GLADSTONE REGIONAL COUNCIL

CONTRACT No. 44-19

QUALITY ASSURED, SCHEDULE OF RATES CONTRACT for the A01 SEWER PUMP STATION (LORD/CHAPPLE STREET) UPGRADE

VOLUME 2 of 4

TECHNICAL SPECIFICATIONS

PREPARED BY: COUNCIL’S ENGINEERING SERVICES SECTION
DATE: September 2018
1 TECHNICAL SPECIFICATIONS

1.1 CONSTRUCTION SPECIFICATIONS
The construction specifications and references to the standards are as listed in the project drawings and this document. These include but are not limited to;

- NATSPEC specifications
- Capricornia Municipal Design Guidelines (CMDG) standards
- Water Services Association of Australia (WSAA) standards

1.2 SITE MANAGEMENT AND PLANS
Refer to technical specification within this document.

1.3 0010 – QUALITY REQUIREMENTS FOR DESIGN
Refer to technical specification within this document.

1.4 0136 - GENERAL REQUIREMENTS (CONSTRUCTION)
Refer to technical specification within this document.

1.5 0222 - EARTHWORK (CONSTRUCTION)
Refer to technical specification within this document.

1.6 0161 - QUALITY (CONSTRUCTION)
Refer to technical specification within this document.

1.7 0257 - LANDSCAPE - ROAD RESERVE AND STREET TREES
Refer to technical specification within this document.

1.8 0310 CONCRETE - COMBINED
Refer to technical specification within this document.

1.9 0319 - MINOR CONCRETE WORKS
Refer to technical specification within this document.

1.10 0341 - STRUCTURAL STEEL
Refer to technical specification within this document.

1.11 0900 - ELECTRICAL
Refer to technical specification within this document.

1.12 1101 - CONTROL OF TRAFFIC
Refer to technical specification within this document.

1.13 1102 - CONTROL OF EROSION AND SEDIMENTATION (CONSTRUCTION)
Refer to technical specification within this document.

1.14 1111 – CLEARING AND GRUBBING
Refer to technical specification within this document.

1.15 1361 - SEWERAGE SYSTEMS - RETICULATION (CONSTRUCTION)
Refer to technical specification within this document.

1.16 1341 WATER SUPPLY - RETICULATION (CONSTRUCTION)
Refer to technical specification within this document.
1.17  CAPRICORNIA MUNICIPAL DESIGN GUIDELINES - D12 - SEWERAGE NETWORK
Refer to technical specification within this document.

1.18  CAPRICORNIA MUNICIPAL DESIGN GUIDELINES - D11 – WATER RETICULATION
Refer to technical specification within this document.

1.19  CAPRICORNIA MUNICIPAL DESIGN GUIDELINES – D2 – PAVEMENT DESIGN
Refer to technical specification within this document.

1.20  GRC-ES001 – ELECTRICAL WORK
Refer to technical specification within this document.

1.21  GRC-ES002 – PREFERRED ELECTRICAL COMPONENTS
Refer to technical specification within this document.

1.22  GRC-ES003 – PREFABRICATED ELECTRICAL SWITCHROOMS
Refer to technical specification within this document.

1.23  GRC-ES004 – MOTOR CONTROL CENTRES
Refer to technical specification within this document.

1.24  GRC-ES006 - FIELD CONTROL PANELS
Refer to technical specification within this document.

1.25  GRC-ES008 – EQUIPMENT IDENTIFICATION
Refer to technical specification within this document.

1.26  GRC-ES009 – POLYETHYLENE PIPE WELDING SPECIFICATION
Refer to technical specification within this document.
1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide site management, as documented.

Incidental works
Generally: Undertake the following:
- Reinstatement: Reinstate undeveloped ground surfaces to the condition existing at the commencement of the contract.
- Minor trimming: As required to complete the works, as documented.

1.2 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:
- Clearance authority: Any authority covering statutory requirements relating to the project and requiring clearances for work in that particular area.
- Clearances: A formal certificate, approval or condition issued by a statutory authority to allow work to be carried out in a particular area.
- Contamination of land: The presence of a substance in, on or under the land which is a designated hazardous material and/or is at a concentration above that which is normally found in that locality, such that there presents a risk of harm to human health or to the environment.
- Green and organic waste: Includes all food wastes, vegetative wastes from land clearing and pruning operations, biosolids produced from the treatment of liquid wastes, garden wastes and forestry waste (bark and saw dust) and paper and cardboard products.
- Environment: The physical factors of the surroundings of human beings including the land, waters, atmosphere, climate, sound, odours, tastes, the biological factors of animals and plants and the social factor of aesthetics.
- Environmental audits: A review of environment management practices, in particular the evaluation of a site for environmental liability.
- Environmental impact assessment: A method for predicting environmental impacts of a proposed development including minimising identified impacts.
- Environmental management plan (EMP): A plan describing the management of the environmental issues and considerations for the activity being undertaken. This applies to the design, construction and operation of the buildings and infrastructure.
- Pollution incident: An incident or set of circumstances during or as a consequence of which there is, or is likely to be a leak, spill or other escape of a substance as a result of which pollution has occurred, is occurring or is likely to occur.
- Weed: An invasive plant that degrades our natural areas, reduces the sustainability or affects the health of people and animals.

1.3 INSPECTION

Notice
Inspection: Give notice so that inspection may be made of the following:
- Enclosures to trees to be retained.
- Trees to be removed.

1.4 MANAGEMENT AND CONTROL

Plans submitted by the contractor
Implementation: Approved management plans documented in Submissions.

Management and control measures
Implementation: Management and control measures documented in Execution.
1.5 SUBMISSIONS

Submissions program

Time for submissions: All plans are to be submitted within 1 week of acceptance of offer.

Training program: Submit a program to familiarise staff regarding the site environmental management plan, environmentally sensitive areas and responsibilities.

Work Health and Safety Plan (WHS)

The Contractor shall:

(a) Prepare a “Work Health and Safety Plan” (“Plan”) as required by the Work and Safety Law and defined under the accompanying regulations; and

(b) Submit the Plan to the Superintendent for review and acceptance:
   i. within 5 working days of commencement of contract; and
   ii. prior to taking Possession of Site.

The Superintendent may at any time request amendment of the Plan. The Contractor shall forthwith amend the Plan in accordance with the Superintendent’s request or provide written justification as to why the Plan should not be amended.

The Contractor shall prepare and present a work health and safety plan including a site specific risk analysis for the contract works to the Superintendent for approval. Obtaining approval may involve interactive analysis of the risk assessment, works method and program with the Superintendent and the Council's Work Health and Safety officer.

The Contractor must ensure that all workplace staff are competent in the work being undertaken. The Contractor will provide the employees and Sub-Contractors/Labour Hire staff with information and supervision in relation to hazardous work processes or material/s.

The Contractor shall ensure that all equipment used during the operation of this contract is safeguarded at least in accordance with the manufacturers' specifications.

The Contractor will comply with any reasonable direction given by the Superintendent relating to WH&S.

If, during the performance of work under the contract, the Superintendent informs the Contractor that it is their opinion the Contractor is:

(a) Not conducting the work in compliance with the WH&S Legislation or relevant policies and procedures: or

(b) Conducting the work in such a way as to endanger the health and safety of the Contractor's employees, Gladstone Regional Council employees or the general public, the Superintendent may direct the Contractor to promptly remedy the breach of WH&S or may direct the Contractor to suspend work until such time as the Contractor satisfies the Superintendent the work will be resumed in a safe manner. If the Contractor fails to rectify any breaches of WH&S for which work has been suspended, or if the Contractor's performance has involved recurring breaches of WH&S, the Superintendent will notify Workplace Health and Safety Queensland and request that an inspector visit the workplace or, they may terminate the work forthwith (depending on the severity of the issue).

The Contractors employees shall:

(a) Undertake Site Specific Safety Inductions on arrival to site.

(b) Have immediately available to him/her appropriate Australian Standard approved Personal Protective Equipment (PPE) which shall be worn and/or fitted as appropriate for the task being undertaken, or as directed by workplace management. As a minimum, Contractor employees are required to wear the following PPE on any Council worksite:
• Long sleeve shirts;
• High-viz shirt or vest;
• Safety footwear; and
• Wide brimmed hat.
• Sunscreen

(c) Have immediately available to him/her on site the current Material Safety Datasheets (MSDS) for all hazardous substances expected to be used in performance of their duties.

Fuels and combustibles kept on site shall be stored in accordance with current Australian Standards.

Smoking is not permitted in buildings or within four (4) metres of any entrance to a building occupied by the Council. Smoking on the site in general to be in accordance with Qld legislation. All persons including the Contractor and the Contractor's Sub-Contractor/Labour Hire staff engaged to perform a service are subject to random drug and alcohol testing when carrying out work on a Gladstone Regional Council site.

Demolition Control Plan
Submit a demolition control plan that complies with the requirements of Part 4.6 of the Work Health and Safety Regulation 2011 and Demolition Work Code of Practice 2013

Environmental management plan (EMP)
EMP: Submit an environmental management plan and include the following details:
- Assignment of responsibility for environmental controls.
- Conditions of approvals, licences and permits to meet statutory requirements.
- Details of potential environmental impacts and operational control measures for implementation including:
  . Heritage.
  . Preservation of visual values.
  . Protection of endangered species.
  . Preservation of habitat.
- Details of environmental protection for each activity.
- Locations of environmental controls and environmentally sensitive areas.
- Communication procedures.
- Emergency response procedures including response time.
- Environmental training plan and procedures.
- Environmental auditing program.
- Other items necessary to protect the surrounding environment.
Address the phases of activity, as appropriate:
- Before construction and site establishment.
- During construction.
- After construction, including rehabilitation activities and maintenance of erosion and sedimentation controls.

Preliminary environmental management plan: Submit with the tender documentation.
Completed environmental management plan: Submit before work commences on site.

Soil erosion and sediment control plan
Plan: Submit a soil erosion and sediment control plan and include the following details:
- Staging of operations and sequence of works.
- Diversion of upstream water around the site.
- Provision of temporary drains and catch drains.
- Application of diversion, dispersal and/or retention measures to concentrate flows to control and dissipate stormwater through the site without damage.
- Spreader banks or other structures to disperse concentrated runoff.
- Temporary grassing or other treatments such as contour ploughing or bunding to disturbed areas and long-term stockpiles.
- Restoration of disturbed areas in progress with the works.
- Use of mulch materials to protect disturbed or exposed areas where suitable.

Areas: Include all site areas and access and haulage tracks, borrow pits, stockpile and storage areas and compound areas.

**Waste management plan**

Plan: Submit a waste management plan and identify major waste streams that will be generated during the contract including:

- Green waste and organic waste.
- Construction waste, including:
  - Acid Sulphate Soils including specific acid sulphate soil management plan if required
  - Spoil.
  - Demolition waste.
  - Asphalt or bitumen.
  - Concrete
  - Metal.
  - Paint materials and empty containers.
  - Office waste.
  - Kitchen waste.
  - Sewage effluent.

- For each waste stream indicate:
  - How and where the waste is to be re-used, recycled, stockpiled or disposed off.
  - Indicate how the waste will be transported between the site and point of re-use, recycling, stockpiling, treating or disposal and who will be responsible.

**Ground contamination control plan**

Plan: Submit a ground contamination plan and include the following details:

- If the land is identified as contaminated, or the presence of acid sulphate soils is found, prepare a Remediation Action Plan (RAP) in conformance with the Environmental Protection Authority (EPA) guidelines.

2 EXECUTION

2.1 GENERAL

**Community liaison**

General: Notify residents about new or changed construction activities which will affect access to, or disrupt the use of, their properties.

Notice: 5 working days unless the work is of an urgent nature with safety implications.

Notification content:
- The nature of the work.
- The reason for it being undertaken.
- The expected duration.
- Changes to traffic arrangements and property access.
- The 24-hour contact number of the responsible representative.
Complaints
Report: Within 1 working day of receiving a complaint about any environmental issue, including pollution, submit a written report to the superintendent detailing the complaint and action taken.
Register: Keep a register of all environmental complaints and action taken.

2.2 CONTROL AND PROTECTION

Air quality control
General: Protect adjoining owners, residents and the public against dust, dirt and water nuisance and injury. Use dust screens and watering to reduce the dust nuisance.

Lighting of fires
Prohibition: Do not light fires.
Monitoring: Measure vibration levels of the peak particle velocity to AS 2187.2.
Limits: Do not exceed the vibration or airblast overpressure recommended in AS 2187.2 Appendix J.

Dust control
Dust control measures: Dust is to be minimised over the duration of the project using generalised methods of treatment such as site watering.

Vegetation and fauna
Wild life protected: All native.
Trees to be removed: Inspect to establish if nesting native fauna are present. All clearing is to be completed using a Registered Flora and Fauna Spotter.

Water quality
Wash out: Make sure that wash out does not enter waterways or stormwater drains.
Cross connection: Make sure that there are no cross connections between the stormwater and the public sewerage system.

Dewatering
General: Keep earthworks free of water. Provide and maintain slopes, crowns and drains on excavations and embankments to make sure free drainage. Place construction, including fill, masonry, concrete and services, on ground from which free water has been removed. Prevent water flow over freshly laid work.

2.3 TRUCK CONTAMINATION

Truck contamination precautions
Covers: Use tarpaulins to prevent the dropping of materials on public roads.
Washing: Wash the underside of all vehicles leaving the site as follows:
- Mud: Do not carry mud on to adjacent paved streets or other areas.
- Noxious plants: If noxious plants, as designated by the local authority, are present on the site ensure seeds are not carried on to adjacent paved streets or other areas.

Wheel wash/shaker bay
Facilities: Provide the following:
- Surface: Crushed concrete or rock of between 100 mm and 200 mm rough diameter.
- Location: Site the shaker bay and provide berms as required to drain to grassed areas of the site and allow infiltration to the subsurface.

2.4 MANAGEMENT AND CONTROL PLAN IMPLEMENTATION

Approval
Implementation
General: Implement the following approved management and control plans:
- Environmental management control plan.
- Soil erosion and sediment control plan.
- Waste management plan.
- Ground contamination plan.

Reporting
General: Compile the environment management plan (EMP) reports regularly to report the progress in relation to:
- Performance against statutory requirements.
- Performance against the EMP and the EMP policy, ecologically sustainable development outcomes and targets.
- Summary of monitoring, inspection and audits.
- Summary of reports required to meet the statutory requirements.
- Summary of environmental emergencies, incidents, non-compliance and complaints.

### 2.5 EXISTING SERVICES

**Location**
Requirement: Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

**Excavation**
General: Do not excavate by machine within 1 m of existing underground services.

### 2.6 SITE CLEARING

**Extent**
General: Clear only the following site areas:
- Areas to be occupied by works such as structures, paving, excavation, regrading and landscaping.
- Other areas designated to be cleared.

Contractor’s site areas: If not included within the areas documented above, clear generally only to the extent necessary for the performance of the works.

**Clearing and grubbing**
Clearing: Remove everything on or above the site surface, including rubbish, scrap, grass, vegetable matter and organic debris, scrub, trees, timber, stumps, boulders and rubble.

Grubbing: Grub out stumps and roots over 75 mm diameter to a minimum depth of 500 mm below subgrade under buildings, embankments or paving, or 300 mm below finished surface in unpaved areas. Backfill holes remaining after grubbing with sand material to prevent ponding of water. Compact the material to the relative density of the existing adjacent ground material.

Old works: Remove old works, including slabs, foundations, pavings, drains and access chambers covers found on the surface.

### 2.7 DISPOSAL OF MATERIALS

**Disposal**
Spoil: Remove cleared and grubbed material from the site and dispose of legally.

### 2.8 PAY ITEMS

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<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
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<td>1.1 Preparation of a Workplace Health and Safety Management Plan</td>
<td>Lump Sum</td>
<td>All costs associated with the development of the H&amp;S Management Plan.</td>
</tr>
<tr>
<td>1.2 Implementation of Workplace Health and Safety Management Plan</td>
<td>Lump Sum</td>
<td>All costs associated with the implementation of the Final Health and Safety Management Plan, the provision of the safety documentation on site and the maintenance of the records during the course of the Contract.</td>
</tr>
<tr>
<td>1.3 Preparation and implementation of a Demolition Control Plan</td>
<td>Lump Sum</td>
<td>All costs associated with the preparation and implementation of a Demolition Control Plan per the requirements of Part 4.6 of Work Health and Safety</td>
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<tr>
<td>Pay items</td>
<td>Unit of measurement</td>
<td>Schedule rate scope</td>
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<tr>
<td></td>
<td></td>
<td>Regulation 2011 and Demolition Work Code of Practice 2013</td>
</tr>
</tbody>
</table>
0136 GENERAL REQUIREMENTS (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide labour, materials, plant and equipment to construct the Works as documented.

1.2 PRECEDENCE

General
Worksections and standards:
- Requirements of other worksections of the specification override conflicting requirements of this worksection.
- The technical requirements of the work sections override conflicting requirements of their referenced documents.
- The requirements of referenced documents are minimum requirements.

1.3 CROSS REFERENCES

General
Requirement: Conform to the following worksection(s):
- 0161 Quality (Construction) and/or 0167 Integrated management.
- 1102 Control of erosion and sedimentation (Construction).
- 1112 Earthworks.

Cross referencing
Within the text:
- Worksection titles are indicated by Italicised text.
- Clause titles are indicated by BOLD text.

1.4 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards
AS 1319-1994 Safety signs for the occupational environment
AS 1348-2002 Glossary of terms - Roads and traffic engineering
AS/NZS 1680 Interior lighting
AS/NZS 1680.2.4-1997 Industrial tasks and processes
AS 2670 Evaluation of human exposure to whole body vibration
AS 2670.1-2001 General requirements (ISO 2631-1:1985)
AS 5488-2013 Classification of subsurface utility information (SUI)
AUSTROADS
AP-C87-2014 Austroads glossary of terms
Intergovernmental Committee on Surveying & Mapping
ICSM QA Specification G71 Road construction surveys

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- AS: Australian Standard.
- CAD: Computer Aided Design.
Definitions
General: For the purposes of this contract the definitions given in AS 1348, AP-C87 and the following apply:
- Authorities: Includes Agencies.
- Documented: Documented, as documented and similar terms mean contained in the contract documents.
- Geotechnical site investigation: The process of evaluating the geotechnical characteristics of the site in the context of existing or proposed construction.
- Give notice: Give notice, submit, advise, inform and similar expressions mean give notice (submit, advise, inform) in writing to the Superintendent.
- Manufacturers’ and suppliers’ recommendations: Recommendations, instructions, requirements, specifications (and similar expressions) provided in written or other form by the manufacturer relating to the suitability, use, installation, storage and/or handing of a product.
- Obtain: Obtain, seek and similar expressions mean obtain (seek) in writing from the Superintendent.
- Permanent marks: Survey control marks that are permanent by nature and are uniquely defined in the state control survey. Also known as State survey marks (SSM) or Bench marks (BM).
- Principal: Principal has the same meaning as Owner, Client and Proprietor and is the party to whom the Contractor is legally bound to construct the Works. The primary obligation of the Principal is to make payments to the Contractor.
- Professional engineer: A person who is listed or eligible for listing on the National Professional Engineers Register (NPER) and has appropriate experience and competence in the relevant discipline at the relevant time.
- Proprietary: Identifiable by naming manufacturer, supplier, installer, trade name, brand name, catalogue or reference number.
- Provide: Provide and similar expressions mean supply and install and include development of design beyond that documented.
- Registered testing authority:
  - An organisation registered by NATA to test in the relevant field; or
  - An organisation outside Australia registered by an authority recognised by NATA through a mutual recognition agreement; or
  - An organisation recognised as being a Registered Testing Authority under legislation at the time the test was undertaken.
- Required: Required by the documents, the Local Council or statutory Authorities.
- If required: A conditional specification term for work which may be shown in the documents or be a legislative requirement.
- Superintendent: Superintendent has the same meaning as Contract Administrator or Principal’s representative. The Superintendent may be party to the contract or appointed by the Principal to administer the contract. The powers, duties and authorities of the Superintendent are covered in the contract. These can be changed in writing at any time during the contract.
- Supply: Supply, furnish and similar expressions mean supply only.
- Tests:
  - Completion tests: Tests carried out on completed installations or systems and fully resolved before the date for practical completion, to demonstrate that the installation or system, including components, controls and equipment, operates correctly, safely and efficiently, and meets
performance and other requirements. The Superintendent may direct that completion tests be carried out after the date for practical completion.

- Pre-completion tests: Tests carried out before completion tests.
- Production tests: Tests carried out on a purchased item, before delivery to the site.
- Site tests: Tests carried out on site.
- Type tests: Tests carried out on an item identical with a production item, before delivery to the site.

- Tolerance: The permitted difference between the specified value and the upper limit and the lower limit of dimension, value or quantity.
- Verification: Provision of evidence or proof that a performance requirement has been met or a default exists.

1.6 SUBMISSIONS

Approval
Submissions: To the Superintendent’s approval.

Alternative construction
Detailed working drawings: If a tender based on the use of alternative material, design or method of construction is accepted, prepare and submit detailed working drawings, design calculations and specifications for the alternative, together with details of necessary alterations to this worksection.
Certification: Prepare and certify design and construction documents by a Professional Engineer experienced in that type of design.
Submission: Submit documents at least four weeks before construction of the relevant part of the work is scheduled to commence. Do not commence work on that part without approval. This is a HOLD POINT.

Costs: Pay the cost of submissions and evaluations and tests of proposed alternatives, whether subsequently accepted as a variation or not. The costs will be calculated at the current charge-out rates of the relevant consultant(s).

Substitution: If alternatives to the documented products, methods or systems are proposed, submit sufficient information to permit evaluation of the proposed alternatives, including the following:
- Reasons for the proposed substitutions.
- Statement of the extent of revisions to the contract documents.
- Statement of the extent of revisions to the construction program.
- Statement of consequent alterations to other parts of the Works.
- Statement of cost implications including costs outside the contract.
- Evidence that the performance is equal to or greater than that specified.
- Evidence of conformity to a referenced document.
- Essential technical information, in English.
- Samples.

Availability: If the documented products or systems are unavailable within the time constraints of the construction program, submit evidence.
Criteria: If the substitution is for any reason other than unavailability, submit evidence that the substitution:
- Is of net enhanced value to the Principal.
- Is not prohibited by the Contract documents and is as effectual as the identified item, detail or method.

Materials
Product certification: Submit evidence of product conformance with relevant product certification schemes.
Product data: For proprietary equipment, submit the manufacturer’s product data as follows:
- Technical specifications and drawings.
- Type-test reports.
- Performance and rating tables.
- Recommendations for installation and maintenance.
WHS: Hazardous materials storage and procedure to counteract spillages.
To be supplied: Nominated TBS items program.

**Type tests**
Requirement: Provide all test results and survey records promptly if requested.

**Work-as-executed drawings**
Submission: Provide marked up and certified work-as-executed drawings for the whole of the Contract before issue of the Final Certificate.
Contract drawings: Digital contract drawings supplied by Superintendent at no cost for mark up.
Roadworks: Mark up in red and certify all changes to the contract drawings and actual values of all levels, signed by the surveyor.
Public utilities: Record as required by the worksections.
Surface utilities: Record information on background or submerged utilities to the documented quality level, conforming to AS 5488.

### 1.7 INSPECTION

**Notice**
General: Give notice so that inspection may be made of the following:

#### Summary of HOLD POINTS

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<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
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<td>Alternative construction details</td>
<td>2 weeks before work commences</td>
<td>Superintendent</td>
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<td>Utilities and Authorities</td>
<td>Confirmation of relocation</td>
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<td>Site facilities</td>
<td>Positioning of services</td>
<td>1 week before installing services</td>
<td>Superintendent</td>
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#### Summary of WITNESS POINTS – Off-site activities

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<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
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<tbody>
<tr>
<td>Items to be supplied (TBS) by the Principal</td>
<td>Notice of time of delivery</td>
<td>2 working days</td>
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</tbody>
</table>

### 2 PRE-CONSTRUCTION PLANNING

#### 2.1 CONTRACT ADMINISTRATION

**Insurance**
Requirement: Provide evidence of currency for Workers Compensation Insurance, Insurance of the Works or Public Liability Insurance.

### 3 CONSTRUCTION REQUIREMENTS

#### 3.1 GENERAL

**Contractual relationships**
Contractual responsibilities: Responsibilities and duties of the Principal, Contractor and Superintendent are not altered by requirements in the referenced documents.
Directions: All instructions are directed to the Contractor, unless noted otherwise.
Approvals: Obtain all approvals from the Superintendent, unless noted otherwise.
Current editions
General: Use referenced documents (including test methods) which are the editions, with amendments, current 3 months before the closing date for tenders, except where other editions or amendments are required by statutory Authorities.

Drawings
Contract documents: The issued drawings which form part of the Contract documents are bound in a separate volume.

Contract documents
General: Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:
- Obtain measurements and other necessary information.
- Coordinate the design and installation in conjunction with all trades.

Spot levels: Documented spot levels take precedence over documented contour lines and ground profile lines.

Inspections
Concealment: If notice of inspection is required for parts of the Works that will be concealed, advise when the inspection can be made before concealment.

Light level requirements: To AS/NZS 1680.2.4.

Adjoining works
Adjoining works: Make sure that there are smooth junctions with the existing or adjoining work.

Materials
Manufacturers’ or suppliers’ recommendations: Provide, including select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use, manufactured items in conformance with the current written recommendations and instructions of the manufacturer or supplier.

Proprietary items/systems/assemblies: Assemble, install or fix in conformance with the current manufacturers’ or suppliers’ recommendations

Project modifications: Advise of activities that supplement, or are contrary to, manufacturers’ or suppliers’ recommendations.

Sealed containers: If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

3.2 PROJECT SPECIFIC REQUIREMENTS

Working area
Working areas: Restrict construction working areas and areas for temporary site facilities such as the storing of materials, use of plant and erection of sheds, to areas documented on the drawings. Do not work or occupy areas outside of the designated areas.

Security: Take security measures for the safe-keeping of any plant, equipment, tools, materials or other property. Submit proposals for any boundary security fencing for approval.

Temporary fencing: Provide and maintain temporary fencing and warning signage during the contract to prevent unauthorised entry into the property.

Existing fencing: Reinstate the existing fencing and remove temporary fencing before the date of practical completion.

3.3 WORK NOT IN CONTRACT

Work by others
Works by others shall be the Ergon Transformer slab/ and supply and installation of transformer

Program precautions: Coordinate the Works with simultaneous and/or adjacent work by others and liaise with other Contractors and Authorities to avoid disruption, delays and possible conflict.

Access: If required, by the Superintendent, allow free access for completion of any work by others.
3.4 SIGNAGE

General
All signs: Submit all safety and project signs for approval before sign manufacture or purchase. This is a HOLD POINT.

Safety signs
Requirement: Provide appropriate regulatory, hazard, emergency information and fire signs to AS 1319.
Location: Display safety signs at prominent locations around the working areas and temporary site facilities including:
- Mandatory signs for personal protective equipment such as eye, head and foot protection.
- DANGER signs such as ‘DANGER, Construction Site. No Unauthorised Access’.

Advertising signs
Advertising: No advertising is permitted on the site other than the following:
- Approved project signs.
- Manufacturer’s name or names of owner on items of construction plant.
- Contractor’s mail box.

Project work signs
Requirement: Supply, install, maintain and remove all project work signs.
Site possession: Install all project works signs no later than one week from receiving the notice of possession of site.
Removal of signs after Practical Completion: Contractor is to remove all Project Work and Advertising signs following practical completion

3.5 SURVEY CONTROL

General
Road construction survey: To ICSM QA Specification G71 Road construction surveys.
Definition: ‘Survey mark’ means a survey peg, bench mark, reference mark, signal, alignment, level mark or any other mark used or intended to be used for the purpose of setting out, checking or measuring the work.

Supplied survey setting out information
Certification: Before commencing the Works, check the digital design model and existing setout pegs provided for discrepancies between the digital design model and the drawings.
Transfer of marks: Transfer permanent survey marks clear of the operations before any of the given survey marks on the base lines or the various control lines are affected by the Works. This is a WITNESS POINT.
Relocation of survey control: Submit request for relocation of survey control, establishment of recovery pegs, or setting out or levelling. If no notice is provided and a control mark is disturbed or destroyed, then the cost of re-establishing the control is borne by the Contractor. This is a HOLD POINT.
Protection: Protect all supplied survey marks. The Contractor is responsible for any costs associated with re-establishing marks.

Set out pegs
Recovery pegs: Provide and fix adequate recovery pegs in suitable locations adjacent to the elements of work.
Removal: Unless otherwise directed, remove all pegs and profiles at practical completion.

Survey equipment
Requirement: Use electronic total stations and ancillary equipment for survey tasks in conformance with the following:
- Electromagnetic distance measuring device (EDM): Standard deviation for error < 5 mm + 5 ppm.
- Horizontal and vertical circles: Angular measurement standard deviation for error < 3 seconds of arc.
- One second of arc minimum count.
- Diametrical vertical circle reading and automatic tilt compensator.
- Capability to electronically record and store field data such as horizontal and vertical angles, distances, point notation, target and instrument heights.
- Calibration procedure and calibrated at all times.
- Calibrate immediately after any repairs.

**Laser and global positioning construction control systems**

Horizontal and longitudinal alignment control requirements:
- Offset pegs on one side of the road formation.
- Offset pegs 500 mm from the surface design edge of subgrade.
- Clearly mark chainages on the pegs.
- Spacing between pegs < 50 m on the straights and < 20 m on curves including all curve tangent points.
- Place pegs vertically.
- Tolerance: ± 25 mm to the exact horizontal location.
- Protect from disturbance. Submit procedure. This is a **HOLD POINT**.

Removal: Remove all pegs at Practical Completion.

### 3.6 SITE COMMUNICATIONS

**Site meetings**

Representation: Provide representation, including any Subcontractors that may be required to attend regular site meetings.

Meeting agenda: Include performance measures, coordination of program and work under the contract and resolution of any questions regarding the intent or interpretation of the documents.

Minutes: Site meetings will be chaired and minuted by the Superintendent. Copies of the minutes will be issued to all present at the meeting and others concerned with the matters discussed.

### 3.7 ENVIRONMENTAL PLANNING

**Protection of the environment**

Erosion and sedimentation control: To the **1102 Control of erosion and sedimentation** worksection.

Work outside working hours: Submit for approval any works required outside of normal working hours. Do not use any plant, machinery or equipment that would cause or is likely to cause a nuisance to the public.

Dust control: Minimise dust from disturbed areas. Submit dust control strategy before commencing excavation/earthworks operations. This is a **HOLD POINT**.

Removal of material: Dispose of material off-site to the requirements of the relevant Authorities.

Keep roads clean of soil: If required, keep roads clean of soil, provide the following:
- Wheel washes and rumble grids at all main road crossings.
- Sweep roads at least once a day where construction vehicles are travelling off the site.
- Cover all loads of soil being taken off site for disposal.

**Drainage of Works**

Stormwater diversion: Provide effectual diversion of surface water and proper flushing for storm and subsoil water across and beyond the works at all times. Do not interrupt the flow of stormwater and drainage along existing gutters and water tables.

Pumping: Keep trenches and excavations dewatered at all times during construction, including maintaining any pumping equipment.

Timing: Complete all temporary erosion and sedimentation control measures before commencing earthworks.

**Air quality**

Exhaust gases: Make sure there is no health risk or loss of amenity due to the emission of exhaust gases to the environment.
Storage of fuels and chemicals
Storage: Safely store all fuel and chemicals and conform to the following:
- Minimise fuels and chemicals stored on site.
- Install bunds and take other precautions to reduce the risk of spills.
- Implement a contingency plan to handle spills.

Toxic chemicals: Do not use herbicides and other toxic chemicals without written approval. This is a WITNESS POINT.

3.8 NOISE AND VIBRATION CONTROLS

Limits on noise
Working hours: Operational hours of plant, including the entry and/or departure of heavy vehicles, is restricted to 7 am to 6 pm Monday to Friday and at no times on Saturdays, Sundays or Public Holidays. Work outside of the hours specified is not permitted without approval.

Maximum noise levels: Avoid excessive noise and long periods of elevated noise that is reasonably anticipated to annoy or adversely effect the adjacent community.

Sound pressure threshold: Less than L_{10} sound pressure level threshold, when measured at noise sensitive locations such as residential premises.

Noise suppression: Minimise noise nuisance including the following:
- Enclose noisy equipment.
- Provide noise attenuation screens.
- Maintain plant in good working order.
- Fit effective residential class silencers to all engine exhausts.
- Fit engine covers to all plant.

Damage
Responsibility for damage: Any damage and compensation payments resulting from non observance of the above requirements are the responsibility of the Contractor.

Limits on ground vibration
Levels: Make sure ground vibration levels transmitted from operating items of plant in the vicinity of residential premises do not exceed levels that are close to the lower level of human perception inside the premise or cause structural damage to the building.

Vibration limits: To AS 2670.1.

Responsibility for damage: Responsible for any damage and compensation payments as a result of non-observance of the above requirements, no claims will be considered by the Principal.

3.9 UTILITIES AND AUTHORITIES

Existing services
Drawings: The location of all existing utilities and services shown on the drawings are indicative only.

Location: Before starting earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

Excavation adjacent to utility services: Use only utility authority approved methods of excavation.

Notify: If there is any conflict between the actual location or elevation of any item and the location or elevation of any item shown on the drawings, notify the Superintendent. This is a WITNESS POINT.

Protection of services and utilities
Precautions: Secure and protect existing gas, water or drainage pipes, sewers, electric conduits or other existing works both underground and overhead.

WHS: Comply with statutory requirements for maintaining safe working clearance to overhead electrical services.

Repair to existing: Repair any damage caused to existing water, gas or drainage pipes, sewers, electric conduit or other existing works or services to the satisfaction of the Superintendent and the relevant Authority.
Costs: If repairs are not acceptable, the Superintendent may arrange repairs and charge the Contractor.

Notice to divert services: Give notice if it is required to remove, divert or cut into any existing sewer, drainage pipe, gas or water main, service pipes, electric conduits or other existing works. Obtain direction for alterations to existing works. This is a **WITNESS POINT**.

Protection responsibility: The Contractor is responsible for the protection of any facilities and structures during the Contract period.

**Liaison**

Contractor responsibilities: Liaise with the service Authorities contractors as follows:

- Make appropriate allowances in the program for coordination with service Authorities.
- Make appropriate allowances in the program for the provision of installation by service Authorities during the works.
- Reinstatement, make good and backfill service trenches to the requirements of the service Authorities.
- Do not stop work due to operations by service Authorities without written notice.
- Do not interfere with the operations of service Authorities or their contractors on or near the site.
- Allow service Authorities to work on or near the site.

Limitations to work methods: Confirm, and include within work method procedures, any limitations with the relevant Authority, such as vibrations in the vicinity of underground and overhead facilities.

### 3.10 SITE FACILITIES

**General**

Requirement: Provide and maintain temporary site facilities for personnel as documented, including an office for the Superintendent, and the necessary temporary utility services. Remove or restore at practical completion.

Facilities required: Provide, equip and maintain temporary ablution facilities, dressing rooms, tool houses and other facilities required by any Industrial Ordinance, Award or Agreement for use of workers employed by the Contractor, or the Contractor’s sub-contractors. Remove them at practical completion.

Latrines: Provide temporary latrine accommodation for use of the workers, suitably enclosed and screened and in conformance with the requirements of the Local Authority.

Site facility design: Before erecting site facilities, submit a proposal for positioning of all units, services including septic or sewer, rubbish collection and storage areas for approval. Obtain approval from the local Authorities prior to submission. This is a **HOLD POINT**.

**Water supply**

Temporary water supply: Provide temporary water supply for site facilities and for carrying out the Works.

Approvals: Obtain all approvals from the appropriate Authority for temporary water supply.

Removal: Remove on completion of the contract the temporary water supply service, except that to the Superintendent’s office.

**Electrical service**

Temporary electricity supply: Provide any temporary electricity supply required for site facilities and for carrying out the work under the contract.

Approvals: Obtain all approvals from the appropriate Authority for temporary electricity supply.

Removal: Remove on completion of the contract the temporary electricity supply service, reticulation and lighting except that to the Superintendent’s office.

**First aid**

Requirement: Provide, equip and maintain an adequate First Aid Treatment Centre on the site with an experienced First Aid person available at all times when work is in progress.

Signage and location: Clearly mark the First Aid facilities and make accessible to all personnel at all times.

Minimum provisions: To the current statutory requirements.
Chain wire fence
Fence: Provide temporary fence panels as appropriate to secure site compound.
Gate: Provide temporary fence panels as appropriate to secure site compound.
Provide a galvanized tubular steel vehicular access gate, for the temporary site facilities as
documented or as directed.
Hessian covering: Cover the mesh fence with a suitable hessian or shadecloth screen for its full
height.
Removal: Remove all galvanized fence, screen material and gate at practical completion.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General
Payments made to the Schedule of rates: To the 0152 Schedule of rates – supply projects
worksection, this worksection, the drawings and Pay items 0136.1.

Methodology
The following methodology will be applied for measurement and payment:
- No separate measurement and payment will be made for compliance with the requirements of this
worksection except as specified in the pay item below.
- Deductions for non-conforming work: Where deductions for nonconforming work are given in the
worksections, the nominated deductions will be applied to the rates given in the Pay Items for that
item of work.

4.2 PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0136.1 Site Establishment and demobilisation</td>
<td>Lump sum</td>
<td>All costs associated with site establishment and disestablishment. To include all documented facilities, site security, fencing, signage, etc.</td>
</tr>
<tr>
<td>0136.2 Confirmation of existing services</td>
<td>Lump sum</td>
<td>All costs associated with locating and documenting existing services, including survey and potholing works.</td>
</tr>
<tr>
<td>0136.4 Supply and install temporary sewer diversion rising main pipework</td>
<td>Lump sum</td>
<td>All costs associated with installing temporary sewer diversion rising main pipework</td>
</tr>
<tr>
<td>0136.5 Supply and install temporary pipework outlet (connection to temporary diesel pump) , including modifications to MH</td>
<td>Each</td>
<td>All costs associated with installing temporary pipework outlet</td>
</tr>
<tr>
<td>0136.6 Supply and install temporary plug to manhole for pumping</td>
<td>Each</td>
<td>All costs associated with installing temporary plug to manhole for pumping</td>
</tr>
<tr>
<td>0136.7 Breakout existing pipe on completion and fill with flowable grout</td>
<td>m³</td>
<td>All costs associated with breakout existing pipe on completion and fill with flowable grout</td>
</tr>
<tr>
<td>0136.8 Remove fence</td>
<td>Lump sum</td>
<td>All costs associated with removing fence including payment of any tip fees</td>
</tr>
<tr>
<td>Pay items</td>
<td>Unit of measurement</td>
<td>Schedule rate scope</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0136.9 Remove all trees within site footprint</td>
<td>Lump sum</td>
<td>All costs associated with removing trees including payment of any tip fees</td>
</tr>
<tr>
<td>0136.10 Remove existing sewer main and access chamber as indicated</td>
<td>Lump sum</td>
<td>All costs associated with removing existing sewer main and access chamber including payment of any tip fees</td>
</tr>
<tr>
<td>0136.11 Remove existing A01 pump station building and concrete pit structures as indicated</td>
<td>Lump sum</td>
<td>All costs associated with removing existing A01 pump station building and concrete pit structures including payment of any tip fees</td>
</tr>
<tr>
<td>0136.12 Remove redundant concrete access</td>
<td>m²</td>
<td>All costs associated with removing redundant concrete access including payment of any tip fees</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Establish, implement and maintain a quality management system (QMS) that provides confidence to the Principal of the following:
- The product specified can be produced.
- Critical processes are under control.
- Product performance has been confirmed.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction).

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards
AS 1289
Methods of testing soils for engineering purposes
AS 1289.1.4.1-1998
Sampling and preparation of soils-Selection of sampling or test sites-Random number method
AS/NZS ISO 9000: 2006
Quality management systems-Fundamentals and vocabulary
AS/NZS ISO 9001: 2008
Quality management systems-Requirements
AS/NZS ISO 10005: 2006
Quality management systems-Guidelines for quality plans
AS ISO 10013: 2003
Guidelines for quality management system documentation
AS/NZS ISO 19011: 2014
Guidelines for auditing management systems

1.4 STANDARDS

General
Standard: To AS/NZS ISO 9001.

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- CAR: Corrective Action Request.
- ITP: Inspection and Test Plan.
- NNC: Notice of Non-conformance.
- QAR: Quality Assurance Representative (Principal).
- QMR: Quality Management Representative (Contractor).
- QMS: Quality Management System.
- WAE: Work-as-executed.

Definitions
For the purpose of this worksection, the definitions given in AS/NZS ISO 9000 and the following apply:
- Certification: A written assertion of facts.
- Corrective action request: A formal advice/instruction from the Superintendent requesting action to eliminate the cause of a detected nonconformity or other undesirable situation. Unless specifically noted, it will not require raising of an NCR.

- Disposition: Action taken to resolve non-conformance. (Lot specific)

- Hold Point: A mandatory verification position in the Contract beyond which work cannot proceed without the designated authorisation.

- Inspection and test plan: The working document which identifies the specific inspections and tests to be carried out for works required by the Contract.

- Lot: Any part of the works which has been constructed/manufactured under a continuous operation of uniform conditions and is essentially homogeneous with respect to material and general appearance. The whole of the work included in a lot of a uniform quality without obvious changes in attribute values.

- Non-conformance report: A mandatory (standard format) report submitted by the Contractor that details the nonconforming work and the Contractor’s proposed disposition of the non-conformance.

- Notice of non-conformance: Formal instruction from the Superintendent regarding product non-conformance from documented requirements. It automatically creates a Hold Point and requires an NCR from the Contractor.

- Performance audit (Process audit, Technical procedure audit, Methods audit): An examination to evaluate whether established methods and procedures are being adhered to in practice.

- Product: The result of a set of interrelated or interacting activities which transforms inputs into outputs.

- Product audit (Conformance audit, Service audit): An assessment of the conformity of the product with the specified technical requirements.

- Qualified surveyor: A surveyor who is eligible for membership of the Spatial Sciences Institute as a certified engineering surveyor.

- Quality assurance representative (QAR): Appointed by the Principal for a specific project and responsible for the auditing, review and surveillance of procedures and documentation required by the Contractor’s approved Quality plan.

- Quality check lists: Forms completed during the manufacture/construction process verifying key steps, and records required for the Quality register. Check lists apply to each identified lot of work.

- Quality management representative (QMR): Also known as Project quality representative, appointed by the Contractor for a specific project with the authority and responsibility for the implementation and operation of the Quality plan, so that Quality management system (QMS) requirements are not subordinated to design and productivity.

- Quality register: The files containing all quality control records such as test results, completed check lists, certificates of compliance, consignment dockets for materials procured.

- Quality management system: The organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

- Quality management system requirements: The administrative activities affecting quality that need to be implemented and controlled to make sure that the product or a service meets documented quality requirements.

- Special processes: Those processes, the results of which cannot be directly examined to establish full conformance. Assurance of satisfactory conformance depends on evidence generated during the process.

- System audit: An examination of the documented quality management system represented by the quality manual, quality plan and quality register to evaluate their effectiveness in meeting the requirements of Australian Standards and the Contract documents.

- Validation: Confirmation, through the provision of objective evidence, that requirements for a specific intended use or application have been fulfilled.

- Witness point: A nominated position in the manufacture/construction stages of the Contract where the option of attendance may be exercised by the Superintendent, after notification of the requirement.
- Works: All labour, plant, equipment and materials required to complete a project in conformance with the Contract documents.

2 QUALITY MANAGEMENT SYSTEM

2.1 GENERAL REQUIREMENTS

Conformance
Work on and off-site: Conform to the QMS described within the Quality plan including products and services for all works under the contract.

Contract documents: The QMS does not pre-empt, preclude or otherwise negate the requirements of any part of the contract documents.

Responsibility: QMS requirements do not relieve the Contractor of the responsibility to conform with the contract documents.

Subcontractors and Suppliers: Conform with this worksection and AS/NZS ISO 9001. This can be achieved by either of the following:
- Suppliers and Subcontractors operating their own QMS, linked to and coordinated under the Contractor’s QMS.
- Suppliers and Subcontractors operating under the Contractor’s QMS.

System requirements
QMS: Plan, develop and maintain a documented QMS conforming to this worksection, Annexure A and AS/NZS ISO 9001.

System purpose: To make sure of the following:
- The proposed work method is consistent with the specification requirements.
- ITPs and checklists are adequate and complete.
- Approved work methods are followed.
- The Superintendent adequately checks Hold and Witness Points.

Format: If the format of the QMS documents differ from the format of AS/NZS ISO 9001, provide a matrix outlining how the documented requirements are addressed by the QMS.

Management responsibility
Commitment: In the development a corporate QMS in conformance with AS/NZS ISO 9001 section 5, top management must perform the following:
- Focus on customer, statutory and regulatory requirements.
- Define authorities and responsibilities.
- Appoint QMR.
- Establish internal communication and review procedures.
- Make sure resources are available.

2.2 DOCUMENTATION REQUIREMENTS

General
QMS documentation requirements: Include the following:
- Quality policy and its objectives.
- Quality manual.
- Procedure documents.
- Work instructions.
- Forms.
- Quality plans.
- Specifications.
- Relevant external documents.
- Records.

Changes: Immediately implement changes to the project Quality plan and QMS if the following occurs:
- Specification requirements are not adequately addressed.
- Non-conformity resulting from the Quality plan or QMS.
- Audit initiates changes to the QMS.
- Practices have changed.

Records: Provide copies of any quality records within 14 days of request.

AS/NZS ISO 9001: Keep a copy on site at all times.

**Quality manual**

Requirement: To AS/NZS ISO 9001 clause 4.2.2 and AS/NZS ISO 10013 clause 4.4. Include the following in the Quality manual:
- Responsibility statements.
- Corporate policy.
- All applicable system requirement descriptions with reasons for those not regarded as applicable.
- Standard method statements.
- Standard ITPs.

**Project Quality plan**

Requirement: Provide and maintain a Quality plan to AS/NZS ISO 9001 and AS/NZS ISO 10005. Provide the following:
- Progressive documentation of new procedures as the work types become evident.
- Planning and control systems: Describe critical processes and activities and provide verification for product control.
- Coordination with the Contractor’s corporate Quality manual.
- Project specific quality system: Inform and direct personnel about the specific quality practices, resources, sequence of activities, controls and checks that must be implemented during the works.
- Controlled conditions: Documentation to explain how each work process will be carried out.
- Organisation structure: Include details of the specific responsibilities and authorities of the key personnel nominated for the management of the project.
- QMR: Include the person’s qualifications, technical experience and present position, together with responsibilities and authorities to resolve quality matters.
- Details of the personnel or contracted testing organisations who will be conducting each type of compliance inspection of testing of completed works, their experience, qualification and responsibilities.
- Details of the person authorised to change construction processes on site.
- ITPs to verify the works conform with the contract documents.
- Purchasing quality requirements:
  - Critical characteristics of purchased products that affect the quality of the final product.
  - Method of communication with suppliers.
  - Methods used to evaluate, select and control suppliers.
  - The facilities and services that will be outsourced.
  - Material samples: The approved sample is the quality benchmark.
- Purchasing quality verification: Conform to the following worksections:
  - 0162 Quality (Supply).
  - 0163 Quality (Delivery).

**Control of documents**

Document control: Conform to AS/NZS ISO 9001 clauses 4.2.3 and 4.2.4, and AS/NZS ISO 10005 clauses 5.6 and 5.7.

Register: Maintain a register of each part of the Quality plan. Register the number, date and recipient(s). Reissue to all registered when the Quality plan is changed, superseded or recalled as required.
 Requirement: Document within the Quality plan the method of keeping quality registers, tracking and handling of NCR’s, NNC’s and site correspondence.

Quality register: Implement and maintain systematic records, indexed and filed so they are retrievable and accessible to the Superintendent or an appointed quality auditor within one working day of request.

Register of method statements: Provide a register listing all method statements (both standard and job specific) including the title, identifier and revision status.

Location: State in the quality plan where records are to be located.

WAE: Keep records of any amendments to design details for inclusion in WAE drawings.

Quality audit schedule: Include a quality audit schedule with the project quality plan in conformance with AS/NZS ISO 19011.

Audit reports: Provide copies to the Superintendent as requested.

2.3 RESOURCE MANAGEMENT

General
Conformance: Conform to AS/NZS ISO 9001 section 6 and AS/NZS ISO 10005 section 5.8.

Provision of resources: Determine and provide resources for the successful implementation of the project Quality plan.

Limited availability: If a resource has limited availability, identify how demand from other projects/contracts will be satisfied.

Human resources: Provide personnel with the appropriate education, training, skills and experience for the project.

Infrastructure: Identify, provide and maintain the infrastructure required to achieve product conformity.

Work environment: Establish and manage the work environment to achieve product conformity.

2.4 PRODUCT REALISATION

Planning and design
Planning: Conform to AS/NZS ISO 9001. Determine the following:
- Quality objectives and requirements for the product.
- Processes and documents specific to the product.
- Required verification, validation, monitoring, measurement, inspection, test activities and the criteria for acceptance of the product.
- Records required as evidence that the realisation processes and resulting products conform.

Design: Design and/or verify the following, to conform with the Technical Specifications and AS/NZS ISO 9001:
- Temporary structures.
- Checking of permanent structures for construction loadings.
- Lifting devices for manufactured items.
- Alternative permanent structures or structural components proposed.
- Concrete mixes for structures and pavements and asphalt mixes for permanent works.
- Traffic control, temporary roadways and detours.
- Permanent works where design is nominated in the contract.

2.5 CONSTRUCTION AND SERVICE PROVISION

Control
Method statements: Detail the construction processes for all activities scheduled in Construction activities table.

Content: Include the following:
- Sequence of operations.
- Documented procedures and work instructions.
- Types of equipment required, capability, maintenance and calibration.
- Any special working environment requirements.
- Personnel competency and skills required.
- Criteria for workmanship and tolerances.
- Materials required.
- Safety requirements.
- Reference documents.
- Records produced.
- Planning.
- Verification measures.
- Inspection, test and control points.
- Monitoring of continuous suitability.
- Responsibility for implementing and monitoring work process controls and rectifying any
deficiencies.

Checklist: Provide a checklist, including the relevant inspection and test points, surveying control
points, Hold Points, Witness Points and the officer responsible to verify each check point.

System audit: Audit each method statement whilst the process is in effect.

Absence of a method statement: If a method statement for a particular activity is required and there is
none submitted, this will generate a Hold Point.

**Lot identification**

Lots: Divide all items of work into lots as follows:

- Limits: Before sampling, choose lots within the limits given in the particular technical specification.
- Lot size: Not exceeding one day’s output for each work process being tested.
- Lot numbering: Allocate unique lot numbers compatible with the construction program. Use lot
  numbers to be identifiers on all QMS data.
- Field identification: Physically identify each lot, clearly identify lot boundaries. Maintain identification
  until the lot has achieved the specified quality.

Work on a lot: Do not commence work until the field identification is established.

Lot boundaries: When boundaries of a lot change, update the quality register.

Lot identification system: Make sure all site records and sample numbering systems allow easy
identification of all test results and the materials incorporated in the works.

**Traceability**

General: Provide and maintain records of components for audit. Include the following traceability in the
records:

- Concrete: Start the trace at the batch plant and finish at the location where the concrete is
  incorporated in the works.
- Asphalt: Start the trace at the batch plant and finish at the location where the asphalt is incorporated
  in the works.
- Stabilised material: Start trace at the batch plant and finish at the location where the material is
  incorporated in the works.
- Steel: Start the trace at the steelworks and finish at the location where the steel is incorporated in
  the works. Record the steel heat number, testing details and final location of installation.
- Batch details: Record all batch quantities, mix and dispatch time, testing details and location of
  placement.

**Control of monitoring and measuring equipment**

Equipment accuracy: Maintain inspection, testing and measuring equipment capable of producing the
degree of accuracy specified in the referenced test methods.

Records: Demonstrate accuracy with regular records of calibration.
2.6 MEASUREMENT AND ANALYSIS

General
Testing: Conduct testing by a NATA registered laboratory accredited for those test methods and sampling procedures. Include the latest NATA advice of the terms of registration and current signatories within the quality plan.
Sampling: Conduct by personnel from the NATA registered laboratory which has been accredited for that sampling procedure and supervised by the approved signatory from that laboratory.
Test results: Report on NATA endorsed test documentation which includes a statement by the approved signatory certifying that the correct sampling procedures have been followed.

Reinstatement: Reinstate all core holes, test holes, excavations and any other disturbance resulting from any testing activity to the standard within the Technical Specification.
Lots: All conformance inspections and tests are based on lots. In all cases the samples are considered representative of the lot and all test results are required to meet the appropriate tolerances for the lot.
Sampling locations: Propose sampling locations for approval prior to proceeding.
In-process and conformance inspections: Required for all works to confirm conformance. Performed by a responsible officer nominated in the checklist and certified by the Contractor's QMR

Frequency of testing
Minimum frequency of testing: Must be not less than that stated in the relevant worksection and as listed within the sub-annexures of Annexure C.
Reduced frequency of testing: Submit proposal for approval with supporting statistical analysis verifying consistent conformance to the quality requirements.

Inspection and test plans
Document: Include within the quality plan all inspections, tests and documentation necessary to demonstrate that the works conform.
ITP: Establish and progressively maintain a system to demonstrate inspection and testing in conformance with AS/NZS ISO 9001 clause 8.2.4.
Minimum information for ITP (or ITP forms): Include the following:
- Person responsible for carrying out in-progress and final inspections or testing and at what stage of works these are to be carried out.
- Proposed inspection or test methods and recording of results.
- Acceptance criteria and frequency of inspection and testing.
- Specification tolerances.
- Person responsible for reviewing inspection and test results, evaluating whether work conforms, determining future action when work does not conform and closing out work lots.
- Measures to control nonconformity.
- When statistical analysis of test results is required.
- Person responsible for performing the final review of results to confirm that all inspections and tests have been carried out to verify complete conformity for each lot.
- Time limits for testing, submission, Hold Points and Witness Points that are nominated in the specifications.
- Identification of Hold Points or Witness Points.
- Check list for each lot.

Test Register
Lot identification register: Include the following information:
- Three dimensional surveyed location of the lot to include the chainage of the start and finish points, lateral location and layer location and/or the particular structure (e.g. pier or abutment number, concrete placement number, etc.).
- Indication of conformance or non-conformance.
- Summary of test results.
- Location of test sites including test identification numbers.
- For nonconforming lots, allocate a new number to the resubmitted/subdivided lot(s), ensure it also references the original lot number.

Inspection and test status: Show either on the ITP records or physically mark in the field the status of conformance for each lot.

**Random sampling**

Requirement: Use random sampling techniques for each lot for the control of compaction of each continuous layer of earthworks, flexible pavement and asphalt.

Test locations: Determine test locations for random sampling in conformance with AS 1289.1.4.1.

Location restrictions: Do not restrict sampling to locations dimensioned or otherwise defined for setting out the works in the drawings or specification.

### 2.7 MONITORING AND MEASUREMENT

#### Hold points

Notice of inspection: Notify the Superintendent in advance of a Hold Point being reached.

Requirements for approval to proceed: In conformance with the following:

- Provide the information required by the technical specification.
- Certify that the particular lot/process is conforming.
- Certify that all underlying and adjacent lots affected by the lot in question are conforming.
- Submit the appropriate form (checklist, NCR or NNC) at least 24 hours prior to the time the Contractor wishes to proceed with the placement/construction of the next lot, unless some alternative arrangements have been agreed with the Superintendent.

Witness point: If the Hold Point has resulted from an NCR or NNC, the Superintendent’s approval may be conditional on a Witness Point being included.

### 2.8 SURVEYING CONTROL

#### Requirements

Survey control: A separate system requirement to include all measurement, calculation and recording procedures necessary to:

- Set out the works.
- Verify conformance with the drawings and specification in relation to dimensions, tolerances and three dimensional position.
- Determine lengths, areas or volumes of materials or products, where required for measurement of work.

Method Statement: Describe the control parameters for special processes which cannot be fully verified by inspection and testing. Address all potential errors that could be introduced by survey methods.

Surveyor qualifications: Appoint qualified surveyors to supervise and take responsibility for all surveying control.

Equipment: The procedures and equipment used must be capable of attaining the tolerances nominated in the specification.

Survey locations: Surveying for conformance verification purposes is not restricted to the locations used to set out the works.

Conformance verification surveys: Perform verification surveys as soon as practicable, but not later than one working day after the lot or component has become accessible for survey.

#### Control of documentation

Survey conformance report: Submit a survey conformance report for each lot or component where design levels, position and/or tolerances have been specified. Refer to the relevant worksection of the technical specification to establish if a Hold Point is generated before further works can commence.

Information required: Indicate the difference between actual and specified values for position and level (defined by co-ordinates or chainage and offset) and provide certification by the qualified surveyor responsible for the verification survey.
Survey records: Provide all survey records including equipment calibration records and nonconformity registers.

Field book pages: Include the following, clear labels, date and signature by the surveyor, cross indexed references to equipment used and lot/component identification. Survey conformance reports produced must reference the relevant field book page numbers.

Retain: Retain any automatically recorded data used for verification surveys, including a printout of both raw (field) data and reduced data.

Audit trail: Prepare procedures to describe the records system, to include, the method of storing and indexing of electronic records and the title of any computer software used for the reduction of survey measurements and calculations.

2.9 CONTROL OF NON-CONFORMING WORKS

General
Detection and reporting: Report any works that depart from the documented requirements on a NCR form within two working days of detection, including the proposed disposition. A sample NCR form is included in Annexure B.

Extension of time: The deliberation on disposition of a non-conformance does not justify an extension of time to the contract period under any circumstances.

Proposed disposition: Include any of the following actions:
- Proposed additional works to bring the lot up to the specified standard.
- Proposed replacement of all or part of the lot to bring it up to the specified standard.
- A request to use the lot for a reduced level of service, if such a clause exists in the relevant worksection of the Technical specification.
- For incidental defects, a request that the Superintendent accept the lot without alteration, as an exception with or without alteration to the respective unit rates.

Monitoring and measuring
NCR: Generates an automatic Hold Point until conformance has been achieved and the Superintendent has signed authorisation to proceed.

Progress: Do not cover any nonconforming works until a disposition has been accepted/approved and implemented.

Reworking: If the non-conformance can be overcome by reworking the lot with the original process, an NCR will not be required. However, maintain a record of the non-conformance to aid continual improvement.

Verification: Reworked/replaced lots to conform to the specified requirements.

Discrepancy: The Superintendent’s test results will prevail where there is any discrepancy in test results.

Control of documentation
CAR: Issued by the Superintendent for non-conformance to the Contractor’s quality system or methods. Unless specifically stated, this will not create a Hold Point.

NNC: Issued by the Superintendent for product non-conformance. This will immediately create a Hold Point and the Contractor is required to submit an NCR.

NCR form: Example form provided in Annexure B. If using alternative form it must include the following:
- Details of non-conformance.
- Proposed disposition.
- Provision for attachments.
- QAR comment/approval/rejection.
- Completion of disposition.
- Release of Hold Point.
- Corrective action to improve quality.
- Close out of NCR.
Authorised representative: All actions are to be signed off by authorised representatives of the Contractor and Superintendent as applicable (i.e. QAR and QMR).

Register: Implement and maintain a suitable numbering and registration system for all NCRs and NNCs, including cross referencing as required.

Corrective action

Requirement: Document procedure for corrective action to quality plan in conformance with AS/NZS ISO 9001 clause 8.5.2.

Proposed corrective action: Indicate on the NCR form the corrective action appropriate to ensure that the quality plan is effective in avoiding a recurrence of the non-conformance and continues to be effective.

2.10 COMPLETION

Finalisation

WAE: Submit WAE drawings for all works upon practical completion.

Register: Submit a copy of the quality register within 14 days of the date of practical completion. If requested, also provide a copy of all quality records.

Defects liability period: All quality related issues must be resolved and closed out before the end of the defects liability period.

Maintenance

Documents: Provide copies of all:
- Commissioning records.
- Operation manuals.
- Maintenance manuals.
- Product warranties.

Review

Requirement: Organise meeting(s) at end of contract to review the quality system and technical issues encountered on the project and the lessons to be learned for future projects. Review to focus on:
- The identification of non-conformances and the implementation of corrective action.
- Issues arising from inspections and audits.
- Specification issues.
- Design and technical issues.
- Safety issues.

Timing: Hold meeting(s) as close to practical completion as possible, before key personnel move on, so that they are still available to participate in review process.

Documentation: Determine procedures for end of contract review within quality plan.

3 MEASUREMENT AND PAYMENT

3.1 MEASUREMENT

General

Payments made to the Schedule of rates: To the 0152 Schedule of rates – projects worksection, this worksection, the drawings and Pay items 0161.1, 0161.2.

In any statement of an amount for payment in a Progress Certificate issued under the General Conditions of Contract, the Superintendent shall not be obliged to include in any such certificate, and the Principal shall not be obliged to pay for, any work for which evidence of conformance has not been submitted as set out in this clause.

Certification and payment shall not be unreasonably withheld, however, where the relevant evidence of conformance has not been submitted due only to the normal delays in processing, testing, analysis and reporting. In this case the Contractor’s payment claim shall set forth the lots claimed for payment but for which conformance reports have not been submitted and certifies that conformance reports for those lots will be submitted prior to the next payment claim.
Unpriced items: If any item, for which a quantity of work is listed in the Schedule of rates, is not priced, make due allowance in the prices of other items for the cost of the activity.

**Methodology**

The following methodology will be applied for measurement and payment:

- Progress payments for **Pay item 0161.1** are calculated on the basis of 30% of the Lump Sum when the complete Quality plan is available and the remainder on pro rata based on the monthly value of work done.
- Progress payments for **Pay item 0161.2** are made pro rata on the monthly value of work done.
- Include any costs associated with preparing and conforming to the supply Quality plan, see the **0162 Quality (Supply)** worksection, in the unit price for product supply.
- Include any costs associated with preparing and conforming to the delivery Quality plan, see the **0163 Quality (Delivery)** worksection, in the unit price for product delivery.

### 3.2 PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0161.1 Quality system documents and records</td>
<td>Lump Sum</td>
<td>All costs associated with the preparation, submission and implementation of the Quality plan and Inspection Test Plans, the provision of the QMR on site and the maintenance of the quality records during the course of the Contract.</td>
</tr>
<tr>
<td>0161.2 Manuals (Including As built information)</td>
<td>Lump Sum</td>
<td>All costs associated with the preparation and submission of Operation and Maintenance manuals including the preparation of Auto-CAD as-built drawings to the satisfaction of the superintendent. All costs associated with preparation and submission of a fully populated asset register to the satisfaction of the superintendent.</td>
</tr>
<tr>
<td>0161.3 Insurance</td>
<td>Lump Sum</td>
<td>All costs associated with Insurance as stipulated within Contract documentation.</td>
</tr>
<tr>
<td>0161.4 Construction Survey (including set-out and controls)</td>
<td>Lump Sum</td>
<td>All costs associated with the survey control, setout and as-constructed survey during the course of the Contract.</td>
</tr>
</tbody>
</table>
4 ANNEXURES

4.1 ANNEXURE A - PROJECT QMS DOCUMENTATION FLOW CHART

- Specification for Contract Quality system
- Technical Specification
- 0147 Conditions of contract

AS/NZS ISO 9001

Quality Manual Annexures

Method Statements

Inspection and Test Plans

Checklists

Company Quality Manual Including SYSTEM REQUIREMENT DESCRIPTIONS

Standard Method Statements

Inspection and Test Plans

Standard Checklists

QUALITY PLAN

JOB SPECIFIC DOCUMENTS

SELECTED STANDARD CORPORATE DOCUMENTATION
### 4.2 ANNEXURE B – SAMPLE NON-CONFORMANCE REPORT (NOT TO BE USED)

<table>
<thead>
<tr>
<th>NON-CONFORMANCE REPORT</th>
<th>NCR No: .............................................</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Date: ...............................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTRACT:  ..............................................................................................................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCT OR SERVICE:  ...................................................................................................................................</td>
</tr>
<tr>
<td>SUBCONTRACTOR (if appropriate):  ......................................................................................................................................</td>
</tr>
<tr>
<td>INSPECTION &amp; TEST PLAN (ITP) No:  ..................................................................................................................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOT No AND DESCRIPTION/LOCATION:  ..................................................................................................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS A SUPPLEMENTARY REPORT ATTACHED?:   YES □   NO □</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRINCIPAL:  APPROVED □   REJECTED □</th>
</tr>
</thead>
</table>
| COMMENT:  ...............................................................................................................................................
|..............................................................................................................................................................|
|..............................................................................................................................................................|
|..............................................................................................................................................................|

| PRINCIPAL SIGNATURE: ..........................................................   DATE: .................................... |
| DISPOSITION COMPLETED |
| (Contractor) ..........................................................   DATE: .................................... |
| RELEASE OF HOLD POINT |
| (Superintendent) ..........................................................   DATE: .................................... |
| CLOSE OUT OF NON-CONFORMANCE REPORT |
| (Contractor QMR) ..........................................................   DATE: .................................... |
4.3 ANNEXURE C - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

General
Lot sizes and test frequency: To the following Sub-annexures.
Contract requirements summary: To the Contract requirements summary table.
Certification: If material/product quality certification can be obtained from the supplier, documented tests need not be repeated.
Large projects: The Superintendent may relax the testing frequency after the Contractor has demonstrated consistent conformance to the quality requirements.

