SCOPE

This section covers all work for foundation for structures which, within the concept of the Specification, shall be considered to comprise those elements of construction below the formation level of footings, pile caps or spread foundations, collectively hereafter referred to as the base or bases for structures.

801.02 MATERIALS

(a) *General*

Materials used in the permanent foundation work shall comply with the relevant clauses in Sections 800 of the Specification.

(b) *Rock (for rock fill)*

Stones shall be hard; angular field or quarry stones of such quality that they will not disintegrate on exposure to water or weathering. The stones shall be free from overburden, shale and organic material. Neither the breadth nor thickness of a single stone shall be less than one-third its length. Not more than 10% of the total volume of rock fill shall consist of stones having a mass more than 5 times the mass specified. Not less than 50% of the total volume of rock fill shall consist of stones larger than the specified mass.

(c) *Crushed stone*

Crushed stone used for the construction of crushed stone fill shall be from sound unweathered rock approved by the Engineer.

(d) *Granular fill*

Granular fill used for the construction of compacted granular fill shall consist of well-graded crushed or uncrushed gravel, stone, rock fill, crushed concrete or slag or a combination of any of these. It shall not contain any unsuitable material, nor have a soluble sulphate content exceeding 2.5g per litre. Not less than 95% of the material shall pass a 125 mm BS sieve and at least 90% shall pass the 75 mm BS sieve, but not more than 10% shall pass the 75 mm sieve.

(e) *Sand fill*

Sand use for filling of caissons and piles shall be clean, hard and free from lumps of clay, organic or other deleterious matter.

(f) *Structural steel*

Steel grade shall comply with the requirements of AS/NZS3678 and specified on the Drawings. Fabricated sections shall comply with the details shown on the Drawings. Steel piles shall comply with the requirements of AS 2159 and AS 5100.3. In circumstances where AS 2159 and AS 5100.3 requirements differ, the requirements of AS 5100.3 shall take precedence over those of AS 2159.

(g) *Permanent pile casing*

The thickness of permanent pile casings that are not designed or required to assist in carrying loads on the Permanent Works. The casings shall be sufficiently rigid so as not to deform permanently or damage during handling and installation and shall remain grout-tight. The Contractor shall determine and be responsible for the structural adequacy of the steel casing. The type and thickness of the steel casing shall be certified as being suitable for its intended purpose, which may and include providing safe access for personnel, resisting all superimposed loads from driving, extraction, earth and water pressure, and the effects of any distortion which is likely to occur to the casing.

(h) *Driven pile casing*

Driven pile shall comply with the requirements AS 2159 and AS 5100.3 and pile casings shall have sufficient strength to permit them being driven and not being distorted by the driving of adjacent piles. They shall be sufficiently watertight to prevent water leaking through the casing walls during the placing of concrete. In circumstances where AS 2159 and AS 5100.3 requirements differ, the requirements of AS 5100.3 shall take precedence over those of AS 2159

801.03 GENERAL

(a) *Subsurface data*

If it is found during the course of excavation that the load bearing strata differs from that shown on the Drawings, the Contractor shall immediately notify the Engineer.

The Engineer shall be entitled, as often as he may deem necessary during the course of excavation, to call upon the Contractor to perform additional foundation investigation and/or tests at or below, the respective founding levels to establish safe bearing pressures and founding depths.

(b) *Channel Preservation*

Streamflow and preservation of marine and freshwater life shall be maintained at all times.

It shall be watertight, of adequate strength and shall be anchored in position to prevent movement. The construction, use and removal of channel shall be conducted in a safe manner and proper provision shall be made for the safety of all persons involved. Access to cofferdams, artificial islands and piling platforms shall be accomplished without disrupting the streamflow at the point of crossing unless otherwise specified in the Special Provisions. Members of the public shall be prevented from accessing the cofferdam, artificial islands and piling platforms.

On completion of the Works, surplus excavated materials, including materials excavated from caisson compartments and piles, materials used in cofferdams and other temporary works, as well as in-situ material, shall be removed and disposed of by the Contractor down to the original bed level or such lower elevation as agreed to by the Engineer or required for stream channellisation works.

801.04 ARTIFICIAL ISLANDS AND DEWATERING

(a) Artificial Islands and Temporary Embankments

Artificial islands and/or temporary embankments may be constructed by the Contractor to gain access to and for construction of pile foundations as agreed by the Engineer.

The platform to support the material, plant and equipment shall, where necessary, be consolidated to provide firm support and the side slopes shall be protected against erosion and scour. The Contractor may use any material he deems suitable for the construction of the island but shall note that separate payment shall not be made for constructing the artificial island.

The Contractor shall submit the following documents to the Engineer for review

- detailed design drawings of the artificial island or temporary embankment
- the method of construction and removal

The method of construction and removal shall include the following

- sequence and method of construction, dismantling and removal
- safety procedures during construction, use and removal including delivery of materials and equipment for artificial island or temporary embankment
- details of access provisions during construction, use and removal
- emergency evacuation procedure and details of emergency equipment such as life-belts and boats for all stages of construction, use and removal

- details of the training of all personnel involved in the construction including safety training

On completion of the work, the Contractor shall remove the artificial island and/or embankments and reinstate the site to the satisfaction of the Engineer.

(b) Dewatering

The Contractor shall be responsible for controlling and limiting the ingress of water into excavations. The preventative measures shall include the construction of proper drainage channels, diversion channels, sumps, the supply and operation of the necessary bailing and pumping equipment and the construction of suitable watertight cofferdams.

The dewatering measures, with the exception of pumping, shall be maintained until the backfilling has been completed. Between the various construction stages pumping may be interrupted as agreed by the Engineer. Any draining or pumping of water from cofferdams or the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away.

801.05 EXCAVATION

(a) General

This work shall include excavations, not provided for elsewhere in these Specifications, required for the foundations of structures as well as for the excavation required for existing bridges and culverts where these have to be demolished, extended or modified.

(b) Ground surface for excavation

Prior to commencement of any excavation, the Contractor shall notify the Engineer in good time to ensure that measurements, cross sections and levels of the undisturbed ground can be taken in order that the ground surface from which the excavation is to be measured can be established and agreed upon between the Engineer and the Contractor.

(c) Excavation

Where, in the opinion of the Engineer, the casting of concrete against the excavated earth faces is not permissible, or where formwork has to be provided, the extremities of the excavation, for purposes of measurement and payment, shall be deemed to be the vertical planes parallel to and 0.6 m outside the perimeter of the member for which formwork is to be provided.

Where suitable stable material is encountered during excavation, that part of the trench or foundation pit shall be excavated to the neat dimensions of the base unless directed

otherwise by the Engineer. Over excavation (overbreak) in hard material shall be backfilled with the same class of concrete as that in the base or with mass concrete fill as specified or as directed by the Engineer.

Boulders, logs or any other unsuitable material excavated shall be spoiled. When hard material suitable for founding is encountered at the founding level, it shall be cut and trimmed to a firm surface, either level, stepped or serrated, as required. Where the material at the founding level is soft material, or hard material that deteriorates rapidly on exposure, excavation to final grade and elevation shall not be made until just before the blinding layer is placed.

Where, in the opinion of the Engineer, unsuitable material (as defined in Clause 202.08) is encountered at founding level, such material shall be removed and replaced with foundation fill in accordance with Clause 801.09 and as directed by the Engineer.

(d) Classification of excavated material

Distinction shall be made for payment purposes between excavation in hard and soft material. All excavation for the foundations of structures shall be classified in accordance with the following classification:

(e) Hard material

Material which cannot be excavated except by drilling and blasting or by the use of pneumatic tools or mechanical breakers shall be classified as hard material.

(f) Soft material

All material not classified as hard material shall be classified as soft material.

(g) Blasting

Where blasting is permitted, it shall be carried out in accordance with the requirements of Clause 101.24.

(h) Deterioration of foundation excavations

Where the bottoms or side of excavations, in which bases are to be cast, are softened due to negligence on the part of the Contractor in allowing storm or other water to enter the excavations, the softened material shall be removed and replaced with foundation fill as directed by the Engineer at the Contractor's expense.

(i) Excavation Safety

The Contractor shall take the necessary precautions to safeguard the stability and safety of the excavations and adjacent structures.

The personal safety of any person shall not be placed in jeopardy nor shall any situation be allowed to arise which may result in damage of whatsoever nature.

(j) Inspection

No concrete shall be placed before the excavation has been properly cleaned and inspected and approved by the Engineer.

801.06 FOUNDING LEVELS

In consequence of possible variations of anticipated founding conditions the dimensions and founding levels specified or shown on the Drawings may have to be varied during construction.

The Engineer has the full and absolute power in terms of this Contract to order such variations and to specify the actual founding level for each foundation fill, base, or caisson during construction and his decision shall be final and binding on the Contractor.

The Contractor shall not be entitled to any additional payment in consequence of any such variation in the dimensions or founding depths regardless of the stage of construction at which the instruction to vary the dimensions or founding depths is given other than payment due for the variation in quality at the rates entered in the Bill of Quantities. However, if in consequence of such variation order the Contractor is compelled to substitute machines and equipment with other machines and equipment in order to successfully complete the work, the Engineer may, at his discretion, reimburse the Contractor for additional expenses incurred provided that the original machines and equipment were suited to the work required prior to the variation order being issued.

No base or pile shall be founded unless authorised by the Engineer. Each founding level shall be accurately measured and recorded. The term "founding level" used in these Specifications shall be deemed to have the followings meanings in respect of:

(a) Foundation fill

The surface of the in-situ material that has been prepared to receive foundation fill.

- Bases: The underside of the base.
- Piles: The underside of the under-ream, bulbous base or rock socket, the tip of the pile shoe or lower pile end, as relevant.

801.07 UTILISATION OF EXCAVATED MATERIAL

Excavated material and material shall, so far as it conforms with this Contract Specification, be utilised for backfill. Material unsuitable for use as backfill or in excess of the quantity required to complete the backfill shall be spoiled or utilised as directed by the Engineer.

Excavated material not used for backfill or not taken to spoil but used in the construction of embankments or other parts of the work, as directed by the Engineer, will be paid for under foundation excavation as well as under the relevant item for the purpose for which it is used.

Excavated and stockpiled material shall be deposited so as not to endanger the uncompleted structure, either by direct pressure or indirectly by overloading the banks contiguous to the structure or in any other way.

801.08 BACKFILL AND FILL NEAR STRUCTURES

(a) General

In placing backfill and fill the following precautions shall be taken:

- The material shall be placed simultaneously, in so far as it is possible to approximately the same elevation on both sides of an abutment, pier, or wall where appropriate. If conditions require placing backfill or fill appreciably higher on one side than on the opposite, the additional material on the higher side shall not be placed until authorised by the Engineer and not until the concrete has been in place 14 days, or until tests show that the concrete has attained sufficient strength to safely withstand any pressure created by the backfill or fill, or the method of construction.
- The material behind abutments restrained at the top by the superstructure, e.g., portal type structure, shall be placed as stated on the Drawings or as directed by the Engineer.

(b) Backfill

Excavated areas around structures and structure foundations, other than at bridge abutments and pedestrian subways shall be backfilled with approved material in horizontal layers all in accordance with Clause 202.13 of this Specification.

(c) Fill

To prevent wedge action against the structure and adjacent slopes, the slopes shall be benched or serrated to a minimum of 2(H) to 1(V) or as directed by the Engineer. In no case shall the toe of the adjacent fill be closer to the concrete face than the height of the exposed face of the abutment or wall.

(d) Fill within restricted areas

The portion of the fill adjacent to the abutment, retaining wall, culvert and pedestrian

subway concrete faces and under the concrete approach slabs, or to the extent shown on the Drawings, shall be termed "fill within restricted area".

Fill within the restricted area shall comply with the requirements of Clause 801.02 (d) except that it shall be compacted in accordance with Clause 202.14 of this Specification. In order to achieve the specified density, the Contractor shall, where necessary, import material of suitable quality.

Payment in accordance with Clause 801.15 for the construction of fill within restricted areas shall only be made when specifically provided for in the Bill of Quantities.

801.09 FOUNDATION FILL

If it is found during the course of excavation that the material at the indicated founding depth does not have the required bearing capacity, the excavations shall be extended at the discretion of the Engineer until satisfactory founding material is encountered. The Engineer reserves the right to order the Contractor to make up the difference in levels with foundation fill.

Where the foundation fill consists of rock or crushed stone fill, it shall be constructed in accordance with the requirements of the Special Provisions or as directed by the Engineer.

Foundation fill consisting of granular material shall be constructed in layers not exceeding 150 mm in thickness after compaction. Each layer shall be compacted in accordance with Clause 202.14 of this Specification.

Mass concrete fill to be used shall be of the class or mix as specified or directed by the Engineer.

Unless specified or directed otherwise by the Engineer, the minimum foundation fill consisting of rock fill, crushed stone fill or compacted granular fill to be constructed shall be defined by a prism with plan area coinciding with the lower base of a truncated pyramid the sides of which slope at an angle of 60° with the horizontal from the underside of the footing or slab to the founding level.

A concrete blinding of 75 mm thickness and Grade 10 concrete shall be placed underneath all bases except where mass concrete fill is used or where authorised by the Engineer. Where mass concrete is constructed under a base it shall be constructed accurately to the final levels of the underside of the base.

801.10 GROUTING OF ROCK FISSURES

Where specified, fissures in the rock below and around the base shall be sealed by pressure grouting with a neat cement or sand-cement grout with a water cement ratio as low as possible, consistent with adequate workability and shall be between 0.38 and 0.45. The extent of fissuring shall be established by water testing under pressure.

Holes of at least 40 mm diameter shall be drilled in positions ordered by the Engineer and grout pumped into these holes under suitable pressures. Grouting shall be carried out in 3 metre stages to the maximum depth ordered. Care shall be taken to avoid further fracturing of the rock strata due to excessive grouting pressures.

Grouting of rock fissures shall be carried out by specialized operators with adequate experience in this class of work.

The grout shall be sampled and tested for compressive strength with 75 mm cubes to demonstrate compliance with the minimum specified strength

801.11 FOUNDATION DOWELS

Where required, foundation dowels of the specified material, diameter and length shall be installed at the positions and to the dimensions shown on the Drawings or as directed by the Engineer. After exposure, clearing and trimming of the rock formation, holes of not less than 40 mm diameter and of specified depth shall be drilled into the rock in to which the dowels shall be fox-wedged and grouted with a 2:1 sand: cement grout or as approved by the Engineer.

801.12 FOUNDATION LINING

Where specified or directed by the Engineer, foundation lining shall be installed as described hereinafter. The Engineer shall have the right to order the use of polyethylene lining against sides of excavations and underside of bases and slabs in lieu of formwork and concrete blinding.

All surfaces to be lined shall be covered with an approved sheeting to provide a clean impervious layer. The material shall be sufficient strength to provide a durable working surface and to support the concrete and environment without tearing. The joint between strips shall have a 150 mm overlap and the linings shall be held firmly in position by nails, pegs, etc.

Polyethylene sheeting of 0.15 mm thickness is generally considered adequate for the use under approach slabs and bases.

801.13 PILING

(a) General

This section covers the construction of structural piles of concrete or steel or a combination of these materials.

(b) Piling layout

The piling layout, the minimum pile size and/or capacity and acceptable type together with the steel reinforcement and class of concrete required shall be as detailed and specified

on the Drawings unless specified otherwise in the Special Provisions.

(c) Alternative pile and pile layout designs

Any priced Bill of Quantities submitted for alternative designs shall be compiled strictly in accordance with the relevant Measurement and Payment clauses of these Specifications. Such submissions shall be made in the manner prescribed by Article 27 of the General Regulations.

Should the Contractor wish to offer alternative pile designs, he shall submit with his tender a detailed description of the type of pile offered and details of the proposed pile group layout, together with details of the method of analysis used in the design of the pile and pile group layout. The type of pile offered shall be defined in terms of size, materials, working and ultimate load. The average length of pile and/or of the piles per group on which the quantities in the Bill of Quantities for the alternative design are based shall be stated in each case.

The Contractor shall price the Bill of Quantities for the original design irrespective of whether an alternative is offered.

Any priced Bill of Quantities submitted for alternative designs shall be compiled strictly in accordance with the relevant Measurement and Payment clauses of these Specifications.

(d) Details from Contractor

In all cases where the choice of the type of pile to be used is left to the Contractor, full particulars, specifications, calculations and drawings of the piles proposed for use by the Contractor shall be submitted with the Tender.

The Contractor shall submit to the Engineer, 4 weeks before any piles are driven, or holes formed a method statement describing on the following:

- Details of concrete mix design to be used;
- Details of piles and casings to be installed;
- Details of concrete to be placed and compacted in the case of cast in-situ piles;
- Details of reinforcing to be maintained in place during the placing and compaction of the concrete in cast in-situ piles;
- Details of any temporary or permanent casings;
- Details of bar chairs and spacers to maintain the required concrete cover

- Details of the methods which the Contractor will use to support the excavated pile shaft prior to concreting.
- Details of requirements for verification of pile capacity and integrity testing

(e) Plant and Equipment

The plant and equipment used for driving, forming of holes or other methods of sinking piles shall be in good working order and to the Engineer's approval. All machinery shall comply with relevant legislation.

Installation equipment shall be of such design as to ensure that piles can be installed in their proper position and to their correct alignment slope.

(f) Piling platforms

Piling platforms shall include the prepared in-situ material, or artificial islands or any structure, excluding the piling equipment, constructed to gain access to the pile position and for carrying out the piling operations.

The foundation material required to support the piling plant and equipment shall, where necessary, be consolidated to provide firm support. The Contractor may use any material it deems suitable for the construction of piling platforms but shall note that obstructions to piling encountered within the artificially constructed platform material shall not be measured and paid for.

Prior to and during the course of installation of piles, the level and alignment of the piling frame shall be constantly checked, and any deviation immediately corrected.

Structural piling platforms shall be rigid while floating barges used for this purpose shall afford sufficient stability to enable piles to be properly installed. The use of a barge in any waterway shall be approved by the relevant authorities.

On completion of the piling the Contractor shall remove the artificially constructed platforms and reinstate the site to the satisfaction of the Engineer.

(g) Setting out

The Contractor shall set out the pile positions and shall stake these positions with a durable marker. Where the level from which the piling is undertaken is above the underside of pile capping slab, due allowance shall be made for the offset of raking piles so that the pile at the underside of pile capping slab is at the correct position. Pile positions, vertically and rake shall be within the tolerances given in Section 801.13 (i).

(h) Ground surface for piling

Prior to commencement of any piling, the Contractor shall notify the Engineer within 48 hours to ensure that levels of the ground surface be taken in order that the ground surface which the piling is to be measured be established and agreed to between the Engineer and the Contractor. Where piling at a site is preceded by excavation or the construction of fill, the surface from which piling is to be undertaken shall be formed as near as possible to the underside of the pile capping slab or as directed by the Engineer.

(i) *Cast in-situ concrete piles:*

Steel Casing

- Quality

Steel for the casing shall be mild steel Grade 250 in accordance with AS/NZS 3678.

- Thickness

If the casing is required to contribute to the strength of the Permanent Works, the Contractor shall determine and be responsible for the wall thickness of the casing and the thickness of the casing toe strengthening plate but under no circumstances shall the wall thickness less than 10mm. The thickness for that purpose shall be specified on the drawings. Notwithstanding any minimum thickness specified on the drawings or elsewhere in this Specification the Contractor shall in any case provide a casing with sufficient thickness to provide stability under all loads during construction including ground pressure and forces imposed as a result of the Contractor's installation method.

- Forming

The casings shall be manufactured from plates rolled to circular shape or spirally wrapped and welded and shall be brought to the site with all shop welds completed.

- Welding

All welding shall conform to the requirements of 'Section 810: Structural Steelwork' of the Specification.

The manufacturing shall be of sufficient accuracy to ensure that units may be welded together on the site without excessive tomming and propping. Adjacent sections of casings to be welded together shall be in good contact and alignment within the tolerance necessary to produce an acceptable weld

in terms of the welding Specification. If the casing is to be considered as contributing to the permanent strength of the cast in situ concrete piles all joints including filed joints shall be full strength butt welds.

If the casing is required only for the support during construction of the cast in situ pile the welds shall be sufficient to carry the construction loads.

Reinforcing

The reinforcing shall be supplied and fabricated in accordance with 'Section 803: Steel Reinforcement for Structures' of the Specification or to a relevant standards where different strength grade reinforcing is proposed.

The reinforcing for each pile shall be as detailed on the drawings. Steel reinforcement shall be accurately maintained in position without damage to the sides of the hole or the reinforcing cage. Where reinforcement is made up in cages, they shall be sufficiently rigid to enable them to be placed, handled and concreted without damage. Concrete wheel spacers approved or other types of spacer approval by the Engineer shall be used at minimum spacings to maintain the steel reinforcement at the required minimum cover

Splicing of steel reinforcement shall be in accordance with AS 5100.5 Clause 13.1. The number of joints in longitudinal reinforcement shall be kept to a minimum. Laps shall not be permitted in sections of the pile which may form plastic hinges during a seismic event.

The assembly of this additional reinforcement shall be carried out expeditiously, and before concreting of any specific pile commences. If splices have to be provided, the longitudinal bars shall overlap in accordance with AS 5100.5 Clause 13.1 or as required by the Engineer.

At the lower end of the cage a circular steel band 75 mm wide by 3mm thick shall be fitted and welded to the vertical rods so that the cage does not drift whilst concrete is being placed and compacted. Mild steel spacer hoops and lifting hoops shall be provided to the reinforcing cage as required by the Contractor.

If welded hoops are used and the splices are made on the cage the longitudinal bars shall be shielded from weld splatter.

Concrete

All concrete used in the pile shafts shall conform with 'Section 804: Concrete for Structures' of the Specification and shall have the minimum 28 day crushing strength and cement content as shown on the Drawings. The slump shall be not

less than 200mm to ensure that the concrete will pass through the reinforcing cage and form the full diameter of the pile without excessive ramming or vibration.

Concreting of the piles shall not commence before the Engineer has given his permission.

The concrete, while being designed to ensure adequate strength and durability, shall be sufficiently workable to enable proper placing and shall be thoroughly compacted by approved means. Extraction of the temporary casing during concreting shall be such that no damage is caused to the pile and the advancing concrete level is at all times kept a minimum of two metres above the temporary casing's trailing edge. Concrete shall generally be placed in the dry, however, where this is not practicable it shall be placed by means of a tremie. Under no circumstance concrete is allowed to drop more than two metres from the face of fresh concrete surface.

The requirements of Clause 804.07(d) for the placing of concrete under water shall apply. In addition, the following requirements shall apply when concrete is placed by tremie:

- The cement content shall not be less than 400 kg per m³ and the slump shall be not less than 200mm.
- A temporary or permanent casing shall be installed to sufficient depth to prevent ingress of water and to provide support to the pile shaft prior to concreting the pile. When concreting under drilling mud, a short temporary casing shall be used to ensure the pile shaft is located in its correct position.
- The hopper and tremie shall be a closed system through which water cannot penetrate.
- The tremie pipe shall be at least 150 mm diameter for 20 mm aggregates and larger for larger aggregates.
- The tremie pipe shall be sealed with a plate taped to its outlet, to prevent direct contact between the first discharge of concrete in the pipe of the tremie and the water. The tremie pipe shall extend to the base of the pile hole before the tremie is charged with concrete
- Before and after placing the pile reinforcement, and prior to concreting, all loose material shall be removed from the pile toe by airlifting.
- The concrete shall be placed in such a manner that mixing of water and

concrete is prevented. The tremie pipe shall at all times remain immersed in the placed concrete by at least 2 metres, until concreting of the entire pile shaft has been completed and any contaminated concrete on top of the tremied concrete has been displaced completely.

- Concreting of that part of the pile below the water level in the casing shall be completed in one operation and the method of placing the concrete shall be maintained throughout. The concrete shall be placed without interruption.
- All tremies shall be scrupulously cleaned before and after use.

Concrete shall be placed in a manner that will prevent grout loss, segregation or bleeding.

- Concrete shall be compacted to its full depth with immersion vibrators.

Construction

Location and Alignment

Piles shall be located in the positions indicated on the drawing and shall be constructed vertical or to the required rake throughout their length. The maximum tolerance for the plan position of the pile head shall be 75 mm.

Piles shall be founded at the minimum founding depth shown on the plans, unless otherwise instructed by the Engineer as a result of ground conditions being different from that adopted for design purposes.

Construction Method

The Contractor shall be responsible for all measures and all expenses direct and indirect in constructing acceptable piles, down to the required founding level, with bases giving the specified bearing capacity.

Casings

All casings shall be installed so as to support the soils outside the pile in an undisturbed state.

For permanent casings in firm cemented soils where over excavation is necessary to install the casing the voids between the casing and the original ground shall be filled by grouting or other approved means before or as the pile is concreted.

For permanent casings in weaker soils the casing shall be advanced ahead of

the excavation to prevent a “run in” of the soils down the side of the casing.

The Contractor shall record the level of the bottom of the casing and the bottom of the pile shaft excavation immediately after installation and excavation of the pile shaft.

Where drilling muds are not used to support the pile shaft during excavation, it may be necessary to maintain a positive surcharge of water inside the casing during excavation and before concreting to prevent collapse of the pile shaft. If a “run in” occurs the Contractor shall stop work and advise the Engineer immediately, who will advise the necessary remedial action to be undertaken by the Contractor.

When the pile has been excavated to the final founding level the base shall be prepared as specified on the drawings. If no special provisions are made to enhance the end bearing (i.e. driven concrete plugs) the base shall be cleaned out and left with a clean, firm level surface for concreting.

Tolerances

The out-of-round tolerance of casings after installation shall nowhere exceed 25 mm measured as the difference between any two mutually perpendicular diameters in the same plane at right angles to the longitudinal centreline of the casing. The average of any two diameters measured as above shall not vary from the nominal diameter of the shell as specified in the drawings by more than 25 mm. The casing shall be watertight when in its final position, prior to concreting. Permanent casings shall be cut off at the level specified with a tolerance of ± 10 mm.

Cutting Ring

It will be the responsibility of the Contractor to ensure that each casing can penetrate any materials likely to be encountered during driving, and to ensure that the casing does not buckle or distort excessively.

Any sharpening or hardfacing, mild steel or hardened steel ring which may be added to the pile casing shall be wholly at the expense of the Contractor. Before undertaking the manufacture of the casing he shall obtain the approval of the Engineer to the details to be adopted.

Inspection

Should it be necessary for any reason for personnel to descend into the pile excavation (including inspection and repair, etc.) the Contractor shall take

adequate precautions as will be acceptable to the relevant Authorities and the Engineer to protect personnel and shall comply fully with the requirements of any relevant Act or Regulation.

Disposal of bored Material and Surplus Water

All spoil and surplus water from the boreholes and piles may, with the concurrence of the Contracting Authority, be discharged into the river.

Placing Reinforcing

Reinforcement shall not be placed in the pile shaft until immediately before concreting. Before the reinforcement is placed, the bottom of the hole shall be thoroughly cleaned of mud, and any loose or soft material.

The reinforcement cage shall be positioned accurately in the casing to the approval of the Engineer to ensure that the stipulated cover to the steel reinforcement is maintained throughout.

The top of the cage shall be oriented so as to provide spaces between the pile reinforcing for the pile cap reinforcing.

Concreting

If in the judgement of the Contractor, the casing can be safely dewatered it shall be emptied for inspection and placing of the concrete.

Underwater concrete in pile shafts shall be placed by means of an approved tremie. Bottom dump buckets and concrete pumps may be used for placing concrete underwater in other structural foundations, subject to the approval of the Engineer.

Where a bottom dump bucket is used it shall be of a type that will discharge the concrete symmetrically about its axis. It shall enable fresh concrete to be placed directly on top of the previously placed charge of concrete and in no instance must the concrete be allowed to fall freely. The top of the bucket shall be fitted with double overlapping canvas flaps, or other approved covers if depositing of concrete under water is approved.

After concreting of the pile shaft has been completed, the top of the concrete shall be scabbled back to sound concrete before the remainder of the concrete is placed. Concreting of the pile shaft should be done in one complete operation without construction joints.

No casing installation or pile shaft excavation shall be carried out adjacent to a

pile which had just been concreted, for a period of at least 24 hours.

(j) *Precast concrete piles*

The piles shall be reinforced or prestressed concrete and shall be manufactured, handled, stored and installed in accordance with AS 5100.3 unless specified otherwise in the Specifications.

➤ Manufacture

The piles may be manufactured in a factory or in a casting yard on the site of the works. The Contractor shall ensure that the factory or casting yard is at all reasonable times open for inspection by the Engineer.

The relevant requirements of Section 804 shall apply to the concrete works.

The pile shall be cast on a rigid horizontal platform in approved moulds. Particular care shall be taken to secure the reinforcement, coupler sockets and pile shoes accurately in position. Adequate provision shall be made for the lifting of piles.

Each pile shall be clearly marked with the date of casting, a reference number and with distance marks at meter intervals from the tip of the pile.

Piles shall be cured for a minimum period of 7 days to develop the strength required to withstand, without damage to the pile, the stresses caused by handling, transport, storing and driving. The piles shall be driven in order of age, but shall not be driven before the concrete in the pile has attained the specified strength nor before an age of 14 days

➤ Handling, transport and storage

Care shall be taken at all stages of lifting, handling and transporting to ensure that the piles are not damaged or cracked.

Piles shall be stored on firm ground that will not settle unequally under the weight of the stack of piles. The piles shall be placed on timber supports that are truly level and spaced so as to avoid undue bending in the piles. The support in the stack shall be located vertically above one another.

Piles that are damaged, cracked or distorted shall be inspected by the Contractor in conjunction with the Engineer. The Contractor shall submit proposals for the rectification of any defects to the Engineer. Piles that do not meet the requirements of the Specification shall be rejected.