Contract requirements summary table

<table>
<thead>
<tr>
<th>Sub-annexure</th>
<th>Reference Worksection</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 Earthworks (Roadways)</td>
<td>1112 Earthworks (Roadways)</td>
</tr>
<tr>
<td>C3 Pavement moisture control</td>
<td>1171 Subsurface drainage, 1172 Subsoil and foundation drains, 1173 Pavement drains, 1174 Drainage mats</td>
</tr>
<tr>
<td>C4 Stabilisation</td>
<td>1113 Stabilisation</td>
</tr>
<tr>
<td>C5 Flexible pavement base and subbase</td>
<td>1141 Flexible pavement base and subbase</td>
</tr>
<tr>
<td>C8 Asphalitic concrete</td>
<td>1144 Asphalitic concrete</td>
</tr>
<tr>
<td>C9 Placement rolled concrete subbase</td>
<td>1131 Rolled concrete subbase</td>
</tr>
<tr>
<td>C14 Ready mixed concrete production and supply</td>
<td>0319 Minor concrete works, 1131 Rolled concrete subbase, 1132 Lean mix concrete subbase, 1133 Plain and reinforced concrete base, 1134 Steel fibre reinforced concrete base, 1135 Continuously reinforced concrete base</td>
</tr>
<tr>
<td>C17 Pavement markings</td>
<td>1191 Pavement markings</td>
</tr>
<tr>
<td>C19 Minor concrete works</td>
<td>0319 Minor concrete works</td>
</tr>
<tr>
<td>C20 Landscape – roadways and street trees</td>
<td>0257 Landscape – road reserve and street trees</td>
</tr>
<tr>
<td>C23 Water supply - reticulation</td>
<td>1341 Water supply - reticulation (Construction)</td>
</tr>
<tr>
<td>C24 Sewerage systems - reticulation</td>
<td>1361 Sewerage systems - reticulation (Construction)</td>
</tr>
<tr>
<td>C25 Water supply - pump stations</td>
<td>1342 Water supply – pump stations (Construction)</td>
</tr>
<tr>
<td>C26 Sewerage systems - pump stations</td>
<td>1362 Sewerage systems – pump stations (Construction)</td>
</tr>
</tbody>
</table>

Sub-annexure C5 Flexible pavement base and subbase
(1141 Flexible pavement base and subbase)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### A01 SEWER PUMP STATION (LORD/CHAPPLE STREET) UPGRADE

**Contract No. 44-19**

#### Base and subbase supply

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Material quality – Supplier's documentary evidence and certification</td>
<td>1 contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Particle size distribution</td>
<td>1 per 1,000 t</td>
<td>AS 1289.3.6.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Liquid limit</td>
<td>1 per 1,000 t</td>
<td>AS 1289.3.1.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Plasticity index</td>
<td>1 per 1,000 t</td>
<td>AS 1289.3.3.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Linear shrinkage</td>
<td>1 per 1,000 t</td>
<td>AS 1289.3.4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Maximum dry compressive strength</td>
<td>1 per 5,000 t</td>
<td>AS 1141.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-CBR</td>
<td>1 per 5,000 t</td>
<td>AS 1289.6.1.1</td>
<td></td>
</tr>
<tr>
<td>Placement</td>
<td>Geometry: Alignment &amp; level</td>
<td>One layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Width and surface trim</td>
<td>2,000 m² or max. 1 day's placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compaction/moisture content/dry density testing</td>
<td>One layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5,000 m² or max 1 day's placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-annexure C19 Minor concrete works (0319 Minor concrete works)</td>
<td></td>
<td></td>
<td>10 per 5,000 m²/layer or 3 per lot if less</td>
<td>T130 AS 1289.5.2.1 AS 1289.5.3.2 AS 1289.5.4.1 AS 1289.5.8.1</td>
</tr>
</tbody>
</table>

#### Sub-annexure C19 Minor concrete works (0319 Minor concrete works)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade</td>
<td>Compaction</td>
<td>1000 lin. m or 1000 m²</td>
<td>1 per 200 lin. m or 200 m²</td>
<td>AS 1289.5.4.1</td>
</tr>
<tr>
<td>Gravel subbase construction</td>
<td>Compaction</td>
<td>1 day's placement</td>
<td>1 per 100 lin. m or 100 m²</td>
<td>AS 1289.5.4.1</td>
</tr>
<tr>
<td></td>
<td>Subbase geometry</td>
<td>1 day's placement</td>
<td>1 per 25 lin. m</td>
<td>3 m straigtedge</td>
</tr>
<tr>
<td>Steel supply</td>
<td>Material quality – Supplier's documentary evidence and certification</td>
<td>1 delivery</td>
<td>1 per production batch</td>
<td></td>
</tr>
<tr>
<td>Concrete supply</td>
<td>Refer sub-annexure C14: Ready-mixed concrete production and supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consistency – slump</td>
<td>15 m³</td>
<td>1 per load</td>
<td>AS 1012.3.1</td>
</tr>
<tr>
<td></td>
<td>Compressive strength (7 and 28 day)</td>
<td>15 m³</td>
<td>2 pairs per 15 m³</td>
<td>AS 1012.1 AS 1012.8.1 AS 1012.9</td>
</tr>
<tr>
<td>Concrete placement</td>
<td>Finished levels</td>
<td>15 m³</td>
<td>1 cross section per 15 m</td>
<td>Survey and 3 m straigtedge</td>
</tr>
<tr>
<td></td>
<td>Surface dimensions</td>
<td></td>
<td>As required to confirm design dimensions</td>
<td>measure</td>
</tr>
<tr>
<td>Backfilling</td>
<td>Material quality:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Maximum particle size</td>
<td>1 contract/ material type</td>
<td>1 per 200 m³ or lot</td>
<td></td>
</tr>
</tbody>
</table>
### Activity Key quality verification requirements Maximum lot size Minimum test frequency Test method

- Plasticity index 1 contract/ material type 1 per 200 m³ or lot AS 1289.3.3.1

Compaction 1 day's work or max 200 m³ 1 per 200 m³ or lot AS 1289.5.4.1

### Sub-annexe C24 Sewerage system - reticulation (1361 Sewerage system - reticulation (Construction))

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials supply</td>
<td>Material quality – Supplier’s documentary evidence and certification of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ductile iron pipes 1 contract</td>
<td>1 per contract</td>
<td></td>
<td>AS/NZS 2280 and AS 2129</td>
</tr>
<tr>
<td></td>
<td>- Precast access chambers 1 contract</td>
<td>1 per contract</td>
<td></td>
<td>AS 4198</td>
</tr>
<tr>
<td>Siting and excavation</td>
<td>Geometry 1 line/ structure</td>
<td>1 per line/ structure</td>
<td></td>
<td>Survey</td>
</tr>
<tr>
<td>Bedding</td>
<td>Material quality – grading 1 contract</td>
<td>1 per contract</td>
<td></td>
<td>AS 1152</td>
</tr>
<tr>
<td>Laying and jointing of pipes, access chambers, structures</td>
<td>Geometry 1 line</td>
<td>1 per line</td>
<td>Survey</td>
<td></td>
</tr>
<tr>
<td>Cast in situ access chambers</td>
<td>Material quality:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tri-calcium aluminate content 1 contract</td>
<td>1 per contract per source</td>
<td>AS 3972</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fineness index 1 contract</td>
<td>1 per contract per source</td>
<td>AS 3972</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Minimum cement content 1 contract</td>
<td>1 per contract per source</td>
<td>AS 3972</td>
<td></td>
</tr>
<tr>
<td>Acceptance test of gravitation mains &amp; access chambers</td>
<td>Compressed air testing 1 line</td>
<td>1 per line</td>
<td>As documented in CMDG D12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hydrostatic testing 1 per test length</td>
<td>1 per line</td>
<td>As documented in CMDG D12</td>
<td></td>
</tr>
<tr>
<td>Backfill and compaction</td>
<td>Compaction 1 line</td>
<td>1 per 2 layers max 100 lin. m</td>
<td>AS 1289.5.7.1</td>
<td></td>
</tr>
</tbody>
</table>

### Annexure D – Matrix for compliance with AS/NZS ISO 9001 and this specification.

<table>
<thead>
<tr>
<th>Clause</th>
<th>AS/NZS ISO 9001</th>
<th>Records</th>
<th>Project quality plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>Control of documents</td>
<td>- List of who holds issued documents.</td>
<td>- Description of how quality records will be stored</td>
</tr>
<tr>
<td>Clause</td>
<td>AS/NZS ISO 9001</td>
<td>Records</td>
<td>Project quality plan</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------</td>
<td>---------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Register of current document issued/revision.</td>
<td>and maintained.</td>
</tr>
<tr>
<td>2.3</td>
<td>Management responsibility</td>
<td>- Corporate QMS.</td>
<td>- List of responsibilities and authorities for Quality Assurance activities.</td>
</tr>
<tr>
<td>2.4</td>
<td>Resource management</td>
<td>- Provision of resources.</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Design and development</td>
<td>- Design records.</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Control of production and service provision</td>
<td>- Procedures describing how to control work processes. - Records demonstrating effectiveness of work process controls. - Records of process validation when applicable.</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Identification and traceability</td>
<td>- Product batch/traceability records. - Lot identification register.</td>
<td>- Method of maintaining traceability. - Method of subdividing the work into lots and allocating lot numbers.</td>
</tr>
<tr>
<td>2.6 and 2.9</td>
<td>Control of monitoring and measuring devices</td>
<td>- Calibration certificates. - Survey control.</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Inspection and test planning</td>
<td>- ITP's. - Records/checklists of inspection and testing. - Conformity reports for each completed lot.</td>
<td>- Procedure for inspections, testing and closing out work lots. - How to keep records of inspection and test results. - ITP and forms. - Method for identifying, controlling and verifying inspection and test status.</td>
</tr>
<tr>
<td>2.8</td>
<td>Monitoring and measurement</td>
<td>- Hold Point and Witness Point schedule. - Inspection and test records.</td>
<td>- Method for release of Hold Points.</td>
</tr>
<tr>
<td>2.10</td>
<td>Control of nonconforming product</td>
<td>- Non-conformity reports. - Notifications of non-conformity register.</td>
<td>- Method of registering and closing non-conformance.</td>
</tr>
<tr>
<td>Corrective action</td>
<td>- Corrective action reports and register. - Corrective action requests.</td>
<td>- Method of ensuring against corrective action.</td>
<td></td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide work site landscaping as documented.

1.2 CROSS REFERENCES

General
Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates (Construction).
- 0161 Quality management (Construction).
- 1101 Traffic management.
- 1102 Control of erosion and sedimentation (Construction).

1.3 STANDARDS

General
Storage and handling of pesticides: To AS 2507.
Tree stock: To AS 2303.

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:

Definitions
General: For the purposes of this worksection the definitions given in AS 2303 and the following apply:
- Ameliorant: Material used to make or improve soil.
- Anionic bitumen: A type of bituminous emulsion where dispersed particles comprise a bituminous binder and are negatively charged.
- Size Index: Numerical expression of the size or physical bulk of a tree stock above ground.

1.5 SUBMISSIONS

Execution details
Ameliorants: If required to include ameliorants, recommend the source of ameliorant material, rates and methods of incorporation.
Plant material: Submit details of proposed fertiliser to be used.
Soil conditioning: If other than gypsum is proposed, submit details.

2 MATERIALS

2.1 TOPSOIL

General
Topsoil: To AS 4419 and as follows:
- Free of refuse or materials toxic to humans, animals or plants.
- Maximum soluble salt content: 0.06% by mass.
Health warning: To AS 4419, on packaging or invoice for bulk supply.

**Management of stockpiles and batters**
Requirement: To **Management of stockpiles and batters** in 1102 Control of erosion and sedimentation (Construction) worksection.

**Hydromulch**
Material: Straw, chaff, wood fibre paper pulp finely shredded to a maximum dimension of 10 mm.
Prohibited material: Meadow hay and weeds. If using paper pulp, do not exceed 50% by mass of total mulch.
Binder: Grade ASS, slow setting anionic bitumen to AS 1160.
Material: Straw matrix.
Prohibited material: Meadow hay and weeds.
Binder: Grade ASS slow setting anionic bitumen to AS 1160.
Straw mat finished thickness: > 20 mm.

### 2.2 PLANT MATERIAL

**Seed**
Requirement: Conform to the following:
- Grass and clover: Pre-packed commercially with an accompanying certificate of germination.
- Native seed: Deliver to the site in separate lots for each species and variety, clearly labelled to show species, variety and weight.
Storage: Do not take possession of the seed more than seven days before sowing is to occur. Store seed in clean, airtight containers and keep away from direct sunlight. Do not expose seed to the elements at any stage during storage.
Replacement: Replace if seed batch is not true to type.

**Turf**
Description: 25 mm depth of dense, well rooted, vigorous grass growth with 25 mm depth of topsoil and free of weeds, soil pests and diseases.
Prohibited material: Kikuyu grass.
Supply: As rolls in long lengths of uniform widths, in sound unbroken condition.
Width of rolls: > 300 mm.

### 2.3 TESTING

**Quality**
Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES.**
Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

### 3 EXECUTION

#### 3.1 GENERAL

**Transport and storage**
Requirement: Inspect all plants at the time of delivery and reject non-conforming plants.

**Program**
Requirement: Conform to the following:
- Between September and May: Plant exposed surfaces before the area exceeds 1 ha.
- Between June and August: Do not carry out planting to exposed surfaces without approval.
Herbicide treatment: Spray herbicide as follows:
- Type: Glyphosphate.
- Rate: 9 litres/200 litres water/ha.
- Program: Maintain sprayed areas undisturbed for 2 weeks.
Pesticide treatment: In the following form, as documented:
  - Liquid:
    - Application rate: 5 litres/hydromulch/ha.
    - Powder: 10 kg/ha.
Herbicides and pesticides: To the Australian Pesticides and Veterinary Medicines Authority (APVMA) register.
Soil conditioning: Provide as follows:
  - Gypsum: Conform to the following:
    - Application rate: 400 g/m².
    - Application: Conform to the following:
      * Spread evenly over the subsoil by a mechanical spreader and topsoil on the same day.
      * Thoroughly mix into the topsoil whilst the topsoil is being removed from stockpiles.
      * Apply conditioners other than gypsum to the supplier’s recommendations.
Fertiliser treatment: Provide as follows:
  - Application rate: 1000 kg/ha.
Seed mixing: Provide as follows:
  - Mix, pre-treat and place seed in the sowing equipment for each operation on site.
  - Sow seed on the day of mixing with pesticide.
Watering: Conform to the following:
  - Potable or sourced from areas without toxins, pollutants or any substance which may adversely affect plant growth.
  - Initial watering: To a uniform moisture condition without run-off.
  - After turfing: Re-water to a uniform moisture condition without run-off.
  - After sowing: If required, re-water to a uniform moisture condition without causing rills in the surface, daily for 15 days.
  - Excessive rilling: If watered areas result in excessive rilling, rehabilitate by re-preparing and re-sowing the affected area.

3.2 SLOPES FLATTER THAN 3H TO 1V

Preparation of the surface
Cultivation: Before applying topsoil, tine to a depth of 200 mm to produce a loose surface and remove all large stones, rubbish and other materials that may delay germination.

Topsoil
Application: Apply uniformly to an average compacted thickness of 50 mm with a minimum compacted thickness of 30 mm at any location.
Cultivation depth: 50 mm for a roughened surface with soil lumps not exceeding 50 mm.

Application of pesticide
Timing: Immediately before sowing.
Pesticide type: Powder form.
Application: Mix thoroughly with the seed, in conformance with EXECUTION, GENERAL, to the equivalent mass of seed to be spread on 1 hectare of the surface.

Grassing
Seeding:
  - Application: Distribute evenly, by a mechanical seeder following the finished contours wherever possible.
  - Depth: 5 mm as sown, or 5 mm cover by raking or harrowing.
  - Fertiliser: Apply concurrently with seeding, as documented.
Turfing:
  - Laying: On the prepared topsoiled surface.
- Runs of turf: Butt runs of turf hard against each other and place perpendicular to the direction of water flow.
- Slopes 5:1 to 3:1: Peg turf and remove pegs when established.

Seams: Topdress with topsoil.

Topdressing:
- Timing: 4 to 6 weeks after laying turf.
- Requirement: Correct any undulations or unevenness in the established turf.

Maximum slope for areas to be maintained by a ride-on mower with a 2 m wide deck: 4:1.

3.3 SLOPES STEEPER THAN 3H TO 1V

Methods
General: Vegetate slopes by one of the following methods, as documented:
- Apply topsoil and hydromulch.
- Apply topsoil, hydroseed and straw mulch.
- Hydroseed.

Preparation of the surface
General: Remove all loose material from fill batters and cut batters.
Timing: No more than seven days before seeding.
Method: If batters are not stepped, prepare the surface by dragging a steel chain of 30 kg/m minimum

Topsoil
Application: Conform to the following:
- General: Apply uniformly to an average thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.
- Stepped batters: Loosely fill with topsoil.

Hydromulching or hydroseeding
Watering: Water dry surfaces with a fine spray before applying the hydromulch.

Pesticide:
- Timing: Apply during preparation of the hydromulch or hydroseed slurry.
- Pesticide type: Liquid.

Equipment: Clean and free of contamination from previous operations.
Mix: Add materials as documented to the slurry storage tank and agitated to maintain a uniform consistency during application.
Application: Uniformly over the whole surface.

Weather conditions: Do not apply hydromulch or hydroseed under the following weather conditions at the site:
- Temperature: > 35°C.
- Winds exceed: 15 km/hr.
- Surface is too wet.
- During rain periods or when rain appears imminent.

Wetting agent:
- Application rate: 1 litre/1000 litres of mix water.

Hydromulching or hydroseeding table

<table>
<thead>
<tr>
<th>Material</th>
<th>Application rate per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydromulching</td>
</tr>
<tr>
<td>Vegetable mulch (kg)</td>
<td>1500</td>
</tr>
<tr>
<td>Water (L)</td>
<td>35,000</td>
</tr>
<tr>
<td>Binder (L)</td>
<td>1200</td>
</tr>
<tr>
<td>Wetting agent (L)</td>
<td>35</td>
</tr>
</tbody>
</table>
Straw mulching
Application: Apply uniformly by a suitable blower.
Rate: 250 bales (each of 20 kg) of straw per hectare of surface.
Bitumen emulsion: Incorporate as a spray into the air stream of the mulch blower.
- Application rate: 2500 litres per hectare of surface.
Straw mat thickness: ≥ 20 mm at any location.

3.4 OPEN DRAINS
Preparation of the surface
Topsoil: Spread to an average compacted thickness of 50 mm, with a minimum compacted thickness of 30 mm at any location.
Timing: Complete vegetation within 7 days of the completion of open drain excavation.
Grass seeding
Application: Apply uniformly by one of the following procedures and conform to the Seed and turf table:
- Mechanical sowing.
- Hydromulching or hydroseeding.

4 ANNEXURES

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause and description</th>
<th>Type*</th>
<th>Submission/Inspection details</th>
<th>Submission/Notice times</th>
<th>Process held</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSPECTIONS, Notice</td>
<td>W</td>
<td>Preparation of surface for cultivation and conditioning.</td>
<td>2 days after preparing surface</td>
<td></td>
</tr>
<tr>
<td>Slopes and drains</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*H = Hold Point, W = Witness Point

4.2 ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES
Seed, imported soil and mulch supply

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported topsoil</td>
<td>Material quality:</td>
<td>10,000 m²</td>
<td>1 per 500 m³ *</td>
<td>AS 4419</td>
</tr>
<tr>
<td></td>
<td>- pH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Organic content</td>
<td>10,000 m²</td>
<td>1 per 500 m³ *</td>
<td>AS 4419</td>
</tr>
<tr>
<td></td>
<td>- Soluble salt content</td>
<td>10,000 m²</td>
<td>1 per 500 m³ *</td>
<td>AS 4419</td>
</tr>
<tr>
<td>Mulch for planting</td>
<td>Material quality</td>
<td>1 contract</td>
<td>1 Contract</td>
<td>AS 4454</td>
</tr>
</tbody>
</table>

* Note: or part thereof, per lot.

4.3 ANNEXURE - PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule Rate inclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0257.1 Vegetation Turfing</td>
<td>m²</td>
<td>All costs associated with the vegetation of surfaces with turfing including the cost of supply of imported topsoil and watering to establish</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide cast concrete, as documented.

Performance
Requirements:
- Conforming to the design details and performance criteria.
- Satisfying quality and inspection requirements.
- Compatible with documented finishes.

Design
Gladstone Regional Council Requirements
Formwork: The design of formwork, other than profiled steel sheeting composite formwork, is the contractor’s responsibility. Allow for dimensional changes, deflections and cambers resulting from the following:
- Imposed actions.
- Concrete shrinkage and creep.
- Temperature changes.
- The application of prestressing forces (if any).
Structural design: To AS 3600.

Precedence
Precedence: The technical requirements of, or any standard drawing provided by, the Gladstone Regional Council, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction)

1.3 STANDARDS

General
Formwork design and construction, formed surfaces: To AS 3610 and AS 3610.1.
Plywood formwork: To AS 6669.
Profiled steel sheeting, including shear connectors: To AS 2327.1.
Specification and supply of concrete: To AS 1379.
Reinforced concrete construction: To AS 3600.
Residential ground slabs and footings: To AS 2870.
Post-tensioning: To AS 3600.
Concrete structures for retaining liquids: To AS 3735.
Strand, bar and wire: To AS/NZS 4672.1.
Design, installation and testing of post-installed and cast-in fastenings: To SA TS 101.

1.4 INTERPRETATION

Definitions
General: For the purposes of this worksection the following definitions apply:
- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Anti-burst reinforcement: Reinforcement cage surrounding anchorages to control the tensile bursting stresses.
- Average ambient temperature: Average value of the daily maximum and minimum ambient
  temperatures over the relevant period at a site.
- Batch: A quantity of concrete containing a fixed quantity of ingredients and produced in a discrete
  operation.
- Concrete class – normal: Concrete which is specified primarily by a standard compressive strength
  grade and otherwise in conformance with AS 1379 clause 1.5.3.
- Concrete class – special: Concrete which is specified to have certain properties or characteristics
  different from, or additional to, those of normal-class concrete and otherwise in conformance with
  AS 1379 clause 1.5.4.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in AS 1379
  Table 1.2.
- Formwork:
  - Jump formwork: Incrementally moved formwork.
  - Lost formwork: Sacrificial formwork left in place.
  - Slip formwork: Continuously slipped or moving formwork.
  - Table forms: Prefabricated and re-usable formwork systems for slabs and beams.
- Green concrete: Concrete which has set but not appreciably hardened.
- Production assessment (concrete): An assessment procedure for concrete specified by strength
  grade, carried out by the supplier on concrete produced by a specific supplying plant and based on
  the statistical assessment of standard compressive strength tests on concrete.
- Project assessment (concrete): An assessment procedure for concrete specified by strength grade,
  specified at the customer’s option, which provides additional test data for the statistical assessment
  of concrete supplied to a specific project.
- Sample: A physical example that illustrates workmanship, materials or equipment, and establishes
  standards by which the work will be judged. It includes samples, prototypes and sample panels.
- Specimen: A portion of a sample which is submitted for testing.
- Weather – cold: Ambient shade temperature less than 10°C.
- Weather – hot: Ambient shade temperature greater than 30°C.

1.5 TOLERANCES

Formwork
Plumb of elements > 8 m high: 1:1000.
Plumb of elements ≤ 8 m high: To AS 3610.1.
Position: Construct formwork so that finished concrete conforms to AS 3600 clause 17.5 and as
documented in the Formwork dimensional deviation schedule.

Reinforcement
Fabrication and fixing: To AS 3600 clause 17.2.
Reinforcement and tendon position: To AS 3600 clause 17.5.3.

Finishes
Formed surfaces quality of surface finish: To AS 3610.1 Table 3.3.2.
Unformed surfaces flatness: To the Flatness tolerance class table, using a straightedge placed
anywhere on the surface in any direction, for the documented class of finish.

<table>
<thead>
<tr>
<th>Flatness tolerance class table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>
1.6 SUBMISSIONS

Calculations
Formwork calculations: Submit calculations by a professional engineer experienced in formwork design to show that allowable concrete stresses will not be exceeded and formwork capability will be maintained for the following:
- Proposed formwork procedures or loadings which differ from those documented.
- Props above a floor that do not coincide with the props below.
- Undocumented formwork shoring or stripping procedures or allowable loadings from stacked materials.

Post-tensioned calculations: Submit the following:
- Calculations of tendon jacking forces, theoretical extensions and losses for each stressing stage.
- Amount of draw-in expected in seating anchorages, friction along tendon (wobble) coefficient and friction curvature coefficient for tendons and duct-forming material.

Certification
Formwork design certification: For other than profiled steel sheeting composite formwork, submit certification by a professional engineer experienced in formwork design verifying conformance of the design.

Formwork execution certification: Submit certification by a professional engineer experienced in formwork design and construction verifying conformance of the completed formwork, including the suitability of the formwork for the documented surface finish class.

Post-tensioned concrete certification: Submit independent certification by professional engineer of the design and erected framing.

Design
Loading: Submit details of proposed construction systems, loads and procedures, including propping and re-shoring.

Execution details
Moveable formwork: Provide the following details on the formwork drawings:
- Table, slip and jump forms: Proposed method and sequence of moving the formwork to provide concrete of the documented quality and surface finish.
- Slip forms: The average rate of movement.

Re-shoring: Submit details of any proposed re-shoring.

Surface repair method: Submit details of any proposed surface repair method before starting repairs.

Concrete: Submit proposals for mixing, placing, finishing and curing concrete including the following:
- Changes to the concrete mix.
- Curing and protection methods.
- Curing period for low-pressure steam curing.
- Cutting or displacing reinforcement, or cutting or coring hardened concrete.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Placing under water.
- Sequence and times for concrete placement, and construction joint locations and relocations.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.
- Sequence of concrete placement: Submit details of any proposed if sequential placement of slab segments.
- Sawn joints: Submit details of proposed methods, timing and sequence of sawing joints.

Reinforcement: Submit the following:
- General: Details of any proposed changes to documented reinforcement.
- Damaged galvanizing: Details of proposed repair to AS/NZS 4680 Section 8.
- Mechanical bar splices Details and test certificates for each size and type of bar to be spliced.
- Provision for concrete placement: Details of spacing or cover to reinforcement that does not conform to AS 3600.
- Splicing: Details of any proposed changes to documented requirements.
- Welding: Details of any proposed welding of reinforcement.

Pre-mixed supply delivery dockets: For each batch, submit a docket listing the information required by AS 1379, and the following:
- For special class performance concrete: Documented performance and type of cement binder.
- For special class prescription concrete: Details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.
- Project assessment carried out each day.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.
- The total amount of water added at the plant and the maximum amount permitted to be added at the site.

**Materials**

Product conformity: Submit current assessments of conformity, as appropriate, as follows:
- Certificate of conformity by a JAS-ANZ accredited third party.
- Report by a NATA accredited laboratory describing tests and giving results which demonstrate that the product conforms.

Concrete mixes: Submit details, for each grade and type of concrete including any proposed use of special-purpose cement types.

Curing compounds: Submit details of any proposed liquid membrane-forming curing compound, including the following:
- Certified test results for water retention to AS 3799 Appendix B.
- Evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.
- For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

Admixtures: Submit details of any proposed admixtures, including the following:
- Brand name.
- Place of manufacture.
- Basic chemical composition.

**Shop drawings**

Cores, fixings and embedded items: Submit the proposed locations, clearances and cover and show any proposed repositioning of reinforcement.

Formwork: Submit shop drawings including details of proposed linings, bolt positions, facings, release agents and, where applicable, re-use of formwork.

**Subcontractors**

Pre-mixed supply: Submit names and contact details of proposed pre-mixed concrete suppliers and alternative source of supply in the event of breakdown of pre-mixed or site mixed supply.

**Tests**

Other tests: Submit results, as follows:
- Site slip resistance test of completed installation to AS 4663.
- Concrete compressive strength test results to AS 1012.9.

**1.7 Inspection**

**Notice**

Inspection: Give notice so that inspection may be made of the following:
- Base or subgrade before covering.
- Membrane or film underlay installed on the base or subgrade.
- Completed formwork and reinforcement, tendons, cores, fixings and embedded items fixed in place.
- Used formwork, after cleaning and before re-use.
- Concealed surfaces or elements before covering.
- Commencement of concrete placing.
- Stripping single storey suspended work, if conformance with AS 3610.1 is not possible.
- Commencement of initial, incremental or final stressing of tendons.
- Cutting and grouting tendons.
- Evaluation of the off-form finishes.
- Evaluation of surface finish.

2 PRODUCTS

2.1 MATERIALS

General
Stockpile: If uniform, consistent colour is documented, stockpile sand, cement and aggregates.

Aggregates
Standard: To AS 2758.1.

Cement
Standard: To AS 3972.
Age: Less than 6 months old.
Storage: Store cement bags under cover and above ground.

Water
Standard: To AS 1379 clause 2.4.
Requirement: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

Polymeric film underlay
Vapour barriers and damp-proofing membranes: To AS 2870 clause 5.3.3.

Chemical admixtures
Standard: To AS 1478.1.

Curing compounds
Curing compounds: To AS 3799.

2.2 CONCRETE

Properties
Concrete mix and supply: Conform to the following:
- Normal-class: To AS 1379 clause 1.5.3.
  - Properties: As documented in the Concrete properties schedule - performance.
- Special-class: To AS 1379 clause 1.5.4.
  - Properties: As documented in the Concrete properties schedule - performance.

Coloured concrete
Standard: To AS 3610.1.

2.3 TESTING

General
Test authority: Concrete supplier or NATA registered laboratory.
Reports and records of test results: To the relevant parts of the AS 1012 series. Keep results on site.

Assessment process of test results
Standard: To AS 1379.
Method of assessment: Project assessment.

Sampling
Method of sampling: AS 1012.1.
Sampling locations: To AS 1012.1 and the following:
- Slump tests: On site, at the point of discharge from the agitator.
- Compressive strength tests: Spread the site sampling evenly throughout the pour.

Frequency of sampling: To AS 1379 Sections 5 and 6 and the following:
- Slump tests: Take at least one sample from each batch.
- Compressive strength tests: To the Project assessment strength grade sampling table.

### Project assessment strength grade sampling table

<table>
<thead>
<tr>
<th>Number of batches for each type and grade of concrete per day</th>
<th>Minimum number of samples: Columns and load bearing wall elements/batch</th>
<th>Minimum number of samples: Other elements/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2-5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6-10</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>11-20</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>each additional 10</td>
<td>1</td>
<td>1 additional</td>
</tr>
</tbody>
</table>

Making and curing of specimens
General: To AS 1012.8.1 and AS 1012.8.2.
Specimens for compressive strength tests: Make and cure at least two specimens from the sample of each grade.
Specimen size:
- Aggregate size ≤ 20 mm: Nominally 200 x 100 mm diameter.
- Aggregate size > 20 mm: Nominally 300 x 150 mm diameter.

Test methods
General: To the relevant parts of the AS 1012 series.
Acceptance criteria:
- General: As documented in the Concrete properties schedule – performance.
- Early age compressive strength: As documented in the Control tests schedule.
Slump tests: Assess slump for every batch. Perform slump test on each strength sample.
Drying shrinkage at 56 days: To AS 1012.8.4 and AS 1012.13.

Embedded pressure pipes
General: Complete leak tests before embedding pipes.

Liquid retaining structures
Testing for liquid tightness: To AS 3735.

### 2.4 FORMWORK

**General**
Form linings, facings and release agents: Compatible with finishes applied to concrete.
Lost formwork: Free of timber or chlorides, and not to impair the structural performance of the concrete members.
Void formers: Material capable of maintaining rigidity and shape until the concrete has set, capable of withstanding construction loads and non-collapsible on absorption of moisture.

**Profiled steel sheeting composite formwork**
Material: Hot-dipped zinc-coated sheet steel to AS 1397.
Minimum steel grade: G550.
Accessories: Adopt material and corrosion protection to match the profiled steel sheeting.

**Plywood formwork**
Material: To AS 6669.
Grade: Use appropriate grade for the documented design dimensions, loading and surface quality.
Joints: Seal the joints consistent with the documented surface finish class.
Tolerances: To AS 3610.1 Section 3.
2.5 REINFORCEMENT

Fibre reinforcement
Standard: To CIA CPN35.

Steel reinforcement
Standard: To AS/NZS 4671.
Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

Protective coating
Standard: To AS 3600 clause 17.2.1.2.
Requirement: For concrete elements containing protective coated reinforcement, provide the same coating type to all that element’s reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, stirrups, plates and ferrules, and protect other embedded metals with a suitable coating.
Epoxy coating: High build, high solids, chemically resistant coating.
Thickness: 200 μm minimum.
Galvanizing: To AS/NZS 4680, as follows:
Sequence: If fabricating after galvanizing, repair damaged galvanising and coat cut ends.
Zinc-coating (minimum): 600 g/m².

Tie wire
General: Annealed steel 1.25 mm diameter (minimum).
External and corrosive applications: Galvanized.

3 EXECUTION

3.1 FORMWORK

General
Requirement: As documented in the Formed surface finishes schedule.

Preparation
Cleaning: Before placing concrete, remove free water, dust, debris and stains from the formwork and the formed space.

Bolt holes
Removable bolts: Remove tie bolts without damaging the concrete.
Formwork tie bolts left in the concrete: Position more than 50 mm from the finished surface.
Bolt hole filling: Provide material with durability and colour matching the concrete.
Recessed filling: Fill or plug the hole to 6 mm below the finished surface.

Corners
Work above ground: Chamfer at re-entrant angles, and fillet at corners.
Face of bevel 25 mm.

Embedments
Fixing: Fix embedments through formwork to prevent movement, or loss of slurry or concrete, during concrete placement.

Openings
Inspection: In vertical formwork provide openings or removable panels for inspection and cleaning, at the base of columns, walls and deep beams.
Access: For thin walls and columns, provide access panels for placing concrete.

Release agents
Application: Before placing reinforcement, apply a release agent to linings and facings.

Slip formwork
Provision for inspection: Provide access below the moveable formwork for surface treatment and inspection.
Profiled steel sheeting composite formwork
Fixing: If sheeting cannot be fixed to structural steel supports with puddle welds, or with welded shear studs in composite construction, provide details of proposed fixings.

Steel linings
Rust: Clean off any rust and apply rust inhibiting agent before re-use.

Visually important surfaces
Surface finish classes 1, 2 or 3: Set out the formwork to give a regular arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface.

3.2 REINFORCEMENT

Dowels
Fixing: If a dowel has an unpainted half, embed in the concrete placed first.
Tolerances:
- Alignment: 1:150.
- Location: ± half the diameter of the dowel.
Grade: 250 N.

Cover
Concrete cover generally: To AS 3600 clause 4.10.
Concrete cover for structures for retaining liquids: To AS 3735.
Concrete cover for residential ground slabs and footings: To AS 2870.

Supports
Proprietary concrete, metal or plastic supports: To AS/NZS 2425 and as follows:
- Able to withstand construction and traffic loads.
- With a protective coating if they are ferrous metal, located within the concrete cover zone, or are used with galvanized or zinc-coated reinforcement.
Spacing:
- Bars: ≤ 60 diameters.
- Mesh: ≤ 800 mm.
Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. If appropriate, place a metal or plastic plate under each support.

Projecting reinforcement
Protection: If starter or other bars extend beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.

Tying
General: Secure the reinforcement against displacement at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of formwork or unformed faces to prevent the ties projecting into the concrete cover.
Beams: Tie stirrups to bars in each corner of each stirrup. Fix other longitudinal bars to stirrups at 1 m maximum intervals.
Bundled bars: Tie bundled bars in closest possible contact. Provide tie wire of at least 2.5 mm diameter and spaced not more than 24 times the diameter of the smallest bar in the bundle.
Columns: Secure longitudinal column reinforcement to all ties at every intersection.
Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections.

3.3 CONCRETE

General
Conformance: As documented in the Concrete properties schedule – performance.

Elapsed delivery time
General: Make sure that the elapsed time between the wetting of the mix and the discharge of the mix at the site is in conformance with the Elapsed delivery time table. Do not discharge at ambient temperature below 10°C or above 30°C unless approved heating or cooling measures are taken to deliver concrete within the range 5°C to 35°C.
### Elapsed delivery time table

<table>
<thead>
<tr>
<th>Concrete temperature at time of discharge (°C)</th>
<th>Maximum elapsed time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 24</td>
<td>120</td>
</tr>
<tr>
<td>24 – 27</td>
<td>90</td>
</tr>
<tr>
<td>27 – 30</td>
<td>60</td>
</tr>
<tr>
<td>30 – 32</td>
<td>45</td>
</tr>
</tbody>
</table>

### Pre-mixed supply
Addition of water: To AS 1379 clause 4.2.3.
Transport method: Select to prevent segregation, loss of material and contamination of the environment, and not to adversely affect placing or compaction.

### Site mixed supply
Emergencies: If mixing by hand, provide details.
Plant: Mix concrete in a plant located on the construction site.

### 3.4 CORES, FIXINGS AND EMBEDDED ITEMS
#### Adjoining elements
Fixings: Provide fixings for adjoining elements. If required, provide temporary support to the adjoining elements during concreting, to prevent movement.

#### Protection
General: Grease threads. Protect embedded items against damage.
Compatibility: Provide inserts, fixings and embedded items that are compatible with each other, with the reinforcement and with the documented concrete mix and the documented surface finish.
Corrosion: In external or exposed locations, galvanize anchor bolts and embedded fixings.

#### Structural integrity
Position: Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain cover to reinforcement.
Isolation: Isolate embedded items to prevent water tracking to concrete providing minimum cover to reinforcement.

#### Tolerances
General: Maximum deviation from correct positions:
- Anchor bolt groups for structural steel: To AS 4100.
- Cores and embedded items generally: 10 mm.
- Other fixing bolts: 3 mm.

### 3.5 PLACING AND COMPACTION
#### Placing
Horizontal transport: Use suitable conveyors, clean chutes, troughs, hoppers or pipes.
Methods: Avoid segregation and loss of concrete, and minimise plastic settlement. Maintain a nominally vertical and plastic concrete edge during placement.
Horizontal elements: Place concrete in layers not more than 300 mm thick. Compact the following layer into previous layer before previous layer has taken initial set.

#### Compaction
Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove entrapped air and to fully compact the mix.
Vibrators: Do not allow vibrators to contact set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the formwork. Avoid causing segregation by over-vibration.

#### Placing records
Log book: Keep on site and make available for inspection a log book recording each placement of concrete, including the following:
- Date.
- Specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

**Rain**
Protection: During placement and before setting, protect the surface from damage.

**Time between adjacent placements**
General: As documented in the Minimum time delay schedule.

**Vertical elements**
Placement: Limit the free fall of concrete to maximum of 2000 mm.

**Placing in hot weather**
Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses.

Temperature limits: Maintain freshly mixed concrete at the following temperature limits:
- Normal concrete in footings, beams, columns, walls and slabs: ≤ 35°C.
- For concrete strength grade less than 40 MPa with section thickness ≥ 1 m in all dimensions: ≤ 27°C.
- For concrete strength grade 40 MPa or greater with section thickness ≥ 600 mm in all dimensions: ≤ 27°C.
- Formwork and reinforcement before and during placing: ≤ 35°C.

Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.

Temperature control: Select one or more of the following methods of maintaining the temperature of the placed concrete at 35°C or less:
- Cool the concrete using liquid nitrogen injection before placing.
- Cover horizontal transport containers.
- Spray the coarse aggregate using cold water before mixing.
- Use chilled mixing water.

**Placing under water**
General: Do not place under water unless conditions prevent dewatering.

Minimum cement content for the mix: Increase by 25%.

### 3.6 CURING

**General**
Requirements: Taking into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to make sure of the following:
- Curing: Cure continuously from completion of finishing until the total cumulative number of days or fractions of days, during which the air temperature in contact with the concrete is above 10°C, conforms to the following, unless accelerated curing is adopted:
  - Fully enclosed internal surfaces/Early age concrete: 3 days.
  - Other concrete surfaces: 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.

**Curing compounds**
Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least for the required curing period after application.

Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to applied finishes, concrete toppings and cement-based render.

Self-levelling toppings: If used also as curing compounds, conform to AS 3799.

Visually important surfaces: Apply curing compounds to produce uniform colour on adjacent surfaces.
Hot weather curing
Curing compounds: If curing compounds are proposed, provide details.
Protection: Select a protection method from the following:
- If the concrete temperature is more than 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect from wind and sun using an evaporative retarder until curing is commenced.
- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Water curing
Method: Select a method of ponding or continuously sprinkling to prevent damage to the concrete surface during the required curing period.

3.7 JOINTS

Construction joints
Location: Do not relocate or eliminate construction joints, or form undocumented construction joints. If emergency construction joints are made necessary by unforeseen interruptions to the concrete pour, submit a report on the action taken.
Finish: Butt join the surfaces of adjoining pours. In visually important surfaces make the joint straight and true, and free from blemishes impermissible for its surface finish class.
Preparation: Roughen and clean the hardened concrete joint surface. Remove loose or soft material, free water, foreign matter and laitance. Dampen the surface just before placing the fresh concrete and coat with a neat cement slurry.

Expansion joints
Joint filling: Fill with jointing materials as documented. Finish visible jointing material neatly flush with adjoining surfaces.
Preparation: Before filling, dry and clean the joint surfaces, and prime.
Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.
Jointing materials: Provide jointing materials compatible with each other, and non-staining to concrete in visible locations.
Bond breaking: Provide back-up materials for sealants, including backing rods, which do not adhere to the sealant.
Foamed materials (in compressible fillers): Closed-cell or impregnated, not water absorbing.

Slip joints
Requirement: If concrete slabs are supported on masonry, provide proprietary slip joints.

3.8 UNFORMED SURFACES

General
Surface finish: As documented in the Unformed surface finishes schedule.
Finished levels: Strike off, screed and level slab surfaces to finished levels and to the flatness tolerance class documented.

Surface repairs
Method: If surface repairs are required, submit proposals.

Finishing methods – primary finish
Machine float finish:
- After levelling, consolidate the surface using a machine float.
- Cut and fill and refloat immediately to a uniform, smooth, granular texture.
- Hand float in locations inaccessible to the machine float.
Steel trowel finish: After machine floating finish, as follows:
- Use power or hand steel trowels to produce a smooth surface relatively free from defects.
- When the surface has hardened sufficiently, re-trowel to produce the final consolidated finish free of trowel marks and uniform in texture and appearance.

Burnished finish: Continue steel trowelling until the concrete surface attains a polished or glossy finish, uniform in texture and appearance, and free of trowel marks and defects.

Wood float finish: After machine floating, use wood or plastic hand floats to produce the final consolidated finish free of float marks and uniform in texture and appearance.

Broom finish: After machine floating and steel trowelling use a broom or hessian belt drawn across the surface to produce a coarse even-textured transverse-scored surface.

Scored or scratch finish: After screeding, use a stiff brush or rake drawn across the surface before final set, to produce a coarse scored texture.

Sponge finish: After machine floating and steel trowelling, use a damp sponge to wipe the surface to produce an even textured sand finish.

Exposed aggregate finish: After floating and when concrete has stiffened, wet the surface and scrub with stiff fibre or wire brushes, flushing continuously with clean water, until the aggregate is uniformly exposed. Rinse the surface with water.

**Finishing methods – supplementary finish**

Abrasive blast: After steel trowelling, abrasive blast the cured surface to provide texture or to form patterns without exposing the coarse aggregate, using hard, sharp graded abrasive particles.

Coloured applied finish: After machine floating, apply a proprietary liquid or dry shake material to the manufacturer’s recommendations and trowel to achieve the required appearance.

Stamped and coloured faux paved or cobblestone finish: Provide a proprietary finishing system.

Polished finish: After steel trowelling, grind the cured surface of the concrete.

### 3.9 COMPLETION

**Formwork removal**

Extent: Remove formwork, other than profiled steel sheeting composite formwork and lost formwork, including formwork in concealed locations.

Timing: Do not disturb formwork until concrete is hardened enough to withstand formwork movements and removal without damage.

Stripping:
- General: To AS 3600 where it is more stringent than AS 3610.1.
- Vertical formwork: To AS 3610.1 Appendix B Table B1.
- Multi-storey work: Remove formwork without disturbing props supporting succeeding floors.
- Post-tensioned concrete: Remove formwork supporting post-tensioned concrete members to AS 3600 clause 17.6.2.7.

**Protection**

General: Protect the concrete from damage due to construction loads, physical and thermal shocks, and excessive vibrations, particularly during the curing period.

Surface protection: Protect finished concrete surfaces and applied finishes from damage.

### MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot sizes</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marshalling Slab and Hose Cock slab</td>
<td>Consistency – slump</td>
<td>5 m³</td>
<td>1 per load</td>
<td>AS 1012.3.1</td>
</tr>
<tr>
<td></td>
<td>Compressive Strength (7 and 28 day)</td>
<td>5 m³</td>
<td>2 pairs per 5 m³</td>
<td>AS 1012.1, AS 1012.8.1, AS 1012.9</td>
</tr>
</tbody>
</table>
### 3.10 ANNEXURE – PAY ITEMS

<table>
<thead>
<tr>
<th>Pay Items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0310.1 Supply and install concrete</td>
<td>Lump Sum</td>
<td>All cost associated with the supply and placing of formwork, reinforcement, concrete, curing and stripping of formwork and placement of any blinding layer required. Also confirm bearing pressure and key into existing ground</td>
</tr>
<tr>
<td>a. Pump Wet Well Base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Pump Wet Well Walls, Pipe Thickening and Lid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Pump Station Valve Pit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0310.2 Supply, forming and installation of Concrete Access ways (2 of</td>
<td>Lump Sum</td>
<td>All cost associated with the supply and placing of formwork, reinforcement, concrete and curing and stripping of formwork.</td>
</tr>
<tr>
<td>east and west)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0310.3(a) Supply and install New switchroom slab</td>
<td>Lump Sum</td>
<td>All cost associated with the supply and placing of formwork, reinforcement, concrete and curing and stripping of formwork. Also confirm bearing pressure and key into existing ground</td>
</tr>
<tr>
<td>0310.3(b) Supply and install New generator slab</td>
<td>Lump Sum</td>
<td>All cost associated with the supply and placing of formwork, reinforcement, concrete and curing and stripping of formwork. Also confirm bearing pressure and key into existing ground</td>
</tr>
<tr>
<td>0310.3(c) Supply and install Miscellaneous slabs</td>
<td>m$^3$</td>
<td>All cost associated with the supply and placing of formwork, reinforcement, concrete and curing. Also confirm bearing pressure and key into existing ground</td>
</tr>
<tr>
<td>0310.4 Supply and install new sleeve and nozzle</td>
<td>Each</td>
<td>All costs associated with installing <strong>sleeve and nozzle</strong></td>
</tr>
<tr>
<td>a. DN300 GRP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. DN300 PVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Connections to access chambers and emergency storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0310.5 Supply and install Wet Well Access Hatch</td>
<td>Each</td>
<td>All costs associated with installing <strong>5700 x 2000mm McBerns or approved equivalent lockable 3 part aluminum access gas tight cover complete with hinged safety grate to AS3996 class A</strong></td>
</tr>
<tr>
<td>0310.6 Supply and install DN50 PVC Conduit</td>
<td>m</td>
<td>All costs associated with installing DN50 PVC Conduit</td>
</tr>
<tr>
<td>0310.9 (b) Supply and install lockable penetration for knife</td>
<td>Each</td>
<td>All costs associated with the supply and installation of</td>
</tr>
<tr>
<td>Item Description</td>
<td>Unit</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>gate spindle</td>
<td></td>
<td>penetration including inset cover box</td>
</tr>
</tbody>
</table>
| 0310.9(c) Supply and installation of pump well fit out. Including but not limited to grout pads, conduit penetrations, SS chain, SS guiderails (CONCRETE COMBINED) | Lump Sum | All costs associated with the installation and fit out of the pump well, including but not limited to:  
- Grout pads  
- Conduit penetrations  
- SS chain  
- SS guiderails  
- Supports |
| 0310.10 Epoxy coating of Wetted Structures (CONCRETE COMBINED)                    | m²     | All costs associated with the supply installation and testing of epoxy coating per GRC specification                                             |
0319 MINOR CONCRETE WORKS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide cast concrete, as documented and as follows:
- Conforming to the design details and performance criteria.
- Satisfying quality and inspection requirements.
- Compatible with documented finishes.

Design
Formwork: The design of formwork, other than profiled steel sheeting composite formwork is the contractor's responsibility.

Precedence
Precedence: The technical requirements of, or any standard drawing provided by, the Gladstone Regional Council, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction).

Standards
General: The following documents are incorporated into this worksection by reference:
Australian standards
AS 1012 Methods of testing concrete
AS 1012.3.1-2014 Determination of properties related to the consistency of concrete—Slump test
AS 1012.14-1991 Method for securing and testing cores from hardened concrete for compressive strength
AS 1141 Methods for sampling and testing aggregates
AS 1141.11.1-2009 Particle size distribution – Sieving method
AS 1141.14-2007 Particle shape by proportional calliper
AS 1141.21-1997 Aggregate crushing value
AS 1141.23-2009 Los Angeles value
AS 1141.24-2013 Aggregate soundness—Evaluation by exposure to sodium sulphate solution
AS 1348-2002 Glossary of terms - Roads and traffic engineering
AS 1379-2007 Specification and supply of concrete
AS 1397-2001 Steel sheet and strip - Hot-dipped zinc-coated or aluminum/zinc-coated
AS 1478 Chemical admixtures for concrete, mortar and grout
AS 1478.1-2000 Admixtures for concrete
AS 1554 Structural steel welding
AS 1554.3-2008 Welding of reinforcing steel
AS 2327 Composite structures
AS 2327.1-2003 Simply supported beams
AS 2550 Cranes, hoist and winches – Safe use
AS 2550.1-2011 General requirements
AS 2758 Aggregates and rock for engineering purposes
AS 2758.1-1998 Concrete aggregates
AS 2870-2011 Residential slabs and footings
AS 3600-2009 Concrete structures
1.3 STANDARDS

General
Formwork design and construction formed surfaces: To AS 3610 and AS 3610.1.
Plywood formwork: To AS 6669.
Profiled steel sheeting, including shear connectors: To AS 2327.1.
Specification and supply of concrete: To AS 1379.
Concrete materials and construction: To AS 3600.
Concrete structures for retaining liquids: To AS 3735.

Methods and equipment
Precast elements: Comply with the recommendations of NP:PCH.

1.4 INTERPRETATION

Definitions
General: For the purposes of this work section the following definitions apply:
- Ambient temperature: The air temperature at the time of mixing and placing of concrete.
- Average ambient temperature: Average value of the daily maximum and minimum ambient temperatures over the relevant period at a site.
- Concrete class:
  - Normal: Concrete which is specified primarily by a standard compressive strength grade and otherwise conforming to AS 1379 clause 1.5.3.
  - Special: Concrete which is specified to have certain properties or characteristics different from, or additional to, those of normal-class concrete and otherwise conforming to AS 1379 clause 1.5.4.
- Early age strength: A mean compressive strength at 7 days exceeding the values shown in Table 1.2 of AS 1379.
- Green concrete: Concrete which has set but not appreciably hardened.
- Joints:
  - Construction joint: A joint with continuous reinforcement provided to suit construction sequence.
  - Control joint: An unreinforced joint between or within discrete elements of construction which allows for relative movement of the elements.
  - Contraction joint: An opening control joint with a bond breaking coating separating the joint surfaces to allow independent and controlled contraction of different parts or components, induced by shrinkage, temperature changes or other causes. It may include unbound dowels to assist vertical deflection control.
  - Expansion joint: A closing control joint with the joint surfaces separated by a compressible filler to allow axial movement due to thermal expansion or contraction with changes in temperature or creep. It may include unbound dowels to assist vertical deflection control.
  - Isolation joint: A joint between elements of a structure designed to isolate structural movement while permitting horizontal and/or vertical movement between abutting elements.
. Weakened plane joint: A contraction joint created by forming a groove, extending at least one quarter the depth of the section, either by using a grooving tool, by sawing, or by inserting a premoulded strip.
. Structural control joint: A control joints (contraction, expansion and isolation) in structural elements when used with applied material and finishes.
. Substrate joint: A joint in the substrate which includes construction joints and joints between different materials.
. Sealant joint: A joint filled with a flexible synthetic compound which adheres to surfaces within the joint to prevent the passage of dust, moisture and gases.
. Pavements: The definitions given in AS 1348 apply.
. Sprayed concrete: Concrete pneumatically applied at high velocity on to a surface. Application may be either a wet or dry process, to produce a sound homogeneous product with surface finish reasonably uniform in texture and free from blemishes.
. Weather:
  - Cold: Ambient shade temperature < 10°C.
  - Hot: Ambient shade temperature > 30°C.

1.5 SUBMISSIONS

Approval
Submissions: To the Superintendent's approval.

Construction proposals
Concrete: Submit proposals for mixing, placing, finishing and curing concrete including the following:
- Changes to the plastic concrete mix.
- Curing and protection methods.
- Handling, placing, compaction and finishing methods and equipment, including pumping.
- Site storage, mixing and transport methods and equipment, if applicable.
- Temperature control methods.

1.6 HOLD POINTS AND WITNESS POINTS

Notice
General: Give notice so that the documented inspection and submissions may be made to the HOLD POINT table and the WITNESS POINT table.

**HOLD POINT table**

<table>
<thead>
<tr>
<th>Clause title/item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground preparation – Base preparation</td>
<td>Inspect base before underlay installation</td>
<td>1 working day prior to covering</td>
<td>Superintendent</td>
</tr>
</tbody>
</table>

**WITNESS POINT table**

<table>
<thead>
<tr>
<th>Clause title/item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete quality requirements – Formwork</td>
<td>Check erection tolerances</td>
<td>1 working day</td>
</tr>
<tr>
<td>Concrete quality requirements – Surface quality</td>
<td>Confirm surface quality</td>
<td>1 working day</td>
</tr>
<tr>
<td>Concrete quality requirements – Flatness</td>
<td>Confirm unformed surfaces</td>
<td>1 working day</td>
</tr>
<tr>
<td>Concrete placing and compaction - Placing</td>
<td>Proposed sequence of concrete placement</td>
<td>7 days prior</td>
</tr>
</tbody>
</table>
2 PRE-CONSTRUCTION PLANNING

2.1 LOADING

Loads on minor concrete structures
Prohibition: Avoid application of superimposed load on any part of what will become a load bearing structure within 21 days after placing concrete unless the structure is effectively and independently supported to the satisfaction of the Superintendent or until the Contractor can demonstrate that 95% of the design strength of the concrete has been achieved.

2.2 PRODUCT CONFORMITY

Requirement
General: Submit current assessments of conformity, as appropriate, as follows:
- Certificate of conformity by a JAS-ANZ accredited third party.
- Report by a NATA accredited laboratory describing tests and giving results which demonstrate that the product conforms.
Curing compounds: Submit details of any proposed liquid membrane-forming curing compound, including the following:
- Certified test results for water retention to AS 3799 Appendix B.
- Evidence of compatibility with concrete, and with applied finishes including toppings and render, if any, including methods of obtaining the required adhesion.
- For visually important surfaces, evidence that an acceptable final surface colour will be obtained.

2.3 DESIGN DOCUMENTATION

Requirement
Formwork design: Conform to AS 3610.1.
Certification: For other than profiled steel sheeting composite formwork, submit certification by a professional structural engineer experienced in formwork design verifying conformance of the design.
Loading: Submit details of proposed construction systems, loads and procedures, including propping and re-shoring.

2.4 CERTIFICATES OF COMPLIANCE

Requirement
Verification: Provide certificates from a NATA registered laboratory. Perform all phases of any particular test at one laboratory. Accompany the certificate with all relevant test results carried out within twelve months of the submission date.
General: Use materials only after receipt of the Superintendent’s notification of acceptance of test reports and other submissions, and then only if they conform to this worksection.

3 MATERIALS

3.1 GENERAL

Stockpile
General: If uniform, consistent colour is documented, stockpile sand, cement and aggregates.
Cement
Standard: To AS 3972.
Age: Less than 6 months old.
Storage: Store cement bags under cover and above ground.

**Aggregates**
Standard: To AS 2758.1.
Coarse aggregate: Grading to AS 1141.11.1 and limits of deviation to AS 2758.1 Table 2.
Fine aggregate: Grading to AS 1141.11.1 and limits of deviation to AS 2758.1 Table 3.
Aggregate properties: As documented in the Aggregate property schedule.
Special aggregates: Stockpile special aggregates at the beginning of the project to minimise colour and other variations.

**Water**
Standard: To AS 1379 clause 2.4.
Quality: Clean, free from oil, acid, alkali, organic or vegetable matter and including not more than 500 mg/l of chloride ions.

**Polymeric film underlay**
Vapour barriers and damp-proofing membranes: To AS 2870 clause 5.3.3.

**Chemical admixtures**
Chemical admixtures: To AS 1478.1.
Chemical admixture content: Free of chlorides, fluorides and nitrates.

**Curing compounds**
Curing compounds: To AS 3799.

### 3.2 CONCRETE

**Properties**
Concrete mix and supply: Conform to the following:
- Normal-class: To AS 1379 clause 1.5.3.
  - Properties: As documented in the Concrete properties schedule - performance.
- Special-class: To AS 1379 clause 1.5.4.
  - Properties: As documented in the Concrete properties schedule - performance.

### 3.3 FORMWORK

**General**
Form linings, facings and release agents: Form for compatibility with applied finishes.
Lost formwork: Free of timber or chlorides, and not to impair the structural performance of the concrete members.
Void formers: Material capable of maintaining rigidity and shape until the concrete has set, withstanding construction loads and non-collapsible on absorption of moisture.

**Plywood formwork**
Material: Plywood sheeting to AS 6669.
Grade: Use appropriate grade for the documented design dimensions, loading and surface quality.
Joints: Seal the joints consistent with the surface finish class.

### 3.4 REINFORCEMENT

**Steel reinforcement**
Standard: To AS/NZS 4671.
Surface condition: Free of loose mill scale, rust, oil, grease, mud or other material which would reduce the bond between the reinforcement and concrete.

**Protective coating**
Standard: To AS 3600 clause 17.2.1.2.
Epoxy coating: High build, high solids chemically resistant coating.
- Thickness: 200 μm minimum.
Galvanizing: To AS/NZS 4680:
- Sequence: If fabricating after galvanizing, repair damaged galvanizing and coat cut ends.
- Zinc-coating (minimum): 600 g/m².

Tie wire
General: Annealed steel 1.25 mm diameter (minimum).
External and corrosive applications: Galvanized.

3.5 MISCELLANEOUS
Surface hardeners, sealants and protectors
Supply: If documented, provide proprietary products to the manufacturer’s recommendations.

3.6 MINOR PRECAST UNITS
Marking
Identification: Identify units by marks which are as follows:
- Remain legible until after the unit has been fixed in place.
- Are not visible in the completed structure.
- Show the date of casting.
- Show the correct orientation of the unit.
- On other than units manufactured as a standard product, indicate the locations within the structure conforming to the marking plan.

Structural performance requirements
Tolerances
Fixings and embedded items in precast units: To AS 3610.1, as applicable.
Attachments
Sealing: Recess lifting attachments such as ferrules, or other types of cast-in fixings, and provide plugs for sealing.
Welding of connections
Standard: To AS/NZS 1554.3.

4 EXECUTION

4.1 GROUND PREPARATION
Base preparation
General: Conforming to base type, as follows:
- Concrete working base: Remove projections above the plane surface, and loose material.
- Graded prepared subgrade: Blind with sand to create a smooth surface free from hard projections.
Wet the sand just before laying the underlay.
Polymeric film underlay installation
General: Lay underlay over the base as follows:
- Lap joints at least 200 mm and seal the laps and penetrations with waterproof adhesive tape.
- Face the laps away from the direction of concrete pour.
- Continue up vertical faces past the damp-proof course where applicable, and tape fix at the top.
- Patch or seal punctures or tears before placing concrete.
- Cut back as required after concrete has gained strength and formwork has been removed.
This is a HOLD POINT.
Rock foundations
Minimum depth: Extend the excavation for a minimum depth of 150 mm into the rock.
Cut-off walls: Provide a depth of cut-off in rock foundations less than that shown in the drawings, if approved by the Superintendent.
Mass concrete bedding on earth foundations (concrete blinding slab)
Concrete walls: Prior to the construction of footings for cast-in-situ concrete walls on earth foundations, cover the latter with a mass concrete blinding slab.
Precast concrete: Unless otherwise specified, place precast concrete wall sections on a fresh mass concrete bedding layer while it is still in a plastic state.
Earth foundation: Place concrete not less than 50 mm thick.
Rock foundation: Place the concrete at least 50 mm above the highest points of rock.
Restriction: Place neither forms nor other materials on the bedding layer within 48 hours of the concrete being placed.

4.2 CONCRETE QUALITY REQUIREMENTS

Formwork
Formed element: AS 3610.1 clause 5.2.2.
Position: Construct formwork so that finished concrete conforms to AS 3600 clause 17.5.
Erection tolerances: Check dimensions and position of forms, after the forms are erected. Align forms accurately and check the location of all fittings and void formers prior to placing concrete. This is a WITNESS POINT.

Surface quality
Formed surfaces: To AS 3610.1 Table 3.3.2 for the surface class documented in the Formed surface finishes schedule. This is a WITNESS POINT.

Flatness
Unformed surfaces: To the Flatness tolerance class table, for the documented class of finish, using a straightedge placed anywhere on the surface in any direction. This is a WITNESS POINT.

Flatness tolerance class table

<table>
<thead>
<tr>
<th>Class</th>
<th>Measurement</th>
<th>Maximum deviation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2 m straightedge</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>3 m straightedge</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>600 mm straightedge</td>
<td>6</td>
</tr>
</tbody>
</table>

Type and frequency
Sampling, identification and testing of specimens: Sample the concrete on site, at the point of discharge from the agitator to the relevant parts of the AS 1012 series and AS 1379.
Frequency: To 0161 Quality (Construction) Sub-annexure C14.
Records and reports: To the relevant parts of the AS 1012 series. Keep results on site.

Concrete testing methods
Slump: Test at least one sample from each batch before placing concrete from that batch in the work.
Strength grade/Characteristic compressive strength: Spread the site sampling evenly throughout the concrete placement.
- Sampling frequency: To the Project assessment strength grade sampling table.

Project assessment strength grade sampling table

<table>
<thead>
<tr>
<th>Number of batches for each type and grade of concrete per day</th>
<th>Minimum number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2-5</td>
<td>2</td>
</tr>
<tr>
<td>6-10</td>
<td>3</td>
</tr>
<tr>
<td>11-20</td>
<td>4</td>
</tr>
<tr>
<td>each additional 10</td>
<td>1 additional</td>
</tr>
</tbody>
</table>

Visually important surfaces
Surface finish classes 1, 2 or 3: Set out the formwork to give a regular arrangement of panels, joints, bolt holes, and similar visible elements in the formed surface.
Formwork panels: Provide formwork for exposed surfaces from panels having uniform widths of not less than 1 m and uniform lengths of not less than 2 m, except where the dimensions of the member formed are less than the specified panel dimensions.

Pattern: Place all form panels in a neat, symmetrical pattern.

Plywood panels: Placed with the grain of the outer plies perpendicular to the studding or joists.
- Thickness: Not less than 15 mm thick, where attached directly to the studding or joists.
- Variations: If form panels are less than 15 mm thick, otherwise conforming to these requirements, provide a continuous backing of dressed material of 20 mm minimum thickness.

Side forms: Where concrete is placed in earth excavations, side forms shall be provided to prevent contact between concrete and the in situ earth.

Mild steel form surfaces: Customise all bolt and rivet heads counter-sunk and grind back all welds to even and smooth surfaces.

Joints: Provide joints in the formwork perpendicular to the main axis of the shape of the concrete.

**Hidden surfaces**

General: Construct forms for all surfaces which will be completely enclosed or permanently hidden below the ground from dressed or undressed timber, steel, plywood or particleboard.

**Void formers**

Use: Cast designated suspended ground floor slabs and beams on void formers.

Protection: Keep void formers dry until use, install on a firm level surface and place reinforcement and concrete with minimum delay.

Void formers: Use void formers tested under laboratory conditions. Place formers on damp sand and load with a mass of wet concrete at least equal to the mass of the beams or slabs to be supported.

Submit certified test results to verify conformance with the following requirements:
- Deflection during placing and compaction of the concrete does not exceed beam or slab span/1000.
- Additional deflection between initial set and 7 days does not exceed span/400.
- Collapse and loss of load carrying capacity occurs not more than 48 hours after flooding with water, creating a void at least 60% of the original depth of the void former.

### 4.3 CONCRETE SUPPLY

**General**

Conformance: As documented in the Concrete properties schedule - performance.

**Strength requirement**

Variation: For departure from the minimum requirements cited in the Concrete strength requirements table reference a specific minimum cement content on the drawings, or submit for approval.

### Concrete strength requirements table

<table>
<thead>
<tr>
<th>Use</th>
<th>Use</th>
<th>Minimum Portland cement GP (GB)</th>
<th>Coarse aggregate nominal size (mm)</th>
<th>Cylinder strength required (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations, mass retaining walls</td>
<td>20</td>
<td>270 (330)</td>
<td>40</td>
<td>15 20</td>
</tr>
<tr>
<td>Mass concrete footings, pitching, linings etc.</td>
<td>20</td>
<td>270 (330)</td>
<td>20</td>
<td>15 20</td>
</tr>
<tr>
<td>Drainage structures, driveways, footpaths, miscellaneous minor concrete work</td>
<td>20</td>
<td>270 (330)</td>
<td>20</td>
<td>15 20</td>
</tr>
<tr>
<td>Reinforced concrete culverts, headwalls, base slabs, sign structure large footings, retaining walls</td>
<td>32</td>
<td>320 (380)</td>
<td>20</td>
<td>24 32</td>
</tr>
<tr>
<td>Safety barriers</td>
<td>40</td>
<td>330 (380)</td>
<td>20</td>
<td>24 40</td>
</tr>
</tbody>
</table>
Extruded concrete | 20 | 270 (330) | 14 | 15 | 20

**Elapsed delivery time**

General: Make sure that the elapsed time between the wetting of the mix and the discharge of the mix at the site conforms to the **Elapsed delivery time table**. Do not discharge at ambient temperature below 10°C or above 30°C unless approved heating or cooling measures are taken to deliver concrete within the range 5°C to 35°C.

**Elapsed delivery time table**

<table>
<thead>
<tr>
<th>Concrete temperature at time of discharge (°C)</th>
<th>Maximum elapsed time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 24</td>
<td>120</td>
</tr>
<tr>
<td>24 – 27</td>
<td>90</td>
</tr>
<tr>
<td>27 – 30</td>
<td>60</td>
</tr>
<tr>
<td>30 – 32</td>
<td>45</td>
</tr>
</tbody>
</table>

**Pre-mixed supply**

Addition of water: To AS 1379 clause 4.2.3.

Transport: Mode must prevent segregation, loss of material and contamination of the environment, and must not adversely affect placing or compaction.

### 4.4 STEEL REINFORCEMENT PLACEMENT

**Tolerances**

Fabrication and fixing: To AS 3600 clause 17.2.

**Dowels**

Fixing: If a dowel has an unpainted half, embed this in the concrete placed first.

Tolerances:
- Alignment: 1:150.
- Location tolerance: ± half the diameter of the dowel.

Grade: 250 N.

**Cover**

Concrete cover generally: To AS 3600 clause 4.10.

Concrete cover for structures for retaining liquids: To AS 3735.

Concrete cover for residential ground slabs and footings: To AS 2870.

**Supports**

Proprietary concrete, metal or plastic supports: Provide chairs, spacers, stools, hangers and ties, as follows:
- Able to withstand construction and traffic loads.
- With a protective coating if they are ferrous metal extending to the surface of the concrete, or are used with galvanized or zinc-coated reinforcement.

Spacing:
- Bars: ≤ 60 diameters.
- Fabric: ≤ 800 mm.

Supports over membranes: Prevent damage to waterproofing membranes or vapour barriers. If appropriate, place a metal or plastic plate under each support.

**Projecting reinforcement**

Projection: If starter or other bars project beyond reinforcement mats or cages, through formwork or from cast concrete, provide a plastic protective cap to each bar until it is cast into later work.
Tying
General: Secure the reinforcement against displacement at intersections with either wire ties, or clips. Bend the ends of wire ties away from nearby faces of forms so that the ties do not project into the concrete cover.
Beams: Tie stirrups to bars in each corner of each stirrup. Fix other longitudinal bars to stirrups at 1 m maximum intervals.
Columns: Secure longitudinal column reinforcement to all ties at every intersection.
Mats: For bar reinforcement in the form of a mat, secure each bar at alternate intersections

Welding
General: If welding of reinforcement is proposed, provide details.

Bending
General: Do not be bend or straighten in a manner that will injure the material. Do not provide bars with kinks or bends not documented.
Heating: Do not use heat to bend or straighten reinforcement.

Splicing
Plan lengths: Provide all reinforcement in the lengths documented. If splicing is required conform to AS/NZS 4671.
Testing of splices not as shown on the drawings: Costs to the Contractor.
Lapped splices: Provide laps in reinforcing bars, wire or fabric as shown on the drawing or as follows:
- Plain bars, Grade 250: Minimum 40 bar diameters.
- Deformed bars, Grade 400: Minimum 35 bar diameters.
- Hard-drawn wire: Minimum 50 bar diameters.
- Securely wired together in at least two places, unless welded.
Splicing in reinforcing fabric: Provide an overlap, measured between outermost transverse wires of each sheet of fabric of not less than the spacing of those wires plus 25 mm.
Staggering: Stagger splices as shown on the drawings or submit proposal for approval.

Marking
Bundles: Bundle bars of identical shape in bundles of three and securely tie together by soft iron wire.
Label: Provide each bundle with a stout metal label of not less than 40 mm diameter.
Marking: Make sure that each metal label has been punched with the appropriate marking conforming to the documented steel list.
Prefix: If documented, make sure that the marking incorporates a prefix. Store bars with different prefixes separately.

Storage
General: Store reinforcement above the surface of the ground and protect from damage and from deterioration by exposure.

Delivery and receipt of reinforcement
Test before delivery: If it is proposed to have the reinforcement tested off-site, obtain the approval before reinforcement is delivered to site. This is a WITNESS POINT.
Payment: No extra payment will be made as a result of any delays incurred by the Superintendent carrying out, or waiving, the inspection with reasonable expediency.

Placing
Reinforcement position: Place reinforcement as documented and hold securely by blocking from the forms, by supporting on concrete or plastic chairs, or metal hangers, and by wiring together at all intersections or at 0.5 m centres, whichever is the greater distance, using annealed iron wire of diameter not less than 1.25 mm.
Prohibition: Do not support steel on metal supports which extend to the surface of concrete, on wooden supports, or on pieces of coarse aggregate.
Cover: Provide reinforcement with the minimum cover documented, or as follows, but in no case less than 1.5 times the diameter of the bar:
- Concrete normally in contact only with air:
  - Slabs: 40 mm.
. Other than slabs: 45 mm.
- Concrete in contact with earth or fresh water:
  - Slabs of box culverts: 50 mm.
  - Other than culverts: 50 mm.

Reinforcement: If changes are proposed to reinforcement shown on the drawings, submit details. This is a WITNESS POINT.

Damaged galvanizing: If repair is required, submit proposals to AS/NZS 4680 Section 8. This is a WITNESS POINT.

Provision for concrete placement: If spacing, splicing, welding or cover of reinforcement does not comply give notice.

Tack welding
Approval: If the use of tack welding instead of wire ties on reinforcing wire is proposed, submit for approval.
Standard: All welding of reinforcing steel to AS 1554.3.
Prohibition: Do not tack weld cold-worked and hard grade bars.

Approval
General: Submit the approval for the reinforcement in each section of the work before any concrete is deposited in that section. Allow adequate time for inspections and any corrective work.

4.5 CORES, FIXINGS AND EMBEDDED ITEMS

General

Cores, fixings and embedded items: Submit shop drawings showing the proposed locations, clearances and cover, and indicating proposed repositioning of reinforcement.
Cutting or coring: If cutting or coring of hardened concrete is proposed, provide details.

Adjoining elements

Fixings: Provide fixings for adjoining elements. If required, provide for temporary support to the adjoining elements during concreting, to prevent movement.
Corrosion: If in external or exposed locations, galvanize anchor bolts and embedded fixings, or propose alternative materials such as stainless steel.
Position: Fix cores and embedded items to prevent movement during concrete placing. In locating cores, fixings and embedded items, displace but do not cut reinforcement, and maintain cover to reinforcement.
Isolation: Isolate embedded items so that water cannot track to concrete providing minimum cover to reinforcement.

4.6 MIXING

Measurement of materials

General: Measure all materials by weight, except if required:
- Water: Measure by volume with an approved adjustable water-measuring and discharging device.
- Cement: Measure by bags as packed by the manufacturer. Proportion batches on the basis of one or more unbroken bags of cement, assumed to weigh 40 kg per bag.

Bulk cement: Weigh in an individual hopper and keep separate from the aggregates until the components of the batch are discharged from the batching hopper.
Measurement by volume for smaller works: Submit for approval.

Measuring by weight: On-site mixing

Mixing by weight on site: If mixing concrete on site, and if mix control is likely to be less efficient than at a central batching plant, conform to the Materials in batch containing 1 bag (40 kg) cement table as a guide to produce the classes of concrete specified.
Small changes: Adopt small changes in the proportions of fine and coarse aggregate to improve density or workability of the concrete if required.

Materials in batch containing 1 bag (40 kg) cement table

<table>
<thead>
<tr>
<th>MPa</th>
<th>Cement (kg)</th>
<th>Fine aggregates (kg)</th>
<th>Coarse aggregates (kg)</th>
<th>Total aggregates (kg)</th>
</tr>
</thead>
</table>
Variation in aggregate moisture content: If the moisture content of fine and coarse aggregates exceeds 8% or 3% respectively, adjust the proportions of the mix to compensate for the excess water in the aggregate.

Measuring by volume: On-site mixing
Mixing by volume on site: If measurement by volume is approved, proportion the materials to produce a mix free of voids and having the specified strength at 28 days.

Volume batching: Adopt the nominal proportions given in Volume batching table may be used as a guide for volume batching.

### Volume batching table

<table>
<thead>
<tr>
<th>MPa</th>
<th>Parts by volume</th>
<th>Coarse aggregate</th>
<th>Coarse aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>2.25</td>
<td>4.5</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Fine aggregate bulking: If the fine aggregate contains sufficient moisture to produce 'bulking' in excess of 10%, increase the volume of fine aggregate a corresponding amount.

Batch measurement: Measure the volumes of fine and coarse aggregates for each batch in boxes or bins, to details approved by the Superintendent including:
- Measure the aggregates loose (i.e. without compaction) in the boxes and strike off level.
- Do not undertake measurements by shovels or like methods.
- Arrange batch proportions for each batch to contain 1 bag of cement. Assume one 40 kg bag of cement to have a volume of 27.5 litres.

### Consistency

General: If approved add sufficient quantity of water to the mix so that the consistency of the concrete enables it to be placed in the forms, compacted and worked into all corners without permitting the ingredients to segregate, or excess free water to collect on the surface.

Standard: Determine the consistency of the concrete to AS 1012.3.1.

Slump: Except for extruded concrete, concrete slump ≤ 75 mm for concrete compacted by vibrators.
Extrusion machine: If concrete is placed by an extrusion machine, provide only sufficient water in the mix to produce a slump of 10 mm to 15 mm.

Mechanical mixing: Mix all concrete with mechanically operated mixers. If there is an emergency, provide proposals for hand mixing.

Mixing location: Submit proposal for concrete mixing location.

Segregation of concrete: Reject any concrete which exhibits signs of segregation as directed by the Superintendent.

### Mixing at site

Machine mixing at site: Conform to the following:
- Mixer requirements: Adopt a batch mixer which will provide a uniform distribution of the materials throughout the batch.
- Mixer capacity: Provide a mixer with capacity for one or more whole bags of cement to be used per batch of concrete. Do not exceed the manufacturer’s rated capacity of the mixer with the volume of the mixed material.
- Mixing time: Allow a mixing time for each batch of not less than 1.5 minutes after all ingredients are assembled in the mixer, and prior to any portion of the batch being removed.
- Total mix discharge: Discharge the entire contents of a batch from the mixer before any materials are placed therein for the succeeding batch.
Mixing in an emergency

Mixing in an emergency: Conform to the following:

- Hand mixing: If there is a breakdown of the mechanical mixing equipment, seek approval of the Superintendent to hand mix in small quantities so as to complete a section of the work or reach a suitable construction joint.

- Hand mixing conditions: Hand mix on an approved water-tight platform of sufficient size to allow the mixing of at least two batches simultaneously. Use an amount of cement 10% more than the amount specified for machine mixed concrete.

- Hand mixing procedure:
  1. First mix the fine aggregate and cement until a uniform colour is obtained, and then spread on the mixing platform in a thin layer.
  2. Spread the coarse aggregate, previously drenched with water, over the fine aggregate and cement in a uniform layer, and turn the whole mass over as further water is added with a rose sprinkler.
  3. After the water is added, turn the mass at least three times, not including shovelling into barrows or forms, until the mixture is uniform in colour and appearance.

- Hand-mixed batches: Do not exceed 0.25 cubic metres each.

Pre-mixed supply

Delivery docket: For each batch, submit a docket listing the information required by AS 1379, and the following information:

- For special class performance concrete, specified performance and type of cement binder.
- For special class prescription concrete, details of mix, additives, and type of cement binder.
- Method of placement and climate conditions during pour.
- Name of concrete delivery supervisor.
- Project assessment carried out each day.
- The amount of water, if any, added at the site.
- The concrete element or part of the works for which the concrete was ordered, and where it was placed.
- The total amount of water added at the plant and the maximum amount permitted to be added at the site. This is a WITNESS POINT.

Subcontractors: Submit names and contact details of proposed pre-mixed concrete suppliers, and alternative source of supply in the event of breakdown of pre-mixed or site mixed supply. This is a WITNESS POINT.

4.7 PLACING AND COMPACTION

Placing

Activities include: Taking delivery of fresh concrete, placing, transfer and/or finishing the concrete into its final position.

Sequence of placement: If sequential placement of slab segments is proposed, provide details. This is a WITNESS POINT.

Preparation: Clean and moisten the area prior to placing concrete: Remove any ponding water.

Method: Use placing methods which avoid segregation and loss of concrete, and which minimise plastic settlement. Maintain a generally vertical and plastic concrete edge during placement.

Layers: Place concrete in layers not more than 300 mm thick. Compact the following layer into the previous layer before the previous layer has taken initial set.

Conveying equipment: Provide conveying equipment including open troughs and chutes, where required, of metal, or with metal linings.

Steep slopes: Provide troughs and chutes with baffles, or place in short lengths in such a way that the direction of flow of the concrete is changed.

Positioning of chutes: Provide chutes long enough to permit delivery to the whole of the area enclosed by the forms.

Discharge of cleaning water: Discharge the water used for flushing the chutes and for cleaning in an area acceptable to the Superintendent.
Compaction
Methods: Use immersion and screed vibrators accompanied by hand methods as appropriate to remove entrapped air and to fully compact the mix.
Vibrators: Do not allow vibrators to come into contact with set concrete, reinforcement or items including pipes and conduits embedded in concrete. Do not use vibrators to move concrete along the forms. Avoid over-vibration that may cause segregation.

Placing records
Log book: Keep on site and make available for inspection a log book recording each placement of concrete, including the following:
- Date.
- Specified grade and source of concrete.
- Slump measurements.
- The portion of work.
- Volume placed.

Rain
Protection: During placement and prior to setting, do not expose concrete to rain.
Protection: Protect surface from damage by covering until hardened.

Time between adjacent placements
General: As documented in the Minimum time delay schedule.

Slurry for extruded concrete
General: If concrete is placed by an extrusion machine place in the special receptacle in the machine, if the machine is so equipped, mix small quantities of cement-sand slurry, comprised of two parts of plasterer’s sand and one part of cement (by volume), together with sufficient water to bring it to a semi-fluid condition, and feed onto the surface of the concrete at a rate sufficient to produce a smooth and uniform finish.

Placing in hot weather
Handling: Prevent premature stiffening of the fresh mix and reduce water absorption and evaporation losses. Mix, transport, place and compact the concrete to conform to the Elapsed delivery time table.
Placing concrete: Maintain the temperature of the freshly mixed concrete to conform to the Hot weather placing table.
Evaporation control barriers: Erect barriers to protect freshly placed concrete from drying winds.
Formwork and reinforcement: Before and during placing maintain temperature at 35°C or less.
Temperature control: Select one or more of the following methods of maintaining the temperature of the placed concrete at 35°C or less:
- Cool the concrete using liquid nitrogen injection before placing.
- Cover the container in which the concrete is transported to the forms.
- Spray the coarse aggregate using cold water prior to mixing.
- Use chilled mixing water.

Hot weather placing table
<table>
<thead>
<tr>
<th>Concrete element</th>
<th>Temperature limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal concrete in footings, beams, columns, walls and slabs</td>
<td>35°C</td>
</tr>
<tr>
<td>Concrete in sections 1 m or more in all dimensions except for concrete of strength 40 MPa or more, in sections exceeding 600 mm in thickness</td>
<td>27°C</td>
</tr>
</tbody>
</table>

Placing under water
General: Do not place under water unless conditions prevent dewatering.
Minimum cement content for the mix: Increase by 25%.
Method: If required, submit proposals. This is a WITNESS POINT.
4.8 CURING

General
Requirements: Taking into account the average ambient temperature at site over the relevant period affecting the curing, adopt procedures to make sure of the following:

- Curing: Cure continuously from completion of finishing until the total cumulative number of days or fractions of days, during which the air temperature in contact with the concrete is above 10°C, is at least the following, unless accelerated curing is adopted:
  - Fully enclosed internal surfaces/Early age concrete: 3 days.
  - Other concrete surfaces: 7 days.
- End of curing period: Prevent rapid drying out at the end of the curing period.
- Protection: Maintain at a reasonably constant temperature with minimum moisture loss, during the curing period.

Curing compounds
Standard: To AS 3799.
Application: Provide a uniform continuous flexible coating without visible breaks or pinholes, which remains unbroken at least for the required curing period after application.
Substrates: Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to applied finishes, concrete toppings and cement-based render.
Self levelling toppings: If used also as curing compounds, confirm compliance with AS 3799.
Visually important surfaces: Apply curing compounds to produce uniform colour on adjacent surfaces.

Hot weather curing
Curing compounds: If it is proposed to use curing compounds, provide details.
Protection: Select a protection method as applicable.
- If the concrete temperature is more than 25°C or if not protected against drying winds, protect the concrete using a fog spray application of aliphatic alcohol evaporation retardant.
- If ambient shade temperature is more than 35°C, protect from wind and sun using an evaporative retarder until curing is commenced.
- Immediately after finishing, either cover exposed surfaces using an impervious membrane or hessian kept wet until curing begins, or apply a curing compound.

Water curing
Method: Select a method of ponding or continuously sprinkling to prevent damage to the concrete surface during the required curing period.

4.9 JOINTS

General
Sawn joints: Submit proposed methods, timing and sequence of sawing joints. This is a WITNESS POINT.

Horizontal construction joint
Location: If horizontal construction joints are found to be necessary in walls, or cast-in-situ drainage structures, make the joints at the base of walls and at other locations in the walls where approved by the Superintendent.
Preparation: In order to provide for bond between the new concrete and the concrete which has already set, clean the surface on which the new concrete is to be placed of loose material, foreign matter and laitance prior to:
- Roughening or keying and saturating with water.
- Removing any excess water, and thinly coating the surface with a neat cement grout.

Retaining wall vertical expansion joints
Location: Provide vertical expansion joints as documented.
Material: Provide jointing material of approved quality, and of thickness as documented, for the full depth of the joint.
Trim: Trim to match the surface of the concrete.

Footpaths, medians, driveways
Location: In footpaths, median toppings and driveways, unless otherwise documented, provide expansion joints 15 mm in width for the full depth of paving, constructed at intervals not exceeding 15 m and where the pavement abuts against gutters, pits and structures.
Material: Preformed jointing material of bituminous fibreboard or approved equivalent.

Unreinforced paving
Location: Provide all unreinforced paving with narrow vertical grooves, 20 mm deep to induce contraction joints for the control of cracking.
Timing and set out: Form joints in the freshly placed concrete in a neat regular pattern to form ‘slabs’ no bigger than 2 m square.
Proportion: The ratio of the longest side to the shortest side ≤ 1.6.

Expansion joints
Joint filling: Fill with jointing materials as documented. Finish visible jointing material neatly flush with adjoining surfaces.
Preparation: Before filling, dry and clean the joint surfaces, and prime.
Watertightness: Apply the jointing material so that joints subject to ingress of water are made watertight.
Jointing materials: Provide jointing materials compatible when used together, and non-staining to concrete in visible locations.
Bond breaking: Provide back-up materials for sealants, including backing rods, which do not adhere to the sealant. They may be faced with a non-adhering material.
Foamed materials (in compressible fillers): Closed-cell or impregnated, not water absorbing.

Slip joints
Requirement: If concrete slabs are supported on masonry, provide proprietary slip joints.

4.10 FORMED SURFACES

General
Surface finish: Provide formed concrete finishes as documented in the Formed surface finishes schedule.
Damage: Do not damage concrete works through premature removal of formwork.
Surface repair method: If required, submit details of the proposed method before commencing repairs. This is a WITNESS POINT.

Curing
General: If forms are stripped when concrete is at an age less than the minimum curing period, commence curing exposed faces as soon as the stripping is completed.

Quality of surfaces
General: Provide concrete surfaces which are true and even, free from stone pockets, depressions or projections beyond the surface. Make sure all arises are sharp and true, and mouldings evenly mitred or rounded.

Repair of defects
General: As soon as the forms are removed from mass or reinforced concrete work, repair all rough places, holes and porous spots by removing defective work and after wetting, filling with stiff cement mortar having the same proportions of cement and fine aggregate as used in the concrete, and bring to an even surface with a wooden float. Similarly repair all cavities caused by removal of fitments or tie wires and pack with cement mortar.
Removal of the wires: Cut back any tie wires or other fitments extending to outside surfaces after removal of forms, to a depth of at least 40 mm with sharp chisels or cutters.
Coating with bonding agent: If required, coat the surfaces of bolt cavities, tie wire holes, and all defects prior to the placing of mortar, grout, or fresh concrete, with an approved bonding agent, in lieu of wetting with water, generally as required by the manufacturer.
4.11 REMOVAL OF FORMS

Formwork removal
Extent: Remove formwork, other than profiled steel reinforcement decking, including formwork in concealed locations, but excepting lost formwork.

Timing: Do not disturb forms until concrete is hardened enough to withstand formwork movements and removal without damage.

Stripping:
- General: To AS 3600 where it is more stringent than AS 3610.1.

Walls, sumps and other structures
General: Maintain all forms in place, after placement of concrete, for following minimum periods, or as extended by the Superintendent if the air shade temperature falls below 10°C:
- Gully pits, sumps and similar drainage structures: 2 days.
- Footpaths, driveways and similar: 2 days.
- Sides of reinforced concrete walls when height of each day pour is:
  - Under 0.6 metres: 1 day.
  - 0.6 m to 3 m: 2 days.
  - 3 m to 6 m: 3 days.
  - 6 m to 9 m: 5 days.
- Supporting forms under deck slabs of culverts: 10 days.

Concrete containing special additives: In case of concrete containing special additives, conform to stripping times as determined by the Superintendent.

Protection of concrete during form removal: Remove forms so that the concrete will not be cracked, chipped or otherwise damaged. Do not use of crowbars or other levering devices exerting pressure on the fresh concrete to loosen the forms.

Removal of hole formers: Remove hole formers such as pipes and bars as soon as the concrete has hardened sufficiently for this to be done without damage to the concrete.

Superimposed load
Prohibition: Do not apply superimposed load to any part of a structure until the concrete has reached at least 70% of the design strength.

4.12 UNFORMED SURFACES

General
General: Strike off, screed and level slab surfaces to finished levels and to the flatness tolerance class documented in the Unformed surface finishes schedule.

Surface finishes
General: As documented in the Unformed surface finishes schedule.

Surface repairs
Surface repair method: If surface repairs are required, submit proposals.
Mortar capping: Not permitted.

Finishing methods – surfaces other than wearing surfaces
General: Compact and tamp so as to flush mortar to the surface, screed off and finally dress with a wooden float to an even surface, including to:
- Drain or otherwise remove promptly any water which comes to the surface.
- Roughen all future contact surfaces, with the coarse aggregate at the surface firmly embedded but not forced below the surface.

Finishing methods – wearing surfaces
General: Compact then screed off the surface with a vibrating screed, or hand screed if the distance between forms perpendicular to the direction of screed is no greater than 2 metres.
Correction: Immediately following compaction and screeding test and correct for high or low spots.
Tolerance: Conform to the following:
- The finished surfaces of concrete structures not adjacent to road pavements – Deviation is ± 25 mm in plan position and ± 25 mm from the specified levels.
In the case of drainage pits and other structures adjacent to road pavements, the finished concrete ≤ 10 mm from the specified levels and alignment.

- Longitudinal surfaces greater than 10 metres in length: Deviation from level or alignment < 5 mm from a straight-edge 3 metres long, subject to any necessary allowances on vertical and horizontal curves.

Final finish: Finish the surface true and uniform and free of any glazed or trowelling finish and finally dress with a wooden template or float, or by the use of belting in an approved manner.

Surface to receive asphalt: After compacting, screeding and correcting, dress with a wooden float and finally broom to produce a rough surface.

Textured patterned surface: Finish coloured, textured or patterned surfaces as directed by the Superintendent.

### 4.13 PRECAST UNITS

**Handling**

Lifting: Lift or support units only at designated or other approved points. Use handling methods which do not overstress, warp or damage the units.

**Attachments**

Remove temporary attachments after erection. Seal and make good residual recesses.

**Installation**

Fixing: Fix the units securely and accurately in their final positions.

Ancillaries: Provide components and materials, including fasteners, braces, shims, jointing strips, sealant, flashings, grout and mortar, necessary for the installation of the units.

**Protection**

General: Protect the units against staining, discolouration and other damage until they are installed in their final location.

**Storage**

Support points: Store elements at designated storage points.

Prevent damage: Adequately store units to prevent warping, twisting, crushing, cracking and staining.

Protection: Protect the units against staining, discolouration and other damage until they are installed in their final location.

**Lifting and handling**

Lifting and handling: Conform to the National code and AS 3850.

Site conditions: Make sure the wind and temperature conditions allow handling and fixing consistent with structural capability and geometry of the element.

Cranes: To AS 2550.1.

Temporary bracing and propping: To AS 3850.

### 4.14 COMPLETION

**Loading**

General: Do not erect masonry walls or other brittle elements on beams and slabs while they are still supported by formwork.

**Unencased reinforcement**

General: If ‘starter bars’ and other items project from cast concrete for future additions and are exposed to the weather, provide details of protection.

**Protection**

Protection: Protect the concrete from damage due to construction load overstresses, physical and thermal shocks, and excessive vibrations, particularly during the curing period.

Surface protection: Protect finished concrete surfaces and applied finishes from damage.
5 MEASUREMENT AND PAYMENT

5.1 MEASUREMENT

General
Payment to the schedule of rates: To 0152 Schedule of rates – supply projects, this worksection, as shown on the drawings and Pay items 0310.1 to 0310.5 inclusive.
Lump Sum prices: Not acceptable.
Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology
The following methodology will be applied for measurement and payment:
- Concrete payment rates: At the scheduled rates provided the concrete meets the strength requirements shown in the Concrete strength requirements table or as otherwise documented.
- Reduction in payment rates: Where any concrete does not reach the strength specified in the Concrete strength requirements table, at the scheduled rate of payment reduced by 2% for each 1%, or fraction thereof, by which the strength of the specimen fails to reach the specified strength, up to a maximum deficiency of 10%.
- Rejection: If the deficiency in strength exceeds 10%, the concrete represented by the specimens may be rejected, in which case no payment will be made for the work nor for any remedial work to rectify the deficiency.

Pay items table

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0319.1 Supply and installation of precast concrete unit (a) DN1500 DN1050 Manhole (b) DN2100 RCP (cb) DN1800 Manhole</td>
<td>Each, measured as individual item</td>
<td>Includes all operations involved in supply, handling and lifting, ground preparation, sealing and installation including converter slabs and lids (trafficable where required).</td>
</tr>
<tr>
<td>0319.2 Supply and install thrust block a. Designed inline block b. CMDG standard detail</td>
<td>Each</td>
<td>All costs associated with installing inline thrust blocks including but not limited to confirmation of existing ground bearing pressures, reinforcement supply and fixing and concrete supply.</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction)
- GRC-ES001 – Electrical Work
- GRC-ES002 – Preferred Electrical Components
- GRC-ES003 – Prefabricated Electrical Switchrooms
- GRC-ES004 – Motor Control Centres
- GRC-ES006 – Field Control Panels
- GRC-ES008 – Equipment Identification

1.2 PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0900.1 Supply and install switchboard</td>
<td>Lump Sum</td>
<td>All costs associated with the supply and installation of the switchboard in accordance with CMDG and GRC standards</td>
</tr>
<tr>
<td>0900.2 Supply and installation of 250 kW submersible pumps, (Flygt Model NT3400/835 or approved equivalent) (Provisional Item)</td>
<td>Each</td>
<td>All costs associated with the supply, delivery and installation of the pump, including wiring up to the switchboard, supply and installation of ducksfoot bend and nylon cable socks</td>
</tr>
<tr>
<td>0900.3 Supply and installation of 30kW submersible pump (Flygt model NP3202MT 3-640 or approved equivalent) (Provisional Item)</td>
<td>Each</td>
<td>All costs associated with the supply, delivery and installation of the pump, including wiring up to the switchboard, supply and installation of ducksfoot bend and nylon cable socks</td>
</tr>
</tbody>
</table>
| 0900.4 Supply and installation of cabling to/from new pump station and switchboard | -Lump Sum | All costs associated with the following:  
- Supply of electrical cabling  
- Feed electrical cable through conduit(s)  
- All cabling requirements between switchboard and pump(s)  
- Termination of electrical cabling |
| 0900.5 Supply and installation of electrical conduits to/from new pump station facilities and switchboard | -Lump Sum | All costs associated with the following:  
- Supply conduits  
- Cut conduits to suitable lengths  
- Lay conduits |
<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0900.6 Supply and installation of electrical pits</td>
<td>-Each</td>
<td>All costs associated with the following: &lt;br&gt;- Supply of electrical pit including lid &lt;br&gt;- Excavation for pit &lt;br&gt;- Installation of pit &lt;br&gt;- Backfill around electrical pit</td>
</tr>
<tr>
<td>0900.7 Supply and install DN600 flow meter</td>
<td>-Each</td>
<td>All costs associated with the following: &lt;br&gt;- Supply of electromagnetic flow meter &lt;br&gt;- Factory testing of flow meter &lt;br&gt;- Delivery of flow meter to site &lt;br&gt;- Installation of conduit and cabling to switchboard &lt;br&gt;- Installation of flow meter including all consumables and associated seals, bolts, nuts, washers, etc.</td>
</tr>
<tr>
<td>0900.8 Manufacture, supply and works testing of electrical control equipment including level sensors, controllers and telemetry and SCADA requirements</td>
<td>-Lump sum</td>
<td>All costs associated with the following: &lt;br&gt;- Supply of approved equipment &lt;br&gt;- Installation and calibration of equipment</td>
</tr>
<tr>
<td>0900.9 Subcontractor cost for construction of Ergon Substation power pole and Energy Pillar</td>
<td>-Lump Sum</td>
<td>All costs associated with the installation of the Ergon substation power pole and energy pillar.</td>
</tr>
<tr>
<td>0900.10 Construction of electricity supply, connection to Ergon Energy pillar box and supply and installation of power cable and conduit from pole to cubicle including excavation, backfilling</td>
<td>-Lump Sum</td>
<td>All associated costs in transferring power from the new electrical pole to the pump station.</td>
</tr>
<tr>
<td>0900.11 Manufacture, supply of Cable tray</td>
<td>-m</td>
<td>All costs associated with the supply and installation of cable tray</td>
</tr>
<tr>
<td>Pay items</td>
<td>Unit of measurement</td>
<td>Schedule rate scope</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0900.12 Supply and install new prefabricated switchboard building</td>
<td>- Item</td>
<td>All costs associated with the installation of new prefabricated switchboard building</td>
</tr>
<tr>
<td>0900.13 Supply and installation temporary diesel pump (including SMS telemetry, level sensors within existing access chamber)</td>
<td>Each</td>
<td>All costs associated with the following: - Supply/hire and installation of the temporary diesel pump including SMS telemetry, level sensors - Supply and installation of temporary PE diversion pipework - Maintenance of the temporary pump system including refueling and monitoring</td>
</tr>
<tr>
<td>0900.14 Supply and install additional HMI panel at the sewage pump well</td>
<td>Each</td>
<td>All costs associated with the installation of additional HMI panel at the sewage pump well</td>
</tr>
<tr>
<td>0900.15 Supply and install pump Local Isolators with additional controls at the sewage pumping station valve pit</td>
<td>Lump Sum</td>
<td>All costs associated with the installation of pump Local Isolators with additional controls at the sewage pump well</td>
</tr>
<tr>
<td>0900.16 Commissioning and testing</td>
<td>Lump Sum</td>
<td>All costs associated with the commissioning and testing of associated electrical items.</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 RESPONSIBILITIES

General
Traffic control: Provide traffic control for works on roads. Construct the work with the least possible obstruction to traffic.

Performance
General: Provide the following, as documented:
- Personnel plant and equipment.
- Temporary roadways and detours.
- Arrangement for traffic.
- Traffic control devices.
Requirements: Make sure the safety of workers and safety and convenience of road users at all times.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction).
- 1102 Control of erosion and sedimentation.
- 1111 Clearing and grubbing.
- 1112 Earthworks (Roadways).
- 1144 Asphaltic concrete (Roadways).

1.3 REFERENCED DOCUMENTS

Standards
General: The following documents are incorporated into this worksection by reference:

Australian standards
AS 1742 Manual of uniform traffic control devices
AS 1742.3-2009 Traffic control for works on roads
AS 1742.14-2014 Traffic signals
AS 1743-2001 Road signs - Specifications
AS 1744-1975 Forms of letters and numerals for road signs (known as Standard alphabets for road signs)
AS/NZS 1906 Retroreflective materials and devices for road traffic control purposes
AS/NZS 1906.1:2007 Retroreflective sheeting
AS 4191-1994 Portable traffic signal systems
AS/NZS 4192-2006 Illuminated flashing arrow signs
AS/NZS 4602 High visibility safety garments
AS/NZS 4602.1:2011 Garments for high risk applications

Other publications
AUSTROADS
AGRD03-2010 Guide to road design - Geometric Design
AGTM06-2013 Guide to traffic management Part 6: Intersection, interchanges and crossings
AP-R337-2009 National approach to traffic control at work sites
1.4 STANDARDS
General
Standard: To AS 1742.3 and AP-R337.

1.5 INTERPRETATION
Abbreviations
General: For the purposes of this worksection the following abbreviation applies:
- TGS: Traffic Guidance Scheme.
Definitions
General: For the purposes of this worksection the following definitions apply:
- Competent person: A person who has, through a combination of training, qualification and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.

1.6 SUBMISSIONS
Approval
Submissions: To the Superintendent’s approval.
Approvals
- Traffic guidance scheme.
- Statutory approvals from council or other relevant authority.
Drawings
- Temporary roadways and detours (if needed).
Execution details
- Schedule of working times.

1.7 INSPECTION
1.8 HOLD POINTS AND WITNESS POINTS
Notice
General: Give notice so that the documented inspection and submissions may be made to the HOLD POINT table and the WITNESS POINT table.

HOLD POINT table

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRE-CONSTRUCTION PLANNING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic guidance scheme</td>
<td>Approval of Traffic guidance scheme</td>
<td>2 weeks before proposed commencement on site</td>
<td>Superintendent.</td>
</tr>
<tr>
<td>Levels of Traffic Guidance Schemes</td>
<td>Carry out a risk assessment for works not involving complex traffic arrangements or staged works or both</td>
<td>2 weeks before proposed commencement on site</td>
<td>Superintendent.</td>
</tr>
<tr>
<td><strong>EXECUTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side roads and property accesses – Notice to property owners</td>
<td>Approval to deny vehicular access and provide notice to property owners</td>
<td>3 working days prior to carrying out works</td>
<td>Superintendent.</td>
</tr>
<tr>
<td>Plant and equipment – Inadequate traffic control devices</td>
<td>Rectify non conforming traffic control devices</td>
<td>1 working day of notice</td>
<td>Superintendent.</td>
</tr>
<tr>
<td>Opening to traffic – Opening temporary road ways and detours</td>
<td>Redirection onto existing roadway in the event of failure</td>
<td>1 working day</td>
<td>Superintendent.</td>
</tr>
</tbody>
</table>
Volume 2: Technical Specifications - 1101 Control of traffic
A01 SEWER PUMP STATION (LORD/CHAPPLE STREET) UPGRADE
Contract No. 44-19

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
</tr>
</thead>
<tbody>
<tr>
<td>to traffic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WITNESS POINT table – On-site activities

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection by the Superintendent</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-CONSTRUCTION PLANNING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Guidance Scheme</td>
<td>Site copy of TGS</td>
<td>Progressive</td>
</tr>
<tr>
<td>Safety Audit</td>
<td>For complex traffic arrangements and staged works carry out safety audits</td>
<td>Progressive</td>
</tr>
</tbody>
</table>

MATERIALS

| Barriers and fencing – Cones and bollards | Restrictions for use of cones when attended by an employee. | Progressive |

EXECUTION

<table>
<thead>
<tr>
<th>Personnel - Traffic controllers</th>
<th>Additional traffic controller required where sight distance is restricted</th>
<th>Progressive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant and equipment – Temporary speed zoning</td>
<td>Diary and method of works</td>
<td>Progressive</td>
</tr>
<tr>
<td>Plant and equipment – Arrangement and placement of traffic control devices</td>
<td>To the approved TGS</td>
<td>Progressive</td>
</tr>
</tbody>
</table>

2 PRE-CONSTRUCTION PLANNING

2.1 TRAFFIC GUIDANCE SCHEME

General
Requirement: Submit a traffic guidance scheme for approval at least 2 weeks prior to proposed commencement on site. The Traffic guidance scheme must include both the traffic management plan and the Traffic control plan. The Traffic Guidance scheme must be prepared by a competent person. Where the control of traffic does not require pavement or drainage works the period of notice will be 2 weeks. This is a HOLD POINT.

Obtain: All necessary approvals from Councils and other authorities for temporary traffic arrangements. This is a HOLD POINT.

Site copy: Keep an approved copy of the Traffic Guidance Scheme on site at all times. This must be used to check the arrangement and maintenance of traffic control devices. This is a WITNESS POINT.

Level of Traffic guidance schemes

Levels: For traffic guidance schemes conform to the following:
- a) Short term and mobile works not involving full or part road closure.
- b) Works involving relatively simple part-roadway closures.
- c) Works involving complex traffic arrangements or staged works or both.

Risk assessments: Carry out for (a) and (b) considering factors such as traffic volume and speed, road geometry and width and the general behaviour of road users. If the risk can not be tolerated a fully protected work site will be required. This is a HOLD POINT.

Traffic Management Plan

Include: The Traffic Management Plan must include the following:
- Design drawings for any temporary roadways and detours to conform to Design drawings showing pavement, wearing surface and drainage details.
- Details of arrangements for construction under traffic.
- Traffic Control Plan(s).
- Vehicle Movement Plan(s) – Planning for movement of work vehicles including deliveries, personnel and contractors and gang trucks.
- Application for temporary speed zoning changes.
- Special consideration to the safety of the workers, pedestrians, cyclists.
- Names, addresses and means of communicating with personnel nominated for contact outside normal working hours to arrange for adjustments or maintenance of traffic control devices and temporary roadways and confirmation that this list has been supplied to the local Police.

**Traffic Control Plan**

Include: The Traffic Control Plan must include the following:
- A proposal to erect a Regulatory Traffic Control Device showing locations and times of operation.
- Appropriate temporary speed zoning signs.
- Boom gates.
- Portable traffic signals.
- Temporary fixed traffic signals.
- A signpost layout plan showing:
  - Location, size and legend of all temporary signs.
  - Temporary regulatory signs and temporary speed zones.
  - All traffic control devices such as temporary traffic signals, linemarking, pavement reflectors, guideposts, guard fence and barrier boards.
- Working times when traffic control measures are in place to minimise disruption to traffic during periods of peak flows.
- Take particular care when requiring reversal of traffic flows or the separation of unidirectional flow by medians or other physical separation.

**Safety audit**

Audit: Conduct a safety audit for the construction phase as recommended in AGRS 06 for complex traffic arrangements and staged works. This includes risk assessments for the workers safety. This is a **WITNESS POINT**.

### 3 MATERIALS

#### 3.1 SIGNS

**Specifications**

Selection of signs: To AS 1742.3.

Design and manufacturing of signs: To AS 1743.

Details of each letter: To AS 1744.

Reflective material: Class 1 material complying with AS 1906.1.

Sign size: To AS 1742.3, AS 1743 and Annexure.

Signs for night work: Floodlit if outside of the car headlight beams to AS 1742.3.

Flashing arrow signs: To AS/NZS 4192 and installed to AS 1742.3.

**Supplementary signs**

Annexure: Signs supplementary to AS 1742.3 and AS 1743.

Use: In lieu of or in addition to those shown in AS 1743 as follows:
- Heavy machinery crossing temporary sign SW5-22 in lieu of trucks entering sign W5-22.
- Cycle hazard grooved road temporary sign ST1-10 in addition to T1-10 where the road is grooved and is a hazard to cyclists.
- Changed traffic conditions ahead temporary sign ST1-6 in addition to T1-1, T1-6, T2-6 and T2-21 on long term works, sidetracks and detours.
3.2 BARRIERS AND FENCING

Barrier boards
Standard: To AS 1742.3.
Size: 150 to 200 mm high, 4 m maximum length.
Colour: Alternate diagonal stripes of black and retroreflective yellow terminating in yellow at each end.
Retroreflective sheeting: Minimum Class 1 to AS/NZS 1906.1.
Placement: Do not place parallel to the direction of traffic flow.
Support: Mount on trestles or fixed posts at about 1 m above the pavement.
Support Material: Timber, metal or other suitable material.
Support Colour: Yellow.
Stability: Provide concrete blocks, sandbags or other approved devices to make sure barriers are stable.
Bases: Keep the bases of the trestles within the ends of the boards.

High visibility flexible mesh fencing
Standard: To AS 1742.3.
Height: Approximately 1 m.
Colour: Orange.
Support: Top of the fence is at least 800 mm above ground level at all times.
Posts: Use temporary post-mounted delineators.
Location: Erect parallel to and in close proximity to traffic.

Boom gates
Type and location: As requested by the Superintendent or Local Roads Authority. This is a WITNESS POINT.

Cones and bollards
Standard: To AS 1742.3.
Cones: Fluorescent red or orange material resilient to impact.
Small cones: Used in most built up areas, footpaths, shared paths, and speeds < 70 km/hr. 450 to 500 mm high.
Large cones: Minimum 700 mm high all other locations or instead of the small cones.
Spacing: To AS 1742.3 and all purposes with speed limit less then 50 km/h maximum spacing 4 m.
Bollards: Vertical tube fluorescent red or orange material resilient to impact. At least 750 mm high and 100 mm diameter.
Placement: Locate traffic cones and bollards to AS 1742.3.
Restrictions: Unless cones are firmly fixed in position use only while work is in progress, or in locations where there is an employee in attendance to reinstate any of the cones which have been dislodged by traffic. Alternatively use bollards or barriers. This is a WITNESS POINT.
Cones and bollards used under night conditions: White horizontal retroreflective class 1 material band, size and location to AS 1742.3.

3.3 TEMPORARY MARKINGS

Pavement reflectorised markings
Pavement markings: Include painted lines, roadmarking tape and raised pavement markers.
Standard: To AS 1742.3.
Edgelining: Where the adjoining roadway is edgelined, provide edgelining to temporary roadways.

Linemarking
Type: Pavement marking tape.
Maintenance: If the pavement linemarking becomes ineffective remark within 48 hours of direction by the Superintendent. This is a WITNESS POINT.

Arrows
Location: If single carriageway is opened adjacent to or in lieu of an existing dual carriageway length.
Place: Pavement arrows indicating the direction of flow of traffic at not more than 500 m.
Remove: Arrows if the section is then reincorporated as dual carriageway.

**Old markings**
Removal: Obliterate or remove all superseded pavement markings immediately before, or after placement of, new markings. Do not obliterate by painting on a final surface. This is a **WITNESS POINT**.

**Raised pavement markers**
Ineffective markers: Replace raised pavement markers which have become ineffective, within 24 hours of direction by the Superintendent. This is a **WITNESS POINT**.

### 4 EXECUTION

#### 4.1 SIDE ROADS AND PROPERTY ACCESSES

**Access**
Passage: At all times provide safe and convenient passage for vehicles, pedestrians and stock to and from side roads and property accesses connecting to the roadway.
Alternative access: Submit proposal for approval prior to commencing the work affecting access.
This is a **HOLD POINT**.

**Notice to property owners**
Denial of vehicular access: Where access needs to be denied due to particular construction activities undertake the following:
- Obtain approval the of the Superintendent.
- Advise the property owners of such occurrences by way of letter drop at least 24 hours prior to such an interruption.
- Repeat this advice verbally to the property owner in a courteous manner.
- Keep these interruptions to an absolute minimum. This is a **HOLD POINT**.

#### 4.2 PERSONNEL

**Traffic controllers**
Standard: To AS 1742.3.
Personnel: Submit names of proposed traffic controllers with a signed declaration that they are appropriately trained in the duties of traffic controllers to AS 1742.3.
Recognition marks: A distinguishing mark on the outer garment of authorised traffic controllers indicating their authority.
Location of traffic controllers: One traffic controller will remain at the head of each traffic queue while it is halted.
Restricted sight distance: An additional traffic controller must be placed at the tail end of the queue.
This is a **WITNESS POINT**.

Two-way radio: Where both ends of the work are not intervisible, use two-way radio for the traffic controller at each end, or an intermediate traffic controller, from whom both other traffic controllers take their cue, is stationed where both can see extremities of the work.

**Night and poor light**
Wand: Use an illuminated red cone wand (torch) with a minimum capacity of 30,000 candela to control traffic.
Lighting: The traffic controller and the work area adjacent must be illuminated where possible by flood lighting. Position the flood lighting above the work area and direct downwards and incline slightly to illuminate the face of the STOP/SLOW bat.
Flood lighting: Must not create glare for approaching drivers.
Environmental effects: Consider the adverse effects of high lighting levels close to residential property.

**Approved clothing for work personnel**
Standard: To AS/NZS 4602.1.
Requirements: All personnel are required to wear a garment or garments of the classification appropriate for the time of work as follows:
- Class D – garments for daytime use only. Red-orange or yellow.
- Class N – garments for night-time use only. Retroreflective strips of White or yellow.
- Class D/N – garments for both day and night use. Red-orange or yellow.

Flammable: Potentially flammable clothing must not be worn close to work likely to generate flame or hot splatter/molten metal.

4.3 PLANT AND EQUIPMENT

Plant delineation
Plant and equipment: When working in a position adjacent to traffic with a projection beyond the normal width of the item, for example, a grader blade. Direct traffic around such plant and equipment as follows:
- Day light conditions: Attach a fluorescent red flag to the outer end of the projection.
- Night or poor light conditions: Provide an additional traffic controller with an illuminated red wand.

Night time Clearance
Remove plant: Where traffic is permitted to use the whole or portion of the existing road, remove all plant items and similar obstructions from the normal path of vehicles

Lateral clearance: At least 6 m where practicable, with a minimum clearance of 1.2 m.

Lamps: Flashing yellow lamps may be used to draw attention to advance signs. Do not use for delineation.

Signs and devices
Conform to the following:
- Must be installed by a competent person.
- Must be appropriate to the conditions at the work site and used to AS 1742.3 unless a competent person has carried out a risk assessment for an alternative arrangement.
- Must be erected before work commences at a work site.
- Regularly check and maintain in a satisfactory condition.
- Remove from the work site as soon as practicable after works complete including stone removal and line marking.
- Keep records of all signing and delineation at roadway or part roadway closures.
- Relocate or reposition traffic control items so they are visible and perform their regulatory function.
- Place 1m clear of the travelled path. For works taking longer than 2 weeks signs must be mounted on poles sunk into the ground and duplicated on the right side of the road if physically possible.

Temporary speed zoning
General: Conform to the following:
- Arrange for the supply of appropriate temporary speed zoning signs, including posts and fittings, for erection where a temporary speed limit has been approved by the Local Council Traffic Committee or Road Authority.
- Erect these signs, cover the signs when the speed zone is not in use and remove the signs when the speed zone is no longer required as part of the provision for traffic as directed or approved.
- Keep a diary recording operation times of the speed zone to be made available when requested. This is a WITNESS POINT.

Arrangement and placement of traffic control devices
Layout: To the approved Traffic guidance scheme and AS 1742.3. This is a WITNESS POINT.

Cover and/or remove: All temporary traffic control devices when no longer required without delay and maintain unambiguous safe guidance to traffic.

Maintain: All traffic control devices in accordance with AS 1742.3 so that they are in good order and in the correct positions day and night. At all times the signs should be neat, clean, clear and legible.

Unacceptable traffic control devices
Do not use: The following items for traffic control:
- Steel drums.
- Isolated or non-continuous barrier units.
- Barrier boards parallel to and within 4m of the direction of traffic flow.

**Inadequate traffic control devices**

Nonconforming traffic control devices: Where the Contractor fails to provide and maintain traffic control devices as specified in this worksection and to conform to the approved Traffic Guidance Scheme and Standards. This is a **HOLD POINT**.

### 4.4 OPENING TO TRAFFIC

**Opening temporary roadways and detours to traffic**

Program: Complete all signposting, pavement marking, guard fence and portable or temporary traffic signals before the opening of temporary roadways to traffic.

Traffic switch: To a temporary roadway or detour must only occur where the Contractor’s usual workforce will be on site for a minimum of two days thereafter. This is a **WITNESS POINT**.

Arrange: The opening of temporary roadways so that sections of existing roadway being replaced are not disturbed for a minimum of forty-eight hours.

Roadway failure: In the event of temporary roadway failure direct the traffic back onto the existing roadway. This is a **HOLD POINT**.

Inspection: Do not open temporary roadways and detours (including portable or temporary traffic signals sites) to traffic until they have been inspected and approved in writing. This is a **HOLD POINT**.

Partial completion: The use of the completed Works or part of the Works in providing for traffic is not considered as full opening to traffic and not a reason for payment under the completion of the works.

Maintain: Temporary roadways and detours and make sure the road surface is kept safe for traffic. Repair any potholes or other failures without delay. This is a **WITNESS POINT**.

**Opening completed work**

Prior notice: Provide the Superintendent with at least five working days written notice confirming the date of opening completed work to traffic. Determine the procedure for opening through consultation with the Superintendent and local Police. This is a **HOLD POINT**.

Complete: All permanent signposting, pavement markings, guard fence and traffic signals relevant to the completed work under the Contract prior to opening completed work to traffic.

Remove: All temporary traffic control devices no longer required for the safety of traffic, when the Works or part thereof are opened to traffic.

Restore: The area to a condition at least equivalent to that at commencement.

### 5 MEASUREMENT AND PAYMENT

#### 5.1 MEASUREMENT

**General**

Payments made to the Schedule of Rates: To 0152 Schedule of rates – supply projects, this worksection, the drawings and Pay items 1101.1.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

**Methodology**

The following methodology will be applied for measurement and payment:

All activities for the construction, maintenance and removal of temporary roadways, including side-tracks and divided road crossovers, and detours detailed in this worksection, to the requirements of specific activity worksections parts, are measured and paid in accordance with those worksections parts.

#### 5.2 PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule Rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1101.1 Control of traffic</td>
<td>Lump Sum</td>
<td>All costs associated with:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- All documentation and</td>
</tr>
<tr>
<td>Pay items</td>
<td>Unit of measurement</td>
<td>Schedule Rate scope</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>approvals (by an accredited traffic management provider):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The design of temporary roadways and detours (if needed), traffic switching operations, the provision of traffic controllers (as specified), signposting, roadmarkings, raised pavement markers, lights, barriers, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Any other traffic control devices required for the safe movement of traffic and the protection of persons and property in accordance with this worksection.</td>
</tr>
</tbody>
</table>
1102 CONTROL OF EROSION AND SEDIMENTATION (CONSTRUCTION)

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide the works and implement measures to control erosion and sedimentation, as
documented and in accordance with the approved Environmental Management Plan.
Performance
Design
Requirements: Design the control measures for erosion and sedimentation to comply with statutory
requirements. Preclude any potential hazard to persons or property.

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0136 General requirements (Construction).
- 0161 Quality (Construction).
- 0222 Earthwork
- 0257 Landscape – road reserve and street trees.
- 1101 Control of traffic.
- 1111 Clearing and grubbing.
- 1121 Open drains, including kerb and channel (gutter).
- 0134 General requirements – supply.
- 0257 Landscape – defined work site
- 1341 Water supply – reticulation (Construction).
- 1351 Stormwater drainage (Construction).
- 1361 Sewerage systems – reticulation (Construction).

1.3 REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:
Australian standards
IPWEA-2002 Local Government Salinity Management: a resource guide for the public
works professional.

1.4 STANDARDS

The following documents are incorporated into this worksection by reference:

1.5 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
CEMP: Environmental Management Plan.
ESCP: Erosion and Sediment Control Plan.
NTU: The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units.
SWMP: Soil and Water Management Plan.
Definitions
General: For the purposes of this worksection the following definitions apply:
- Crossfall drainage: Drainage which occurs when the surface of a track has sufficient cross slope to cause water to flow across and off the surface, rather than along it. Stormwater drainage for unsealed tracks can be classified as follows:
  - Crown: Where water sheds from both sides.
  - Infall: Where water flows into the hillside.
  - Outfall: Where fall is away from the hillside.
- Erosion: The wearing away of land by the action of rainfall, running water, wind, moving ice or gravitational creep. Soil detachment (erosion) occurs when the erosive forces exceed the soil’s resistance, causing the soil particles to move.
- Sediment: Sediment is the result of erosion, and consists of small detached soil particles. It occurs when the transportation of detached soil particles ceases or slows and the soil particles fall out of suspension.

### 1.6 SUBMISSIONS

**Approval**

Submissions: To the Superintendent’s approval.

**Documents**

- Erosion and Soil Control Plan (ESCP).
- Program for coordination of work schedules including order of works and timing.

**Drawings**

- Borrow pits and stock areas.
- Compound areas.
- Features of the site.
- Relevant construction details.

### 1.7 HOLD POINTS AND WITNESS POINTS

**Notice**

General: Give notice so that the documented inspection and submissions may be made to the HOLD POINT table and the WITNESS POINT table.

#### HOLD POINT table

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-CONSTRUCTION PLANNING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractors Environmental Management Plan (CEMP) - General</td>
<td>Submit CEMP with detailed section plans for each catchment area and site section</td>
<td>14 days before site possession</td>
<td>Superintendent</td>
</tr>
</tbody>
</table>

#### EXECUTION

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection by the Superintendent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion and sedimentation control measures - Control measures</td>
<td>Diversion and catch drains - constructed and lined before the adjacent ground is disturbed and the excavation is commenced</td>
<td>3 working days before ground disturbance</td>
</tr>
<tr>
<td></td>
<td>Areas of erodible material not approved for clearing or disturbance clearly marked, fenced off or protected against</td>
<td>3 working days before the adjacent ground is disturbed</td>
</tr>
<tr>
<td>Clause title/Item</td>
<td>Requirement</td>
<td>Notice for inspection by the Superintendent</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Erosion and sedimentation control measures - Access and exit areas</td>
<td>Decontamination - shake-down or other methods for the removal of soil materials from motor vehicles</td>
<td>7 days before site disturbance</td>
</tr>
<tr>
<td>Temporary erosion and sedimentation control - General</td>
<td>Provide temporary erosion and sedimentation control measures</td>
<td>7 days before site disturbance</td>
</tr>
<tr>
<td>Temporary erosion and sedimentation control - Control measures</td>
<td>Provide temporary sediment traps and trash barriers</td>
<td>3 working days before ground disturbance</td>
</tr>
<tr>
<td>Temporary erosion and sedimentation control - Removal</td>
<td>Removal of temporary erosion and sedimentation control works</td>
<td>3 working days before each stage of progressive removal</td>
</tr>
</tbody>
</table>

2 PRE-CONSTRUCTION PLANNING

2.1 CONTRACTORS ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

General

Minor works: Prepare a CEMP covering erosion and sedimentation control.

Site sections: At least seven days before the natural surface is disturbed on each of these sections, submit a CEMP for that section. Superimpose the plan on the drainage drawings of the works. This is a HOLD POINT.

Responsibility: The Contractor has the responsibility to provide whatever measures are required for the effective erosion and sedimentation control at all times.

Responsibilities

Adherence: Adhere to the approved CEMP. Submit a revised CEMP for approval 14 days in advance of an intended variation from the approved plan.

Salinity prevention: In known salt affected areas, seek advice from the relevant land and water resource authority to make sure that the proposed CEMP conforms to the current salinity prevention measures outlined in the IPWEA publication, *Local Government Salinity Management Handbook*.

Minimising erosion

Objective: To minimise the quantity of soil lost during construction due to land clearing and earthworks.

Content: Provide documentation and program scheduling to address the following:

- Minimum land clearance, particularly of areas of highly erodible soils and steep slopes prone to water and wind erosion.
- Progressive revegetation and mulching, as each site section is complete.
- Coordination of work schedules for multiple contractors, to avoid delays resulting in disturbed land remaining un-stabilised.
- Time schedules for the construction of structures and the implementation of measures to control erosion and sedimentation. Where possible, program the work to avoid seasonal intense rain storms.
- An order of works based upon construction and stabilisation of all culverts and surface drainage works, at the earliest practical stage.
- A Time schedule to address HOLD POINTS and WITNESS POINTS.

Documentation: Implement ahead of, or in conjunction with clearing and grubbing operations (as required by 1111 *Clearing and grubbing*) all permanent and temporary erosion and sedimentation control measures, including the control measures.
2.2 SOIL AND WATER MANAGEMENT PLAN - SUPPLEMENT

General
Objective: To minimise the generation of contaminated stormwater.
Content: Provide documentation to address the following:
- Minimising the quantity of uncontaminated stormwater entering cleared areas.
- Establishing cut-off or intercept drains to redirect stormwater away from cleared areas and sloping to stable (vegetated) areas or effective treatment installations.
- Reducing water velocities.

Preparation
Expertise: Employ an experienced consultant to design, document and technically report on the implementation of the plan and submit details of experience.
Environmental assessment: Identify and obtain information on any relevant environmental impact that may be caused by the works.
Risk assessment: Identify and quantify risks and remedial action that may arise from the construction of the works.

Sediment controls
Objective: To minimise the impact of contaminated water on receiving waters.
Content: Provide documentation to address the following:
- Installing erosion and sediment control measures before construction where possible.
- Identifying drainage lines and install control measures to handle predicted stormwater and sediment loads generated in the mini catchment.
- Designing erosion and sediment run-off control measures appropriate to the site conditions to handle storm events with 2 year ARI with intensity of 6 hours, for temporary structures, and 50 year ARI, for permanent structures.
- Preparing an inspection, maintenance and cleaning program for sediment run-off control structures.
- Creating contingency plans for unusual storm events.
- Planning for the continual assessment of the effectiveness of sediment control measures.

De-watering work sites
Objective: To make sure that de-watering operations do not result in turbid water entering natural waterways.
Content: Provide documentation to address the following with regard to de-watering by pumping:
- Treating contaminated water if the turbidity exceeds 30 NTU.
- Only pump water into natural waterways that does not exceed regulatory water quality standards.
- Pumping water, wherever practical, to vegetated areas of sufficient width to remove suspended soil, or to sediment control structures.
- Monitoring turbidity hourly, if discharge is to a natural waterway.

Dust control
Objective: To make sure there is no health risk or loss of amenity due to emission of dust to the environment.
Content: Provide documentation to address the following:
- Suppressing dust by watering.
- Installing wind fences.

Management of stockpiles and batters
Objective: To manage soil stockpiles so that dust and sediment in run-off are minimised.
Content: Provide documentation to address the following:
- Minimising the number of stockpiles, and the area and the time stockpiles are exposed.
- Separating soil and overburden stockpiles.
- Locating stockpiles away from drainage lines, at least 10 m away from natural waterways and where least susceptible to wind erosion.
- Designing stockpiles and batters with slopes no steeper than 2H:1V.
- Stabilising stockpiles that will remain bare for more than 28 days by covering with mulch, anchored fabrics or seeding with sterile grass.
- Establishing sediment controls around unstabilised stockpiles and batters.

3 EXECUTION

3.1 EROSION AND SEDIMENTATION CONTROL MEASURES

Control measures
Construction: To the CEMP and the drawings.
Requirement: Provide erosion and sedimentation control measures to include, but not limited to, the following:
- The installation of permanent drainage structures before the removal of topsoil and before the commencement of earthworks for formation within the catchment area of each structure.
- The prompt completion of all permanent and temporary drainage works, once commenced, to minimise the period of exposure of disturbed areas.
- The construction of diversion and catch drains to divert uncontaminated runoff from outside the site, clear of the site. Construct and line catch drains before the adjacent ground is disturbed and the excavation is commenced. This is a WITNESS POINT.
- To provide for the passage of uncontaminated water through the site without mixing with contaminated runoff from the site.
- The provision of contour and diversion drains across exposed areas before, during and immediately after clearing and the re-establishment and maintenance of these drains during soil removal and earthworks operations.
- The provision of sediment filtering or sediment traps, ahead of and in conjunction with earthworks operations, to prevent contaminated water leaving the site.
- The restoration of the above drainage and sedimentation control works on a day to day basis to make sure that no disturbed area is left without adequate means of containment and treatment of contaminated water.
- The limitation of areas or erodible material exposed at any time to those areas being actively worked. Clearly mark, fence off or otherwise protect any areas not approved for clearing or disturbance. This is a WITNESS POINT.
- The minimisation of sediment loss during construction of embankments by means such as temporary or reverse superelevations during fill placement, constructing berms along the edge of the formation leading to temporary batter flumes and short term sediment traps.
- The progressive revegetation of the site, in accordance with 0257 Landscape – Road reserve and street trees.

Stockpile sites
Location: Areas pre-approved for such use.
Protection: Provide a 5 m buffer zone to between stockpile sites and any stream or flow path. Protect all stockpiles from erosion and contamination of the surrounding area by use of the measures approved in the CEMP. This is a HOLD POINT.

Access and exit areas
Decontamination: Include shake-down or other methods approved for the removal of spoil materials from construction plant or vehicles. This is a WITNESS POINT.

3.2 TRACK AND TRAIL EROSION CONTROL MEASURES

Water turn-outs
Requirement: Provide where soil type, structure or slope is highly erodible, e.g. where there is little vegetative cover and heavy rainfall.

Maximum spacing of water turn-out

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Factors to use in the spacing formula</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Preventing water erosion

Track and trail planning and drainage: See 0281 Bushfire perimeter tracks.

For slopes below 5°: Allow for contour cultivation.

For slopes below 10°: Allow for a combination of contour ripping or contour furrowing in conjunction with contour cultivation. Construct furrows and rips precisely on the contour.

- Contour ripping: Rip to a depth of 60-90 cm with single or multiple ripper (by bulldozer). Use two tynes spaced at one metre apart, with individual rip lines spaced 2-6 m apart, depending on slope angle.

- Contour furrowing: Use a single tyne, fitted with a mould board attachment, to lift soil from the furrow to form a small bank on the downhill side, to increase water-holding capacity.

Contour banks: These are larger versions of contour furrows with a larger runoff storage capacity, which will be discharged at designated points. These can be divided into 3 types as follows:

- True contour or level banks: These banks are constructed exactly on the contour. Runoff may be discharged at both or either ends.

- Absorption banks: These are constructed along the contour with both ends turned uphill to a specific height to along for water ponding along the bank length to a desired depth.

- Graded banks: These banks are constructed away from the contour to a designated grade so that water drains to one part of the slope.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL

General

Continuous control: Make sure that effective erosion and sedimentation control is provided at all times during the contract. Remove and/or reinstate any temporary or redundant control works at appropriate times during the contract.

Runoff: Prior to dispersing any runoff must be free of pollutants as defined in the relevant legislation. Disperse clean runoff to stable areas or natural water courses.

Control: Provide temporary erosion and sedimentation control measures where the natural surface is disturbed by construction, including roads, depot and stockpile sites. This is a WITNESS POINT.

Maintenance: Provide and maintain slopes, crowns and drains on all excavations and embankments to ensure satisfactory drainage at all times. Do not allow water to pond on the works unless such ponding is part of an approved CEMP.

Control measures

Temporary drains: Control runoff from areas exposed during the work by construction of temporary contour drains and/or temporary diversion drains, which take the form of a channel constructed across a slope with a ridge on its lower side. They may require progressive implementation and frequent alteration as the work progresses.

Contour drains: Provide contour drains across the natural surface at approximately the same elevation. Immediately after a construction site is cleared, intercept and divert runoff from the site to nearby stable areas at non-erodive velocities. Construct as follows:

- Contour drains, as shown on the drawings, formed with a grade of not less than 1% or greater than 1.5% and spaced at intervals of not less than 20 m or greater than 50 m, depending on the erodibility of the exposed soil.

Diversion drains: Provide diversion drains across haul roads and access tracks when such roads and access tracks are identified as constituting an erosion hazard due to their steepness, soil erodibility or potential for concentrating runoff flow, constructed as follows:

- Formed to intercept and divert runoff from the road or track to stable outlets.
- Spacing of diversion drains not greater than that required to maintain runoff at non-erosive velocities.

Temporary sediment traps: Provide devices during construction to remove sediment from runoff flowing from areas of 0.5 ha or more before the runoff enters stormwater drainage systems, natural water courses or adjacent land. This is a WITNESS POINT.

Trash barriers: Provide and maintain trash barriers to prevent debris from entering natural watercourses.

Batter protection: Take all necessary action to protect batters from erosion during the contract. Minimise scour of newly-formed fill batters during and after embankment construction by diverting runoff from the formation away from the batter until vegetation is established.

Maintenance

Maintenance and inspection: Inspect all temporary erosion and sedimentation control works after each rain period and during periods of prolonged rainfall. Rectify any defects revealed by such inspections immediately. Clean, repair and augment, as required, the works, to ensure effective erosion and sedimentation control thereafter.

Access: Provide and maintain access from within the road reserve, or from other acceptable locations, for clearing out sedimentation control works. This is a WITNESS POINT.

Removal

Timing: Remove all temporary erosion and sedimentation control works when revegetation is established on formerly exposed areas before the end of the contract. Remove from the site, or otherwise dispose, all materials and components used for the temporary erosion and sedimentation control works. This is a WITNESS POINT.

4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To 0152 Schedule of rates – supply projects, this worksection, the drawings and Pay items 1102.1 inclusive.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

- Clearing and grubbing is measured and paid in accordance with 1111 Clearing and grubbing.
- Landscaping works are measured and paid in accordance with 0257 Landscape – road reserve and street trees.
- Topsoil stripping and removal of unsuitable material are measured and paid in accordance with 1112 Earthworks (Roadways).

4.2 PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1102.1 Environmental Management Plan</td>
<td>Lump sum</td>
<td>All costs associated with the development and maintenance of an Environmental Management Plan (EMP) and implementation of required controls throughout construction</td>
</tr>
</tbody>
</table>
1111 CLEARING AND GRUBBING

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide clearing, grubbing and removal of vegetation, debris and minor built structures for site works, as documented.

1.2 CROSS REFERENCES

General
Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:
- 0136 General requirements (Construction).
- 0152 Schedule of rates (Construction).
- 0161 Quality management (Construction).
- 0257 Landscape - defined work site.
- 1101 Traffic management.
- 1102 Control of erosion and sedimentation (Construction).

1.3 STANDARDS

General
Pruning of amenity trees: To AS 4373.

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviation applies:
- CTPO: Council’s Tree Preservation Officer.

Definitions
General: For the purposes of this worksection the following definitions apply:
- Dripline: The most outer reach of a tree’s branches.
- Weed: An invasive plant that degrades natural areas, reduces the sustainability or affects the health of people and animals. Species of weeds are included in local government listings.

1.5 SUBMISSIONS

Design documentation
Survey: Submit a survey plan with area proposed for clearing.

Execution details
Clearing and grubbing plan: Submit a Clearing and grubbing plan in conformance to PRE-CONSTRUCTION PLANNING, CLEARING AND GRUBBING PLAN.
Weed management plan: Submit a Weed management plan in conformance to PRE-CONSTRUCTION PLANNING, WEED MANAGEMENT PLAN, Weed control.
Establishment: Submit a method statement in conformance to PRE-CONSTRUCTION PLANNING, ESTABLISHMENT, Method statement.
Areas to be cleared outside the limits: If proposed, state the purpose for clearing and submit plan for approval.
Weed control: Submit pesticide operator’s licence for personnel engaged in pesticide spraying.
Unsound trees in defined work site: Submit a proposal to clear unsound trees remaining within the defined work site, but outside the limits of clearing.

Records
Gladstone Regional Council (GRC) consent: Submit a copy of the GRC’s written consent to enter defined work site to remove timber for disposal from defined work site.
Reports
Clearing report: Before clearing, submit a clearing report in conformance to PRE-CONSTRUCTION PLANNING, WEED MANAGEMENT PLAN, Clearing report.

Variations

1.6 INSPECTIONS

Notice
General: Give notice so that inspection may be made of the following:
- Weed control: Determine if additional areas require weed control.
- Tagging: Tagging of protected trees.
- Limits of clearing: Peg out area for clearing.
- Trees marked outside the limits of clearing.

2 PRE-CONSTRUCTION PLANNING

2.1 CLEARING AND GRUBBING PLAN

General
Requirement: Prepare a clearing and grubbing plan including the following details:
- Areas to be cleared and grubbed.
- Areas of weed removal.
- Threatened flora species and trees marked for preservation.

2.2 WEED MANAGEMENT PLAN

Weed control
Requirement: Prepare a weed management plan including the following details:
- Identification of weeds and infestation zones within the work site and investigation date.
- Method of cleaning vehicles and machinery, and cleaning date (if needed).
- Cleaning bay location and treatment date (if needed).
- Contaminated fill stockpile, treatment type and treatment date.

Clearing report
General: Prepare a Clearing report including the following:
- Statement from an ecologist identifying species and location of any weeds in the areas to be cleared and grubbed.
- Locations of threatened flora species and trees identified for preservation.
- List of any trees outside limits of clearing which are unsound and likely to fall on roadways or into neighbouring property.

2.3 ESTABLISHMENT

Survey
Requirement: Survey the proposed area for clearing and prepare site plans showing the clearing perimeters.
Pegging: Peg out the site area including recovery pegs.

Erosion control
As per 1102 Control of erosion and sedimentation (Construction).

Method statement
Requirement: Document the proposed methods, equipment and materials to be used for works within the exclusion zone, including the following:
- Protection methods.
- Excavation methods.
- Cutting of tree roots more than 50 mm diameter.
- Proposal for elevated platforms for earthwork machinery.
- Rehabilitation of damaged areas.
- If proposed, work within the dripline of trees within the exclusion zone.

**Planning and programming**

Requirement: Progressively carry out clearing with only the minimum area of land being disturbed at any time. Make sure that the absolute minimum area for construction is cleared.

### 3 EXECUTION

#### 3.1 LIMITS OF CLEARING

**General**

Extent of clearing: As documented and areas occupied by the following:

- The completed Works.
- Erosion and sedimentation measures.
- Stockpile sites and borrow areas.
- If the natural fall of the ground is towards the roadway, a clearance zone of 4 m beyond tops of cuts and toes of embankments.
- If the natural fall of the ground either slopes away from the roadway or is level, a clearance zone of 2 m beyond the tops of cuts and toes of embankments.