➤ Lengthening of precast piles

Piles shall be lengthened where required by such means and methods as approved by the Engineer. Care shall be exercised to ensure that the additional length of pile joined is truly axial to the original pile within the tolerance requirements for straightness of Clause 801.13(i).

Driving shall not be resumed until the pile extension and any bonding agent used has attained the required strength.

(k) *Steel piles*

➤ Materials

Unless otherwise described in the Contract, steelwork for piling shall comply with the requirements of AS/NZS 3678. The steel piling shall be manufactured in accordance with the requirements of Section 801.

➤ Storage and handling

Where piles are to be stored, they shall be placed on sufficient supports on firm ground to avoid damage. Packings of uniform thickness shall be provided between pile groups.

Each pile shall be indelibly marked to show its identification number, grade of steel and length.

➤ Driving

Piles previously driven shall not be used, except with the approval of the Engineer, for any Permanent Work. The Engineer shall be notified 24 hours before the commencement of driving. Piles shall be driven to the approved set or prescribed depth and in the sequence of driving approved by the Engineer. The set shall be taken in the presence of the Engineer unless permission to the contrary has been obtained in writing.

Driving of bearing piles shall be continuous until the approved set or prescribed depth has been reached, except that the Engineer may permit the suspension of driving if he is satisfied that the rate of penetration before the suspension will be substantially re-established on its resumption.

Where any pile is driven by application of the driving effort at the toe, a layer of dry concrete cushion between 300 mm and 600 mm thick shall be placed in the bottom of the pile immediately before driving.

Where it is not possible to complete the driving within 8 hours, the pile shall be left for 3 days, following which another fresh dry concrete cushion between

300 mm and 600 mm thick shall be placed on top of the original cushion before re-driving.

The ratio of the mass of the hammer to the mass of the pile shall be a minimum of 1.

The maximum height of fall of the hammer shall be determined by the Contractor and in no case shall be greater than 3 m when driving at the toe of the pile or 2 m when driving at the head of the pile.

Covers shall be securely fastened over the tops of shell piles until the concrete core has been placed for safety purposes and to prevent the entry of foreign materials. Covers may be removed only for the purpose of placing reinforcement and concrete.

➤ Lengthening of piles

Full penetration butt welds shall be used for all joining and lengthening in accordance with AS/NZS1554.3 or as specified on the drawings. All piles shall be from the same rolling wherever practicable to facilitate welding. Sections to be jointed shall be maintained in true alignment and position. After welding, the affected areas shall be thoroughly cleaned and protected in the same way as adjacent surfaces.

Longitudinal seam welds and spiral seam welds of lengths of tubular piles shall wherever possible be evenly staggered, but if, in order to achieve a satisfactory match of the ends of piles or the specified straightness, the longitudinal seam or spiral seams are brought closely to one alignment at the joint then they shall be staggered by at least 100 mm.

➤ Surplus length of piles

Any length of piles surplus to that required in the Contract shall be cut off and removed.

➤ Tolerances

All steel piles shall conform to the tolerances specified in Clause 801.13(i) of the specification.

(l) *Driving*

➤ Installation Equipment

Piles and pile casings shall be driven with a gravity hammer, rapid action power hammer or by other approved means. Prestressed concrete piles shall be driven

with a hammer of mass at least equal to that of the pile. Other piles shall preferably be driven by a hammer with similar mass characteristics. The hammer shall not, during driving operations, damage any permanent component of the pile. Pile driving leaders shall be constructed by such a manner as to afford freedom of the movement of the hammer and shall be held in position to ensure adequate support of the pile or pile casing during installation. Inclined leaders shall be used to install raked piles.

The head of precast concrete piles shall be protected with packing of resilient material, care being taken to ensure that it is evenly spread and held in place. A helmet shall be placed over the packing and provided with a dolly of hardwood or other material not thicker than the width of the pile.

➤ Water Jetting

The Contractor may employ water jetting to install piles in granular material. Jettings shall be discontinued prior to the leading end of the pile having reached a depth of 80 per cent of the anticipated final depth as agreed with the Engineer. After jetting, piles or their casings shall be driven to the required depth, level or set.

➤ Installation sequence

Unless otherwise specified or ordered, the sequence of installing piles shall be the responsibility of the Contractor. However, the sequence of driving piles in a group shall be programmed to minimize the creation of consolidated blocks of ground into which piles cannot be driven or which cause fictitious penetration values. Piling shall generally commence at the centre of the group and be progressively extended to the perimeter piles unless otherwise agreed to by the Engineer.

The installation of piles shall be taken in such a manner that structural damage, distortion or positioning defects are not caused to previously installed piles or casings.

➤ Heaving of piles

In soils of which the installation of piles may cause previously installed piles to heave, accurate level marks shall be placed on each pile immediately after installation and all piles that have heaved shall be redriven to the required resistance, unless redriving tests on neighbouring piles have shown this to be unnecessary. Piles shall not be concreted nor shall any pile capping slab be constructed until the piles within a heave influence zone have been redriven as

required.

(m) Augering and boring

➤ Auger and bore holes

Augering and boring of pile holes shall be carried out as expeditiously as local conditions permit taking due account of services or other restrictions on the site.

Holes shall be cleaned after auguring and boring to obtain a clean and level surface.

Suitable casing shall be installed in those portions of the augered holes where the sides are in danger of caving in before concreting is completed.

During extraction of the casing care shall be exercised to avoid lifting of the concrete and damage to the pile.

The use of water for augering and boring holes or for any other purpose where it may enter the hole shall not be permitted. Surface water shall not be allowed to enter the hole.

➤ Inspection of preformed holes

The provision and operation of equipment for the inspection of pile shafts shall comply with the requirements of AS 2159 and AS 5100.3.

Immediately before the reinforcement is to be installed or the concrete to be placed, the Engineer shall be informed so that he may inspect the pile holes and/or check that all loose material has been removed from the pile toe.

(n) *Rock sockets*

Where required, rock sockets to the required dimensions shall be formed in rock formation of adequate strength, quality and thickness to transmit the specified load. The Engineer shall determine the founding level for all piles with rock sockets.

(o) *Obstructions*

Definitions

➤ Identified Obstructions

Identified obstructions shall mean any obstruction that has been described on the Drawings or in the Special Provisions and for which provision for payment for penetrating the obstructions has been made in the Bill of Quantities.

➤ Unidentified obstructions

Where provision has been made in the Bill of Quantities for penetrating identified obstructions and obstructions not described are encountered, such obstructions shall be classified as unidentified obstructions and paid in accordance with Clause 801.15 subject to the condition that the rate of penetration drops to below that achieved for identified obstructions when using the same methods and effort, or subject to additional methods and effort over and above those required for identified obstructions being required to penetrate the obstruction

OR

Where no provision is made in the Bill of Quantities for penetrating identified obstructions and obstructions are encountered and, after resorting to the methods specified in the submission in terms of Clause 801.13(d), it is found not possible to form the holes in the proper position, inclination and depth, and the Contractor has to resort to additional methods to successfully form the pile holes, such obstructions shall be classified as unidentified obstructions.

Classification of materials

For piling only the following classification of materials shall apply to the identification and description of obstructions.

➤ Matrix

The matrix shall comprise that part of the material with a particle size that will pass through a sieve with 50 x 50 mm openings.

➤ Coarse gravel

Coarse gravel shall comprise that part of the material (stones, pebbles, cobbles, etc.) that will pass through a 200 x 200 mm opening, but will not pass through a 50 x 50 mm opening.

➤ Boulders

Boulders shall mean any rock mass of at least Class R1 rock hardness that will pass through a square opening of dimension equal to the maximum size boulder specified in the Bill of Quantities but will not pass through a 200 x 200 mm opening.

➤ Rock formation

Rock formation shall be any rock of at least Class R1 rock hardness that will not pass through a square opening of dimension equal to the maximum boulder specified in the Bill of Quantities. Where a boulder is cut through and part thereof

is left imbedded in the wall of the hole, such bolder obstruction shall be classified as rock formation.

For the identification of rock in terms of this clause, the classification in Table 801.131 shall apply.

Table 801.131 Rock Classification

Description of Hardness			
Class	Description	Field Indicator Tests	Unconfined Compression Strength (MPa)
R1	Very soft rock	Material crumbles under firm (moderate) blows with a sharp end of geological pick and can be peeled off with a knife; it is too hard to cut a triaxial sample by hand	0.7 to 3.0
R2	Soft rock	Can just be scraped and peeled with a knife; indentations 1mm to 3mm show in specimens with firm (moderate) blows of the pick point	3.0 to 10.0
R3	Hard rock	Cannot be scraped or peeled with a knife; specimen can be broken with hammer end of a geological pick with a single firm (moderate) blow	10.0 to 20.0
R4	Very hard rock	Hand-held specimen breaks with hammer end of pick under more than one blow	20.0 to 70.0
R5	Extremely hard rock	Specimen requires many blows with geological pick to break through intact material	More than 70.0

Driven displacement and prefabricated piles

Where obstructions make it difficult to install driven displacement and prefabricated piles on the position and inclination shown and to the proper lengths by the methods specified in the submission in terms of Clause 801.13(d), the Contractor shall resort to additional methods feasible to the pile type. If it is not possible to successfully install any pile after resorting to such methods, the Engineer may order an additional pile or

piles to be installed. All such work and additional piles shall be paid for in accordance with the tendered rates where these are applicable.

(p) Determination of pile length

The design of the piles, and pile groups, and quantities in the Bill of Quantities are based on subsurface data gathered during geotechnical investigation of the sites. Such data is available for inspection and/or copying on request to the Contracting Authority or the Engineer during the Tender period.

The Engineer will determine the depth of piles as work proceeds.

Should there be variations in the subsurface conditions as regards materials and height of water table, the Engineer shall be informed immediately.

If the Contractor is not satisfied that the piles will be capable of carrying the specified loads at the depth determined by the Engineer, he shall have the right to vary the length of pile to reach a founding depth at which he is willing to guarantee the load bearing capacity of the pile. The length of pile installed is paid for at the tendered rates.

The Engineer may require additional foundation investigation under Clause 801.13(a) and/or piles to be test loaded in accordance with Clause 801.13(u) in order to determine final pile length and foundation levels.

(q) Piling records

Pile driving records shall be in accordance with AS 2159 Clause 7.7. Records of the information listed hereunder shall be kept for each pile installed in a form prescribed by the Engineer.

Driven Piles

- Date of driving
- The effort used to drive the pile and the resistance to penetration at founding
- Details of the number of blows required to achieve each 0.5 m penetration over the full length of each individual pile.
- Manufacturing lot number and date of casting of the pile as well as the permanent casing if used.
- An individual 'set card' for each pile driven taken at the pile founding level which shows the final set and temporary compression values.
- The maximum working load of the pile

- The length of the pile and the accuracy of installation in respect of position and inclination.

Bored Piles

- Pile diameter, method of supporting pile shaft, length and thickness of any casings
- Pile toe level on completion of excavation
- Pile toe level immediately prior to concreting after 'air lifting'
- Full records of concreting operation times, batch size placed, height of shaft concreted per batch, volume placed in complete shaft
- Date/time pileshaft excavation commenced and completed length of pileshaft excavated per shift, nature of material excavated.
- A sonic logging tube or tubes shall be installed and securely attached to the reinforcement cage. The diameter and construction of the tubes shall be determined by the Contractor nominated Specialist consultant, which shall be provided to the Engineer for approval.

(r) Reinforcement

The reinforcement for the tops and toes of the piles will be scheduled on the Drawings showing the number, size, type and arrangement of the bars.

(s) Cutting Back Piles

Precast piles shall be installed at a level of at least 1.0 m above the cut-off level. The excess concrete shall be cut back such that the remaining sound concrete will project 75 mm into the pile capping slab.

The stripping-off of the concrete shall be performed in such a manner so as to avoid damaging the pile below the cut-off level. In the case of such damage or defective concrete in the completed pile, the damaged/defective concrete shall be cut away and made good with new concrete well bonded to the old concrete or the pile shall be replaced as directed by the Engineer at the Contractors cost.

The main reinforcement from the piles shall extend a minimum of 40 bar diameters beyond the cut-off level into the pile capping slab. This reinforcement shall be left straight unless otherwise detailed or directed by the Engineer.

The "cut-off" level for steel piles shall be deemed to be a level 150 mm above the underside of the pile capping slab.

Concrete cast in place piles shall be broken back to sand concrete, prior to start of construction of the base or pile cap.

(t) *Construction of pile capping slab*

The Contractor shall not be permitted to construct the pile capping slab before the Engineer has confirmed in writing that all relevant load testing has been completed and the piles have been accepted.

(u) *Construction and Testing of Trial Pile*

General

A trial pile, of specified diameter, shall be constructed and tested over water using the same plant and methods to be used for constructing the Permanent Works piles over water. The location of the trial pile shall be applied by the Engineer prior to its construction. The trial pile to be tested shall include a rock socket and shall be tested prior to commencement of construction of the Permanent Works piles. On completion, the test pile shall be capped above HHWL and will be left as a mooring dolphin. The trial pile shall be tested to 2.5 times the Design Working Load of 7500 kN.

The procedure for test loading a trial pile shall comply with the requirements specified hereinafter. During the period of testing, construction activities that may adversely influence the testing will not be permitted.

The Contractor shall provide the necessary plant, equipment, instruments and labour to carry out the test and to determine accurately the settlement of the piles under each increase or decrease of load. The plant, equipment and instruments used and the testing procedure is to be to the approval of the Engineer and shall be in accordance with the 'Specification for Piling and Embedded Retaining Walls', ICE, Thomas Telford, 1996, unless otherwise stated herein.

Loads shall be measured within an accuracy of 2%. Settlements shall be measured within an accuracy of 0.10 mm.

The Contractor shall obtain the approval of the Engineer to the method of construction and testing of the Trial Pile prior to the start of its construction and shall give the Engineer at least 24 hours' notice of the commencement of the test.

Test Procedure

The full test load shall be 2.5 times the working load (as indicated on the Drawings) unless otherwise specified by the Engineer.

Loading and unloading shall be carried out in the stages shown in Table 801.132. Following each increment or decrement of load, the load shall be held for not less than the period shown in Table 801.132 or until the rate of settlement or recovery is less than 0.1 mm/h and slowing down for loads up to 150% of the Working Load. For loads greater than 150% of the Working Load the load shall be applied for the minimum hold time specified.

Observations or settlements at constant load shall be made immediately on reaching the load, at 5 minute intervals for the first 15 minutes, thereafter at 15 minute intervals for the first hour and at 30 minute intervals for the next 3 hours and then at hourly intervals.

Table 801.132 Loading and Unloading time

Load as % of Working load	Minimum time of holding load
25	1 h
50	1 h
75	1 h
100	24 h
75	10 min
50	10 min
25	10 min
0	1 h
25	10 min
50	10 min
75	10 min
100	1 h
125	1 h
150	6 h
175	1 h
200	6 h
225	1 h
250	6 h
175	10 min

Load as % of Working load	Minimum time of holding load
150	10 min
125	10 min
100	10 min
75	10 min
50	10 min
25	10 min
0	12 h

Presentation of the results

Within 24 hours of completion of the test, the Contractor shall submit to the Engineer a complete record of each pile test. This shall include all the test readings, and graphs of load against time, settlement against time and load against settlement.

(v) Load Testing of Works Piles

General

A Works Pile, of specified diameter, shall be selected by the Engineer for testing by the Contractor. The load test shall be carried out to a maximum test load of 1.5 times the Working Load of 3250 kN.

The procedure for test loading a trial pile shall comply with the requirements specified hereinafter. During the period of testing, construction activities that may adversely influence the testing will not be permitted.

The Contractor shall provide the necessary plant, equipment, instruments and labour to carry out the test and to determine accurately the settlement of the piles under each increase or decrease of load. The plant, equipment and instruments used and the testing procedure is to be to the approval of the Engineer and shall be in accordance with the 'Specification for Piling and Embedded Retaining Walls', ICE, Thomas Telford, 1996, unless otherwise stated herein.

Loads shall be measured within an accuracy of 2%. Settlements shall be measured within an accuracy of 0.10 mm.

The Contractor shall obtain the approval of the Engineer to the method of load testing and monitoring prior to the start of load testing and shall give the Engineer at least 24 hours notice of the commencement of the test.

Test Procedure

The full test load shall be 1.5 times the working load (as indicated on the Drawings) unless otherwise specified by the Engineer.

Loading and unloading shall be carried out in the stages shown in Table 801.133. Following each increment or decrement of load, as a minimum the load shall be held for not less than the period shown in Table 801.133. Testing shall continue until the rate of settlement or recovery is less than 0.1 mm/h and slowing down.

Observations or settlements at constant load shall be made immediately on reaching the load, at 5 minute intervals for the first 15 minutes, thereafter at 15 minute intervals for the first hour and at 30 minute intervals for the next 3 hours and then at hourly intervals.

Table 801.133 Loading and Unloading Schedule for test procedures

Load as % of Working load	Minimum time of holding load
25	1 h
50	1 h
75	1 h
100	24 h
75	10 min
50	10 min
25	10 min
0	1 h
25	10 min
50	10 min
75	10 min
100	1 h
125	1 h
150	6 h
125	10 min
100	10 min
75	10 min

Load as % of Working load	Minimum time of holding load
50	10 min
25	10 min
0	12 h

Presentation of the results

Within 24 hours of completion of the test, the Contractor shall submit to the Engineer a complete record of each pile test. This shall include all the test readings, and graphs of load against time, settlement against time and load against settlement and residual settlement.

(w) Pile Integrity Testing

Integrity testing of all bored piles shall be undertaken by sonic logging using the two-probe (transmitter and receiver) method. The external diameter of the probes shall be compatible with the internal diameter of the probe ducts shown on the Drawings. Testing shall be undertaken in each probe duct placed at the locations shown on the Drawings.

Integrity testing shall not be undertaken until at least seven days after casting the pile and, in the case of trial and test piles, the interpreted results shall be available to the Engineer before the piles are loaded. The tests shall be undertaken over the full length of the pile element and shall be capable of producing readings at not more than 0.02m depth intervals.

The testing shall be carried out by a specialist firm, subject to demonstration to the Engineer of satisfactory performance on other similar contracts before the commencement of testing. The Contractor shall submit to the Engineer the name of the specialist integrity testing firm, a description of the testing equipment, a test method statement and a programme for executing the testing prior to commencing the Works.

A competent and experience person shall interpret the test results. To assist in the interpretation, the Contractor shall give all available details on ground conditions, pile construction methods and records for each pile to the specialist firm before testing is undertaken.

A preliminary report shall be submitted to the Engineer within 24hrs of undertaking the test. The final test results from each pile group shall be submitted to the Engineer as a report within 10 days of completing the test on the last pile in the pile group. The report shall contain a summary of the method of interpretation including all assumptions, calibrations, corrections, algorithms, and derivations used in the analyses. Where the

results are presented graphically, the same scales shall be adopted throughout and for all reports. The units on the scales shall be clearly marked.

In the event that any anomalies are detected by the testing which indicate possible defects in the pile, the Contractor shall report such anomalies to the Engineer immediately. The Contractor shall demonstrate to the Engineer that the pile element is satisfactory or shall carry out remedial works to make it so. The sonic logging tubes shall be grouted up after the Contractor has demonstrated to the Engineer that the pile element is satisfactory.

(x) *Defective piles*

The trial piles and/or test piles and the piles represented by the test pile shall be classified as defective if shown, in terms of Clause 801.13(u or v), to have inadequate bearing capacity or excessive settlement when compared with the design values. Defective piles shall also include any pile damaged beyond repair, piles with structural defects or piles that do not comply with the tolerance requirements of Clause 801.13(i).

Defective piles shall be corrected by one of the following methods approved by the Engineer:

- Extracting the pile and replacing it with a new pile
- Installing a new pile adjacent to the defective pile
- Lengthening the pile to the correct length if defective in length only
- Altering the design to meet the new conditions caused by the defective pile(s).

Piles which are deemed to be defective by virtue of damage to the pile, structural defects, or failure to comply with the tolerance requirements of Clause 801.13(i) shall be corrected at the Contractor's expense. Piles designed by the Contractor which are found to be defective for any reason shall be corrected at the Contractor's expense.

(y) *Painting for Splash Zone*

Steel piles and steel permanent casings to bored piles are to be coated with an approved bituminous paint in the 'splash zones' as detailed on the drawings i.e. from the underside of the pile cap to a distance 6 m below the existing river bed or from the casing cut-off level to 6m below the existing river bed. All surfaces of the steelwork shall be prepared and coated in accordance with the provisions of Section 801 of this specification.

801.14 BORE HOLE INFORMATION

In addition to the bore hole information, factual report and interpretative report given in the Contract Documents the Contractor may, at his own cost, carry out any further subsoil investigations and

tests that he feels necessary to verify the ground conditions at site.

The additional boreholes shall be undertaken in the presence of the Engineer.

SECTION 802 – FALSEWORK, FORMWORK AND CONCRETE FINISH

802.01 SCOPE

This section covers the design, supply and erection of all falsework and formwork used in the construction of Permanent Works.

This section also describes the classes of concrete surface finishes on formed and unformed concrete surfaces.

802.02 MATERIALS

(a) *General*

Falsework and formwork shall conform to the requirements of AS 3610. The materials used in the construction of falsework and framework shall be suitable for the purpose for which they are required and be of quality to produce the standard of work specified. The type, grade and condition of the material shall be subject to the Engineer's approval.

(b) *Falsework*

Timber, structural steel and scaffolding used shall be free from defects that may prejudice the stability of the falsework. The jacks, devices, clamps and fittings shall all be in good working order and of adequate design and strength.

(c) *Formwork*

Tongued and grooved boarding

Tongued and grooved boarding shall be suitably dried timber that will not warp, distort or cause a discolouration of the concrete. The widths of the boards shall be as specified on the Drawings or in the Bill of Quantities or as directed by the Engineer. Boards shall be supplied in lengths not shorter than 3 metres.

Steel and plywood forms to exposed surfaces

The formwork surface material for exposed concrete surfaces shall be steel plate conforming to AS/NZS 1594 or plywood conforming to AS/NZS 2271, unless otherwise shown on the drawings.

For class F3 and F4 surface finish for which steel forms are permitted and Class F2 surface finish the individual and assembled panels shall be sufficiently rigid and clamped so as not to deform or kick during handling or under the pressure of the wet concrete.

Plywood panels shall be placed with the grain of the outer piles in the direction of the

span. Plywood panels shall be supplied in the maximum practicable width and length to minimise the number of joints.

The surface of forms that are to be in contact with concrete shall be clean, free from deposits or adhering matter, weld runs, ridges and spatter that will impart irregularities and blemishes to the concrete surface as well as be free from indentation and wraps

Void Formers

Formers used for the purpose of forming voids in concrete components shall be as follows:

- (i) prefabricated formers, including associated end caps and anchorages, for
circular voids;
- (ii) solid formers made of lightweight material, including associated anchorages, for voids with irregular shapes.

Void formers used in the Permanent Works shall be subject to the approval of the Engineer.

The void former details shall include the following:

- (i) a full technical description of the proposed void former, including documented evidence of previous use and performance;
- (ii) the material type;
- (iii) the method of construction and installation;
- (iv) the type and spacing of anchors and supports to hold down the void former;
- (v) the maximum pressure head and maximum height differential between the two sides of the void former which shall be consistent with the most adverse conditions that may exist during the concreting operations. Where void formers of a particular type or special design are required, details of the material, thickness thereof and relevant information will be specified in the Special Provisions or Bill of Quantities or on the Drawings.

Void formers shall be manufactured from material that will not puncture, tear or damage during the

course of construction and shall be of such tight construction as to prevent undue loss of the mortar component of the concrete through leakage. The units shall be sufficiently rigid not to deform during handling or under pressure of the wet concrete.

As a minimum solid former shall be rigid cellular expanded polystyrene complying with Class S as stated in AS 1366.3

802.03 DESIGN

(a) Falsework

Falsework shall be designed to withstand all forces resulting from the loads as specified in this clause or from the loads specified in AS 3610 and AS 1170 Parts 1 and 2, whichever produces the greater effect, and any additional loads that may be imposed on the falsework during construction. The design shall take into account the magnitude, direction and duration of these forces individually and collectively to ensure that on completion of the permanent structural components, the line, levels and dimensions of the constructed component comply with the requirements of the Contract.

The Contractor shall make his own assessment of the allowable bearing pressure on the foundation material and shall design the footings and falsework to guard against overloading, differential settlement and unacceptable overall settlement. In assessing the allowable bearing pressure, due consideration shall be given to the effect wetting has on the foundation material. Where the falsework settles under load such that the allowable dimensional tolerances on the permanent structural components are exceeded, a non-conformance shall be raised and the falsework shall be modified such that the finished permanent structural components comply with the requirements of the Contract with regard to dimension, position and tolerances.

Where required, the falsework design shall include hydrologic and hydraulic design parameters to assess the potential for scour and bank erosion and allow for suitable protective measures.

In the design of falsework, recognition shall also be taken of the redistribution of load that may occur due to the effect of temperature, wind force, prestressing of curved and skewed structures, stage construction, flooding and debris.

The design of all falsework members and connections shall comply with AS 3610, AS 4100 and AS 1720. Guard railing and access requirements shall comply with AS 1576.

Falsework members shall be designed and constructed to limit deflections to prevent cracking or settlement of previously cast sections due to subsequent casts. Deflections of beams and dimensional changes in other members and connections shall be limited to

ensure that the finished concrete is within the specified tolerances for line and level.

Falsework shall not be supported or braced from completed permanent structural components unless it can be demonstrated that such temporary loading will not affect the structural integrity of the relevant component or the stability and integrity of the overall falsework system.

(b) Formwork

Formwork shall be designed to be sufficiently rigid to ensure that the specified dimensional tolerances can be achieved under the combined action of self-weight, dead loads and imposed loads as well as the additional loads resulting from the rate of concreting, the lift cast in one operation and the method of placing and compaction. Where formwork is to be re-used the formwork design shall allow for the deterioration of materials through use and handling.

The formwork drawings shall include all details of formwork, formwork joints, sealing procedures, ties, size and spacing of framing and details of any proprietary fittings or systems proposed to be used. Where vibration is to be applied externally, the design of formwork shall include details of external vibrators to ensure efficient compaction and to avoid surface blemishes.

802.04 CONSTRUCTION

(a) Falsework

Falsework shall be erected in accordance with the approved drawings incorporating such minor modifications as required by the Engineer.

The Contractor shall take precautions to guard against deterioration of the foundations during the course of construction.

The falsework shall incorporate features that will permit adjustment to the alignment of the formwork to compensate for the expected settlement and deflection under load.

(b) Formwork

General

The formwork for bridge decks shall be erected to lines and levels shown on the drawings and shall be adapted to allow for the specified pre-camber as well as for the expected deflection and settlement of the fully loaded falsework and formwork. The levels shall be set out and controlled at intervals not greater than 2.50m.

For the construction of formwork, the Contractor may subject to the provisions of the Clause 802.02,

use any material suited to and compatible with the class of surface finish and dimensional tolerances specified for the particular member.

Formwork shall be sufficiently rigid to maintain the forms in their correct position, shape and profile and shall be of such tight construction that the concrete can be placed, and compacted without undue loss or leakage of the mortar component of the concrete.

The joints between contiguous formwork elements shall be tight fit and the joints shall be caulked, taped or packed with a sealing gasket. Paper, cloth or similar material shall not be used for this purpose.

The formwork construction shall permit accurate erection and easy stripping without shock, disturbance and damage to the cast concrete. Where necessary the formwork assembly shall permit the removal or release of side forms independently of the soffit forms.

Metal supports, ties, hangers and accessories embedded in the concrete shall be removed to a depth not less than the cover specified for the reinforcement. The use of wire ties is not permitted.

All external corners shall be chamfered by fixing strips into the corners of the formwork to form 25 x 25 mm chamfers. Re-entrant angles need not be chamfered unless this is specified. Cutting or grinding of chamfers shall not be allowed. Formwork to exposed surfaces

The forms and boards shall be arranged to form a uniform and regular pattern in perpendicular with the main axis of the member, unless approved or directed otherwise by the Engineer.

Joints between contiguous members shall after caulking, taping or sealing be treated to prevent blemishes, stains and undue marks from being imparted to the concrete surface.

Bolt and tie positions shall be so arranged that they conform to the symmetry of the formwork panels or boards. Bolt and rivet heads that will be in contact with the formed surface shall be of the countersunk type and shall be treated to prevent from forming in the concrete surface.

The formwork at construction joints shall be braced to prevent steps from forming in the concrete surfaces at the joints between successive stages of construction.

Where moulding or recess strips are specified they shall be neatly butted or mitred.

Formwork to open joints

The requirements for formwork to open joints shall, unless specified otherwise, only apply to cases where the distance between opposite concrete surfaces is equal to or less than 150mm.

Formwork to open joints shall be constructed to produce a Class F1 surface finish to concealed surfaces or a Class F2 or F3 surface finish corresponding to the in-plane surface finish for the bordering concrete surfaces. The material used and construction of the formwork shall permit complete removal thereof to form the open joint. Where polystyrene or similar material the

susceptible to damage, is used to form open joints, it shall be lined with a hard surface on the side to be concreted. The hard material shall be sufficiently resilient to ensure that the required quality of work can be achieved.

Permanent formwork

Where the Contractor proposes or is required to use Permanent Formwork, he shall submit final details of the formwork to the Engineer for approval prior to its use. Permanent Formwork shall generally be of an inert material that will not deteriorate or adversely affect the appearance or durability of the Permanent Works and shall be of sufficient strength and stiffness to support the Permanent Works during construction.

Preparation of formwork

The surfaces of forms that are to be in contact with fresh (wet) concrete shall be treated to ensure non-adhesion of the concrete to the form and may release during stripping of the formwork.