#### 3.2 AREAS TO BE CLEARED OUTSIDE THE LIMITS

**General**

Extent: If areas outside the limits are proposed to be cleared, clear the area to the extent defined in approved plans.

Requirement: Avoid danger to personnel, traffic, other trees, shrubs and structures.

Natural landscape features: Protect natural rock outcrops, natural vegetation and soil

#### 3.3 WEED CONTROL

**Procedures**

Requirement: Tag areas documented in the WEED MANAGEMENT PLAN.

Implementation: Do not spread weeds during the clearing operations and remove all identified weeds as a separate operation.

Qualification: Use personnel with current pesticide operators’ licence issued by the local authority.

#### 3.4 VEGETATION PRESERVATION

**Tagging**

Requirement: Mark all trees documented for preservation or transplanting with ribbon markers.

**Signage**

Warning sign: Display a sign in a prominent position at each entrance to the site, warning that trees and other plants are to be protected during the contract.

Lettering: Road sign type sans serif letters, 100 mm high, in red on a white background, to AS 1744.

**Work near trees noted for protection**

Exclusion zone: Do not carry out the following activities within 4 m of the trunks of protected trees:

- Erection of structures.
- Filling.
- Changes to soil profiles.
- Stockpiling of spoil.
- Storage of other materials.
- Driving or parking of any vehicle or machinery.

Dripline: Conform to the following:

- Area within dripline: Free of sheds and paths, construction material and debris.
- Bulk materials: Do not place bulk material and harmful materials under or near trees.
- Spoil: Do not place spoil from excavations against tree trunks.
- Wind-blown material: Prevent wind-blown materials such as cement from harming trees and plants.
Tree enclosures
General: Provide temporary protective enclosures consisting of wire, mesh or chainwire material.
Size: 10 times the trunk diameter measured at 1500 mm above ground, as a radius from the trunk.
Wire enclosures: Four strands of fencing wire, or plastic mesh barrier, supported on plastic capped star pickets spaced at not more than 4 m.
Mesh enclosures: SL 62 to AS/NZS 4671 reinforcing mesh 1800 mm high wired to 2400 mm long star pickets, driven 600 mm into the ground, spaced 1800 mm apart at a minimum distance of 1 m from the tree trunk.
Chain wire enclosures: 1800 mm high chainwire panels fixed to 40 mm diameter galvanized steel posts.

Tree protection
Program: Install protection measures before starting clearing.
Trunk protection: If space is not available for tree enclosures, construct trunk protection comprising 2000 mm long planks of 100 mm x 50 hardwood stacked vertically around the trunk and secured with 10 gauge wire over hessian protective padding.
Sheeting to excavations: If excavating near trees, provide continuous 900 mm high corrugated galvanized steel sheeting, bedded 150 mm into the ground, and wired to the enclosure.
Damage: Prevent damage to tree bark and root system. Do not attach stays and guys to trees.
Tree removal: Minimise damage to protected trees by felling trees towards the centre of the area to be cleared. Cut tree in sections from top downward.
Roots: If tree roots less than 50 mm are cut, use cutting method that does not unduly disturb the remaining root system. Water the tree and apply a liquid rooting hormone immediately after cutting to stimulate the growth of new roots.
Compacted ground: Do not compact the ground or use skid-steel vehicles within the dripline.
Mulching: Spread 100 mm thick organic mulch to the whole of the area within the dripline of all protected trees.

Transplanting of trees
Method: Lift and temporarily store the documented vegetation for transplanting to TRANSPLANTING TREES in the 0257 Landscape - defined work site worksection.

Protection of other vegetation
Existing shrubs, native grasses and ground covers: Protect areas by temporary fencing.

3.5 CLEARING OPERATIONS
General
Requirement: Remove items including vegetation both living and dead, minor structures, redundant kerbs and gutters, bitumen surfacing, footpaths and driveways, rubbish and any other materials located within the limits of clearing.
Excavation near tree trunks
Open excavations: Minimise the time period an excavation is left open under tree canopies.
Topsoil: Do not remove or add topsoil to the area within the dripline.
Clearing machines: Fit machines used for pushing and heaping operations with appropriate attachments and operate to limit the amount of soil removed and heaped with the cleared vegetative material.
Working near tree roots
Hand excavation methods: If excavation is required within the dripline, use hand methods to preserve root systems intact and undamaged. Use hand methods to locate, expose and cleanly cut the roots on the line of the excavation.
Backfill material: A mixture of three parts by volume of topsoil and one part of well-rotted compost with a neutral pH value and free from weed growth and harmful materials.
Maximum backfill depth: 300 mm.
Compaction of backfill: Place layers of backfill and compact to a dry density similar to the original or surrounding soil.
Backfill height: Do not backfill around tree trunks to a height greater than 200 mm above the original ground surface.

Watering: Water trees as required, including where roots are exposed, at ambient temperature greater than 35°C. Thoroughly water the root zone immediately after backfilling.

**Damage**

Restoration: Rectify damage to vegetation, landforms, fauna habitat, and fencing that occurs during the clearing operations. Restore all damage to pre-construction conditions in the shortest period of time using the following methods:

- Deep ripping or hand scarifying and raking of wheel tracks and compacted soil.
- Reinstatement of rocks or stones.
- Planting of seeds or seedlings together with subsequent nurturing.
- Repairs to foliage or root systems of trees and shrubs and reinstatement of fauna habitat.

**Unsound trees in defined work site**

Marking of unsound trees: Tag unsound trees outside the limits of clearing.

Pruning: To AS 4373.

Disposal: Dispose of any unsound trees and overhanging branches to **TREATMENT OF CLEARED VEGETATION**.

Timber falling on private property: Prevent timber from falling on private property at all times.

### 3.6 GRUBBING

**General**

Extent: All trees and stumps on, or within the limits of clearing which can not be felled and removed.

Depth of grubbing: Carry out grubbing operations to a depth of 0.5 m below the natural surface or 1.5 m below the top of the selected material zone.

**Backfill**

Holes and depressions: Immediately backfill holes or depressions remaining after grubbing trees and stumps to prevent the infiltration and ponding of water. Fill with soil material similar to the adjacent ground and compact the backfill material to at least the relative compaction of the material existing in the adjacent ground.

Areas outside the limits of clearing: Final backfill with 50 mm topsoil and vegetate within 7 days of removal of stump.

### 3.7 TREATMENT OF CLEARED VEGETATION

**Milling**

Timber species documented for milling: Trim branches to AS 1473.1. Stack in neat manageable stockpiles in approved locations.

**Fauna habitat**

Large tree trunks: Cut into transportable logs not less than 3.4 m in length any tree trunks nominated for salvage as fauna habitat logs and stockpile clear of construction.

**Woodchip mulch**

Prepare: Cut or split to a size to facilitate chipping or incorporation into the existing topsoil, as documented. All remaining timber that is not for milling, use as fauna habitat logs or for disposal offsite.

Woodchip mulch: Produce a woodchip mulch from crowns of shrubs and maximum 100 mm diameter branches of trees cleared under this worksection.

Dimensions of woodchip mulch: Two orthogonal dimensions less than 75 mm and 50 mm.

Timing: Chip cleared vegetation within 7 days of clearing to avoid excessive drying out of the vegetation and loss of seed stock.

**Stockpiling of chipped vegetation**

Landscaping: Stockpile the woodchip mulch for subsequent use in landscaping to the **Management of stockpiles and batters** in the 0257 Landscape - defined work site worksection or for use at other locations if required.

Mixing: Mix the chipped vegetation into the existing topsoil during topsoil operations, as documented.
Avoid degradation: Carry out stockpiling operations so that chipped vegetation is suitable for use in the revegetation works.

Avoid contamination: Provide vegetation stockpiles free from stones, soil, rubbish and other materials and make sure stockpiles are not contaminated with matter toxic to plant growth.

Shape of stockpile: 5 m bottom width, 1.5 m high, batter 1H:1.5V.

Weed free: Keep vegetation stockpile sites free of weeds for the duration of the stockpiling period. Treat as necessary to control the weed species in conformance with requirements of local council.

Location: Locate stockpile sites away from drainage lines and position to allow ease of transport of materials at any time. Make sure stockpiles do not influence driver’s sight lines or affect road safety.

Rehabilitation: Rehabilitate stockpile sites to Grassing in the 0257 Landscape - defined work site worksection.

3.8 DISPOSAL OF MATERIALS

General

Re-use: Wherever possible re-use material.

Removal from site: Remove from site any material that cannot be reused, in conformance with the Waste management plan.

Hazard minimisation: If burning is permitted by relevant authorities, conform to the following:
- Apply for relevant permits.
- Prevent damage to protected trees or trees outside the limits of clearing.
- Make sure that smoke resulting from such burning off does not cause a traffic hazard.
- Give notice of the intention to burn to neighbours and to the Fire Warden of the Fire Brigade.

3.9 COMPLETION

General

Requirement: At completion of clearing and grubbing, do not drive machinery or equipment over or disturb areas where there is no construction works proposed.

Warning signs on protected trees: Remove all tags.

4 ANNEXURES

4.1 ANNEXURE - SUMMARY OF HOLD AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause and description</th>
<th>Type*</th>
<th>Submission/Inspection details</th>
<th>Submission/Notice times</th>
<th>Process held</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBMISSIONS, Design documentation Survey</td>
<td>H</td>
<td>Submit a survey plan showing the proposed area for clearing to confirm the clearing perimeters</td>
<td>7 days before commencement of clearing</td>
<td>Commencement of clearing</td>
</tr>
<tr>
<td>SUBMISSIONS, Execution details Clearing and grubbing plan</td>
<td>H</td>
<td>Submit a clearing and grubbing plan</td>
<td>7 days before commencement of clearing</td>
<td>Commencement of clearing</td>
</tr>
<tr>
<td>SUBMISSIONS, Report Clearing report</td>
<td>H W</td>
<td>Clearing report</td>
<td>7 days before commencement of clearing</td>
<td>Commencement of clearing</td>
</tr>
<tr>
<td>SUBMISSIONS, Execution details Establishment</td>
<td>H W</td>
<td>Submit a method statement including proposed methods, equipment and materials</td>
<td>7 days before commencement of clearing</td>
<td>Commencement of clearing</td>
</tr>
<tr>
<td>Clause and description</td>
<td>Type*</td>
<td>Submission/Inspection details</td>
<td>Submission/Notice times</td>
<td>Process held</td>
</tr>
<tr>
<td>-----------------------</td>
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<td>-------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>INSPECTION, Notice</td>
<td>H</td>
<td>Peg out area for clearing</td>
<td>7 days before commencement of clearing</td>
<td>Commencement of clearing</td>
</tr>
<tr>
<td>Limits of clearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSPECTIONS, Notice</td>
<td>W</td>
<td>Trees marked for preservation and transplanting are tagged</td>
<td>7 days before commencement of clearing</td>
<td>-</td>
</tr>
<tr>
<td>Tagging</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSPECTIONS, Notice</td>
<td>W</td>
<td>Marking of trees outside the limits of clearing</td>
<td>3 days before site clearing</td>
<td>-</td>
</tr>
<tr>
<td>Unsound trees in defined work site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INSPECTIONS, Notice</td>
<td>W</td>
<td>Identify any additional areas that require weed control</td>
<td>1 day after tagging of areas to be weed controlled</td>
<td>-</td>
</tr>
<tr>
<td>Weed control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBMISSIONS, Execution details</td>
<td>H W</td>
<td>Submit a method statement</td>
<td>7 days before work within exclusion zone and dripline</td>
<td>Work within exclusion zone and dripline</td>
</tr>
<tr>
<td>Work within exclusion zone and dripline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*H = Hold Point, W = Witness Point

### 4.2 ANNEXURE - PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope inclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111.1 Clearing and grubbing</td>
<td>m²</td>
<td>All costs associated with documentation, survey, clearing and grubbing works within the defined work site including disposal or chipping of material as required.</td>
</tr>
</tbody>
</table>

### 4.3 ANNEXURE – REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

- AS 1473: Woodprocessing machinery
- AS 1473.1: 2000 Primary timber milling machinery
- AS 1744: 2015 Standard alphabets for road signs
- AS 4373: 2007 Pruning of amenity trees
- AS/NZS 4671: 2001 Steel reinforcing materials
GENERAL

RESPONSIBILITIES

General
Requirements: Provide sewerage transfer and reticulation works as documented.

Precedence
Precedence: The technical requirements of, or any standard drawings provided by the Gladstone Regional Council used in conjunction with and in conflict with this worksection take precedence.

CROSS REFERENCE

General
Requirements: This worksection is not a self-contained specification. In addition to the requirement of this worksection, conform to the following:

Capricornia Municipal Design Guidelines D12 – Sewerage Network
0136 General requirements (Construction).
0152 Schedule of rates (Construction).
0161 Quality management (Construction).
0257 Landscape – defined work site and street trees.
1102 Control of erosion and sedimentation (Construction).

1.1 STANDARDS

General

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Drawing Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMDG-S-020</td>
<td>Access chambers 1050mm Nom. Dia insitu construction</td>
</tr>
<tr>
<td>CMDG-S-023</td>
<td>Access chambers, alternative drops, insitu construction</td>
</tr>
<tr>
<td>CMDG-S-050-Series</td>
<td>Standard Sewer Pump Station drawing set for GRC</td>
</tr>
<tr>
<td>CMDG-S-090</td>
<td>Sewer construction, pipeline construction types</td>
</tr>
</tbody>
</table>

1.2 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
PE: Polyethylene.
PVC: Polyvinyl chloride
DICL: Ductile iron cement lined.

Definitions
General: For the purposes of this worksection the definitions given in WSA 02-2014 and the following apply:
Inadequate foundation material: Material beneath or adjacent to the proposed sewerage pipeline and fittings which is of insufficient strength to support the structure and loads on the structure, or material whose characteristics would adversely affect the performance or construction of the sewerage supply pipeline and fittings.

Section: A length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves.

Water Agency (Gladstone Regional Council): An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining design, construction and maintenance requirements for a sewerage system.

SUBMISSIONS

Approvals
Submissions: To the Superintendent’s approval. Submit the following for approval:
- Materials: Off-site certificates of components.
- Calculations: Survey set out of sewerage works and quantity calculations.
- Work-as-executed drawings: Include sewerage system information sheets and works.
- Components: Pipes and fittings.
- Samples: For conformity testing to relevant referenced documents.
- Technical data: Product information.
- Execution details: Refer to HOLD POINTS.

**HOLD POINTS AND WITNESS POINTS**

**Notice**

General: Give notice so that inspections and submissions may be made to the HOLD POINT table and WITNESS POINT table:

<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
<th>Release by</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATERIALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorised products and materials</td>
<td>Submit for approval alternative products and materials</td>
<td>2 weeks before ordering</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>EXECUTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Establishment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation near underground services – Public utilities within the excavation for sewerage system</td>
<td>Approval from relevant Authority for the method of excavation</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td>Excavation near underground services – Marking</td>
<td>Locate and mark existing underground services affected.</td>
<td>3 working days</td>
<td>Superintendent</td>
</tr>
<tr>
<td>Excavation near underground services – Protection of other services</td>
<td>Submit for approval Give notice of any interference to the works caused by an existing service and submit a proposed work method statement</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Excavation for sewerage systems</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General – Soil type</strong></td>
<td>Confirm surrounding soil type, give notice if different to design</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>General – Excavation across improved surfaces</strong></td>
<td>Approval from the land owner before excavating across improved surfaces</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Support of excavation - Trench instability</strong></td>
<td>Submit for approval the proposal to provide adequate permanent stability of the ground affected by trenching</td>
<td>1 week before relevant action</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Bedding for pipes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trench floor preparation – Significant differences</td>
<td>Give notice where soil conditions exposed by excavation are different</td>
<td>3 working days</td>
<td>Superintendent</td>
</tr>
<tr>
<td>Clause title / Item</td>
<td>Requirement</td>
<td>Notice for inspection</td>
<td>Release by</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td>------------------</td>
</tr>
<tr>
<td><strong>Maintenance holes, shafts and inspection openings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precast concrete MH/MS/IS systems</td>
<td>Submit proposed proprietary items, if not selected</td>
<td>2 weeks before ordering</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Embedment and backfill</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe embedment support – Notification of pipeline laid and jointed.</td>
<td>Present the laid and jointed pipes for approval before the trench backfilling</td>
<td>2 working days</td>
<td>Superintendent</td>
</tr>
<tr>
<td>Pipe embedment support – Flooding compaction</td>
<td>Submit approval from Water Authority relating to the use of flooding compaction.</td>
<td>2 working days</td>
<td>Superintendent</td>
</tr>
<tr>
<td>Embankment fill – Embankment</td>
<td>Submit proposal for construction of embankments</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Acceptance testing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General – Unsatisfactory test results</td>
<td>Rectify any defects even when results are in conformance</td>
<td>1 week</td>
<td>Superintendent</td>
</tr>
<tr>
<td><strong>Connections to existing sewers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General – Notice</td>
<td>Submit request to connect to the existing sewer and give notice of works including any affected occupants</td>
<td>2 weeks before connection</td>
<td>Water Agency - Superintendent</td>
</tr>
<tr>
<td><strong>Restoration of surfaces</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General – Original condition requirement</td>
<td>Restore progressively and as soon as possible after the section of works is completed</td>
<td>2 working days</td>
<td>Superintendent</td>
</tr>
</tbody>
</table>

**WITNESS POINT table**

<table>
<thead>
<tr>
<th>Clause title / Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATERIALS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conformance with manufacturer’s recommendations – Requirement</td>
<td>Inspect material and products at time of delivery</td>
<td>2 working days</td>
</tr>
<tr>
<td><strong>Pipes and fittings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General – Certification</td>
<td>Provide product or material certification before delivery to the works</td>
<td>3 working days</td>
</tr>
<tr>
<td><strong>Valves, holes/shafts and access covers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves – Certification</td>
<td>Provide product or material certification before delivery to the works</td>
<td>1 week</td>
</tr>
</tbody>
</table>

**EXECUTION**

Establishment
<table>
<thead>
<tr>
<th>Clause title/Item</th>
<th>Requirement</th>
<th>Notice for inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong> – Set out</td>
<td>Confirm the set out locations immediately before construction</td>
<td>3 working days</td>
</tr>
<tr>
<td><strong>General</strong> – Crossings Authority approvals</td>
<td>Approval from relevant Authority and payment of fees</td>
<td>2 weeks</td>
</tr>
<tr>
<td><strong>Temporary drainage during construction</strong> – Discharge</td>
<td>Approval from appropriate Authority for any discharge to sewers, stormwater drains or watercourses</td>
<td>2 weeks</td>
</tr>
<tr>
<td><strong>Excavation for sewerage systems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate foundation material – Notice</td>
<td>Give notice of any area of the foundation that may contain inadequate foundation material</td>
<td>1 week</td>
</tr>
<tr>
<td>Inadequate foundation material – Rock foundation</td>
<td>Excavate for an additional depth as directed. Backfill and compact the additional excavation</td>
<td>1 week</td>
</tr>
<tr>
<td>Trench excavation – Trench size for pipelines</td>
<td>Conformance with documentation</td>
<td>1 week</td>
</tr>
<tr>
<td>Trench excavation – Trench widths</td>
<td>Present trench width within permitted over-excavation</td>
<td>1 week</td>
</tr>
<tr>
<td><strong>Pipe laying, jointing and connecting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrust and anchor blocks and restrained joints – Notice</td>
<td>Give notice if the allowable bearing pressure of the ground and the design pressure of the pipeline differ from actual pressures on site</td>
<td>1 week</td>
</tr>
<tr>
<td>Welding for steel pipelines – Field welding of flanges</td>
<td>Submit proposal for approval</td>
<td>1 week</td>
</tr>
<tr>
<td><strong>Maintenance holes, shafts and inspection shafts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance holes (MH) – MH location</td>
<td>Submit any proposal to change positions of maintenance holes before commencing the works</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Covers and frames – Delivery</td>
<td>Submit conformance certification of the covers and/or frames before delivery to the works</td>
<td>3 working days</td>
</tr>
<tr>
<td><strong>Embedment and backfill</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embankment fill – Embankment</td>
<td>Geotechnical assessment and supervision of work, if required.</td>
<td>Progressive</td>
</tr>
<tr>
<td>Trench stops and concrete bulkheads – Concrete bedding and encasement to pipe</td>
<td>Concrete bulkhead in conformance with documentation</td>
<td>2 working days</td>
</tr>
<tr>
<td><strong>Acceptance testing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General – NATA</td>
<td>Provide NATA certified test results for all testing</td>
<td>2 working days progressive</td>
</tr>
<tr>
<td>General – Notice</td>
<td>Give notice for compaction testing, hydrostatic pressure testing, block testing and water quality testing</td>
<td>3 working days progressive</td>
</tr>
<tr>
<td>Visual inspection – Requirement</td>
<td>Inspect system component markers for conformance with the documents</td>
<td>2 working days</td>
</tr>
<tr>
<td>Visual inspection – Verify</td>
<td>Submit purchasing records for products and materials</td>
<td>2 working days</td>
</tr>
<tr>
<td>Clause title/Item</td>
<td>Requirement</td>
<td>Notice for inspection</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Air pressure and vacuum testing of sewers – Testing of concrete MH</td>
<td>Test concrete MH</td>
<td>2 working days</td>
</tr>
<tr>
<td>Infiltration testing – Infiltration testing requirement</td>
<td>Submit method of infiltration testing</td>
<td>1 week</td>
</tr>
<tr>
<td>Deflection (ovality) testing of flexible sewers – Deflection testing</td>
<td>Submit proposal for deflection testing</td>
<td>1 week</td>
</tr>
<tr>
<td>CCTV inspection – Verification</td>
<td>Carry out a CCTV verification inspection</td>
<td>2 working days</td>
</tr>
<tr>
<td>Pressure testing of inverted syphons – Requirement</td>
<td>Submit proposed method of pressure testing</td>
<td>2 weeks</td>
</tr>
</tbody>
</table>

**Connections to existing sewers**

| General – Connecting to existing sewers | Submit proposal for connection to existing sewers including work method, timing, equipment | 2 weeks |

**Restoration of surfaces**

| Backfill – Disposal of surplus material | Submit for approval proposal for spreading surplus material. | 2 working days progressive |

### MEASUREMENT AND PAYMENT

**MEASUREMENT**

**General**

Payments made to the Schedule of Rates: To 0152 Schedule of rates – supply projects, this worksection, the drawings and Pay items 1361.1 to 1361.9 inclusive

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

**Methodology**

The following methodology will be applied for measurement and payment:

Miscellaneous minor concrete work not included in the pay items in this worksection: To 0319 Minor concrete works.

**PAY ITEMS**

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1361.1 Excavation of earth material a. DN600 DICL b. DN150 PVC c. Wet well and Valve Pit d. Rising Main and scour</td>
<td>Lump Sum</td>
<td>All costs associated with: Setting out and associated survey. Excavation in all materials (including rock) Haulage to stockpile. Restoration of surface. Replacement for over-excavation for any reason. Control of stormwater runoff, temporary drainage and erosion and sedimentation control. Excavation protection including shoring, bench/batter or sheet piling as required</td>
</tr>
<tr>
<td>Pay items</td>
<td>Unit of measurement</td>
<td>Schedule rate scope</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1361.2 Supply and install new rising sewer pipe and fittings</td>
<td>Lump Sum</td>
<td>All costs associated with:</td>
</tr>
<tr>
<td>(a) DN200 S/Steel, DICL</td>
<td></td>
<td>- Supply of pipe and fittings.</td>
</tr>
<tr>
<td>(b) DN450 S/Steel, DICL</td>
<td></td>
<td>- Installation of pipe and fittings.</td>
</tr>
<tr>
<td>(c) DN600 DICL</td>
<td></td>
<td>- Wrapping pipeline or other protective measures.</td>
</tr>
<tr>
<td>(d) DN300 S/Steel, DICL</td>
<td></td>
<td>- Survey and setting out.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Marker tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Jointing (including connections).</td>
</tr>
<tr>
<td>1361.3 Supply and lay new gravity sewer pipe and fittings</td>
<td>Linear metre</td>
<td>All costs associated with:</td>
</tr>
<tr>
<td>a. DN600 DICL</td>
<td></td>
<td>- Supply of pipe and fittings.</td>
</tr>
<tr>
<td>b. DN150 PVC</td>
<td></td>
<td>- Wrapping pipeline or other protective measures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Survey and setting out.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Junctions and connection sewers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Marker tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Jointing (including connections).</td>
</tr>
<tr>
<td>1361.4 Backfill</td>
<td>Lump sum</td>
<td>All costs associated with backfilling including but not limited to:</td>
</tr>
<tr>
<td>(a) – Imported material (sand)</td>
<td></td>
<td>- supply and installation of geotextile where appropriate</td>
</tr>
<tr>
<td>(b) – Imported material (approved fill)</td>
<td></td>
<td>- supply and delivery of imported material (a) + (b)</td>
</tr>
<tr>
<td>(c) – Stockpiled material</td>
<td></td>
<td>- haulage from stockpile location (c)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- placement of material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- treatment of material to required moisture content for compaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- compaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- lawful disposal of surplus stockpiled material (c)</td>
</tr>
<tr>
<td>1361.5 Inadequate foundation material</td>
<td>m³</td>
<td>All costs associated with removing, disposing and reconditioning the unsuitable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>foundation material.</td>
</tr>
<tr>
<td>1361.6 Existing infrastructure cutins</td>
<td>Lump Sum</td>
<td>All costs associated with cutting into the existing services including but not</td>
</tr>
<tr>
<td>(a) – Gravity main(s)</td>
<td></td>
<td>limited to:</td>
</tr>
<tr>
<td>(b) – Rising main</td>
<td></td>
<td>- provision of vacuum trucks, temporary pumps and sewer bungs needed to isolate and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>redivert gravity flows.</td>
</tr>
<tr>
<td>1361.7 Supply and install Valve</td>
<td>Each</td>
<td>All costs associated with the supply, delivery and installation of the valves,</td>
</tr>
<tr>
<td>(a) – DN600 Knife gate</td>
<td></td>
<td>including but not limited to:</td>
</tr>
<tr>
<td>(b) – DN450 Non-Return Valve</td>
<td></td>
<td>- Supply of valves</td>
</tr>
<tr>
<td>(c) – DN200 Non-Return Valve</td>
<td></td>
<td>- Delivery of valves</td>
</tr>
<tr>
<td>(d) – DN600 Isolation Valve</td>
<td></td>
<td>- Installation of valves</td>
</tr>
<tr>
<td>(e) – DN450 Isolation Valve</td>
<td></td>
<td>- Installation of spindle risers and support structures</td>
</tr>
<tr>
<td>(f) – DN200 Isolation Valve</td>
<td></td>
<td>- Consumables</td>
</tr>
<tr>
<td>(g) – DN50 Frog Flap</td>
<td></td>
<td>- All associated seals</td>
</tr>
<tr>
<td>(h) - Tapping Band Junction C/W 25mm S.S. Ball Valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) – DN300 Non-Return Valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(j) – C/W 25mm S.S. Ball Valve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Pay items

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>(j) – DN300 Isolation Valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1361.8 Supply and install rising main pit</td>
<td>Lump Sum</td>
<td>All costs associated with:&lt;br&gt;- Supply and installation of precast access chamber complete&lt;br&gt;- Supply and installation of lids as specified&lt;br&gt;- Supply and installation of fittings&lt;br&gt;- Supply and installation of surrounding concrete slab including bollards</td>
</tr>
<tr>
<td>(a) - Pigging Pit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) – Flowmeter Pit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1361.9 Commissioning and testing</td>
<td>Lump Sum</td>
<td>All costs associated with commissioning including all labour, test equipment and consumables to undertake and record the full commissioning procedure for all equipment and systems, and to carry out all necessary modifications and adjustments to the system so that it operates in conformance with the contract requirements.</td>
</tr>
<tr>
<td>1361.10. Termination of redundant rising main</td>
<td>Lump sum</td>
<td>All costs associated with decommissioning and termination of redundant rising main</td>
</tr>
<tr>
<td>1361.11 Supply and install 316SS Pressure gauge containment box</td>
<td>Each</td>
<td>All costs associated with installing 316SS Pressure gauge containment box and pressure gauge equipment</td>
</tr>
<tr>
<td>1361.13(P) Acid Sulphate Treatment (Provisional Item)</td>
<td>m³</td>
<td>All costs associated with:&lt;br&gt;- Lime stabilisation&lt;br&gt;- Testing for conformance&lt;br&gt;- Removal from site to landfill.</td>
</tr>
</tbody>
</table>
1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide water supply for the A01 pump station facility works, as documented.

Precedence
Precedence: The technical requirements of, or any standard drawing provided by, the Gladstone Regional Council, used in conjunction with and in conflict with this worksection, take precedence.

1.2 CROSS REFERENCES

General
Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:
- Capricornia Municipal Design Guidelines D11 – Water Supply
- 0136 General requirements (Construction).
- 0152 Schedule of rates (Construction).
- 0161 Quality management (Construction).
- 0257 Landscape – defined work site and street trees.
- 1102 Control of erosion and sedimentation (Construction).

1.3 STANDARDS

1.4 INTERPRETATION

Abbreviations
General: For the purposes of this worksection the following abbreviations apply:
- PE: Polyethylene.
- PVC: Polyvinyl chloride.

Definitions
General: For the purposes of this worksection the definitions given in WSA 03-2002 and the following apply:
- Inadequate foundation material: Material beneath or adjacent to the proposed water pipeline and fittings which is of insufficient strength to support the structure and loads on the structure, or material whose characteristics would adversely affect the performance or construction of the water supply pipeline and fittings.
- Section: A length of pipeline which can be effectively isolated for testing, e.g. by means of main stop valves.
- Water Agency (Gladstone Regional Council): An authority, board, business, corporation, Council or local government body with the responsibility for planning or defining design, construction and maintenance requirements for a water supply and/or sewerage system.

1.5 SUBMISSIONS

Authority approvals
Requirement: Submit details of all authority approvals before commencing the works for which the approval is granted, including the following:
- Road openings: Submit an approved works on road permit before starting any works within a road or road reserve.
- Temporary drainage: Submit approval from the relevant authority to dam up or divert existing watercourses.
- Tree protection: Submit approval from tree owners for cutting roots over 60 mm diameter, tree removal or works under the tree canopy or within the root zone.
- Underground services: Submit approval from relevant authority of excavation methods adjacent to existing underground services.
- Acceptance testing: Submit approval from Water Agency of completed acceptance testing before connecting new works to an existing water main.

**Execution details**
Installation of pipes: Submit details of proposed method of any required cutting and disposal of existing asbestos cement pipe.

**Records**
Work-as-executed: Submit work-as-executed details in conformance with WORK-AS-EXECUTED.

**Variations**
Alignment: Submit any proposals to adjust alignment or position to suit on-site measurements.
Trench excavation: Submit details of soil conditions discovered upon excavation, if inconsistent with design assumptions.

## 1.6 INSPECTIONS

**Notice**
General: Give notice so that inspection may be made of the following:
- Inadequate foundation material: Any area of the foundation including the sides of the trenches that may contain material that is inadequate to support the proposed drainage structure.
- Pipe embedment: Completed pipe laying, jointing and corrosion protection.
- Acceptance testing: When testing is due to take place.
- Existing condition: Corroded or damaged existing water mains.

## 2 MATERIALS

### 2.1 GENERAL

**Products and materials**
Requirement: To WSA 03-2002 clause 12.

### 2.2 PIPES AND FITTINGS

**General**
Standard: To AS/NZS 4020.

**Polyethylene (PE) water mains**
Standard: To AS/NZS 4130, WSA 01 and the Polyethylene (PE) pipeline schedule.
Property service pipe: HDPE 100, PN 16 (SDR11), series 1.
Mapress: Blucher Australia Mapress stainless steel pressure fittings

**Backflow prevention device**
General
A reduced pressure zone (RPZ) device shall be installed applicable to the Queensland Plumbing Code and AS 2845.1:2010 Water Supply – Backflow prevention

**General**
Flanges: To AS 2129 and AS/NZS 4087.

**Stop valves**
Standard: To the following:
- Gate valves: To AS/NZS 2638.1 and AS/NZS 2638.2.
- Knife gate valves: To AS 6401.
- Butterfly valves: To AS 4795.1 and AS 4795.2.
- Ball valves: To AS 4796.

**Surface fittings**
Standard: As documented.
2.3 TESTING

Quality
Requirement: Test for all characteristics in conformance with ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES.
Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 EXECUTION

3.1 GENERAL

Construction

3.2 TESTING

General
Requirement: To WSA 03-2002 clause 19.
Quality: Test for all characteristics in conformance with ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES.

Compaction testing
Requirements: To WSA 03-2002 clause 19.3.
Test methods:
- Cohesionless materials: To AS 1289.5.6.1.
- Cohesive materials: To AS 1289.5.7.1.

Hydrostatic pressure testing
Requirement: To WSA 03-2002 clause 19.4.
Test method to AS/NZS 2566.2 clause 6.3: (Test Pressure 1250 kPa)
Sections: Test pipeline sections as soon as practicable after each section has been laid, jointed and backfilled or 7 days after the last placement of concrete thrust or anchor block. Leave some or all of the pipe joints uncovered until the whole of the section has been successfully pressure tested.
Wet weather: Do not perform pressure testing during wet weather.
Field joints: During pressure testing, make sure all field joints, which have not been backfilled, are clean, dry and accessible for inspection.
Stop valves: During pressure testing, test each stop valve to at least the full test pressure on one side of the valve in the closed position, with no pressure on the other side, for a minimum of 15 minutes.
Filling with water: Before testing, clean the pipe and fill it slowly with water, taking care that all air is expelled. Promote purging of air from rising mains by opening air valves or hydrants.
Stable testing conditions: To allow for absorption, movement of the pipeline and escape of entrapped air, keep the section full of water for a minimum period of 24 hours before starting pressure testing.
Test pressure: Do not exceed the manufacturer’s recommended test pressure for the lowest rated component in the section.
Test duration: Maintain the required test pressure for a minimum of 6 hours.
Compressed air test: Do not test the pipeline using compressed air.

3.3 CONNECTIONS TO EXISTING WATER MAINS

Acceptance testing
Requirement: Complete acceptance testing to the approval of the Water Agency before connecting to existing water mains.

Existing condition
Requirement: Inspect the condition of the existing water main for corrosion or other surface damage.

Connections
Requirement: To WSA 03-2002 clause 22.
3.4 ASSET DETAILS

Work-as-executed

Requirement: Prepare work-as-executed details and operation and maintenance information as follows:
- Drawings in the same format as the design drawings, certified by a Registered Surveyor, showing the actual location and alignment of pipelines. Include the size, type, and levels of pipelines, valve and hydrant chamber types and cover details, and easement requirements for maintenance.
- Asset register data to ADAC specifications.

4 ANNEXURES

4.1 ANNEXURE – SUMMARY OF HOLD AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause and description</th>
<th>Type*</th>
<th>Submission/Inspection details</th>
<th>Submission/Notice times</th>
<th>Process held</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBMISSIONS, Variations Alignment</td>
<td>H</td>
<td>Proposals to adjust alignment or position</td>
<td>3 days before excavating trenches</td>
<td>Trench excavation</td>
</tr>
<tr>
<td>SUBMISSIONS, Quality Bedding material</td>
<td>H</td>
<td>Details of Material Quality - Grading</td>
<td>2 days before backfill</td>
<td>Trench excavation</td>
</tr>
<tr>
<td>SUBMISSIONS, Variations Trench excavation</td>
<td>H</td>
<td>Details of unexpected soil conditions</td>
<td>3 days before preparing trench floor</td>
<td>Preparation of trench floor</td>
</tr>
<tr>
<td>SUBMISSIONS, Compaction Bedding and General Backfill Zones</td>
<td>W</td>
<td>Details of compaction ratio/index</td>
<td>2 days before backfill completion</td>
<td>Trench backfill (Refer CMDG D11)</td>
</tr>
<tr>
<td>SUBMISSIONS, Execution details Excavation support</td>
<td>H</td>
<td>Permanent stability proposals</td>
<td>3 days before installing permanent stability measures</td>
<td>Installation of permanent stability measures</td>
</tr>
<tr>
<td>INSPECTIONS, Notice Inadequate foundation material</td>
<td>W</td>
<td>Any area that may contain material inadequate for support</td>
<td>5 days before preparing trench floor</td>
<td>-</td>
</tr>
<tr>
<td>SUBMISSIONS, Execution details Inadequate foundation materials</td>
<td>H</td>
<td>Details for providing adequate foundation</td>
<td>3 days before preparing trench floor</td>
<td>Preparation of trench floor</td>
</tr>
<tr>
<td>INSPECTIONS, Notice Trench floor preparation</td>
<td>W</td>
<td>Completed trench excavation</td>
<td>2 days before placement of bedding</td>
<td>Initial work lot then random audit</td>
</tr>
<tr>
<td>INSPECTIONS, Notice</td>
<td>W</td>
<td>Completed pipe laying, jointing and corrosion protection</td>
<td>2 days before trench backfilling</td>
<td>Initial work lot then random audit</td>
</tr>
</tbody>
</table>
### 4.2 ANNEXURE – MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key quality verification requirements</th>
<th>Maximum lot size</th>
<th>Minimum test frequency</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials supply</td>
<td>Material quality – Supplier's documentary evidence and certification of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- PVC pipe</td>
<td>1 contract 1 per contract</td>
<td>AS/NZS 1477, AS/NZS 4441 or AS/NZS 4765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- PE pipe</td>
<td>1 contract 1 per contract</td>
<td>AS/NZS 4130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Copper pipe</td>
<td>1 contract 1 per contract</td>
<td>AS 1432</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Ball valves</td>
<td>1 contract 1 per contract</td>
<td>AS 4796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bedding and embedment grading, Atterberg limits</td>
<td>50 m³ 1 per lot</td>
<td>Relevant CMDG specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siting and excavation</td>
<td>Geometry 1 line 1 per line</td>
<td>Survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber covers and frames</td>
<td>Geometry 1 cover/frame 1 per cover/frame</td>
<td>Measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backfill and compaction</td>
<td>Compaction 100 lin. m Bedding - 1 test per lot Overlay - 1 test per lot Backfill - 1 test every 2 layers per lot</td>
<td>AS 1289.5.6.1or AS 1289.5.7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing of pipelines</td>
<td>Pressure testing 1 line (max 1000 m) 1 per line</td>
<td>Refer to WSA 03-2002</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water quality 1 line 1 per line</td>
<td>Refer to WSA 03-2002 clause 19.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulated joints</td>
<td>Electrical resistance 1 joint 1 per joint</td>
<td>Refer to WSA 03-2002 clause 19.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3 ANNEXURE - PAY ITEMS

<table>
<thead>
<tr>
<th>Pay items</th>
<th>Unit of measurement</th>
<th>Schedule rate scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1341.1 Supply and install water service including installation of all internal pipework</td>
<td>Lump Sum</td>
<td>All costs associated with the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Supply and installation of pipeline and fittings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Survey and setting out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Bedding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Jointing (including connections)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Temporary bracing and strutting of excavation</td>
</tr>
<tr>
<td>1341.2 Supply and install PVC meter box, Class C</td>
<td>Each</td>
<td>All costs associated with the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Setting out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Excavation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Supply and installation of valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Supply and installation of cover and frames</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Temporary stockpiling before backfilling</td>
</tr>
<tr>
<td>1341.3 Supply and install Well Washers</td>
<td>Lump Sum</td>
<td>All costs associated with supply and installation of well washers including nozzles, flexible hose and support structures</td>
</tr>
<tr>
<td>1341.4 Supply and install Backflow prevention devices</td>
<td>Lump Sum</td>
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<tr>
<td>Other miscellaneous concrete works</td>
<td></td>
<td>To the 0319 Auxiliary concrete works worksection.</td>
</tr>
</tbody>
</table>

4.4 ANNEXURE - REFERENCED DOCUMENTS

The following documents are incorporated into this worksection by reference:

- AS 1012 Methods of testing concrete
- AS 1012.1 2014 Sampling of concrete
- AS 1012.3.1 2014 Determination of properties related to the consistency of concrete - Slump test
- AS 1012.8.1 2014 Method for making and curing concrete - Compression and indirect tensile test specimens
- AS 1012.9 2014 Compressive strength tests - Concrete, mortar and grout specimens
- AS 1214 1983 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
- AS 1289 Methods of testing soils for engineering purposes
- AS 1289.5.6.1 1998 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- AS 1289.5.7.1 2006 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- AS 1432 2004 Copper tubes for plumbing, gasfitting and drainage applications
- AS/NZS 1477 2006 PVC pipes and fittings for pressure applications
- AS 1579 2001 Arc welded steel pipes and fittings for water and waste water
- AS 1627 Metal finishing - Preparation and pretreatment of surfaces
AS 1627.4  2005  Abrasive blast cleaning of steel
AS 1657  2013  Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS/NZS 2032  2006  Installation of PVC pipe systems
AS/NZS 2033  2008  Installation of polyethylene pipe systems
AS 2129  2000  Flanges for pipes, valves and fittings
AS/NZS 2280  2014  Ductile iron pipes and fittings
AS/NZS 2566  2002  Buried flexible pipelines
AS/NZS 2566.2  2002  Installation
AS/NZS 2638  2011  Gate valves for water works purposes
AS/NZS 2638.1  2011  Metal seated
AS/NZS 2638.2  2011  Resilient seated
AS/NZS 3500  2015  Plumbing and drainage
AS/NZS 3500.1  2015  Water services
AS 3571  2009  Plastics piping systems - Glass-reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin
AS 3571.2  2009  Pressure and non-pressure water supply (ISO 10639:2004, MOD)
AS 3681  2008  Application of polyethylene sleeving for ductile iron piping
AS 3688  2005  Water supply - Metallic fittings and end connectors
AS 3705  2012  Geotextiles - Identification, marking, and general data
AS/NZS 3879  2011  Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings
AS 3952  2002  Water supply - spring hydrant valve for waterworks purposes
AS 3996  2006  Access covers and grates
AS/NZS 4020  2005  Testing of products for use in contact with drinking water
AS/NZS 4087  2011  Metallic flanges for waterworks purposes
AS/NZS 4130  2009  Polyethylene (PE) pipes for pressure applications
AS/NZS 4441  2008  Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4680  2006  Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4765  2007  Modified PVC (PVC-M) pipes for pressure applications
AS 4794  2001  Non-return valves - Swing check and tilting disc
AS 4795  2006  Butterfly valves for waterworks purposes
AS 4795.1  2011  Wafer and lugged
AS 4795.2  2011  Double flanged
AS 4796  2001  Water supply - Metal bodied and plastic bodied ball valves for property service connection
AS 4809  2003  Copper pipe and fittings - Installation and commissioning
AS 4956  2008  Air valves for water supply
AS 5081  2008  hydraulically operated automatic control valves for waterworks purposes
AS 6401  2003  Knife gate valves for waterworks purposes
PIPA POP001  2013  Electrofusion jointing of PE pipe and fittings for pressure applications
PIPA POP003  2011  Butt fusion jointing of PE pipes and fittings - recommended parameters
PIPA POP007  2015  Metal backing flanges for use with polyethylene (PE) pipe flange adaptors
PIPA POP202  2008  PVC and PE pressure pipe installation on curved alignments
WSA 01  2004  Polyethylene Pipeline Code 2004 3rd edition Version 3.1
WSA 03-2002  2011  Water Supply Code of Australia Version 3.1
WSA 132  2011  Industry standard for ductile iron access covers for water supply and sewerage
WSA PS-264  2015  Non-return (reflux) valves for pressure applications - Water supply and sewerage
WSA PS-265  2015  Air valves for pressure applications - Water supply
WSA PS-267  2015  Hydrants (spring) for pressure applications - Water supply
WSA PS-268  2015  Automatic control valves for pressure applications - Water supply
<table>
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<tr>
<td>EN 545</td>
<td>2010</td>
<td>Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods</td>
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<tr>
<td>ASTM A276/A246M</td>
<td>2015</td>
<td>Standard Specification for Stainless Steel Bars and Shapes</td>
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</table>
0222 EARTHWORK

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide earthworks to the dimensions and tolerances, as documented.

Design
Design of depths: As per Design Drawings
General: The footing or pier depths shown on the drawings are provisional.
Authority requirements: Gladstone Regional Council and Capricornia Municipal Design Guidelines

1.2 CROSS REFERENCES

General
Requirement: Conform to the following:
- 0171 General requirements.
- 0172 Environmental management.
- 0136 Sewerage Systems (Gravity and Pressure)

1.3 STANDARDS

General
Earthworks: Conform to the recommendations of those parts of AS 3798 which are referenced in this worksection.

1.4 REFERENCED DOCUMENTS

<table>
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<td>Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort</td>
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<td>AS 1289.5.4.1</td>
<td>Soil compaction and density tests - Compaction control test - Dry density ratio, moisture variation and moisture ratio</td>
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<td>Soil compaction and density tests- Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)</td>
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<td>AS 1726</td>
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<td>AS 3705</td>
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<td>AS 3798</td>
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<tr>
<td>AS 4678</td>
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<tr>
<td>BCA 3.2.4</td>
<td>Acceptable construction - Footings and slabs</td>
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The following documents are mentioned only in the Guidance text:

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<td>AS 2870</td>
<td>Residential slabs and footings</td>
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<td>AS 4133</td>
<td>Methods of testing rocks for engineering purposes</td>
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<td>AS 4482</td>
<td>Guide to the sampling and investigation of potentially contaminated soil</td>
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<tr>
<td>AS 4482.1</td>
<td>Non-volatile and semi-volatile compounds</td>
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1.5 INTERPRETATION

Abbreviations

General: For the purposes of this worksection the following abbreviations apply:
- GITA: Geotechnical inspection and testing authority.
- GTA: Geotechnical testing authority.

Definitions

General: For the purposes of this worksection the definitions given in AS 1348, AS 3798 and the following apply:
- Description and classification of soils: To AS 1726.
- Site classification: To BCA 3.2.4.
- Bad ground: Ground unsuitable for the work, including fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances and ground which is, or becomes, soft, wet or unstable.
- Base: Layer(s) of material, forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Discrepancy: A difference between contract information about the site and conditions encountered on the site, including but not limited to discrepancies concerning the following:
  . The nature or quantity of the material to be excavated or placed.
  . Existing site level.
  . Services or other obstruction beneath the site surface.
- Rock: Monolithic material with volume greater than 0.3 m$^3$ which cannot be removed until broken up by rippers or percussion tools.
- Site topsoil: Soil excavated from the site which contains organic matter, supports plant life, conforms generally to the fine-to-medium texture classification to AS 4419 (loam, silt, clay loam) and is free from:
  . Stones more than 25 mm diameter.
  . Clay lumps more than 75 mm diameter.
  . Weeds and tree roots.
  . Sticks and rubbish.
  . Material toxic to plants.
- Subbase: Material laid on the subgrade (or selected material), below the base, either for the purpose of making up additional pavement thickness, to prevent intrusion of the subgrade into the base, or to provide a working platform.
- Subgrade: The trimmed or prepared portion of the formation on which the pavement, footing or slab is constructed. Generally taken to relate to the upper line of the formation.
- Zone of influence: A foundation zone bounded by planes extending downward and outward from the bottom edge of a footing, slab or pavement and defining the extent of foundation material having influence on the stability or support of the footings, slab or pavement.

1.6 TOLERANCES

General

Finish: Finish the surface to the required level, grade and shape within the following tolerances:
- Under building slabs and load bearing elements: +0, -25 mm.
- Pavement subgrades: +0, -40 mm.
- Batters: No steeper than the slope shown on the drawings. Make sure flatter slopes do not impact on boundaries or required clearances to buildings, pavements or landscaping.
- Other ground surfaces: ± 50 mm, provided the area remains free draining and matches adjacent construction where required. Provide smoothness as normally produced by a scraper blade.

1.7 SUBMISSIONS

Design
Calculations: Submit calculations by a professional engineer to show that proposed excavations and temporary supports, including where applicable supports for adjacent structures, will be stable and safe.

Execution details
Report: Submit a time based schedule noting the methods and equipment proposed for the earthworks, including the following:
- Dewatering and groundwater control and disposal of surface water.
- Excavation methods, stages, clearances, batters and temporary supports.
- Stockpiles and borrow pits.
- Placing and compaction methods and stages.
Geotechnical site investigations: Provide a geotechnical report supporting the procedures proposed for excavation.
Disposal location: Submit the locations and evidence of compliance with the relevant authorities for the disposal of material required to be removed from site.
Temporary shoring: Submit a proposal for any temporary shoring or underpinning required including the progressive removal.
Proof rolling: Submit method and equipment for proof rolling.
Certified records of measurement: Submit a certified copy of the agreed records of measurement.
Construction records: Submit the following to AS 3798 clause 3.4 and Appendix B:
- Geotechnical site visit record; and
- Earthworks summary report or daily geotechnical reports.

Materials
Imported fill: Submit certification or test results by a GTA registered laboratory which establish the compliance of imported fill with the contract including the source.

Tests
Compaction: Submit certification and/or test results in conformance with the specified level of responsibility to AS 3798.

1.8 INSPECTION

Notice
Inspection: Give notice so that inspection may be made of the following:
- Items to be measured as listed in RECORDS OF MEASUREMENT.
- Areas to be cleared and/or stripped of topsoil.
- Areas stripped of topsoil.
- Excavation completed to contract levels or founding material.
- Proof roll subgrade before placing fill.
- Filling completed to contract levels.
- Stockpiled topsoil before spreading.

2 PRODUCTS

2.1 FILL MATERIALS

General
Suitable material: To AS 3798 clause 4.4 including inorganic, non-perishable material suitably graded and capable of compaction to the documented density.

Unsuitable materials: Do not use unsuitable material for fill in conformance with AS 3798 clause 4.3.
Sulfur content: Do not provide filling with sulfur content exceeding 0.5% within 500 mm of cement bound elements (for example concrete structures or masonry) unless such elements are protected by impermeable membranes or equivalent means.

Re-use of excavated material: Only re-use suitable material in conformance with AS 3798 clause 4.4.

Stockpiles: Segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted under the contract, dispose of excavated material off-site to AS 3798 clause 6.1.8.

2.2 BORROW OR IMPORTED FILL

General

Borrow or imported material: Only when no suitable excavated material is available.
- Suitable material: To AS 3798 clause 4.4.
- Material complying with the following: TMR specifications, fill material to meet Clause 14.2.2 MRTS04 class A1

Borrow pits:
- Location: More than 3 m from any fence line, boundary, edge of excavation or embankment.
- Strip and stockpile topsoil.
- Provide erosion protection during winning operations of material and make sure drainage is maintained.
- On completion of winning operations grade abrupt changes of slope, respread topsoil and apply and maintain hydroseeded grassing.
- Borrow and imported fill additional testing: As per MRTS04 (if needed).

3 EXECUTION

3.1 SITE PREPARATION

Erosion and sedimentation control

Drainage, erosion and sedimentation control: To the 0172 Environmental management worksection.

3.2 GEOTECHNICAL

As found site conditions

General: If the following are encountered, give notice immediately and obtain instructions before carrying out any further work in the affected area:
- Bad ground.
- Discrepancies.
- Rock.
- Springs, seepages.
- Topsoil > 100 mm deep.

Inspection and testing

Inspection and testing: Conform to the following:
- Level 1 GITA required to AS 3798 clause 8.2.
- Level 2 GTA required to AS 3798 clause 8.3.

3.3 RECORDS OF MEASUREMENT

Excavation and backfilling

Agreed quantities: If a schedule of rates applies, provisional quantities are specified, or there are variations to the contract levels or dimensions of excavations, do not commence backfilling or place permanent works in the excavation until the following have been agreed and recorded:
- Depths of excavations related to the datum.
- Final plan dimensions of excavations.
- Quantities of excavations in rock.
Method of measurement: By registered surveyor unless otherwise agreed.

Rock
Level and class: If rock is measured for payment purposes, whether as extra over excavation of material other than rock or for adjustment of provisional measurements, do not remove the rock until the commencing levels and the classes of rock have been determined.

3.4 REMOVAL OF TOPSOIL

General
Extent: Areas of cut or fill and areas occupied by structures, pavements and embankments.
Maximum depth: 200 mm.

Topsoil stockpiles
General: Stockpile site topsoil intended for re-use and imported topsoil where necessary.
Stockpile heights: Establish stockpiles to maximum height of 1.5 m.
Mark: Identify stockpiles of different soil types.
Vegetation: Do not burn off or remove plant growth which may occur during storage.
Protection: Provide the following:
- Drainage and erosion protection.
- Do not allow traffic on stockpiles.
- If a stockpile is to remain for more than four weeks, sow with temporary grass.
- Protect the topsoil stockpiles from contamination by other excavated material, weeds and building debris.

Remove: Remove topsoil that is unsuitable for re-use from the site to AS 3798 clause 6.1.8.

3.5 EXCAVATION

Extent
Site surface: Excavate over the site to give correct levels and profiles as the basis for structures, pavements, filling and landscaping. Make allowance for compaction, settlement or heaving.
Footings: Excavate for footings, pits, wells and shafts, to the required sizes and depths. Confirm that the foundation conditions meet the design bearing capacity.

Rock
General: Do not use explosives.

Existing footings
Requirement: If excavation is required within the zone of influence of an existing footing, use methods including (temporary) shoring or underpinning that maintain the support of the footing and make sure that the structure and finishes supported by the footing are not damaged.

Existing services
Location: Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching.
Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.
Excavation: Do not excavate by machine within 1 m of existing underground services.

Proof rolling
Extent: Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the presence of any bad ground.

Proof rolling method and equipment: To AS 3798 clause 5.5.
Outcome: If excessive settlement, rebound or heaving is encountered, provide test pits or trenching to determine the extent of bad ground.

Disposal of excess excavated material
General: Remove excess excavated material from site not required or unsuitable for fill.
Standard: To AS 3798 clause 6.1.8.
3.6 SUBGRADES AFFECTED BY MOISTURE

General
Requirement: If the subgrade is unable to support construction equipment, or it is not possible to compact the overlying pavement only because of a high moisture content, perform one or more of the following:
- Allow the subgrade to dry until it will support equipment and allow compaction.
- Scarify the subgrade to a depth of 150 mm, work as necessary to accelerate drying, and recompact when the moisture content is satisfactory.
- Excavate the wet material and remove to spoil, and backfill excavated areas.

3.7 BEARING SURFACES

General
Requirement: Provide even plane bearing surfaces for loadbearing elements including footings. Step to accommodate level changes. Make the steps to the appropriate courses if supporting masonry.

Deterioration
General: If the bearing surface deteriorates because of water or other cause, excavate further to a sound surface before placing the loadbearing element.

3.8 REINSTATEMENT OF EXCAVATION

General
Fill adjacent structures and trenches: To AS 3798 clause 6.2.6.
Zone of influence: Within the zone of influence of footings, beams, or other structural elements, use concrete of strength equal to the structural element, minimum 15 MPa. Make sure that remedial concrete does not create differential bearing conditions.
Below slabs or pavements: Provide selected fill compacted to the specified density.
Cut subgrades: Where the over excavation is less than 100 mm, do not backfill. Rectify by increasing the thickness of the layer above.
Rock depressions and subsoil drains: Backfill rock depressions and over excavation of subsoil drains using coarse subsoil filter.

3.9 SUPPORTING EXCAVATIONS

Removal of supports
General: Remove temporary supports progressively as backfilling proceeds.

Voids
General: Guard against the formation of voids outside sheeting or sheet piling if used. Fill and compact voids to a dry density similar to that of the surrounding material.

3.10 ADJACENT STRUCTURES

Temporary supports
General: Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works.
Lateral supports: Provide lateral support using shoring.
Vertical supports: Provide vertical support where necessary using piling or underpinning or both.

 Permanent supports
General: If permanent supports for adjacent structures are necessary and are not described, give notice and obtain instructions.

Encroachments
General: If encroachments from adjacent structures are encountered and are not shown on the drawings, give notice and obtain instructions.

3.11 ROCK BOLTING

General
Requirement: Provide proprietary high strength steel bars or tubes anchored into holes drilled in the rock and tensioned against plates bearing on the rock face to provide temporary or permanent support.
for the rock face. Schedule the installation to conform to systematic bolting or calculated relief, as documented.

Standard: To AS 4678.

**Protection**

General: Protect permanent rock bolts by grouting the drilled hole with cement grout after tensioning the rock bolt. Protect the bearing plate and the exposed portion of rock bolt and anchorage with a protective coating or by embedment in concrete.

**3.12 GEOTEXTILE**

**General**

Material: UV stabilised polymeric fabric formed from a plastic yarn composed of at least 85% by weight.

Identification and marking: To AS 3705.

Bidim A34 or equivalent

Preparation: Trim the ground to a smooth surface free from cavities and projecting rocks.

Placing: Lay the fabric flat, but not stretched tight, and secure it with anchor pins. Overlap joints 300 mm minimum.

**3.13 PREPARATION FOR FILLING**

**Preparation**

Stripping: Prepare the ground surface before placing fill (including topsoil fill), ground slabs or load bearing elements to AS 3798 clause 6.1.5. Remove materials which will inhibit or prevent satisfactory placement of fill layers, loose material, debris and organic matter.

Foundation preparation: To AS 3798 clause 6.1.7.

Compaction: Compact the ground exposed after stripping or excavation to the minimum relative compaction in AS 3798 Table 5.1.

Scarify method: Loosen exposed excavation by scarifying to a minimum or 150 mm, moisture condition and compact to AS 3798 Section 5.

Impact roller and impact compaction: Use an approved method.

Slope preparation: If fill is placed on a surface steeper than 4:1 (horizontal:vertical), bench the surface to form a key for the fill. As each layer of fill is placed, cut the existing ground surface progressively to form a series of horizontal steps more than 1 m in width and more than 100 mm deep. Recompact the excavated material as part of the filling. Shape to provide free drainage.

**Under earth mounds**

General: Cultivate the ground to a depth of 200 mm before mound formation.

**Under slabs, paving and embankments**

Compact the ground: To AS 3798 Table 5.1. If necessary, loosen the ground to a depth of more than 200 mm and adjust the moisture content before compaction to a density consistent with subsequent filling.

**Rock ledges**

General: Remove overhanging rock ledges.

**3.14 PLACING FILL**

**General**

Layers: Place fill in near-horizontal layers of uniform thickness, deposited systematically across the fill area.

Extent: Place and compact fill to the designated dimensions, levels, grades, and cross sections so that the surface is always self-draining.

Edges: At junctions of fill and existing surfaces, do not feather the edges.

Mix: Place fill in a uniform mixture.

Previous fill: Before placing subsequent fill layers, make sure that previously accepted layers still conform to requirements, including moisture content.

Protection: Protect the works from damage due to compaction operations. Where necessary, limit the size of compaction equipment or compact by hand. Commence compacting each layer at the structure and proceed away from it.
Protective covering: Do not disturb or damage the protective covering of membranes during backfilling.

**Placing at structures**

General: Place and compact fill in layers simultaneously on both sides of structures, culverts and pipelines to avoid differential loading. Carefully place first layers of fill over the top of structures.

Concrete: Do not place fill against concrete retaining walls until the concrete has been in place for 28 days unless the structure is supported by struts.

### 3.15 PLACING TOPSOIL

**Stockpiled topsoil**

Cultivation: Rip to a depth of 100 mm or to the depth of rippable subgrade if less. Cultivate around services and tree roots by hand. Trim to allow for the required topsoil depth.

Herbicide: Apply before placing topsoil.

Placing: Spread and grade evenly.

**Disposal of excess topsoil**

On-site: Dispose of surplus topsoil remaining on site by spreading evenly over the areas already placed.

Off-site: Remove excess topsoil from the site and dispose of legally.

Compaction: Lightly compact topsoil so that the finished surface is smooth, free from lumps of soil, at the required level, ready for cultivation and planting.

Edges: Finish topsoil flush with abutting kerbs, mowing strips and paved surfaces. Feather edges into adjoining undisturbed ground.

### 3.16 FILL MOISTURE CONTROL

**General**

Moisture content: Adjust the moisture content of fill during compaction within the range of 85 to 115% of the optimum moisture content determined by AS 1289.5.1.1 or AS 1289.5.2.1, as appropriate, to achieve the required density.

### 3.17 COMPACTION REQUIREMENTS FOR FILL AND SUBGRADE

**Density**

General: Compact the subgrade and each layer of fill to the required depth and density, as a systematic and construction operation. Shape surface to provide drainage and prevent ponding.

Excavated and stripped ground surface: After excavation and/or stripping, compact these surfaces to a minimum depth of 150 mm.

Maximum rock and lump size in layer after compaction: To AS 3798 clause 6.2.2.

Fill batter faces: Either compact separately, or overfill and cut back. Form roughened surfaces to the faces.

Minimum relative compaction: To AS 3798 Table 5.1.

**Compaction control tests**

Compaction control tests: To AS 1289.5.4.1 or AS 1289.5.7.1.

**Compaction control test frequency**

Standard: To AS 3798 Table 8.1.

Confined operations: 1 test per 2 layers per 50 m².

### 3.18 COMPLETION

**Grading**

External areas: Grade to give falls away from buildings, minimum 1:100.

Subfloor areas: Grade the ground surface under suspended floors to drain ground or surface water away from buildings without ponding.

**Temporary works**

Tree enclosures: Remove temporary tree enclosures at completion.

Tree marking: Remove temporary marks and tags at completion.

Temporary supports: Remove temporary supports to adjacent structures at completion.
Site restoration
Requirement: Where variation of existing ground surfaces is not required as part of the works, restore surfaces to the condition existing at the commencement of the contract.

3.19 PAY ITEMS

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<th>Schedule rate scope</th>
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<td>Lump sum</td>
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<td>0222.2 Inadequate foundation material</td>
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Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.
GENERAL

D2.01 SCOPE

1. This section sets out the Guidelines for the design of the road pavement to meet the required design life, based on the subgrade strength, traffic loading and environmental factors, and including the selection of appropriate materials for select subgrade, subbase, base and wearing surface. Design Criteria

2. The Specification contains procedures for the design of the following forms of surfaced road pavement construction: Surfed Pavement Types

   (a) flexible pavements
   (b) rigid pavements (i.e. cement concrete pavements);

3. Consideration to the design of unsealed (gravel) pavements will only be given for minor rural subdivisions/developments in isolated rural areas where the access to the subdivision is via an existing unsealed road. Unsealed Pavements

D2.02 OBJECTIVES

1. The objective in the design of the road pavement is to select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs adequately and requires minimal maintenance under the anticipated traffic loading for the design life adopted. Pavement Performance

D2.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

   D1   - Geometric Road Design
   D4   - Subsurface Drainage Design
   C242 - Flexible Pavements
   C244 - Sprayed Bituminous Surfacing
   C245 - Asphalitic Concrete
   C248 - Plain or Reinforced Concrete Base

(b) QLD State Authorities

   Department of Transport and Main Roads
      - Pavement Design Manual.
   MRS11.11 - Specification for Sprayed Bituminous Surfacing.

(c) Other

   AUSTROADS - Pavement Design, A Guide to the Structural Design of Road Pavements, 2004
   AUSTROADS - Guide to Control of Moisture in Roads.
PAVEMENT DESIGN CRITERIA

D2.04 DESIGN VARIABLES

1. Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the following five input variables:

   (a) Design Traffic
   (b) Subgrade Evaluation
   (c) Environment
   (d) Pavement and Surfacing Materials
   (e) Construction and Maintenance Considerations

D2.05 DESIGN TRAFFIC

1. The design traffic shall be calculated based on the following minimum design lives of pavement:

   (a) Flexible - 20 years
   (b) Rigid (Concrete) - 20 years

2. Design traffic shall be calculated in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity. For new subdivisions, the design traffic shall take account of both the construction traffic associated with the subdivision development and the in-service traffic. For interlocking concrete segmental pavements, the simplification of replacing ESA’s with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA-T45 is acceptable up to a design traffic of $1 \times 10^6$. Beyond this, ESAs should be calculated.

3. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic.

4. Any carriageway less than 7.0m wide shall be considered as one (1) lane when calculating design ESA’s.
5. The calculation of the Design Traffic Volume will include traffic generated by construction vehicles, in-service vehicles, buses (where applicable) and garbage collection vehicles as given below (Ref: ARRB Transport Research Sealed Local Roads Manual, Design Traffic Loading).

**Construction Traffic:**

Construction traffic ESA’s = (Number of houses serviced by the street) x (Number of ESA’s generated by the average house)

Where the number of ESA’s generated by the average house during construction is 20.

**In-service Traffic:**

In-service traffic ESA’s = \(N_s \times 365 \times Y\)

where \(N_s\) = ESA’s per day per lane for commercial vehicles other than buses and garbage collection vehicles

\[N_s = \frac{AADT}{2} \times \frac{\%CV}{100} \times \frac{ESA’s}{CV}\] (refer Table D2.05.1 for \%CV and ESA’s/CV)

\[Y = \text{Growth factor}\]

\[r = \text{Traffic growth rate}\]

\[P = \text{Design life in years}\]

\[Q = \text{Time in years for traffic to reach saturation level (however saturation is not likely on local roads)}\]

**Table D2.05.1 Traffic Statistics for Residential Streets**

<table>
<thead>
<tr>
<th>AADT Limits</th>
<th>%CV</th>
<th>ESA’s/CV</th>
<th>ESA/day/lane</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;150</td>
<td>1.0 – 15.0 (3.6)</td>
<td>0.01 – 0.70 (0.20)</td>
<td>0.03 – 5.0 (0.40)</td>
<td>0.00</td>
</tr>
<tr>
<td>150 - 700</td>
<td>1.0 – 25.0 (5.0)</td>
<td>0.10 – 1.00 (0.50)</td>
<td>0.2 – 15.0 (4.0)</td>
<td>0.01</td>
</tr>
<tr>
<td>700 – 2000</td>
<td>2.0 – 20.0 (7.0)</td>
<td>0.10 – 1.20 (0.50)</td>
<td>5.0 – 90.0 (30.0)</td>
<td>0.015</td>
</tr>
<tr>
<td>&gt;2000</td>
<td>2.0 – 8.0 (3.7)</td>
<td>0.20 – 0.90 (0.50)</td>
<td>20.0 – 190.0 (60.0)</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Figures in brackets are mean values and shall be used in the absence of actual traffic count data.
### Table D2.05.2 Values of the Growth Factor Y as a function of P and r

<table>
<thead>
<tr>
<th>r</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>5.00</td>
<td>10.00</td>
<td>15.00</td>
<td>20.00</td>
<td>25.00</td>
<td>30.00</td>
<td>35.00</td>
<td>40.00</td>
</tr>
<tr>
<td>0.005</td>
<td>5.06</td>
<td>10.24</td>
<td>15.57</td>
<td>21.02</td>
<td>26.61</td>
<td>32.36</td>
<td>38.22</td>
<td>44.25</td>
</tr>
<tr>
<td>0.010</td>
<td>5.13</td>
<td>10.51</td>
<td>16.18</td>
<td>22.13</td>
<td>28.38</td>
<td>34.95</td>
<td>41.87</td>
<td>49.14</td>
</tr>
<tr>
<td>0.015</td>
<td>5.19</td>
<td>10.78</td>
<td>16.80</td>
<td>23.29</td>
<td>30.28</td>
<td>37.82</td>
<td>45.93</td>
<td>54.65</td>
</tr>
<tr>
<td>0.020</td>
<td>5.26</td>
<td>11.06</td>
<td>17.47</td>
<td>24.55</td>
<td>32.35</td>
<td>40.98</td>
<td>50.50</td>
<td>61.03</td>
</tr>
<tr>
<td>0.025</td>
<td>5.32</td>
<td>11.34</td>
<td>18.15</td>
<td>25.85</td>
<td>34.57</td>
<td>44.48</td>
<td>55.60</td>
<td>68.21</td>
</tr>
<tr>
<td>0.030</td>
<td>5.39</td>
<td>11.63</td>
<td>18.88</td>
<td>27.28</td>
<td>37.00</td>
<td>48.28</td>
<td>61.36</td>
<td>76.54</td>
</tr>
</tbody>
</table>

### Bus Traffic:

Bus traffic ESA’s = \( N_b \times 365 \times Y \)

where \( N_b \) = bus types \( \Sigma \) (number of services per day per lane x ESA’s per bus)

### Garbage Traffic:

Garbage traffic ESA’s = \( N_g \times 52 \times P \)

where \( N_g \) = ESA’s per garbage collection vehicle x number of passes per week x \( f \)

\( f \) = Proportion of time the garbage collection vehicle traffic the outer wheel path

- 0.5 for minor and local access streets
- 1.0 for collectors and distributors

where ESA’s per garbage collection vehicle is taken as 2.6 ESA’s.

6. In the absence of other traffic data, the following traffic values (in ESAs) may be taken as a guide to the design traffic, but shall be subject to variation depending on the circumstances for the particular development.

### Design ESAs

#### Table D2.05.3 Minimum Traffic Loadings

<table>
<thead>
<tr>
<th>Street Type</th>
<th>%CV</th>
<th>%ESA/CV</th>
<th>Minimum ESA's</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access Place</td>
<td>3.6</td>
<td>1.0</td>
<td>( 5 \times 10^4 )</td>
</tr>
<tr>
<td>Access Street</td>
<td>5</td>
<td>1.0</td>
<td>( 1 \times 10^5 )</td>
</tr>
<tr>
<td>Minor Urban Collector</td>
<td>7</td>
<td>1.0</td>
<td>( 5 \times 10^5 )</td>
</tr>
<tr>
<td>Major Urban Collector</td>
<td>10</td>
<td>1.0</td>
<td>( 1 \times 10^6 )</td>
</tr>
<tr>
<td><strong>Rural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;250vpd</td>
<td>5</td>
<td>1.0</td>
<td>( 5 \times 10^5 )</td>
</tr>
<tr>
<td>&gt;250vpd</td>
<td>9</td>
<td>1.0</td>
<td>( 1 \times 10^6 )</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To be determined by specific design data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Business/ Commercial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To be determined by specific design data</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
D2.06 SUBGRADE EVALUATION

1. Subgrade evaluation shall be carried out by a NATA registered materials test authority and shall be by the conduct of insitu and soaked 4 day CBR laboratory testing. Design CBR for each subgrade area shall be determined in accordance with the method outlined in AUSTROADS – Pavement Design, A Guide to the structural design of Road Pavements, 2004.

2. The following factors must be considered in determining the design strength/stiffness of the subgrade:
   - (a) Sequence of earthworks construction
   - (b) The compaction moisture content and field density specified for construction
   - (c) Moisture changes during service life
   - (d) Subgrade variability
   - (e) The presence or otherwise of weak layers below the design subgrade level.

3. The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure. Warrants for the provision of subsurface drainage are given in Specification for SUBSURFACE DRAINAGE DESIGN. If subsurface drainage is not provided, then the Design CBR adopted must allow for a greater variability in subgrade moisture content during the service life of the pavement, and hence a Design Moisture Content above the Optimum Moisture Content.

D2.07 ENVIRONMENT

1. The environmental factors which significantly affect pavement performance are moisture and temperature. Both of these factors must be considered at the design stage of the pavement. Reference should be made to AUSTROADS Pavement Design, APRG Report 21, and to NAASRA (Now AUSTROADS) – Guide to Control of Moisture in Roads.

2. The following factors relating to moisture environment must be considered in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:
   - (a) Rainfall/evaporation pattern
   - (b) Permeability of wearing surface
   - (c) Depth of water table
   - (d) Relative permeability of pavement layers
   - (e) Whether shoulders are sealed or not
   - (f) Pavement type (boxed or full width)
   - (g) Subject to flooding (eg. Causeways and Floodways).

3. The effect of changes in moisture content on the strength/stiffness of the subgrade shall be taken into account by evaluating the design subgrade strength parameters (ie. CBR or modulus) at the highest moisture content likely to occur during the design life, ie the Design Moisture Content. The provision of subsurface drainage
may, under certain circumstances, allow a lower Design Moisture Content, and hence generally higher Design CBR.

4. The effect of changes in temperature environment must be considered in the design of pavements with asphalt wearing surfaces, particularly if traffic loading occurs at night when temperatures are low, thus causing a potential reduction in the fatigue life of thin asphalt surfacing. The effect of changes in temperature environment should also be considered for bound or concrete layers.

5. The pavement design shall include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

**PAVEMENT THICKNESS DESIGN**

**D2.08 PAVEMENT STRUCTURE – GENERAL**

1. The minimum pavement requirements excluding asphalt shall be as detailed in Table D2.08.1.

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Minimum Pavement (mm)</th>
<th>Minimum Surface Treatment</th>
<th>Minimum Base Course CBR</th>
<th>Minimum Subbase Course CBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Place/Access Street</td>
<td>200</td>
<td>30mm (DG10) or 45mm (DG14)</td>
<td>80</td>
<td>35</td>
</tr>
<tr>
<td>Urban Collectors (Major and Minor)</td>
<td>200</td>
<td>45mm (DG14)</td>
<td>80</td>
<td>45</td>
</tr>
<tr>
<td>Sub-Arterial</td>
<td>250</td>
<td>45mm (DG14)</td>
<td>80</td>
<td>45</td>
</tr>
<tr>
<td>Arterial</td>
<td>In accordance with DTMR Pavement Design Manual</td>
<td></td>
<td>80</td>
<td>45</td>
</tr>
<tr>
<td>Park Residential</td>
<td>200</td>
<td>30mm (DG10) or 45mm (DG14)</td>
<td>80</td>
<td>35</td>
</tr>
<tr>
<td>Rural &amp; Rural Residential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• &lt;100 vpd</td>
<td>150(^b)</td>
<td>Gravel</td>
<td>80</td>
<td>35</td>
</tr>
<tr>
<td>• &gt;100 vpd</td>
<td>200</td>
<td>2 coat seal</td>
<td>80</td>
<td>35</td>
</tr>
<tr>
<td>Industrial</td>
<td>300</td>
<td>50mm (DG14)</td>
<td>80</td>
<td>45</td>
</tr>
<tr>
<td>Roundabouts</td>
<td>250</td>
<td>50mm (DG14 Polymer modified)</td>
<td>80</td>
<td>45</td>
</tr>
</tbody>
</table>

Note:

a) Should supply of CBR 80 material be unavailable then CBR 60 material may be used subject to satisfactory pavement design.

b) depth of base course only (subbase course not required)

2. Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of subbase and base layers shall not be less than the following:-

   (a) Flexible pavement: Subbase 100mm, Base 100mm
   (b) Rigid pavement: Subbase 100mm, Base 150mm

3. The subbase layer shall extend a minimum of 150mm behind the rear face of any kerbing and/or guttering.
4. The base and surfacing shall extend to the face of any kerbing and/or guttering. Where the top surface of the subbase layer is below the level of the underside of the kerbing and/or guttering, the base layer shall also extend a minimum of 150mm behind the rear face of the kerbing and/or guttering.

5. For unkerbed roads, the subbase and base layers shall extend at least to the nominated width of shoulder.

D2.09  FLEXIBLE PAVEMENTS

1. Flexible pavements with a design traffic up to $5 \times 10^5$ ESA's shall be designed in accordance with APRG Report 21.
   - Urban Residential/Park Residential - Figure 13.8.2 (A) 95% Confidence limit
   - Rural/Rural Residential - Figure 13.8.2 (B) 90% Confidence limit

2. Flexible pavement with a design traffic above $5 \times 10^5$ ESA's shall be designed in accordance with AUSTROADS – Pavement Design, A Guide to the structural design of Road Pavements, 2004.

D2.10  RIGID PAVEMENTS

1. Rigid (concrete) pavements, with design traffic up to $1 \times 10^6$ ESAs shall be designed in accordance with APRG Report 21.

2. Rigid (concrete) pavements for design traffic above $1 \times 10^6$ ESAs, the design shall be in accordance with AUSTROADS Pavement Design, A Guide to the structural design of Road Pavements, 2004.

D2.11  SEGMENTAL PAVERS

1. Segmental pavers generally are not accepted in any Local Government.

SURFACING DESIGN

D2.12  BITUMEN WEARING SURFACE

1. Except where the pavement is designed for concrete or where a gravel pavement is permitted in a rural situation, the wearing surface shall be a bituminous wearing surface of primer seal, plus asphalt

2. Where a 2 coat spray seal is permitted by the Council in a rural situation the design of the seal must comply with Austroads Design of Sprayed Seals 1990.
D2.13 ASPHALTIC CONCRETE

1. In Urban residential, Access Places and Streets, the asphalt mix design shall be either a 'high-bitumen content' mix or the ARRB Gap-graded mix in accordance with ARRB-SR41.

Table D2.13.1 Preferred Asphaltic Concrete applications

<table>
<thead>
<tr>
<th>Road Type</th>
<th>DG10 (Depth)</th>
<th>DG14 (Depth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Place</td>
<td>30mm</td>
<td>45mm</td>
</tr>
<tr>
<td>Access Street</td>
<td>30mm</td>
<td>45mm</td>
</tr>
<tr>
<td>Minor Urban Collector</td>
<td></td>
<td>45mm</td>
</tr>
<tr>
<td>Major Urban Collector</td>
<td></td>
<td>45mm</td>
</tr>
<tr>
<td>Trunk Collector Street</td>
<td></td>
<td>45mm</td>
</tr>
<tr>
<td>Sub Arterial</td>
<td></td>
<td>45mm</td>
</tr>
<tr>
<td>Park Residential</td>
<td>30mm</td>
<td>45mm</td>
</tr>
<tr>
<td>Industrial Access</td>
<td></td>
<td>50mm</td>
</tr>
<tr>
<td>Industrial Collector</td>
<td></td>
<td>50mm</td>
</tr>
</tbody>
</table>

2. In Urban residential collector streets, commercial roads and in all industrial and classified roads, the asphalt mix design shall be a dense graded mix.

3. As a minimum, a 7mm or 10mm primer seal shall be indicated on the Drawings below the asphalt surfacing (required for all new surfaces which will have a new asphalt surfacing applied).
CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

WATER SUPPLY NETWORK

D11

DESIGN & CONSTRUCTION GUIDELINE
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<td>D11.24 POWER DESIGN</td>
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<td><strong>QUALITY CONTROL AND TESTING</strong></td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>
Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.
DESIGN & CONSTRUCTION

D11.01  SCOPE

1. This Guideline sets out the requirements for the design of the NON-TRUNK infrastructure water supply network to achieve the Desirable Standards of Service in accordance with requirements of the Sustainable Planning Act and the Water Supply (Safety and Reliability) Act. For any TRUNK infrastructure, refer to the Water Service Provider.

2. The following order of priority for interpretation of documents will apply:

(a) CMDG D11 Water Supply Design & Construction Guideline
(b) CMDG Standard Drawings
(c) Water Reticulation Code of Australia WSA 03-2011
(d) AS 3500 Part 1
(e) AS 2566 Buried Flexible Pipelines
(f) AS 2032 Installation of PVC pipe systems
(g) AS 2033 Installation of polyethylene pipe systems
(h) Department of Environment and Natural Resources, Planning Guidelines for Water Supply and Sewerage, March 2014
(j) Water Supply (Safety and Reliability) Act
(k) Plumbing and Drainage Act

D11.02  OBJECTIVE

1. All premises in the Water Supply Service Area are to be connected directly and separately to the water supply network.

2. The water supply non-trunk network is to provide to the consumer a reliable reticulated potable water supply to meet the quality, pressure and flow demands imposed upon it by both the consumers and fire fighting requirements.

3. The Desired Standards of Service are determined and displayed by each Water Service Provider. These Guidelines provide acceptable solutions to meet a range of DSS.

4. Optimisation of lifecycle cost, including capital, operation, maintenance, decommissioning and replacement, is to be considered in the design and construction of all water infrastructure.
D11.03 DEFINITIONS AND MATERIALS

1. Water Service Provider (WSP) means the entity responsible for providing the water supply services is in accordance with the Water Supply (Safety & Reliability) Act. The Water Service Provider for each of the participating Councils is as follows:

<table>
<thead>
<tr>
<th>Council</th>
<th>Water Service Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Banana Shire Council</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Central Highlands Regional Council</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Gladstone Regional Council</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Isaac Regional Council</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Livingstone Shire Council</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Maranoa Regional Council</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Fitzroy River Water</td>
</tr>
</tbody>
</table>

2. Trunk infrastructure is defined in the Sustainable Planning Act and involves a list of assets as identified by the Water Service Provider. In general, trunk infrastructure is not determined by asset size, but function. The function of trunk infrastructure is to serve a catchment or zone that is significant to the function/service of the network. Also, trunk infrastructure is not non-trunk infrastructure. In practice, trunk infrastructure is the bulk supply, treatment and transfer of potable water via: dams, treatment plants, high lift pump stations, trunk mains, and reservoirs.

No individual connections are permitted to Trunk Infrastructure.

3. Non-trunk infrastructure is defined in the Sustainable Planning Act and involves internal works and/or external works and/or safety and efficiency of the network. For water supply networks, the efficiency of the network means to avoid duplication of assets by sizing assets for the service area by a network analysis. In practise, non-trunk infrastructure is: property connections, reticulation water mains, distribution mains, localised booster pump stations.


5. ET means Equivalent Tenement.

6. PVC* means pipe material of Polyvinyl Chloride (Unplasticised (uPVC), Modified (MPVC) and Oriented (OPVC)) and composites and PE* means pipe material of Polyethylene in accordance with CMDG Purchase Specifications listed in Appendix B and Clause D11.07.

7. DI means ductile iron and CI means cast iron for pipes and fittings in accordance with CMDG Purchase Specifications listed in Appendix B. In general, DICL pipe is AS2280 PN35 and fittings are typical 1200 kPa working pressure range.

8. Ductile Iron Fittings utilised for flexible pipe systems must have a socket depth which complies with AS1477 Table 7.1

9. Pipe colour and/or marking and/or sleeving colour shall be blue.

10. Flanges are to be in accordance with the CMDG Purchase Specifications listed in Appendix B. In general flanges are AS4087 PN16 unless required otherwise through pressure calculations and/or by the relevant Water Service Provider.
11. Covers and Frames for access chambers are AS3996 Class B for non-trafficable locations and Class D for trafficable locations.

12. Bolts in above ground uses shall be at least hot dip galvanised in accordance with AS1214.

13. Bolts in below ground uses shall be grade 316 stainless steel with nuts and washers grade 304 stainless steel. Bolts to be protected with anti-seize lubricant before installation. If required by Table D11.03.02, the entire fitting shall be sleeved with polyethylene sleeving in accordance with Australian Standard AS 3680 - Polyethylene Sleevng for Ductile Iron Pipe.

<table>
<thead>
<tr>
<th>Water Service Provider</th>
<th>Sleevng of fittings required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>No</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>No</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>No</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>No</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>No</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>No</td>
</tr>
</tbody>
</table>

14. All ductile iron pipes and cast/ductile iron fittings shall be wrapped, taped and sealed completely with polyethylene sleeving 0.25mm thick. Sleevng material shall be an approved proprietary product. Wrapping shall be carried out in accordance with the pipe manufacturer’s recommendations.

15. Pipe bedding material shall:
   i. Consist of hard durable inert grains of washed river, marine or dune sand or hard rock sand or a blend of these naturally occurring sand types;
   ii. Have a grading which complies with Table 11.03.03;
   iii. Have resistivity greater than 1500 Ohm.cm² when tested in accordance with AS1289.4.4.1
   iv. Have a pH in the range 5-9 when determined in accordance with AS 1289.4.3.1;
   v. Be free from noxious weeds as proclaimed by the relevant regulators; and
   vi. Be free from dangerous chemicals as proclaimed by the relevant regulators.

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Mass of Sample Passing (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>Grade B*</td>
</tr>
<tr>
<td>6.7</td>
<td>100</td>
</tr>
<tr>
<td>4.75</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36</td>
<td>85-95</td>
</tr>
<tr>
<td>1.18</td>
<td>65-80</td>
</tr>
<tr>
<td>0.6</td>
<td>50-70</td>
</tr>
<tr>
<td>0.3</td>
<td>30-50</td>
</tr>
<tr>
<td>0.15</td>
<td>5-12</td>
</tr>
<tr>
<td>0.075</td>
<td>3-8</td>
</tr>
</tbody>
</table>
16. Polyethylene piping is to be in accordance with the CMDG Purchase Specification listed in Appendix B. Pressure rating to be in accordance with Table 11.08.01. The colour coding for water supply pipe is at least a blue stripe.

17. Isolation Valves for below ground use (sluice valves) are to comply with the CMDG Purchase Specification listed in Appendix B. In general the isolation (sluice) valves are to be AS2638 Class 14, resilient seated, anti-clockwise closing, operated with a removable key.

18. Isolation Valves for above ground use (gate valves) in general are AS2638 Class 14, resilient seated, clockwise closing, operated by a handwheel.

19. Non-return valves shall be full-bodied swing flap type manufactured in accordance with AS3578 and CMDG Purchase Specification listed in Appendix B.

20. Spring Hydrants shall be 100mm flange type manufactured in accordance with AS3952.

21. Tapping bands shall be provided as per Table D11.03.04 manufactured in accordance with CMDG Purchase Specification listed in Appendix B.

Table D11.03.04 Tapping Band Material

<table>
<thead>
<tr>
<th>Council</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Gunmetal or Plastic</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Gunmetal or Plastic</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Gunmetal only</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Gunmetal on PVC pipes or Plastic with SS bolts on Poly pipes</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Gunmetal or Plastic</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Gunmetal or Plastic</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Gunmetal or Plastic</td>
</tr>
</tbody>
</table>

22. Steel pipes and fittings shall be externally coated with a fusion bonded polyethylene coating to AS 4321 (Sintakote or equivalent) and internally cement lined, and manufactured in accordance with AS1579.

23. Property Water Service is the pipework between the Main Tap (ferrule) and the Property Point of Connection. This pipework will be an asset of the Water Service Provider.

24. The outlet of the Water Service Provider’s Water Meter marks the Property Point of Connection.

25. Capricorn Municipal Development Guideline purchase specifications for products and materials shall apply except where modified herein.

The Water Service Providers purchase specifications, as modified from time to time, shall be used in preference to the Water Services Association of Australia purchase specifications. These are available on the Capricorn Municipal Development Guidelines website (www.cmdg.com.au). Where Water Service Providers have not developed a purchase specification then the Water Services Association of Australia purchase specifications for products and materials shall apply, as modified by the relevant constraints of the guideline.
D11.04 HYDRAULIC DESIGN

1. The hydraulic design capacity calculations shall be in accordance with AS2200 – Design Charts for water supply and sewerage.

2. Colebrook-White roughness coefficient typical is 0.3mm or equivalent.

D11.05 PLANNED SERVICE AREA

1. The planned service area, hydraulic capacity and component sizing shall be as approved by the Water Service Provider via a Water Supply Network Analysis. Software used by consultants for Water Supply Network Analysis must be compatible with that use by the relevant Council. A list of the software used by each of the participating Councils has been provided below.

<table>
<thead>
<tr>
<th>Council</th>
<th>Software Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>H2OMAP</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>EPANET</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>WATER GEMS</td>
</tr>
</tbody>
</table>

Note: EPANET is freely available online via the USEPA.

2. The design of the water supply non-trunk network will take into consideration all external demands that are presently acting on the system or are likely to do so in the future. The Water Service Provider must be contacted to ascertain these external demands, point of connection to existing reticulation and operating parameters.

3. Water mains shall be extended to the boundaries of the development site where the water main is intended to service an existing and future stage or other development. An acceptable solution is for a hydrant plus capped (thrusted) stub to be provided at the development/stage boundary to allow flushing / scouring of main.

4. The hydraulic capacity shall be sufficient to allow current and planned (including staging) service area of all allotments, to be services directly and separately with the Desired Service Standard of the Water Supply Service Provider.

5. Where the entire area of any allotment cannot achieve the Desirable Service Standards, a plan showing the serviced area should be produced, and the Local Government or water Supply Service Provider approval sought before proceeding. Building pad covenants or Community Title may be required.

6. Water mains shall be interconnected wherever practical to:
   - eliminate dead ends,
   - maintain hydraulic efficiency, and
   - maintain supply in the event of maintenance shut-down of a street.

Looped mains are permitted in cul-de-sacs and in accordance with CMDG-W-081.
D11.06 DESIGN DEMANDS

1. The AD (average day) consumption and peaking factors for the relevant local government shall be as provided in Table D11.06.01:

**Average Daily Consumption (AD)**

<table>
<thead>
<tr>
<th>Average Daily Consumption (AD)</th>
<th>Mean Day Max Month (MDMM)</th>
<th>Max Day (MD)</th>
<th>Max Hour (MH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>650</td>
<td>1.5xAD</td>
<td>2.25xAD</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>2500</td>
<td>1.6xAD</td>
<td>1.85xAD</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>558</td>
<td>1.5xAD</td>
<td>2.25xAD</td>
</tr>
<tr>
<td>GRC (Agnes Water, Mt Larcom, Miriam Vale, Bororen)</td>
<td>450</td>
<td>1.5xAD</td>
<td>2.25xAD</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>650</td>
<td>1.5xAD</td>
<td>2.25xAD</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>1620</td>
<td>1.4xAD</td>
<td>1.89xAD</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>650</td>
<td>1.7xAD</td>
<td>2.30xAD</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>500</td>
<td>1.4xAD</td>
<td>1.89xAD</td>
</tr>
</tbody>
</table>

2. Figure D11.06.01 below represents the Maximum Day (MD) diurnal half-hourly demand pattern for the Gladstone Region (refer Appendix D for complete flow data). This diurnal pattern is an example, to be used only when Council specific water demand information is not available.

3. A minimum design pressure head for Domestic Demands alone, for each Water Service Provider as presented in Table D11.06.02, shall be provided during the MH (maximum hourly maximum day) on third consecutive Maximum Day consumption at the defined building pad level or at the mean lot level, which ever is the highest elevation.
Table D11.06.02 Minimum and Maximum Pressures

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Minimum Pressure</th>
<th>Maximum Desirable Pressure</th>
<th>Absolute Maximum Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>22 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>22 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>25 m (in main)</td>
<td>50 m (reticulation network)</td>
<td>80 m (trunk network)</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>22 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>22 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>20 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>22 m</td>
<td>50 m</td>
<td>80 m</td>
</tr>
</tbody>
</table>

4. The maximum design pressure shall not be exceeded. The maximum desirable design pressure for each local government is outlined in Table D11.06.02. Where, practical, pressure reducing valves or other network design measures shall be utilised to achieve this requirement.

5. Flow velocities for domestic demands, should not exceed 2.0 m/s.

The maximum allowable head loss in any main is as detailed in Table D11.02.06.03. This is to be determined using flow rates applicable at MHMD (Maximum Hour, Maximum Day). Reservoir filling main are to be assessed during a fill cycle.

Table D11.06.03 Maximum Head Loss

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Maximum Head Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>no specific requirements</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>no specific requirements</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>5m / 1,000m (Gladstone Network) 10m / 1,000 m (Other networks)</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>no specific requirements</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>no specific requirements</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>no specific requirements</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>no specific requirements</td>
</tr>
</tbody>
</table>

6. Fire fighting requirements shall ensure a minimum residual pressure of 12 m at the fire hydrant(s) being assessed and a minimum residual pressure of 6 m at any other location in the water supply hydraulic zone.

These pressures are to be calculated at maximum hour maximum day demand plus fire fighting flows of:
- Residential demand - 15l/s for 2 hours duration, (3 stories and less)
- Commercial demand - 30l/s for 4 hours duration

7. Design EP’s are calculated based on development type. Refer to the relevant local government Planning Scheme documents / Infrastructure Charges policies for the equivalent demands for each development type. In the absence of Local Government specific information, refer Appendix C for default equivalent demand values.
D11.07 ALIGNMENT, CLEARANCES, TENURE & EASEMENTS

1. All water supply works will require written evidence of appropriate tenure rights. In general, all properties associated with the water supply works shall be required to be identified in any Operational Works application.

2. Written approval shall be obtained from the registered owners of each of the affected property(s) affected by water construction works, by the Developer and submitted to the Water Service Provider.

3. All water mains are normally located within road reserves and parallel with existing local road reserves/property boundary/pathways (including at corner truncations). The alignment for all water mains shall be in accordance with Table D11.07.01. The designer shall check that the water mains do not conflict with other utility services and/or locate the water mains to the satisfaction of the Local Government road manager. Refer to CMDG Standard Drawing CMDG-R-100 for typical water main alignment.

Table D11.07.01 Water main alignment

<table>
<thead>
<tr>
<th>Region</th>
<th>Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary)</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary)</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Water mains shall be on a 1.5m alignment (measured from the property boundary), and shall be located on the opposite side of the residential road reserve to underground electricity supply.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary), and shall be located on the opposite side of the residential road reserve to underground electricity supply. Refer to CMDG Standard Drawings CMDG-R-0100 AND CMDG-R-0101.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary), and shall be located on the opposite side of the residential road reserve to underground electricity supply. Refer to CMDG Standard Drawings CMDG-R-0100 AND CMDG-R-0101.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary)</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Water mains shall be on a 2.5m alignment (measured from the property boundary), and shall be located on the opposite side of the residential road reserve to underground electricity supply. Refer to CMDG Standard Drawings CMDG-R-0100 AND CMDG-R-0101.</td>
</tr>
</tbody>
</table>

4. In central business districts, and commercial zones, it is desirable for a water main on each side of the road reserve.

5. Water mains in private allotments are not permitted without written consent from Council. Where water mains are required to be installed in areas other than road reserves, an easement shall be provided in accordance with Table D11.07.02 below. The easement should be centrally located over the water main, unless co-located with other public utility then similar road alignments should be provided.
### Table D11.07.02 Minimum Width of Easements over Water Mains

<table>
<thead>
<tr>
<th>Council</th>
<th>Required Easement Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>5.0m</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>5.0m</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>10.0m</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>5.0m</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>5.0m</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>5.0m</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>5.0m</td>
</tr>
</tbody>
</table>

6. Where water mains are to be located within and parallel with existing dedicated Main Road Reserves, the designer shall locate the water mains to the specifications of the Main Roads manager in accordance with public utility plant. Refer to Clause 80 Transport Infrastructure Act.

7. Where a pipeline crosses a Department of Transport and Main Roads controlled road, Railway Line, creek or involves features under the control of any Authority/Corporation, the affected work shall be carried out in accordance with the requirements of that Authority/Corporation. It shall be the Contractor's responsibility to complete written notification to the Authority/Corporation of the intention to carry out the work.

8. The minimum horizontal and vertical clearance to all other crossover underground services shall be 100mm. For local alignment deviations, the minimum horizontal clearance to all parallel underground services shall be 300mm clearance provided the other services have marker tape and mechanical protection as defined by AS3500.

9. All service crossing angles shall be as per Table D11.07.03 following

### Table D11.07.03 Service Crossing Angle

<table>
<thead>
<tr>
<th>Water Service Provider</th>
<th>Service Crossing Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Between 45 degrees and 90 degrees.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>
D11.08 WATER MAINS

1. All water mains shall be PVC*, PE or DICL, unless otherwise approved by the Water Service Provider.

2. The following table outlines approved water main materials and classes for each Local Government. Ductile Iron pipe is required where stated in Table 11.08.02.

Table D11.08.01 PVC* Water Main pipe classes

<table>
<thead>
<tr>
<th></th>
<th>uPVC</th>
<th>MPVC</th>
<th>OPVC</th>
<th>DICL</th>
<th>PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Class 12</td>
<td>Class 16</td>
<td>Class 16</td>
<td>PN35</td>
<td>PE100 PN12.5</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>-</td>
<td>Class 12</td>
<td>-</td>
<td>PN35</td>
<td>PE100 PN12.5</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Class 16</td>
<td>Class 16</td>
<td>Class 16 (Material Class 450)</td>
<td>PN35</td>
<td>PE100 PN16</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Class 12</td>
<td>Class 16</td>
<td>Class 16 (Material Class)</td>
<td>PN16</td>
<td>PE100 PN12.5</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Class 12</td>
<td>Class 16</td>
<td>Class 16 (Material Class 450)</td>
<td>PN35</td>
<td>PE100 PN12.5</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>-</td>
<td>Class 16</td>
<td>Class 16</td>
<td>PN35 for Road Crossings &amp; Aerial Creek Crossing</td>
<td>PE100 PN12.5</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Class 12</td>
<td>Class 16</td>
<td>Class 16 (Material Class 450)</td>
<td>PN35</td>
<td>PE100 PN12.5</td>
</tr>
</tbody>
</table>

Table D11.08.02 Use of Ductile Iron Pipe for road and creek crossings

<table>
<thead>
<tr>
<th></th>
<th>Ductile Iron Pipe for Road Crossing</th>
<th>Ductile Iron Pipe for Aerial Creek Crossing</th>
<th>Ductile Iron Pipe for Buried Creek Crossing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Yes</td>
<td>Yes</td>
<td>No (use poly)</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

3. The minimum water main size shall be 100mm nominal diameter (DN) in residential areas and minimum 150mm DN in industrial/commercial areas, with the exception of 63OD poly in residential cul-de-sac loop-mains, if permitted by the Water Supply Service Provider. In all cases, pipe sizes and residual pressures shall be designed to cater for fire fighting flows.

4. The minimum depth of cover to be provided for water mains and water service conduits shall be in accordance with Table D11.08.03 below. Cover under roads to be measured from the adjacent kerb or edge of gravel or edge of pavement.
Table D11.08.03 Minimum Depth of Cover over Water Mains

<table>
<thead>
<tr>
<th>Council</th>
<th>Minimum Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Refer Table D11.08.04</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Refer Table D11.08.04</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>750mm or 100mm below subgrade whichever is greater</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Refer Table D11.08.04</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Refer Table D11.08.04</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Refer Table D11.08.04</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Refer Table D11.08.04</td>
</tr>
</tbody>
</table>

Table D11.08.04: Varied depth of cover to water mains and water service conduits

<table>
<thead>
<tr>
<th>Location of Pipe</th>
<th>PVC*</th>
<th>DI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Areas not subject to vehicular loading:</td>
<td>600mm</td>
<td>450mm</td>
</tr>
<tr>
<td>2. Areas subject to vehicular loading:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) not in roadway</td>
<td>600mm</td>
<td>600mm</td>
</tr>
<tr>
<td>b) in sealed roadway</td>
<td>900mm*</td>
<td>750mm*</td>
</tr>
<tr>
<td>c) in unsealed roadway</td>
<td>900mm*</td>
<td>750mm*</td>
</tr>
</tbody>
</table>

*or 100mm below subgrade whichever is greater

5. Marker Tape with non-corrosive detector wire shall be used over all water mains.

6. Pipeline installation in general is to be in accordance with AS2032, AS2033, AS2566.2 and AS3500 unless noted otherwise. Refer also to standard drawing CMDG-W-040.

7. Lesser cover may be permitted at a localised situation, subject to special protection of the pipeline to the satisfaction of the Water Supply Service Provider. This may involve: DI pipe section, and/or cement stabilized sand and/or cover slab as approved in the drawings shall be constructed in accordance with CMDG Standard Drawing CMDG-W-040.

8. Joint deflections shall be in accordance with AS2032 and AS2033. Unnecessary joint deflections shall be kept to an absolute minimum to limit “form” pressure losses. Changes in direction shall be effected by the appropriate fitting.

9. All pipes shall have a minimum length of 2.5 pipe diameters spacing between edge of socketed fittings.

10. Valves are required to be installed in a flanged arrangement with Tees as required by Table 11.08.05.

Table D11.08.05 Valves and Tees Instalment Arrangement

<table>
<thead>
<tr>
<th>Council</th>
<th>Flanged Valves and Tees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Yes</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>No</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>No preference</td>
</tr>
</tbody>
</table>
11. Gibaults shall be elongated and centred, with type 316 stainless steel bolts. If required by Table D11.03.02 the entire gibault shall be sleeved with Polyethylene sleeving in accordance with Australian Standard AS 3680 - Polyethylene Sleeving for Ductile Iron Pipe.

D11.09 FIRE HYDRANTS AND ISOLATION VALVES

1. Hydrants shall be located at RP boundaries.

   Hydrants shall not be located in road pavement or driveways.

   Hydrants shall also be located at tees in accordance with Table D11.09.01 below.

<table>
<thead>
<tr>
<th>Council</th>
<th>Hydrants Required at Tees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>No</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>No</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>No</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>No</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>No</td>
</tr>
</tbody>
</table>

2. For urban areas, fire hydrants shall be at maximum 80m spacing for all non-trunk water supply network mains, and located so that they comply with AS2419 – hydrant location.

3. Spring hydrant bodies, tees and risers shall be 100mm size flanges in accordance with AS4087 and in accordance the CMDG Purchase Specifications listed in Appendix B.

4. For rural and park residential allotments where fire flow is provided, hydrants shall be located at 80m or every second property boundary, whichever is the greater. Either option must be located at a RP boundary.

5. In all areas, the 'high' and 'low' point of the mains are to be co-located with hydrants to allow for air and water scouring as required.

6. Dead ends - temporary and permanent shall have a fire hydrant (flushing) connected to the 'duckfoot' fitting.

7. Isolation valves (below ground sluice valves) are to be placed to minimise disruption and/or maintain supply to water consumers during water maintenance incidents in parts of the network. In addition to the above, isolation valves are to be spaced generally in accordance with Table D11.09.02 below.

**Table D11.09.02 Isolation (Stop) Valve Spacing Criteria**

<table>
<thead>
<tr>
<th>Water main size (DN)</th>
<th>Number of property service connections (nominal)</th>
<th>Maximum spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤150</td>
<td>40</td>
<td>300*</td>
</tr>
<tr>
<td>200-300</td>
<td>100</td>
<td>750</td>
</tr>
<tr>
<td>375</td>
<td>150</td>
<td>1000</td>
</tr>
</tbody>
</table>

*In rural areas, the maximum spacing shall be 500m.
8. Isolation Valves should be located opposite property boundary truncations or at RP boundaries or as per alignment standard drawing CMDG-W-20.

9. Refer Table D11.09.02 for the minimum number of isolation valves that must be provided at each tee within each Council area. Refer to CMDG Standard Drawing CMDG-W-020.

The arrangement for construction of valving arrangements at intersections is by use of flanged valves and tees if required by Table D11.08.05.

10. Socketed valves may be used on straight lines remote from intersections or bends.

11. Isolation Valves shall preferably not be located under road pavement, or driveways. If the valve location is within paved roads, the designers shall gain approval from the relevant authority, for an acceptable location of the valve.

12. Where reflux valves or pressure reducing valves are required in the reticulation network they shall be located in accordance with the specific requirements of each Water Service Provider.

13. All isolation valves (sluice valves) for water supply purposes shall be anti-clockwise closing or as approved by the Water Service Provider.

14. Hydrant and valve boxes shall be an approved cast iron (trafficable areas) and pre-cast concrete surround or polyethylene (box and surround) (other areas). The surrounds are to be finished at ground surface level and provided in all locations. Refer CMDG Standard Drawing CMDG-W-061. Materials used are to be in accordance with the CMDG Purchase Specifications listed in Appendix B.

15. In cul-de-sacs, the fire hydrant and isolating valve shall be provided in accordance with CMDG Standard Drawing CMDG-W-081.

D11.10 THRUST BLOCKS & ANCHOR BLOCKS

1. Thrust blocks and anchor blocks shall be provided at any point where unbalanced forces resulting from internal pressures will occur, such as: isolation valves, bends, tees, end caps, enlargers and reducers.

2. The thrust blocks bear against undisturbed material normal to the direction of thrust resulting from internal pressures over a bearing area not less than that shown on Standard Drawing CMDG-W-041 & CMDG-W-40.

3. The Contractor shall provide temporary thrust facilities adequate to restrain the pipe when under test.

4. Where a main is installed at a grade of 1 in 6 or steeper, concrete anchor blocks shall be provided in accordance with CMDG Standard Drawing CMDG-W-040.

5. Concrete works shall comply with the specification of MINOR CONCRETE WORKS C271. Concrete Grade N32 is to be used.

D11.11 PROPERTY WATER SERVICES, WATER CONDUITS

1. Property Water Service and Point of Connection shall be installed at the time of water main installation in accordance with the relevant CMDG Standard Drawing and Table D11.11.01 relevant to the Water Service Provider.
Table D11.11.01 Property Point of Connection Location

<table>
<thead>
<tr>
<th>Location of Point of Connection</th>
<th>Point of Connection Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Below ground – in the footpath</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Above ground – in the property (no greater than 500mm from the front and side boundary)</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Below ground – outside property (no greater than 500mm from the front and side boundary)</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Below ground – outside property (no greater than 500mm from the front and side boundary)</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Below ground – in the footpath</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Above ground – in the property</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Below ground – in the footpath</td>
</tr>
</tbody>
</table>

2. Water main tapping points (tapping bands) on PVC* pipe shall not be located closer than 2.5 pipe diameters from the outer edge of any fitting or another service connection.

3. Main taps (ferrules) shall have an inspection shaft (IS) to surface in accordance with Table D11.11.02 relevant to the Water Service Provider. Inspection shaft installations must be cast iron squat type boxes. Plastic boxes are not permitted. Refer CMDG-W-090 and CMDG-W-090A.

Table D11.11.02 Main Tap Inspection Shaft required

<table>
<thead>
<tr>
<th>Main Tap Inspection Shaft required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
</tr>
<tr>
<td>Gladstone Regional</td>
</tr>
<tr>
<td>Isaac Regional</td>
</tr>
<tr>
<td>Livingstone Shire</td>
</tr>
<tr>
<td>Maranoa Regional</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
</tr>
</tbody>
</table>

4. Water Conduits under roadways shall be minimum SN 8 PVC and of a minimum 100mm diameter bore. Conduits shall be sealed each end with Abelflex (or equivalent) and/or heavy duty plastic tape.

Where a concrete footpath is constructed on the verge and the water service connection is not being installed at the time of construction the conduit shall extend under the concrete footpath.

5. Water Conduits shall be installed under all roads to service the following:
   (a) Landscaped traffic islands & medians.
   (b) Water service connections.
   (c) Parks and Open Space.

6. Water Conduits shall be installed at ‘property boundary to property boundary’ alignments, as shown in CMDG-W-090. The maximum deviation from perpendicular is generally 30º, unless otherwise specifically required by the road reserve manager.

7. A marker plaque (marked “w”) shall be placed in the kerb when wet, where the conduit crosses the kerb. Refer Standard Drawing CMDG-W-090 for marker plate details.
8. Minimum cover to conduits shall be the greater of 600mm nominal cover or 100mm below subgrade.

9. The minimum residential service line size is shown in Table D11.11.03

Table D11.11.03 Residential Service Line Size

<table>
<thead>
<tr>
<th></th>
<th>Residential Service Line Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>32mm ID / 40mm OD in all situations</td>
</tr>
</tbody>
</table>
| Central Highlands Regional | Short Single – 20mm ID / 25mm OD   
                          | Short Dual, Long Single and Long Dual – 25mm ID / 32mm OD         |
| Gladstone Regional   | 32mm ID / 40mm OD in all situations                                 |
| Isaac Regional       | Short Single – 20mm ID / 25mm OD   
                          | Short Dual, Long Single and Long Dual – 25mm ID / 32mm OD         |
| Livingstone Shire    | 32mm ID / 40mm OD in all situations                                 |
| Maranoa Regional     | Short Single – 20mm ID / 25mm OD   
                          | Short Dual, Long Single and Long Dual – 25mm ID / 32mm OD         |
| Rockhampton Regional | 32mm ID / 40mm OD in all situations                                 |

11. The minimum industrial service line size is shown in Table D11.11.04, or as required by the Registered Water Service Provider

Table D11.11.04 Industrial Service Line Size

<table>
<thead>
<tr>
<th></th>
<th>Industrial Service Line Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>32mm ID / 40mm OD</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>25mm ID / 32mm OD</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>50mm ID / 63mm OD</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>32mm ID / 40mm OD</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>32mm ID / 40mm OD</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>25mm ID / 32mm OD</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>32mm ID / 40mm OD</td>
</tr>
</tbody>
</table>

12. In cul-de-sacs, property services shall be connected to the poly ring main in order to generate flow within the loop. A maximum of 5 services shall be taken off the poly loop.

D11.12 TRENCHES & EXCAVATIONS

1. Trench width, depth, foundations, stability and safety assessments shall have Notes on the Operational Works Drawings.

2. Stabilised and compacted trench foundation is required in soft (typically less than 50kPa bearing capacity) or unstable or over-excavated ground conditions.

3. The Contractor shall leave a clear space of 600mm minimum between the edge of any excavation and the inner toe of spoil banks. No excavated materials shall be stacked against the walls of any building or fence without the written permission of the owner of such building or fence. Topsoil from excavations shall be kept separate and utilised to make good the surface after backfilling.
4. In the event of any trenching being left open for longer than one week, the Contractor shall provide erosion control measures to ensure minimal soil disturbance and material loss off the site. Some or all of these measures shall be provided immediately upon the onset of rain with an open trench.

Erosion Control

5. Control measures shall include:

(a) Provision of trench stops every 30 metres along a trench with provision for overtopping to be directed to the kerb.

(b) Placement of blue metal bags along kerb and gutter at maximum 30 metre spacings.

(c) Placement of blue metal bags around downstream drainage pits.

(d) Construction of diversion banks to divert the uphill catchment water from entering the trench.

6. The minimum clear width of trench (inside internal faces of timbering or sheet piling, if used) to a height of 150mm above the top of the pipe shall be 100mm each side of the pipe, as shown in AS2566 or as specified by the Approved Operational Works drawings.

Min Trench Width

7. The maximum width of trench from the base of the trench to 150mm above the top of the pipe shall be the outside diameter of the pipe plus 600mm unless detailed otherwise on the Approved Operational Works drawings.

Max Trench Width

8. In waterlogged ground, de-watering shall be undertaken to reduce the water level below pipe level until sufficient backfill is placed to prevent pipe flotation.

De-watering

9. For sites where ground level settlement is expected, a specialised design is required.

Settlement

10. Where a trench is excavated across a paved surface, the width of the trench shall be kept to a minimum. Bitumen and concrete surfaces shall be carefully cut by saw cutting or other approved means, so as to provide a neat straight line free from broken ragged edges.

Trenching Under Pavement

11. For mains to be laid on rock foundation, excavation shall be carried out to a depth of not less than 100mm below the underside of the pipe barrel and socket or coupling.

Rock Foundations

12. For mains laid on other than rock, excavation shall be carried out to a depth of not less than 75mm below the underside of the pipe barrel and socket or coupling.

13. The Contractor shall adequately support all excavations as the works proceed. When withdrawing supports, the Contractor shall exercise every precaution against trench collapse by means of intermediate shoring, planking or props. Backfilling shall be performed simultaneously with the withdrawal of supports.

Trench Support

14. The safety of the general public shall be considered in the preparation of the site safety plan for the works. In urban areas, at completion of work each day, all trenches are to be backfilled. Where this requirement is unavoidable, safety fencing shall be installed along edges of open excavations to isolate them from the public. Where necessary, fenced walkways and vehicular crossways shall be provided across trenches to maintain access from carriageway to individual properties or within individual properties. All such installations shall be of adequate size and strength and satisfactorily illuminated.

Public safety

D11.13 LAYING AND JOINTING OF PIPES

1. Before being laid, all pipes, fittings, valves, etc shall be cleaned and examined by the Contractor.

Examination
2. The Contractor shall provide and use approved drag scrapers or "detectors" to ensure that the interior of the pipeline is clean and free from obstructions. Approved plugs shall be used to prevent foreign matter entering sections of pipeline which are left uncompleted overnight.

3. The Contractor shall take all necessary precautions to prevent flotation of pipes during laying, backfilling and initial testing. Any temporary supports shall be removed prior to completion of backfilling.

4. Joints in pipelines shall be flexible rubber ring joints (either roll-on rubber ring or skid type) or mechanical joints (either fixed flange or bolted gland type). The joint type shall be as shown on the Drawings.

5. For pipes with rubber ring joints, spigots and sockets shall be clean and dry. When the joint is made, the witness mark shall at no point be more than 1mm from the end of the socket. After making the joint, a feeler gauge shall be used to check that the rubber ring has rolled in evenly, and if not, the pipe shall be withdrawn and the joint remade.

6. Only the lubricant specified by the pipe manufacturer and or fitting manufacturer shall be applied.

7. Pipes shall be cut as needed to suit closing lengths, to remove damaged pipe or fittings or to remove sockets if necessary when jointing a socketed fitting.

8. For field cuts, only an approved mechanical pipe cutter shall be used. All field cuts shall achieve a 'square cut' finish.

9. Any pipes cut in the field shall have their ends prepared in accordance with the manufacturer's written instructions.

10. Where pipes are cut in the field, a witness mark shall be made on the pipe at the length specified by the manufacturer from the end of the pipe. Scoring of MPVC pipes shall not be permitted. Where spigots and sockets are not made by the same manufacturer, reference shall be made to the socket manufacturer for the correct marking depth.

11. Where "PVC pipes are to be joined to pipes of another material, the joints shall be made as follows:

   (a) For jointing PVC* spigot to VC socket or PVC* socket to VC spigot, an approved PVC* adaptor shall be used. The joints in both instances shall be made using a ring conforming to AS1646.

   (b) For jointing PVC* socket to ductile iron spigot, an approved adaptor coupling shall be used.
12. Flexibly jointed pipelines for rising mains with gradual changes in alignment or grade shall be laid with the joint being deflected after it has been made. Table D11.13.01 shows the allowable pipe deflection for each Sewerage Service Provider. The manufacturer’s written recommendations in respect of maximum deflection for each joint shall be complied with provided that no joint shall be deflected to such an extent as to impair its effectiveness.

Table D11.13.01 Pipe Deflections

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Allowable pipe deflection for rising mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>75% of manufacturers recommendations</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>75% of manufacturers recommendations</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>75% of manufacturers recommendations</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
</tbody>
</table>

13. Deflection within a pipe length is not permitted.

D11.14 VALVE COVERS AND FRAMES

1. The Contractor shall construct around each valve and hydrant a chamber of the type and to the details shown on the Standard Drawings CMDG-W-060 and CMDG-W-061.

2. All concrete works shall comply with the CMDG Specification for MINOR CONCRETE WORKS C271.

3. Covers and frames shall not be warped or twisted.

Surfaces shall be finished such that there are no abrupt irregularities and gradual irregularities shall not exceed 3mm. Unformed surfaces shall be finished by approved methods to produce a surface that is dense, uniform and free from blemishes. Tolerances for the dimensions on the COVER shall be -3mm + NIL. Tolerances for the dimensions on the SURROUND shall be -3mm + 3mm.

4. Covers shall be finished flush with the surface in roadways, footpaths and paved surfaces. Elsewhere, covers shall be finished 25mm above the surface of the ground, in a manner designed to avoid as far as possible, the entry of surface water.

D11.15 BACKFILL AND COMPACTION

1. Compacted (95 per cent of the standard maximum dry density of the bedding material in accordance with AS1289.5.7.1) underlay bedding sand for pipes and fittings shall be a minimum depth of 100mm.

2. Flooding of non-cohesive material shall be considered as an acceptable method of compacting bedding underlay material.

3. Compacted (95 per cent of the standard maximum dry density of the bedding material in accordance with AS1289.5.7.1) overlay bedding sand for pipes and fittings shall be a minimum depth of 150mm.

4. Material for the side support and bedding overlay of the pipe shall comply with the pipe bedding material. The material shall be compacted in layers of not more than 150mm to...
95 per cent of the standard maximum dry density of the bedding material used when determined in accordance with AS1289.5.7.1.

5. Other than under roads, the remainder of the excavation shall be backfilled with excavated material. The backfill shall be compacted as specified in the drawings and specification. Flooding of cohesive material shall NOT be permitted as a means of compacting backfill under roads.

6. Under roads, backfill shall comprise of approved roadbase material, sand or stabilised sand. Refer CMDG-W-040 for trench backfill details.

7. Backfilling and compaction shall be carried out without damaging the pipe or its external coating or wrapping or producing any movement or deflection of the pipe.

D11.16 VALVE / HYDRANT MARKERS

1. For open space areas, gravel pavements and sealed roads without kerbing, marker posts shall be provided at all hydrants, sluice valves, air valves and scour valves in accordance with Standard Drawing CMDG-W-060.

2. In areas with sealed pavements, fire hydrants adjacent to roads shall be identified by blue prismatic Retro Reflective Pavement Markers (RRPM's) adhered to the road surface in accordance with Standard Drawing CMDG-W-062. Sluice valves, air valves and scour valves shall be identified by yellow Retro Reflective Pavement Markers (RRPM’s) accordance with Standard Drawing CMDG-W-062.

3. Kerb painting, for identification of valves and hydrants, is to be provided in accordance with Table D11.16.01 below:

Table D11.16.01 Kerb Painting for Valves and Hydrants

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Kerb Painting (for valve and hydrants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Not Required</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Not Required</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>The kerb is to be painted (white – valves, yellow – hydrants) in the location perpendicular to the asset. Painted area is to be 300mm wide.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>The kerb is to be painted (blue – valves, yellow – hydrants) in the location perpendicular to the asset. Painted area is to be 300mm wide.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Not Required</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Not Required</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

All paint colouring to comply with AS 2700 - Colour Standards for General Purposes.

4. All pavement markers shall comply with the CMDG Specification for PAVEMENT MARKINGS.

D11.17 RESTORATION OF SURFACES

1. Pavements, lawns and other improved areas shall be cleaned and left in the same order as they were at the commencement of the works. Lawns shall be restored with turf cut and set aside from the original surface and/or with commercially available turf.

2. All restored surfaces shall be maintained in the condition to which they are restored until the expiry of the Defects Liability Period applicable to those surfaces, not withstanding that any deterioration of the restored surfaces, and the need for their...
maintenance may or may not be due to defects which become apparent or arise from events which occur during the Defects Liability Period. Pavements shall be maintained with crushed metal, gravel or other suitable material allowing for consolidation and shall then be restored to a condition equivalent to that of the original pavement.

3. Immediately the backfilling of a trench excavated through a pavement has been completed, the pavement shall be temporarily restored. Where the trench crosses bitumen or concrete pavement, a pre-mixed asphaltic material shall be used for such temporary restoration. Temporary restoration shall be maintained by the Contractor until final restoration is carried out. Final restoration of the pavement shall be carried out to restore the pavement and its sub-base to no less than the original condition. Final restoration may include, if required, the removal of temporary restoration.

4. Backfill shall be placed sufficiently high to compensate for expected settlement and further backfilling shall be carried out or the original backfill trimmed at the end of the Defects Liability Period in order that the surface of the completed trench may then conform to the adjacent surface. Surplus material shall be removed and disposed of to areas arranged by the Contractor.

5. Where, within public or private property, the reasonable convenience of persons will require such, trenches to be levelled off at the time of backfilling. Any subsequent settlement shall be made good by the Contractor, as required by placing additional fill.

6. In locations where surplus material left in the vicinity of the trench would not be objectionable, the surplus material may be disposed by spreading neatly in the vicinity of the trench in such a way as to minimise future erosion of the backfill and adjacent ground surfaces. The Contractor shall maintain the backfill and adjacent ground until the expiry of the Defects Liability Period.

7. Where approved by the relevant authority underboring under paving, kerb and gutter or other improved surfaces in lieu of trenching, backfilling shall be so carried out as to restore full support to those surfaces. The Contractor shall remain responsible for the repair of the improved surfaces, if subsequently damaged due to subsidence of the backfill, until the end of the Defects Liability Period.

**PIPELINE INSPECTION AND TESTING**

**D11.18 INSPECTION**

1. All pipes, fittings and components are to be inspected and approved by a Registered Professional Engineer, Queensland, and/or relevant Water Authority approved inspector.

2. Inspections are to be in compliance with Operational Works Permit conditions or CMDG Works Inspections.

3. Inspection schedule, inspector contact, notifications, fees, and workplace safety procedures are to be recorded at the pre-start safety meeting for the works.

**D11.19 TESTING OF PIPELINES**

1. Mains shall be pressure tested to detect excessive leakage and defects in the pipeline including joints, thrust and anchor blocks.

2. Pipelines shall be tested in sections as soon as practicable after each section has been laid, jointed and backfilled, provided that:
   
   (a) All joints are required to be exposed and inspected for defects and pressure tested before being backfilled. If the contractor wishes to backfill the joints prior to the testing then it is at their own risk; and
(b) The pressure testing shall not be commenced earlier than seven days after the last concrete thrust or anchor block in the section has been cast.  

3. For the purpose of this sub-clause, a section shall be defined as a length of pipeline which can be effectively isolated for testing, eg by means of main sluice valves.  

4. Pressure testing shall not be carried out during wet weather unless otherwise approved by Water Service Provider.  

5. During pressure testing, all field joints which have not been backfilled shall be clean, dry and accessible for inspection.  

6. During the pressure testing of a pipeline, each sluice valve shall sustain at least once, the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.  

7. Before testing a pipeline section, it shall be cleaned to the satisfaction of the Superintendent and filled slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves. In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24 hours prior to the commencement of the pressure testing.  

8. The hydrostatic test pressure which shall be applied to each section of the pipeline shall be such that at each point of the section the test head shall be equal to or greater than the pressure rating of the pipe specified or shown on the Drawings, but shall not exceed same by more than 20 per cent. The minimum test pressure shall be 1250kPa.  

9. The specified test pressure shall be maintained as long as required, while the whole section is examined, and in any case not less than 15 minutes.  

10. The pressure testing of a section shall be considered to be satisfactory if:  
   (a) there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component;  
   (b) there is no visible leakage; and  
   (c) there is no loss of pressure in the 15 minute test period.  

11. Any failure, defect, visible leakage, which is detected during the pressure testing of the pipeline (even if the test is a pass) or during the Defects Liability Period shall be made good by the developer.  

D11.20 CLEANING, FLUSHING AND DISINFECTION  

1. Cleaning, flushing and disinfection shall be carried out in three (3) stages on all newly laid mains and water services:  
   (a) Preliminary Flushing  
   (b) Chlorination  
   (c) Final flushing  

Except on acceptable short sections, where swabbing has been approved.  

2. The water main shall be flushed prior to chlorination so that a minimum velocity of 0.76m/sec is obtained in the main. Where possible scour valves and hydrants shall be used for this purpose. The quantity of water used, must be 20% more than the calculated volume of the main to be flushed, to ensure full flushing is achieved.
3. Sodium hypochlorite solution (10% available chlorine) or other approved chlorine-bearing agent shall be used for chlorination of the main. The agent shall be added as a water mixture. The dose of chlorine shall be 20mg/L or to achieve a free chlorine value of 5mg/L whichever is greater.

4. When the main is completely filled with chlorinated water, the section shall be closed and a contact period of 24 hours allowed. In the process of chlorinating, valves, hydrants and other appurtenances in the newly laid pipe section shall be operated while the pipeline is filled with the chlorinating agent. No direct connection of the newly laid main is permitted to the existing system, until the new main has been appropriately flushed.

5. The preferred point of application of the chlorine-bearing water mixture is at the beginning of the pipeline extension or any valved section of it and through a cock inserted in a tapping band or a hydrant. The required dose is added as each section of the main is filled. In a new system, application of chlorine may be made at an elevated tank, standpipe or reservoir providing these are properly cleaned first and with due allowance for the volume of water in the tank, standpipe or reservoir.

6. Following chlorination, all treated water shall be thoroughly flushed from the newly laid pipeline at its extremes. Care should be taken in disposal as the solution is aggressive and toxic. De-chlorination may be required prior to discharge.

7. Swabbing of water mains consists of foam which is inserted into the water main and using the water pressure and flow, pushed through to the main discharge point to remove deleterious material. Swabbing of new mains is to be carried out when required by the Water Service Provider and in accordance with Section 18 of WSAA’s Water Supply Code of Australia (V3.1).

8. Testing for residual chlorine in the newly laid main is required once the flushing is completed. The free chlorine residual shall be in the range of 0 – 2.0 mg/l.

9. If the residual chlorine levels are outside the desired range then the flushing and sterilization process shall be recommenced until the required levels are reached.

10. Bacteriological testing is required on all new mains following satisfactory completion of swabbing/flushing and pressure testing in accordance with Table D11.20.01 and as follows:

   (a) Scour past the sampling point.
   (b) Engage a Recognised Testing Laboratory accredited for the test to collect representative water samples from the test section of the water main.
   (c) Dispose of testing water in accordance with the relevant environmental Regulator and/or Water Agency requirements.

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Bacteriological Testing Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Yes</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>No</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Yes</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Yes</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>No</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>No</td>
</tr>
</tbody>
</table>
Sections of new water main, subject to bacteriological testing in accordance with Table D11.20.01 will be accepted if:

(a) The test results fall within the water quality parameter limits specified in the Table D11.20.02; or

(b) The water quality parameter test results in the test section of water main are no worse than the water quality parameter test results measured by testing an influent sample of existing mains water, provided that the influent sample was collected by the NATA registered laboratory at the same time as water sample from the test section of water main was collected.

### Table D11.20.02 Water Quality Parameter Limits

<table>
<thead>
<tr>
<th>Water quality parameter</th>
<th>Unit</th>
<th>Acceptable range</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td></td>
<td>6.8C8.5*</td>
</tr>
<tr>
<td>Chlorine (free)</td>
<td>mg/L</td>
<td>0C2.0</td>
</tr>
<tr>
<td>Total Coliform count</td>
<td>cfu/100mL</td>
<td>0</td>
</tr>
<tr>
<td>Faecal Coliform count or E.Coli count</td>
<td>cfu/100mL</td>
<td>0</td>
</tr>
<tr>
<td>Heterotrophic Plate count</td>
<td>cfu/mL</td>
<td>0C10</td>
</tr>
</tbody>
</table>

* for cement mortar lined mains an upper level pH of 9.2 is acceptable

### D11.21 DEFECTS / MAINTENANCE PERIOD

1. The satisfactory performance, repair and maintenance of all assets, infrastructure and its components, constructed, installed and/or purchased by the developer is the responsibility of the developer during the Defects Liability (Maintenance) Period. The relevant Council is responsible to approve the necessary rectification works, the cost of defect rectification works are the sole responsibility of the developer.

### D11.22 CONNECTION TO EXISTING WATER NETWORK

1. The connection of all new water mains or additional hydrant or additional Property Connections, etc to the existing water network shall be made by the Water Service Provider staff at the developers cost, unless otherwise approved by the Water Service Provider.

### PUMPING STATIONS

#### D11.23 GENERAL

1. The design pumping capacity and pump type is to be nominated by the Water Service Provider (RWSP) for the planned loading, according to the planning horizon and staging plan. Typically the pump type is centrifugal. RWSP should be consulted prior to design to determine specific requirements for: pumps, VSD, cabling, switchboards, telemetry, gantry crane, ventilation, fuel storage, bunding, etc.

2. All pumpstations are to be provided with a duty / stand-by pumping arrangement with automatic controls to alternate all pumps between duty and stand-by functions. Stand-by pump/s must be sized to meet the maximum demand of the duty pump/s.
3. The pump station must be located on a freehold parcel of land to be transferred the Water Service Provider. 

4. Pumpstations are to be located with minimum clearances from property boundaries and habitable dwellings in accordance with Table D11.23.01 below.

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Clearance from Property Boundaries(^1)</th>
<th>Clearance from Habitable Dwellings(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Adequate clearance to ensure compliance with Environmental Protection (Noise) Policy 2008</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Adequate clearance to ensure compliance with Environmental Protection (Noise) Policy 2008</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>20m</td>
<td>50m</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Adequate clearance to ensure compliance with Environmental Protection (Noise) Policy 2008</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Clearance measured from edge of the pump building to the closest property boundary.

5. Pumpstations are to be designed and operated to meet the requirements of the Environmental Protection (Noise) Policy 2008. Refer Schedule 1 of the aforementioned policy Acoustic quality objectives (maximum dB), measured at the receptor, for different neighbouring development types. A design statement, certified by a suitably qualified person, must be provided to demonstrate compliance with this requirement.

6. The incoming water feed must be high reliability via a designated gravity trunk main or reservoir. Trunk feed main to be designed to have excess capacity (150% of pump flow) to feed the PS with minimum feed pressure.

7. Refer to standard drawings CMDG-W-071-to CMDG-W-073 for a standard pump station layout.

**D11.24 POWER DESIGN**

1. Each pump station shall be designed for Primary and Secondary Power Supply. The Primary Power Supply shall be the Electricity Provider as nominated by the Water Service Provider (WSP). The Secondary Power Supply as nominated by the WSP, typically either mobile generator or fixed on-site generator or a second independent supply from the Electricity Provider.

2. The nominated Secondary Power Supply shall be incorporated into the switchboard, conduits, service poles, etc, even if a Secondary Power Supply is not required at the particular stage.

D11.25  CONTROL AND TELEMETRY DESIGN

1. Each pump station shall be connected to the Water Service Provider’s telemetry monitoring system.


3. Refer to WSAA for design requirements for water hammer and dynamic stresses.

DOCUMENTATION

D11.26  NON-TRUNK WATER SUPPLY NETWORK

1. Master Plans are required to be submitted to, and approved by the relevant Council, as part of any Development Application submission. Master Plans must comply with all requirements of CMDG.

2. The proposed water supply network and facilities detailed design, including calculations shall be submitted to the Water Service Provider, and if required to the Local Government for approval as part of the Operational Works application.

3. The Drawings (digital format and ‘A3’ size RPEQ signed hardcopy) shall show to scale:-
   (a) Plan: contours, alignment of water mains, sizing of water mains, pipe materials, valves, hydrants, fittings, thrust blocks location, water service conduits, property connection points, pumping stations, existing and proposed allotment contours and boundaries, and electricity services, sample thrust block size, compaction.
   (b) General arrangement of pumping stations with site plan; concrete outlines; number, make, model and details of pumps; inlet and outlet pipework details and levels; pump cut in; cut out and alarm levels; switchboard location; pumping station access details.
   (c) Include a drawing note at each connection ‘Connection to the existing network to be carried out by Water Service Provider, at the developer’s costs’.
   (d) Drawing Notes shall include: pipe Class, pipe colour, connection to existing system, Dial Before You Dig.

4. Detail plans shall be drawn to a scale of 1:1000 or as approved otherwise by the Water Service Provider.

5. The operational works submission must be accompanied by design calculations relating to water pumping stations including:
   - Design Statement regarding noise levels;
   - Design flow calculations (including plan of identified catchment area); and
   - Pump selection including pump curve with proposed duty point.

6. At the Pre-start Meeting and during construction, the Superintendent and Contractors must have and work to up-to-date Approved Operational Works Drawings on-site plus a copy of the Operational Works Decision Notice and any attached conditions.

7. If any CMDG drawings are specifically referenced in the drawing package, the CMDG drawings shall be attached in the drawing package. It is the designers’ responsibility to
check and obtain the most up to date copies of the standard drawings from the CMDG website at the time of submission.

8. CMDG Standard drawings (or part thereof) are not to be replicated in the submitted drawings. However, any deviations (slight or significant) from CMDG standards and drawings must be shown on the submitted drawings, RPEQ certified and Council approved prior to construction.

**D11.27 AS CONSTRUCTED DETAILS**

1. As constructed data shall be submitted to the Water Service Provider showing the asset location and attributes of pipelines, fittings, valves, hydrants, all pumping station details together with operating and maintenance manuals. Refer to standard drawing CMDG-W-020 for an example layout.

2. Refer to the Capricorn Municipal Development Guidelines web site [www.cmdg.com.au](http://www.cmdg.com.au) for further information on the applicable Local Government’s As Constructed data submission requirements. These will appear within the ‘As Constructed’ tab.
## APPENDIX A

### QUALITY CONTROL AND TESTING

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key Quality Verification Requirements</th>
<th>Maximum Lot Size</th>
<th>Minimum Test Frequency</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANDATORY TESTING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siting and Excavation</td>
<td>Geometry</td>
<td>1 line</td>
<td>1 per line</td>
<td>Survey</td>
</tr>
<tr>
<td>Testing of Pipelines</td>
<td>Pressure testing</td>
<td>1 line</td>
<td>1 per line</td>
<td>As specified D11.19</td>
</tr>
<tr>
<td><strong>AUDIT TESTING – IF ORDERED BY COUNCIL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials Supply</td>
<td>Material Quality - Supplier's documentary evidence and certification of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- MPVC Pipes</td>
<td>1 contract</td>
<td>1 per contract</td>
<td>AS1477 Series 2</td>
</tr>
<tr>
<td></td>
<td>- Ductile Iron Pipes</td>
<td>1 contract</td>
<td>&quot;</td>
<td>AS2280 and AS2129</td>
</tr>
<tr>
<td></td>
<td>- Copper Pipe</td>
<td>1 contract</td>
<td>&quot;</td>
<td>AS1432</td>
</tr>
<tr>
<td></td>
<td>- Polyethylene Pipe</td>
<td>1 contract</td>
<td>&quot;</td>
<td>AS1159</td>
</tr>
<tr>
<td></td>
<td>- Sluice Valves</td>
<td>1 contract</td>
<td>&quot;</td>
<td>AS2638 and AS2129</td>
</tr>
<tr>
<td></td>
<td>- Material</td>
<td></td>
<td>&quot;</td>
<td>AS3578</td>
</tr>
<tr>
<td></td>
<td>- Non Return Valves</td>
<td>1 contract</td>
<td>&quot;</td>
<td>AS2544 or AS3952</td>
</tr>
<tr>
<td></td>
<td>- Spring Hydrants</td>
<td>1 contract</td>
<td>1 per contract</td>
<td>AS2032</td>
</tr>
<tr>
<td>Bedding</td>
<td>Material Quality - Grading</td>
<td>1 contract</td>
<td>1 per contract per source</td>
<td>AS2032</td>
</tr>
<tr>
<td>Thrust and Anchor Blocks</td>
<td>Refer Construction Specification C271</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Encasement</td>
<td>Refer Construction Specification C271</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamber Covers and Frames</td>
<td>Geometry</td>
<td>1 cover/frame</td>
<td>1 per cover/frame</td>
<td>Survey</td>
</tr>
<tr>
<td>Backfill and Compaction</td>
<td>Compaction</td>
<td>1 line</td>
<td>1 per 2 layers max 100m²</td>
<td>AS1289.5.7.1</td>
</tr>
</tbody>
</table>
APPENDIX B

PURCHASE SPECIFICATIONS

- Precast Sewerage Access Chamber Components
- Cover & Frames for Access Chambers – Water Supply & Sewerage
- Cast Iron Fittings for Pipelines
- Battery Powered Electromagnetic Water Meters
- Electromagnetic Water Meters
- Ductile Iron Pressure Pipes
- Polyethylene Pressure Pipe
- PVC Pressure Pipe
- PVC Gravity Sewer Pipe and Fittings
- Domestic On-Site Sewage Pump Station
- Polyethylene Sleeving for Pipes
- Detectable Marker Tape for Pipelines
- Tapping Bands for Pipelines
- Air Valves for Water Supply Purposes
- Brass Valves
- Butterfly Valves for General Purposes
- Cast Iron Gate Valves for General Purposes
- Spring Hydrant Valves for Waterworks Purposes
- Metal Seated Sluice Valves
- Non-Return Valves – Swing Check & Tilting Disk
- Resilient Seated Sluice Valves
- Sewerage Vent Pole
- Single Detector Check Valve
APPENDIX C

TYPICAL LOADINGS PER DEVELOPMENT TYPE

The EP’s per development type are to be in accordance with each Council’s Developer Contribution Policies. Where these policies do not provide sufficient information, the EP’s given in Table D11.C.01 can be used as a guide. Refer also to relevant Adopted Infrastructure Charges Resolution for the Local Government.