Coating compounds and agents shall be applied strictly in accordance with the manufacturer's instructions and every precaution shall be exercised to avoid contamination of the reinforcement, prestressing tendons and anchorages. In the selection of compounds and agents due regard shall be given to the necessity for maintaining throughout a uniform colour and appearance on exposed concrete surfaces.

Before placing the concrete all dirt and foreign matter shall be removed from the forms and the forms thoroughly wetted with water.

802.05 REMOVAL OF FALSEWORK AND FORMWORK

Falsework and formwork shall not be removed before the concrete has attained sufficient strength to support its own mass and any loads that may be imposed on it. This condition shall be assumed to require formwork to remain in place, after placing of the concrete, for the appropriate minimum period of time given in Table 802.051, unless the Contractor can prove to the satisfaction of the Engineer that shorter periods are sufficient to fulfil this condition. In such case the formwork may be removed after the agreed shorter periods of time.

Falsework and formwork shall be removed carefully without shock, disturbance and damage to the cast concrete or structure.

Weather may be regarded as "normal" when atmospheric temperatures adjacent to the concrete, as measured by a maximum and minimum thermometer, do not fall below 15°C, and as "cold" when temperatures similarly fall below 5°C. When minimum temperatures are between these values, stripping times shall be between the periods specified for normal and cold weather.

Any period during which the temperature remains below 2°C shall be disregarded in calculating the

minimum time which elapses before forms are removed.

On continuous reinforced concrete structures the falsework and supporting formwork shall not be removed before the concrete of the last pour has reached the appropriate minimum age given in Table 802.051 or the appropriate minimum strength specified on the Drawings. Where the structure is constructed in stages the falsework and supporting formwork shall be removed as specified on the Drawings or directed by the Engineer.

In lieu of the times specified in Table 802.051, the falsework and formwork to soffits of slabs and beams may be removed once the concrete has attained 70% of its specified cylinder crushing strength. The compressive strength of the concrete shall be determined from a representative and adequate number of cylinders that have been stored under conditions that simulate the field conditions. Similarly, side forms may be removed when the concrete has attained a cylinder crushing strength of not less than 10 MPa.

On prestressed concrete structures the falsework and supporting formwork shall be removed after the full prestressing force relating to the particular stage of construction has been applied, unless shown otherwise on the Drawings or indicated by the Engineer.

Table 802.051 Removal of Falsework and Formwork: Minimum time in days

Falsework and Formwork to:	Type of cement used					
	Portland cement		Rapid hardening Portland cement		Portland and blast - + furnace cement	
	Normal weather	Cold weather	Normal weather	Cold weather	Normal weather	Cold weather
1. Beam sides, walls unloaded columns:	1	1.5	0.5	1	2	4
2. Soffits of slabs and beams:						
(a) Spans up to 3m	4	7	2	4	6	10
(b) Spans over 3 m up to 6 m	10	17	5	10	14	24
(c) Spans over 6 m up to 12	14	24	A	18	21	28

m						
(d) Spans over 12 m	21	30	18	28	28	36

- Also applicable to 50/50 mixture of Portland cement and milled granulated blast furnace slag
- Shorter periods may be used for sections of thickness exceeding 300mm

802.06 FORMED SURFACES: CLASSES OF FINISH

(a) *General*

In addition to complying with the tolerance specified in Clause 809.07, the concrete surface finish on formed surfaces shall also comply with the following requirements.

(b) *Class F1 surface finish*

After effecting repair work to surface defects in accordance with Clause 802.08(b) no further treatment of the as-stripped finish will be required. This finish is required on concealed formed surfaces.

(c) *Class F2 surface finish*

This finish shall be equivalent to that obtained from the use of wrought thickness square edged timber panels and boards, shutter board or from steel forms, arranged in a regular pattern. The finish is intended to be left as struck but surface defects shall be remedied in accordance with Clause 802.8(b). While minor surface blemishes and discolorations will be permitted, large blemishes and severe stains and discoloration's shall be made good where directed by the Engineer. This surface finish is intended for exposed formed structures that cannot readily be seen by the general public as in the case of culverts, remote structures and structures to which access is restricted.

(d) *Class F3 surface finish*

The resulting finish shall be smooth and of uniform texture and appearance. The formwork lining shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imports no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the finish, internal ties and embedded metal parts shall not be used.

(e) *Class F4 Finish*

The requirements for Class F4 and as for F3 except that internal ties and embedded metal parts shall be permitted.

(f) *Board surface finish*

This finish shall be that obtained from the used of tongued and grooved timber boarding arranged in a regular pattern approved by the Engineer. The finish is intended to be left as struck but surface defects shall be remedied in accordance with Clause 802.8(b) and large fins trimmed where directed by the Engineer.

(g) Protection of surfaces

The Contractor shall ensure that permanently exposed concrete surfaces are protected from rust marks, spillage and stains of all kinds and other damage during construction.

802.07 REMEDIAL TREATMENT OF FORMED SURFACES

(a) General

Any remedial treatment to surface shall be agreed with the Engineer following inspection immediately after moving of formwork and shall be carried out without delay. No surface may be treated before inspection by the Engineer.

(b) Repairs

Surface defects such as small areas of honeycombing, cavities produced by form ties, large isolated blow-holes, broken corner edges, etc., shall be repaired with mortar consisting of a cement and sand mix equal to that of the concrete being prepared.

For the repair of large or deep areas of honeycombing and defects, special methods and techniques, such as pneumatically applied mortar, pressure grouting, epoxy bonding agents, etc., may be used as agreed by the Engineer.

Where in the opinion of the Engineer, the extent of the honeycombing or defects is of such degree that doubts exists about the effectiveness of repair work, the Contractor shall at his own cost perform a load test in accordance with Clause 804.14(a) or other such tests as the Engineer may consider necessary to prove that structural safety of the repaired member has not been prejudiced; failing which the structure shall be rebuilt in part or in full at the Contractor's cost.

Where the concrete has been damaged by adhesion of the concrete to the formwork panel, the cracked and loose concrete shall be removed; or where lifting-off of the fresh concrete at construction joints has occurred the crack shall be scraped out immediately on both sides of the wall to a depth of at least 50 mm. The cavities so formed shall thereafter be repaired as described above.

(c) Rubbing of surfaces

If the finish of the exposed formed surfaces does not comply with the requirements for

uniformity of texture, appearance and colour, the Contractor shall, when instructed to do so by the Engineer, rub down the exposed surfaces of the entire structure or any part thereof as specified below.

The surface shall be saturated with water for at least one hour. Initial rubbing shall be carried out with a medium coarse carborundum stone, using a small amount of mortar on the face, in the proportions specified in Clause 802.08(b). Rubbing shall be continued until all form marks, projections and irregularities are removed and a uniform surface is obtained. The paste produced by the rubbing shall be left in place. The final rubbing shall be carried out with a fine carborundum stone and water. This rubbing shall continue until the entire surface is of a smooth, even texture and uniform in colour. Thereafter the surface shall be washed with a brush to remove surplus paste and powder.

802.08 UNFORMED SURFACES: CLASSES OF FINISH

(a) Class U1 surface finish

This surface is required on those portions of bridge decks or culvert decks which are to receive concrete surfacing or which are to be covered by backfilling material, or as otherwise shown on the Drawings.

On completion of placing and compacting the concrete as specified in Clause 804.07 the top surface shall be levelled and screeded off with the template to the required cross section and tamped with a tamping board to compact the surface thoroughly and to bring mortar to the surface, leaving a uniform surface to the profile shown on the Drawings.

(b) Class U2 surface finish

This surface finish is required on sidewalks; tops of wingwalls and retaining walls; exposed concrete shoulders and unsurfaced areas on bridge decks, and inverts of box culverts, or as otherwise shown on the Drawings.

The surface shall first be given a Class U1 surface finish and after the concrete has hardened sufficiently, it shall be wood-floated to a uniform surface free of trowel marks. For non-skid surfaces such as on sidewalks and bridge decks, the surface shall thereafter be given a broom finish. The corrugations produced shall be approximately 1 mm deep, be uniform in character and width and have a pattern perpendicular to the centre line of the pavement.

(c) Class U3 surface finish

This surface finish shall be required at bearing areas and tops of concrete railings, or as otherwise shown on the Drawings. The surface shall be given a Class U1 finish, and after

the concrete has hardened sufficiently it shall be floated by means of a steel float under firm pressure to produce a dense uniform smooth surface to within the dimensional tolerance specified in Clause 809.07.

Rubbing with carborundum stone after the concrete has hardened shall be allowed but under no circumstances will plastering be permitted.

(d) Class U4 Surface Finish

This finish is for bridge decks that are to receive waterproofing systems. The concrete shall be levelled and screeded to produce a uniform surface. When the concrete has sufficiently hardened and the bleed water evaporated the surface shall be trowelled to produce a hard dense surface free from screed marks and exposed aggregate. Finally, the surface shall be lightly textured with a wooden float or equivalent.

The finished surface shall not deviate from the required profile by more than 10mm over a 3m gauge length or have any abrupt irregularities more than 3mm.

SECTION 803 – STEEL REINFORCEMENT FOR STRUCTURES

803.01 SCOPE

This section covers the furnishing and placing of steel reinforcement in concrete structures.

803.02 MATERIALS

(a) Steel reinforcement

The steel reinforcement shall comply with

- (i) AS/NZS 4671 Steel reinforcing materials
- (ii) AS 5100.5 Bridge design - Concrete
- (iii) BS6744 Stainless steel bars

Grades of steel reinforcement used shall comply with the following requirements

- (i) Steel for reinforcing bars shall be Grade 500N, complying with the requirements of AS/NZS4671 unless otherwise shown on the drawings. Steel for welded steel reinforcing mesh shall be Grade 500L, complying with the requirements of AS/NZS4671.
- (ii) Where the use of stainless steel reinforcement is indicated on the drawings, stainless steel reinforcement shall consist of ribbed (deformed) bars or coil, deformed wire or welded mesh complying with the requirements of BS6744 Grade 500. The chemical composition of stainless steel reinforcement and / or wire used to tie stainless steel shall conform to one of designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN10088 (as identified by BS6744).

The Contractor shall supply the reinforcement cut to length and bent to shape.

The Contractor shall prepare his own reinforcement schedules.

The Contractor shall make appropriate allowances when preparing his reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of reinforcement taking into account the practical variations in the tolerances noted and other margins normally applied by reinforcement suppliers.

Two copies of the reinforcement schedules shall be supplied to the Engineer at least four weeks prior to the schedule date for cutting and bending of the reinforcement.

(b) Test Certificates

The Contractor shall provide evidence that the reinforcement supplied for these works

conforms with the requirements of AS/NZS 4671 as appropriate.

803.03 HANDLING AND STORAGE

Steel reinforcement shall be stored in conditions that minimize or prevent the formation of surface rust.

Steel reinforcement that has been damaged in any way shall not be incorporated into or used in the works

803.04 BENDING OF REINFORCEMENT

Steel reinforcement shall be supplied cut to length and bent to shape, as detailed on the drawings. The Contractor shall make appropriate allowances when preparing the steel reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of steel reinforcement and any post-tensioning sheathing or other fitments, taking into account the practical variations in the tolerances noted and other margins normally applied by steel reinforcement suppliers.

Bending and re-bending of steel reinforcement shall comply in accordance with the requirements of AS 5100.5 or as specified on the Drawings.

Steel reinforcement shall not be bent or straightened in a manner that will cause damage to the steel. Steel with kinks or bends not shown on the Drawings or in the steel reinforcement schedule shall not be used.

No flame-cutting of high tensile steel bars shall be permitted except with the approval of the Engineer. Except as provided for below, all bars shall be bent cold and bending shall be done slowly, a steady, even pressure being used without jerk or impact.

Heating of Grade 500N steel reinforcement to a maximum of 450°C is permitted under controlled workshop conditions, subject to methods in accordance with the manufacturer's recommendations, provided:

- (a) the steel is heated uniformly through and beyond the portion to be bent
- (b) the temperature of the steel does not exceed 450°C
- (c) the bar is not cooled by quenching.

803.05 SURFACE CONDITIONS

Prior to the concrete is placed around the reinforcement, the reinforcement shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance that can have an adverse

chemical effect on the steel or concrete, or reduce the bond between the steel reinforcement and concrete.

The surface condition of reinforcement shall be such as to not impair its bond to the concrete or its performance in the member. Steel reinforcement shall not be coated unless specified, in which case the nature and type of the coating to be used and the conditions of application shall be separately specified. When carbon steel reinforcement is specified on the drawings to be hot-dip galvanised, the hot-dip galvanising shall be in accordance with AS 4680. Use of epoxy coated steel reinforcement shall not be permitted.

Stainless steel reinforcement shall be supplied, handled and stored separately from other steels. Tools used for cutting, bending and transport of stainless steel reinforcement shall not have been used for other materials.

803.06 PLACING AND FIXING

Reinforcement shall be positioned as shown on the Drawings and accurately secured in these positions within the tolerance given in Clause 801.02 (f) by tying with 1.6 mm diameter soft annealed iron wire for unexposed surfaces, 1.2 mm diameter stainless steel wire for exposed surfaces or by the use of suitable clips or, where permitted by the Engineer, by tack welding.

Wooden supports, metal supports and plastic coated metal supports which extend to the surface of the concrete shall not be used. Cover and spacer blocks required to support the reinforcement shall be as small as possible consistent with their use and be of approved design and material. Projecting ends of ties or clips shall not encroach into the concrete cover. Placing steel reinforcements on layers of fresh concrete as the work progresses and adjusting reinforcements during the placing of concrete will not be permitted. Where protruding steel reinforcements are exposed to the elements for an indefinite period the steel reinforcements shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.

803.07 COVER

The term “cover” in this context shall mean the minimum clear thickness of concrete between the surface of the reinforcement and face of the concrete. The minimum cover shall be as shown on the Drawings. Where no cover is indicated, the minimum thickness provided shall be not less than the appropriate values shown in Table 803.071.

The cover shall be increased by the expected depth of any surface treatment, e.g., when concrete is bush hammered or when rebates are provided. Additional cover as directed by the Engineer shall be provided if porous aggregates are used. Cover blocks or spacers required for ensuring that the specified cover is obtained shall be of a material, shape and design acceptable to the Engineer.

Concrete spacer blocks shall be made with 10 mm maximum size aggregate and shall be of the same strength and material source as the surrounding concrete. The blocks shall be formed in specially manufactured moulds and the concrete compacted in a table vibrator all to the approval of the Engineer.

Table 803.071 Minimum cover thickness of covers

CONDITION OF EXPOSURE		DESCRIPTION OF MEMBER/SURFACE TO WHICH THE COVER APPLIED		MIN. COVER (mm)				
				Concrete Class*				
				20	25	30	40	50
1.	MODERATE Sheltered from severe rain and not subject to freezing while saturated	1.1	Enclosed surfaces					
		1.2	Surfaces protected by an overlay					
		1.3	Buried structures/members	40	40	40	40	40
		1.4	Structures/members continuously under water	75	75	NA	NA	NA
		1.5	Underwater concrete	30	30	30	30	30
		1.6	Surface formed with permanent formwork	40	40	40	40	40
		1.7	Piles - cast in-situ (wet cast against casing)					
		1.8	Piles - cast in-situ (dry cast against soil)	50	50	50	50	50
		1.9	Piles - cast in-situ (wet cast against soil)					

		1.1 0	Piles - precast	35	35	35	35	35
2.	SEVERE Exposed to driving rain alternate wetting and drying. Subject to heavy condensation, freezing while wet corrosive fumes, chemicals, aggressive soils.	2.1	Exposed surfaces	NA	50	40	30	306
		2.2	Buried structures/members					
		2.3	Piles - cast in-situ (wet cast against casing)	50	50	50	50	50
		2.4	Piles - cast in-situ (dry cast against soil)	75	75	75	75	75
		2.5	Piles - cast in-situ (wet cast against soil)					
		2.6	Piles - precast	40	40	40	40	40
3.	VERY SEVERE Exposed to: sea water, off-sea winds, abrasion, water with pH below 4.5	3.1	Marine structure	NA	NA	NA	NA	NA
		3.2	Piles - cast in-situ (wet cast against casing)	NA	NA	NA	50	75
		3.3	Piles - precast	NA	NA	NA	50	50

For concrete cast under water 1.5 shall apply.

- Concrete Class refers to the specified minimum 28 day cylinder strength.

803.08 LAPS AND JOINTS

Laps, joints, splices and mechanical couplings shall be made only by the methods, specified and at the positions shown on the Drawings or as agreed to by the Engineer.

In lapped splices, the steel reinforcements shall be placed in contact and wired together in such a manner as to maintain a clearance to the surface of the concrete of not less than the cover specified.

The lap shall be long enough to develop the full strength of the reinforcement shall be not less than the tensile or compressive development length determined in accordance with AS 5100.5. Splicing of steel reinforcement shall be in accordance with AS 5100.5

803.09 WELDING

Welding of reinforcement shall only be carried out where shown on the Drawings or agreed to by the Engineer.

Tack welding of steel reinforcement will be permitted for Grade250N and Grade500N steel reinforcement bars provided welding is not within 50mm of the tangent point of a bend in the steel. All the tack welding shall comply with the requirements of AS/NZS 1554.3

Flash butt welding shall only be carried out with the combination of flashings; heating, upsetting and annealing to the Engineer's approval, and only those machines that automatically control this cycle of operations shall be used. Metal-arc welding of reinforcement shall be carried out in accordance with AS/NZS 1554.3 and the recommendations of the reinforcement manufacturer subject to the approval of the Engineer and the satisfactory performance of trial joints

Other methods of welding e.g. resistance welding may be used subject to the approval of the Engineer and to their satisfactory performance of trial joints. Welded joints shall be full strength welds and their strength shall be assessed by tests to destruction on samples selected by the Engineer.

Care shall be taken during welding to avoid excessive heating of the reinforcing bar.

SECTION 804 – CONCRETE FOR STRUCTURES

804.01 SCOPE

This section covers the manufacture, transport, placing and testing of concrete used in the Work where plain, reinforced or prestressed concrete is specified.

804.02 MATERIALS

(a) *Cement*

Ordinary Portland Cement shall be used in all concrete works unless otherwise specified herein or ordered by the Engineer

Australian Standards

- (i) AS 3972 General purpose and blended cements
- (ii) AS 3582 Supplementary cementitious materials for use with Portland cement and blended cement
- (iii) A3582.1 Fly ash
- (iv) A3582.2 Slag – Ground granulated iron blast furnace
- (v) A3582.3 Amorphous silica

Cement which contains air-set or hardened lumps, foreign matter repowdered air-set material or which has been contaminated or is unsatisfactory of the Engineer will be rejected and shall be removed from the Site without delay.

The cement shall either be delivered in sealed bags marked with the manufacturers name or in bulk consignments in a manner approved by the Engineer.

No part of any consignment shall be used unless approved by the Engineer.

Damaged or defective cement shall be immediately removed from the Site and shall not be used in any part of the Works.

Each separate consignment of cement shall be tested by the manufacturer before delivery and certified copies of the results of such tests shall be supplied to the Engineer before any part of the consignment is used in the Works. The Engineer may request samples not exceeding 5kg in weight to be taken from any consignment for testing. Cement shall be delivered to site in quantities sufficient to ensure that there is no suspension or interruption of the work of concreting at any time.

The minimum cementitious material content and water/cementitious material (w/c) ratio

shall be shown on Table 804.021

Table 804.021 The minimum cementitious material content and maximum w/c ratio

<u>Concrete Grade</u> <u>(MPa)</u>	<u>Minimum</u> <u>Cementitious Material</u> <u>Content (kg/m³)</u>	<u>Maximum W/C</u> <u>Ratio</u>
32	330	0.50
40	400	0.45
50	450	0.40
55	470	0.36
60 - 100	520	**

**The w/c ratio of the proposed concrete mix design shall not be less than 0.30 for the concrete cast in situ and 0.28 for concrete utilised in precast works.

Portland cement or a mixture of Portland cement with one or more supplementary cementitious materials or in combination with other supplementary material shall be approved by Engineer. Supplementary cementitious materials are fly ash, ground granulated blast furnace slag or amorphous silica and shall comply with the requirements of AS 3582.1, AS 3582.2 and / or AS 3582.3

The minimum mass of Portland cement in concrete mixes containing fly ash, ground granulated blast furnace slag and amorphous silica shall be 75%, 60% and 90% respectively of the total mass of cementitious material in the concrete mix. In a triple blend concrete mix, the Portland cement content shall be a minimum of 60% and the individual contribution of fly ash, ground granulated blast furnace slag or amorphous silica shall be a maximum of 25%, 40% or 10% respectively, of the total mass of the cementitious material in the concrete mix.

(b) Aggregates

Fine and coarse aggregate for concrete shall comply with the requirements of AS 2578.1. The Contractor shall carry out the sampling and testing of aggregates at frequent intervals as specified and as required by the Engineer.

The maximum amount of water absorption for fine aggregate, coarse aggregate, combined coarse aggregate and combined fine aggregate shall not exceed 2.5%.

Aggregates shall be stored in such a manner that they will not segregate, become

contaminated by foreign matter, or become intermixed. Stockpiles shall be arranged to prevent entry of adjacent surface or ground water and allow free drainage of rain water.

Fine Aggregate

The fine aggregate for concrete shall conform to the following requirements:

- Description

The fine aggregate shall consist of clean, hard, durable, naturally occurring sands, and shall be free from clay, dust, lumps, soft or flaky particles, shale, salt, alkali organic matter, soil or other deleterious substances. Any manufactured sands used as fine aggregates shall be crushed from rock that produces aggregates complying with the requirements of this Section 804.

- Testing for Impurities

If required by the Engineer, fine aggregate shall be tested for impurities in accordance with AS 1141. The combined fine aggregate shall have a sand equivalent of not less than 80 as determined by the appropriate test method.

- Grading

The Contractor shall be prepared to supply a number of sands for combining in the mix in such proportions that the combined sand mix complies with grading requirements. No sand supplied shall be the product of mechanical mixing of more than one natural material unless written permission is obtained from the Engineer.

Fine aggregate shall be uniformly graded from coarse to fine sizes and when tested with standard sieves shall comply with the limits in the Table 804.022.

Table 804.022 Fine aggregate grading

Aperture Size of Sieve (mm)	Percentage Passing by Mass
9.5	100
4.75	90 –100
2.36	75 – 100
1.18	50 - 90

0.6	30 – 70
0.3	10 – 35
0.015	2 – 10
0.075	0 – 3

- Uniformity

The grading of fine aggregate shall not deviate from the submitted grading by more than 5%. If at any time in the opinion of the Engineer there is a significant variation in the grading or other characteristics of the combined sands from that determined from the original samples, the Contractor shall be required to submit fresh samples and may not be allowed to continue concreting until a fresh mix has been designed, tested and approved.

- Source Rock and Coarse Aggregate Properties

Source rock for crushed aggregates shall be in accordance with Clause 301.03(b) excluding the requirements of Clauses 301.03(b)(ii) and 301.03(b)(iv). The Source rock for crushed aggregates shall have LA loss values not exceeding 35 and shall meet the durability criteria as specified in Table 804.023.

The Los Angeles loss is based on test results for samples from current production. Bulk samples obtained for testing shall represent the typical product available at the site with regard to stone quality.

Table 804.023- Durability Requirements

Rock Type	Degradation Factor ⁽¹⁾ (min.)	Secondary Mineral Content ⁽²⁾ (%) (max.)	Accelerated Soundness Index ⁽³⁾ (min.)
IGNEOUS (INTRUSIVE)			
Granodiorite	50		
Diorite	50		

Tonalite	50		
Monzonite	5		
IGNEOUS (EXTRUSIVE)			
Basalt		25	94
Andesite			

Notes to Table 804.023

1. AS 1141.25.1 Degradation factor source rock
2. AS 1141.26 Methods for sampling and testing aggregates – Secondary minerals content in igneous rocks
3. AS 1141.29 Methods for sampling and testing aggregates – Accelerated soundness index by reflux

The coarse aggregate for concrete shall consist of crushed aggregates which are clean, hard, durable, angular fragments of igneous, or metamorphic rock produced by crushing rock from a source acceptable to the Engineer, and shall be free from clay organic matter and elongated particles.

Aggregates from source rocks which do not meet the test limits specified above but which have been proven by testing and field performance to have satisfactory durability, may be acceptable for use subject to the written approval of the Engineer.

- Product

Aggregates will only be accepted from sources which have been tested and comply with the source rock requirements listed above.

The Engineer may at any time take a sample of the coarse aggregate to check the rock quality. If the sample is found to contain:

- more than 5% by mass of unsound rock
- more than 10% total by mass of unsound rock plus marginal rock;

then that aggregate may be rejected for use in concrete, in which case production of concrete will be suspended until that aggregate is replaced with material that complies with this specification.

The flakiness index of the coarse aggregate shall not exceed 35%.

- Grading

Coarse aggregates size ranges when combined and tested by means of standard sieves shall have a nominal maximum size between 10mm and 20mm and shall comply with the requirements of AS 2758.1.

Unless otherwise approved by the Engineer, concrete in various parts of the structure shall contain coarse aggregate with the following effective maximum sizes:

Joint and pedestal concrete	10mm
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all other concrete	20mm
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The effective minimum size will generally be 10mm for crushed material and 5mm for rounded materials.

- Uniformity

The testing requirements shall not contain more than 5% by mass of unsound rock or more than 10% total by mass of unsound rock plus marginal rock. The flakiness index of the coarse aggregate shall not exceed 35%.

If at any time in the opinion of the Engineer there is a significant variation in the grading or other characteristics of the combined coarse aggregates from that determined from the original samples, the Contractor shall be required to submit fresh samples and may not be allowed to continue concreting until a fresh mix has been designed, tested and approved.

(c) *Water*

Water for use in mixing concrete and mortar and for curing and related purposes shall be obtained from a source approved by the Engineer. Water shall be clean and free from detrimental concentration of acids, alkalis, salts, sugar and other organic or chemical substances. If the water used is not obtained from a public drinking water main the Water shall be shall only be used from water main. Water from other sources shall be tested by the Contractor to have the suitability of the water proved by an approved laboratory prior to use. Water abstracted directly from any River without treatment shall not be permitted for use in mixing or curing concrete. The amounts of chloride in the water shall be not greater than 0.03% (300 ppm). The amount of sulphate (as SO₄) in water shall not be greater than 0.04% (400 ppm).

(d) *Admixtures*

Admixtures shall not be used in concrete without the prior approval of the Engineer who may require tests to be made before their use to prove their suitability. Admixtures shall not contain chlorides, chlorine, sulphur, sulphides or sulphites, or any other substance which may be detrimental to concrete or steel. Use of calcium chloride or admixtures containing calcium chloride will not be permitted. Admixtures, if allowed, shall comply with AS 1478.

(e) *Alkali Silica Reaction*

- The Contractor shall either use non-reactive aggregates (as defined in (ii) or (iii) below) or restrict the content of equivalent sodium oxide in the mix. Concrete containing non-reactive aggregates where there is no restriction on the equivalent sodium oxide shall not be used in locations where it will be in direct contact with concrete containing reactive aggregates.
- Coarse aggregates and sands (i.e. fine aggregates) shall be considered non-reactive if they each contain at least 95% (by weight) of one or more of the rock or artificial types in the Table 804.024 and are not contaminated with any opal, tridymite or cristobalite. In addition, non-reactive coarse aggregates and sands individually or in combination shall not contain more than 2% (by weight) of chert, flint, chalcedony, micro-crystalline silica or cryptoerystalline silica taken together.

- **Table 804.024 Alkali silica reaction**

Air cooled blast furnace slag	Granite
Andesite	Limestone
Basalt	Marble
Diorite	Microgranite
Dolerite	Quartz
Dolomite	Schist
Expanded blast furnace slag/clay/shale/slate	Sintered pfa
Feldspar	Slate
Gabbro	Syenite
Gneiss	Trachyte
	Tuff

- Quartz in the 95% content stated above shall not be in the form of quartzite, or contain more than 30% (by weight) of highly strained quartz. The quartz shall be classified as highly strained if the petrological examination of thin sections of grains give an average undulatory extinction angle of more than 25%. The extinction angle shall be measured on at least 20 separate grains.

- The combination of coarse aggregate and sand (i.e. fine aggregate) shall be considered non-reactive when the combined coarse and sand fractions of the aggregate contain more than 60% by mass of chert or flint and at least 5% by mass of chert or flint and at least 5% by mass of chert or flint of particle size less than 5mm, provided that there is no combination of either aggregate with any opal, tridymite or cristobalite.

- The petrographical examination of aggregates for alkali-silica reaction shall be carried out in accordance with ASTM Test Method C295.

- When the coarse aggregates and sands (i.e. fine aggregates) are not accepted as non-reactive the amount of equivalent sodium oxide shall not exceed 3.0kg in any cubic metre of concrete.

- The equivalent sodium oxide content of the cement shall be taken as that calculated for a quantity of cement equal to the proposed quantity of cement in the mix with 10kg of cement added for each cubic metre of concrete (to allow for tolerances in batching).

- The acid-soluble alkali content of the Portland cement shall be taken as the average of 25 daily determinations of equivalent sodium oxide, plus twice the standard deviation for the period in which the cement was manufactured. The Contractor shall submit to the Engineer test certificates furnished by the cement manufacturer giving the results of these tests. The acid-soluble alkali content of the Portland cement shall be determined in accordance with BS EN 196 Part 21 National Annex (NA) or by an x-ray fluorescent technique calibrated against this Standard.

- The Contractor shall submit to the Engineer test certificates giving, in terms of equivalent sodium oxide, the acid-soluble alkali content (AC) of any GGBS or pulverised-fuel ash shall be taken as the average of 25 weekly determinations for the period immediately preceding the certificate, plus twice the standard deviation of the results. The AC of the GGBS or the pulverised-fuel ash shall be determined in accordance with AS 3582 or by an x-ray fluorescent technique calibrated against this Standard.