Table D11.C.01 Design EP’s per development type

<table>
<thead>
<tr>
<th>Planning Areas</th>
<th>Unit</th>
<th>EP per Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Areas</td>
<td>Lot</td>
<td>3</td>
</tr>
<tr>
<td>Accommodation Building, Multi-unit dwelling, Aged care accommodation, duplex</td>
<td>Dwelling Unit</td>
<td>2.5</td>
</tr>
<tr>
<td>Group Housing</td>
<td>Gross hectare</td>
<td>120</td>
</tr>
<tr>
<td>Local Commercial (Garden Centre, Shop, Take away food store, Vet)</td>
<td>Gross hectare</td>
<td>75</td>
</tr>
<tr>
<td>Educational Institutions</td>
<td>Student</td>
<td>0.2</td>
</tr>
<tr>
<td>Hospitals / Nursing homes</td>
<td>Bed</td>
<td>2.5</td>
</tr>
<tr>
<td>Public Open Space</td>
<td>Gross hectare</td>
<td>10</td>
</tr>
<tr>
<td>Other High Density Commercial (Cinema, Major Shopping Outlet, Nightclub, Service Station)</td>
<td>Gross let-able floor space, 10,000 square meters</td>
<td>500-800</td>
</tr>
<tr>
<td>Industrial Areas</td>
<td>Gross hectare</td>
<td>56</td>
</tr>
<tr>
<td>Environmental Protection Areas</td>
<td>N/A</td>
<td>Nil</td>
</tr>
<tr>
<td>Community/Recreation Uses</td>
<td>Gross hectare</td>
<td>56</td>
</tr>
<tr>
<td>Development Type/class</td>
<td>Equivalent Persons / Connection</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td>Single Family Dwelling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot &gt; 1500m²</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Lot 1101m² to 1500m²</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Lot 901 m² to 1100m²</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Lot 401m² to 900m²</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Lot &lt; 400m²</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Multi Unit Accommodation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units &gt; 3 Bedrooms</td>
<td>0.4 + 0.6 / Bedroom</td>
<td></td>
</tr>
<tr>
<td>Units = 3 Bedrooms</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Units = 2 Bedrooms</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Units &lt; 2 Bedrooms</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Caravan Parks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Van Site / Camping Site</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Shops/Offices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per 90 m² GFA</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:

a) Based on 3.0 Equivalent Persons / Equivalent Tenement (EP/ET), with 1 ET equivalent to a single residential dwelling on a standard size allotment (401m² to 900m²).

b) For undeveloped land equivalent populations shall be calculated in accordance with the maximum allowable population density in the Planning Scheme.

c) No development shall reduce the existing service levels below the requirements contained in section D11.05 or existing service levels which are currently below the standards as set in section D11.05.
## APPENDIX D

### DIURNAL WATER DEMAND PATTERN (GLADSTONE REGION)

The following represents the Maximum Day (MD) diurnal half-hourly demand data for the Gladstone Region.

<table>
<thead>
<tr>
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### POWER DESIGN

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### CONTROL AND TELEMETRY DESIGN

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D12.34

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D12.35

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D12.36

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D12.37

## APPENDIX B

D12.38

## APPENDIX C

D12.39

### Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.
D12 DESIGN AND CONSTRUCTION

D12.01 SCOPE

1. This Guideline sets out the requirements for the design and construction of the NON-TRUNK infrastructure sewerage network to achieve the Desirable Standards of Service in accordance with requirements of the Sustainable Planning Act and the Water Supply (Safety and Reliability) Act.

2. For the order of priority for interpretation of the following documents, applicable to a Local Government, refer to Table D12.02.1.

(a) CMDG D12 Sewerage Design and Construction Guideline
(b) CMDG Standard Drawings
(c) Gravity Sewerage Code of Australia WSA 02-2014
(d) Sewage Pumping Station Code of Australia WSA 04-2005
(e) AS2566 Buried Flexible Pipelines
(f) AS2032 Installation of PVC pipe systems
(g) AS3500 Plumbing and Drainage
(h) Department of Environment and Natural Resources, Planning Guidelines for Water Supply and Sewerage, March 2014
(j) Water Supply (Safety and Reliability) Act
(k) Plumbing and Drainage Act

D12.02 OBJECTIVE

1. All premises in the Sewerage Service Area are to be connected directly and separately to the sewerage network.

2. The sewerage network is to transport sewage from domestic, commercial and industrial properties using gravity flow pipes and, where this is uneconomic, by pumping, to the treatment plant. The sewerage reticulation system shall be designed to minimise the number of pump stations.

3. The sewerage network is to provide a holistic solution to the greater community, through the efficient construction, operations and maintenance of the Sewerage Systems. This solution is achieved through the adherence to Master Plans.

4. Master Plans are required to reflect a holistic approach of achieving the Least life cycle costs for the relevant Council.

5. The Desired Standards of Service (DSS) are determined and displayed by each Local Government and/or Sewerage Service Provider (SSP). These Guidelines provide acceptable solutions to meet a range of DSS. Designs that do not comply with an acceptable solution shall require a functional design, be RPEQ certified, and supported by design references and calculations.
D12.03 Definitions and Materials

1. Sewerage Service Provider means the entity responsible for providing the sewerage services in accordance with the Water Supply (Safety & Reliability) Act. The following table outlines the Sewerage Service Provider for each local government area.

<table>
<thead>
<tr>
<th>Council</th>
<th>Sewerage Service Provider</th>
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<td>Banana Shire Council</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Central Highlands Regional Council</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Gladstone Regional Council</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Isaac Regional Council</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Livingstone Shire Council</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Maranoa Regional Council</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Fitzroy River Water</td>
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</table>

2. Trunk infrastructure is defined in the Sustainable Planning Act and involves a list of assets as identified by the Local Government. In general, trunk infrastructure is not determined by asset size, but function and limited access. The function of trunk infrastructure is to serve a catchment or zone that is significant to the function/service of the network. Also, trunk infrastructure is non-trunk infrastructure. In practice, trunk infrastructure is the limited access, bulk catchment collection and treatment of sewage via: trunk gravity mains, zone pump stations, zone rising mains, treatments plants, effluent re-use, and effluent disposal.

3. Non-trunk infrastructure is defined in the Sustainable Planning Act and involves internal works and/or external works required for the safety and efficiency of the network. For sewerage networks, the efficiency of the network means to avoid duplication of assets by sizing assets for the service area by a network analysis. In practice, non-trunk infrastructure is: access property connections, reticulation gravity sewer mains, reticulation collector mains, local sub-catchment sewage pump stations and associated rising mains.

4. EP means Equivalent Person

5. ET means Equivalent Tenement

6. PVC* means pipe material of Polyvinyl Chloride (Unplasticised (uPVC), Modified (MPVC) and Oriented (OPVC)) and composites and PE* means pipe material of Polyethylene in accordance with CMDG Purchase Specifications listed in Appendix B. In general non-pressure pipe is SN8 stiffness.

7. DI means ductile and CI means cast iron pipes and fittings in accordance with the published purchase specification of the relevant Sewerage Service Provider. Default specifications CMDG Purchase Specifications listed in Appendix B. In general DICL pipe is to comply with AS2280, have a pressure rating of PN35 and fittings are to have a pressure rating of 1200 kPa working pressure. Refer to Table D12.03.02 for the cement lining type.

<table>
<thead>
<tr>
<th>Council</th>
<th>Cement Lining type for sewerage</th>
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<tr>
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<td>Calcareaeous (Pentair-Hydroline CA or equivalent)</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Normal</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Calcareaeous (Pentair-Hydroline CA or equivalent)</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Normal</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Normal</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Normal</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Normal</td>
</tr>
</tbody>
</table>
8. Pipe colour and/or sleeving colour shall be: cream or grey for raw sewage, lilac for treated effluent reuse.

9. Flanges are to be in accordance with the published purchase specification of the relevant Sewerage Service Provider. Default specifications CMDG Purchase Specifications listed in Appendix B. In general flanges are AS4087 PN16 unless required otherwise through pressure calculations and/or by the relevant Water Service Provider.

10. Covers and Frames for access chambers are to be in accordance with the published purchase specification of the relevant Sewerage Service Provider. Default specifications CMDG Purchase Specifications are listed in Appendix B. In general Cover and Frames are AS 3996 Class B for non-trafficable locations and Class D for trafficable locations.

11. External to a sewerage wet well, structural steelwork, ladders, brackets, covers etc shall be abrasive blast cleaned to AS1627 Class 3 and hot dip galvanised to AS1650. Within a wet well environment all components shall be 316 Stainless Steel with the exception of the covers to wet wells and valve pits which shall be aluminium to reduce lifting weight for maintenance personnel.

12. Precast sewerage access chambers components are to be in accordance with published purchase specification of the relevant Sewerage Service Provider. Default specifications CMDG Purchase Specifications listed in Appendix B. In general they shall comply with AS 4198.

13. Bolts in above ground uses shall be at least hot dipped galvanised in accordance with AS1214, and as acceptable in a Local Government, refer to Table D12.03.03.

**Table D12.03.03 Galvanised Bolts in Above Ground Uses**

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<tr>
<td>Rockhampton Regional</td>
<td>Approved</td>
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</table>

14. Bolts in below ground uses shall be grade 316 stainless steel with nuts and washers grade 304 stainless steel. Bolts to be protected with anti-seize lubricant before installation. If required by Table D12.03.04, the entire fitting shall be sleeved with polyethylene sleeving in accordance with Australian Standard AS 3680 - Polyethylene Sleevings for Ductile Iron Pipe.

**Stainless Bolts**

**Table D12.03.04: Sleevings of fittings**

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<tr>
<td>Rockhampton Regional</td>
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15. All ductile iron pipes and cast/ductile iron fittings shall be wrapped, taped and sealed
completely with polyethylene sleeving 0.25mm thick. Wrapping shall be carried out in accordance with the pipe manufacturer’s recommendations.

16. Pipe bedding material shall:
   i. Consist of hard durable inert grains of washed river, marine or dune sand or hard rock sand or a blend of these naturally occurring sand types;
   ii. Have a grading which complies with Table 11.03.05;
   iii. Have resistivity greater than 1500 Ohm.cm² when tested in accordance with AS1289.4.4.1
   iv. Have a pH in the range 5-9 when determined in accordance with AS 1289.4.3.1;
   v. Be free from noxious weeds as proclaimed by the relevant regulators; and
   vi. Be free from dangerous chemicals as proclaimed by the relevant regulators.

Table D12.03.05 Sand Grading

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<td>50-70</td>
<td>70-100</td>
</tr>
<tr>
<td>0.3</td>
<td></td>
<td>30-50</td>
<td>50-100</td>
</tr>
<tr>
<td>0.15</td>
<td></td>
<td>5-12</td>
<td>0-40</td>
</tr>
<tr>
<td>0.075</td>
<td></td>
<td>3-8</td>
<td>0-5</td>
</tr>
</tbody>
</table>

*Taken from Table G3 of AS/NZS 2566.2-2002

17. Property Connection Junction is the junction ‘not at grade’ between the Sewer Main and the Property Connection Branch.

18. Property Connection Branch is the pipework between the Property Junction and the Property Point of Connection. This pipework will be an asset of the Sewerage Service Provider.

19. Property Point of Connection is the point where the private sanitary drainage connects to the Service Provider’s Sewerage Network. The IO (Inspection Opening) usually marks the Property Point of Connection.

D12.04 HYDRAULIC DESIGN

1. The hydraulic design capacity calculations shall be in accordance with AS2200 – Design Charts for water supply and sewerage.

2. Colebrook-White roughness coefficient typical is 1.6mm, the proportional velocity and discharge for a part-full pipe is typically 1.13 and 0.9 respectively. Refer AS2200 Chart 13.
3. Vacuum sewer systems are not approved within the scope of this Guideline.

4. Special Sewerage Arrangements, Designs and Low Pressure systems are not approved within the scope of this guideline. Refer to the relevant Sewerage Service Provider.

D12.05 PLANNED SERVICE AREA

1. The ultimate planned service area, staged service area, hydraulic capacity and component sizing shall be as approved by the relevant Sewerage Service Provider via a Sewerage Network Analysis. Software used by consultants for Sewer Reticulation Network Analysis must be compatible with that use by the relevant Council. A list of the software used by each of the participating Councils has been provided below.

Table D12.05.01 Sewer Reticulation Network Analysis Software

<table>
<thead>
<tr>
<th>Council</th>
<th>Software Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td></td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>SWMM5</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>SEWERGEMS</td>
</tr>
</tbody>
</table>
Note: SWMM5 is freely available online via the USEPA.

2. Sewer mains shall be extended to the boundaries of the development site where the sewer main is intended to service existing and/or future development. An acceptable solution is for an access chamber to be provided at 1.5 from the boundary with a capped stub extending to the property boundary.

3. The depth of sewer mains shall be sufficient to allow current and planned service area and all allotments, to be serviced directly and separately. Refer to SSP approved Network Analysis.

4. Property Connection Junction Depth shall not exceed 3m unless otherwise specifically approved by the SSP.

5. Where the whole area of any allotment cannot be serviced by a gravity Point of Connection, a plan showing serviced area should be produced, and the Local Government or Sewerage Service Provider approval sought before proceeding. Building pad covenants shall be provided for the serviced area where it is less than the whole area of the allotment.

Table D12.06.01  Design Average Dry Weather Flow (ADWF)

<table>
<thead>
<tr>
<th>Council</th>
<th>Design ADWF</th>
<th>EP/ET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>200 L/d/EP</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>250 L/d/EP</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>250 L/d/EP</td>
<td>2.6</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>250 L/d/EP</td>
<td>2.7</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>540 L/d/ET</td>
<td>2.7</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>200 L/d/EP</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>540 L/d/ET</td>
<td>2.7</td>
</tr>
</tbody>
</table>

2. The ADWF diurnal hourly flow pattern ratios are as per Figure D12.06.02 and Table D12.06.03.

Table D12.06.02- Sewer Weekly Curves

<table>
<thead>
<tr>
<th>Day</th>
<th>Residential</th>
<th>Business</th>
<th>school</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>100%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>Mon</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Tues</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Wed</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Thurs</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Fri</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>Sat</td>
<td>100%</td>
<td>20%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Figure D12.06.1  ADWF Diurnal flow ratios

Table D12.06.03  Design Average Dry Weather Flow (ADWF)

<table>
<thead>
<tr>
<th>Time</th>
<th>Residential</th>
<th>Residential Weekend</th>
<th>Commercial</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>0.24</td>
<td>1.4</td>
<td>0.528</td>
<td>0</td>
</tr>
<tr>
<td>1:00</td>
<td>0.192</td>
<td>1.25</td>
<td>0.408</td>
<td>0</td>
</tr>
<tr>
<td>2:00</td>
<td>0.168</td>
<td>1.143</td>
<td>0.288</td>
<td>0</td>
</tr>
<tr>
<td>3:00</td>
<td>0.192</td>
<td>0.875</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>4:00</td>
<td>0.387</td>
<td>0.558</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>5:00</td>
<td>0.889</td>
<td>0.486</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>6:00</td>
<td>2.16</td>
<td>0.489</td>
<td>0.264</td>
<td>0</td>
</tr>
<tr>
<td>7:00</td>
<td>2.06</td>
<td>0.932</td>
<td>0.48</td>
<td>0</td>
</tr>
<tr>
<td>8:00</td>
<td>1.629</td>
<td>1.381</td>
<td>0.888</td>
<td>0</td>
</tr>
<tr>
<td>9:00</td>
<td>1.356</td>
<td>1.659</td>
<td>1.32</td>
<td>2.112</td>
</tr>
<tr>
<td>10:00</td>
<td>1.163</td>
<td>1.72</td>
<td>1.632</td>
<td>3.792</td>
</tr>
<tr>
<td>11:00</td>
<td>1.005</td>
<td>1.592</td>
<td>1.68</td>
<td>3</td>
</tr>
<tr>
<td>12:00</td>
<td>0.885</td>
<td>1.525</td>
<td>1.776</td>
<td>3</td>
</tr>
<tr>
<td>13:00</td>
<td>0.855</td>
<td>1.404</td>
<td>1.92</td>
<td>3.168</td>
</tr>
<tr>
<td>14:00</td>
<td>0.89</td>
<td>1.24</td>
<td>1.872</td>
<td>2.808</td>
</tr>
<tr>
<td>15:00</td>
<td>0.977</td>
<td>1.155</td>
<td>1.8</td>
<td>2.4</td>
</tr>
<tr>
<td>16:00</td>
<td>1.182</td>
<td>1.041</td>
<td>1.656</td>
<td>1.8</td>
</tr>
<tr>
<td>17:00</td>
<td>1.479</td>
<td>0.947</td>
<td>1.44</td>
<td>1.104</td>
</tr>
<tr>
<td>18:00</td>
<td>1.787</td>
<td>0.879</td>
<td>1.152</td>
<td>0.408</td>
</tr>
<tr>
<td>19:00</td>
<td>1.479</td>
<td>0.88</td>
<td>1.008</td>
<td>0.408</td>
</tr>
<tr>
<td>20:00</td>
<td>1.153</td>
<td>0.895</td>
<td>0.936</td>
<td>0</td>
</tr>
<tr>
<td>21:00</td>
<td>0.864</td>
<td>0.972</td>
<td>0.84</td>
<td>0</td>
</tr>
<tr>
<td>22:00</td>
<td>0.624</td>
<td>1.038</td>
<td>0.768</td>
<td>0</td>
</tr>
<tr>
<td>23:00</td>
<td>0.384</td>
<td>1.188</td>
<td>0.624</td>
<td>0</td>
</tr>
</tbody>
</table>
3. The Peak Dry Weather Flow (PDWF) shall be 2.5 times ADWF.

4. The Wet Weather Flow (WWF) shall be 5 times ADWF. The flow pattern is a constant flow for 24hrs.

5. Screened overflow pits are required, for loadings greater than WWF (5ADWF) capacity, to prevent overflow into buildings and public health exposure locations. Refer to Risk Assessment and Compliance with Environmental Duty of Care responsibilities under environmental legislation.

6. Design EP’s are calculated based on development type. Refer to the relevant local government Planning Scheme documents / Infrastructure Charges policies for the equivalent demands for each development type. In the absence of Local Government specific information, refer Appendix C for default equivalent demand values.

D12.07 ALIGNMENT, CLEARANCES, TENURE & EASEMENTS

1. All sewerage works will require written evidence of appropriate tenure rights. In general, all properties associated with the sewerage works shall be required to be identified in any Operational Works application.

2. Written approval shall be obtained from the registered owners of each of the affected property(s) affected by sewer construction works, by the Developer and submitted to the Sewer Service Provider.

3. Sewer Mains shall preferably be located as stated in Table D12.07.01. Where sewer mains are located adjacent to roofwater drainage the alignment shall be 2.00m.

Table D12.07.01 Sewer Main Alignment

<table>
<thead>
<tr>
<th>Preferred sewer location</th>
<th>Within Properties</th>
<th>Within Road Reserve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alignment Front &amp; Rear Boundaries</td>
<td>Alignment from side Boundaries</td>
</tr>
<tr>
<td>Banana Shire</td>
<td>within properties</td>
<td>1.5m</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>within properties</td>
<td>2.0m</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>road reserve</td>
<td>2.0m</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>within properties</td>
<td>2.0m</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>within properties</td>
<td>2.0m</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>within properties</td>
<td>2.0m</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>within properties</td>
<td>2.0m</td>
</tr>
</tbody>
</table>

4. All sewerage infrastructure within private allotments shall be required to be covered by an easement as shown in Table D12.07.02 unless otherwise approved by the Sewerage Service Provider.
Table D12.07.02 Minimum Width of Easements Over Sewer Mains

<table>
<thead>
<tr>
<th>Council</th>
<th>Required Easement Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Minimum 4.0m, with the formula being twice the depth of the sewer line with the sewer line located centrally in the easement</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>4.0m</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>4.0m with the sewer main to be located within a central zone in the easement which is at least 1m from the edge of the easement.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>4.0m with the sewer main to be located in the centre of the easement.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>4.0m</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Minimum 4.0m, with the formula being depth of the sewer line minus 1.0m plus the offset from the property boundary</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>4.0m *</td>
</tr>
</tbody>
</table>

* Easement requirement associated with infill development to be at Council’s discretion.

5. The easement shall be centrally located over the sewer main where possible.

6. Clearance from buildings (any protrusions) to sewer infrastructure are to be in accordance with Queensland Development Code MP1.4. Building over Sewer requirements must comply with the Queensland Development Code and the relevant Council’s Building over Sewer Policy. Large tree species shall not be planted within 1m of a sewer main.

7. Where a pipeline crosses a main road, watercourse or involves features under the control of any Authority/Corporation, the affected work shall be carried out in accordance with the requirements of that Authority/Corporation. It shall be the Superintendent’s responsibility to obtain written approval from the Authority/Corporation to carry out the work as part of the Development approval.

8. Where sewer mains are to be located within and parallel with existing local road reserves, the designer shall check that the sewer mains do not conflict with other utility services and locate the sewer mains to the satisfaction of the Local Government road manager. Refer to CMDG-R-100 for sewer alignment in these instances. There may be a need for additional verge width and hence additional road reserve width where sewer mains are located in road reserves.

9. Where sewer mains are to be located within and parallel with existing dedicated Main Road Reserves, the designer shall locate the sewer mains to the specifications of the Main Roads manager in accordance with public utility plant. Refer to Clause 80 Transport Infrastructure Act.

10. All crossings of roads, watercourses, etc shall be designed to minimise the crossing length. The desirable alignment is perpendicular to the road or watercourse alignment.

11. For local deviations (around a single point eg service pole) only, the minimum horizontal and vertical clearance from parallel services shall be 300mm.

12. The minimum horizontal and vertical clearance to all other crossover underground services shall be 100mm. For local alignment deviations, the minimum horizontal clearance to all parallel underground services shall be 300mm clearance provided the other services have marker tape and mechanical protection as defined by AS3500.
13. All service crossing angles shall be as per Table D12.07.03 following

Table D12.07.03 Service Crossing Angle

<table>
<thead>
<tr>
<th>Water Service Provider</th>
<th>Service Crossing Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Between 45 degrees and 90 degrees.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Between 45 degrees and 90 degrees. If this cannot be achieved then mechanical protection or greater clearances may be required.</td>
</tr>
</tbody>
</table>

12. It shall be the Superintendent's responsibility to identify the existence of utility services including 'Dial Before You Dig' and/or contact with all Utility Service Providers. The location of existing utility services shall be confirmed by the Contractor by ‘Dial Before You Dig’ and/or contact the Utility Service Providers and by pot-holing prior to excavation.

D12.08 ACCESS CHAMBERS

1. Access Chamber locations (on gravity sewer mains) shall be at every change of direction, change of grade, sewer main junctions except where horizontal and vertical curves are permitted in accordance with Table D12.09.04. Where possible, access chambers should be located above Q100 flood level.

2. Circular Access Chamber Internal Diameters shall be in accordance with Table D12.08.01 Rectangular Access Chamber shall have a minimum 600mm dimension opening. For more than 3 connecting lines the Sewerage Service Provider may require a larger access chamber internal diameter than specified in Table D12.08.01.

3. Access Chamber maximum spacing shall be in accordance with Table D12.08.02 for the relevant Local Government.

Table D12.08.01 Access Chamber Minimum Diameter

<table>
<thead>
<tr>
<th>Sewer Size (mm)</th>
<th>Minimum chamber internal diameter (mm) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 – 300</td>
<td>1050</td>
</tr>
<tr>
<td>375 and larger</td>
<td>1500</td>
</tr>
</tbody>
</table>

* for up to 3 connecting lines
Table D12.08.02 Access Chamber Maximum Spacing

<table>
<thead>
<tr>
<th>Council</th>
<th>Sewer Mains 150 – 300 mm diameter Maximum Spacing (m)</th>
<th>Sewer Mains 375mm diameter and larger Maximum Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>90 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>90 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>120 m</td>
<td>120 m</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>90 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>120 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>90 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>90 m</td>
<td>150 m</td>
</tr>
</tbody>
</table>

Table D12.08.03 Approved use of maintenance shafts and Lampholes

<table>
<thead>
<tr>
<th>Council</th>
<th>Maintenance Shafts</th>
<th>Lampholes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Not Approved</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Approved*</td>
<td>Approved</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Not Approved</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Not Approved</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Approved*</td>
<td>Approved</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Not Approved</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Not Approved</td>
<td>Approved</td>
</tr>
</tbody>
</table>

* Subject to item 4 below

4. Where approved by the relevant Sewerage Service Provider in Table D12.08.03, Maintenance Shafts in accordance with AS4999 or AS4798, may be used for sewer mains to minimise the number of closely spaced Access Chambers required for change of direction/slope. Maintenance Shafts are NOT to replace access chambers required at gravity sewer main junctions or maximum spacing (refer Table D12.08.02)

5. Precast access chambers in accordance with AS4198, are preferred over cast in situ access chambers. Refer to CMDG Standard Purchase Specification and standard drawings CMDG-S-020, CMDG-S-021, and CMDG-S-022.

6. All gravity sewer mains shall have an Access Chamber located at the upper reach of the line, except where the last reach is less than 40m, these gravity sewer mains may be constructed with a lamphole access chamber or Maintenance Shaft (where approved by the relevant Sewerage Service Provider). Refer CMDG-S-026.

7. The minimum drop measurement across the Access Chamber base shall be in accordance with standard drawing CMDG-S-005.

8. Access Chamber bases incorporating changes of flow direction greater than 90 degrees are not permitted unless specific approval is given by the relevant Sewerage Service Provider.

9. Drop Inlets to Access Chambers are indicated in standard drawings CMDG-S-021 and CMDG-S-023. The maximum number of internal drop inlet pipes is as per drawing CMDG-S-021.
10. Access Chamber numbering shall be ascending, progressing upstream. Convention is manhole # / line #.

Access Chamber Numbering

11. Step irons shall NOT be provided in Access Chambers.

Step Irongs

12. Tolerances for lateral and vertical deviations from the design position of access chambers shall be in accordance with the tolerances for deviations of pipelines (refer Section D12.13 Laying and Jointing of Pipes). Longitudinal deviations (ie chainage) from that position shall not exceed 300mm.

Tolerances

13. Concrete work for all cast-in-situ access chambers shall comply with the CMDG Construction Guideline C271 MINOR CONCRETE WORKS, in relation to the supply and placement of concrete and steel reinforcement, formwork, tolerances, construction joints, curing and protection.

Concrete Work

14. Cement used in Cast-In-Situ Access Chambers shall be Type SR to AS 3972.

Cement Type

15. Generally, precast access chambers shall be made up with components consisting of a fibreglass base section, concrete shaft sections of section lengths such as to minimise the number of joints required, a concrete cone section (or converter slab for shallow depths), cover and surround. Make-up Rings may be used between cone sections and surrounds to make up height differentials. Use of precast conical access chamber bases (Humes “Supabowl” or approved equivalent) are permitted in accordance with Table D12.08.04.

Pre-Cast Components

<table>
<thead>
<tr>
<th>Council</th>
<th>Precast Conical access chamber bases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Not approved</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Approved</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Not approved</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Approved</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Not approved</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Not Approved</td>
</tr>
</tbody>
</table>

Table D12.08.04 Use of Precast Conical access chamber bases

16. The installation of all precast access chamber components shall be in accordance with the manufacturers’ recommended procedures and requirements.

17. Backfill for all precast access chambers shall be placed and compacted evenly around the access chamber to a level 300mm above the top of the highest incoming pipe and for the full width of the excavation. If necessary, the Contractor shall import and compact non-cohesive granular material. Refer D12.12 Backfill and Compaction.

Back-fill

18. Covers and frames shall be in accordance with AS3996 and Appendix B CMDG Purchase Specification. The Unit Load Classification shall be either Class B within private property and no vehicle loadings or Class D for all vehicle loadings and all outside private property and all Maintenance Shafts.

Covers and Frames Class

19. Covers and Frames fastening (bolt down) are required as per the following Table D12.08.05.

Bolt Down Covers
Table D12.08 Use of Bolt Down Covers

<table>
<thead>
<tr>
<th>Council</th>
<th>Use of Bolt down covers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Not Approved. Access Chambers shall be located to have FSL</td>
</tr>
<tr>
<td></td>
<td>100mm above Q100 where possible.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Required for Access Chambers below Q10 flood level, and</td>
</tr>
<tr>
<td></td>
<td>below Highest Astronomical Tide (HAT) level</td>
</tr>
</tbody>
</table>

20. Access Chamber covers shall be finished in accordance with Table D12.08.06.

Table D12.08.06 Access Chamber Finished Surface Level

<table>
<thead>
<tr>
<th>Location</th>
<th>Access Chamber Finished Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads, Footpaths</td>
<td>Flush with surface</td>
</tr>
<tr>
<td>Private Property</td>
<td>75mm above finished earthworks level</td>
</tr>
<tr>
<td>Floodways</td>
<td>As directed by Local Government</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>Covers shall be finished minimum 50mm to a maximum 100mm above the surface of the ground, in</td>
</tr>
<tr>
<td></td>
<td>a manner designed to avoid as far as possible, the entry of surface water</td>
</tr>
</tbody>
</table>

D12.09 SEWER MAINS

1. All gravity and rising sewer mains shall be in accordance with Table D12.09.01.

Table D12.09.01 Sewer Main Material Type

<table>
<thead>
<tr>
<th>Council</th>
<th>Gravity Mains – 150mm and 225mm</th>
<th>Gravity Mains 300mm and greater</th>
<th>Rising Mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>PVC RRJ in 3m lengths</td>
<td>To be determined by Sewerage Service Provider</td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>PVC RRJ in 3m lengths</td>
<td>Ductile Iron PN35 (Tyton Extreme or equiv)</td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>PVC RRJ in 3m lengths</td>
<td></td>
<td>PE 100</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>PVC RRJ in 3m lengths</td>
<td>To be determined by Sewerage Service Provider</td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>PVC RRJ in 3m lengths</td>
<td></td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>PVC RRJ in 3m lengths</td>
<td>To be determined by Sewerage Service Provider</td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>PVC RRJ in 3m lengths</td>
<td></td>
<td>PVC Class PN 16 or DI PN35</td>
</tr>
</tbody>
</table>
2. All PVC* gravity sewer mains shall be minimum Class SN8 with heavier classes applicable for deeper sewer mains in accordance with the manufacturers requirements. All PVC* sewer rising mains shall be in accordance with CMDG Standard Purchase Specifications. All ductile pipe shall be PN35 or greater. All Ductile Pipe and fittings shall be sleeved with polyethylene sleeving.

3. The minimum grade of gravity sewer mains shall be in accordance with Table D12.09.02.

<table>
<thead>
<tr>
<th>Sewer Size (mm)</th>
<th>Minimum Grade</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>1:150</td>
<td>0.65</td>
</tr>
<tr>
<td>225</td>
<td>1:290</td>
<td>0.34</td>
</tr>
<tr>
<td>300</td>
<td>1:420</td>
<td>0.23</td>
</tr>
<tr>
<td>375</td>
<td>1:570</td>
<td>0.17</td>
</tr>
<tr>
<td>450</td>
<td>1:730</td>
<td>0.13</td>
</tr>
<tr>
<td>525</td>
<td>1:900</td>
<td>0.11</td>
</tr>
<tr>
<td>600</td>
<td>1:1000</td>
<td>0.10</td>
</tr>
<tr>
<td>675</td>
<td>1:1200</td>
<td>0.08</td>
</tr>
<tr>
<td>750</td>
<td>1:1500</td>
<td>0.06</td>
</tr>
</tbody>
</table>

* Unless otherwise approved by the Sewerage Service Provider (in writing), the minimum grade of gravity sewers (larger than 225mm diameter) must ensure that a slime stripping velocity is achieved.

4. Unless otherwise specified on the drawings, the minimum depth of cover to be provided for gravity sewer mains and sewer rising mains shall be as listed in Table D12.09.03 (all depths from finished surface). Cover under roads to be measured from the adjacent kerb or edge of gravel or edge of pavement.

<table>
<thead>
<tr>
<th>LOCATION OF PIPE</th>
<th>GRAVITATION MAINS &amp; RISING MAINS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-Rigid (inc. PVC*) DI</td>
</tr>
<tr>
<td>1. Areas not subject to vehicular loading:</td>
<td>600mm 300mm</td>
</tr>
<tr>
<td>2. Areas subject to vehicular loading:</td>
<td></td>
</tr>
<tr>
<td>a) not in roadway</td>
<td>600mm 450mm</td>
</tr>
<tr>
<td>b) in sealed roadway</td>
<td>900mm 600mm</td>
</tr>
<tr>
<td>c) in unsealed roadway</td>
<td>900mm 750mm</td>
</tr>
</tbody>
</table>

5. Pipeline installation in general is to be in accordance with AS2032, AS2033, AS2566.2 and AS3500 unless noted otherwise. Refer also to standard drawing CMDG-S-090.

6. Where pipelines are connected to large structures (e.g. sewage pump stations or 1500mm diameter Access Chambers) or where excessive differential movement might occur, then connection by means of 600mm long pipes and two flexible joints is required. The first joint being at or within 150mm of the face of the structure. Where flexible joints cannot be made with cut pipes, the Contractor shall select pipes from the various lengths provided in order to make the second joint within 300mm of the position shown on the drawings. Foam cores shall be provided for future connections.
7. The horizontal and vertical clearance to all other crossover underground services shall be 300mm desirable minimum and 100mm absolute minimum. The minimum horizontal and vertical clearances to all parallel underground services shall be 300mm desirable minimum and 100mm absolute minimum clearance provided the other services have marker tape and mechanical protection as defined by AS3500.

8. Where permitted in accordance with Table D12.09.04, long radius sweep bends are permitted for horizontal and vertical change of alignment of sewers subject to the following requirements:
   i. Maximum change of direction at each bend of 45 degrees;
   ii. Maximum of 2 bends between access chambers; and
   iii. Maximum access chamber spacings still apply.

Table D12.09.04 Use of Horizontal and Vertical sewer bends

<table>
<thead>
<tr>
<th>Council</th>
<th>Horizontal Sewer Bends</th>
<th>Vertical Sewer Bends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Not approved</td>
<td>Not approved</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Not approved</td>
<td>Not approved</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Approved</td>
<td>Not approved</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Not Approved</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Approved</td>
<td>Approved</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Not approved</td>
<td>Not approved</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Not approved</td>
<td>Not approved</td>
</tr>
</tbody>
</table>

9. Sewer mains laid on grades greater than 1 in 6 shall be provided with concrete anchor blocks. Refer Standard Drawing CMDG-S-090. An anchor block is required behind each socket. The nominal size of the anchor block is to be shown on the drawings.

10. Use of inverted syphons is NOT permitted.

11. The depth of a reticulation sewer main is recommended to be a desirable maximum of 3.5m to invert of pipe.

12. The rising main shall be sized to allow free movement of the largest sphere diameter that can pass through the pump impeller. An acceptable solution for minimum rising main internal diameter shall be 100mm.

13. Scour valves shall be installed at significant low points in the sewer rising main in accordance with the relevant standard drawing. Air valves shall be installed at critical high points in the sewer rising main. Grading of the sewer rising main shall be carried out to minimise the number of air valves and scour valves. Refer to standard drawings CMDG-S-072, CMDG-S-073, CMDG-S-074.

14. Diameter of the sewer rising main to be selected to achieve:
   - Self-cleansing velocity of the main (the recommended minimum velocity for smaller pressure mains (<300mm) is 0.7m/s;
   - The maximum velocity during WWF is some 2.0 m/sec.; and
   - Upper-limit of friction head. (typically a maximum pump head of 35m is regarded as acceptable.)
15. Discharge access chambers shall be in accordance with Table D12.09.05. The level of the sewer rising main inlet into the Discharge Access Chamber shall be at the same level as the outlet pipe to avoid turbulence. Discharge Access Chambers shall be installed with an air vent unless otherwise approved by the Sewerage Service Provider. Refer to standard drawings CMDG-S-070A.

**Table D12.09.05 Discharge Access Chambers**

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Discharge Access Chamber Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Fabricated polyethylene type or approved equivalent with integral benching, bottom, top, access neck and pipe stubs; OR Concrete epoxy coated (Parchem or equivalent products)</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Concrete epoxy coated – Parchem or equivalent products</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Fabricated polyethylene type or approved equivalent with integral benching, bottom, top, access neck and pipe stubs; OR Concrete epoxy coated (Parchem or equivalent products)</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Fabricated polyethylene type or approved equivalent with integral benching, bottom, top, access neck and pipe stubs. Concrete epoxy coated (Parchem or equivalent products) may be used for refurbishing existing concrete access chambers only.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Fabricated polyethylene type or approved equivalent with integral benching, bottom, top, access neck and pipe stubs; OR Concrete epoxy coated (Parchem or equivalent products)</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>

**D12.10 VENTING**

1. Vents shall be installed, as required by the Sewerage Service Provider. Refer to standard drawing CMDG-S-070A. Proprietary odour unit vents may be considered by the Sewerage Service Provider.

2. A vent may be required to manage excessive odour discharge to atmosphere. Typically this is most likely required at the bottom of a long steep line where a hydraulic jump may occur in the flatter pipe section.

**D12.11 TRENCHES & EXCAVATIONS**

1. Trench width, depth, foundations, and stability are to be recorded as Notes on the Operational Works Drawings.

2. Stabilised and compacted trench foundation is required in soft (typically less than 50kPa bearing capacity) or unstable or over-excavated ground conditions.

3. The Contractor shall leave a clear space of 600mm minimum between the edge of any excavation and the inner toe of spoil banks. No excavated materials shall be stacked against the walls of any structure or fence without the written permission of the owner of such structure or fence. Topsoil from excavations shall be kept separate and utilised to make good the surface after backfilling.

4. In the event of any trenching being left open for longer than one week, the Contractor shall provide erosion control measures to ensure minimal soil disturbance and material loss off the site. Some or all of these measures shall be provided immediately upon the onset of rain with an open trench.
5. Control measures shall include:
   
   (a) Provision of trench stops every 30 metres along a trench with provision for overtopping to be directed to the kerb.
   
   (b) Placement of blue metal bags along kerb and gutter at maximum 30 metre spacings.
   
   (c) Placement of blue metal bags around downstream drainage pits.
   
   (d) Construction of diversion banks to divert the uphill catchment water from entering the trench.
   
6. The minimum clear width of trench (inside internal faces of timbering or sheet piling, if used) to a height of 150mm above the top of the pipe shall be 100mm each side the pipe, as shown in AS2566 or as specified by the Approved Operational Works drawings.

7. The maximum width of trench from the base of the trench to 150mm above the top of the pipe shall be the outside diameter of the pipe plus 600mm unless detailed otherwise on the Approved Operational Works drawings.

8. In waterlogged ground, de-watering shall be undertaken to reduce the water level below pipe level until sufficient backfill is placed to prevent pipe flotation.

9. For sites where ground level settlement is expected, a specialised design is required.

10. Where a trench is excavated across a paved surface, the width of the trench shall be kept to a minimum. Bitumen and concrete surfaces shall be carefully cut by saw cutting, or other approved means, so as to provide a neat straight line free from broken ragged edges.

11. For mains to be laid on rock foundation, excavation shall be carried out to a depth of not less than 100mm below the underside of the pipe barrel and socket or coupling.

12. For mains laid on other than rock, excavation shall be carried out to a depth of not less than 75mm below the underside of the pipe barrel and socket or coupling.

13. The Contractor shall adequately support all excavations as the works proceed. When withdrawing supports, the Contractor shall exercise every precaution against slips or falls by means of intermediate shoring, planking or props. Backfilling shall be performed simultaneously with the withdrawal of supports.

14. The safety of the general public shall be considered in the preparation of the site safety plan for the works. In urban areas, at completion of work each day, all trenches are to be backfilled. Where this requirement is unavoidable, safety fencing shall be installed along edges of open excavations to isolate them from the public. Where necessary, fenced walkways and vehicular crossways shall be provided across trenches to maintain access from carriageway to individual properties or within individual properties. All such installations shall be of adequate size and strength and satisfactorily illuminated.

D12.13 LAYING AND JOINTING OF PIPES

1. Before being laid, all pipes, fittings, valves, etc shall be cleaned and examined by the Contractor.

2. The Contractor shall provide and use approved drag scrapers or "detectors" to ensure that the interior of the pipeline is clean and free from obstructions. Approved plugs shall be used to prevent foreign matter entering sections of pipeline which are left uncompleted overnight.
3. Laying of pipelines shall commence at the lower end of the line and sockets shall face uphill.

4. The Contractor shall take all necessary precautions to prevent flotation of pipes during laying, backfilling and initial testing. Any temporary supports shall be removed prior to completion of backfilling.

5. Joints in pipelines shall be flexible rubber ring joints (either roll-on rubber ring or skid type) or mechanical joints (either fixed flange, gibault or bolted gland type). The joint type shall be as shown on the Drawings.

6. For pipes with rubber ring joints, spigots and sockets shall be clean and dry. When the joint is made, the witness mark shall at no point be more than 1mm from the end of the socket. After making the joint, a feeler gauge shall be used to check that the rubber ring has rolled in evenly, and if not, the pipe shall be withdrawn and the joint remade.

7. Only the lubricant specified by the pipe manufacturer and or fitting manufacturer shall be applied.

8. Pipes may be cut as needed to suit closing lengths, to remove damaged pipe or fittings or to remove sockets if necessary when jointing a socketed fitting.

9. For field cuts, only an approved mechanical pipe cutter shall be used. All field cuts shall achieve a 'square cut' finish.

10. Any pipes cut in the field shall have their ends prepared in accordance with the manufacturer's written instructions.

11. Where pipes are cut in the field, a witness mark shall be made on the pipe at the length specified by the manufacturer from the end of the pipe. Scoring of uPVC pipes shall not be permitted. Where spigots and sockets are not made by the same manufacturer, reference shall be made to the socket manufacturer for the correct marking depth.

12. Where PVC* pipes are to be joined to pipes of another material, the joints shall be made as follows:

(a) For jointing PVC* spigot to VC socket or PVC* socket to VC spigot, an approved PVC* adaptor shall be used. The joints in both instances shall be made using a ring conforming to AS1646.

(b) For jointing PVC* socket to ductile iron spigot, an approved adaptor coupling shall be used.

13. Gravity pipelines shall be constructed to the tolerances specified hereafter:

   (a) The maximum horizontal deviations to either side from the design axis of a pipeline shall be 50mm for all sizes of pipes.

   (b) For vertical deviations from the design grade of pipelines of any diameter and grade, the following alternative methods A and B apply. Refer to Table D12.13.01 for which alternatives apply to each local government:

Table D12.13.01 Vertical Construction Tolerances

<table>
<thead>
<tr>
<th>Council</th>
<th>Vertical Construction Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Alternative A</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Alternative B</td>
</tr>
</tbody>
</table>
Alternative A

(i) Any one pipe in a length between two access chambers or a dead-end and an access chamber, shall be placed so as to have a fall from the higher to the lower access chamber or a fall from the dead-end to the access chamber.

(ii) No affected section shall be more than 6m long, only if it complies with the above restrictions and that there is an overall fall in the section of pipe.

(iii) The invert level shall not deviate from the design grade line by more than 10mm, and only if it complies with the above restrictions and that there is an overall fall in the section of pipe.

Alternative B

The invert level shall not deviate from the design grade line by more than 5mm as long as it achieves the minimum grade.

14. Flexibly jointed pipelines for rising mains with gradual changes in alignment or grade shall be laid with the joint being deflected after it has been made. Table D12.13.02 shows the allowable pipe deflection for each Sewerage Service Provider. The manufacturer’s written recommendations in respect of maximum deflection for each joint shall be complied with provided that no joint shall be deflected to such an extent as to impair its effectiveness.

### Table D12.13.02 Pipe Deflections

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Allowable pipe deflection for rising mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>75% of manufacturers recommendations</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>100% of manufacturers recommendations</td>
</tr>
</tbody>
</table>

15. Deflection within a pipe length is not permitted.

16. In all locations other than urban road reserves with a constructed road, marker posts at changes of direction and at such chainages that the location of the main is marked at least once each 250 metres, shall be provided as shown on Standard Drawing CMDG-S-28.

**D12.12 BACKFILL AND COMPACTION**

1. Compacted (95 per cent of the standard maximum dry density of the bedding material in accordance with AS1289.5.7.1) underlay bedding sand for pipes and fittings shall be a minimum depth of 100mm.

2. Flooding of non-cohesive material shall be considered as an acceptable method of compacting bedding underlay material.
3. Compacted (95 per cent of the standard maximum dry density of the bedding material in accordance with AS1289.5.7.1) overlay bedding sand for pipes and fittings shall be a minimum depth of 150mm.

4. Material for the side support and bedding overlay of the pipe shall comply with the pipe bedding material. The material shall be compacted in layers of not more than 150mm to 95 per cent of the standard maximum dry density of the bedding material used when determined in accordance with AS1289.5.7.1.

5. Other than under roads, the remainder of the excavation shall be backfilled with excavated material. The backfill shall be compacted as specified in the drawings and specification. Flooding of cohesive material shall NOT be permitted as a means of compacting backfill under roads.

6. Under roads, backfill shall comprise of approved roadbase material, sand or stabilised sand. Refer CMDG-W-040 for trench backfill details.

7. Backfilling and compaction shall be carried out without damaging the pipe or its external coating or wrapping or producing any movement or deflection of the pipe.

D12.14 PROPERTY CONNECTION BRANCH & POINT OF CONNECTION

1. Property Connection Junctions, Property Connection Branch and Point of Connections shall be installed in accordance with Standard Drawing CMDG-S-030. Show the connection chainage on the design drawings.

2. Each Property Connection Junction chainage is to be measured from the centre of the downstream Access Chamber.

3. The invert level of the non-trunk sewer main at the Property Connection Junction chainage shall be sufficient to service any ground level on the allotment, and shall consider the probability of any adverse cut & fill ground level changes, at building stage. An acceptable solution is the calculation of the most adverse distance and fall combination using a 1:40 grade, less 0.5m for cover and special fittings.

4. Property Connection Junctions located at the depth of greater than 2.0m from finished surface level shall have a WSAA approved heavy duty reinforced fibreglass junction.

5. Property Connection Junction preferred location in a non-trunk sewer main shall be in accordance with Table D12.14.01.
### Table D12.14.01 Property Connection Junction preferred location

<table>
<thead>
<tr>
<th>Council</th>
<th>Acceptable Solution for Property Connection Junction Location into non-trunk sewer main.</th>
<th>Property Connection Junction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Access Chamber where possible</td>
<td></td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Access Chamber where possible, can connect into a Lamphole</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Non trunk sewer main</td>
<td></td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>(a) Non-trunk Sewer Main; and (b) Not direct into any trunk sewer main.</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>(a) Non-trunk Sewer Main; or (b) Lamphole and Access Chamber; (c) Not direct into any trunk sewer main.</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Access Chamber where possible</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>(a) Non-trunk Sewer Main; or (b) Lamphole and Access Chamber; (c) Not direct into any trunk sewer main.</td>
<td></td>
</tr>
</tbody>
</table>

6. Property Connection Junction direct into a trunk sewer main may only be used with the site specific approval of the Sewerage Service Provider.

7. Property Connection Junctions are ‘Not At Grade Junctions’ as defined by AS3500. This means that the Connection Branch invert level is at the non-trunk sewer main obvert level or higher. Junction ‘at grade’ may only be used with the site specific approval of the Sewerage Service Provider.

8. Backfill around risers shall be sand compacted to the top of the socket or coupling on the highest branch off the riser, for the full width of trench and for a minimum distance of 500mm upstream and downstream of the riser.

9. Where a non-trunk sewer main lies within an adjoining allotment, the Property Connection Branch is to extend a distance of 1.5m into the allotment from the property boundary, to be serviced with a Property Point of Connection. For battle-axe allotments with the Property Point of Connection may be located within the access, then pre-laying of private sanitary drainage shall extend along the access to a point 1.5m within the main part of the allotment.

10. Property Connection Branch size shall be a minimum 100mm diameter for residential and 150mm diameter for commercial / industrial unless approved by the Sewerage Service Provider.

11. Property Point of Connection should generally be located at the lowest corner of the allotment 1.5m upstream of the allotment boundary (where provided direct to a non-trunk sewer main) or to an access chamber. The Property Point of Connection shall not be located closer than 1.0m to a roofwater line.

12. The desirable maximum Property Connection Branch length must extend to 1.5m within the property (measured perpendicular to the property boundary) it is servicing.

13. Property Point of Connection invert level is to be sloped higher than the Property Connection Junction invert level and shall be sufficient to service any ground level on the allotment, and should consider the probability of any adverse cut & fill ground level changes, at building stage. An acceptable solution is the calculation of the most adverse distance and fall combination using a 1:40 grade, less 0.5m for cover and special fittings.

14. Property Point of Connection shall be a finished with a cap on the Property Connection Branch at Operational Works construction stage. This will allow some level
options for the plumbing stage connection of sanitary drainage. At plumbing stage an
Inspection Opening shall be fitted by the plumber at the Point of Connection.

<table>
<thead>
<tr>
<th>Table D12.14.02</th>
<th>Method of marking property connection location (pre site development detail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Type 1: Star picket driven into the ground adjacent to the riser and finished 500mm above the surface of the surrounding ground and finished with a PVC safety cap. The star picket shall be connected to an underground identification tape.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Type 1: Star picket driven into the ground adjacent to the riser and finished 500mm above the surface of the surrounding ground and finished with a PVC safety cap. The star picket shall be connected to an underground identification tape.</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Type 1: Contractor to loop yellow marking tape around end of house connection branch during backfilling. 25mm diameter grey conduit (2m long) to be installed on top of the cap.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Type 1: Star picket driven into the ground adjacent to the riser and finished 500mm above the surface of the surrounding ground and finished with a PVC safety cap. The star picket shall be connected to an underground identification tape.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Type 1: Star picket driven into the ground adjacent to the riser and finished 500mm above the surface of the surrounding ground and finished with a PVC safety cap. The star picket shall be connected to an underground identification tape.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Type 2: Property Service PVC capped riser is extended 1m above finished ground surface.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Type 1: Star picket driven into the ground adjacent to the riser and finished 500mm above the surface of the surrounding ground and finished with a PVC safety cap. The star picket shall be connected to an underground identification tape.</td>
</tr>
</tbody>
</table>

15. The position of each Property Service Point of Connection shall be clearly marked by the Contractor on completion of backfilling, the marking shall be as per Table D12.14.2 and standard drawing CMDG-S-030.  

16. The identification tape shall be tied to the riser and held in a vertical position during backfilling. The top end of the tape shall be spiked by the identification star picket immediately upon completion of backfilling.  

17. Water seals (boundary traps) are to be provided to property connections for odour control only if required by the Sewerage Service Provider.  

18. Crossover sanitary drains (at an angle of greater than 45° to the easement axis) are permitted within an easement.

D12.15 ANCHOR BLOCKS

1. Concrete anchor blocks shall be installed where the main is installed at a grade of 1 in 6 or steeper. Concrete anchor blocks shall be provided on the pipe barrel behind the socket at each pipe joint and in accordance with CMDG Standard Drawing CMDG-W-040.  

2. The Contractor shall provide thrust blocks to bear against undisturbed material normal to the direction of thrust resulting from internal pressures over a bearing area not less than that shown on Standard Drawing CMDG-W-041.  

3. Concrete works shall comply with the CMDG Construction Guideline C271 - MINOR CONCRETE WORKS  

4. The Contractor shall provide temporary anchorages adequate to restrain the pipe when under test.
D12.16  RESTORATION OF SURFACES

1. Pavements, lawns and other improved areas shall be cleaned and left in the same order as they were at the commencement of the works. Lawns shall be restored with turf cut and set aside from the original surface and/or with commercially available turf.

2. All restored surfaces shall be maintained in the condition to which they are restored until the expiry of the Defects Liability Period applicable to those surfaces, notwithstanding that any deterioration of the restored surfaces, and the need for their maintenance may or may not be due to defects which become apparent or arise from events which occur during the Defects Liability Period. Pavements shall be maintained with crushed metal, gravel or other suitable material allowing for consolidation and shall then be restored to a condition equivalent to that of the original pavement.

3. Immediately the backfilling of a trench excavated through a pavement has been completed, the pavement shall be temporarily restored. Where the trench crosses bitumen or concrete pavement, a pre-mixed asphaltic material shall be used for such temporary restoration. Temporary restoration shall be maintained by the Contractor until final restoration is carried out. Final restoration of the pavement shall be carried out to restore the pavement and its sub-base to no less than the original condition. Final restoration may include, if required, the removal of temporary restoration.

4. Backfill shall be placed sufficiently high to compensate for expected settlement and further backfilling shall be carried out or the original backfill trimmed at the end of the Defects Liability Period in order that the surface of the completed trench may then conform to the adjacent surface. Surplus material shall be removed and disposed of to areas arranged by the Contractor.

5. Where, within public or private property, the reasonable convenience of persons will require such, trenches to be levelled off at the time of backfilling. Any subsequent settlement shall be made good by the Contractor, as required by placing additional fill.

6. In locations where surplus material left in the vicinity of the trench would not be objectionable, the surplus material may be disposed by spreading neatly in the vicinity of the trench in such a way as to minimise future erosion of the backfill and adjacent ground surfaces. The Contractor shall maintain the backfill and adjacent ground until the expiry of the Defects Liability Period.

7. Where approved by the relevant authority underboring under paving, kerb and gutter or other improved surfaces in lieu of trenching, backfilling shall be so carried out as to restore full support to those surfaces. The Contractor shall remain responsible for the repair of the improved surfaces, if subsequently damaged due to subsidence of the backfill, until the end of the Defects Liability Period.
D12.17  INSPECTION

1. All pipes, fittings, access chambers and components are to be inspected by an authorised inspector or authorised CCTV method, as specified by the Sewerage Service Provider.

**Table D12.17.01**  Inspection requirements for completed sewer

<table>
<thead>
<tr>
<th>Municipal Region</th>
<th>Method of inspection for completed sewer mains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Visual inspection</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>CCTV</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>CCTV</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Visual inspection / CCTV if required by Council</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Visual inspection / CCTV if required by Council</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Visual inspection</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Visual inspection / CCTV if required by Council</td>
</tr>
</tbody>
</table>

2. Inspections are to be in compliance with Operational Works Permit conditions or CMDG Works Inspections.

3. Inspection schedule, inspector contact, notifications, fees, and workplace safety procedures are to be recorded at the pre-start safety meeting for the works.

4. For CCTV, flushing of the system must be completed and the CCTV procedure must be completed when all other tests have been completed. A DVD of the CCTV footage is to be submitted to the Sewerage Service Provider as part of the certification of the pipe system.

5. CCTV Inspections are to be conducted in accordance with WSA-05, including inclination reports.

D12.18  TESTING GENERAL

1. All Sewer Mains and Access Chambers shall be subject to testing as soon as practicable after construction, backfilling, concrete curing, and cleaning.

2. Sewer Mains or Access Chambers failing any test shall be repaired and the test repeated. The process of testing, repair of defects and retesting shall continue until a satisfactory test is obtained. If an asset fails twice, the repair / replacement methodology is to be submitted to the Sewerage Service Provider for approval before the works are undertaken.

3. All lines shall be clear and free from soil, slurry, liquids and other foreign substances at the time of initial and acceptance testing.

4. The Contractor shall provide temporary thrust equipment resulting from internal test pressures at temporary caps.
D12.19 TESTING OF GRAVITY SEWER MAINS

1. All gravity sewer mains shall be tested with approved procedures for each Sewerage Service Provider and whether testing is to be carried out by a NATA accredited body are highlighted in Table D.12.19.01. Vacuum testing is only accepted for gravity sewer mains as per the following Table D12.19.01.

Table D12.19.01 Testing Requirements for Gravity Sewer

<table>
<thead>
<tr>
<th>Council</th>
<th>Low Pressure Air Testing of gravity Sewer Mains</th>
<th>Hydrostatic Testing of Gravity Sewer Mains</th>
<th>NATA Accreditation</th>
<th>Vacuum testing for Gravity sewer mains as per AS2566</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Approved</td>
<td>Approved</td>
<td>No</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Approved</td>
<td>Approved</td>
<td>No</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Approved</td>
<td>Not Approved</td>
<td>Yes</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Approved</td>
<td>Approved</td>
<td>No</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Approved</td>
<td>Approved</td>
<td>Yes*</td>
<td>Approved</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Approved</td>
<td>Approved</td>
<td>No</td>
<td>Not Approved</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Approved</td>
<td>Approved</td>
<td>No</td>
<td>Not Approved</td>
</tr>
</tbody>
</table>

* provided the entire contributing network is tested.

2. The low pressure air testing procedure shall be as follows:

2.1. Each section of the sewer main to be air tested shall be plugged at each end, one plug containing an air hose (and isolating valve) connection. Care shall be taken to ensure that the force, due to pressure on the plug, is not taken by the pipe joint, but is taken by struts bearing on the plug.

2.2. An air hose from a compressor shall be connected, and the pressure raised as quickly as possible to 30 kPa.

2.3. The 30 kPa air pressure shall be held constant for a minimum of three (3) minutes, to stabilise temperatures. Before closing the isolating valve, the pressure shall be sufficiently raised above the 30 kPa pressure, so that when the isolating valve is fully closed, the test pressure in the sewer main is maintained at or just above this 30 kPa pressure.

2.4. When the isolating valve on the air supply is closed, then the elapsed time shall be measured for the sewer main test pressure to drop by 5kPa from the starting pressure.

2.5. If the elapsed time for the test pressure to drop by 5kPa, is less than 3 minutes, then test shall be deemed to have failed.

2.6. Repairs and retesting shall be carried out until the low pressure air test is passed.

3. The hydrostatic testing procedure shall be as follows:

3.1. Hydrostatic testing shall be in accordance with AS3500.2:2003 Section 13.2 except that the sewer main shall be subject to 3m minimum and 5m maximum head.
4. The test gauge shall be minimum 150mm face diameter, and shall be certified to be correct by an approved testing authority. **Test Gauge**

5. Tests on sewer mains shall be carried out with the Property Connections constructed so that the Property Connection Branches are tested at the same time as the sewer main, with all Inspection Openings sealed, and lines capped. **Property Connections**

### D12.20 TESTING OF ACCESS CHAMBERS

1. Each Access Chamber shall be tested. The test should be undertaken soon as practicable after the Access Chamber is constructed and the Access Chamber cover surround fitted. Table D12.20.01 outlines the normal methods of testing accepted by Sewerage Service Providers. Low pressure air test or vacuum testing in accordance with AS2566 may be agreed with the Sewerage Service Provider as an alternative.

#### Table D12.20.01 Testing of Access Chambers

<table>
<thead>
<tr>
<th>Council</th>
<th>Method of testing of Access Chambers</th>
<th>NATA Accreditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Hydrostatic testing in accordance with the procedure outlined below.</td>
<td>No</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Vacuum Testing in accordance with AS2566.</td>
<td>Yes</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Vacuum Testing in accordance with AS2566 OR Hydrostatic testing in accordance with the procedure outlined below.</td>
<td>No</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Hydrostatic testing in accordance with the procedure outlined below.</td>
<td>No</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hydrostatic Test**

2. The hydrostatic test shall be made by plugging all pipe openings in the walls and then by filling the Access Chamber with water to the lowest point on the top of the Access Chamber cover surround. The plugs shall be positioned in the pipes as near as practicable to the internal face of the Access Chamber. **Method**

3. The Access Chamber will be filled with water and then left for 24 hours allowing an adequate period for absorption. **Absorption**

4. The Access Chamber shall be refilled and the loss of water during the following 3 hours will be measured. The hydrostatic test on the Access Chamber will be considered satisfactory provided the level does not drop more than 30mm in the 3 hours. **Duration**

5. The plug of the outlet shall be fitted with a suitable isolating valve for emptying the Access Chamber on satisfactory completion of the test. **Emptying**

6. Repairs and retesting shall be carried out until the hydrostatic test is passed. **Retest**

### D12.21 TESTING OF SEWER RISING MAINS

1. Sewer Rising Mains shall be water pressure tested to detect excessive leakage and defects in the pipeline, including joints, thrust blocks and anchor blocks. Compressed air or vacuum testing is not accepted for pressure sewer mains. **Water Pressure Test**
2. Pipelines shall be tested in sections as soon as practicable after each section has been laid, jointed, backfilled and cleaned, provided that the pressure testing shall not be commenced earlier than seven days after the last concrete thrust or anchor block in the section has been cast.

3. For the purpose of this sub-clause, a section shall be defined as a length of pipeline which can be effectively isolated for testing, eg by means of isolating valves or caps.

4. Water pressure testing shall not be carried out during wet weather unless otherwise approved by the Sewerage Service Provider.

5. During the water pressure testing of a pipeline, each isolating valve shall sustain at least once, the full test pressure on one side of the valve in closed position with no pressure on the other side for at least 15 minutes.

6. The water pressure test procedures which apply to Sewerage Service Providers shall be as follows:

```
Table D12.21.01 Water Pressure Testing of Rising Mains

<table>
<thead>
<tr>
<th>Area</th>
<th>Method of testing of Rising mains</th>
<th>NATA Accreditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>Water Pressure Testing in accordance with the procedure outlined in item 7 below.</td>
<td>No</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>Water Pressure Testing as per WSA-07 (Poly) and WSA-04 (Other materials).</td>
<td>Yes</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>Water Pressure Testing in accordance with the procedure outlined in item 7 below.</td>
<td>No</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>Water Pressure Testing as per WSA-07 (Poly) and WSA-04 (Other materials).</td>
<td>No</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>Water Pressure Testing as per WSA-07 (Poly) and WSA-04 (Other materials).</td>
<td>Yes</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>Water Pressure Testing in accordance with the procedure outlined in item 7 below.</td>
<td>No</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>Water Pressure Testing in accordance with the procedure outlined in item 7 below.</td>
<td>No</td>
</tr>
</tbody>
</table>
```

7. Water Pressure Testing Procedure

7.1 The pipeline section shall be filled slowly with water, taking care that all air is expelled. Purging of air from rising mains shall be promoted by opening air valves.

7.2 In order to achieve conditions as stable as possible for testing by allowing for absorption, movement of the pipeline and escape of entrapped air, the section shall be kept full of water for a period of not less than 24 hours prior to the commencement of the water pressure testing.

7.3 The maximum water test pressure which shall be applied to the lowest part of each section of the pipeline shall be 1250kPa.

7.4 The water test pressure shall be maintained as long as required, while the whole section is examined, and in any case not less than 15 minutes.

7.5 The pressure testing of a section shall be considered to be satisfactory if:

(a) there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component; and

(b) there is no visible leakage; and

(c) there is no loss of pressure in the 15 minute test period.
8. Any failure, defect, and/or visible leakage, which is detected during the pressure testing of the pipeline shall be repaired and retested.

9. Testing of Poly welds is to be in accordance with WSA-07 Clause 18.3

D12.22 CLEANING OF SEWERS

1. Before the sewers, manholes and property connections are accepted they shall be cleaned to remove all clay, sand and other materials.

2. All water plus materials used in the flushing of the reticulation system shall under no circumstances be discharged into existing sewers downstream of construction. All lines shall be inspected after flushing and will not be accepted until they present a clear barrel, free from any obstruction.

D12.23 DEFECTS / MAINTENANCE PERIOD

1. The satisfactory performance, repair and maintenance of all assets, infrastructure and its components, constructed, installed and/or purchased by the developer is the responsibility of the developer during the Defects Liability (Maintenance) Period. The relevant Council is responsible to approve the necessary rectification works, the cost of defect rectification works are the sole responsibility of the developer.

D12.24 CONNECTIONS TO EXISTING SEWERAGE NETWORK

1. The connection of all new sewer mains, access chambers or Property Connections to the existing sewerage network shall be made by the Sewerage Service Provider staff at the developers cost, unless otherwise approved by the Sewerage Service Provider.

PUMPING STATIONS

D12.25 PUMPING STATIONS GENERAL

1. Pump stations shall be designed in accordance with the following criteria and relevant Standard Drawings CMDG-S-061, CMDG-S-062, CMDG-S-063, CMDG-S-064

2. The following criteria are intended to further clarify and compliment Sewage Pumping Station Code of Australia WSA 04-2001. The Sewerage Service Provider should be consulted prior to design to determine specific requirements for pumps, electrical, switchboard, site security and telemetry. Arrangements for supply of electrical switchboard

3. Generally the Sewerage Service Provider will supply and install electrical and telemetry equipment for the Sewage Pump station at the developers cost. The Sewerage Service Provider should be consulted regarding their preferences and a quotation sought to provide these services if necessary.

D12.26 LOCATION

1. Pump station shall be located as far as possible away from existing or proposed habitable dwellings. Table D12.26.01 shows the minimum setbacks applicable.
Table D12.26.01 Minimum setback for Sewage Pump Stations

<table>
<thead>
<tr>
<th>Council</th>
<th>Minimum setback for Sewage Pump Stations from habitable dwellings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>30m</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>50m – measured from edge of wet well to property boundary</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>30m</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>

2. Pump stations shall be located on freehold land to be transferred to the Sewerage Service Provider.

3. Driveway for the pump station shall be in the form of a sealed industrial access (concrete, asphalt, etc) and shall have a minimum sealed width of 3.0m.

4. A turnaround area shall be provided for Sewerage Service Provider’s service vehicle with a minimum concrete hard stand area 4.0m x 3.0m adjacent to the pump well access lids.

5. The top slab of the pump well shall be 150mm min above the finished ground level and the surrounding ground shall be shaped to fall away from the pump station.

6. A 1.8m high chainmesh security fence shall be provided around the boundary, if directed by the Sewerage Service Provider.

7. The top slab, switchboard and electrical pits must be located above Q100 flood level or storm surge level.

8. Typical area of land required for the sewage pump station (excluding any access laneway) would be 20m x 20m for a dual well site. Smaller sites may be approved.

9. The general arrangements for a sewage pump station are as follows in Table D12.21.02.

Table D12.26.02 Sewage Pump Station General Arrangements

<table>
<thead>
<tr>
<th>Council</th>
<th>Standard drawings showing Sewage Pump Station General Arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>CMDG-S-58, and CMDG-S-61-64</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>GRC-STD-S-501</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>CMDG-S-58, and CMDG-S-61-64</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>
D12.27 DESIGN CRITERIA – PUMPS AND WET WELLS

1. The design pumping capacity and pump type is to be nominated by the Sewerage Service Provider for the planned loading, according to the planning horizon and staging plan. Typically the pump type is to be centrifugal and capable of passing a 75mm sphere.

2. Duty/standby pumping shall be provided in accordance with Table D12.27.01.

Table D12.27.01 Sewage Pump Duty

<table>
<thead>
<tr>
<th>Council</th>
<th>Sewage Pump Duty Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>2 pumps required. 1 pump operates at PDWF, and 2 pumps together operate at WWF. *</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>2 pumps required. Each pump sized to operate at WWF</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>2 pumps required. 1 pump operates at PDWF, and 2 pumps together operate at WWF. *</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>2 pumps required. 1 pump operates at PDWF, and 2 pumps together operate at WWF. *</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td></td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>

* Typically if the duty point is chosen as the two pumps operating to meet the nominated WWF loading for 2.0m/sec, then this usually achieves the minimum scouring velocity of one pump (PDWF) operation.

3. Depending upon the characteristics of the catchment area, size of pump station and associated rising main, grinder pumps may be permitted, with the specific approval of the Sewerage Service Provider.

4. The minimum wet well internal diameter shall be 2400mm.

5. Wet wells shall not be provided with ladders unless specifically directed by the Sewerage Service Provider. If required, ladders shall be in accordance with AS1657. Retractable handgrip stanchions, refer AS1657 Fig 5.2 are preferred.

6. At full design loading, the detention time of the wet well and rising main should not be more than two hours during daytime (6:00am to 6:00pm) to reduce the generation of hydrogen sulphide. Detention time may be calculated using the formula “\( T = \frac{0.025Q_p + 0.218 L d^2}{Q_a} \)” where:

   \( T \) = Detention Time (hours)
   \( Q_p \) = Pump Capacity (L/s)
   \( L \) = Pressure Main Length (m)
   \( d \) = Pressure Main diameter (m)
   \( Q_a \) = ADWF (L/s)

7. Pump Stop and Start Level may be calculated using the formula “\( V = 900xQ_p / S \)” where:

   \( V \) = Volume between pump stop & start level (L)
   \( Q_p \) = pump capacity (L/s)
   \( S \) = allowable number of starts per hour

   To reduce the septicity at wet well and pressure main recommended number of starts per hour is between 5 and 10 during the daytime. (Maximum 10 or 90% of manufacturers recommended number, whichever is lower.)
8. Valve pits shall be located in accordance with Table D12.27.02.

Table D12.27.02 Valve Pit Location

<table>
<thead>
<tr>
<th>Council</th>
<th>Valve Pit Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>External to the wet well, attached to the wet well structure to prevent differential movement.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td></td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>External to the wet well, separate to the pump well structure.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td></td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td></td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>External to the wet well, attached to the wet well structure to prevent differential movement.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td></td>
</tr>
</tbody>
</table>

9. Wet wells shall have an internal corrosion resistant protective coating if required by the Sewerage Service Provider.

10. Provision of well washers is to be in accordance with Table D12.27.03.

Table D12.27.03 Well washers

<table>
<thead>
<tr>
<th>Council</th>
<th>Provision of Well Washers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>An approved automatic wet well washer connected to potable supply via a backflow prevention device shall be provided.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>None Required.</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>An approved automatic wet well washer connected to potable supply via a backflow prevention device shall be provided.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>None Required.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>An approved automatic wet well washer connected to potable supply via a backflow prevention device shall be provided.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>None Required.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>None Required.</td>
</tr>
</tbody>
</table>

11. Pumps shall be mounted on stainless steel guides with a fixed discharge bend – free standing pumps are not permitted. Lifting chains shall be stainless steel.

12. Where septicity control is required by the Sewerage Service Provider, the preferred method is by dosing of proprietary sewage conditioning agents. Soda ash solution is a quick and effective sewage conditioning agent.

13. All incoming sewer mains shall flow into one inlet access chamber, which will then have ONE inlet line flowing into the pump station.

14. An inlet valve is required on the inlet pipe. The inlet valve is to be located internal to the wet well.

15. The typical maximum depth of the inlet pipe invert is some 3.5m.

16. The typical floor level of the wet well is some 1.5m below the inlet pipe invert.

17. Each sewage pump station shall have a screened overflow pit in accordance with standard drawing CMDG-S-058. The overflow level shall be for inflows greater than the planning horizon WWF (SADWF)
18. Vent poles or proprietary odour units must be provided.

19. The wet well must be designed to counteract buoyancy and supporting design calculations are to be provided.

20. Flow meters are required to be installed in the pumping station valve pit, and connected to Council's SCADA system. A second flow meter, may be required at the rising main discharge point depending on the outcomes of a risk assessment.

**D12.28 EMERGENCY STORAGE / STANDBY GENERATOR**

1. The standard emergency storage capacity of the pump station shall be in accordance with Table D12.28.01. Where the required storage cannot be met then additional on site emergency storage wells must be provided.

**Table D12.28.01 Emergency Storage**

<table>
<thead>
<tr>
<th>Area</th>
<th>Emergency Storage Requirement</th>
<th>Calculation method for Emergency Storage Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana Shire</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
<tr>
<td>Central Highlands Regional</td>
<td>4 hours Average Dry Weather Flow (4xADWF) plus 50% of immediate upstream pump stations emergency storage requirements</td>
<td>Volume of wet well or other immediate upstream emergency storage devices below overflow level. Upstream network capacity is excluded.</td>
</tr>
<tr>
<td>Gladstone Regional</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
<tr>
<td>Isaac Regional</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
<tr>
<td>Livingstone Shire</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
<tr>
<td>Maranoa Regional</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
<tr>
<td>Rockhampton Regional</td>
<td>4 hours Average Dry Weather Flow (4xADWF)</td>
<td>Volume of wet well plus upstream network capacity (pipes and access chambers) below overflow level.</td>
</tr>
</tbody>
</table>

* An absolute minimum of two hours Average Dry Weather Flow (2xADWF) emergency storage may be provided subject to completion of a satisfactory risk assessment and subject to provision of on-site generator Secondary Power Supply

2. A risk assessment must be approved by the Sewerage Service Provider and must be cognisant of sensitive public and environmental health duty of care legislative responsibilities, quality of electricity supply and operational plant of the relevant Sewerage Service Provider. The risk assessment will address the need for on site generators.

3. Pump stations with larger flows (pump capacity is more than 50L/s) shall be provided with an on-site generator Secondary Power Supply, even if it complies with emergency storage capacity.

**D12.29 POWER DESIGN**

1. Each sewage pump station shall be designed for Primary and Secondary Power Supply. The Primary Power Supply shall be the Electricity Provider as nominated by the Sewerage Service Provider (RSSP). The Secondary Power Supply as nominated by the RSSP, typically either mobile generator or fixed on-site generator or a second independent supply from the Electricity Provider.
2. The nominated Secondary Power Supply shall be incorporated into the switchboard, conduits, service poles, etc, even if a Secondary Power Supply is not required at the particular stage.


D12.30 CONTROL AND TELEMETRY DESIGN

1. Each pump station shall be able to be connected to the Sewerage Service Provider’s telemetry monitoring system.


D12.31 WATER SERVICE & WATER METER & BACKFLOW PROTECTION

1. All sewage pumping stations shall have an adequate water supply for cleaning & washdown sprays purposes.

2. A metered water service shall be arranged with the Registered Water Service Provider. Refer to standard drawing CMDG-W-030.

3. The water service shall be protected from contamination due to backflow by the installation of a registered break tank or reduced pressure zone device in accordance with the Plumbing & Drainage Act and AS 3500.

4. All internal water plumbing is regulated under the Plumbing & Drainage Act and requires all necessary applications and fees for Compliance Permits and Certificates.

DOCUMENTATION

D12.32 SEWERAGE NETWORK

1. Master Plans / Network Analysis are required to be submitted and approved by the Sewerage Service Provider as part of any development application submission. These plans must show the proposed finished surface levels over the entire site, the location and pipe diameter of the proposed reticulation system, the location of any pump stations and rising mains required and the connection points to the existing reticulation network.

2. The proposed sewerage network design, including calculations shall be submitted to the Sewerage Service Provider, and if required to the Local Government for approval as part of the Operational Works application.

3. The Drawings shall show to scale:

   3.1 Plan: contours, alignment of sewer mains, sizing of sewer mains, access chambers, valves, pumping stations, existing and proposed allotment contours and boundaries, and services, Property Connection Junction chainage, access chamber numbering, sample thrust block size, compaction.

   3.2 Longitudinal section drawing of each sewer main will display the existing and finished surface, size, class and grade of sewer mains and rising mains, access chamber location, access chamber size (diameter), invert level of the inlet and outlet of the access chamber, deflection angle of the outlet pipe, type of pipe and crossing services. Property Connection Junction chainage, Property Connection Branch type, Point of Connection invert level.
3.3 General arrangement of pumping stations with site plan; concrete outlines; number, make, model and details of pumps; inlet and outlet pipework details and levels; pump cut in; cut out and alarm levels; switchboard location; pumping station access details.

3.4 The operational works submission must be accompanied by design calculations relating to sewage pumping stations including:

- Buoyancy calculations;
- Wet well structural certification;
- Design flow calculations (including plan of identified catchment area);
- Pump selection including pump curve with proposed duty point and rising main characteristics;
- Emergency storage calculation;
- Design assumptions including wet well control volume, rising main detention time etc.

3.5 Include a drawing note at each connection 'Connection to the existing network to be carried out by Sewerage Service Provider, at the developer’s costs’.

3.6 Drawing Notes shall include (but not be limited to): pipe class, pipe colour, connection to existing system and Dial Before You Dig.

4. Detail plans shall be drawn to a scale of 1:1000 and longitudinal sections to a horizontal scale of 1:1000 and a vertical scale of 1:200 or as approved otherwise by the Sewerage Service Provider. Refer to standard drawing CMDG-S-010.

5. At the Pre-start Meeting and during construction, the Superintendent and Contractors must have up-to-date Approved Operational Works Drawings on-site plus a copy of the Operational Works Decision Notice and any attached conditions.

6. If any CMDG drawings are specifically referenced in the drawing package, a copy of the CMDG drawings shall be attached in the drawing package. It is the designers’ responsibility to check and obtain the most up to date copies of the standard drawings from the CMDG website at the time of submission.

CMDG Standard drawings (or part thereof) are not to be replicated in the submitted drawings. However, any deviations (slight or significant) from CMDG standards and drawings must be shown on the submitted drawings, RPEQ certified and Council approved prior to construction.

D12.33 PUMPING STATION

1. Prior to commencement of the manufacture of any pumps and control equipment, four (4) copies of the following shall be submitted to the required Sewerage Service Provider for review.

   (a) Switch and Control gear Assemblies - Proposed fully dimensioned manufacturing details, general arrangement (showing internal/external details) and foundation/gland plate details.

   (b) Common Control – Complete circuit diagram and description of operation.

   (c) Schedule of Equipment - Completed as to the equipment to be provided.

   (d) Other Engineering drawings as required to fully describe the proposed equipment.

2. Drawings shall be on -"A3“ size. All symbols used shall conform to AS 1102 and all wires and terminals shall be numbered.
3. Review, assessment or approval of the drawings by the Sewerage Service Provider shall not relieve the Developer of the responsibility of complying with this Specification.

**D12.34 AS CONSTRUCTED DETAILS**

1. As constructed data shall be submitted to Sewerage Service Provider showing the asset location and attributes of pipelines, access chambers and junctions, all pumping station details together with operating and maintenance manuals. Details shall include the size, type, levels, grade of pipelines, access chamber location, types and cover details, pump details, switchboard equipment details and station structural details.

2. Refer to the Capricorn Municipal Development Guidelines web site [www.cmdg.com.au](http://www.cmdg.com.au) for further information on the applicable Local Government’s As Constructed data submission requirements. These will appear within the ‘As Constructed’ tab..
# APPENDIX A

## QUALITY CONTROL, INSPECTIONS AND TESTING

<table>
<thead>
<tr>
<th>Activity</th>
<th>Key Quality Verification Requirements</th>
<th>Maximum Lot Size</th>
<th>Minimum Test Frequency</th>
<th>Test Method</th>
</tr>
</thead>
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<tr>
<td><strong>INSPECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravity Sewer Mains and Property Services</td>
<td>Prior to backfilling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer Rising Mains</td>
<td>Prior to backfilling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrust blocks</td>
<td>Prior to backfilling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access Chambers</td>
<td>Base and benching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage Pump Station</td>
<td>(a) Prior to placement of wet well floor concrete (b) valve pit starter bars (c) (If applicable) Pre-fabricated well installation</td>
<td>each access chamber</td>
<td>D12.20</td>
<td></td>
</tr>
<tr>
<td>On-Maintenance Liability Period</td>
<td>Prior to acceptance by Council</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-Maintenance Liability Period</td>
<td>After 12 months from On-Maintenance Notice and Prior to release by Council</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>MANDATORY TESTING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siting and Excavation</td>
<td>Geometry</td>
<td>1 line/ structure</td>
<td>1 per line/ structure</td>
<td>Survey</td>
</tr>
<tr>
<td>Gravity Sewer Mains and Property Services</td>
<td>(a) CCTV Inspection (If Applicable) (b) Compressed Air Testing</td>
<td>all</td>
<td>all</td>
<td>D12.19</td>
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<tr>
<td>Access Chambers</td>
<td>Hydrostatic Testing or Vacuum Testing (Refer D12.20)</td>
<td>each access chamber</td>
<td>D12.20</td>
<td></td>
</tr>
<tr>
<td>Sewer Rising Mains</td>
<td>Hydrostatic Pressure Testing</td>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage Pump Station</td>
<td>(a) Hydrostatic Testing (b) Practical Completion</td>
<td>each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backfill and Compaction</td>
<td>Trafficable - 50m of sewer trench Non-trafficable – 100m of sewer trench Access Chambers or Maintenance shaft</td>
<td>1 per 300mm of fill 1 per 900mm of fill 1 at 1m depth within 300mm of structure As directed by Local Government</td>
<td>AS1289.5.7.1</td>
<td></td>
</tr>
<tr>
<td>Sewer &gt; 2m deep and road crossings</td>
<td>Compaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer &lt; 2m deep</td>
<td>Compaction</td>
<td></td>
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</table>
### AUDIT TESTING – IF ORDERED BY COUNCIL

<table>
<thead>
<tr>
<th>Materials Supply</th>
<th>Material Quality - Supplier's documentary evidence and certification of:</th>
<th>1 contract</th>
<th>As directed by Local Government</th>
<th>AS1477</th>
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<tbody>
<tr>
<td>- uPVC Pipes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Ductile Iron Pipes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Precast Access Chambers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedding</td>
<td>Material Quality - Grading</td>
<td>1 contract</td>
<td>1 per contract per source</td>
<td>Q103</td>
</tr>
<tr>
<td>Concrete Bedding</td>
<td>Refer C271 Minor Concrete Works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laying and Jointing of Pipes, Access Chambers, Structures</td>
<td>Geometry</td>
<td>1 line</td>
<td>1 per line</td>
<td>Survey</td>
</tr>
<tr>
<td>Thrust and Anchor Blocks</td>
<td>Refer C271 Minor Concrete Works</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Concrete Encasement</td>
<td>Refer C271 Minor Concrete Works</td>
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<td></td>
<td></td>
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<tr>
<td>Cast-in-situ Access Chambers</td>
<td>Material Quality - Tri-Calcium Aluminate Content</td>
<td>1 contract</td>
<td>1 per contract per source</td>
<td>AS3972</td>
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<tr>
<td></td>
<td>- Fineness Index</td>
<td>1 contract</td>
<td>1 per contract per source</td>
<td>AS3972</td>
</tr>
<tr>
<td></td>
<td>- Minimum Cement Content</td>
<td>1 contract</td>
<td>1 per contract per source</td>
<td>AS3972</td>
</tr>
</tbody>
</table>
APPENDIX B

PURCHASE SPECIFICATIONS

Precast Sewerage Access Chamber Components
Cover & Frames for Access Chambers – Water Supply & Sewerage
Cast Iron Fittings for Pipelines
Battery Powered Electromagnetic Water Meters
Electromagnetic Water Meters
Ductile Iron Pressure Pipes
Polyethylene Pressure Pipe
PVC Pressure Pipe
PVC Gravity Sewer Pipe and Fittings
Domestic On-Site Sewage Pump Station
Polyethylene Sleeve for Pipes
Detectable Marker Tape for Pipelines
Tapping Bands for Pipelines
Air Valves for Water Supply Purposes
Brass Valves
Butterfly Valves for General Purposes
Cast Iron Gate Valves for General Purposes
Spring Hydrant Valves for Waterworks Purposes
Metal Seated Sluice Valves
Non-Return Valves – Swing Check & Tilting Disk
Resilient Seated Sluice Valves
Sewerage Vent Pole
Single Detector Check Valve
Maintenance Shafts for Sewer Mains
APPENDIX C

TYPICAL LOADINGS PER DEVELOPMENT TYPE

The EP’s per development type are to be in accordance with each Council’s Developer Contribution Policies. Where these policies do not provide sufficient information, the EP’s given in Table D12.C.01 can be used as a guide. Refer also to relevant Adopted Infrastructure Charges Resolution for the Local Government.

Table D12.C.01 Design EP’s per development type

<table>
<thead>
<tr>
<th>Development Type</th>
<th>Unit</th>
<th>ET</th>
<th>EP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accommodation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential - detached dwelling</td>
<td>lot</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>Residential - Apartment/Unit/duplex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Bedroom</td>
<td>unit</td>
<td>0.5</td>
<td>1.3</td>
</tr>
<tr>
<td>2 Bedroom</td>
<td>unit</td>
<td>0.8</td>
<td>2.08</td>
</tr>
<tr>
<td>3+ Bedroom</td>
<td>unit</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>Caravan Park - Van Site</td>
<td>site</td>
<td>0.8</td>
<td>2.08</td>
</tr>
<tr>
<td>Caravan Park - Tent Site</td>
<td>site</td>
<td>0.3</td>
<td>0.78</td>
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<tr>
<td>Hostel Accommodation</td>
<td>bed</td>
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<td>1.3</td>
</tr>
<tr>
<td>Motel</td>
<td>room</td>
<td>0.6</td>
<td>1.56</td>
</tr>
<tr>
<td>Aged Care Accommodation (full service nursing home)</td>
<td>bed</td>
<td>1.1</td>
<td>2.86</td>
</tr>
<tr>
<td><strong>Retirement Village</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Bedroom</td>
<td>unit</td>
<td>0.6</td>
<td>1.56</td>
</tr>
<tr>
<td>2 Bedroom</td>
<td>unit</td>
<td>0.9</td>
<td>2.34</td>
</tr>
<tr>
<td>3 Bedroom</td>
<td>unit</td>
<td>1.3</td>
<td>3.38</td>
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<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Care Centre</td>
<td>staff &amp; pupils</td>
<td>0.1</td>
<td>0.26</td>
</tr>
<tr>
<td>Education – Primary School</td>
<td>staff &amp; pupils</td>
<td>0.1</td>
<td>0.26</td>
</tr>
<tr>
<td>Education – Secondary School</td>
<td>staff &amp; pupils</td>
<td>0.2</td>
<td>0.52</td>
</tr>
<tr>
<td>Education – Tertiary Institution</td>
<td>staff &amp; pupils</td>
<td>0.2</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Central Business</td>
<td>ha</td>
<td>21.3</td>
<td>55.38</td>
</tr>
<tr>
<td>Commercial Premises</td>
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</tr>
<tr>
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<tr>
<td>Fast Food Services</td>
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<tr>
<td>Food Services</td>
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<td>5.2</td>
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<td>Hotel</td>
<td>100 sqm GFA</td>
<td>1.2</td>
<td>3.12</td>
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<tr>
<td>Major Shopping Development</td>
<td>100 sqm GFA</td>
<td>0.7</td>
<td>1.82</td>
</tr>
<tr>
<td>Medical Centre</td>
<td>100 sqm GFA</td>
<td>0.7</td>
<td>1.82</td>
</tr>
<tr>
<td>Restaurant</td>
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<td>4.16</td>
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<tr>
<td>Service Station</td>
<td>100 sqm GFA</td>
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<td>2.08</td>
</tr>
<tr>
<td><strong>Industrial</strong></td>
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</tr>
<tr>
<td>Heavy Industry</td>
<td>ha</td>
<td>28.1</td>
<td>73.06</td>
</tr>
<tr>
<td>Light Industry</td>
<td>ha</td>
<td>28.1</td>
<td>73.06</td>
</tr>
<tr>
<td><strong>Other</strong></td>
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<tr>
<td>Crematorium</td>
<td>100 sqm GFA</td>
<td>0.8</td>
<td>2.08</td>
</tr>
<tr>
<td>Hospital</td>
<td>bed</td>
<td>1.4</td>
<td>3.64</td>
</tr>
<tr>
<td>Place of Worship</td>
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<td>1.04</td>
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<tr>
<td>Public Building</td>
<td>100 sqm GFA</td>
<td>0.7</td>
<td>1.82</td>
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ENGINEERING STANDARD

Control Systems

Document: GRC - ES007  Revision: 1

REVISION HISTORY

<table>
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<th>Date</th>
<th>Description</th>
<th>Prepared By</th>
<th>Approved By</th>
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<td>1</td>
<td>30/10/2017</td>
<td>Issued for Use</td>
<td>C. Duncan-Kemp</td>
<td>C. Swanton</td>
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APPENDIX A Graphic Examples
1 PURPOSE

The purpose of this Engineering Standard is to describe the requirements for the design, installation and commissioning of PLC, RTU and SCADA systems for Gladstone Regional Council. This Engineering Standard shall be read in conjunction with the separate project-specific functional specification document.

2 SCOPE

This Engineering Standard is applicable to all Gladstone Regional Council projects where use of control systems hardware or software has been specified. This includes but is not limited to the following:

- Programmable logic controllers (PLCs) and connected remote I/O units.
- Local HMI, e.g. a touch-screen on a pump cabinet.
- SCADA systems.
- RTUs for remote sites, e.g. bore pump stations, reservoirs and wet wells.
- Telemetry systems linking these control systems to existing GRC control infrastructure.

3 RESPONSIBILITIES

All persons involved in the purchasing, design, supply and installation of any control system hardware or software for use on GRC sites shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.
## 4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClearSCADA</td>
<td>A SCADA solution offered by Schneider Electric, used as GRC's primary SCADA network.</td>
</tr>
<tr>
<td>Contractor</td>
<td>The corporation or business that designs, installs and/or commissions the equipment described by this Engineering Standard.</td>
</tr>
<tr>
<td>ControlLogix CompactLogix MicroLogix</td>
<td>Brand lines of Allen-Bradley PLCs, scaling in degrees of functionality, complexity and price.</td>
</tr>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>DNP3</td>
<td>Distributed Network Protocol 3</td>
</tr>
<tr>
<td>Ethernet</td>
<td>A common networking protocol used to connect devices in a local area network (LAN).</td>
</tr>
<tr>
<td>EtherNet/IP</td>
<td>An industrial communications protocol that utilises Ethernet networks. Not interchangeable with Ethernet.</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>HMI</td>
<td>Human-Machine Interface.</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network.</td>
</tr>
<tr>
<td>Mimic</td>
<td>A ClearSCADA term, used to describe a graphic or page.</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller.</td>
</tr>
<tr>
<td>Purchaser</td>
<td>The individual or corporation responsible for purchasing the equipment described by this Engineering Standard on behalf of GRC.</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote Terminal Unit.</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition.</td>
</tr>
<tr>
<td>SCADAPack</td>
<td>A brand line of Schneider Electric RTUs, capable of various industrial communication protocols, interfacing with local I/O and communicating through data radios.</td>
</tr>
<tr>
<td>Studio 5000</td>
<td>Development software for the latest versions of ControlLogix and CompactLogix processors. Formerly named RSLogix 5000.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
</tr>
<tr>
<td>Trio</td>
<td>A brand line of Schneider Electric data radios, communicating with variants of Ethernet or serial data transmission using radio antennas.</td>
</tr>
</tbody>
</table>
5 REFERENCE DOCUMENTS

This standard shall be read in conjunction with the following standards and documents.

5.1 GRC Engineering Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRC-ES002</td>
<td>Preferred Electrical Components</td>
</tr>
</tbody>
</table>

5.2 Manufacturer Documentation

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCADA Expert</td>
</tr>
<tr>
<td>SCADAPack E Technical Reference Manuals (available on Configurator software)</td>
</tr>
<tr>
<td>Allen-Bradley</td>
</tr>
<tr>
<td>Allen-Bradley</td>
</tr>
</tbody>
</table>
6 CONTROL SYSTEM OVERVIEW

6.1 Automation

6.1.1 PLC Automation
The automation of large or complex process systems (such as water treatment plants) is typically controlled by full-scale PLC systems. PLC systems typically consist of a single processor installed in a control cabinet, I/O cards for connection of field instrumentation, and any necessary communications interfaces to integrate the processor with intelligent devices such as VSDs, ‘smart’ protection relays and on-site HMIs.

6.1.2 RTU Automation
Less complex process systems may be automated by smaller-scale control systems, such as ‘compact’ PLCs with on-board I/O or RTUs with internal programmed logic (see section 9.3). This allows the implementation of basic control within the same unit that interfaces with the site’s SCADA network, reducing cost and cabinet size.

6.2 Monitoring and Control
Any controls or feedback deemed necessary for the healthy operation of the system (e.g. alarms, start/stop buttons, running indicators) shall be made available to the system’s intended operator, as per the operation requirements in the project specific functional specification.

At its smallest scale, this takes the form of a local control station, with indicator lights, push buttons/selector switches etc. as required in an accessible location. More complex systems may include touch-screen HMIs and connection to GRC’s site wide network.

6.2.1 Local HMIs
Touch-screen HMIs provide operators with a way of locally monitoring and controlling plant without requiring a connection to GRC’s site wide network or manually inspecting plant (e.g. looking in MCC drives, reading flowmeter displays, etc.).

Consult section 8’s “Local HMIs” subsections when designing plant HMIs.

6.2.2 Site Wide SCADA
The majority of GRC’s operations and monitoring is driven by a site-wide ClearSCADA network (explained in section 8.1.1). If the control system is to be monitored by GRC’s central ClearSCADA system, it will need to be connected to GRC’s existing network architecture.

6.3 Network Architecture

6.3.1 Local Networks
As mentioned in section 6.1.1, PLCs, RTUs and smart devices such as local HMIs, motor protection relays and power meters may be interfaced with each other in a local network. The Contractor shall ensure all networking/communications protocols used are currently and widely supported by manufacturers. For example, EtherNet/IP, DNP3, Modbus RTU and Modbus TCP/IP are acceptable; obsolete protocols like ControlNet or DeviceNet are not.

6.3.2 Site Wide Network
GRC uses a ClearSCADA-based control system that allows the monitoring and control of a hierarchy of remote systems using a combination of Ethernet and serial radio communications and RTUs.

If it has been deemed necessary to integrate the control system into GRC’s existing network, the Contractor shall provide a means of communication with this network (see section 9.2), such as a serial data radio.

The Contractor shall discuss the communication requirements of the control system with GRC to ensure compatibility (e.g. correct frequency, addressing, licensing, etc.) and compliance with broadcasting regulations.
7 PLC SYSTEMS

7.1 Architecture

All PLC systems designed and supplied to GRC sites shall be based on the Allen-Bradley ControlLogix or CompactLogix range of PLCs. Allen-Bradley MicroLogix PLCs may also be used for small applications where expressly approved by GRC.

These PLC systems typically consist of any or all of the following:

- Local I/O.
  Digital and analog signals wired to I/O modules located in the main PLC.
- Remote I/O.
  Digital and analogue signals wired to I/O modules located in field mounted I/O panels, connected to the PLC via the site communication network.
- I/O via intelligent devices.
  Devices such as Motor Protection Relays (MPR), Variable Speed Drives (VSD) or Electronic Soft Starters (ESS) controlled by the PLC may be connected to it via the site communication network.
- Site communication.
  Any hardware that requires communication with the PLC should, wherever possible, be on a common communication network to allow for easy troubleshooting. This is typically an Ethernet local area network.

7.2 Program Style and Structure

Control system application logic is typically written and supported by many people throughout the life of an industrial process plant. To maximise the maintainability of this logic and the safety of the process and personnel when changes are made, three key areas of discipline apply:

a) Consistency of Style within each PLC program and between all programs on site.

b) Development of logically structured tasks, programs and routines.

c) High quality documentation – for tag names / descriptions, in logic and for each routine.

7.2.1 Consistency of Style

Consistency of style both within each program and across the site minimises the learning effort for those unfamiliar with the standard when reviewing new code. This standard defines guidelines that provide a standardised, consistent approach to ControlLogix programming and shall be similarly applied to CompactLogix programming.

7.2.2 Structured Programming

Well-written programs require a substantial effort on the part of the engineer to logically and consistently lay out tasks and functions within the program. A top-down, structured programming approach is required to guide control system design and the subsequent development of the PLC application program.

Structured programming incorporates all major aspects of program design such as allocation and naming of tasks, programs and routines, logic layout within routines, tag naming and descriptions, handling of I/O configuration and I/O data mapping and consistent definition of common control functions such as SCADA interfaces, inter-PLC messaging, initialisation and fault handlers.

This document provides methods and guidelines to support structured programming.
7.3 Tasks, Programs and Routines

7.3.1 ControlLogix Tasks

ControlLogix processors run a multitasking Operating System. Programmers are able to define multiple tasks to encapsulate logic within a processor. The processor swaps between these tasks (as well as system-defined tasks) at timeframes controlled by the task type definitions and priorities.

User Tasks can be defined as:

- Continuous (one only per processor) – Operates whenever no higher priority task is running.
- Periodic – Triggered at a given period.
- Event – Triggered by a programmed condition.

The continuous task shall not be used.

A MainTask shall be defined as periodic with a period set to at least 50ms or roughly double the standard execution time for the task whichever is longer. This enables the processor to better manage non-user tasks and communications without relying on the System Overhead Timeslice parameter.

Faster Periodic or Event-driven Tasks may be used for any process that may be adversely affected by the MainTask scan rate, such as PID calculations, rate controllers, material handling and high-speed event counters or sequencing routines. If such tasks are used, the corresponding programs must be restricted to the minimal required logic. Additional tasks may be named with any appropriate text.

7.3.2 ControlLogix Programs

The default program is called “MainProgram” under the MainTask. The default program name shall not be changed; it should contain the top level sequencing, control and SCADA interface routines for a complex project, or all of the logic, excluding input and output mapping, for a simple project.

Within the MainTask two additional programs must be created:

- An Input_Mapping program that contains routines that perform input mapping of physical inputs to internal tags for I/O on the local chassis and on each control or I/O network. It may also perform mapping from a Level1 HMI device (such as PanelView) or the Level 2 (SCADA) system. This program must be the first scheduled under the MainTask.
- An Output_Mapping program that contains routines that perform output mapping of internal tags to physical outputs for I/O on the local chassis and on each control or I/O network. It may also perform mapping to a Level1 HMI device (such as PanelView) or the Level 2 (SCADA) system. This program must be the last program scheduled under the MainTask.

A ControlLogix Program should be created for each major equipment item or functional section within the relevant process. Other Programs within MainTask may be defined for other sub-processes, for particular control, data handling or reporting for Level 1 HMI or Level 2 SCADA interfaces, for event handling or process simulation logic as required.

Program names are presented in the configured execution order (within Task properties in the Controller Explorer) and should reflect the process being controlled by that program. Program names must be unique across all tasks within the Controller (i.e.: there cannot be more than one “MainProgram” in different tasks).

7.3.3 ControlLogix Routines

Routines have a pre-defined programming language and contain the executable logic for the control functions defined within an application program. The default MainProgram always contains a single ladder-logic routine called “MainRoutine” from which all other sub-routines are called. Sub-routine calls shall not be nested within any other sub-routine. This ensures that the main routine is the only initiating point controlling the execution order of the application program. The MainRoutine is not to contain any process-specific logic; this is delegated to area or process specific logic routines.
Additional, user created programs do not have any routines by default, these are created as required. For each additional program a MainRoutine must be created (as Ladder Logic, and configured as the main routine for that program) in order to provide a standard, recognisable entry point for that program. A single sub-routine may be created for each program for Fault handling as appropriate. Typically it monitors conditions such as low battery, math overflow or serial port fault. This routine is called unconditionally from the MainRoutine.

7.3.4 Program Timing

Studio 5000 configuration of PLC program execution is very flexible. This flexibility can lead to incorrect configuration and result in poor PLC communication or PLC shutdown through generation of a CPU fault. The suggested configuration of PLC program execution is as follows:

- One MainTask comprising many Programs.
- Programs are grouped into Control Functions e.g. I/O Mapping, Motors.
- Programs comprising many Routines.
- Routines are grouped into Plant Areas e.g. by area number and area description.

7.3.4.1 Main Task Configuration

Main Task configuration should be as follows:

- Type = Periodic.
- Period = 50-100ms.
- Priority = 10.
- Watchdog = 5 x Period.
- Disable Automatic Output Processing = Unchecked.
- Inhibit Task = Unchecked.

7.3.4.2 Program Configuration

Program configuration should be as follows:

- Main = MainRoutine.
- Fault = <none>.
- Inhibit Program = Unchecked.

7.3.5 Selection of Programming Language

When a routine is created, it is declared to have a specific language type, as defined within the IEC standard 61131-3. These languages are Ladder (LD), Function Block Diagram (FBD), Structured Text (ST), Sequential Function Chart (SFC) and Instruction List (IL).

All programming shall use the Ladder language, except for specific analogue and process control routines which may use the Function Block Diagram language.

7.4 Tag Naming

ControlLogix processors use tag names to define internal variables rather than using a file and file offset based address as in the SLC500 and PLC/5 series. It is left to the application programmer to apply a consistent tag naming convention to identify the type and purpose of this named data.

ControlLogix processors enforce certain conventions for naming objects in accordance with standard IEC-1131:
An identifier is a string of letters, digits, and underline characters which begin with a letter or underline character. Underlines are significant in identifiers (e.g. A_BCD is interpreted differently to AB_CD). Multiple leading or multiple (consecutive) embedded underlines are not allowed, trailing underlines are not allowed, and letter case is not considered significant.

7.4.1 Use of Controller vs Program Scoped Tags
Within a ControlLogix application, program-scoped tags cannot be used outside of the Program in which they are created. Program Tags shall only be used for a tag which will never need to be accessed from outside the Program. For example a TIMER tags for which the DN bit will only be used on the next rung.

7.4.2 Use of ControlLogix Tag Aliasing
Tag aliasing is not to be used except for that within I/O Mapping as outlined in Section 7.4.10.

7.4.3 Active State of Discrete Program Tags
Discrete tags must always be defined to use “positive logic” such that the active, high or true state is described by the tag name and description. “Negative logic” shall never be used. In the case of “Emergency Stop” inputs where the physical input is often active low, tag descriptions must still match the state of the bit when set (e.g. “Emergency Stop Healthy”).

7.4.4 Construction of Internal PLC Tag Names
Studio 5000 allows up to 40 characters to be used for a tag name, however tag names should be kept reasonably short for readability.

All tag names must ensure an easy relationship to equipment shown on project drawings such as Schematics, Process Flow Diagrams and P&IDs.

Tag naming for I/O data has special requirements, these are discussed in Section 7.4.10.

7.4.5 Constants/Parameter Usage
Constants or fixed parameters are to be dealt with in a consistent fashion and clearly distinguished from standard tags.

The following is a list of guidelines for the use of constants:

a) All constants that are or may be used more than once shall be loaded into a tag. Constants generally should not be hard-coded via MOV instruction. This allows setting constant values with the Studio 5000 Tag Monitor.

b) If a constant value is used only once within the logic and does not require changing during normal process tuning or calibration then it may be directly hard-coded into the instruction (e.g.: within a move, compare, timer or counter instruction, etc). If unclear, the associated rung comment shall identify the meaning of this constant.

The last six characters of the tag name will be "CONST" in upper case, following the standard tag name. The last line of the tag description shall indicate the value is a constant and its intended value (or range of values).
7.4.6 Rack Configuration

While the ControlLogix system does not have any restrictions upon which slot the controller or communications modules are placed into, this standard requires that the controller (processor) is preferably in slot 0, and that Ethernet, ControlNET, DeviceNET and DHRIO communications modules are to be installed into the chassis in subsequent slots (prior to any I/O modules being installed).

There are two reasons for this restriction:

a) It is a generally recognised industry convention, and
b) If the program is run in a test environment (without I/O), it enables a small chassis to be used on the test bench such that the Controller and key communications modules do not need to be moved. (If a processor or other communications module is moved from higher slots in the field to another slot in a smaller test chassis, the program will fault unless all slot numbers and message routes within the program are manually updated).

7.4.7 Ownership of I/O Modules

Multiple controllers are able to subscribe to I/O updates across the ControlLogix chassis backplane or via ControlNet. A controller that requires direct access to an I/O module shall also be granted ownership of that module. Other controllers that require data from that module must have a listen-only connection.

Connections between controllers and each I/O chassis are to use rack optimisation to minimise the number of connections consumed.

Unicast connections should be used over Ethernet/IP when supported by both devices.

7.4.8 Configuring Discrete and Analog I/O Channels

Discrete inputs must be configured so that the I/O module provides open circuit, short circuit and jitter/oscillation alarms as appropriate for that module type. Filtering on the I/O module shall only be used as appropriate.

Analog inputs and outputs must be configured to return a floating point value that is scaled to the raw range of the input transducer or output driver (eg: 0.0-10.0V or 4.0-20.0mA). The card must not perform scaling to Engineering Units (eg: kPA, °C), this must be done within the application program. The analog I/O module may implement filtering of the input value as appropriate.

Alarms for under-range and over-range that are implemented on the I/O module may be used if these alarms are configured to capture transducer / output short circuit, open circuit or otherwise invalid electrical range, but not for process alarms. Process alarms (eg: HH, H, L, LL) are to be configured and set within the application program.

This configuration standard is applied for the following reasons:

a) Some I/O networks such as ControlNET support only limited online re-configuration of I/O modules, network mapping and scheduling. This requires the I/O network to be placed into edit mode (stopping the process) in order to perform configuration changes.

b) When diagnosing systems, it is very useful to be able to measure the raw value of an input or output (in mA or V) with a multimeter and compare this to the value read by the PLC. If the I/O card scales to EU, this visibility is removed.

c) If an instrument is re-calibrated or exchanged, it is much easier to update the EU, range and alarm process setpoints in the application program, avoiding the need to re-configure the I/O networks in external applications such as RSNetworx.

d) In the interest of maintaining common code libraries for devices such as transducers (eg: PT, TT, FT, etc) and VSD or Analog Control Valve output devices, it is desirable that the lowest common denominator interface to I/O modules is catered for (not all I/O modules support the same alarming and scaling capabilities).
7.4.9 Module Naming

To maintain traceability of the physical location of all I/O data, the name of each network node and I/O device in a ControlLogix system is to be created according to the physical location of that module – by Control Panel, I/O type, logical rack and the slot number (within a rack). Where a slot number is not applicable, “xx” may be used as a place-holder. The required naming syntax and field structure is thus:

<table>
<thead>
<tr>
<th>Field</th>
<th>Control Panel</th>
<th>Network or Device Type</th>
<th>Rack</th>
<th>Slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>4 characters</td>
<td>2 characters</td>
<td>2 digits</td>
<td>2 digits</td>
</tr>
</tbody>
</table>

Examples:

1. CP03 di 01 03 CP03di0103
2. CP03 ai 01 04 CP03ai0104
3. CP04 EN 02 xx CP04EN02xx

a) Digital Input module in Slot 3 of Rack 1 within Control Panel CP03.
b) Analog Input module in Slot 4 of Rack 1 within Control Panel CP03.
c) An Ethernet communications adapter (eg: 1794-AENT) at Rack 02 within panel CP04. A slot address does not apply in this case as FlexI/O communications adaptors do not occupy a slot position.

The pre-defined 2-character Network or Device types are:

<table>
<thead>
<tr>
<th>Type Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple I/O Types</td>
<td>Digital Input, Digital Output or combination Digital I/O module</td>
</tr>
<tr>
<td>di, do, dx</td>
<td>Analog Input, Analog Output or combination Analog I/O module</td>
</tr>
<tr>
<td>ai, ao, ax</td>
<td>Thermocouple Input module, Pulse Input module</td>
</tr>
</tbody>
</table>

Complex Network-Connected Devices and I/O Network Types

<table>
<thead>
<tr>
<th>Type Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN, CN, DN</td>
<td>Ethernet (or Ethernet/IP), ControlNET or DeviceNET network</td>
</tr>
<tr>
<td>RN</td>
<td>Allen-Bradley Remote I/O, or RIO network (not required for DH+)</td>
</tr>
<tr>
<td>SR</td>
<td>Serial (RS232/422/485) multi-drop or point-to-point devices</td>
</tr>
<tr>
<td>MB, PB, ...</td>
<td>Modbus, Profibus, etc as required (2 character abbreviation)</td>
</tr>
</tbody>
</table>

7.4.10 I/O Usage, Tagging and Mapping

Physical inputs are to be “buffered” or mapped into internal tags in the InputMapping program. This program must be scheduled as the first program in the main task (by default the continuous task “MainTask”). Similarly, output mapping is performed by the routines in a Program called OutputMapping which must be scheduled as the last program in the main task.

The local chassis I/O and every separate I/O network (ControlNET, DeviceNET, Ethernet/IP, etc) shall have its own I/O mapping routine in the appropriate InputMapping or OutputMapping Program. These routines may also contain initialisation logic, network alarms and diagnostic status for the network scanner controlling that network.

The tag name for raw I/O data is automatically generated when the corresponding I/O module or device is configured in Studio 5000.

Real world inputs and outputs shall appear only in the associated mapping routine, not as interlocks for other items of equipment. Real world outputs shall only be used as an instruction output (OTE) and never as an instruction input (XIC).

If access is required to raw input fault bits, Over or Under Range bits (on an analog card), etc, an additional tag is required to map to these bits.
Unlike PLC5 and SLC 500 PLCs, a ControlLogix controller scans its inputs asynchronously to the program scan and updates outputs at the end of each task (by default). As a consequence, a task may need to buffer its input data so that a consistent I/O snapshot which cannot change mid-scan is provided for the program logic.

7.5 Program Documentation

Program documentation is the best means for a programmer to record the structure and rationale behind the application logic. Documentation of controller code can take two major forms: using the facilities provided by the PLC software development environment or via separate documents such as Functional Specifications, Annotated Sequence, Loop and Equipment Lists (Control Functions), Cause & Effect Charts, I/O Allocation spreadsheets and other design documents.

Documentation within the PLC application program shall describe the design philosophy and data structures for each logic function in the rung comments in each routine. By necessity, the PLC controller that defines plant operation is the last word as to the actual control strategies employed. After years in service, the controller documentation is often the only reliable record of the details of plant operation, thus this level of commenting is typically the most valuable.

7.5.1 Tag Descriptions

All tag descriptions are to be four-lines in length such that each line identifies the following:

a) The process, plant area or machine area which the tag belongs to.
b) The Device, Item or Equipment which the tag belongs to (ie: “Waste Water Pump”, etc).
c) The actual information or value that the tag contains (eg: “Running” state or “Speed”).
d) Additional type-specific metadata such as:
   i. For discrete tags: identifying the bit as an internal latch or one-shot, an Alarm mapped input or output, SCADA control or status bit, etc.
   ii. For Analog tags: identify the scaled range and Engineering Units (eg: 0-100%).
   iii. For message data, an indication of the source controller or device for that data.

When a structured format is used the entire tag database, descriptions and aliases can be automatically or semi-automatically generated from a hierarchical equipment list.

7.5.2 Ladder Logic Rung Comments

The first rung of every ladder routine must contain a [NOP] output instruction only, and have a rung comment that identifies the function of that routine. For the assigned Main Routine within a program, this rung comment applies to that entire program. Within other routines in a program the rung comment on the first instruction applies to just that routine.

The first comment in the MainRoutine of the Main Program shall also indicate the original author / company and date of development.

Elsewhere, rung comments shall be liberally used to describe any unusual instruction usage or unclear aspect of logic or data structures and the rationale (if this is not self evident from the code). They must be kept up to date as maintenance is performed on the program logic over time.

Rung comments are to be written with the following guidelines in mind:

- Rung comments shall be written using proper English sentences and be succinct, but sufficient to make the intent and operation of the program or routine clear.
- Normal sentence case shall be used. Capitals may be used as appropriate at the start of a sentence, for highlighting or for acronyms.
- The last line of the rung comment shall be a single space only to separate the tag descriptions in the ladder and the rung comment for easier reading.
- If the rung comment is long and complex, the first line shall be a summary, in upper case.
Identify subdivisions within routines with a capitalised section heading underlined.
Identify maths and formula calculations.

7.5.3 Function Block Comments
As with ladder logic, each non-obvious region of function block logic must be commented to make the code more readable. Function Blocks may have a Text Box attached to various regions of code to provide such comments. Basic commenting for Function Block diagrams must include:

- All Function Block sheets must be labelled with a short title.
- As appropriate, a description shall be added to predefined function blocks to describe the intent and meaning of the output value(s) of that function.
- If further explanation is required, a text box comment shall be attached to the code adjacent to the relevant region of logic.

7.6 General ControlLogix Guidelines

7.6.1 Programming Guidelines
For ladder logic and function block programming, the following guidelines must be considered:

- In general, a more verbose program using simpler instructions is preferred over a clever, complicated program.
- Conditionally executed code shall not be used as a substitute for logical interlocking - if a machine has three modes of operation, these modes shall not be programmed independently and then conditionally called based on the machine mode. The same outcome can be achieved with logical interlocking;
- Use common marshalling points for common functions. If a machine can perform two actions then there shall be only one place where all interlocks and permissives for Action A are marshalled and one place where all interlocks and permissives for Action B are marshalled;
- Permissives and initiating actions shall be triggered from state changes of a single internal controller tag, not from real-world I/O. ie: If certain actions result because a mobile machine stops, then that action should be initiated by the fact that the machine operating bit went false and not by marshalling all the inputs which might cause that machine to stop. This is a common flaw in programs: it defines the same condition twice since the machine travel interlocks should already be marshalled somewhere else;
- Although Latch and Unlatch coils have valid uses, they are to be used cautiously and with due consideration to alternative approaches. Latch instructions and the corresponding unlatch instructions shall not be separated by large sections of code. Self-latching rungs are preferred over latch / unlatch coils for the following reasons:
  a) Both the set and clear triggers are always found in the same rung.
  b) Latch/unlatch priority is explicitly defined in the logic and so is not scan order dependent.
  c) Self-latching rungs are fully resolved before execution continues: where latch / unlatch coil pairs are separated by other code and do not have mutually exclusive conditions on the latch and unlatch conditions, some program logic may see the latch set and other logic can see it reset. This condition makes maintenance and diagnostics very difficult.
- All alarm conditions generated by the application code must be latched using a self-latching rung (as described above) with an explicit reset. Unlatched alarms are disallowed as they can cause a shutdown but then “disappear” when their causal conditions clear. This may cause the SCADA to miss the alarm (because of the short on-time) and makes diagnostics very difficult.
- Use alarm bits in Permissive and Interlock rungs, not real world I/O. This ensures that if some action cannot occur, there will be an alarm explaining why. It also ensures that the condition is latched, not transient – improving diagnostic ability.
- The use of JSR (Jump Sub Routine) instructions with parameters is unacceptable as AOI’s (Add On Instructions) and built-in instructions are more suitable due to visibility.
- Output instructions shall never appear before an input instruction on a ladder rung.
- Output instructions on the same rung shall each have a separate branch.

7.6.2 Alarm Handling

In general, alarms are to be stored within a DINT (32-bit double integer) data type, where each bit of the DINT is a single alarm. Alarms specific to a standard device or function block are stored within a DINT in the UDT for that device. All alarms are to be positive logic, such that the logical True state is set when an alarm is activated.

Alarm bits must be latched by the PLC logic, using a self-latching rung that is reset only by the alarm reset bit for that plant area. This ensures that alarms are logged and recorded by the SCADA or HMI devices before the underlying process condition clears. The PLC is not required to participate in alarm acknowledgement strategies (this is the responsibility of the SCADA only).

7.6.3 Scan Time Independent Code

Code that implements strictly time dependant functions such as ramp rates, material tracking or PID controls must use a separate periodic task with a sufficient priority to ensure that variations in the controller scan time do not cause calculation errors.

7.6.4 Handling of Processor Forces and AFI Conditions

Forces are not to be left enabled in the processor at any time. Forces may be used for online testing and diagnosis, but must be removed before the online programming session ends as:

- Forces can be turned off or on globally, creating the potential for untested or disabled code to be unintentionally executed.
- There is no means of documenting the reasons for using a force on an I/O point within the code or tag database.

If an input or output must be bypassed or forced for an extended period of time, then the program logic must be modified in a safe and sustainable fashion and a suitable explanation left in the rung comments or instruction description as to the reason for performing the modification.

AFI instructions may be used to disable logic during commissioning / troubleshooting etc, however a suitable explanation shall be placed in the rung comments or instruction description.

7.6.5 Peer to Peer PLC Communications

Peer to peer communications between PLC controllers will generally occur across Ethernet, ControlNet or DH+.

Messaging logic must handle errors appropriately (including raising an alarm if required) and must provide a heartbeat signal if the data transfer is critical to process stability.

When communication is between two ControlLogix controllers the preferred method of data exchange is via the produced and consumed tags. Data that is produced or consumed by a controller must be mapped in the InputMapping, OutputMapping or dedicated Peer Communications routines. This ensures that consumed data in the program is synchronous to the logic scan and provides a point in the logic where all the data that is consumed in the program can be viewed. Data produced for other controllers must be marshalled into a User-defined Data Type (UDT) to optimise the number of connections required.

7.7 Add-On Instructions

Add-On Instructions provide a convenient method to encapsulate re-usable code sections. The use of add-on instructions is encouraged whenever identical code is required. The use of JSRs with parameters shall not be used for this purpose.
Add-on instructions shall not be used when a built-in instruction exists with equivalent functionality, particularly within Safety Tasks.

When using an add-on instruction, all destructive operations on the main AOI defined data type operator shall be at the AOI call itself, or in the immediate preceding rungs. This can be readily checked by performing a cross reference on this operand.

Add-on instructions allow a consistent interface and logic for each device. Add-on instructions defined for water treatment plant sites include:

- **DOL_Motor** – Encapsulates all control logic, alarming and SCADA interface for equipment utilising a DOL motor starter.
- **VSD_Motor** – Encapsulates all control logic, alarming and SCADA interface for equipment utilising a VSD motor starter.
- **ESS_Motor** – Encapsulates all control logic, alarming and SCADA interface for equipment utilising an ESS motor starter.
- **Instrument** – Encapsulates all scaling, alarming and SCADA interface for analogue process instruments.
- **DiscreteValve** – Encapsulates all control logic, scaling, alarming and SCADA interface for a discrete valve.
- **ControlValve** – Encapsulates all control logic, scaling, alarming and SCADA interface for a position controlled valve.
- **PID_Controller** – Encapsulates all control logic, scaling, alarming and SCADA interface for a Proportional, Integral, and Derivative control loop.
8 SCADA SYSTEMS

8.1 Architecture

8.1.1 ClearSCADA
The GRC SCADA architecture is provided by a set of ClearSCADA 2017 servers installed in various locations around the Gladstone region listed below:

- A duty/standby set of servers titled ‘GRC’, one located in the Gladstone Works Depot and one located in the Calliope Call Centre.
- A duty/standby set of servers titled ‘AGNES’ located in Agnes Water.
- A standalone server for the Tannum Sands sewage treatment plant.
- A standalone server for the Calliope sewage treatment plant.

ClearSCADA ‘ViewX’ clients are installed in various locations around the GRC network (e.g. Calliope Call Centre, Gladstone Works Depot) which are capable of connecting to these servers. This is the primary method of controlling and monitoring GRC plant.

8.1.2 Local HMIs
Touchscreen HMIs may also be installed locally on sites to provide operators assistance with running plant and troubleshooting problems. These HMIs directly interface with the PLC to provide this control, and as such shall be selected based on their compatibility with the PLC and communication systems specified. Local HMIs shall be selected in accordance to GRC-ES002 (Preferred Electrical Components).

8.2 Users and Security

8.2.1 ClearSCADA
The GRC ClearSCADA system is configured with individual user logins for each authorised user. The privileges granted to each user is summarised below:

<table>
<thead>
<tr>
<th>Role</th>
<th>Permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>View Only</td>
<td>View alarms and pages</td>
</tr>
<tr>
<td>GRC Operations</td>
<td>View and acknowledge alarms</td>
</tr>
<tr>
<td></td>
<td>Browser through database explorer</td>
</tr>
<tr>
<td></td>
<td>Edit notes</td>
</tr>
<tr>
<td></td>
<td>Run pumps</td>
</tr>
<tr>
<td>Engineer</td>
<td>Full rights over system, including the privilege to:</td>
</tr>
<tr>
<td></td>
<td>Manually start/stop plant</td>
</tr>
<tr>
<td></td>
<td>Adjust plant set points</td>
</tr>
<tr>
<td></td>
<td>Add, edit and delete database objects</td>
</tr>
</tbody>
</table>

Users are automatically logged out following 10 minutes of inactivity.

8.2.2 Local HMIs
HMI security varies depending on the system selected. The Contractor shall take measures to prevent unauthorised operation of plant where needed.

When designing the PLC program to respond to SCADA-driven commands as well as HMI-driven or automated commands, the Contractor should also ensure the PLC correctly responds to changes from each monitoring system (e.g. masking commands to a pump sent from SCADA while operating it automatically or via local HMI).
8.3 Database Tags and Objects

8.3.1 ClearSCADA

A ClearSCADA I/O point is a reference to data within an I/O device such as a PLC, an RTU or the server itself. A basic point consists of the following information:

- Point type (e.g. SCADAPack Binary Point, OPC Analog Point, Internal String Point).
- Point name.
- Connection or ‘outstation’ (e.g. Curtis Island HV RTU).
- Memory address (e.g. Modbus register number, DNP point number).
- Historic configuration (see section 8.6).
- Status descriptions (e.g. 0 = “Faulted”, 1 = “Healthy”).
- Status colours (see section 8.4.1).
- Alarm/event configuration (see section 8.8.1).

To ensure the correct operation of the point and ease of integrating it into SCADA mimics, the Contractor shall accurately define each of these fields.

The following rules shall be applied to all points defined:

- All points shall be located in an appropriate group. For new plants/projects, a new group should be created to avoid interference with the existing database.
- All analog points shall have appropriate raw and engineering ranges, engineering units and formats.
- Points defined by templates shall also adhere to the requirements specified in section 8.3.1.

8.3.2 Local HMIs

Where using Allen-Bradley PLCs and PanelView HMIs, direct links to the PLC tag may be used instead of defining separate HMI tags. In all other situations, tag/object conventions shall adhere to the requirements defined in the ClearSCADA section where feasible.

8.3.3 Naming Conventions

Tags should be named such that anyone reading the program can easily identify what data the tag represents. Tags representing the functionality of a device are best named according to the location and function of the device. This can be achieved by breaking down the tag into the following sections:

- Area name (e.g. Agnes Water Reservoir).
- Equipment name (e.g. Clearwater Pump 1).
- State name (e.g. Pump Failed to Start).

For local HMIs the area name can be omitted unless several areas are included within the HMI scope. For ClearSCADA points, nesting points into groups based on area and equipment is suggested (e.g. a point called Pump Failed to Start, in a group called Clearwater Pump 1, in a group called Agnes Water Reservoir).

All tag names shall be in title case for readability.
8.4 Mimic Configuration and Navigation

Section 8.4 primarily concerns ClearSCADA development practices. Where feasible, the Contractor shall provide as similar a ‘look and feel’ to the ClearSCADA system when developing HMI applications.

8.4.1 Colour Schema

Equipment displayed within ClearSCADA mimics/HMI pages shall be coloured depending on its state as below:

<table>
<thead>
<tr>
<th>Colour</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Active (e.g. drive running, valve open, breaker closed)</td>
</tr>
<tr>
<td>Green</td>
<td>Inactive (e.g. drive stopped, valve closed, breaker open)</td>
</tr>
<tr>
<td>Yellow</td>
<td>Fault/Alarm</td>
</tr>
<tr>
<td>Magenta</td>
<td>Bad Quality (i.e. cannot communicate to equipment)</td>
</tr>
</tbody>
</table>

Equipment that is not animated or connected to anything (e.g., a filter bed) may be coloured to the Contractor’s discretion, though the above colours should be avoided to prevent confusion.

Additionally, process piping shall be coloured as below:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turquoise</td>
<td>Raw Water</td>
</tr>
<tr>
<td>Blue</td>
<td>Clear/Treated Water</td>
</tr>
<tr>
<td>Fuchsia</td>
<td>Chemicals</td>
</tr>
<tr>
<td>White</td>
<td>Plant Air</td>
</tr>
<tr>
<td>Brown</td>
<td>Waste Water</td>
</tr>
<tr>
<td>Dark Brown</td>
<td>Sludge</td>
</tr>
</tbody>
</table>

Where possible in ClearSCADA, the Contractor shall make use of the stored colour configurations within the database’s Config group. This ensures that colours match. Refer to “~Config.Colours.Legend” within the GRC SCADA database for the full GRC Colour Legend.

8.4.2 Appearance

All mimics shall use the GRC ClearSCADA mimic header template located in group ‘~Config.Symbols.Display’ to provide operators with the capability of navigating to other parts of the GRC network. Background colour for all mimics shall be #E0E0E0 (224, 224, 224).

ClearSCADA mimics are vector-based and as such are not built for a particular resolution.

All text used shall be kept in Arial font and use appropriate punctuation. Font sizes should be kept between 10 and 12 pt to maintain readability. All buttons and controls on ClearSCADA mimics shall be clearly labelled.

8.4.3 Equipment Information

When clicking on mimic objects depicting equipment, the Contractor shall make accessible to the operator any additional information for that equipment. This can be done through a ‘pick menu’ (a dropdown menu containing several options), through a tool tip (a basic text description displayed when hovering over the object), or through opening a popup/faceplate when clicked.

The Contractor shall identify the equipment information displayed by showing either its tag number or its unique name. The Contractor shall also display the state of the equipment in readable, written form (e.g. ‘Tripped’). Proper point configuration (see section 8.3.1) simplifies this task. Purely graphical depiction of this
state (e.g. a yellow pump graphic) shall only be used outside of these faceplates. This allows an operator with minimal site-specific experience to easily understand a plant’s state.

8.4.4 Housekeeping
Where possible, the Contractor shall make use of layering functionality to make objects within mimics easier to select and manipulate.

The Contractor shall keep use of internal HMI/SCADA logic to a minimum, to reduce server overhead and centralise all automation logic within the relevant PLC/RTU.

Similarly, in HMI applications the Contractor shall also conserve use of resource-intensive tasks (e.g. complex expressions and animations) to ensure appropriate operating performance.

8.5 Use of Templates
Where several (i.e. three or more) instances of the same type of equipment are used, it is suggested to use template functionality to easily reproduce identical instances of one type of equipment. Through ClearSCADA, this can be done through Template/Instance of Template functionality. Through PanelView HMIs, this can be done through the Global Object function.

- ClearSCADA templates shall override all properties necessary to make its individual instances (e.g. equipment tag name, outstation name, point number).
- Mimic/graphic overrides (i.e. allowing engineers to alter the appearance of each instance) shall be kept to a minimum, to ensure ease of changing instance appearance via altering the template.
- Default properties of the points in these templates shall abide by all requirements normally expected of ClearSCADA points.
- Where a point name cannot be changed due to a template restriction, the template itself should be named in order to be correctly identifiable.

Examples of existing GRC templates are included in Appendix A (Graphics Examples).

8.6 Trending
Each ClearSCADA point can be individually configured to record/historise its data. The exact requirements for this historic recording are specified in site/project-specific functional specifications.

Trending is configured to display and compare this historised data on axis scales (time vs. point value). These trends can be accessed through opening the point's associated menu. Alternatively, a trend object can be separately configured to compare several points against each other on a single time scale.

The Contractor shall ensure that SCADA points are correctly configured to record the state of important plant data (e.g. water quality) and retain the information for an appropriate length of time, and that all trends are scaled appropriately for operator readability.

8.7 Reporting
ClearSCADA reporting is performed by a Crystal Reports server connected to the ClearSCADA database.

Any desired reports will need to be able to execute on Crystal Reports on either scheduled intervals or user demand.

8.8 Alarming

8.8.1 ClearSCADA
Point states (e.g. true, false, above a certain threshold) may be configured for alarm or event functionality.
Event functionality is used for significant events that do not warrant operator acknowledgement. Examples of these events would be switching a motor from Auto to Manual, or resetting a 'run hours' counter.

Alarm functionality is used for significant events that warrant operator acknowledgement or rectification. Examples of this include pump faults, deviations from acceptable water quality standards, etc.

The severity of these alarms in ClearSCADA are defined as below:

- **Critical** (severity 1000) – Critical incident that affects plant ability to operate at all. Requires immediate attention; out of operation hours, a callout/SMS is generated to remote staff (who then notify on-call tradespeople, etc.).
- **High** (severity 667) – High-priority incident that affects plant ability to operate effectively. Operator should address incident before end of shift.
- **Medium** (severity 334) – Moderate-priority incident that affects plant ability to operate effectively. Operator should address incident within 24 hours.
- **Low** (severity 1) – Noteworthy incident that requires operator acknowledgement, but not immediate rectification.

The Contractor shall alarm all new points according to these severities. Though the capability exists to create new severities between 1 and 1000, this shall not be done without express consent of GRC.

Through compliance with this Standard (see section 8.3.1), the Contractor’s segregation of these points based on area allows operators to filter alarms based on group/area and severity.

In addition to these requirements, when equipment contains a point in alarm state, the alarm should be visible within the ClearSCADA mimic (e.g. an alarm bell above a pump). This allows easy identification of plant issues.

**8.8.2 Local HMIs**

Alarms generated within local HMIs shall be capable of alerting any operators to their presence, whether by displaying an alarm banner or redirecting the operator to an alarms page.

In the case of PanelView HMIs, it is recommended to put all necessary PLC alarms into an integer array, with each individual bit corresponding to a unique alarm.

Similar to the requirements set in ClearSCADA, these alarms shall be visually identifiable (e.g. through an ‘alarm’ indicator on the relevant piece of equipment) and only used for events that prevent the normal operation of a plant.
9 RTU SYSTEMS

9.1 Hardware

RTUs connect to the wider telemetry network via a mixture of Schneider Electric ‘Trio’ serial and Ethernet radios, where they can then interface with a SCADA network.

Schneider Electric SCADAPack RTUs are used by GRC to monitor and control small remote sites such as pump stations and several larger sites (e.g. water treatment plants).

The Contractor shall specify Schneider Electric E-Series SCADAPacks (e.g. SCADAPack 357E) when supplying RTU hardware. Deviations from this shall only be permitted with express approval from GRC.

Where RTU systems need to be supplied as part of a project, the Contractor shall confirm with GRC that the RTU and telemetry equipment supplied is compatible with the existing telemetry network. Examples of this include:

- Selecting hardware easily configurable to work with ClearSCADA (e.g. proprietary systems like MultiTrode may require an additional driver to work).
- Ensuring the radio supplied can broadcast at the frequency required.
- Ensuring that frequencies at which data is broadcast is appropriately licensed.
- Conserving radio bandwidth on shared-frequency networks.
- Installing and testing equipment (antennas, radios etc.) communications with existing infrastructure.

9.2 SCADAPack E RTU Configuration

The GRC communications network relies primarily on DNP3 to effectively communicate with many outstations at once. The outstations are configured to report back to the server based on ‘Class’ polls of each point. For example, a pump’s state would be polled more frequently by ClearSCADA than its accumulated runtime.

The Contractor shall make available all RTU configurations to GRC staff to ensure that points are appropriately classed to avoid congestion of radio traffic. The Contractor shall also acquire from GRC unique DNP3 device addresses and other unique communications addresses to use (such as Ethernet IP addresses, if the system is to connect to the wider GRC network) where required.

The easiest native method of making device data available to a SCADAPack RTU is by making use of its Modbus addressing.

<table>
<thead>
<tr>
<th>DNP Point Type</th>
<th>Modbus Register #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary Input</td>
<td>Discrete Input (10000 + DNP point number)</td>
</tr>
<tr>
<td>Binary Output</td>
<td>Coil (0 + DNP point number)</td>
</tr>
<tr>
<td>Analog Input</td>
<td>Input Register (30000 + DNP point number)</td>
</tr>
<tr>
<td>Analog Output</td>
<td>Holding Register (40000 + DNP point number)</td>
</tr>
</tbody>
</table>

It is important to note several things:

- While DNP is capable of using point number 0, Modbus protocols generally cannot use register number 10000, 30000 etc. It is suggested to avoid this number when using Modbus functionality. Similarly, in 5-digit mapping, point numbers beyond 9999 cannot be mapped.
- The above mapping is defined as the SCADAPack’s native or ‘legacy’ mapping. While custom mapping (5 or 6 digit) exists, the Contractor should avoid using this where possible to make configurations simpler to troubleshoot.
• While Modbus segregates each group separately, DNP only segregates between Analog, Digital and Counter points. For example, Analog Point 100 can be defined as an input or an output object, but not both, nor can an input and output object share the same point number.

• Any use of 32-bit values (long/double integers, floating points) must be declared in the RTU configuration. This will cause the RTU to allocate two registers for the one point, causing the succeeding registers to offset by one for each point declared this way.

Peer-to-peer communication between RTUs may be necessary when controlling remote systems via a PLC rather than purely SCADA-based or internally-derived logic. Where this is required, the appropriate function blocks shall be used, ensuring adequate communications without congesting radio traffic.

Existing ClearSCADA templates are in use to send diagnostics polls to SCADAPack E Series RTUs and Trio data radios. The following data points shall be included in SCADAPack config files (.rtu files) with the following configurations:

<table>
<thead>
<tr>
<th>DNP Point</th>
<th>Description/Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary 50100</td>
<td>ISaGRAF Application 1 Halted (Class 1)</td>
</tr>
<tr>
<td>Binary 50205</td>
<td>Local I/O Module Failure (Class 1)</td>
</tr>
<tr>
<td>Binary 50206</td>
<td>Local Input Power Supply Low (Class 1)</td>
</tr>
<tr>
<td>Binary 50207</td>
<td>Local Onboard Battery Low (Class 1)</td>
</tr>
<tr>
<td>Binary 50208</td>
<td>Local Calibration Parameters Invalid (Class 1)</td>
</tr>
<tr>
<td>Analog 50001</td>
<td>OS Firmware Version (g30v2, Class 0)</td>
</tr>
<tr>
<td>Analog 50060</td>
<td>Input Supply Voltage (g30v5, Class 1)</td>
</tr>
<tr>
<td>Analog 50062</td>
<td>Internal Temperature, deg C (g30v5, Class 1)</td>
</tr>
<tr>
<td>Analog 50090</td>
<td>CPU ID, low 32 bits (g30v1, Class 0)</td>
</tr>
<tr>
<td>Analog 50091</td>
<td>CPU ID, high 32 bits (g30v1, Class 0)</td>
</tr>
<tr>
<td>Analog 52000</td>
<td>ISaGRAF Application 1 Version (g30v1, Class 0)</td>
</tr>
</tbody>
</table>

All other data points should be configured as Class 1 events (if binary) and Class 2 events (if analog) unless explicitly approved by GRC. When setting the event threshold, network congestion should be taken into consideration.