- The equivalent sodium oxide (Na_2O) in the mix shall be the sum of the equivalent sodium oxide ($\text{Na}_2\text{O} + 0.66 \text{K}_2\text{O}$) in the Portland cement component, 1/2 or 1/6 the equivalent sodium oxide contributed by the GGBS or pulverised-fuel ash respectively, 0.76 times the chloride ion (Cl^-) content of the aggregate and the amount of equivalent sodium oxide in any admixtures or water to be used in the mix as follows:

$$\text{Equivalent Na}_2\text{O (concrete)} = (A) + (B) + (C)$$

where:

A = Equivalent acid-soluble Na_2O (cement + admixtures + water)

B = 0.76 Cl^- : ion (aggregate)

C = EITHER 1/2 the acid-soluble equivalent Na_2O (GGBS)

OR 1/6 the total acid-soluble equivalent Na_2O (PFA)

- Sources of cement, PFA, and GGBS which have been agreed with respect to the calculation of equivalent sodium oxide in the concrete shall not be changed without the prior agreement of the Engineer.
- Proposals by the Contractor for any changes in the sources of materials shall be accompanied by test certificates giving the equivalent sodium oxide content and its variability for each material. This information shall relate to tests carried out in the period immediately preceding the Contractor's proposals.
- Where at least 25 consecutive weekly test figures are not available, then 10 consecutive daily results relating to the period immediately preceding the proposal shall be submitted to the Engineer, and daily testing from the source shall continue for 10 days after the acceptance of the proposals. After these 10 days the results of weekly testing will be accepted for the source until further changes are notified.
- The equivalent sodium oxide content of the coarse aggregate and sand (i.e. fine aggregate) shall be calculated from the quantity of chloride ion present, which shall be measured by the method in BS 812: Part 117.

804.03 STORAGE OF MATERIALS

(a) Cement

Cement which is stored on site shall be kept under cover that provides adequate protection against moisture and other factors which may promote deterioration. When the

cement is supplied in bags, they shall be closely and neatly stacked to a height not exceeding 12 bags and arranged so that they can be used in the order in which they were delivered to the site. Storage of cement in bulk in silos or similar containers shall be permitted provided that the cement drawn for use is measured by mass and not by volume.

Cement shall not be kept in storage for longer than six weeks without the Engineer's permission and different brands and/or types of the same brand shall be stored separately.

(b) Aggregates

Aggregates of different nominal sizes shall be stored separately and in such a way that segregation is avoided. Intermixing of different materials and contamination by foreign matter shall be avoided. Aggregates exposed to a marine environment shall be covered to protect them from salt contamination. Where intermixing or contamination of the material has occurred, such material shall not be used unless obtained approval by the Engineer.

(c) Storage Capacity

The storage capacity provided and the amount of material stored (whether cement, aggregates or water) shall be sufficient to ensure that no interruptions to the progress of the work are occasioned by lack of materials.

(d) Deteriorated Material

Material that has deteriorated, or that has been contaminated or otherwise damaged, shall not be used in concrete. Such materials shall be removed from the site without delay.

804.04 CONCRETE QUALITY

(a) General

The following items shall be issued to describe the class of concrete required:

Ordinary structural concrete:

This is concrete of any grade which is used in reinforced, prestressed or plain concrete construction and which does not contain admixtures of materials other than the following:

- Portland cement complying with the requirements of AS 3972, Portland blast furnace cement and, sulphate resisting Portland cement complying with the requirements of AS 3582.
- Aggregates from natural sources

- Water which is clean and free from harmful matter.

Special structural concrete:

The structural concrete should be considered as “special” when it contains admixtures or materials other than those described above.

Designed mix:

When a “design mix” is specified the Contractor or manufacturer will be responsible for selecting the mix proportions in accordance with Clause 804.4(b) to achieve the required strength and workability, but the Engineer will be responsible for specifying the minimum cement content and any other properties required to ensure durability.

Prescribed mix:

When a “prescribed mix” is specified, the Engineer will specify the mix proportions and the Contractor, or the manufacturer, will undertake to provide a properly mixed concrete containing the constituents in the specified proportions in accordance with the appropriate provisions of Clause 804.4 (b). The Engineer will therefore be responsible for ensuring that the mix proportions prescribed will provide the strength and durability he requires.

The class of concrete mix required will therefore be covered by one of the following descriptions:

- Designed mix for ordinary structural concrete
- Prescribed mix for ordinary structural concrete
- Designed mix for special structural concrete
- Prescribed mix for special structural concrete

(b) Designed Mix Concrete

Minimum cement content:

For given aggregates the cement content should be sufficient to provide adequate workability with a low water/cement ratio so that the concrete can be completely compacted with the means specified. Table gives the minimum cement content per cubic metre of finished concrete to provide acceptable durability under the conditions of exposure. The maximum water/cement ratio shall be 0.50.

Maximum cement content:

The cement content for any class of concrete shall not exceed 550 kg/m³ of concrete.

Target mean strength:

The concrete mix should be designed to have at least the required minimum cement content and to have a mean strength greater than the required characteristic strength by at least the current margin. The current margin for each particular type of concrete mix shall be taken as have the smaller of the values given by (1) or (2).

(1) 1.64 times the standard deviation of cylinder tests on at least 100 separate batches of concrete of nominally similar proportions of similar materials and produced over a period not exceeding 12 months by the same plant under similar supervision, but not less than 1/6 of the characteristic strength for Grade 10 concrete or 3.0 N/mm² for concrete of higher strength classes.

(2) 1.64 times the standard deviation of cylinder tests on at least 40 separate batches of concrete of nominally similar proportions of similar materials and produced over a period exceeding 5 days but not exceeding 6 months by the same plant under similar supervision, for Grade 10 concrete or 6.0 N/mm² for concrete of higher strength classes.

Evidence of suitability of proposed mix proportions

Evidence should be submitted to the Engineer for each class of concrete showing that at the intended workability, the proposed mix proportions and manufacturing method will produce concrete of the required quality.

If adequate data for “target mean strength” is not available, trial mixes should be prepared.

The following information should be provided before any designed mix is supplied.

1. Nature and source of each material
2. Either
 - Appropriate existing data as evidence of satisfactory previous performance for target mean strength, and current margin and if required workability and water/cement ratio, OR
 - Full details of tests on trial mixes.
3. Proposed quantities of each ingredient per cubic metre of fully compacted concrete.

Subsequently, the Contractor should declare any change in source of materials and any change in cement content.

Trial mixes:

Where trial mixes are required three separate batches of concrete should be made using materials likely to be typical of the proposed supply and preferably under full scale production conditions. If circumstances make this inconvenient, the batches may be mixed in a laboratory unless this is specifically precluded by the Engineer.

Sampling and testing should be in accordance with AS 1012.

The workability of each of the trial batches should be determined (generally the slump of the concrete shall not exceed 80mm for strength classes up to 40 megapascals and 60mm for higher strength classes) and three cylinders made from each batch for test at 28 days. A further three cylinders from each batch should be made for test at an earlier age if required. The trial mix proportions should be approved if the average strength of the nine cylinders tested at 28 days exceeds the specified characteristic strength by the current margin minus 3.5 N/mm² or if nine tests at an earlier age indicate that it is likely to be exceeded by this amount.

Table 804.041 Minimum cement content per cubic metre of finished concrete

Strength Grade (Megapascals)	Minimum Mass of Cement Per Cubic Metre (kgs)
20	320
25	360
30	400
35	440
40	480
45	520

If trial mixes are required to demonstrate that the maximum free water/cement ratio is not exceeded, two batches should be made in a laboratory with cement and surface dry aggregates known to be typical. The proposed mix proportions will not be accepted unless both batches have the correct cement content and a free water/cement ratio below the maximum specified value at the proposed degree of workability. The workability required shall be “medium” unless otherwise stated in the Bill of Quantities or in the Special Provisions. For this purpose existing laboratory test reports may be accepted instead of trial mixes only if the Engineer is satisfied that the materials to be used in the structural concrete are likely to be similar to those used in the tests.

Prescribed Concrete Mix (Not applicable for this contract)

The Engineer will be responsible for determining the proportions of each constituent material of the concrete mix. The Contractor shall provide, on the site, concrete using the specified materials and in the proportions ordered by the Engineer.

The Contractor shall be responsible for supplying the constituent materials for the concrete, and he

shall, at least two months before the start of any concrete work on the site, supply to the Engineer samples of each aggregate for testing purposes. If the materials comply with the specification, the Contractor shall supply further samples of sizes indicated by the Engineer, for determination of the mix proportions for each class of concrete.

The classes of concrete for prescribed mixes shall be specified in the Special Provisions, except for the three “nominal” classes specified hereinafter. For each class the following shall be specified.

- The estimated minimum compressive strength in MPa at 28 days.
- The maximum nominal size of coarse aggregate in mm, and its proportions in the mix.
- The proportion of the fine aggregate in the mix.
- The type and proportion of cement in the mix.
- The cement/water ratio.
- The slump in mm.

The Engineer shall have the right to vary, as the work proceeds, the proportions of the constituents of the concrete. Payment for variations shall be made at the tendered rates as specified in the Special Provisions.

The nominal mixes specified for use where indicated on the drawings or in the Bill of Quantities or where ordered by the Engineer, are given in Table 804.042.

Table 804.042 Nominal mixes

Constituent or Property	Grade 1:4:8 Concrete	Grade 1:3:6 Concrete	Grade 1:2:4 Concrete
Cement (kg)	50	50	50
Total aggregate (m ³)	0.40	0.30	0.20
Max. total water (litre)	50	42	30
Estimated 28 day compressive strength (MPa)	8	15	20

Notes:

- The maximum size of coarse aggregate in mm required in a mix shall be designated as a suffix to the class, e.g. Grade 1:4:8/40.

- The ratio of fine to coarse aggregate shall be adjusted to produce a dense workable mix.
- The total quantity of water shall include that contained in the aggregates.

Consistency and Workability

The concrete shall be of suitable workability without the excessive use of water so that it can be readily compacted into the corners of the formwork and around reinforcement, tendons and ducts without segregation of the material. Workability shall be assessed by means of the slump test.

804.05 MEASUREMENT OF MATERIALS

(a) Cement

Where cement is supplied in standard bags the bags shall be assumed to contain 50 kg. All cement taken from bulk storage containers and from partially used bags shall be batched by mass, to an accuracy of within 3 per cent.

(b) Water

Mixing water for each batch shall be measured, either by mass or by volume to an accuracy of within 3 per cent.

(c) Aggregates

All aggregates shall be measured separately by mass, except as otherwise provided in this Clause, to an accuracy of within 3 per cent. Volume batching shall not be.

Separate fine and coarse aggregates shall be used except for Grade 10 concrete where all-in aggregate may be used.

(d) Admixtures

Any solid admixtures to be added shall be measured by mass, but liquid or paste admixtures may be measured by volume or mass. The quantity shall be measured to an accuracy of within 5 per cent. Admixtures shall only be thoroughly mixed with the water for the concrete batch, prior to mixing with the aggregates and cement.

(e) Adjustment to mix Proportions

During production adjustments of mix proportions may be made in order to minimise the variability of strength and to approach more closely the target mean strength. Such adjustments are regarded as part of the proper control of production but the specified limits of minimum cement content and maximum water/cement ratio shall be maintained. Changes in cement content shall be declared. Such adjustments to mix proportions shall not be taken to imply any change to the current margin.

804.06 MIXING

(a) *General*

Unless otherwise permitted by the Engineer, mixing of materials for concrete, shall be conducted by an experienced operator at a concrete batching plant located within 0.5km of the Site. Unless otherwise approved, mixing shall be carried out in a mechanical batch mixer of approved type and capable of producing a uniform distribution of ingredients through the batch. Calibration of the weighing mechanism of any batching plant shall be carried out in the presence of the Engineer prior to start of production and at such intervals as the Engineer may determine.

(b) *Charging the Mixer*

The sequence of charging shall be approved by the Engineer and, unless otherwise instructed, the same sequence shall be maintained. The volume of the mixed material per batch shall not exceed the manufacturers rated capacity of the mixer.

(c) *Mixing and Discharge*

The period of mixing shall be measured from the time when all materials are in the drum until the commencement of discharge. The mixing period shall be sufficient to ensure that the aggregates, water and additives are thoroughly mixed to a uniform consistency. The first batch to be run when starting with a clean mixer, shall contain only 2/3 of the required amount of coarse aggregate to facilitate "coating" of the mixer drum.

Discharge shall be so carried out that there is no segregation of the materials in the mix. The mixer shall be emptied completely before it is recharged.

(d) *Maintenance and Cleaning of the Mixer*

If the mixer has stopped running for any period in excess of 30 minutes, it shall be thoroughly cleaned out, particular attention being paid to the removal of any build-up of materials in the drum, in the loader, and around the blades or paddles. Worn or bent paddles shall be replaced. Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed.

(e) *Standby Mixer*

When concreting elements, particularly piles, where it is important that concreting should continue without interruption, a standby mixer shall be held in readiness to run on 15 minutes notice in case of breakdown of the stock mixer.

(f) *Ready Mix Concrete*

Ready mix concrete as defined in AS 1379 batched off the site may be used only with the agreement of the Engineer and shall comply with all requirements of the contract. The concrete shall be carried in purpose made agitators, operating continuously, or truck mixers. Prior to the discharge of concrete at the site, the mixer or agitator shall be operated at a mixing speed for a minimum period of one minute or until the concrete achieves the required uniformity.

When truck mixed concrete is used, water shall be added under supervision, either at the site or at the central batching plant, as agreed by the Engineer but in no circumstances shall water be added in transit.

Concrete shall be discharged at the works within 60 minutes of the time of addition of water except that delivery times may be extended by the Engineer if the concrete temperature is less than 30°C or if other means have been incorporated to offset the hydration of the cement. Unless otherwise agreed by the Engineer, truck mixer units and their mixing and discharge performance shall comply with the requirements of AS 1379.

804.07 PLACING AND COMPACTION

(a) General

Concrete shall be transported and placed in a manner that will prevent segregation, or loss of constituent materials and contamination. Concrete shall not be placed in any part of the works until the Engineer's approval has been given. If concreting is not started within 24 hours of approval being given approval shall again be obtained from the Engineer.

Concrete operations shall only be carried out during daylight hours unless proper lighting arrangements have been made and lights are in working order by noon. Workman shall not be allowed to work double shifts and the Contractor shall provide a fresh team for nightshifts. The placing and compaction of concrete shall at all times be under the direct supervision of an experienced concrete Engineer.

Once concreting has begun it shall be carried out in a continuous process between construction joints. Concrete shall be placed within 15 minutes from completion of mixing and within one hour from the start of mixing. All excavations and other contact surfaces of an absorbent nature such as timber formwork shall be damp but no free water shall be permitted to remain on these surfaces. The formwork shall be cleaned internally.

(b) Placing

Whenever possible concrete shall be deposited vertically into its final position. Where chutes are used the length and slope shall be such as not to cause segregation and

suitable spouts or baffles shall be provided at the lower end to prevent segregation. The displacement of concrete by vibration instead of direct placing will not be allowed. Concrete shall not be allowed to fall freely through a height of more than 1.5m.

Care shall be taken when casting bridge decks of substantial thickness to avoid layering of concrete and the whole thickness shall be placed in one pass. Fresh concrete shall not be placed against concrete that has been in position for more than 30 minutes unless a construction joint is formed.

Pumping of concrete shall be subject to the approval of the Engineer. Aluminium pipes shall not be used for this purpose.

In plain concrete of thickness more than 300mm, hard clean stone “plums” of mass 15-55 kg, may if approved, be included to displace concrete for up to 20 per cent of the total volume provided that:

- Such plums have no adhering films or coatings;
- No plums have a dimension greater than one third of the smallest dimension of the concrete member or 300mm whichever is less; and
- Each plum is surround by at least 75mm of concrete.

(c) Placing concrete with pumping equipment

Placing of concrete using concrete pumps will only be permitted when the Contractor has submitted evidence of the suitability of the proposed mix proportions for a special concrete pump mix in accordance with Clause 804.04 (b). Before concrete is pumped into the forms, an initial discharge of concrete shall be pumped to waste until a consistent workable mix is discharged. Aluminium pipes shall not be used for the delivery of pumped concrete. The Contractor shall ensure that a stand-by pump is available.

(d) Placing Under Water

Normally concrete shall only be placed in the dry. Placing under water shall be allowed only in exceptional circumstances where in the opinion of the Engineer it is not feasible to dewater before placing. No concrete shall be placed in flowing water. Underwater concrete shall be placed by means of tremies. Full details of the method proposed shall be submitted in advance to the Engineer for his approval. Placing by skip or pipeline will also be considered in certain circumstances.

During concreting by tremies, air and water must be excluded from the tremies by keeping the pipe filled with concrete at all times. In charging the tremie a plug formed of suitable paper, sacking or vermiculite granules shall be first inserted in the top of the pipe. Once

concreting has begun the discharge end of the tremie shall be kept well below the surface of the concrete. Should this seal be broken the tremie shall be lifted and plugged before concreting is recommenced. Distribution of concrete by lateral movement of the tremie will not be permitted.

During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended until the Engineer permits them to be continued. The concrete mix used for under water placing shall be specifically designed and approved for this purpose to ensure good flowability, plasticity and cohesion. Increased sand and cement contents over normal mixes will usually be required.

(e) *Compaction*

Concrete shall be fully compacted by approved means during and immediately after placing. It shall be thoroughly worked against the formwork around the reinforcement, tendons, ducts and embedded fittings and into corners to form a solid mass free from voids. The concrete shall be free from honeycombing and planes of weakness and successive layers of the same lift shall be thoroughly bonded together.

Unless otherwise agreed by the Engineer concrete shall be compacted by means of vibrators. Internal vibrators shall be capable of producing not less than 10,000 cycles per minute and external vibrators not less than 3,000 cycles per minute. Sufficient standby vibrators shall be held available in case of breakdown.

Vibrators shall be applied by experienced labour and over vibration resulting in segregation, surface water and leakage shall be avoided. Contact with reinforcement and formwork shall, as far as practicable be avoided when using internal vibrators. Concrete shall not be subjected to disturbance by vibration within 4 to 24 hours after compaction. Whenever vibration is applied externally, the design of the formwork and positioning of vibrators shall be such as to ensure efficient compaction and avoidance of surface blemishes all subject to prior approval of the Engineer. Internal vibrators shall always be used when external form vibrators are used.

Concrete shall be deposited in horizontal layers not more than 350 mm thick except in the manufacture of prestressed concrete members. For prestressed members the concrete shall be built up to the full depth of the section and the concrete face moved forward progressively. For prestressed concrete members over 600 mm deep this may occur in two or three passes.

During and immediately after placing, the concrete shall be effectively compacted by internal vibrators of adequate size, number and frequency and supplemented as required by external form vibrators. A minimum of two internal vibrators shall be provided at any

time.

Vibration shall be applied to the full depth of each layer and extended into the top 100 mm of the underlying layer. Vibration shall continue at each point until air bubbles cease to emerge from the concrete, then withdrawn slowly to avoid leaving a defect. Concrete shall not be vibrated to the point where segregation of the ingredients occurs.

Internal vibrators shall be inserted vertically at successive locations at spacings not exceeding the manufacturer's stated zone of influence, and shall not be allowed to rest on the steel reinforcement, embedded fixtures or formwork.

Vibration shall not be applied either directly or through the reinforcement to any concrete which has taken its initial set.

Concrete decks or slabs shall be compacted by internal vibrators and vibrating screeds such that uniform consolidation is achieved throughout the deck and slab area. Special attention shall be given to the compaction of concrete in the anchorage zones and behind the anchor plates and in all places where high concentrations of reinforcing steel or cables occur.

In such cases where the placing and compaction of concrete is difficult a mix containing small size aggregate may be used but only with the approval of the Engineer and after a mix containing such aggregate has been designed and tested.

804.08 CONSTRUCTION JOINTS

(a) General

Concreting shall be carried out continuously up to the construction joint shown on the working drawings or as approved, except that is, because of an emergency (such as breakdown of the mixing plant or the occurrence of unsuitable weather), concreting has to be interrupted, a construction joint shall be formed at the place of stoppage in the manner which will least impair the durability, appearance, and proper functioning of the concrete.

Unless otherwise shown on the drawings the exact position of horizontal construction joints shall be marked on the formwork by means of grout checks in order to obtain truly horizontal joints. Stub columns or stub walls on footings shall be cast integrally with the footings and not afterwards.

(b) Preparation of Surfaces

When the concrete has set and while it is still green the surface film and all loose material shall be removed, without disturbing the aggregates, by means of a water jet assisted by

light brushing to expose the aggregate and leave a sound, irregular surface. Where this is not possible the surface film shall be removed after the concrete has hardened by mechanical means appropriate to the degree of hardness to the concrete so as to expose the aggregate and leave a sound, irregular surface. The roughened surface shall be washed with clean water to remove all laitance, dirt and loose particles.

(c) *Placing Fresh Concrete at Construction Joints*

When fresh concrete is placed the same day as the construction joint was formed the fresh concrete shall be cast directly against the face of the construction joint. When concreting recommences a day or more after the forming of the construction joint the following procedure shall be followed.

The construction joint shall be kept continuously wet for a period of at least two hours before concreting starts but shortly before reconcreting further application of water shall cease so that the surface is just damp when further concreting has to commence. Any dirt, excess water and loose particles shall be removed prior to starting reconcreting. Epoxy resins specially designed for bonding old concrete to new shall be used at construction joints where so directed by the Engineer. The preparation of the construction joint surface and the application of the epoxy resin shall be strictly in accordance with the manufacturer's recommendations and the Engineer's instructions. The actual brand and type of resin used shall be subject to the Engineer's approval.

804.09 CURING AND PROTECTION

Formwork shall be retained in position for the appropriate times given in Clause 804.9 and as soon as practicable in the opinion of the Engineer, all exposed concrete surfaces shall be protected from loss of moisture by one or more of the following methods:

- Retaining formwork in place for the full curing period.
- Ponding the exposed surface by means of water, except where atmospheric temperatures are low i.e., less than 5°C.
- Covering with sand, or mats made of a moisture retaining material and keeping the covering continuously wet.
- Continuous spraying of the whole area of the exposed surfaces with water (only on surfaces where ponding or sand cover is not possible).
- Covering with a waterproof or plastic sheeting firmly anchored at the edges.
- Using an approved curing compound applied in accordance with the manufacturer's instructions except that where the surface must be subsequently waterproofed, coated or

guniting this method shall not be used. Curing compounds shall comply with the requirements of AS 3799 and shall be pigmented as specified or as required by the Engineer.

- Steam curing (precast units)

The method of curing adopted shall be subject to the Engineer's approval and shall not cause staining, contamination, or marring of the surface of the concrete.

The curing period shall be continuous for at least 7 days for concrete made with Portland cement, at least 7 days for that made with rapid hardening Portland cement, and at least 9 days if Portland blast furnace cement or a 50/50 mixture of Portland cement and ground granulated blast furnace slag is used. When the temperature of concrete falls below 5°C these minimum curing periods shall be extended by the period during which the temperature of the concrete was below 5°C. Curing of the concrete shall be accomplished by means of a fog spray to keep it wet continuously for the period stated above or until a curing compound, meeting the requirements of AS 3799 is applied. Where a curing compound is used, two coats of curing compound at the minimum application rate shall be applied. Wetting of the concrete shall be by means of a mixed spraybar along the full length of the sliding formwork. The spraybar shall be connected to a suitable high pressure water supply. Wetting shall be discontinued when the ambient air temperature drops below 5°C and care shall be exercised to ensure that the water does not erode the fresh concrete surface.

804.10 ADVERSE WEATHER CONDITIONS

(a) Cold Weather

Concrete shall not be placed during falling temperatures when the ambient air temperature falls below 7°C or during rising temperatures when the ambient air temperature is below 3°C. When placing concrete at air temperature below 5°C the concrete temperature shall not be below 10°C.

The temperature of placed concrete shall not be allowed to fall 5°C until the concrete has attained a strength of at least 5 MPa and the Contractor shall be responsible for all protective measure necessary to ensure this. All concrete that has been damaged by frost or the formation of ice in the concrete shall be removed and replaced by the Contractor at his own expense.

(b) Hot Weather

When the ambient air temperature exceeds 32°C during a concreting operation the Contractor shall take measures approved by the Engineer to control the temperature of the concrete ingredients so that the temperature of the placed concrete does not exceed 25°C. Such measures will include spraying aggregate stock piles with water to promote

cooling down by evaporation and where feasible shading of stock piles and the area where concrete is carried out. Curing shall commence immediately after placing of the concrete to prevent excessive moisture loss.

804.11 PIPES AND CONDUITS

No pipes and conduits other than those shown on the drawings shall be embedded in the concrete without the Engineer's approval. The clear space between such pipes or any reinforcement shall be at least 40mm or the maximum size of the aggregate plus 5mm whichever is the greater. The amount of concrete cover over pipes and fittings shall be at least 25mm.

The ends of all ferrules used for bracing formwork shall be neatly finished off to the details shown on the Drawings. Where no details are given on the Drawings ferrules shall be cut back and the holes filled in with mortar and finished off flush with the concrete surface.

804.12 APPLIED LOADING

No load shall be applied to any part of a structure until the specified curing period has expired, and thereafter, applied loading shall only be allowed after approval by the Engineer. The Engineer's decision will be based on the type of load to be applied, the age of the concrete, the magnitude of stress induced and the propping of the structure. No structure shall be opened to traffic until test cylinders made of the concrete in all parts thereof have attained the specified minimum 28 day strength.

804.13 PRECAST CONCRETE

This clause applies to all reinforced and prestressed concrete members other than precast concrete piles, culverts and pipes in as far as they are dealt with separately elsewhere in these Specifications. All precast members shall be manufactured in accordance with the requirements specified for cast in situ members in as far as these requirements are relevant. In addition the following shall apply: The Contractor shall take all necessary safety measures and precautions during the handling and erection of precast members and for the stability of members as positioned prior to casting-in. Where concrete members are precast offsite the manufacturer shall keep, and make available to the Engineer, full records of all concrete mixes and strength tests pertaining to the members cast. The Contractor shall notify the Engineer in advance of the casting dates to arrange for inspection and testing of precast members.

For the purpose of identification all members shall be marked with paint in neat lettering with the member number shown on the Drawings or ordered by the Engineer and an identification number relating to the manufacturing records, letters etc., shall be so positioned as not to be visible when the member is placed in its final position in the completed structure. All precast members that have

been chipped, cracked, warped or otherwise damaged to the extent that such damage will be in the opinion of the Engineer prejudice the appearance, function or structural integrity of the members shall be rejected or where so allowed, repaired to the satisfaction of the Engineer.

804.14 TESTING AND QUALITY CONTROL

(a) Process Control

Testing of aggregates

Coarse aggregates shall be tested for grading once for every 100m³ delivered on site and fine aggregate once for every 50m³ delivered, or more frequently if considered necessary.

- Sampling of concrete to obtain concrete cylinders for 7 and 28 day crushing shall be controlled by the Contractor at not less than the following frequencies as shown in Table 804.141:

Table 804.141 Testing of aggregates

Volume per day	No of samples (minimum)
0 – 8 m ³	1
8 – 20 m ³	2
20 – 40 m ³	3
40 – 80 m ³	4

For each additional 40m³ one additional sample will be taken.

A sample test shall be the test results of one 7 day and an average value for two 28 day cylinders prepared from the same batch of concrete, the samples being consolidated in the moulds by rodding as per AS 1012.

The above sampling will be carried out by the Contractor in the presence of the Engineer.

The Contractor will be responsible for the stripping, curing, handling and cartage of the concrete test cylinders to a laboratory as nominated by the Engineer where they will be cured and test by the laboratory. The Contractor is to provide written details to the laboratory when delivering these cylinders which shows the following information:

- nature of samples and dates on which these were taken
 - sample identification marks
 - class of concrete and slump recorded
 - concrete position in the works
- *Accelerated cylinder crushing tests*

In the case of major structures the Contractor is advised to carry out regular accelerated compressive strength tests in order to predict the 28 day compressive strength of concrete i.e., testing one cylinder at 7 days as specified above. The methods of testing and predicting 28 day strengths shall be as determined in consultation with the Engineer. Whenever accelerated tests indicate that the 28 day strengths will not be obtained the Contractor shall immediately effect such changes in materials and mix proportions as may be necessary to ensure future compliance.

- *Control Charts*

The Contractor shall institute a system of control charts depicting test results of all concrete 7 and 28 day strengths.

- *Provision of Records*

The Contractor shall maintain written records that provide the following:

- Date on which each section concreted, class of concrete, time was taken to place, the position of the section in the works.
- Daily maximum and minimum temperatures
- Nature of samples and dates on which they were taken, including identification marks.
- Results of tests on samples taken and description of concrete section represented by samples.

These records shall be maintained in a form agreed by the Engineer and shall at all times be up to date and available to the Engineer for inspection.

- *Quality Control by Engineer*

Routine inspection and quality control will be carried out by the Engineer. The testing of concrete shall be specified in Clause 804.04.

Strength testing

The characteristic strength is that 28 day cylinder strength below which not more than 5% of test results may be expected to fall. Compliance with the specified characteristic strength shall be judged by tests made on cylinders at an age of 28 days unless a particular testing regime is capable, to the satisfaction of the Engineer, of predicting the strength at 28 days, of concrete tested at an earlier stage, when compliance may be based on the results of such tests alone.

Concrete shall be sampled at the rate shown in the tabulation under 804.14 (a) and a set of three test cylinders shall be made from each sample.

The samples should, where practicable, be taken at the point of discharge from the mixer.

Criteria for compliance with requirements

The Specification will be satisfied if the average compressive strength of the two cylinders tested at 28 days is not less than the specified 28 day strength, provided that the compressive strength of either cylinder is not less than 90% of the specified strength.

Compliance with workability requirements may be assumed if the test results are within the following limits as shown in Table 804.142

Table 804.142 Slump testing

Specified slump, mm	Tolerance, mm
<60	±10
≥60 ≤80	±15
>80 ≤110	±20
>110 ≤150	±30
>150	±40

- Slump ± 20mm

Procedure in the event of failure

Any concrete represented by test cylinders failing to meet the criteria specified for the compressive strength may be rejected, or:

The Contractor may apply for resubmission of the concrete in question on the basis of cores drilled to the approval of the Engineer. The method of taking cores, testing them and evaluating the test results, shall be as described hereinafter in Clause 804.14(b). The procedure for determining compliance of test results shall be as specified hereinafter in Clause 804.14(b) (iv). The costs of drilling and testing the cores shall be for the Contractor's account regardless of the outcome of the tests on the cores. Before cores are taken, the members concerned shall be cured and allowed to age to at least 28 days but not more than 56 days.

Where the Engineer so directs full scale load tests shall be carried out in accordance with his requirements to determine whether any structure or member can be accepted. The cost of such test shall be for the Contractor's account regardless of the outcome of the tests.

The Engineer may give consideration to the acceptance of the whole or part of the concrete represented by the samples at a reduced price in accordance with the General Conditions of Contract.

In all cases where concrete that fails to meet the requirements for strength has been produced the Contractor shall immediately take the required remedial action by changing the mix proportions to obtain the required strength.

Concrete cores – strength requirements

The actual number of cores to be taken from a resubmitted lot shall depend on the size of the lot and the nature of the structure and will be determined by the Engineer. The lot shall be deemed to have met the requirements for characteristic strength if the "estimated potential strength" of the cores, determined as indicated under sub section (vi) of this clause, meets with the requirements specified in Clause 804.14 (b)(i) for 28 day cylinder compressive strength tests.

Core locations shall be submitted for approval by the Engineer.

Cores shall not be cut from prestressed concrete after the prestressing force has been applied or transferred to the concrete, unless the proposed coring is certified by the proof engineer. The certification shall state that the proposed coring will not be detrimental to the prestressed concrete member.

(b) Testing ordered by the Engineer

Where routine testing of concrete cylinders is not carried out on site by the Engineer he may have the concrete cylinders that have been made by himself tested at the Fiji Roads Authority's nominated laboratory to confirm the

contractor's cylinder results.

The Engineer may order the following additional facilities to be provided by the Contractor for the sampling and testing of concrete:

(i) *Testing Equipment*

Concrete coring machine

A concrete coring machine shall be capable of drilling 100mm or 150mm cores through the full depth of a concrete pavement where specified.

(ii) *Tests*

The following additional tests methods shall apply to concrete:

Coring and testing of cores

Where it is desired that sections of concrete which have failed to meet the Specifications be further investigated by the extraction and testing of concrete cores, 100 or 150mm cores shall be drilled and tested. The sampling and testing procedure to be followed shall be in accordance with AS 1012.

The instruction of this report shall be followed to determine the "estimated potential strength", which shall be compared with the specified 28-day cylinder strength specified for each type of concrete. The corrections to be applied to the actual core strength to allow for excess voids, included steel and length/diameter ratio of cores shall be as stated in this publication and the correction for curing history shall be determined by the Engineer in accordance with this publication and such other information as he may consider applicable.

The Engineer's decisions regarding the properties, suitability and measure of compliance of concrete represented by cores tested as described above, shall be final and binding.

SECTION 805 – PRESTRESSING

805.01 SCOPE AND DEFINITIONS

The section covers the materials, equipment and work required to prestress structural concrete members.

The following definitions and terms shall apply to this section:

(a) *Anchorage*

Anchorage is the device comprising all the components and materials required to retain the force in a tensioned tendon and to transmit this force to the concrete of the structure.

(b) *Anchorage Reinforcement*

Anchorage reinforcement is the spiral and other reinforcement that forms part of the anchorage and is required to strengthen the anchorage and/or assist in transmitting the tendon force into the concrete.

(c) *Bursting Reinforcement*

Bursting reinforcement is the reinforcing steel required in and adjacent to the anchorage zones to resist the tensile stresses induced in the concrete by the anchorage(s).

(d) *Cable*

Cable is the tendon together with the anchorage, sheathing and all fittings.

(e) *Characteristic Strength*

Characteristic strength of prestressing steel is the manufacturer's guaranteed tensile strength below which no more than 5 percent of test results in a statistical population shall fall.

(f) *Duct*

Duct is the void formed to house the tendon(s) and may be formed by coring, sheaths or extractable cores.

(g) *Prestress*

Prestress is the stress induced in concrete by tensioned tendons.

(h) *Prestressed concrete*

Prestressed concrete is structural concrete in which effective internal stresses are induced by means of tensioned tendons.

(i) *Pre-tensioned Concrete*

Pre-tensioned concrete is prestressed concrete where the tendon is tensioned before the concrete has been cast.

(j) *Post-tensioned concrete*

Post-tensioned concrete is prestressed concrete where the tendon is tensioned after the concrete has hardened.

(k) *Pull-In*

Pull-in is the elastic shortening of the tendon caused by relative movement between the anchorage or coupler components due to seating and gripping action during or immediately after transfer.

(l) *Release*

Release is the specified elastic shortening of the tendon at the anchorage that shall be achieved before or during transfer.

(m) *Sheath*

Sheath is the tube or casing enclosing the tendon and which temporarily or permanently allows a relative movement between the tendon and surrounding concrete.

(n) *Tendon*

Tendon is the prestressing steel consisting of bar, wire or strand individually placed, or bars, wires or strands placed in a duct, all of which are tensioned to impart prestress to a concrete member.

(o) *Tensioning*

Tensioning is the action of inducing and regulating the force in a tendon by means of tensioning and measuring equipment.

(p) *Transfer*

Transfer in the case of pre-tensioned concrete is the action of transferring the tensioning force from the tensioning equipment (jack) to the anchorage.

Transfer in the case of post-tensioned concrete is the action of transferring the force in the tensioned tendon(s) to the concrete.

805.02 MATERIAL

(a) *General*

All materials and prestressing systems used in the prestressing of structural concrete member shall be subject to the approval of the Engineer.

(b) *Prestressing Steel*

General

The type of prestressing steel shall be designated by the characteristic strength and 0.2% proof stress, or the characteristic strength and the yield stress, expressed by the two figures in MPa units in that order, e.g. 1770/1500.

The Contractor shall keep proper records of all material analyses and test certificates of the batches of prestressing steel used in the Works. Where required by the Engineer the Contractor shall produce certificates from recognised testing authorities certifying compliance of the prestressing steel with the relevant standard specifications listed in Clause 805.2(b) .

Where prestressing steel is available in weld free lengths (production lengths) and lengths containing welds (standard lengths) the batches delivered on site shall be clearly labelled for identification.

In no circumstances shall prestressing steel after manufacture be subjected to heat treatment other than provided for in these Specifications.

Bars

Cold-worked high tensile alloy steel bars for prestressed concrete shall comply with the requirements of BS 4486.

Wires

Steel wire for prestressed concrete shall comply with the requirements of AS/NZS 4671.

Seven-wire Strand

Seven-wire strand for prestressed concrete shall comply with the requirements in AS 2193 or have properties that are not inferior.

Straightness

Prestressing bars delivered on site shall be straight. Only small adjustments for straightness may be made and shall be done by hand on the site at temperatures above 5°C and under the supervision of the Engineer. Where heating is required this shall be by means of steam or hot water. Bars bent in the threaded portion shall be rejected.

Prestressing wire and strand shall be supplied in coils of sufficiently large diameter to ensure that the wire and strand pay off straight.

Surface Condition

Prestressing steel shall be clean, free from faults and defects, and harmful films matter that may impair adhesion to the grout or concrete. A film of rust is not necessarily harmful and may improve the bond. It may, however, increase the tendon/duct friction.

The depth of imperfections or pits on the surface of prestressing steel shall not exceed 0.1 mm for wire of up to and including 8 mm diameter, or 0.2 mm for bars or wire of diameter larger than 8 mm.

Steel that shows any evidence of damage, kinks or bends shall not be used. Tendons may be cleaned by wire brushing or by passing through a pressure box containing carborundum powder. Solvent solutions shall not be used for cleaning without the approval of the Engineer.

Prestressing steel shall be delivered to Site suitably protected against damage and corrosion. Such protection or the use of a corrosion inhibitor where allowed by the Engineer shall not have any deleterious effect on the steel or concrete or impair the bond.

Galvanising

Galvanised prestressing steel shall not be used unless specified. In no circumstances shall prestressing steel be subjected to galvanising after manufacture.

Welds

Prestressing steel used in structural prestressed concrete shall be weld free. Where the steel is supplied in standard lengths the welds shall be cut out and delivered to the Engineer.

(c) Anchorages and Couplers

Anchorages and couplers for use in prestressed concrete shall comply with the requirements of AS/NZS 1314 and shall be of a proved and approved type, constructed of durable material completely free from imperfections and shall not damage, distort or kink the prestressing steel in a manner that would result in ultimate tensile strength reduction. They shall resist, without failure and/or excessive deformation or relaxation of the force in the tendons, the full ultimate tensile strength of the tendons. The characteristic

value for anchorages and couplers, determined in accordance with AS/NZS 1314, shall not be less than 90%. The Contractor shall supply the test certificates from recognised testing authorities certifying compliance of the anchorages with the requirements of AS/NZS 1314 to the Engineer on delivery of the anchorages.

The anchorages shall effectively distribute the force in the tendon to the structural member and the resulting local stresses and strains in the member shall be so limited as to prevent damage. Wedges and the inside of barrels or cones shall be clean to allow free movement and seating of the wedges inside the taper.

The threads of bars, nuts, anchorages and couplers shall be suitably protected against damage and corrosion. The protection shall be removed at the last moment and the threads properly lubricated before use.

Spiral or other reinforcement specified by the manufacturer for use in conjunction with anchorage devices shall be of the size and dimensions recommended by the manufacturer for the post-tensioning system.

Anchorage shall be kept free from dirt, mortar, loose rust, tar, paint, oil, or any other harmful substances.

All steel components including threads shall be protected from corrosion by greased wrappings or plugs until required for use.

Damaged anchorage components shall not be used.

25 mm minimum diameter grout holes shall be provided at both anchorages and shall be placed at the highest point of the anchorage. Each of the grouting holes shall be equipped with a plug valve or similar device capable of withstanding a pressure of 1.0 MPa without loss of water, air or grout

(d) *Sheaths*

Sheaths shall be of grout-tight construction and of such material and configuration that bond forces can be transferred from the grout to the surrounding concrete. The properties of the sheath material shall be sufficiently flexible to accept the required curvature without kinking as well as strong enough to retain its cross section and alignment and resist damage due to handling, transporting, tying and contact with vibrators during concreting.

Metal sheathing shall not be used. At the same time of incorporation in the structural member the sheathing shall be free from lubricants and harmful matter.

External and internal sheath surfaces shall be kept free from loose rust, oil, grease, tar, paint, mud or any other harmful substances that might impair the bond between the sheath

and the concrete or grout, contaminate the tendons or alter the co-efficient of friction of the sheath.

Unless specified otherwise, the internal diameter of the sheath shall be at least 10 mm greater than the diameter of the tendon. For vertical tendons and when tendons are to be drawn into cast-in sheaths, the duct areas shall be at least three times the cross sectional area of the tendon.

(e) *Cable Supports*

Supports of reinforcing steel or structural steel suitably braced to prevent buckling under load shall be used to support the cables. The cable saddles shall be rigid and secured in position by welding or equivalent mechanical means to resist both gravitational and buoyancy forces. Normal web reinforcement shall not be utilised to support cables.

Saddles for external cables shall be of special design and material to ensure low friction and to prevent the tendon or parts thereof from grooving the surface. The saddle plates shall be curved to the requisite radius to prevent the tendon or part thereof from bearing on the end of the plate and shall incorporate features to ensure that individual bars, wires, and strands are seated separately.

(f) *Tendon Spacers*

Tendon spacers used inside the ducts to separate individual bars, wires and strands of the tendon shall be of a proved and approved type and manufactured material that will not induce corrosion of the prestressing steel.

(g) *Grout*

Tendons shall be grouted as soon as practicable, but not more than two weeks after their installation. If tendons cannot be grouted within this period of time, the duct shall be sealed to protect the tendons from corrosion.

Prestressing anchorages shall be sealed before grouting, to prevent loss of grout.

(h) *Protection Agents for Unbonded Tendons*

The material used for permanent protection of unbonded tendons shall have the following properties:

- It shall remain free from cracks and not become brittle or fluid within the temperature range of -20°C to 70°C.
- It shall be chemically stable for the life of the structure.
- It shall be non-reactive with the surrounding materials, i.e. concrete, tendons,

wrapping or sheathing.

- It shall be non-corrosive or corrosion inhibiting.
- It shall be impervious to moisture.
- It shall be sufficiently tough to withstand the abrasion caused when a tendon, pre-coated with the material, is drawn into the sheath.
- It shall have no appreciable shrinkage or excessive volume increase.
- It shall have a suitable viscosity at ambient temperature or require only moderate pre-heating to permit injection.

(i) Testing

Prestressing steel, anchorage and couplers, and grout shall be tested in accordance with the requirements of Series 800. Materials and Testing shall be carried out at the frequencies as directed by the Engineer.

805.03 EQUIPMENT

(a) General

All equipment used shall be in good working order and properly maintained.

(b) Tensioning and Measuring Equipment

The Contractor shall maintain current calibration certificates conforming to the requirements of AS 2193 Grade B for the jack and pressure gauges or other force measuring devices. Jacks and pressure gauges and other devices shall be calibrated and used as a single unit. Calibration to AS 2193 shall be carried out by an independent laboratory.

The power unit shall be adjusted so that the rate of extension of the tendon is within the specified limits. The measuring equipment shall permit measurement of the tendon force prior to lock-off to the degree of accuracy required by AS 2193 Grade B. The measuring equipment used shall permit elongation to be determined to an accuracy of $\pm 2\%$. The equipment shall prevent unwinding of the strand during tensioning.

The sag take-up force in the tendons shall be measured with equipment which complies with the repeatability and accuracy requirements of AS 2193 Grade B, at a scale mark at which the equipment has been calibrated. The readability requirements of AS 2193 Grade B shall be ignored for the purpose of establishing sag take-up. Sag take-up force shall not exceed 20% of the required tendon force, and shall be not less than 10% of the required tendon force or 10% of gauge capacity, whichever is the greater.

Tensioning and measuring equipment shall be such that the tendon force can be established to an accuracy of $\pm 2\%$ during any stage of the tensioning operations. Unless authorised otherwise by the Engineer, tensioning equipment shall be power driven and shall be such that a controlled total force can be applied gradually without inducing dangerous secondary stresses in the tendon, anchorage or concrete.

The force in the tendon during tensioning shall be measured by direct-reading load cell(s) (dynamometer) or obtained directly from pressure gauges fitted in the hydraulic system to determine the pressure in the jacks. Pressure gauges shall be concentric scale complying with the requirements of AS 2193. The gauges shall not be less than 150 mm diameter and shall be used within the range of 50-90% of their full capacity at maximum service pressure.

When pressure gauges not using glycerine are used, a snubber or similar device shall be fitted to protect the gauge against sudden release of pressure. Provision shall also be made for T-connections for the attachment, when required, of supplementary control gauges. Only self-sealing connections shall be used in the hydraulic circuit. Where the pressure input pipe connects to the jack a pipe rupture valve shall be installed in the circuit.

Tensioning equipment shall be calibrated before the tensioning operation and thereafter at frequent intervals, as directed by the Engineer, against a master gauge or proving ring, and the Engineer furnished with a calibrated chart. The load-measuring devices shall be calibrated to an accuracy of $\pm 2\%$.

(c) *Extension of tendons*

Extension of tendons shall be measured to an accuracy of $+2\%$ or $+ 2\text{mm}$, whichever is the more accurate, and pull-in and release to an accuracy of $+ 2\text{mm}$.

Mixer

Only mechanically operated mixers or a type capable of producing high local turbulences while imparting only a slow motion to the body of the grout shall be used.

The mixer shall be equipped with a screen with openings not exceeding 1 mm and shall be capable of consistently producing grout of a colloidal consistency.

Injection Equipment

The pump shall be of the positive displacement type (piston, screw or similar type), capable of exerting a constant pressure of at least 10 bars on completely grouted cables and shall incorporate a safety device to prevent the build-up of pressure above 20 bars. The pump shall be fitted with a pressure gauge and a valve that can be locked-off without loss of pressure in the cable.

The pump shall be capable of delivering grout such that the speed of the grout in the cable is

between 6 and 12 m per min. All connections in the pipes and between the pipe and the cable shall be air tight. Only threaded, bayonet or similar type connections shall be used.

805.04 TECHNICAL DATA

The following technical data for pre-tensioned and post-tensioned structural members required on the Contract will be supplied on the Drawings:

(a) *Tension Alignment*

A diagrammatic layout showing the alignment of each tendon or group of tendons in both the horizontal and vertical planes together with the ordinates, offset dimensions and curve equations of the centroid of the tendon(s), as relevant.

(b) *Tendon Systems*

The tendon system on which the design is based, designated by the number and nominal diameter of the bars, wires or strands per tendon and the type of prestressing steel, expressed in that order, e.g. 12k15 7-Hi strand 1818/1545.

(c) *Tensioning Force*

The maximum tensioning force and the effective force at the live anchorage(s) after transfer, as well as the corresponding stress level in the prestressing steel, for each tendon or group of tendons. The forces will be given in kN units, and the stress levels will be expressed as a percentage of the characteristic strength, the 0.2% proof stress or the yield stress of the prestressing steel, as relevant.

(d) *Extension*

The extension per tendon or group of tendons under the maximum tensioning force together with the modulus of elasticity (E) on which it has been based. The releases to be attained at each live anchorage as well as the pull-in allowed for.

(e) *Prestressing Losses in Tendons*

The losses allowed for in the design due to the causes listed hereunder will be given as follows:

Friction Loss

The formula used to determine the tendon/duct friction loss together with the value adopted for the friction coefficient due to curvature, and the wobble factor (k) due to unintentional variation from the specified alignment.

Elastic Deformation of Concrete

The “elastic factor”, which when multiplied by the compressive stress in the concrete adjacent to the tendon will give the loss due to elastic deformation of the concrete.

Creep of Concrete

The “creep factor”, which when multiplied by the compressive stress in the concrete adjacent to the tendon will give the loss due to the creep of the concrete.

Shrinkage of Concrete

The stress loss in MPa due to shrinkage of the concrete.

Relaxation of Prestressing Steel

The stress loss in MPa at a stress level of 70% of the characteristic strength of the prestressing steel due to relaxation of the prestressing steel.

(f) Anchorages

The positions where loop or fan type dead-end anchorages may be used.

(g) Bursting Reinforcement

The bursting reinforcement for the prestressing system on which the design is based.

(h) Precamber

The precamber at intervals not exceeding 0.25 times the span length.

805.05 PRESTRESSING SYSTEM

The use of all prestressing systems will be subject to approval by the Engineer. Tenderers are advised to get approval for the prestressing system they intend using prior to submitting their tenders. Within one month after the award of the tender or within a period agreed by the Engineer, the Contractor shall submit full details on the prestressing system(s), materials and equipment he intends using as well as on the methods he proposes to adopt in the prestressing and related operations.

The Engineer, at his own discretion, may call for further information in the form of detailed drawings, proof of successful previous use, and performance certificates from an approved independent testing authority and calculations substantiating the adequacy of the system. The Contractor shall furnish such information within 2 weeks of being called upon to do so or within a period agreed by the Engineer. If, after investigating all the information, the Engineer is not satisfied that the prestressing system offered by the Contractor, the Engineer reserves the right to order the Contractor to use any system which is suited to the work and which is readily available to the

Contractor.

Only minor alterations to the concrete dimensions shown on the Drawings will be considered in order to accommodate the prestressing system finally selected. Major alterations due to the prestressing system offered by the Contractor and is incompatible with the tendon system specified in Clause 805.04(b) shall be treated as "Alternative Designs".

805.06 DRAWINGS PREPARED BY THE CONTRACTOR

All drawings prepared by the Contractor and submitted to the Engineer for consideration shall comply with the requirements of Section 101.

The Contractor shall submit to the Engineer at least 3 months before he intends commencing with the prestressing work, drawings detailing the layout and alignment for the individual tendons, the cable supports, modification to the bursting and other reinforcement, anchorage recesses, tensioning sequence, tensioning loads and extensions, as well as requirements for the control of the tensioning operations. For the prestressing system finally selected, the technical data that are at variance with the information given on the Drawings shall be shown on the drawings. Each tendon shall be separately numbered for identification.

When required, the Contractor shall submit calculations in respect of the variation of the tendon force along the length of the tendon, the expected extension and the bursting forces.

After approval by the Engineer of the drawings and calculations prepared by the Contractor no departure shall be permitted from the forces, stresses and extensions shown thereon, without authorisation by the Engineer.

No work shall commence on the prestressing work before the relevant drawings have been accepted and signed by the Engineer.

The Contractor shall make full allowance in his tendered rates for all costs in connection with the furnishing of information, for performing calculations and for the preparation and submission of drawings. However, no allowance need be made for the cost of checking undertaken by the Engineer of drawings and calculations for work that does not qualify as alternative design.

805.07 PRECAST WORK

(a) Casting yard on the Site

Subject to the approval by the Engineer, precast work may be done at any location selected by the Contractor. Before the casting yard is established the Contractor shall submit plans to the Engineer, demarcating the site and detailing the layout of the works together with a flow diagram of the construction stages and storage.

(b) *Manufacture off the Site*

The Contractor shall notify the Engineer in advance of the date when tensioning of tendons, casting of members and transfer, as relevant, will be undertaken. Within 7 days after transfer, the Contractor shall submit to the Engineer a certificate giving the tendon force(s) and extension(s) attained as well as records of the cylinder crushing strength and age of concrete at transfer.

Test results relating to all aspects of the work shall be sent to the Engineer immediately upon their becoming available.

Where the Engineer requires tests to be carried out on completed members, no member to which the tests relate shall be dispatched to the site until the tests have been satisfactorily completed and the members accepted by the Engineer.

(c) *Manufacture*

Before work is commenced, details of the manufacture and phasing of the work shall be submitted to the Engineer for approval. After approval no changes shall be made to the methods or system without authorisation by the Engineer.

The Contractor shall determine the precamber required to enable the final structure position to be at the time and level specified on the drawings. The magnitude of precamber shall be subject to variation depending on the Contractor's construction programme and the Contractor shall, before manufacture ascertain in writing from the Engineer the increase or decrease in precamber required to achieve the correct structure profile. Lifting and supporting of precast members shall be made only at the points marked on the members and provided for.

Precast members which have not been fully tensioned, fully stage tensioned or which have ungrouted tensioned tendons shall not be handled without authorisation by the Engineer. When members with ungrouted tensioned tendons are handled, control shall be exercised to guard against possible slip of the tendon at the anchorage. Prestressed precast concrete members shall also comply with the requirements of Clause 804.13.

805.08 PRE-TENSIONING

During the period between tensioning and transfer, the force in the tendon shall be fully maintained by some positive means. At transfer, de-tensioning shall take place slowly to minimise shock that could adversely affect the transmission length of the tendon.

In the long-line method of pre-tensioning, sufficient locator plates shall be distributed throughout the length of the bed to ensure that the straight tendons are maintained in their proper position during

concreting. Where a number of units are manufactured in line, they shall be free to slide in the direction of their length and thus permit transfer of the tendon force to the concrete along the whole line.

In the individual mould system, the moulds shall be sufficiently rigid to provide the reaction to the tendon so that friction losses are eliminated. If, however, a system is used that develops a frictional force, this force shall be determined by test and due allowance made.

For single tendons the deflector in contact with the tendon shall have a radius of not less than 5 times the tendon diameter for wire, or 10 times the tendon diameter for a strand, and the total angle of deflection shall not exceed 15°.

Transfer of the tendon force to the concrete shall be effected in conjunction with the release of hold-down and hold-up forces as approved by the Engineer. Transfer shall not be effected until compressive strength tests on the concrete show that the concrete of the particular member has attained a compressive strength of at least 2.5 times the maximum compressive stress in the concrete or the strength shown in the Drawings. The transmission length is affected by the concrete strength and the necessary modification for the concrete strength at transfer shall be made in conjunction with the Engineer. The tendons shall be cut off flush with the end of the member and the exposed ends covered with a heavy coat of approved bituminous compound or epoxy resin.

805.09 POST TENSIONING

(a) Storage, handling and protection

During storage, transit, construction and after installation the sheaths, prestressing steel, anchorages and couplers shall be protected against corrosion, damage or permanent deformation. The manner and extent of protection required will depend on the environmental conditions and the length of time before permanent corrosion protection is applied, and shall be to the satisfaction of the Engineer. Under severe corrosive conditions at coastal, damp and wet areas and under aggressive conditions the materials shall be stored clear of the ground and while in storage shall not be exposed to the weather.

When prestressing steel has been stored on site for a prolonged period and there is evidence of deterioration of the steel the Engineer may call on the contractor to prove by tests that the quality of the steel has not been significantly impaired and still complies with the provisions of the Specifications.

Suitable protection shall be provided to the threaded ends of bars.

After fabrication the cable ends shall be covered with protective wrapping to prevent the ingress of moisture into the duct.

When the tendon is to be left untensioned for a prolonged period after installation, precautions shall be taken to protect the tendon against corrosion. Corrosion inhibitors, oils or similar materials used as lubricants or to provide temporary protection shall be such that they can be completely removed before permanent protection is affected.

(b) Fabrication

All cutting of prestressing steel shall be performed with a high-speed abrasive cutting wheel or method approved by the Engineer. Flame cutting shall not be permitted.

Care shall be taken to prevent the prestressing steel or anchorages from coming into contact with splashes from flame cutting or welding processes in the vicinity. Where possible, all bars, wires or strands tensioned in one operation shall be taken from the same parcel of prestressing steel. The tendon or cable shall be labelled to show the tendon or cable number, as well as identify from which parcel the steel has been taken.

Where bars, wires or strands in a tendon are not tensioned simultaneously, tendon spacers shall be used in accordance with the recommendations for the prestressing system, or in the absence thereof, as directed by the Engineer.

Cables shall be fitted at both ends with pipes of at least 10 mm diameter for the injection of grout or protection agents. The ends of the injection pipes shall be fitted with a clamp, valve or device capable of withstanding a pressure of at least 15 bars without loss of grout or protection agent.

Vent pipes shall be provided in the ducts at intervals not greater than 10 metres along the duct. Additional vents with plug valves shall be provided at high and low points in the duct, , change of sheath cross-section and at such intermediate positions as may be required by the Engineer for the satisfactory grouting/protection of long tendons. The vent pipes shall extend to at least 750 mm above the concrete and comply with the requirements for injection pipes.

Connections to, and joints in sheaths shall be made grout-tight either by special detailing or taping. With bonded systems, the length of taping shall not exceed six sheath diameters. Where over sleeves are used, equal overlaps shall be provided over each length of sheathing. Joints in adjacent sheaths shall be spaced at least 300 mm apart.

(c) Installation

The installation of tendons shall not commence until the requirements of Clause 805.06 have been complied with.

The cable, sheath or extractable cores shall be accurately installed to the specified alignment and securely held in position both vertically and horizontally at intervals appropriate to its rigidity, such that it will not be displaced during concreting either by weight of the concrete or buoyancy. The spacers of the cable supports shall furthermore ensure that the tendon can be installed to a smooth

alignment without kinks and within the tolerance specified in Clause 810.19. A spacing from 1.0 - 1.5 metres should generally not be exceeded.

Extractable cores shall not be coated with release agent unless approved by the Engineer.

Unless shown otherwise on the Drawings, the alignment of the tendon within a distance of 1.0 m from the live anchorage and/or coupler shall be straight. Anchorages shall be set square to the tendon axis and firmly secured in position so as not to move during concreting. External anchorages shall be seated on a thin mortar bedding to bear evenly on the concrete surface and axially to the tendon.

Unless shown otherwise on the Drawings the minimum concrete cover over the outside surface of the sheath of the cable support shall comply with the requirements of Clause 803.07 except that for sheaths the cover shall not be less than 50 mm.

The spacing of cables will depend on the size of the cable and shall be such that the concrete can be properly placed and compacted.

Immediately before concreting, the Contractor shall inspect the sheaths for grout tightness and shall seal all damaged and suspect sections.

External tendons shall be installed to the same standards and accuracy specified herein for internal tendons. The tendons shall be temporarily supported at regular intervals along the straight length between saddles. The supports shall consist of rigidly constructed frames secured to the concrete face.

(d) Concrete Strength

Full tensioning of all or part of the tendons shall not commence until the compressive strength tests on the concrete of the particular member have attained a compressive strength of 40 MPa or 2.5 times the maximum compressive stress induced in the concrete by the tendons to be tensioned whichever is the greater.

Where initially, all or part of the tendons are to be partially tensioned, tensioning shall not commence before the concrete has attained the compressive strength indicated on the Drawings.

The compressive strength of the concrete shall be determined from cylinders manufactured and tested in accordance with Clause 804.14 and which have been cured under the same conditions as the structural member that is to be prestressed. The number of concrete cylinders required for this purpose shall be as agreed by the Engineer.

(e) Tensioning

Preparation

Within 2 hours after concrete has been placed, the Contractor shall demonstrate that sheaths are

free from obstruction, that extractable cores can be removed and where the design permits, that all tendons are free to move in the ducts. Thereafter all water in the ducts shall be expelled with compressed air and the cables sealed until tensioning takes place.

Before tensioning is commenced, side forms and other restraining elements shall be released or removed to give the structural member the freedom to deform under the induced force.

Tensioning sequence

The sequence of tensioning to be followed shall be as shown on the Drawings and/or drawings prepared by the Contractor in terms of Clause 805.06. The Contractor shall allow in his tendered rates for all additional costs which he may incur as a result of having to tension fully only part of the tendons at any one stage or instant.

Where partial tensioning of tendons is required the work shall be executed in accordance with the details on the drawings or as directed by the Engineer. The Contractor shall allow in his tendered rates for all additional costs which he may incur as a result of having to tension partially only part or all of the tendons at any one stage or instant.

Assembly of equipment and safety precautions

The tensioning and measuring equipment shall be assembled for tensioning in exactly the same way as they are combined for calibration.

The Contractor shall take all necessary safety precautions to prevent accidents due to the malfunction or failure of any part of the equipment or material and shall accept full responsibility for injury and damage to persons and property resulting therefrom.

The Contractor shall establish no-go zones with warning signs and substantial barricades in order to provide a protective barrier for site personnel, other persons and property and to prevent the entry of unauthorised persons into the hazard zone around and behind the jacking equipment.

Jacking and other site personnel shall not be permitted to stand behind the jack or close to the line of the tendons while stressing is in progress.

During stressing operations, warning signs shall be displayed at both ends of the member being tensioned.

The stressing jack shall be adequately supported and restrained in order to ensure that it cannot cause injury to personnel operating the jacking equipment should the jack lose its grip on the tendons or should the tendon fail.

Friction

The Engineer may require the Contractor to perform friction tests on designated tendons and revise the relevant theoretical extensions to compensate for the discrepancy between the values adopted

in the design and test results.

Where applicable, allowance shall be made in the tensioning force to compensate for friction loss in the jack and in the anchorage.

Tensioning

Tensioning shall be carried out under the supervision of a technician skilled in the use of the prestressing system and equipment and the methods of tensioning to be adopted.

Tensioning shall not commence before the Engineer has been advised of each tensioning operation and has given his approval for the work to start.

The technician and operators shall be supplied with a schedule listing the sequence of tensioning of the various tendons and a tensioning record sheet showing the theoretical gauge readings, jacking forces, extensions, release and pull-in for each tensioning operation. The record sheet shall furthermore provide for the entering of the corresponding information recorded and observations made during tensioning. A graph of tensioning force and/or gauge reading versus theoretical extensions measured for each load increment shall be plotted on the graph. Copies of the completed record sheets and graphs shall be submitted to the Engineer within 24 hours of completion of each tensioning operation.

The Contractor shall note that the extensions shall be regarded as an indirect measurement of the tensioning force and shall serve as a control on the tensioning force applied.

The protruding ends of all bars, wires or strands shall be clearly marked for the accurate measurement of extension, release and pull-in.

Before tensioning is commenced on external tendons a small load shall be applied to each tendon, commencing with the uppermost tendon. The force shall be sufficient to take up all slack and prevent entanglement of the tendons.

The jacking force shall be increased to approximately 5 - 10% of the final jacking force to take up the tendon slack and to determine the zero position for the extension measurements and to check the gripping devices and the position and alignment of the jacks. Thereafter the load shall be increased gradually to the full specified tensioning force while intermediate gauge readings and extensions are recorded at regular intervals.

The final stage of tensioning shall be deemed to have been satisfactorily accomplished when all the following requirements have been satisfied.

- The tendons have been tensioned to the required force
- The measured extension on individual tendons is within + 6% of the theoretical extensions

- The average variation between the measured and theoretical extensions of all the tendons in a structural member is less than + 3%
- The release and/or pull-in is within + 2 mm of the theoretical values.

When the above conditions are not met individually and collectively, the Contractor shall immediately advise the Engineer and obtain a ruling as to the procedure to be followed.

In the event of the tendon friction being too high, the Contractor may, subject to the approval of the Engineer, inject an approved lubricant into the sheath after first detensioning the tendon. The cost of the remedial and corrective measures and of the release and retensioning of tendons, which have been occasioned by failure of the operations to meet the above requirements, shall be for the Contractor's account. After the tensioning has been accepted by the Engineer, the Contractor may cut off the tendons behind the anchorage as described in Clause 805.9(b).

(f) Permanent Protection and Bonding of Tendons

General

Prior to any grouting of the permanent works full scale grouting trials will be performed by the Contractor and witnessed by the Engineer. After tensioning all tendons shall receive permanent protection against mechanical damage and corrosion.

Internal tendons shall be protected and bonded to the structural member by cement grout or, when permitted by the Engineer, by sand cement grout. Where bond is not important, protection may be rendered by the use of bitumen, petroleum based compounds, epoxy resins, plastics and similar products, all complying with the requirements of Clause 805.2(h) and subject to the approval of the Engineer. The minimum compressive strength of test cubes made, cured and tested in accordance with AS 1478.2 shall be 32 MPa at 28 days. At least one pair of cubes shall be taken from each 5 cubic metres or part thereof of grout.

Tendons located outside the structural sections (i.e. external tendons) shall be encased with a dense concrete, dense mortar or material sufficiently stable and hard, all subject to the approval of the Engineer. The encasement shall be of the thickness shown on the Drawings. Where bonding of the tendon to the structural concrete is required, this shall be achieved by reinforcement of the concrete encasement to the structure as detailed on the Drawings.

Protection and bonding of the tendons shall be effected within 7 days after final tensioning of the tendon(s), or as specified on the Drawings, but shall not take place without prior approval of the Engineer.

After the permanent protection or bonding has been completed the anchorages shall be encased in concrete or grout or shall be completely coated with a corrosion resistant material. The protection rendered shall in every case prevent the ingress of water or aggressive agents.

Preparation of Ducts

Before permanent protection and/or bonding of tendons is effected the following precautions shall be covered:

- The cables shall be checked for blockages by means of water injection or compressed air.
- Unlined ducts that are to be filled with grout shall be flushed with water to wet the concrete.
- Temporary protection or lubricants which are incompatible with the permanent protection or bonding, shall be removed by flushing with water or an inert solution or by any suitable method approved by the Engineer.
- On completion of the above, the excess fluid shall be expelled from the ducts by means of compressed air, or be displaced by the protection agent or grout, as relevant.

Any blockages, leakages or factors that may in any way affect the permanent protection or bonding, shall immediately be reported to the Engineer.

Mixing

Protection Agents: The mixing of protection agents shall be strictly in accordance with the manufacturer's instructions.

Grout: The aggregate, if used, and the cement shall be measured by mass and the water by mass or volume.

The water/cement ratio by mass shall be as low as possible within the range of 0.36 to 0.45, consistent with the fluidity requirements of Clause 805.2(g).

When an admixture is used it shall be dissolved in a part of the mixing water before it is added to the grout.

Mixing shall commence by adding two thirds of the cement to the main part of the mixing water, then adding the pre-dissolved admixture if used, and finally the remainder of the cement. Mixing shall continue for not longer than 4 minutes and thereafter the grout shall be continually agitated at low speed throughout the injection operation.

When an aggregate is used in the grout mix, the word "cement" in the preceding paragraph shall be replaced by the term "cement/aggregate component".

Injection

The injection of the permanent protection agents or grout shall not commence before the Engineer has given his permission for the work to start. Before injection commences all air shall be expelled from the injection equipment and hoses and all connections checked for air tightness.

Injection shall take place from the anchorage or coupler whichever is situated at the lower end of

the cable.

Protection agents

The injection of protection agents shall be strictly in accordance with the instructions, and with the equipment specified by the manufacturer.

Grout

Immediately after mixing and during injection the fluidity of the grout shall be tested at regular intervals in accordance with Clause 805.2(g). Injection shall be continuous, without interruption at a rate of 6-12 m per minute. As soon as grout with the original consistency flows from the intermediate vent pipes they shall be successively closed. Injection shall continue until the grout flowing from the vent at the free end is of the same consistency as that of the injected grout. At this stage the vent shall be closed and the final pressure or a pressure of 5 bars, whichever is the greater, maintained on the grout column for 5 minutes before the valve at the injection end is closed.

All vents shall be kept closed and supported vertically until final setting of the grout has taken place.

On vertical cables, a riser pipe with funnel shall be fitted to the top anchor to ensure that the separated (bleed) water migrates upwards without extending into the cable. If an expanding agent is used in the grout mix, the air vent shall be re-opened after grouting to release any separated water and subsequently be closed again.

Unless a retarder is used in the grout mix, the grout not used within 30 minutes of mixing shall be discarded. During the course of grouting 150 mm cylinders shall be made for testing in accordance with Clause 805.2(g). Whilst pouring the grout into the cylinder mould the sides thereof shall be slightly tapped to permit the entrapped air to escape. Precautions shall be taken not to discharge escaping grout onto railway lines, public roads or private property.

If a blockage occurs during the course of grouting, grouting shall be stopped before the maximum grouting pressure is reached, the duct flushed out immediately and the blockage cleared.

The grout shall be sampled and tested for compressive strength with 75 mm cubes to demonstrate compliance with the minimum specified strength.

805.10 LOSS OF PRESTRESS

Any structural member which has lost all or part of its prestress through failure or malfunction of any part of the prestressing component may be rejected by the Engineer and shall be removed from the Work unless remedial measures, approved by the Engineer, are successfully carried out on the member. No payment shall be made in respect of such remedial work or loss suffered by the Contractor in this regard.

SECTION 806

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SECTION 807 – JOINTS IN STRUCTURES

807.01 SCOPE

This section covers the supply and installation of all permanent joints that will permit relative movement between continuous structural members. Expansion joints are designed and dimensioned for installation at a mean temperature of 25°C to 35°C. Joint gaps shall be constructed as shown on the Drawings to a cross-sectional tolerance of 3mm.

807.02 MATERIALS

(a) *General*

All materials used in the forming, construction and sealing of permanent joints as well as all proprietary or custom-built expansion joint assemblies shall be subject to the approval of the Fiji Roads Authority.

The Contractor shall submit test certificates from an approved independent testing authority to show that the respective materials conform with the specified requirements, or a certificate from the patent holder or designer certifying that the manufactured item complies in all respects with relevant product specifications.

(b) *Joint Filler*

Joint filler shall be performed, compressible cellular, and resilient and shall not become brittle in cold weather. Joint filler shall consist of sheets or strips of the following materials and be shown on the Drawings

- Bitumen impregnated fibreboard and bitumen impregnated corkboard -
- Resin impregnated corkboard -
- Flexible foams of expanded polythene, polyurethane or polystyrene.
- Rigid foams of expanded polyethylene, polyurethane or polystyrene -
- Other joint filler materials may be used if approved by the Fiji Roads Authority after submission of full specifications and information by the Contractor.

(c) *Sealants*

- Joint sealants shall be non-degradable for its particular application. It shall be elastoplastic and shall possess a movement accommodation factor of at least 25 per cent.
- For horizontal joints in structures or pavements unless otherwise shown on the

Drawings, the sealants shall be a type A1 rubberised bituminous compound to BS 2499 and shall have a minimum life expectancy of 10 years.

- In other situations, the sealants shall be synthetic rubber based on polysulphide to BS 4254 or BS 5215 or based on polyurethane or silicone to the approval of the Engineer and shall have a minimum life expectancy of 15 years.
- Where the joint sealant is to be in contact with a protective coating as shown on the Drawings the Contractor shall satisfy the Engineer that the sealant and the protective coating are compatible.
- All sealant shall be stored in accordance with the manufacturer's instructions and no sealant shall be used after its shelf life has elapsed.
- To ensure non-adhesion to the back of the joint cavity a bond breaker tape is to be fixed where this is specified by the manufacturer of the sealant. Primer shall be obtained from the same manufacturer as the sealant.
- Thermoplastic hot-poured sealants shall comply with the requirements of US Federal Specification SS-S-1401B, BS 2499 or AASHTO specification M173. The sealants shall be of the rubberised bituminous type containing a minimum of 20% natural or synthetic rubber.
- Thermoplastic cold-applied sealants shall comply with the requirements of US Federal Specification SS-S-156. The sealant shall be of rubberised bituminous type containing a minimum of 20% natural or synthetic rubber.
- Thermosetting chemically curing sealant shall comply with the requirements of US Federal Specification SS-S-195B, American National Standards Institute Specification ANSI A 116.1 (formerly ASA A 116.1 and USASI A 116.10 or BS 4254).
- The final IRHD hardness of the sealant shall 20 + 5.
- Other sealants may be used if approved by the Fiji Roads Authority after submission of full specifications and information by the Contractor.

(d) Preformed elastomeric compression seals

Preformed elastomeric compression seals shown on the Drawings.

(e) Waterstops

Waterstops shall be of natural rubber, or flexible PVC, and of the type specified or shown on the Drawings.

(f) *Accessory Materials*

- Primers

When a primer is to be used in conjunction with the sealant it shall be of the prescribed proprietary material.

- Adhesives

Adhesives used in conjunction with preformed seals shall be of a proved and approved type compatible with the material of the seal.

- Bond Breakers

Polyethylene tape, coated papers, metal foils or similar material may be used where bond breakers are required.

- Backup Material

Backup material shall consist of a compressible material of correct width and shape, to ensure that after installation it is in approximately 50% compressed and the sealant can be formed to the specified depth.

Backup materials shall be compatible with the sealant used. Material containing bitumen or volatiles shall not be used with thermosetting chemically curing sealants.

(g) *Steel Protection Angles*

Steel used for the fabrication of the expansion joint protection angles shall conform to the standards specified on the drawings. Steel protection angles shall be fabricated and coated in accordance with the requirements of Section 810.

807.03 FILLED JOINTS

Filled joints shall be accurately formed to the dimensions shown on the drawings with the filler material specified. The filler shall be secured in position not to displace during concreting, or thereafter if the filler is to remain permanently in the joint.

Where polystyrene or similar material susceptible to damage is used to form joints, it shall be lined with a hard surface on the side to be concreted. The hard surface shall be sufficiently resilient to ensure that the joint and surfaces can be formed free from defects.

807.04 CONCRETE NOSINGS

Concrete nosings forming the edges of expansion joints shall be constructed as follows:

- After the construction in the structural member has hardened sufficiently, the protruding ends of the reinforcing steel shall be bent flat onto the concrete surface of the formed recess.
- Before the asphalt surfacing is laid, the recess shall be filled with well compacted crusher run, sand or weak mortar. Care shall be exercised to ensure that the concrete surfaces and reinforcing steel are not contaminated with bituminous agents. Thereafter, the asphalt surfacing shall be laid continuously over the joint.
- The asphalt surfacing corresponding to the width of the nosing shall be cut with a diamond saw blade and all material removed from the nosing recess. The concrete surfaces of the recess shall then be roughened to expose the aggregate and leave a sound, irregular surface. The reinforcing steel shall thereafter be bent, fixed and placed as detailed on the Drawings.
- The prepared concrete surfaces shall, immediately before the concrete nosings are cast, be treated with an approved epoxy resin adhesive. Opposite concrete nosings, separated by a 10 mm thick joint filler strip, shall be cast simultaneously in accordance with Clause 804.08(c), and compacted by surface vibrator. The nosing shall be screeded flush with the premix surfacing and give a Class U2 surface finish.
- Curing shall be in accordance with Clause 804.09 except that the curing period shall be 10 days.
- After the concrete in the nosing has been cured for at least 3 days, the gap between the nosings shall be enlarged to the requisite dimensions by cutting both sides with parallel diamond saw blades. The depth of the saw cut shall be such that a ledge is formed along the lower edge of the cut on which the sealer unit can be supported.
- The exposed corners of the nosings shall be ground to have a 10 mm chamfer.
- After the joint has been sealed, the wearing surface of the nosings shall be treated with a bituminous primer to the satisfaction of the Engineer.
- The traffic shall not be permitted to pass over the joint before the concrete in the nosing has aged for at least 10 days.
- The concrete used in the construction of the nosings shall be Grade 40/20 and shall have a slump of not less than 50 mm and not exceeding 75 mm.

807.05 EPOXY MORTAR NOSINGS

Epoxy mortar nosings shall not be used unless detailed on the Drawings and specified in the Special

Provisions. Where epoxy mortar nosings are permitted, they shall be constructed in accordance with the requirements specified in the Special Provisions and to the manufacturers specification.

807.06 SEALING OF JOINTS

Sealed joints shall be made watertight over the full length of the joints unless permitted otherwise by the Engineer. Unless a waterstop is equipped with an effective watertight interlocking system for the joining of sections, all joints in waterstops shall be bonded or fused to have a tensile strength of at least 50% of that of the unjointed material.

At intersections and abrupt changes of direction, waterstops shall be jointed with prefabricated junction pieces. Restrictions on joint width and temperature at the time of installation of the sealant or seal will be shown on the Drawings. In the absence of these and unless specified otherwise, installation shall only be carried out within the temperature range of 5°C to 30°C.

(a) Preparation of Joints

Sawing of joints shall be undertaken at such time as to avoid edge spalling or ravelling.

After the removal of the temporary filler material or breaking out of the excess concrete, the inside faces of the joint shall be wire brushed or grit blasted to remove all laitance and contaminants; the joint shall thereafter be cleaned out and blown out with compressed air to remove all traces of dust. Solvents shall not be used to remove contaminants from concrete and porous surfaces.

Care shall be exercised to ensure that primers or adhesives are applied only to surfaces that are absolutely dry. The primer or adhesive shall be applied strictly in accordance with the manufacturer's instructions. Unless specified otherwise the primer shall be applied within the temperature range of 10°C to 40°C and the sealant shall be applied after the curing period of the primer and within the period that the primer remains active.

(b) Sealants

Sealants shall be applied strictly in accordance with the manufacturer's instructions by a person skilled in the use of the particular type of sealant. Trapping of air and formation of voids in the sealants shall be avoided. The sealant shall be finished to a neat appearance flush with the edges of the concrete or to the specified depth.

Thermoplastic hot-poured sealants shall not be poured into the joints when the temperature of the joint is below 10°C. The safe heating temperature shall not exceed the specified pouring temperature by more than 10°C. Two-part thermosetting chemically curing sealants shall not be applied after expiry of the specified pot-life period which commences once the base and activator of the sealant have been combined.

(c) *Preformed Compression Seals*

The seal shall be inserted and secured with a lubricated adhesive covering both sides of the seal over the full area in contact with the inside faces of the joint. The lubricant adhesive shall be applied immediately ahead of inserting the seal.

The seal shall be installed with the appropriate equipment in a compressed state such that under the most adverse condition the seal will remain in compression. The seal shall at all times be between 5 and 10 mm below the level of the pavement. The seal shall not be stretched during installation; however, any unintentional stretching which may occur shall not exceed 5%.

Joints in the seals shall be bonded or fused and shall be only at positions agreed by the Engineer.

(d) *Waterstops*

Waterstops shall be securely and accurately located in position not to displace or deform during construction.

807.07 PROPRIETARY EXPANSION JOINTS

(a) *General*

The use of any type of expansion joint shall be subject to approval by the Engineer.

(b) *Dimensions*

Attention is drawn to the overall dimensions of the expansion joints and to the limiting concrete dimensions of that portion of the structure that is to accommodate the joints. No alterations to the concrete that will be visible in the final structure or major re-arrangement of the prestressing anchorages, shall be permitted in order to accommodate joints of excessive size.

All joints to be installed along a skew shall be accurately dimensioned to ensure compliance with Clause 807.08.

Unless specified otherwise, proprietary expansion joints shall include the complete expansion joint assembly, traversing the roadway, kerbs, footpaths and median and shall include the coping and parapet cover plates as well as the drainage system to drain the expansion joint.

(c) *Design and Manufacture*

The expansion joint shall be designed to withstand the movements, displacements and rotations specified on the Drawings in conjunction with the loads prescribed in the code

of practice adopted for the design of the structure without overstressing any part in terms of "Working Load" requirements or exceeding the requirement for Serviceability Limit State. Any strengthening required of the supporting member to resist forces imparted by the joint to the structure, shall be for the Contractor's account.

The specified movements, displacements and rotations shall be accepted without impairment of efficiency or riding quality of the joint. The joint shall be vibration free, resistant to mechanical wear and other forms of abrasion, and resist corrosion, have good riding characteristics, be skid resistant and silent; be of watertight construction or have provision for the disposal of water, debris or grit collecting in the joint; and be of construction to facilitate easy inspection, maintenance and repair.

Prior to manufacture of the joints, the Contractor shall submit to the Engineer for his acceptance detail drawings, in accordance with the requirements of Section 101, of each expansion joint and shall provide information on his intended method of installation.

The expansion joints delivered on the site shall be suitably marked to show clearly the sequence and position of installation.

807.08 INSTALLATION OF EXPANSION JOINTS

No expansion joint or part thereof shall be installed prior to the establishment of final surfacing levels based on a complete level survey of the bridge deck(s). The survey shall be carried out before the construction of kerbs, channels or bituminous surfacing. The expansion joint shall form an even surface with the road surface on either side and shall be installed to the manufacturers specification and in the presence of and to the satisfaction of the Engineer.

The steel protection angles shall be held firmly in place during concreting by methods approved by the Engineer. Butted joints in plates shall be sealed to prevent leakages of mortar during concreting. Care shall be taken to ensure the concrete is thoroughly compacted around anchor bars, under flanges of angles and other areas where concrete placement is difficult.

SECTION 808 – BEARINGS FOR STRUCTURES

808.01 SCOPE

This section covers the requirements for the manufacture, testing, supply and installation of bearings for structures. Bearings shall be designed to support the loads and to accommodate the movements and rotations shown on the Drawings. All the relevant standards are listed in AS 5100.4 Clause 2.0

808.02 MATERIALS

Materials and components for use in bearings shall comply with AS 5100.4. The completed bearings shall satisfy the structural performance and dimensional requirements of the design.

When requested by the Engineer, the Contractor shall submit test certificates from an approved, independent testing authority to show that the respective materials conform with the specified requirements, or design certifying that the manufactured item complies in all respects with relevant product specifications.

808.03 ELASTOMERIC BEARINGS

Bearing shall comply with the testing requirements of AS 5100.4 and shall be tested in accordance with AS 5100.4 Appendix D

Alternative bearings

Where alternative bearings are offered by the Contractor, they shall be designed in accordance with the requirements of AS 5100.4 for the loadings and deformations shown on the Drawings.

Inspection and Testing

On completion of manufacture of the bearings, the Contractor shall submit, if so directed by the Engineer, bearing pads selected by the Engineer, or specially manufactured simple pads authorised by the Engineer, to an independent testing authority for testing. The tests to be undertaken shall be as directed by the Engineer and in accordance with these specifications.

A variation of + 20% shall be permitted between the actual and theoretical stiffness for compression and shear of the elastomer. Where this variation is exceeded, acceptance of the pads shall be at the sole discretion of the Engineer.

Copies of test results and certificates for the above mentioned testing shall be submitted by the Contractor to the Engineer timeously to enable the Engineer to assess the information before the bearings are installed.

808.04 PROPRIETARY BEARINGS

(a) *General*

This clause covers custom built bearings, bearings manufactured under licence except elastomeric bearings. Combined bearings, consisting of an assembly of an elastomeric bearing in conjunction with a low friction sliding or mechanical component shall fall under this clause. The tenderer may base his tender on any bearing that complies with the specified requirements, provided that the efficiency of the bearings has been verified by tests and successful previous use. Evidence of these as well as information on the bearing's durability and suitability for the specified use shall be submitted to the Engineer for his consideration. Details of the product guarantee shall be submitted to the Engineer for consideration.

(b) *Drawings and Approval*

Typical detail drawings shall be shown clearly the construction of the bearings and information on the friction characteristics based on actual tests performed on the relevant materials shall be submitted to the Engineer. Prior to manufacture, the Contractor shall submit the following information to the Engineer for consideration.

Manufacturer's Specification containing detailed information on the design standards, materials, manufacture processes and standards and technical data. Drawings complying with the provision of Clause 101 showing the bearing construction and installation details. All bearings used in the permanent works shall be subject to the approval of the Engineer.

(c) *Technical Data*

Technical data for the proprietary bearings required in the Contract will be supplied on the Drawings, and shall also be supplied on the drawings prepared by the Contractor for submission to the Engineer.

Design Loads and Movements - The maximum and minimum vertical loads and co-existing horizontal loads as well as the maximum horizontal load and co-existing vertical load.

Mechanical Fit - Mechanical fit on unidirectional and fixed bearings expressed as the maximum permissible slack (play) between the shear transfer members of the bearings that are required to resist the applied horizontal loads.

- Identification -

Identification of each bearing by a number, the degree of freedom of movement (fixed, multidirectional or unidirectional) and the type of bearing (spherical, elastomer-pot, etc.).

(d) *Design*

The bearings shall be designed to accept the specified load combinations in conjunction with the maximum eccentricity and rotation without overstressing any part in terms of “Ultimate Load” requirements or exceeding the requirements for Serviceability Limit State.

Unless specified otherwise in the Special Provisions or on the Drawings the following shall be complied with:

- The maximum average contact stress and maximum edge stress on the concrete or mortar bedding shall not exceed 20 MPa and 25 MPa respectively.
- The initial peak static coefficient of friction shall not exceed 0.06 and the final static coefficient of friction shall not exceed 0.04.
- The bearing shall be of overall dimension such that it will fit into the space allowed for the installation thereof. Major alterations to the contiguous member will not be considered.

(e) Manufacture

- i. The bearings specified on the drawings shall be manufactured in accordance with the requirements of AS 5100.4.

The bearing material components shall be tested to ensure compliance with the design and appropriate codes and standards and the following documentation shall be made available to the Engineer:

- ✓ Material test results (mechanical and chemical) dry film thickness and of colour dissimilar to that of the final coat of paint.
- ii. Application of a final coat of high build chlorinated rubber paint a minimum 75 micron dry film thickness and of dark grey colour.

(f) Inspection and Testing

The Engineer may require tests to be carried out to verify compliance of the bearing with the Specification and/or its performance under the design loads. Test certificates of all tests carried out shall be made available to the Engineer.

The bearings shall come factory assembled and under no circumstances shall they be taken apart and re-assembled on the site except when it is an unavoidable feature of the installation procedure, in which case the dismantling, installation and re-assembly shall be under the Engineer of qualified personnel. Rehabilitation, modification and repair work to bearings shall be carried out only in the factory or in an approved engineering works.

808.05 DOWELS AND GUIDES

Dowels and guides shall be of such material, design and construction as is detailed on the Drawings. Where dowels and guides are used in conjunction with bearings they shall not complicate or prevent the removal of bearings.

808.06 STORAGE AND HANDLING

The bearings shall at all times be stored under cover and clear of the ground, away from sunlight, heat, oils and chemicals deleterious to the bearings. The bearings shall not be stacked in a manner or on a surface that will cause distortion of the bearing.

The bearing shall be handled with care to ensure that they are not subjected to impact loads or any other condition that may be harmful.

If the bearings are contaminated or damaged in any way, they shall be cleaned of all contaminants and offered to the Engineer for inspection. Bearings that are damaged by contamination, inadequate storage or handling shall be replaced at the Contractor's expense

808.07 INSTALLATION

The concrete surface on elements required to receive bearings shall comply with the requirements of Clause 808.04(c). Plastering of the surface will under no circumstances be permitted. Before the mortar bedding is constructed the concrete surface shall be chipped back to expose the aggregate and leave a sound irregular surface. Bonding of the mortar bedding to the concrete surface shall be in accordance with the manufacturer's recommendations and the Engineer's instructions. The bedding shall be of dimensions to permit the spreading of load at an angle of 45° through the bedding. However, the thickness of the bedding shall not be less than 15 mm and 25 mm for proprietary and elastomeric bearings respectively, nor shall the maximum thickness exceed 50 mm.

Unless shown otherwise on the Drawings, the bearings shall be installed on a horizontal plane and shall be in full contact with the concrete and bedding surfaces. To accommodate soffit irregularities and camber in the case of precast members, the member shall be lowered onto a mortar skim on top of the bearing. The member shall thereafter be propped until the mortar skim has hardened into a wedge.

The bearings shall be accurately installed to the specified level, alignment and orientation all within the construction tolerance in accordance with Section 806 and the details shown on the Drawings. Where the bearing has long sliding plates, these shall be rigidly supported to prevent distortion under the weight of the wet concrete and construction loads.

Before the bearing is incorporated into the structure it shall be cleaned to remove all deleterious substances and adhering matter, and thereafter wrapped in polyethylene sheeting and adequately sealed to prevent the ingress of mortar and slush onto the bearing during the course of construction.

After installation, the polyethylene wrapping shall be removed, the bearing thoroughly cleaned and lugs removed as directed by the Engineer.

On completion of installation of bearings the Contractor shall obtain the Engineer's approval before proceeding with the next stage of the work.

SECTION 809 – BRIDGE PARAPETS, HANDRAILINGS AND FOOTPATHS

809.01 SCOPE

The section covers the construction of bridge parapets, handrailings and footpaths on bridge decks and abutments including end name posts, copings, kerbing and other items which form part of the bridge parapets, handrailings or footpaths.

809.02 MATERIALS

(a) Concrete

All concrete work shall be carried out in accordance with the requirements of Sections 802, 803, 804 and 807 of this Specification.

(b) Structural Steel

Structural steel work shall be supplied and fabricated in accordance with the provision of Section 810 of these Specifications and to the details shown on the drawings.

(c) Structural Aluminium

Aluminium castings shall be manufactured to AS 1874. Hollow aluminium sections shall be manufactured to AS 1866.

809.03 CONCRETE PARAPETS

Concrete parapets shall be either solid concrete parapets. Where possible precast elements shall be placed with the unformed surface downwards or outwards.

809.04 METAL HANDRAILINGS

Metal bridge handrailings shall be of steel or aluminium as shown on the Drawings.

Unless otherwise indicated, all joints in fabricated metalwork shall be welded using appropriate techniques to develop the full strength of the component parts. All fabricated metalwork shall be neatly finished off without sharp edges and with sharp corners rounded off. Metalwork shall be completed with all necessary connections, fastenings and anchor bolts.

Steelwork which is to be cast or grouted into concrete shall be unpainted and shall be cleaned of loose rust, scale, oil or other material which may impair the bond between concrete and steel. All steelwork shall comply in accordance with the requirements of AS 5100.4. Where the coating is damaged by site welding during erection it shall be made good using a repair stick. After thorough wire brushing the area to be made good is to be heated with an oxyacetylene torch and the stick rubbed over the area.

Surfaces which will be inaccessible after erection shall be painted before erection commences. Aluminium work which is to be cast or grouted into or be in contact with concrete shall be painted with two coats of approved bituminous aluminium paint or thorough coated with aluminium impregnated compound on the contact surfaces before installation. Where aluminium work is to be fixed to steelwork, the aluminium and steel shall be completely isolated from one another with plastic or other approved washers, gaskets and sleeves. Exposed aluminium work shall be left unpainted.

809.05 BRIDGE NUMBER PLATES

Bridge number plates shall be fixed in the positions and according to the method of fixings shown on the Drawings. The concrete surface on which the plate is to be fixed shall be suitably prepared prior to the application of any adhesive by roughening and removing all surface laitance.

809.06 CONCRETE FOOTPATHS

Prior to construction of footpaths, including kerbs and copings the bridge deck shall be accurately surveyed to establish final lines and levels. The previously cast bridge deck area shall be prepared as specified in Clause 804.8 to receive footpath concrete.

Forms shall be accurately set to final lines and levels and shall be firmly held in position during the placing of the concrete. Stops at the ends of sections shall be accurately placed to ensure that joints between adjacent sections are truly perpendicular to the surface of the concrete and at right angles to the edge of the road or to the skew angle of the deck at the expansion joint.

After removal of the forms the exposed surfaces of the kerbs and copings shall be rubbed in accordance with the requirements of Clause 802.08. All edges shall be rounded to a radius of 20 mm unless otherwise shown on the Drawings.

809.07 CONCRETE SURFACE FINISH REQUIREMENTS

All formed concrete surfaces shall have a Class F3 surface finish as specified in Clause 802.06 and all unformed concrete surfaces shall have a Class U3 surface finish in accordance with Clause 802.08.

809.08 CONSTRUCTION TOLERANCES

The alignment levels and dimensions of the various items described in this section shall conform to the requirements given in Section 810.

SECTION 810 – STRUCTURAL STEELWORK

810.01 SCOPE

This section covers the use of structural steelwork in the Works.

810.02 FABRICATION OF STEELWORK – GENERAL

The fabrication of steel structures or steel members from structural steel plates, sections and hollow sections shall be carried out in compliance with Clauses 810.05 to 810.20 as appropriate to the design. This Section is limited to the use of steel parent material with a specified minimum yield strength not exceeding 500 MPa, and applies to all work on the steel after manufacture to final size at the originating steel mill.

810.03 MATERIAL AND WELDING STANDARDS

Structural steel and welding shall comply with the requirements of the following standards and referenced documents except if specified elsewhere in the documents;

AS 3678 Hot Rolled Structural Steel Plates, Floorplates and Slabs

AS 3679 Hot Rolled Structural Steel Bars and Sections

AS 1163 Structural Steel Hollow Sections

AS 1554 Structural Steel Welding Code

Part 1 - Welding of Steel Structures

Part 2 - Arc Stud Welding

Part 5 - Welding of Steel Structures Subject to High Levels of Fatigue Loading.

810.04 SHOP DRAWINGS

The Contractor shall submit two copies of the shop drawings to the Engineer before fabrication commences.

Joints or groups of joints in which it is especially important that the welding sequence and technique of welding be carefully controlled to minimise shrinkage stresses and distortion shall be noted on the drawings. Joints where no welding is permitted shall also be clearly indicated. Weld lengths specified on the drawings shall be the required effective lengths.

810.05 MATERIAL COMPLIANCE

All materials shall comply with the standards and specifications shown on the drawings. All structural steel, associated components and welding consumables shall be manufactured by companies that hold quality systems certification to AS/NZS ISO 9001.

The Contractor shall submit to the Engineer a Certificate of Compliance and related test certificates. The test certificates shall be certified by a testing authority whose qualifications and registration are acceptable to the Engineer and shall be related to the steel by trademarks and heat number which shall be legibly marked on each piece.

Steelworks shall be deemed to be non-conforming where defects or imperfections due to the manufacture of the steel become evident at any stage of fabrication. Any defects or imperfections in the steel shall be assessed against the Freedom from Defects clause in AS 1163, AS/NZS 1594, AS/NZS 3678 or AS/NZS 3679.

The Contractor shall submit details of any proposal to use weld repaired steel, including the proposed location in the structure and post-weld inspection requirements. Weld repaired steel shall include lengths of plates or sections containing welds to make up member lengths with welds not otherwise shown on the drawings. All grinding of surface imperfections and weld repairs shall produce a surface roughness similar to and blend in with the surface finish of surrounding areas. Grinding marks shall be parallel to the direction of Employer stress and shall be produced using a grinding disc of grain size number 40 or finer.

810.06 HANDLING AND STORAGE OF MATERIALS

All steel whether fabricated or not, shall be stored above the ground and adequately protected against corrosion. Excessively rusted, bent or damaged steel shall be rejected.

Girders and beams shall be placed upright and stored. Long members shall be adequately supported at points sufficiently close together to prevent damage from deflection.

The method of handling, transporting and erection of the steelwork shall be such that the members are not stressed or deformed beyond the design limit and that there is no damage to the protective coating during these operations.

Steelwork shall not be loaded for transport until the paint system is sufficiently hard for handling. Suitable packings shall be placed between layers of stacked steelwork. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.

Components weighing less than one tonne shall be kept in a storage area away from their erection point in order to minimise damage to protective coatings. If in the opinion of the Engineer, damage to coatings is excessive, or may be difficult to deal with satisfactorily after erection, the Contractor shall restore the coatings before erection.

Any damage to steelwork or protective coating shall be repaired to the Supervisor's satisfaction or the member replaced. All costs of this work shall be borne by the Contractor.

When requested by the Supervisor the Contractor shall submit for review detailed drawings and structural computations certified by an engineer experienced in structural design, not less than 14 days prior to handling, transporting or fabrication of steelwork.

810.07 STRAIGHTENING MATERIAL AND COMPONENTS

The Contractor shall submit details of his proposed method of straightening materials and not conforming with the material and fabrication tolerances for review by the Engineer.

The methods used to straighten materials shall not reduce the properties of those materials below the minimum property values as specified in the relevant Australian Standards.

Sharp kinks and bends shall be cause for rejection.

Where hot bedding is permitted or directed by the Engineer the material shall be bent by approved methods. The temperature of the steel shall not exceed 600°C and, after bending, allowed to cool by water or other fluids shall not be used until the temperature of the steel is below 200°C.

Steelwork which is bent subsequent to delivery shall be repaired or replaced, as directed by the Engineer, at the Contractor's expense.

810.08 CUTTING

Cutting of steel shall be carried out by methods that will not be detrimental to the finished product. Cutting shall be by sawing, shearing, plasma cutting, or flame cutting using machines which are mechanically guided and move at uniform speed, unless otherwise specified below. The Contractor shall perform cutting of members in accordance with work instructions for cutting. Hand-held or hand-guided cutting shall not be permitted.

Shearing or cropping shall not be used for main plates, reinforcing plates, main gussets, splice plates, rolled sections and shapes or any steel thicker than 16 mm. Distortions caused by shearing shall be removed.

Plasma or flame cutting procedures for tension members shall not produce heat affected zone hardness exceeding 350 HV (Vickers Hardness Number) along the cut edges, as evidenced by the Vickers hardness testing of a cutting procedure test specimen.

Unless otherwise shown on the drawings, all plates shall be finished square, straight and in plane without burrs or imperfections.

Any cut surface not incorporated in a weld shall have a surface roughness not greater than the

appropriate value given in Table 810.081. A cut surface to be incorporated in a weld shall comply with AS/NZS 1554 Part 1.

Table 810.081 Maximum Cut Surface Roughness

Application	Maximum Roughness, CLA (μm)
Normal applications, i.e. where the face and edges remain as-cut or with minor dressing	25 (Roughness Class 3 specified in WTIA Technical Note 5)
Fatigue application (detail categories as specified in AS 5100.6)	
AS 5100.6 Detail Category \geq 80 MPa	12 (Roughness Class 2 specified in WTIA Technical Note 5)
AS 5100.6 Detail Category $<$ 80 MPa	25 (Roughness Class 3 specified in WTIA Technical Note 5)

- Notes:**
- 1 Guidance on flame cutting of steels can be obtained in WTIA Technical Note 5.
 - 2 Roughness values may be estimated by comparison with surface replicas, such as the WTIA Flame Cut Surface Replicas.
 - 3 CLA = Centre Line Average Method
 - 4 Flame cut surfaces may require some surface grinding to make the surfaces suitable for the application of protective coating treatments.

Cut surfaces with roughness exceeding the values in Table 801.081 shall be repaired by grinding to give a value less than the specified roughness. Grinding marks shall be parallel to the direction of the cut.

Any cut steel surface having notches, gouges or other imperfections with a depth of 2 mm or greater shall be repaired by welding in accordance with AS/NZS 1554 Part 1. Notches, gouges or other imperfections with a depth of less than 2 mm shall be removed by machining or grinding, and the depression shall be tapered out smoothly for a distance of at least 75 mm on both sides of the defect.

Notches, gouges or other imperfections with a depth of less than 1mm on an otherwise satisfactory surface are acceptable provided that they are not closer than 20 times the thickness of the component. The finished product shall be within the specified tolerances.

Where steelwork is to be given protective coating, all edges shall be ground or machined to a smooth even surface finish with a minimum radius of 2 mm. Rolled edges need not be ground provided that the corners are rounded and that the edges are square and straight.

All re-entrant corners shall have a radius of not less than 20 mm and shall be shaped to be smooth and without notches.

810.09 SHEAR CONNECTORS

Materials

The welding of stud shear connectors shall be to AS/NZS 1554 Part 2 "Arc Stud Welding".

Procedure Test

The process and operator shall be qualified by a procedure test. This test consists of welding six studs of the size and type to be used, onto a test plate of similar thickness and width to the actual flange to which the studs will be welded.

The reinforcement formed within the ceramic ferrule shall be formed over 100% of the circumference.

Two studs shall be hammered at least 30° from the original position without failure.

A further two test studs welded to the test plate shall withstand a load representing a minimum tensile stress of 415 megapascals.

The remaining two test studs shall be tested to AS 2205.5.1 - "Macro Test". The two studs shall indicate complete fusion to the parent steel. All tests studs shall pass the above tests, and if any one stud fails, the procedure tests will be considered a failure.

Fabrication

After welding, 5% of the studs on each girder shall be tested by hammering through 30°.

If any stud fails all studs on the girder shall be tested.

810.10 CAMBERING

Cambering of members and measurement of camber shall be performed in accordance with a work instruction, prepared and issued by the Contractor in accordance with the quality system

In the measurement of camber, where the member spans between supports, allowance shall be

made for this deflection due to self-weight. This allowance shall be calculated by an experienced structural engineer, as approved by FRA.

810.11 HOLES FOR BOLTING GIRDERS

(a) General

Holes may be either drilled full size or reamed to full size after sub-drilling. Holes may be drilled from the solid metal instead of being sub-drilled and reamed, provided such drilling is done with the material assembled in the same manner as is required for reamed work. Sub-drilled holes shall be smaller in diameter than the nominal diameter of bolts by no less than the following amounts:

bolts greater than 20 mm diameter	3 mm
bolts 20 mm and smaller	2 mm

(b) Sub-drilled Holes

All holes shall be located with an accuracy such that after the steel is assembled and before any reaming is done, a cylindrical pin 3 mm smaller in diameter than the nominal diameter of hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the contiguous holes in the same plane. If this requirement is not fulfilled; the pieces shall be rejected. If any hole will not pass a pin 5 mm smaller in diameter than the nominal size of the punched hole, this shall be cause for rejection. Drifting to enlarge holes shall not be allowed.

(c) Reamed or Drilled Holes

Reamed or drilled holes shall be cylindrical and perpendicular to the face of the member.

All reamed or drilled holes shall be located with an accuracy such that after the holes have been reamed or drilled, 85% of the holes in any contiguous group shall show no offset greater than 1 mm between adjacent thickness of metal.

The assembly, including camber, alignment, and accuracy of sub-drilled holes shall be reviewed by the Engineer before reaming or drilling is commenced. All joints shall be matchmarked before the structure is dismantled. Holes for field connections of minor members may be sub-punched or sub-drilled and reamed or drilled from the solid to a hardened steel template not less than 25 mm thick, and all corresponding holes in the members to which they connect shall be reamed or drilled to the same template. Alternatively, these connections may be reamed or drilled with the members assembled.

810.12 HOLES FOR BOLTING - OTHER WORK

All holes shall be drilled by mechanical means, and shall be cylindrical and perpendicular to the face of the member. Burrs on the outside surfaces shall be removed. Each member shall be assembled full length before drilling is commenced.

The assembly, including camber, alignment, and location of holes shall be reviewed by the Engineer before drilling is commenced. All joints shall be matchmarked before the structure is dismantled.

810.13 WELDING PROCEDURE QUALIFICATION

Welding procedures for all specified welds shall be qualified by testing and reviewed by the Engineer before welding commences. The qualification method shall be in accordance with Clause 4.2(e) of AS 1554 Part 1 or Part 5. In addition to these requirements the following shall apply:

- (a) Submission to the Engineer of the written statement of the welding procedure.
- (b) The production of a welded test plate witnessed by the Engineer. Seven (7) days' notice is required by the Engineer prior to the production of the test plate.
- (c) Testing of the test plate for the requirements specified in this specification.
- (d) Submission to the Engineer of test certificates demonstrating compliance with the requirements of this specification. All test certificate reporting the weld macro test (Clause 4.6.5 of AS 1554/NZS) shall include a photograph of the etched surface at a magnification of one or greater.
- (e) A welding procedure qualification test shall also qualify the welding operator for that particular procedure. The above qualification method shall apply for welding operator qualification testing when additional operators are required for the same welding procedure, except that testing shall be by macro test only, and shall comply with Clause 4.6.5 of AS/NZS 1554 - Part 1 or Part 5, as specified.
- (f) For all welding procedures for flange butt welds, the following tests shall be performed in addition to the macro test (Clause 4.6.5 of AS/NZS 1554) and shall form part of the flange butt weld procedure qualification.

Table 810.131

Test	AS/NZS 1554
(i) one weld joint tensile test	Clause 4.6.6
(ii) 2 side bend or 1 face and 1 root bend	Clause 4.6.7
(iii) 3 Charpy impact tests	Clause 4.6.8 and Note below

(iv) one hardness comparison test	Clause 4.6.9
(v) one hardness test - heat affected zone	Clause 4.6.10

Charpy Impact Tests

For weld metal deposited in the flange butt weld procedure test, the requirements for the Charpy impact test shall be:

Average Energy	Minimum for One Test	Temperature of Test
(i) For welds between or including non-impact certified grades of steel		
35 Joule minimum	23 Joule	0°C
(ii) For welds between L15 steels		
40 Joule minimum	26 Joule	-15°C

For all welding procedures for web to flange fillet or T butt joints, a weld macro test shall be performed (Clause 4.6.5 of AS/NZS 1554). For T butt welds at web to flange connections, a weld joint tensile test to Clause 4.6.6 of AS/NZS 1554 shall be performed using, if necessary, a loading bracket attached to the flange.

810.14 WELD PROCEDURES TO BE QUALIFIED

The following welding procedures shall be qualified by the method described above.

1. Flame cutting
24 mm flange plate
2. Tack welding
14 mm to 24 mm flange plate
9 mm web to 24 mm fillet splice
3. Butt Welding
9 mm web butt weld
24 mm to 34 mm flange butt weld
4. Web-to-flange fillet splice 9 mm fillet

9 mm web to 34 mm flange

2 test plates required:

Plate A 300 mm minimum run length

Plate B 2000 mm minimum run length on full section of girder.

5. Fillet weld 6 mm

12 mm gusset to 9 mm webs

6. Stud Weld

19 mm diameter stud on 34 mm flange

7. Flame cutting (written procedures only)

9 mm web plate

24 mm flange

8. Tack Welding (written procedures only)

14 mm to 24 mm flange plate

9 mm to 24 mm web/flange plate

810.15 WELDING

All welding consumables shall be stored, handled and used in accordance with Clause 2.3 of AS/NZS 1554.

Electrodes shall be used in accordance with the recommendation of the manufacturer.

Welding shall be carried out in strict accordance with the relevant sections of AS/NZS 1554, Part 1 or Part 5, as specified, and in accordance with the following additional requirements.

- (i) Low hydrogen electrodes shall be used for all manual metal arc butt welds.
- (ii) Minimum length of tack weld shall be 50 mm for a 5 mm fillet weld or 80 mm for a 4 mm fillet weld.
- (iii) Suitable run-on and run-off tabs should be used for all butt welds and web to flange fillet welds. Each weld pass should be terminated on the run-on/run-off tabs at least 20 mm beyond the edge of the parts to be joined.
- (iv) Root runs of butt welds shall be back-gouged sufficient to ensure full penetration.
- (v) The maximum size of electrode for down hand position welding, excepting root runs of

multiple pass welds, shall be 6 mm unless the work is in the first (natural-vee) position where 8 mm electrodes may be used. For welds made in all other positions and the root runs of multiple pass welds, the maximum size shall be 5 mm.

- (vi) The maximum size of fillet weld which may be made in one pass shall be 8 mm, except that 10 mm fillet welds may be made in the flat (natural-vee) position.
- (vii) A single layer of weld metal, whether deposited in one pass or made up of several parallel beads, shall not exceed 3 mm in thickness except that the bead at the root may be 6 mm in thickness if the position of welding and viscosity of the weld metal is such that it does not overflow onto unfused parent metal. When welding in the vertical position the direction of welding for all passes shall be upward.
- (viii) Exposed faces of weld shall be made reasonably smooth and regular, shall conform as closely as practicable to specified dimensions and shall not at any place be less than the specified dimensions.
- (ix) Butt weld run-on and run-off tabs shall be removed after the joint has cooled and the ends of the weld shall be finished smooth and flush with the faces of the abutting parts. Butt welds shall be finished smooth and flush with abutting surfaces where required for assembly, where specified in the drawings, where the welds are to be non-destructively inspected and on the exterior faces of exterior girders.
- (x) All weld spatter shall be removed from the surfaces of the weld and the parent metal.

810.16 SAFETY PRECAUTIONS

Welding shall be carried out in accordance with the safety requirements of AS/NZS 1554 Part 1.

Precautions shall be taken to protect all persons working or present near welding operations, including visitors and the public. Precautions include the control of exposure to arc radiation, hot metal and welding fumes as well as the prevention of electric shock and fire.

Suitable opaque welding screens shall be provided to protect other people in the vicinity of welding, against stray radiation from arc welding. Where non-destructive tests employing industrial x-ray plant or radioactive isotopes are used, special precautions shall be observed to ensure that the personnel in the vicinity shall not be subjected to direct or scattered radiation. The relevant regulations governing the use of x-ray plant and equipment shall be complied with.

810.17 EXTENT OF NON-DESTRUCTIVE INSPECTION OF WELDS

The extent of non-destructive inspection using other means (radiography or ultrasonics to Table 6.2

of AS 1554)

The reinforcement of flange butt welds that are to be ultrasonically examined shall be ground smooth and flush.

The Contractor shall submit test certificates for all non-destructive inspections to the Engineer.

810.18 DELIVERY

Each member shall be marked for identification and an erection diagram shall be furnished with the erection marks shown thereon. All field splices in members shall be protected from damage in transit. All loose angles or gusset plates shall be packed in convenient bundles and temporarily bolted or bound together with heavy gauge wire. All small articles, such as bolts, shall be packed in secure containers adequately labelled, with the details and quantity of the contents clearly stated.

The Contractor shall furnish to the Engineer two copies of material lists, dispatch notes and erection diagrams. The mass of the individual members shall be shown on the despatch notes. Members of mass greater than 2 t shall have the mass marked thereon.

The Contractor shall submit sketches showing details of his proposed method of loading, transporting and unloading the structural members such that they are not excessively stressed, deformed or otherwise damaged during these operations. All packing and bracing required for satisfactory transport shall be provided by the Contractor.

810.19 DIMENSIONAL TOLERANCES

The dimension of structural members shall be within the tolerances specified on the drawings. Where tolerances are not so specified they shall be as follows:

Overall Length

Up to and including 20 m	± 6 mm
Additional allowance to be made to the above	
for each additional 10 m or part thereof	± 2 mm
e.g. 55 m total tolerance equals	± 14 mm

The tolerance on the gap between connecting girders specified in Item (m) below will override the above tolerances for connecting girders.

Centre to Centre of any Pair of Bearings

Up to 15 m	± 3 mm
Greater than 15 m and up to 60 m	± 6 mm

Greater than 60 m ± 12 mm

Deviation from Specified Camber

At midspan up to 50 m ± 6 mm

At cantilever ends ± 2 mm

Sweep

6 mm or 1 mm per 2 m of member, whichever is the greater, measured between the ends of the member. Sweep shall be even throughout the length of the member.

Maximum Allowable Deviation between Centreline of Web and Centreline of Flange of Built Up girders at Contact Surface

Within 600 mm of the end of the girder 2 mm

At splice points 1 mm

At all other points 3 mm

Deviation from Flatness of Girder Webs

In any length of 150 mm 2 mm

In length between stiffeners or in a length equal to the depth of the girder:

At splice points 2 mm

Exterior girders 5 mm

Interior girders 5 mm

Combined warpage and tilt of flange of welded girders shall be determined by measuring the offset at the toe of the flange from a line normal to the plane of the web through the intersection of the centre line of the web with the outside surface of the flange plate. This offset shall not exceed 1/100 of the total width of flange or 5 mm whichever is the lesser.

Out of Flatness of Seats, Base Plates or Sole Plates

To be set on fresh grout or concrete 6 mm maximum

To be set on elastomeric bearing pads 2 mm maximum

To be set on unmachined steel or lead 0.25 mm maximum

To be set on machined steel surfaces As shown on the drawings

The Maximum Deviation from Specified Depths for Welded Beams and Girders Measured at the Web Centre Line shall be:

For depths up to 1 m	± 3 mm
For depths over 1 m	± 5 mm
At splices	± 2 mm

Widths of Flange Plates

At splice joints	+1 mm
At all other points	+2 mm

Twist

The angular rotation of any cross-section relative to an end cross-section shall not exceed 1 mm per 100 mm depth of girder. Deviation from flatness of girder flanges in lengths between stiffeners or in a length equal to the depth of the girder shall not exceed 2 mm for exterior girders or 3 mm for interior girders.

Deviation from specified splice joint dimensions shall be:

Gap between connecting girders	+6 or -2 mm
Bolt hold edge distance	+2 mm
Splice plate dimensions	+2 mm

810.20 TRACEABILITY OF STEEL AND STEEL MEMBERS

All steel to be incorporated into the works shall be marked or tagged (for bundles):

- (i) to identify the manufacturer;
- (ii) to enable it to be traced to the heat number from which it was made;
- (iii) to indicate the grade of steel by using the designation system as described in AS/NZS 1163, AS/NZS 3678, AS/NZS 3679 and AS 1163;
- (iv) to enable it to be identified with the appropriate standard.

All steel and steel members shall be traced from the point of purchase to its final location by a unique identification number.

810.21 ERECTION OF STEELWORK – GENERAL

This section deals with the erection of structural steelwork for the Permanent Works. The erection of steelwork shall be in compliance with Clauses 810.23 - 810.35 as appropriate to the design.

810.22 METHODS AND EQUIPMENT

The Contractor shall provide all falsework, erection equipment, tools, machinery and appliances, including pilot and driving nuts, drift pins and fitting up bolts, necessary for the work. These items will be considered as equipment and will remain the property of the Contractor. Before commencing work the Contractor shall submit to the Engineer for approval, details of the proposed method of erection, including falsework, together with the type and size of the erection equipment to be used. The falsework shall be properly designed and substantially constructed for the loads which will come upon it and shall be adequately maintained while in use. Details of the proposed method of erection shall include calculations by a qualified structural engineer who is eligible for Corporate Membership of Engineers Australia to demonstrate that the proposed method does not lead to overstressing or instability of the girders during erection. The calculations shall establish the temporary bracing required during erection and prior to connection to the permanent cross frames and shall be accompanied by detailed drawings showing the type and location of bracing, the location of lifting points, and the necessary attachments to facilitate erection of the girders. The approval of the Engineer shall not relieve the Contractor from the responsibility for the adequacy and safety of his methods and equipment, nor from his responsibility for carrying out the work in strict accordance with the drawings and specifications.

The written approval of the Engineer shall be obtained before erection commences.

810.23 ERECTION PROCEDURE

The structure shall be erected plumb and true to line and level. As erection progresses adequate temporary supports shall be provided, where necessary, to ensure that the structure is not overstressed during erection. Wherever necessary adequate temporary bracing shall be fixed to the steelwork to ensure that the parts that have been erected are stable and will not be overstressed. Such temporary bracing shall be left in position until sufficient permanent bracing has been installed.

Temporary supports and bracing shall be to the approval of the Engineer.

No permanent connections shall be made between the various parts of the structure until the alignment of all parts which will be affected has been checked and approved by the Engineer.

810.24 ASSEMBLY

The parts shall be accurately assembled as shown on the drawings and in accordance with identification marks on the members. The material shall be carefully handled so that parts will not be bent, twisted or damaged in any way.

Hammering which will mark or distort the members will not be permitted. Bearing surfaces to be in

permanent contact shall be cleaned to the approval of the Engineer, and treated as specified before the members are assembled.

810.25 MISFITS

The correction of misfits involving minor amounts of reaming, cutting and grinding will be considered part of the erection and no additional payment will be made on this account.

Any error in the shop fabrication or deformation resulting from handling and transportation, which prevents the proper assembly and fitting up of the parts by the moderate use of drift pins, reaming, cutting and grinding, shall be reported to the Engineer. The method of correction shall be subject to the approval of the Engineer. These corrections shall be made in the presence of Engineer's Representative.

810.26 FIELD CUTTING

Field cutting of beams, girders or main members shall only be done with the written permission of the Engineer and in the presence of the Engineer's Representative. Minor defects on the other members may be corrected by field cutting.

All field cutting shall be done in a neat and workmanlike manner, and where required by the Engineer's Representative, the cut surface shall have striations and burrs removed by grinding. Cutting torches will not be permitted on the structures except when used in accordance with the above requirements.

810.27 BOLTED CONNECTIONS

Bolted connections shall be used only where specified. Temporary bolted connections shall only be used where approved by the Engineer. The type of bolt to be used shall be as specified or approved by the Engineer.

Bolted parts shall have effective contact without the interposition of gaskets or other flexible materials. Where bearing faces of bolted parts are not parallel, tapered washers shall be used to compensate for the lack of parallelism. The angle between the axis of the bolt and the surface under the bolt head or nut shall be $90^{\circ} \pm 3^{\circ}$. Tapered washers shall be placed under the non-rotating component where possible.

The parts of a member shall be assembled, pinned, and firmly drawn together with temporary bolts and erection pins before reaming or permanent bolting is commenced. At least 25% of the holes shall be filled with temporary bolts and 25% with cylindrical erection pins. Temporary bolts and erection pins shall be of nominal diameter 2 mm less than the diameter of the holes. Steel packing shall be provided where necessary to ensure that the surfaces are in effective contact. All packing

shall have a surface condition similar to that of the adjacent material and shall be subject to the approval of the Engineer.

Drifting during assembly shall not enlarge the holes or distort the metal. Holes which do not match shall be reamed or drilled, and if required by the Engineer, bolts of a larger diameter shall be used.

The holes in the parts to be joined shall be sufficiently aligned to permit bolts to be positioned without damage.

Bolts and nuts shall always be tightened in accordance with a prescribed sequence. Where the sequence is not shown on the drawings a staggered pattern shall be adopted with tightening proceeding from the centre of the joint outwards.

810.28 COMMERCIAL BOLTS

Commercial bolts shall be in accordance with AS 1111. The diameter of holes for commercial bolts shall not exceed the nominal diameter of the bolt by more than 2 mm. Bolts shall be assembled with washers under the heads and nuts.

Bolts shall be of such a length that they will extend entirely through the nuts, but not more than 12 mm beyond them. The shank shall be threaded to such a length that not less than one thread shall be within the grip of the bolt after tightening. Bolt heads and nuts shall be tightened with a suitable wrench and the nuts shall be effectively locked where specified.

810.29 TURNED BOLTS

Turned bolts shall be manufactured from the material specified on the drawings or specified by the Engineer. Turned bolts shall be machined parallel throughout the unthreaded portion of the shank, and finished with a finishing cut. The finished diameter shall be the diameter specified on the drawings. The bearing faces of heads and nuts shall be machined square to the shank.

Holes for turned bolts shall be reamed to size with the parts assembled in their respective positions. If considered necessary by the Engineer the parts shall be disassembled and the burrs removed. The following limits of tolerance will be permitted on the diameter of the unthreaded portion of the shank, and the holes into which they fit:

bolts from +0.000 to -0.120 mm

holes from +0.120 to -0.000 mm

The threaded portion of the shank shall be entirely outside the grip of the bolt and a washer shall be provided to prevent the nut binding on the start of the thread. Bolts shall be of such a length that they will extend through the nuts but by no more than 6 mm. Bolts shall be driven accurately into the holes without damaging the threads or the head. Bolts shall be assembled with washers under the

heads and nuts, and shall be drawn tightly against the work with a suitable wrench not less than 400 mm long. Bolt heads shall be tapered with a hammer while the nuts are being tightened and the nuts shall be effectively locked after final tightening.

810.30 HIGH STRENGTH BOLTS

High strength bolts, nuts and washers shall be as specified in the drawings. Nuts shall be of the double faced or washer faced hexagon type. Washer faced nuts shall be used with the washer face as the bearing face. The diameter of holes for high strength bolts shall not exceed the nominal diameter of the bolt by more than 2 mm. Each bolt and nut shall be assembled with at least one washer. The washer shall be placed under the bolt head or nut, whichever is to be rotated during the tightening operation. Tapered washers shall be fitted where the angle of the seating at the bolt or nut exceeds 3° from the normal to the axis of the bolt.

All bolts shall be tightened by the “part-turn” method to produce, on completion of the joint, not less than the minimum bolt tension appropriate to the particular bolt diameter as specified below. Tightening of bolts and nuts by the part-turn shall be in accordance with the following procedure:

- (i) On assembly of the joint, all bolts and nuts shall be first brought to a “snug tight” condition to ensure that the parts of the joint are brought into effective contact with each other. “Snug tight” is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using a standard podger spanner. Large joints shall have two runs over the bolts to check the “snug tight” position.
- (ii) After completion of this preliminary tightening to “snug tight” of all nuts in the joint, suitable location marks shall be established in such a way that the relative position of bolt and nut may be observed. Marked wrench sockets may be used, but location marks on the nut and bolt will be required for subsequent inspection. Permanent marks shall be provided on the bolt and nut if required by the Engineer’s Representative.
- (iii) Bolts shall be fully tightened in accordance with the Table 810.301:

Table 810.301 High strength bolts

Diameter of Bolt (millimetres)	Minimum Bolt Tension (kilonewtons)	Nut Rotation Required *	
		½ Turn for Bolt Grips not exceeding (millimetres)	¾ Turn for Bolt Grips between (millimetres)
16	95	120	120 and 240

20	145	120	120 and 240
24	210	160	150 and 350
30	335	160	160 and 350
*Nut rotation shall be measured relative to the bolt from the snug tight condition and the tolerance on rotation shall be one sixth of a turn over and nothing under.			

During this tightening there shall be no rotation of the part not turned by the wrench. The Engineer's Representative shall approve of the tightening of all bolts to the "snug tight" position and the satisfactory marking of the nuts and bolts before final tightening. The same tightening pattern shall be used for both "snug tight" and final tightening, i.e. proceed from the most rigid part of the joint towards the free edges. The slackening off and retightening of fully-tightened bolts will not be permitted. Bolts shall not be re-used.

After final tightening of each joint or group of bolts the Engineer's Representative will inspect the joint and no further loads shall be applied to the joint until it has been approved. The Engineer's Representative may use a standard torque wrench in accordance with the provisions of AS 1511.

810.31 REMOVAL OF FALSEWORK

Upon completion of the erection work and before final acceptance, the Contractor shall remove all falsework and construction equipment. Excavated materials placed above the final ground levels shall be removed. Bed logs, temporary piles and trestles, temporary concrete bases, etc., used in the construction operation shall be removed, pulled out or cut off at least 300 mm below ground level or stream bed level.

Equipment for pulling piles will not be allowed to operate from the new structure. Equipment for removing falsework shall not be operated upon or attached to any portion of the new structure except with the written approval of the Engineer. All the above work shall be done to the satisfaction of the Engineer.

810.32 DEFECTIVE WORKMANSHIP

The Contractor shall be fully responsible for the erection of the steelwork in accordance with the drawings and this specification. Approval of any completed work or methods by the Engineer shall not relieve the Contractor of this responsibility. Work which has not been completed in accordance with this specification or which in the opinion of the Engineer, is defective, shall be completed or

corrected within the limits assigned by the Engineer at no additional cost to the Fiji Roads Authority.

810.33 PROTECTION OF STEELWORK AGAINST CORROSION – GENERAL

Surface preparation and protection against corrosion of steelwork shall be carried out in compliance with Clauses 810.5 to 810.21 and Table 810.331 as appropriate to the design and method of fabrication of the components.

Table 810.331 Details of corrosion protection requirements

System Ref.	Location	Min. total dft (microns)	Preparation*	Primer	Undercoat	Finishing Coat
A	Exterior main surfaces	325	Blast clean to clean steel, Class 2.5 blast finish	Inorganic Zinc Silicate (75 microns) to AS 2105	High Build, High solids epoxy MIO (175 microns)	High Build, High solids epoxy MIO (75 microns) site applied
B	Contact surfaces at HSFG joints	25	Blast clean to clean steel, Class 2.5 blast finish	Epoxy blast primer (25 microns)	N/A	N/A
C	Handrails, expansion joints, scuppers and Lighting poles	85 plus 175 (site)	Pickling	Galvanised and then coated on site with MIO High Build Epoxy Mastic (175 microns)		
D	Pile Splash Zone	500	Blast clean to clean steel. Class 2.5 blast finish	High Build, High Solids catalysed epoxy or 2 coats of approved bituminous paint		

* Class blast finish to Australian Standard AS 1627, Part 4.

810.34 SURFACE PREPARATION

Steel components shall be free of surface defects including deep pitting, weld defects, weld spatter, slag, burrs, and fins. Sharp edges shall be ground to a minimum radius of 2 mm to meet the requirements of Preparation Grade P2 as defined in ISO 8501.3. The steelwork to be coated shall be inspected for compliance with all relevant Section 810 before protective coating works commences.

Surfaces being prepared and coated shall be protected from the weather.

All surfaces to be coated shall be free of all oil and grease. Where appropriate, contaminated surfaces shall be cleaned by solvent washing in accordance with AS 1627.1 prior to commencement of surface preparation by abrasive blast cleaning. All solvents or degreasing agents shall be approved by the coating manufacturer. Anionic detergents shall not be used.

Steelwork shall be sand or grit blasted to achieve the Class of finish specified in Table 810.331 and in accordance with AS 1627, Part 4. The maximum profile height shall be 0.08 mm.

810.35 PROCEDURES FOR TREATMENT OF LOCAL FAILURE IN PROTECTIVE COATING

In the shop, failed paint coating shall be restored. Abrading down to sound paint only, is permissible.

On site, failed paint coatings shall be restored except that:

- (i) abrading down to sound paint or to bright steel, or
- (ii) blast cleaning to a Class 2.5 finish
- (iii) are permissible methods of surface preparation when restoring paint systems over a steel substrate.

In all cases of local failure, the extent of the failure and the required surface preparation, including extent of initial wet or dry cleaning down, shall be agreed with the Engineer.

Restoration of protective coatings shall not be started until the standard of surface preparation, including the cleanliness of the surface, has been passed as satisfactory by the Engineer's Representative.

810.36 PAINT AND SIMILAR PROTECTIVE COATINGS

Definitions of painting terms contained in AS/NZS 2310 shall apply where these terms are used in the Specification.

Coating film thickness is specified in microns, in accordance with industry practice, where one micron is equal to one micrometre.

All materials (including thinners) for the coating system shall be supplied by the same paint manufacturer.

Conditions of application and curing shall comply with the requirements of this specification and the paint manufacturer's written recommendations.

Unless otherwise specified, coating materials shall have approval to the Australian Paint Approval Scheme Specifications (APAS) specification listed in the applicable Coating System Specification.

Zinc primer, where used on the works, shall have a minimum zinc dust pigment content of 80% by mass.

All coating materials shall be compatible with each other and the substrate surface on which they are to be applied. Where more than one coat of paint is to be applied, the colour of successive coats shall be different to aid application and inspection.

The Engineer shall nominate the colour(s) to be used for topcoats.

All paint of a particular type for a topcoat of a particular structure shall be from the same batch.

All paint shall be stored, handled and used in accordance with the paint manufacturer's recommendations, including for storage conditions, shelf life and pot life restrictions, and mixing and straining requirements.

The Contractor shall record details of all paints used, including manufacturer's name, product name and batch number of all products, and results of all testing carried out by the Contractor to assess conformity of the product.

The term paint shall be deemed to refer also to similar protective coatings including specialist coatings such as grease paints.

The Contractor shall submit to the Engineer for approval, information as to the type, colour, manufacture, trade name and service records of the coating which he is proposing to use together with the method of curing. The Engineer's approval to the painting systems will not relieve the Contractor of his obligations under this contract.

810.37 METAL COATINGS

For steel components that are detailed on the drawings to be hot-dip galvanized, this shall be carried out in accordance with AS 4680. All requirements for hot-dip galvanizing for surface preparation, application of coating, film thickness and acceptance are included in AS 4680. Galvanized

components that are subsequently required to be coated with paint shall be coated in accordance with this section.

Galvanised coatings shall, unless otherwise described in the Contract, comply with the appropriate Australian Standard and with the following;

- (i) Inhibited hydrochloric acid with a strength not exceeding 14% and within a temperature range of 15°C to 25°C or inhibited sulphuric acid with a strength not exceeding 18% and within a temperature range of 60°C to 80°C shall be used for pickling.
- (ii) Components shall not be immersed in the pickling acid longer than is necessary for cleaning the surfaces prior to galvanising.
- (iii) The surfaces of components to be galvanised shall be dried before immersion in the molten zinc.
- (iv) When an aqueous flux is to be used, all traces of acid shall be washed off immediately after pickling.
- (v) Galvanised coating shall be virtually free from imperfections, including porosity, to the satisfaction of the Engineer.
- (vi) Detrimental surface contamination of galvanised coatings which are to be painted shall be removed by wet cleaning in compliance with Clause 810.6. Surfaces to be painted shall not receive chromate passivation treatment.
- (vii) Vent holes drilled in hollow sections prior to galvanising shall be plugged to the satisfaction of the Engineer.

810.38 APPLICATION OF PAINT

Paints shall comply with the following requirements

- AS 1580.108.2 Paints and related materials – Methods of test - Dry film thickness - Paint inspection gauge
- AS 1580.408.4 Paints and related materials – Methods of test – Adhesion (crosscut)
- AS 1580.408.5 Paints and related materials – Methods of test – Adhesion - Pull-off test
- AS 1627.1 Metal finishing - Preparation and pre-treatment of surfaces – Removal of oil, grease and related contamination
- AS 1627.4 Metal finishing - Preparation and pre-treatment of surfaces – Abrasive blast cleaning of steel
- AS/NZS 2311 Guide to the painting of buildings

AS/NZS 2312	Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings
AS 2700	Colour standards for general purposes
AS/NZS 4548.5	Guide to long-life coatings for concrete and masonry Part 5: Guidelines to methods of test

Unless otherwise approved by the Engineer all paints to be applied to a particular surface as part of a paint system shall be obtained from a single manufacturer.

Where priming of materials is executed before delivery to site the Contractor shall ensure and obtain a written guarantee from the appropriate supplier that the primers used in these instances shall be obtained from the same manufacturer as that approved by the Engineer for the finishing coats.

The Contractor shall satisfy himself as to the covering capacity of paints according to the absorption of the various surfaces and shall allow in his prices accordingly.

The methods employed for the application of paints shall be sufficient to give solid cover in the number of coats specified.

Where appropriate the Contractor shall certify to the Engineer that paints supplied for use on the works are compatible with any timber preservation or fire proofing treatment which may be specified.

All paints shall be delivered to site in containers sealed and labelled by the paint manufacturer. Labels shall detail the following items:

- Manufacturer's name
- Paint colour
- Paint type
- Batch number
- Paint storage requirements
- Appropriate safety instructions

The capacity of containers for single pack paints shall not exceed five litres. Containers of epoxy paint shall be of a pack-size suitable for complete usage when thoroughly mixed by one operator within the pot life of the material at the highest likely ambient temperature. The Engineer may approve the supply and use of larger packs but only where the proportioning of the various parts, their mixing, and issue of paint, shall be under the direct control of a skilled and experienced operator. An electrically operated mixer may be used where it can be shown that it does not entrain air in the paint.

The pot-life of epoxy primers and paints when mixed shall not be less than one hour at the temperature at the place of application at the time of mixing. When approving paints the Engineer will have regard to the ambient temperatures likely to be experienced for field application and may restrict paint application to such times as the temperature is sufficiently low for the specified pot-life to be ensured. On no account are thinners to be mixed with epoxy materials. Strict control shall be exercised in the issue of thinners for cleaning brushes and equipment.

Within 4 hours after completion of the surface preparation, or within the time period specified by the manufacturer, the surface shall be completely and uniformly covered, with paint, in accordance with the requirements of Table 810.331.

The coatings shall be applied in accordance with the manufacturer's instructions and, if necessary, shall be protected from the weather until resistant to moisture. The coatings shall be applied under dry conditions and shall not be applied when atmospheric conditions are unsatisfactory or are likely to become unsatisfactory. Paint which has exceeded the pot or shelf life recommended by the manufacturer shall not be used. The coating shall be smooth, uniform and without runs, beads, pinholes, surface crazing, or other imperfections. The finished system shall have an even and uniform appearance.

The thicknesses of the dry paint shall not be less than specified in Table 810.331. If the paint coating is too thin, or shows evidence of having been applied under unfavourable conditions, or the workmanship is poor, or the specified requirements are not fulfilled, the surface shall be retreated to the extent required so as to conform to the requirements of this specification.

The paint systems shall be cured in accordance with the manufacturer's instructions. Before commencing parting the Contractor shall furnish the Engineer with details of the overall wet film thickness for each coat he proposes to apply. He shall also provide information as to the total amount of paint he expects to use for each coat of each system. The calculation of the amount of paint to be used shall be based on the volume of solids plus an allowance for waste.

The following requirements on paint film thickness shall apply:

- (i) Wet film thickness gauges shall be used where practicable to check that the wet film

$$\frac{\text{minimum dry film thickness (mdft)} \times 100}{\text{Volume solids \%}}$$

thickness is not less than:

- (ii) During the application of a paint system the Contractor shall ensure that the progressive total thickness of the applied coats will allow the specified minimum total dft of the system to be attained without exceeding, overall, the proposed wet film thicknesses referred to in this Clause by more than 20%.
- (iii) In no case shall the total dry film thickness of a paint system or the mdft of the last undercoat and finish be less than that specified in Table 810.331.

- (iv) The local dry film thickness for any primer shall not exceed the specified mdft by more than 30% and for other paints by more than 75%.

Each coat of paint of a specified system shall have satisfactory adhesion as demonstrated by the following adhesion test:

Using a straight edge and a hardened steel scribe which has been ground to a sharp 30 degrees point, two parallel lines shall be scribed at a distance apart equal to 10 times the average coating thickness. In scribing the two lines, enough pressure shall be applied on each occasion to cut through the coating to the base metal in a single stroke. If at the second cut any part of the coating between the lines breaks away from the base metal, the coating shall be deemed to have failed the test.

(a) *Shop Painting*

Unless otherwise specified, all steelwork shall be painted under workshop conditions after completion of the fabrication.

Contact surfaces between parts to be fixed together shall be painted in accordance with Table 810.331.

Surfaces of steelwork against which concrete is to be cast, shall be left unpainted except for a strip approximately 25 mm wide along the boundary of the contact surfaces.

(b) *Field Painting*

Field painting of steelwork shall be in accordance with Table 810.331.

The Contractor shall protect adjoining property, pedestrian, vehicular and other traffic upon or in the vicinity of the bridge, and other portions of the bridge against disfigurement or damage by paint.

Where parts are to be joined by field welding, surfaces within 50 mm of the weld location shall be stripped of paint prior to welding. Any paint scarred or damaged by the welding shall be removed. All uncoated areas shall then be sandblasted and coated in accordance with this specification. Special precautions shall be taken to ensure that surfaces previously coated are not damaged by the sandblasting operations.

Field welds, the heads of bolts and all other areas where the shop paint has been damaged or has been omitted for field connections, shall be cleaned in accordance with the relevant part(s) of AS 1627 to produce a clean metallic surface for the application of paint.

810.39 STORAGE AND TRANSPORT OF STEEL AND FABRICATED STEELWORK

Steel awaiting fabrication for the Permanent Works and uncoated steelwork shall be adequately protected from contaminants liable to cause heavy rusting and possibly pitting of the surfaces. Steelwork shall not be loaded for transport until the paint system is sufficiently hard for handling.

During storage, steelwork shall be kept clear of the ground and shall be laid out or stacked so as to prevent water or dirt accumulating on or against any of the surfaces. Suitable packings shall be placed between layers of stacked steelwork. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.

Components weighing less than one tonne shall be kept in a storage area away from their erection point in order to minimise damage to protective coatings. If in the opinion of the Engineer, damage to coatings is excessive, or may be difficult to deal with satisfactorily after erection, the Contractor shall restore the coatings before erection.

810.40 PAINTING OF PILES WITHIN THE SPLASH ZONE

The manufactured steel piles are to be protected from corrosion in the splash zone areas as defined on the drawings and within Section 801 of the specification.

The surface of the steel piles, in the splash zone, shall be prepared and coated as specified in Table 810.331 of this specification.

810.41 GALVANISED OPEN DECK WALKWAYS

The steel open deck walkway panels shall be manufactured such that they are shaped to avoid pipework and are self-draining, ventilating and fireproof. Galvanising shall be undertaken in accordance with Clause 810.37

The maximum total weight of any panel shall be 50kg to facilitate maintenance and shall be capable of resisting full pedestrian loading requirements to AS 5100

Fixing shall be provided using the proprietary fixing clips shown on the Construction drawings.

SECTION 811 – BRIDGE DRAINAGE AND SERVICE DUCTS

811.01 SCOPE

This section covers the construction of bridge drainage works such as weep holes, drainage pipes and scuppers, no-fines concrete backing and concrete channelling as well as the supply and installation of service ducts, for the various Public Utilities, to the details shown on the drawings.

811.02 WEEP HOLES, DRAINAGE PIPES, SCUPPERS AND CHANNELLING

Weep holes, drainage gullies, scuppers, pipes and channelling shall be provided in accordance with the details shown on the drawings or ordered by the Engineer. Weep holes shall not be placed within 40 mm of any reinforcement and shall be cleaned to permit the free flow of water on completion of the works.

Drainage pipes shall be non-metal pipes of the material called for on the Drawings and shall on completion be cleared of all foreign matter and the interior surface left smooth. The steel gullies shall be located as shown on the Drawings and shall be galvanized and top coated as detailed in Section 810 of the specification.

Cast in situ concrete channelling shall be provided next to kerbing where shown on the

Drawings and according to the details provided. Concrete work shall be carried out in accordance with the provisions of Section 804 and channelling shall be given a Class U.2 surface finish as specified in Clause 802.08(b). The channelling shall be bonded to the bridge deck concrete in accordance with the provisions of Clause 804.08.

811.03 DRAINAGE TO RETAINING WALLS AND ABUTMENTS

Drainage shall be provided to rear faces of retaining walls and abutments as indicated on the Drawings. Drainage shall meet the requirements of Section 502.

Geotextiles shall meet the requirements of Section 608.

Permeable filter materials shall comply with the requirements of Clause 202.04(e).

SECTION 812

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SECTION 901 – LANDSCAPE WORKS

901.01 DESCRIPTION

This section covers the requirements for works associated with the vegetation of the site. This includes, but is not limited to, material supply, site preparation, mulching, planting, grassing, the control of erosion, irrigation and landscape maintenance.

901.02 SUPPLY OF MATERIALS

All materials shall be supplied by the Contractor.

901.03 SETTING OUT PLANTING AREAS AND PLANTS

The Contractor shall set out the planning beds and the location of individual plants in accordance with the drawings by scaling dimensions from the drawings or by complying with plant number and density requirements and locating by reference to existing features.

901.04 GROUND PREPARATION

(a) *Grassed Areas*

Areas to be grassed which have no topsoil shall be topsoiled to a depth of 75mm. On batters steeper than 4:1, prior to spreading topsoil the Contractor shall roughen the ground to ensure the topsoil is keyed into the ground to minimise slippage and erosion.

(b) *Planting Areas*

Planting areas shall be prepared by removing any grass or weeds using an approved herbicide or by mechanical means and ripping to a minimum depth of 500 mm at the specified planning locations. Details of chemical herbicides and the method of application proposed shall be submitted to the Engineer for approval prior to use. Immediately prior to planting, the beds shall be cultivated to a depth of 300 mm.

Rocks and other material 75 mm in diameter or greater dislodged during cultivation shall be removed and disposed of by the Contractor. Additional topsoil shall be used to fill any depressions caused by the removal of rock and debris.

In the event of saturated ground conditions, cultivation shall be delayed until the ground has satisfactorily dried out.

Ripping shall occur when soil is at or approaching the plastic limit of dryness. Ripping

shall be postponed when the soil is at or wetter than field capacity. Narrow tines shall be used in rocky ground and winged tines in other ground types. Rock and rubbish brought to the surface shall be removed and disposed. The Contractor shall inform the Engineer of sites where the presence of rock prevents the specified minimum ripping depth being achieved and implement alternative techniques (such as a standard tine) to maximise planting bed ground preparation depth.

Ripping shall not occur within the extent of existing vegetation areas marked for protection or within the drip line of existing woody plants. In the vicinity of woody plants to be retained with greater than 600 mm trunk diameter at breast height, 1.5 times the height of the tree measured horizontally from the tree trunk shall be considered and marked as an area to be protected. For trees less than 600 mm diameter the area to be protected shall be the area within the drip-line. Any planting to be carried out within these protected areas shall be done using hand cultivation techniques to minimise damage to existing tree roots zones.

The Contractor shall make available each ripped planting area, individual tree planting and grassing area prior to mulching, planting or grassing. The Contractor shall not proceed until the Engineer acknowledges requirements for ripping have been met. In areas where ripping is not practicable, the Engineer shall submit alternative methods to achieve an equivalent result to the Engineer for review.

(c) Removal of Unwanted Matter

The Contractor shall remove unwanted matter. Unwanted matter includes the following:

(i) Mown Grass Areas

- weeds, plastic, metal, glass or material toxic to plants
- surface stone, rock, building rubble greater than 25 mm in diameter
- clay lumps, sticks and exposed tree roots greater than 50 mm diameter

(ii) Planting Areas

- weeds, plastic, metal, glass or material toxic to plants
- visible surface stone, rock, building rubble greater than 75 mm in diameter
- clay lumps, sticks and exposed tree roots greater than 100 mm diameter

901.05 GRASSING

Except for those areas in which trees and shrubs are to be planted, all areas to be grassed, including catch drains and open channels and all areas disturbed by the Contractor which will not be a planting area, shall be sown with premixed grass seed and fertiliser.

Grass seed shall be sown at minimum 100 kg/Ha (if drilled) or 200 kg/Ha (if broadcast), distributed evenly to achieve an even and dense grass cover.

Germination rate shall be minimum 80% cover within 8 weeks and 95% cover within 3 months of sowing. If germination has not been achieved in any grassed area within 8 weeks, then the area(s) shall be reseeded with the specified grass seed mix.

The Contractor shall apply fertiliser evenly over the prepared surface in accordance with the manufacturer's recommendations.

The Contractor shall carry out the first cut when at least 50% of the grassing area to be cut has grown to minimum 75 mm and maximum 150 mm height and mow to a minimum height of 75 mm. Less than 1/3 the height of the grass shall be removed in the first cut.

901.06 EROSION PROTECTION

Where specified or shown on the drawings erosion prone areas shall be protected immediately following topsoiling by the use of Erosion Matting.

Matting shall be laid and anchored in accordance with the manufacturer's instructions, or in the absence of specific instruction matting on batters shall be laid in strips with overlap and fixed above the crest and below the toe of the batter by burying in a 300 mm deep trench. In drainage channels the matting shall cover the full width of the floor and extend 600 mm up each side and be fixed at the upstream and downstream end by burying in a 300 mm deep trench. Where the batter slope feeding the drain is also to be matted, the batter matting shall be placed under the drain matting down to the drain invert.

901.07 PLANTING

(a) General

The natural soil shall be damp at the time of planting, but free water shall be allowed to drain.

Plants shall be thoroughly watered 24 hours prior to and immediately after planting.

Planting shall be carried out in such a manner to ensure healthy, vigorous growth of plants. All plants shall be planted, mulched and fertilised as specified.

Initial planning shall be completed a minimum of six (6) months before the due date for the end of the maintenance period specified.

The Contractor shall carry out planting so as to ensure healthy, vigorous growth of plants. In the event the specified plant is unlikely to be suited to the as constructed growing conditions, the Engineer shall be notified.

Holes in heavy soils or on batters shall be prepared so as to ensure adequate drainage. Holes shall not be left smooth sided in 'plastic' soils. Drill or auger hole diggers shall only be permitted where soils have been cultivated.

Planting holes shall be backfilled with friable topsoil free of debris, rocks and clods greater than 50 mm in diameter.

Under no circumstances shall any plant be planted into a dry planting hole (soil moisture at wilting point or drier). If the soil is dry, the planting hole shall be saturated with water prior to planting.

(b) Staking

Where specified, plants shall be staked in accordance with the drawings.

(c) Tree Guards

Tree guards shall be placed around all tube stock at the time of planting and shall be securely anchored.

(d) Mulching

Approved mulch or weed mat shall be placed at least 500 mm around all plants. Mulch shall be placed to a depth of 75 mm to 125 mm, and shall be kept clear of stems to avoid collar rot. When planting in garden beds, mulch shall extend at least 1000 mm beyond plants at the outer edges of the beds.

901.08 MAINTENANCE

(a) Scope of Maintenance

The Contractor shall maintain the whole of the landscape works performed under the Contract for the term of the defects liability period. Maintenance of the landscape work shall include the following tasks:

- replanting, weed control, watering, mowing/slashing, reseeding of seeded grass areas pest and disease control, re-mulching, pruning, repairs to erosion treated areas

- maintaining the site in a neat and tidy condition
- repair and removal of stakes

(b) Maintenance Program and Joint Inspections

A joint inspection of all landscape work by the Contractor and Engineer shall be carried out at the commencement and conclusion of the maintenance period.

The Contractor shall carry out any remedial works identified during the inspections within two weeks of the date of the inspection unless otherwise directed by the Engineer. Between these inspections at 3 monthly intervals the Contractor shall conduct inspections of the work and remedy any defect identified.

Grassing and planting may be delayed until suitable conditions prevail subject to the agreement of the Engineer.

(a) Replanting

Maintenance for replanting shall begin as soon as planting has begun in a planting area. Plants which die or do not show healthy growth within the maintenance period for any reason shall be replaced and replanted by the Contractor.

(b) Weed Control

All mulched areas, including mulch around individual plants, shall be maintained in a weed free state. All grassed areas shall be maintained free of broadleaf and noxious weeds.

Bare ground that results from weed control activities shall be cultivated and re-grassed to establish a minimum 95% grass cover.

Weeds within planting areas and around tree plantings are to be managed from when cultivation of the planting site is complete. All planting areas shall be managed by the Contractor to maintain a minimum of 90% weed free surface with no weeds taller or broader than 200 mm at all times and all weeds are to be removed prior to the production of viable seed. Weeds within Individual Tree Plantings are to be managed for a radius of not less than 1.5 metres at each planting location.

(c) Watering

The Contractor shall water all plants as necessary to ensure continued healthy and vigorous growth from time of planting.

(d) Mowing/Slashing

The Contractor shall mow/slash all grassed areas to maintain grass heights of between

50-150 mm.

(e) *Re-seeding*

In addition to areas grassed by the Contractor, the Contractor shall maintain all other grassed areas within the limits of work. Areas with less than 95% grass cover (for each grassed area) within three months after sowing shall be re sown by the Contractor. The Contractor shall ensure that 95% cover is maintained throughout the duration of the maintenance period.

(f) *Pest and Disease Control*

All plants shall be maintained free of insect infestation and plant disease.

The control of pests and diseases shall begin before the first planting. The Contractor shall maintain all plants free of insect infestation and plant disease so that healthy, vigorous plant growth is sustained. Minor infestations of native pests and diseases on indigenous plants not threatening survival or healthy growth need not be controlled.

The Contractor shall provide protection to plants from vertebrate grazing animals. All planting killed by grazing animals shall be replaced. If more than 5% of planting in a planting area shows signs of damage by grazing animals, the Contractor shall take immediate action to prevent further grazing damage. As a minimum the Contractor shall immediately install tree guards or suitable protective fencing securely around all plants subject to vertebrate grazing.

Where chemical repellents are to be used to prevent grazing, the repellent shall be applied until the growing tip of the plant is beyond the grazing height of the pest animal, subject to the approval of the Engineer.

(g) *Re-Mulching*

All areas covered with shredded or chipped mulch shall be maintained at a minimum depth of 100 mm of mulch. The Contractor shall prune plants as required to remove damaged branches.

Maintenance of areas mulched shall begin from the first planting.

Areas mulched with shredded wood mulch that do not have full foliage cover at ground level shall be maintained at a minimum consolidated depth of 75 mm by the Contractor. Re-mulching is not required where shrub or groundcover canopies have fully connected foliage.

(h) *Repairs to Erosion Treated Areas*

Maintenance and repairs to erosion treated and affected areas shall begin from the earlier of installation of treatment or erosion occurring. The Contractor shall maintain all areas of erosion protection treatments from the earlier of installation of treatment or erosion occurring and shall repair all damage or erosion which arises. Such areas shall be re prepared and re protected as necessary in accordance with Clauses 901.05 and 901.06 to minimise erosion occurring and to establish a stable condition.

(i) *Maintaining the Site in a Neat and Tidy Condition*

At any time the site is accessible to the public, the Contractor shall keep the site in a neat and tidy condition free of litter, debris or extraneous materials not associated with the works. Litter that may be carried from the site by wind or water shall be controlled, collected and removed by the Contractor from Possession of Site.

END OF SECTION