9.3 **ISaGRAF**

Internal logic for SCADAPack RTUs shall be designed in ISaGRAF (Target 3).

Logic may be required for many different tasks, including peer-to-peer communication and plant control (e.g. bore or reservoir pumping), whether completely autonomously or by remote command.

The Contractor shall ensure the program will protect the plant (including local operators) from damage in both normal and abnormal circumstances. For example, a pump station RTU controlled by ClearSCADA should check the integrity of its communications while running the pump, and disable the pump in the event of a communications failure.

Due to the limited capabilities of ISaGRAF and the RTU processor, the Contractor shall keep any RTU logic functionality to a minimum. Due to peer-to-peer blocks only being available in functional block diagram, it is suggested to keep programs in this format or structured text.

Similar to RTU configurations, the Contractor shall also make available archives of all Isagraf code (.pia files) in the event of RTU troubleshooting or replacement.
APPENDIX A

Graphic Examples
Figure 1 - Example ClearSCADA display (no communications)

Figure 2 - Example HMI DOL motor faceplate
Figure 3 - Example ClearSCADA DOL motor faceplate (standard size)

Figure 4 - Example ClearSCADA DOL motor faceplate (small size/RTU version)
Figure 5 - Example ClearSCADA dosing pump faceplate

Figure 6 - Example ClearSCADA flowmeter faceplate

Figure 7 - Example ClearSCADA valve faceplate (solenoid version)
Figure 8 - Example ClearSCADA valve faceplate (positioner version)

Figure 9 - Example ClearSCADA system interface faceplate
# ENGINEERING STANDARD

## Electrical Work

| Document: | GRC-ES001 | Revision: | 2 |

## REVISION HISTORY

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Description</th>
<th>Prepared By</th>
<th>Approved By</th>
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<tr>
<td>1</td>
<td>10/09/2011</td>
<td>Original Issue</td>
<td>J. Hickey</td>
<td>C. Swanton</td>
</tr>
<tr>
<td>2</td>
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<td>Revised and Updated</td>
<td>B. James</td>
<td>C. Swanton</td>
</tr>
</tbody>
</table>

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1 PURPOSE

The purpose of this Engineering Standard is to describe the minimum general requirements for the installation of electrical and instrumentation equipment at Gladstone Regional Council sites.

2 SCOPE

This Engineering Standard is applicable to all electrical and instrumentation installation work carried out at Gladstone Regional Council sites.

This standard provides general installation requirements and shall be read in conjunction with the project specific scope of work document and all applicable manufacturer’s instructions.

3 RESPONSIBILITIES

All persons involved in the design, fabrication, supply or installation of electrical and instrumentation equipment and associated infrastructure for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent</td>
</tr>
<tr>
<td>Contractor</td>
<td>Person or company carrying out the electrical and instrumentation works</td>
</tr>
<tr>
<td>Contractor’s Representative</td>
<td>Person authorised to act on behalf of the Contractor</td>
</tr>
<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage in accordance with AS/NZS 3000</td>
</tr>
<tr>
<td>Install</td>
<td>Set out, erect, mount, align, fix, connect, adjust, test, commission and hand over in proper working order and shall also mean, unless stated clearly to the contrary, supply of the item(s)</td>
</tr>
<tr>
<td>ITP</td>
<td>Inspection and Testing Plan</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage, Exceeding 32VAC or 115VDC but not exceeding 1000VAC or 1500VDC</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>The corporation or business that manufactures and/or assembles the equipment described by this Engineering Standard</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
</tr>
<tr>
<td>Provide</td>
<td>Supply and install</td>
</tr>
<tr>
<td>PVC</td>
<td>Poly-vinyl Chloride</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>Remove</td>
<td>Disconnect, strip components, make safe and move redundant equipment to a nominated lay down area</td>
</tr>
<tr>
<td>RPEQ</td>
<td>Registered Professional Engineer of Queensland</td>
</tr>
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</table>
### Term | Definition
--- | ---
SAT | Site Acceptance Test
SCADA | Supervisory Control and Data Acquisition
Substation | Installations that convert high voltage to lower voltages to supply local equipment. The installation may include a fenced yard, buildings, transformers and switchboards
Supply | Purchase, obtain, store offsite as necessary, deliver to site, offload, position, store and protect on site
Superintendent | Person authorised to act on behalf of GRC with respect to the Contract works
Switchroom | Building that houses switchboards, motor control centres and other ancillary equipment
XLPE | Cross-linked Polyethylene

### 5 REFERENCE DOCUMENTS

All equipment and materials, and their installation and testing shall comply with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

#### 5.1 GRC Engineering Standards

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<td>GRC-ES008</td>
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<td>GRC-ES011</td>
<td>Plain, Reinforced and Prestressed Concrete</td>
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<tr>
<td>GRC-ES012</td>
<td>Earthworks, Drainage and Associated Works</td>
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<td>Typical DB Power Distribution Board – RCD with Test</td>
</tr>
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<td>GRC-ED-003</td>
<td>Typical DB lighting section – RCD with Test</td>
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<tr>
<td>GRC-ED-004</td>
<td>Typical DB with RCD internal arrangement</td>
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<td>GRC-ED-005</td>
<td>Typical DB with RCD label</td>
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<td>GRC-ED-010</td>
<td>Typical Schematic &lt;4kw DOL starter</td>
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<td>GRC-ED-011</td>
<td>Typical Schematic 4kw - 40kw Soft starter</td>
</tr>
<tr>
<td>GRC-ED-012</td>
<td>Typical Schematic &gt;40kw VSD</td>
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<td>Professional Engineers Act 2002</td>
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<td>Professional Engineers Regulation 2003</td>
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<td>Work Health and Safety Act 2001</td>
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<tr>
<td>Work Health and Safety Regulation 2011</td>
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6 GENERAL REQUIREMENTS

6.1 Health, Safety and Environment

The Council has a commitment to attaining the highest standards in health, safety, environment and community obligations. The Contractor shall comply with GRC’s health, safety, environmental and community policies and procedures.

a) The Contractor shall comply with GRC Safe Work Procedures for all work undertaken on site. The Contractor shall submit a Work Method Statement (WMS) prior to commencing work.

b) No work shall be carried out on live equipment unless specifically authorised by the Superintendent.

c) The Contractor shall comply with GRC isolation procedures for all work undertaken on site.

d) The Contractor shall use Job Safety Analysis (JSA) and Take 5 techniques for risk assessment. All possible measures shall be taken to reduce risks to appropriate and safe levels prior to commencing work.

e) All incidents shall be reported to the Superintendent as soon as is practicable.

f) The Contractor shall comply with all obligations under the Work Health and Safety Act and Regulations.

g) The Contractor shall comply with all obligations under the Environmental Protection Act and Regulations. This includes storage and disposing of contractor construction waste, chemicals and empty containers in the approved manner.

6.2 Low Voltage Insulated Gloves

All electrical workers on GRC sites, including Contractor employees, shall wear approved low voltage insulated gloves with a current test certification when working on or near live low voltage supplies. Damaged gloves shall not be used.

Typical work that will require gloves to be worn includes but is not limited to:

- Fault-finding on live low voltage power and control circuits.
- Testing low voltage circuits to confirm correct isolation.
- Calibrating or fault finding on low voltage supplied items of equipment.

The Contractor shall supply all gloves used by Contractor employees.

6.3 Cables Coated with Asbestos Based Fire Retardant Material

Contractors shall ensure that the correct work procedures are followed when work is performed that involves the installation or removal of cables and there is the potential for the disturbance of asbestos-based fire retardant material.

6.4 Asbestos Based Material in Switchgear Panels

Some older switchgear panels on GRC sites have arc chute covers and/or internal heat protection panels made of material that contains asbestos. Panels containing this material are identified on the panel door with a warning label. Contractors shall follow GRC safe work procedures for work to be undertaken in these panels.
6.5 Insulation Material Containing Chrysotile Asbestos Fibres

Some redundant control cabinets may have equipment-mounting boards fabricated from insulation material that contains chrysotile asbestos fibres. All control cabinets shall be inspected before disposal and any such boards shall be removed and disposed of at the Council's asbestos disposal site.

6.6 Capacitors Containing PCB’s

Redundant light fittings and control boxes may include capacitors that contain PCB’s. Unless it can be positively determined that the redundant capacitors do not contain PCB’s, they shall be removed from the fitting or box prior to their disposal at the Council's dumping area.

6.7 Prohibited Materials

Components that contain asbestos, mercury, cadmium, PCB’s, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short term effects on the health of personnel if they are inhaled, ingested or otherwise contacted during normal and reasonable use shall not be used in electrical equipment or installations on GRC sites.

All components supplied by Contractors as well as their own fabrication tools and equipment brought on site to carry out electrical installation work covered by this Engineering Standard shall comply with this requirement.

6.8 Site Inductions

The Contractor shall ensure that all Personnel working on Site must have obtained all relevant GRC inductions prior to work commencing.

6.9 Supervision

All work shall be supervised throughout by a competent person or persons experienced in the type of work being performed. Unless agreed otherwise by the Superintendent, the Supervisor shall:

a) Be nominated prior to commencement of work and their name and contact details provided.

b) Be contactable at all times for the duration of installation and commissioning periods.

c) As far as practical be the same person(s) for the duration of the project.

d) Be at the worksite as often as is necessary to adequately carry out the tasks given below:

- Supervise tradesmen and liaise with the Contract Superintendent.
- Ensure all workmanship is to be of the highest standard throughout.
- Understand all aspects of the scope of work and ensure that work is completed according to scope.
- Be responsible for ensuring that work is carried out according to applicable regulations, standards, safe work practices and levels of workmanship.
- Ensure that work is carried out according to schedule and be familiar with schedule constraints.
- Keep the Contract Superintendent informed of progress and any issues needing resolution.
- Obtain authorisation in writing for any cost variations before work outside the scope is performed.
6.10 Personal Protective Equipment (PPE)

a) The Contractor shall provide all PPE, unless stated otherwise to meet GRC Site Standards. As minimum, hard hats, safety glasses, steel-cap boots and high visibility clothing shall be worn at all times while on site.

b) It is the Contractor’s responsibility to ensure that all Sub-Contractors under their supervision are informed of the PPE requirements on site.

6.11 Quality of Workmanship

a) All work carried out shall be to a high standard of workmanship. Competent personnel experienced in their respective work shall complete all work in a neat, substantial and tradesman-like manner, in accordance with the current best practice.

e) Personnel carrying out any particular task shall be suitably qualified, trained and possess the necessary skills to complete the task to a high standard of workmanship.

f) All electrical works shall be performed by electrical tradesmen with a current Queensland Electrical License working under a person with an Electrical Contractor’s License, licensed under the Queensland Electrical Workers and Contractors Act.

g) The Contractor shall provide all quality assurance installation verification documents such as ITPs, test and check sheets signed by the Contractor’s Representative.

h) Building structures and surfaces that are disturbed in effecting the electrical installations shall be restored to their original condition.

i) The Company reserves the right to inspect all works and request re-work if the quality of work is not acceptable to the Company’s Representative. If the Company’s Representative is not satisfied that the personnel carrying out particular work possess the necessary skills, the Contractor shall provide alternative personnel.

6.12 Equipment and Materials

a) All materials and equipment shall be new, free of defects, of the best quality and of a design most suitable for operating under the conditions prevailing at the site. Materials and equipment shall operate without distortion, deterioration or subject to excessive stresses that might affect the performance or life of the equipment or materials.

j) Equipment selection and design shall be based on greater than 20 years’ reliable operational life.

k) Unless specified otherwise, all equipment used on the installation shall be selected in accordance with Engineering Standard GRC-ES002 – Preferred Electrical Components.

l) The Contractor shall take delivery of, load or unload as necessary, transport to the site, securely store and protect the equipment and materials.

m) The Contractor shall submit to the Superintendent for approval a list of the materials proposed to be supplied for the installation. The Contractor shall provide complete details, including catalogue information, for the proposed equipment for installation.

6.13 Painting and Surface Preparation

Steelwork surface preparation, anti-corrosion protection and the surface coating system shall be to Australian Standards. Evidence shall be provided that these items meet the relevant Australian Standards.
The painting system used for local control stations and other field panels shall be powder coated to a total thickness of 70 microns. The standard painting system of the supplier may be used provided details of the system are submitted and approval for use is received from the Purchaser.

a) The colour and finish of Local Control Stations and field panels shall be ‘Pale Eucalypt'
b) Escutcheon panels shall be ‘Gloss White’

6.14 Equipment Identification and Labels

a) Each item of electrical and instrumentation equipment, including all internal and external components and accessories, shall be clearly identified by an engraved or etched label. Labels shall be marked with the identification number and name of the equipment.
b) All labelling shall be provided in accordance with Engineering Standard GRC-ES008 – Equipment Identification Labels.
c) For new installations, safety signage shall be fitted to comply with AS 3000 and for high voltage installations AS 2067.

6.15 Drawing Control

The Contractor shall not carry out any electrical installation work without approved drawings marked ‘For Construction’ and a Scope of Work document. All work shall be carried out in accordance with the approved design documentation.

The Contractor shall be responsible for the control of all drawings once they have been issued for construction. The Contractor shall ensure that a paper copy of all drawings marked “MASTER” is available before construction starts. The master copy shall include all latest mark ups to show the “As Built” status of the equipment. This will also apply for the installation of equipment in a prefabricated building off-site.

The Contractor shall be responsible for the provision of ‘As-Built’ installation drawing markups. This shall include the following:

- Create a master set of drawings (each drawing must be stamped MASTER).
- Make available the master set at all times in the switchroom for inspection by the Superintendent.
- Update the “Master” drawings with red ink during installation, commissioning and testing to show the as built status of the equipment.

At the completion of the contract, the Contractor shall submit a complete set of the contract drawings to the Superintendent stamped “As-Built” and individually signed and dated by the Contractors Representative. This set of drawings shall reflect and contain all variations between the issued contract drawings and the actual installation marked-up in red ink.

The Contractor shall provide all necessary QA documents to the Superintendent for approval, prior to energising the installation. The QA documents include inspection and test plans, test sheets and check sheets. These documents shall be approved and signed by the Contractor’s Representative.

6.16 Change Management

The Contractor shall bring to the attention of the Superintendent any errors or omissions that are detected in the design documentation.
The Contractor shall check and confirm on site all cable lengths and distances prior to cable installation and advise the Superintendent if there are any discrepancies.

The Contractor shall not vary from the approved design documentation without prior approval.

6.17 Interference

Contractors shall not interfere with the operation of or hinder access when working alongside an operating facility without prior written notice to and written approval from the Superintendent.

6.18 Operation of Council’s Equipment

Contractors shall not operate or attempt to operate any of the Council’s process equipment and facilities under any circumstances.

7 INSTALLATION OF ELECTRICAL EQUIPMENT

7.1 General

a) The location for the installation of equipment shall be determined from the contract drawings and in consultation with the Superintendent on site. All locations shall be selected and equipment oriented to provide access for maintenance. All locations shall be approved by the Superintendent prior to the equipment being installed.

b) Unless approved otherwise, all electrical equipment shall be arranged such that cabling is bottom entry.

c) Following the installation of equipment, protection shall be provided for that equipment against any damage that might occur due to the construction activities taking place.

d) The Contractor shall be responsible for the manufacture of minor support structures to suit particular requirements.

e) Any damage that occurs to equipment after installation shall be made good to the satisfaction of the Superintendent, or the equipment replaced.

f) If damage occurs to the protective coating of any equipment after installation, a temporary protective coating of zinc enriched paint or similar shall immediately be applied to prevent the development of corrosion prior to a full restoration of the protective coating.

g) At the completion of installation, the equipment shall be left clean, painted, tested, in good and serviceable order and all electrical test sheets shall be submitted to the Superintendent.

h) The centre of all control stations, instruments, meters, light switches and power outlets shall be 1300mm above the operating floor or platform level. All field equipment shall be mounted so that cabling is bottom entry, unless stated otherwise.

i) Final locations of all equipment, including cable ladder and conduit routes, shall be verified by the Superintendent prior to commencement of equipment installation.

7.2 Electric Motor Driven Equipment

Installation of motor driven equipment and the alignment of motors will generally be carried out by others.

7.3 GRC Owned Power Transformers

a) Transformers shall be installed in accordance with the project drawings and manufacturer’s instructions.
b) Transformers shall be mounted on a properly engineered and designed concrete plinth and levelled using shims prior to bolting down.

c) Cables to the transformer shall be installed in underground conduits or in accordance with the project drawings and terminated in accordance with this Engineering Standard. The Contractor shall check phasing before final cable connections are made.

d) Auxiliary equipment that has been removed for transport shall be fitted in accordance with the manufacturer’s instructions.

e) The earthing to the transformer and in the transformer compound shall be installed in accordance with the project drawings.

f) The Contractor shall ensure that the transformer oil tapping connection is readily accessible for maintenance personnel to take oil samples.

7.4 Motor Control Centres

a) Motor Control Centres shall be designed and manufactured in accordance with the requirements of Engineering Standard GRC-ES004 – Motor Control Centres.

b) Motor Control Centres (MCC) shall be erected and assembled strictly in accordance with the contract drawings and with the manufacturer’s installation instructions.

c) The Contractor shall ensure that there are appropriate clearances between opened panel doors from the MCC, other equipment and switchroom walls.

d) The motor control centre may be shipped in sections which will require joining of the sections and the busbars. Each shipping section shall be provided with lifting lugs. The Contractor shall use the switchboard lifting lugs for lifting and handling so that no distortion will result from lifting. The Contractor shall use rollers to move the MCC sections and take care not to damage the switchroom floor, walls and other equipment. The MCC shall be firmly bolted to the switchroom foundation steelwork or secured by appropriately sized masonry bolts to a concrete floor. The MCC sectioned busbar joints shall be bolted with a torque wrench using torque settings supplied by the MCC manufacturer.

e) Cable entries shall be bottom entry. If top cable entry is required, the Contractor shall obtain approval from the Superintendent. Cable entry gland plates shall be 6mm thick brass or aluminium plate and solidly bonded to the MCC earth bar with an earth conductor of minimum size 25mm².

7.5 Distribution Boards

a) Distribution boards shall be designed and manufactured in accordance with the requirements of Engineering Standard GRC-ES005 – Light and Power Distribution Boards.

b) Field distribution boards shall be mounted on brackets fixed to steel work, or on a suitable stand. Outdoor distribution boards shall be provided with a protective sun shield and overhanging rain hood.

c) The top of the distribution boards should be 2000mm above the operating floor or platform level.

d) Power and lighting circuits shall have earth leakage protection set at 30mA for both single and three phase circuits.

e) If required, distribution boards shall be fitted with daylight control circuits and emergency lighting test circuits.

f) When a sub-circuit is connected into a distribution board, the cable cores shall be identified with PVC slip-on markers with black characters on a white background. An active wire shall be numbered with the same number as the circuit breaker to which it is connected, e.g. CB5-A. The neutral wire shall be numbered with the same number as the circuit breaker to which its active conductor is connected, e.g. CB5-N, and shall be connected into the corresponding
neutral bar hole, e.g. hole number five. The earth wire shall be numbered with the same number as the circuit breaker to which its active conductor is connected, e.g. CB5-E, and shall be connected into the corresponding earth bar hole, e.g. hole number five.

g) As-built circuit schedules shall be installed in clear plastic sleeves mounted on the inside of each distribution board’s door.

7.6 PLC, HMI, Control and Communications Panels

a) PLC, Control and Communications Panels shall be installed in accordance with the project layout drawings, in nominated locations with sufficient space for accessing inside the panels with opened doors.

b) The panels may be installed on a plinth subject to the project requirements.

c) The centre of HMI screens shall be 1500mm above floor level.

d) Instrument and control cables shall be terminated to the terminals specified on the project drawings. Stripped cores of the cables shall be contained neatly in cabinet ducting with sufficient excess length.

7.7 UPS, Battery Chargers and Batteries

a) UPS and Battery Chargers shall be installed in accordance with the project drawings and supplier recommendations. A UPS bypass switch shall be installed in a nominated location in the vicinity of the UPS and shall be easily accessible for operation.

b) Batteries shall be installed in a battery cabinet strictly in accordance with the manufacturer’s instructions. Battery installations in buildings shall comply with AS 3011.

c) Adequate venting shall be provided for batteries installed inside cabinets as per supplier’s recommendations.

7.8 Motor Local Control and Isolator Stations

a) Local Control Stations (LCS) shall be designed and constructed in accordance with the approved drawings and shall incorporate the following features as a minimum:

- Enclosure fabricated from 1.6mm 316 grade stainless steel with a minimum IP65 protection rating. Enclosure shall incorporate a 316 grade stainless steel rain hood.
- Minimum enclosure dimensions of 400mm height, 300mm width, 200mm depth.
- Three phase motor isolator with auxiliary contact, interlocked with enclosure door so that enclosure can only be opened with the isolator in the OFF position.
- Emergency stop pushbutton.
- Din rail terminal block for termination of control cables in accordance with the approved drawings.
- Earth terminal bar.
- 5mm thick brass gland plate.

b) Where specified by the approved drawings or documentation, manual stop/start pushbuttons and a control selector switch, along with any required control terminals and internal wiring, shall also be included in the LCS.

c) Each isolator shall be fitted with an auxiliary N/O contact to enable isolated status indication and interlocking with the starter contactor.

d) The line terminals of each isolator shall be shrouded to prevent accidental contact.
e) The emergency stop pushbutton shall have a red mushroom head operator that will latch in the OFF position. Manual stop and start pushbuttons shall be red and green respectively.

f) Control selector switches shall be three position switches and shall be labelled LOCAL-OFF-REMOTE unless specified otherwise.

g) Each local control station shall be located adjacent to, or within six metres (process permitting) of the motor being controlled and in a position that provides a clear view of the motor.

h) Local control stations shall be located such that an operator is not exposed to process substances or other operating hazards.

i) Local control stations shall not be located where they are exposed to damage from maintenance activities or passing traffic.

j) Each local control station shall be installed on a mounting frame and stand. The LCS for groups of drives may be located on a common stand in a central location.

7.9 Field Junction Boxes and Panels

a) Field junction boxes and panels shall be selected in accordance with the requirements of Engineering Standard GRC-ES002 – Preferred Electrical Components.

b) Field junction boxes and panels shall be fabricated from 316 grade stainless steel with a minimum IP65 protection rating.

c) Field junction boxes and panels shall be mounted on brackets fixed to steel work or on a suitable stand, and if exposed to the weather shall be fitted with overhanging rain guards. Where exposed to sunlight a sun shade shall be fitted.

d) Field junction boxes and panels shall be fitted with a hinged door secured with a locking mechanism. Cables shall be terminated on gland plates of brass or aluminium, of minimum thickness 5mm.

7.10 Lighting

a) Notwithstanding the location shown on the drawings, the Contractor shall ensure that each light is located in a position that provides safe access for maintenance. Preference shall be given to locating light fittings where they can be reached from an existing platform or walkway.

b) The Contractor shall bring to the Superintendent’s attention prior to installing the fittings, any lighting locations as shown on the drawings that will not allow safe access for maintenance, or are not appropriate in that location. Light fittings shall be installed complete with lamps, lenses, reflectors, guards and covers.

c) The Contractor shall ensure that light fittings installed in rows are positioned in a straight line and at the same height.

d) Light fittings shall be securely screwed or bolted directly to building structures, or to brackets that are bolted to mounting poles or welded to the structure. All mounting poles shall be fitted with a facility to lower the pole for maintenance. The poles shall be located and oriented to allow unimpeded lowering and safe and convenient access to the light fitting when in the lowered position.

e) Control gear shall be installed within 12m of the light fitting and in locations easily and safely accessible without the use of ladders.

f) Indoor office light fittings shall be fitted with flexible cables and plug tops. A matching outlet shall be installed adjacent to the fitting and connected to the permanent wiring.

g) Where required, junction boxes shall be installed at light fittings to permit the looping of wiring from fitting to fitting. These junction boxes shall be installed in easily accessible locations and shall be an approved three way weather proof type.
h) High bay lighting shall be suspended from a galvanized steel bracket by two galvanized shackles. Two stainless steel safety chains shall be installed, attached to the light fitting body at one end and the building at the other by threaded nuts and bolts with flat and spring washers. High bay light fittings shall be fitted with a 2.5mm² flexible cables and plug tops. A matching outlet shall be installed adjacent to the fitting and connected to the permanent wiring.

i) Floodlight fittings shall be provided with an aiming angle indicator and after installation shall be aimed at the angle shown on the drawings.

j) The exterior lighting shall be controlled by a daylight switch. The daylight switch shall be installed in the nominated outdoor location. A bypass control switch, marked BYPASS-AUTOMATIC-OFF, shall be installed in the distribution board with the lighting control contactors.

k) Emergency light fittings shall be located in corridors, walkways, and stairs and above exit doors in accordance with AS2293. They shall be connected to the local lighting circuit and arranged to switch on when the local lighting fails, but not when local lighting is switched off.

l) An inspection of the lighting shall be undertaken during the hours of darkness to verify light levels, glare and the aiming of light fittings. Illuminance readings shall be taken at regular intervals and marked on lighting layout drawings and submitted with the as-built drawings.

7.11 Socket Outlets

a) Socket outlets shall be installed at the locations indicated on the contract drawings and on building columns. If no columns are available, the Contractor shall install a stand for the outlets.

b) All socket outlets shall be supplied from a circuit breaker with 30mA earth leakage protection.

c) All socket outlets installed in offices or in control room areas shall be moulded plastic, flush mounting and coloured white.

d) All socket outlets installed in outdoor and plant areas shall be Clipsal 56 HD IP56 series.

e) Welding outlets shall be placed so that any location where welding is likely to be required will be within 30m from the outlet. Welding outlets shall be 415V, three phase + neutral, 50A, 5 pin outlets, unless otherwise stated. The 3-phase outlets for welding equipment and other portable tools shall be protected by appropriate Residual Current Devices (RCD) with 30mA sensitivity.

7.12 Lightning Protection

a) Lightning protection shall be installed on structures as required by the project drawings and requirements of AS/NZS 1768 - Lightning Protection.

b) The lightning protection system shall include air terminals, down conductors, earth electrodes and an earthing system. All equipment shall be approved for the purpose of lightning protection.
8 INSTALLATION OF INSTRUMENTS

8.1 Storage and Handling

Upon receipt, all instruments and ancillary equipment shall be kept in a dust and weatherproof store. When instruments are taken from the store for testing, they shall be returned to the store and repacked. All instruments shall be transported and handled with the utmost care. All covers and plugs on instrument connections shall be left in place until the proper connections are made. Machined surfaces such as flange facings shall be protected by covers until they are installed.

8.2 Calibration and Testing

a) The Contractor shall determine the requirements for calibration and testing of the various instruments according to the manufacturer's recommendations and in consultation with the Superintendent. Calibration and function testing shall be carried out on the instruments for which it is required and the results recorded. Where possible, the testing or calibration shall be performed in the Contractor's site workshop prior to installation of the equipment on site.

b) All test equipment used shall be calibrated to a NATA traceable standard, which has been calibrated within six months of the date of the tests to be performed and shall have accuracy equal to or exceeding that of the manufacturer's stated accuracy of the equipment under test. The Contractor shall submit copies of the calibration certificates to the Company's Representative prior to carrying out any calibrations.

c) The personnel performing the calibrations must be fully conversant with both the equipment to be tested and the test equipment to be used.

8.3 Programming and Configuration

Unless directed otherwise, the Contractor shall enter all parameters, settings and configuration data required by any programmable instruments. This data will be the basic data for the application. Fine tuning of the configuration will be carried out by GRC.

Program and configuration details and data sheets shall be provided to the Superintendent in electronic format.

8.4 Layout, Location and Arrangement

a) The Contractor shall ascertain on site, in consultation with the Superintendent, the exact location of all equipment to be installed including the location of instruments, instrument stands and brackets, instrument air reticulation, signal and impulse tubing, and the routing of cable ladders, conduits and cables.

b) Unless directed by the Superintendent, all field equipment shall be arranged so that cabling is bottom entry. The Contractor shall inform the Superintendent accordingly, and modify at his own expense, any top or side entry equipment.

c) Equipment shall have adequate clearance from other services and, when mounted along or in access ways, shall be positioned, modified or protected such that it does not present a hazard to vehicular or pedestrian traffic using the access way, nor be subject to accidental operation or damage. Access for the removal and replacement of in-line measurement and control devices must be considered when the mounting position of devices is being determined.

d) Instrument stands shall be mounted on concrete slabs, opposed to welding or securing to building columns, concrete structures or tanks.

e) Equipment and/or accessories shall not be mounted on building cladding or top handrails. Where equipment is mounted in close proximity to handrails, the supporting stands or bracketing shall be spaced to leave the handrails at least 75mm clear of obstruction.
8.5 Work Normally Excluded

The Electrical/Instrumentation Contractor’s scope of work will not normally include the installation of in-line instruments. The Mechanical/Piping Contractor shall be responsible for the installation of all in-line devices and equipment requiring mechanical installation works. These shall include but not be limited to:

- Control Valves.
- In-line Solenoid Valves.
- Orifice Plates, Tapping Points and Flanges.
- Magnetic Flowmeters.
- Thermowells.
- Instrument Air Supply headers including the primary isolation valves for each consumer.
- Process connections on pipe work.

The Contractor shall be responsible for liaising with the Mechanical/Piping Contractor during the installation of the above equipment, and shall provide the Mechanical/Piping Contractor with any instrument manufacturer's specific installation details or tolerances that may affect the instrument's performance.

8.6 Mounting

a) All instruments shall be mounted in accordance with the applicable instrument installation detail or manufacturer’s recommendation.

b) All instruments other than types specifically designed for vessel or pipe mounting shall be mounted on stands or within a panel.

c) All equipment shall be mounted so that it is accessible from the ground or platform without the use of ladders or scaffolding, unless otherwise approved by the Superintendent.

8.7 Instrument Labelling

The Contractor shall supply, engrave and fix in position nameplates and labels for the following items of equipment.

- Instrument tag numbers if not supplied with the instrument.
- Junction Boxes.
- Cables.
- Earth Terminal Bars.

Nameplates and labels shall be stainless steel, unless otherwise approved. Refer to GRC Engineering Standard ES008 - Labelling, for specific details.
9 INSTALLATION OF CABLES

9.1 General

a) All cables shall be as specified on the approved cable schedule. The Contractor shall obtain approval from the Superintendent for any departure from the specified cable types. Cable lengths shown on the cable schedule are approximate and it is the responsibility of the Contractor to verify all lengths. The Contractor shall advise the Superintendent if any cable lengths in the cable schedule are short. The Council will not except any claims based on lengths stated in the cable schedule.

b) The Contractor shall ensure by calculation, that cable sizes for unscheduled cables are rated correctly for current carrying capacity, voltage drop, fault withstand capacity, earth fault-loop impedance and other requirements in accordance with AS/NZS 3000 and AS/NZS 3008.

c) Low voltage power cables shall be multicore copper conductor with an integral insulated earth core, V90 insulated, 0.6/1kV grade PVC/PVC or XLPE/PVC orange circular cables to AS/NZS 5000.

d) Single core (SDI) V90 insulated, 0.6/1kV grade PVC/PVC or XLPE/PVC orange circular cables to AS/NZS 5000 may also be used where indicated on the cable schedule.

e) Earth cables shall be single core, stranded copper cables with 0.6/1kV Green/Yellow PVC single sheath insulation.

f) Variable speed drive motor power cables shall be 3 core + 3 earth EMC screened, 0.6/1kV grade XLPE/PVC to AS/NZS 5000.

g) High voltage power cables shall be 3 core XLPE insulated, screened and PVC sheathed with a voltage rating of 3.8/6.6kV, 6.35/11kV or 12.7/22kV to suit the application requirements.

h) Control cables shall be 0.6/1kV PVC/PVC with white cores and black core identification numbers, integral insulated earth core and black overall sheathing.

i) Instrument cables shall be PVC insulated PVC sheathed twisted pairs with individual and overall screen.

j) All cable types shall have metre markings stamped on the outer cable sheath.

9.2 Segregation of Cables

a) With the exception of fibre optic cables, no cables other than HV cables shall be installed in HV cable ladders or conduits.

b) Control, instrumentation or communications cables shall not be installed in the same conduit or duct as HV or LV cables.

c) Screened signal cables shall not be installed within 300mm of high or low voltage power and control cables.

d) Where ELV or signal cables run on the same ladder as low voltage power and control cables, a dividing barrier shall be installed on the ladder for the full length and a minimum spacing of 300mm maintained between the cables.

e) Network data and voice communications cables shall not be installed in the same cable ladder or conduit as HV, LV or ELV cables. They shall be installed in their own dedicated cable ladder or conduit.

9.3 Fibre Optic Cables

a) Fibre optic cables may be installed in any cable ladder with a preference for installation in HV cable ladders.
b) When fibre optic cables are not installed in cable ladder they shall be installed in individual steel conduit or galvanised conduit for mechanical protection, with similar requirements to those applicable to power cables.

c) When the destination of a fibre optic cable is the same as that of a power or control cable, they may be installed in the same conduit provided there is sufficient capacity for both cables.

9.4 Top Entry Cables

a. Where cables enter a conduit or duct from above, provision shall be made to prevent the entry of water or other liquids by filling around the cables with a water-based silicone sealant and sheathing overall with a black heat shrink sleeve. Solvent-based sealants shall not be used.

b) Drainage openings shall be provided at the lowest point of the conduits nearest to the point of entry. Flexible conduits shall be drilled with a 6mm minimum diameter hole at their lowest point for drainage.

9.5 Bottom Entry Cables

Cable entries into all field mounted equipment shall be bottom entry as a first the first preference, followed by side entry where practical, to minimise the potential ingress of substances.

9.6 Protection of Installed Cables

a. Regardless of the method on installation, the Contractor shall ensure that all cables are fully protected from the risk of damage including mechanical impact, vibration, heat, chemical attach and termites.

b. The Contractor shall select cable routes to minimise risk of damage and install conduits, brackets, covers, barriers, vibration damping and whatever means are required to protect cables from the likelihood of damage.

b) All cables installed externally to a switchboard or electrical panel shall be installed in either cable ladder or conduit for the full length of the cable in accordance with the requirements of Sections 11 and 12 below.

c) Any cables leaving a cable ladder or conduit for connection to a final device shall be protected using heavy duty PVC sheath non-metallic flexible conduit and compatible nickel plated brass or stainless steel fittings and glands.

9.7 Sealing of Cable Penetrations

a. Any penetrations created for cable entry shall be sealed after completion of cable laying. Unused holes and conduits shall also be sealed. The sealing method used shall restore the integrity and degree of weatherproofing of the original surface.

b) A non-combustible foam sealant may be used to create a non-fire rated seal. Any excess foam shall be removed to leave a neat finish. Penetrations through fire rated walls shall be sealed in such a way that the original fire rating is restored. An approved fire rated mortar such as KBS Mortar shall be used. The section of cables inside the area to be sealed shall be carefully cleaned and the mortar installed in accordance with the manufacturer’s instructions.

9.8 Marking of Cables

a. All cables shall be identified with an approved cable marker and in accordance with Engineering Standard GRC-ES008 – Equipment Identification. The marker shall be engraved with the cable number as shown on the cable schedule. Cable markers shall be laser etched stainless steel tags attached to the cable with a minimum of two cable ties.
b) Cable markers shall be attached at each end of the cable as a minimum. The location of the cable marker shall be selected to allow ease of reading as follows:
   - Prior to the cable entering an enclosure for field mounted enclosures and MCC entries.
   - Both sides of the gland plate for bottom entry enclosures where both sides of the gland plate cannot be viewed from the one location e.g. bottom entry MCC’s and switchboards inside a substation.
   - Single core power cables shall have 150mm of coloured heat shrink applied at the termination point of the cable. The colour of the heat shrink shall indicate the phase of the cable e.g. red, white or blue.

10 TERMINATION OF CABLES

10.1 General

a. All cable cores shall be terminated including earths and shields with the exception of spare control cable cores. Each core shall be fitted with the correct type of lug or pin and crimped, except when insulation displacement terminals are used. Each core shall be identified, either with a ferrule number or by colour.

b) Cables not installed in conduit shall be fitted with the correct compression gland. Instrument cable shielding shall be earthed in accordance with the drawings and generally at the source end.

c) The cable shall be arranged, clamped or otherwise supported so that the termination is not supporting the weight of the cable.

d) HV cable terminations shall be carried out by suitably qualified personnel experienced in HV cable terminations.

10.2 Termination of Low Voltage Power Cables

a. The cores of LV power cables shall be terminated with the correct size crimp lug. The exposed conductors shall be completely enclosed within the barrel of the lug prior to crimping. Lugs shall be crimped with a crimping device which, if hand operated, shall be of a type that will not release until the correct crimping pressure has been reached. All conductors with a cross-sectional area less than 6mm² shall be terminated by means of insulated crimp (bootlace ferrule) or compression lugs unless otherwise specified. Preferably, only one wire shall be crimped in each lug or pin.

b) Uninsulated lugs shall be insulated by applying phase coloured heat shrinkable sleeving over the barrel of the lug and equal distance along the conductor sheath.

c) Electrostatic screening present on VSD power cables shall be earthed at both ends of the cable over the largest surface area possible. Earthing at motors shall be achieved using a gland designed for this purpose (EMC), and earthing at the VSD cubicle shall be achieved by clamping the screen to an earthed bar.

d) All armouring for cables carrying low voltage and higher shall, when entering non-metallic boxes, be earthed through the cable gland to an earthed stud inside the box.

10.3 Termination of Control and Instrumentation Cables

a. External sheathing shall be stripped back to within 50mm of the point where the cable enters the termination enclosure. Sufficient length of cable shall always be left to permit re-termination, and the preferred arrangement is for cables cores to be cut such that each core can reach the most distant terminal in the relevant terminal strip. Wiring not contained within a duct shall be neatly loomed and tied with PVC cable ties.
b) All cores of control and instrument cables shall be terminated at both ends of the cable with the exception of spare cores. Each spare core shall be fitted with a ferrule marked SPARE, boot-laced and terminated. If terminals for termination of spare cores are not available, the bare spare core ends shall be cut off flush with core insulation, terminated to a blue point connector and left in the duct.

c) For screw type terminals, correct sized crimp lugs or ferrules shall be crimped to the conductor and screen drain wire with a crimping tool of a type that will not release until the correct crimping pressure has been reached. The drain wire shall be sleeved with a clear sleeve prior to crimping. The crimp lug or ferrule shall be inserted into the terminal and the screw tightened to the correct torque.

d) For insulation displacement type terminals, the wire shall be inserted into the terminal using the correct tool and technique. Drain wires shall be sleeved with clear sleeving prior to termination.

e) Screen drain wires for instrument cables shall be terminated to an earthed terminal at the switchroom end. In marshalling boxes, screens shall be cut off at the end of the cable bedding, and drain wires shall be fitted with clear PVC insulating tubing. The exposed screen at the end of the bedding shall be insulated with black heat shrink tubing. Drain wires shall be connected at dedicated terminals to ensure continuity of the screen shielding system.

f) At field equipment, the screens and drain wire shall be cut off at the end of the cable bedding, and the exposed screen at the end of the bedding shall be insulated with black heat shrink tubing.

g) The requirements for earthing of protective screens may vary from situation to situation and care shall be taken to comply with the drawings in each case.

10.4 Ferruling of Control and Instrument Cable Cores

All control, instrumentation and communications cables shall have numbered ferrules fitted to each core and to the screen drain wire. Numbers shall be in accordance with the contract drawings. Ferrules shall have black characters engraved on a white strip and fitted into a transparent carrier. The carrier shall be a type that encircles the core and shall be sized such that it will not slip off over the lug or pin.

10.5 Termination of Communications Cables

a. The termination of communication cables shall be carried out correctly and in accordance with any specific requirements applicable. Communications cables terminated at terminals shall be terminated generally as above with the exception of removal of the outside sheath. The length of cable stripped out of the outside sheath and protective shield for termination shall be kept to a minimum and the twisting of the pairs shall continue up to the terminals.

b) Where there is a requirement to fit a plug or terminating device to a communications cable, this shall be done correctly, in accordance with the relevant instructions and by personnel skilled in such tasks. Care shall be taken to earth the shield or screen in accordance with the relevant instructions. General practice shall be to make the screen continuous along the communications link and earthed at one end only.

10.6 Jointing of Cables

a. All new cables shall be installed as continuous lengths with no joints other than when it is not possible or practicable to obtain sufficient length from the manufacturer for a single run.

b) Cable joints may also be accepted when existing cables are extended to accommodate relocation of equipment. When joints are required, they shall be approved by the Superintendent. The location of the joint shall be chosen to provide good access for later inspection and repair, and shall be marked on the drawings.
c) Joints in power cables shall be a resin encapsulated type and shall generally be located in the cable ladder. Joints in control, instrumentation and communications cables shall be made at labelled terminal blocks in junction boxes and shall be mounted on columns or similar to provide good access from either ground level or a platform.

d) Joints in all underground cables shall be a resin encapsulated type, shall be made in a cable pit and covered by a concrete cover marked “Cable Joint Below”.

10.7 Cable Glands and Shrouds

a. Cable sealing glands shall be used to terminate all cables except those terminated using flexible conduits and fittings. Glands shall be 316 grade stainless steel or nickel-plated brass UFP types unless specified otherwise.

b) Stainless steel cable glands shall be used to terminate all HV cables.

c) Aluminium cable glands shall not be used for any application on site.

d) PVC shrouds shall be used on all glands on site, to reduce the possibility of ingress of moisture past the gland.

e) 11kV and 3.3kV cable glands regardless of their connection being top or bottom entry into an enclosure, shall have UV stabilised heat shrink applied to the glands.

f) PVC glands may be used in switchrooms and control rooms only unless specified otherwise.

10.8 Redundant Cables

10.8.1 Removal

Redundant cables shall be completely removed unless otherwise specified. The following procedure shall generally be followed for all cable removal:

a. Isolate cable source of supply following standard isolation procedures and confirm cable is dead by testing at both ends of the cable.

b) Disconnect both ends of the cable.

c) Verify further that the correct cable has been isolated by shorting two cores at one end and testing the other end with an ohmmeter.

d) Proceed to remove the identified cable and cut the cable off in short sections after removal where the loose end of the cable is within the field of vision of the person cutting the cable. The cut-off point shall be reached by ‘hand over hand’ identification of the cable from the loose end.

Following the removal of all redundant cables from a location, all holes in switchboards, MCC’s, terminal boxes and the like shall be plugged, sealed, or, in the case of the removal of a large number of cables from a location, a new blank gland plate shall be provided. The method adopted shall not compromise the IP rating of the enclosure or lessen the electrical integrity of the equipment.

When cables have been removed from building penetrations and fire rated or weatherproofing sealant has been disturbed, removed or holes are left in it by cable removal the Contractor shall restore the integrity of the sealant using Council approved sealant suitable for the location after all redundant cables have been removed.

10.8.2 Removal of Large Numbers of Redundant Cables

Where a project such as the replacement of an MCC requires the removal of a large number of redundant cables Contractors may delay removal of individual cables until all cables to be removed
as a part of the project have been isolated and identified and/or the new installation has been commissioned. All redundant cables may then be removed at the same time.

Individual cables awaiting removal shall be identified and bonded as per Section 10.8.4 below and temporarily stored in a manner that does not interfere with other activities in the area.

The above requirement to bond, tape and identify a cable that will be completely removed the same day it is disconnected need not be carried out. However, any cable that is only partially removed at the end of the working day shall be identified, bonded, taped and then safely stored ready for removal the next day.

10.8.3 Redundant Cables Impractical to Remove

Cables that Contractors consider impractical to remove shall be brought to the attention of the Council. Reasons that may qualify a cable for not being removed shall include but not be limited to:

a. Cable is of considerable length and installed at the bottom of a heavily loaded cable ladder where it is physically impossible to access and remove the cable.

b) Where a safety-risk-analysis has identified a significant risk to personnel if a complete removal was undertaken.

c) Cables are installed underground in concrete slabs. This applies particularly to single cables between a motor and an adjacent column where the cable is to be abandoned and it is impossible to remove the cable due to a collapsed or blocked underground conduit.

Contractors shall not automatically assume that an application to not remove a cable will be successful as the Council may have special reasons for removing a cable.

10.8.4 Redundant Cables not to be Removed

When the Council agrees it is not practical to remove redundant cables, one of the following procedures shall be used to safely secure the cable. The procedure used shall depend upon the accessibility of both ends of the cable.

a) If both ends of the cable are accessible and the cable can be disconnected from its’ source of supply then both ends shall be securely bonded, the cable ends shall be taped and the cable shall be stored within the confines of the cable tray.

The term 'bonded' in this instance shall be taken to mean establishing a sound common electrical connection between all cores including the earth core. Lugging all cores and bolting all of them together shall achieve this. An alternative approved method of bonding that does not require the lugging of all cores is to connect all cores using a single brass split bolt connector. The use of hose clips, nylon zip ties or similar to achieve bonding is not permitted.

Cable markers similar to those used for cable numbering shall be attached at both ends of the cable stating 'REDUNDANT CABLE EX XXXXXXX' where XXXXXXX is the number that was applied to the cable when it was in use.

b) If one end of a cable to be removed is terminated in a location that contains live equipment that needs to be totally isolated to safely remove the cable but cannot be isolated without major disruption, the following procedure shall be followed:

i. Isolate the source of supply of the cable to be removed and lock out and tag in the approved manner.

ii. Identify the redundant cable where it exits the electrical enclosure and confirm that the cable is no longer live.

iii. Cut the cable just outside where it exits the enclosure leaving enough length to terminate the cable still connected to the enclosure in a phenolic or similar j-box.
Leave these cores not bonded but open circuited and either individually tape or connect to terminals in the box. Fill in an information tag and leave in the box. The reasons for not bonding cores in this application are to avoid creating an illegal MEN link between the earth wire and any neutral wire in the cable or, should the still connected wires be accidentally activated, the following fault could damage equipment and compromise personal safety.

iv. Fill in an information tag and hang on the cable where it terminates inside the enclosure. If the cable cannot remain terminated, disconnect and tape individual cores and then completely over tape all cores.

v. Advise the Superintendent who will maintain a register of cables that have been made redundant in this manner for later removal by others from the switchboard or electrical enclosure when equipment comes off line.

vi. Completely remove the cut off external cable.

vii. If an external redundant cable has been approved by the Council to remain in position bond and tape the other end of the cable just cut off and terminate and stow in the trays above the electrical enclosure as described above.

viii. Identify, bond and tape the field end of the cable just cut off and terminate and stow in the ladders as described above.

In both of the above applications, if cable ladder is not available to stow the cables, the cables shall be terminated into a phenolic or similar junction box fixed to the structure and bonded, over taped and stored inside the box.

11 INSTALLATION OF CABLE LADDER

Cable ladder systems shall be installed to provide continuous mechanical and UV protection and support whenever large numbers of cables are to be installed between locations and between individual or grouped items of equipment.

All cable ladder, connectors and covers of a single ladder system shall be constructed of the same material. These components and their fittings and accessories shall be designed and constructed by the same manufacturer and shall be in accordance with NEMA Standard VE1 as a minimum requirement.

11.1 Routing of Cable Ladder

Cable ladder routing shall be as indicated in the contract drawings. In the event that the Contractor is required to determine a cable ladder route, the route chosen shall avoid areas of frequent maintenance activity such as above pumps or mechanical equipment, or under tanks. Where possible, the routes chosen shall also avoid areas where cranes may need to swing when dismantling piping, valves or other frequently dismantled equipment. The route shall strive to provide safe access for personnel required to install cables or access the ladder and shall be approved by the Superintendent prior to installation of cable ladder.

11.2 Cable Ladder Types and Materials

a) Cable ladders shall be manufactured of materials to suit the environment where they are to be installed. Each cable ladder shall have a minimum of 20% spare capacity.

b) NEMA 20A and NEMA 20C aluminium ladders shall be used in all areas including conveyor systems, process areas, switchrooms, substations, workshops and termination rooms. NEMA 20A aluminium ladder is classified as standard duty and NEMA 20C aluminium ladder is classified as heavy duty as outlined below.
c) Heavy duty ladder shall be used for all external cable ladder installations unless specified otherwise.
d) Standard duty cable ladder shall only be installed inside substations, switchrooms and control buildings.
e) Standard duty cable ladder may also be used in external application for short runs up to 1m, to protect cables prior to entry to Local Control Stations.
f) 316 grade stainless steel ladder, covers and support brackets shall be used where the cable ladder may be occasionally or frequently subjected to corrosive spray or splashing, or installed within 5m of open plant containing process fluids.
g) Hot-dipped galvanised admiralty pattern type cable tray is only permitted inside equipment such as switchboards, MCC’s and control panels.
h) Cable ladders manufactured from fibreglass, plastics or of wire rack construction are not permitted on GRC sites.

11.3 Cable Ladder Dimensions

a. Ladders shall be 6 metres in length except for stainless steel ladder that shall be supplied in 3 metre lengths.
b) All ladders shall have inside widths of 150, 300, 450 or 600mm as specified in the drawings. The use of wider trays is discouraged due to space limitations but may be proposed for special applications subject to the approval of the Superintendent.
c) Standard rung spacing for all types shall be 300mm.
d) The radius of change of direction ladder fittings such as bends, tees, crosses and risers shall be 450, 600 or 900mm depending on the application.
e) The use of hinged horizontal and vertical splice plates is permitted provided their use allows the correct cable bending radii to be obtained.

11.4 Cable Ladder Supports

a) Cable ladder shall be supported on pipe rack or on purpose made supports that may either be free standing or fixed to existing structures. The location of the supports shall be in accordance with the requirements of the NEMA Standard VE-1. The maximum separation for supports shall be six meters. At any change of direction of the ladder, a support shall be provided within 750mm of the direction change and on all sides of the direction change.
b) Vertical ladder runs shall be supported with a maximum spacing of 2.5 meters between supports.
c) Vertical ladder installed on the horizontal plain is not permitted.
d) The Contractor shall be responsible for the engineered design and manufacture of cable ladder supports as required in the Scope of Work. The design of cable ladder supports shall take into account the weight of the ladder when fully loaded and any additional loading due to wind.
e) Except for supports mounted to concrete, all supports shall be welded to steel structures in preference to bolting.
   Bolted clamps may be used to attach ladder supports to structures for lightly loaded, vibration free, indoor installations but shall not be used for any other application.
f) Certified welders shall carry out fabrication and installation of all supports and brackets for welded installations.
g) Steel columns and support brackets as shown on the drawings shall support cable trays that cannot be supported from existing columns, structures or other suitable supports.
h) Unless specified otherwise, the Contractor shall furnish and install the support columns, with all the necessary hardware including anchor bolts, washers, nuts and lock nuts, on concrete footings as shown.

i) The support columns, brackets and concrete footings shall be designed by an RPEQ certified structural engineer. Design calculations and drawings of the proposed supports shall be submitted to the Superintendent for approval prior to commencement of fabrication.

j) Where aluminium cable ladder is mounted outdoors on steel supports, insulating plates and ferrules shall be fitted to avoid metal to metal contact.

11.5 Cable Ladder Covers

a) Covers shall be made of the same material as the ladder that they will be covering and shall be fitted to all external cable ladders for the entire route length.

b) Where multi-level ladders are installed along the same route but at different elevations, the ladders at all levels, not just the top ladder, shall be fitted with covers.

c) Ladders inside substations, switchrooms and control buildings shall not be fitted with covers, except for ladders installed below 2000mm. Ladders installed below 2000mm shall be fitted with covers for their full length.

d) Covers with a peak angle of 15 degrees shall be used for all straight ladder runs. Bends, tees, risers, reducers and cross fittings shall be provided with flat covers.

e) Where cables with an outside diameter larger than the depth of the ladder are installed, the additional height required by the cables shall be provided by means of specially fabricated deeper than normal covers.

f) All covers shall be fixed using stainless steel spring clips of the type that have no threaded components and are easily installed and removed without damage. Clips shall be installed at each nominated point on both sides of the tray. Adjoining covers shall overlap each other by approximately 50mm.

g) Vertical ladder covers shall be provided with an additional stainless steel self-tapping screw on both sides of the ladder 100mm from the top edge of the cover to fix the cover to the tray lip to prevent possible slippage of the cover.

11.6 Installation of Cable Ladder

a) Cable ladder shall be installed to provide a continuous cable support system with no sharp edges or projections. Cable ladder runs shall be straight and square to the building lines.

b) The routes for cable ladder shall be as shown in the contract drawings. However, the Contractor shall not install cable ladder so that it impedes access to equipment, subjects the cables to high levels of heat or exposes cables to a high risk of mechanical damage or stress. Any cable ladder routes with these problems shall be brought to the attention of the Superintendent prior to installation.

c) An expansion splice plate shall be installed at any point where the ladder crosses a building expansion joint, and at any other point where required as indicated by the manufacturer’s recommendations.

d) The Contractor shall ensure that cables of different voltage levels are properly segregated in accordance with the requirements of Section 9.2. Where necessary, cables of different voltage levels shall be separated into individual cable ladders.

e) Where ELV or signal cables are installed in the same ladder as LV power and control cables, the Contractor shall install continuous metal segregation barriers. The metal barrier shall be screwed to the ladder at least once per metre. The minimum width for a section of cable ladder segregated by metal barrier shall be 75mm. Segregated sections shall continue to the end of the cable ladder, including sections of ladder dropping to motors or other termination points.
f) The Contractor shall install barriers in accordance with these requirements when installing additional cables to existing cable ladder on which the required barriers are not already in place.

g) Where multiple cable ladders are stacked vertically, there shall be a minimum separation of 450mm between the bottom of one ladder and the bottom of the ladder above. Separation of at least 100mm from the top of the ladder shall be maintained when the ladder crosses below steel work at right angles. Cable ladder running parallel to and below steel work shall maintain a minimum clearance of 300mm from the top of the cable ladder. A minimum clearance of 2200mm shall be maintained under cable ladder in walkways areas.

h) Where cables of different voltage levels have been separated into individual cable ladders, the cable ladders shall be installed in the following positional order:
   - Network data and voice communications cable ladder at the highest level.
   - ELV and signal cables ladder at the second highest level.
   - LV power and control cable ladder at the second lowest level.
   - HV cable ladder at the lowest level.

11.7 Mounting of Equipment on Cable Ladder

Cable ladder shall be used for supporting cables and conduits. Other than ‘Unistrut’ type brackets for mounting of conduit, no junction boxes, local control stations or other equipment shall be mounted on cable ladder.

11.8 Removal and Replacement of Covers

a) All cable tray covers removed from cable trays to provide access to install additional cables or remove redundant cables as required by the scope of work shall be re-installed and securely fastened immediately following completion of the work.

b) Covers removed shall be stacked and secured in a location at ground level adjacent to the jobsite in a neat and tidy manner where they will not be subject to damage, do not present a safety hazard to personnel working in the area or interfere with normal plant operations.

c) New cover fixing clips shall be provided to replace existing cover fixing clips that have either been lost, damaged or are unsuitable for reuse.

d) The Superintendent shall be advised of any ladder in the work area that is not fitted with a cover or is fitted with cover that is in poor condition before the Contractor commences installation work.

12 INSTALLATION OF CONDUIT

Conduit shall be used to enclose and protect all electrical cables installed within GRC sites, unless cables are enclosed and protected within cable ladder. PVC ducting may also be used for some indoor applications, subject to approval by the Superintendent.

12.1 Metallic Conduit

a) Rigid metallic conduit shall be threaded galvanized steel pipe. Conduit shall be correctly sized for cables and shall have a minimum diameter of 20mm.

b) Stainless steel conduit shall be used in areas subject to chemical or acidic corrosion including:
   - Inlet works
   - Oxidation ditches
Conductors shall be supported off the surface upon which it is run and shall be saddled to brackets fixed to the surface. Maximum spacing of fixings shall be 1.5m and saddles shall be fitted within 900mm of the conduit entering a junction box or other fitting. The maximum length of unsupported conduit shall be no more than two metres.

Conduit fittings shall be the machine cast type. Solid elbows, bends and tees shall be used. Conduit bends shall have a minimum radius of nine (9) times the nominal diameter of the conduit.

Metallic conduit shall be installed for all conduit runs other than in areas which are deemed to require non-metallic conduit as indicated in Section 12.2. Conduit used for installation of steel wire armoured cable is principally for support and need not be continuous.

In wet areas, fixings shall include stainless steel U-bolts fixed to fabricated stainless steel brackets, stainless steel flat bar welded to the conduit or stainless steel clamps to stainless steel Unistrut. In dry areas, fixings shall include galvanised steel U-bolts fixed to fabricated brackets, galvanised clamps to Unistrut or galvanised double sided saddles. Half saddles shall not be used.

Rigid steel conduit terminated into enclosures not equipped with a threaded entry shall be provided with double locknuts and bushings designed to prevent damage to the cable from the end of the conduit.

A short length of flexible metallic conduit shall be used to connect the conduit run to electric motors and equipment subject to vibration. Flexible conduit shall also be used to provide vibration isolation at any point where a conduit passes two differentially vibrating structures.

The ends of conduit shall be cut off square. After cutting, each conduit shall be end reamed to remove any burrs or projections that may damage cable insulation during installation.

### 12.2 Non-metallic Conduit

- **Flexible conduit shall be heavy duty PVC sheath non-metallic flexible conduit.** Flexible conduit greater than 50mm diameter shall be nylon reinforced black PVC hose such as Heliflex or equivalent.

- **Non-metallic conduit shall be installed for underground conduit runs.**

- **Non-metallic conduit for use in-ground shall be heavy duty (HD) PVC and coloured orange, except for telecommunications conduit which shall be white.** Light duty PVC conduit shall only be used in above ground installations. All conduits exposed to sunlight shall be UV stabilised.

- **Underground conduits entering buildings shall be continued a minimum of 75mm above the finished floor level on the inside of the building, and shall extend at least 1000mm clear of footings or secondary concrete outside the building.**

- **Allowance shall be made for expansion in accordance with the manufacturer’s instructions in long conduit runs.** Methods of allowing for expansion may include the use of expansion fittings, or not restraining the conduit at changes of direction to allow any expansion to be converted into lateral deflection.

- **Conduit installations shall be adequately supported so that movement of conduit is prevented during concrete placement.**
g) Conduits to be embedded in concrete slabs shall be located so that they do not affect the structural strength or durability of the slabs. The drawings will indicate precisely where the conduits or pipes shall be placed to ensure that this requirement is met. Any need to change these locations shall be brought to the attention of the Superintendent prior to placement.

h) Conduits larger than 25mm in diameter and located in reinforced concrete slabs shall be installed parallel with the main reinforcement wherever possible. When at right angles to the reinforcement the conduit shall be installed close to the supports of the slab.

i) All dirt and grease shall be removed with a rag dipped in methylated spirits before assembly of PVC conduit using couplings and solvent cement. Both surfaces to be joined shall be coated with solvent cement and assembled giving a quarter turn to evenly spread cement. Excess cement shall be immediately wiped off.

j) Both ends of conduits shall be sealed with threaded caps or plugs prior to pouring concrete to prevent concrete from entering the conduit or pipe.

k) Rigid PVC conduit bends, bends formed in standard pipe or manufactured steel bends of a radius appropriate for the diameter of the cable and conductor material shall be provided.

l) Curved portions of conduits shall not be visible above the finished floor slab.

m) All conduit shall be adequately identified at each termination point before any concrete is poured around them.

n) Where conduits are installed in process area slabs, a concrete surround shall encase the pipe stub-ups for a minimum height of 225mm above the finished concrete surface.

o) Protective concrete surrounds for conduit stub-ups shall be installed to provide a minimum of 75mm of concrete between the outside surface of the surround and the outside surface of the conduit. Stub-ups shall extend at least 150mm above the finished surface of the concrete surround.

p) All conduits shall be swabbed throughout their entire length and blown free of debris after concrete work has been completed and the formwork has been removed.

q) Fittings, accessories and conduit shall remain properly plugged prior to drawing in cables to ensure that no foreign matter enters conduits or pipes, fittings and accessories.

12.3 Underground Installations

a) All underground conduit shall be installed in accordance with the requirements of AS/NZS 3000 Section 3.11, except for the depth from finished surface to the top of the conduit, which shall be:
   - 600mm for general areas and low traffic areas.
   - 750mm under roadways and high traffic areas.

b) When crossing roadways or traffic areas underground conduits shall be encased in concrete. Concrete envelopes shall be sized to provide a minimum of 100mm of concrete between the outside surface of the envelope and the outside surface of the conduit. A minimum of 50mm of concrete shall be required between the outside surfaces of adjacent conduits.

c) The Contractor shall notify the Superintendent immediately if any underground service is exposed or damaged during excavation. All excavation work shall cease until the notified problem is resolved. In the case of exposure of an electrical cable no one shall interfere with the cable or touch it until authorised by the Superintendent.

d) Open trenches shall be barricaded at all times and illuminated during the hours of darkness with flashing warning lights at all access points as required for safety in conformance with the regulations.

e) The Contractor shall restore the area surrounding an excavation including roadways, kerbs, footpaths and paved areas to their original condition as determined by the Council after completion of backfilling.
13 EARTHING

13.1 Earthing System

The earthing system is a direct earthed system in accordance with AS/NZS 3000. High voltage and low voltage equipment shall be earthed to a common earth bar to form a combined earthing system as defined in AS/NZS 3000 and AS 2067.

The project drawings shall specify all details of the earthing system design including main grid buried conductors and connections to the equipment and buildings. All connections shall be made with approved earth clamps specified in the contract drawings.

13.2 Earthing of Substations

The earthing for electrical substations shall be in accordance with the requirements of AS/NZS 3000 and AS 2067 and shall include:

a) An earthing grid of 120mm² bare copper conductor installed in the ground, outside the perimeter of the substation or transformer compound and at the specified depth. The cable shall connect the earth electrodes together to form a grid.

b) Earth electrodes shall be installed at each corner of the earth grid. Earth electrodes shall be 19mm diameter copper sheathed steel rods in standard 1500mm lengths. Electrodes shall be driven into the ground, with the top of the electrode 150mm below grade.

c) Inspection pits and test links shall be provided for each earth electrode and shall be minimum 300mm diameter concrete type with lid. The top of the inspection pit shall be 50mm above grade.

d) Two connections between the earth grid and the substation earth bar(s) with 120mm² PVC insulated earth copper cable. The connections shall be made to diagonally opposite corners of the earth grid network.

f) Two connections between the earth grid and the building steel frame and columns with 70mm² PVC insulated earth copper cable.

g) Connections between individual fencing sections of transformer compounds.

h) Connections between the fences and gates of transformer compounds and the earth grid.

13.3 Earthing of Transformer Enclosures

All exposed steelwork within a transformer enclosure shall be connected to the earthing system. An earth connection shall be made to the transformer tank, any steelwork supporting the transformer, any steel reinforcements in concrete mounting plinths, the metal fencing and gates, electrical enclosures and any other metal objects within the enclosure. The transformer tank shall have two connections to the earth system.

13.4 Earthing of Equipment

a) All electrical equipment shall be earthed in accordance with the requirements of AS/NZS 3000. All earth cables shall be sized in accordance with the requirements of AS/NZS 3000 and shall be insulated with green/yellow PVC insulation.

b) The earth connection for equipment with LV electrical supply shall be to the earth terminal or earth bar of the switchboard from which the equipment is supplied. Equipment supplied with multicores shall be earthed by a conductor laid up in the multicores. Equipment supplied by single core cables shall be earthed by a separate PVC insulated earth conductor.
c) Cable entry gland plates shall be earthed with minimum size 25mm² earth cable for MCC and distribution boards, and a minimum size 6mm² earth cable for local control stations and other panels and boxes.

d) All earth connections to earth bars shall be labelled to identify the cable. Where a numbering scheme is not shown in the design documents the Contractor shall determine a numbering scheme in conjunction with the Superintendent. The numbering scheme shall then be submitted in the marked-up as-built drawings.

e) Variable Frequency Drives and corresponding motors shall be earthed in accordance with the manufacturer’s recommendations. The three earth cores in the VSD cable shall be connected to an earth terminal at both ends. Additional earthing to motors may be provided depending on specific installation requirements.

f) Tanks, vessels and sumps shall be earthed by connection to the earthing system.

g) Vibrating equipment shall be earthed to the surrounding structure using two flexible earthing cables at opposite sides of the equipment. The cables shall be installed to minimise fatigue in the flexible cable.

13.5 Earthing of Cable Ladder

All cable ladders in a run shall be considered bonded together by the standard splice plates. The ladders shall be solidly earthed at their point of origin to the substation earth bar and continuity maintained for the length of the ladder run. Where a gap or hinge between cable ladders occurs, continuity shall be maintained by one 10mm² PVC copper earth cables with crimp lugs between both cable ladder ends, one on each side of the ladder, unless otherwise specified.

14 INSPECTION AND TESTING

14.1 General Requirements

a) All electrical installations shall be verified as safe to energize and will operate correctly in accordance with AS/NZS 3000, project documentation and this Engineering Standard.

b) The Contractor shall be responsible for the inspection, testing and commissioning of all electrical equipment installed as part of the project.

c) The Contractor shall submit all inspection, test and commissioning documents for review by the Superintendent prior to any site testing being carried out.

d) The Contractor shall submit all inspection and test plans, test sheets and check sheets to the Superintendent for approval. These documents shall be signed by the Contractor’s Representative prior to energising any equipment.

e) The Contractor shall submit commissioning plans and other relevant commissioning documents to the Superintendent for approval prior to transferring the equipment to operations.

f) Current calibration certificates shall be submitted to the Superintendent prior to the use of all measuring and test equipment. The calibration certificates shall be from recognised calibration laboratories and shall exist for every measurement and test instrument used on the project.

g) The Contractor shall provide to the Superintendent at least one week’s notice of on-site tests.

h) The Contractor shall provide, within 7 days of completion, neatly typed copies of test reports for all tests carried out.
14.2 Installation Checks and Testing

Checking and testing of equipment installation shall consist of, but may not be limited to, the following:

- Checking that equipment has been installed in accordance with specifications and drawings.
- Testing the equipment to the requirements of AS/NZS 3000. This includes all electrical equipment such as MCC’s, distribution boards, local control stations, motors, junction boxes, PLC and SCADA panels, equipment earthing and earthing systems etc.
- Testing and inspection of HV, LV, earthing, control, instrument, communication and fibre cables.
- Setting of configurable devices such as protection relays, timers, instrumentation and communications hardware.

During installation checks, no circuits shall be energized and no mechanical equipment shall be operated by any electric drive.

14.3 Electrical and Control System Function Testing

The objective is to prove that the equipment under test and any associated ancillary or auxiliary equipment will operate correctly when power is applied.

During functional testing control power is applied. Control circuits shall be tested, interfaces with PLC and SCADA verified and, as far as possible, functional testing shall be carried out. Electric motors shall be bumped for direction checks and may be run un-coupled. Mechanical equipment shall not be operated during this stage.

Electrical and control system function testing shall include, but not be limited to, the following:

- Testing the operation of control circuits
- Checking of PLC and SCADA inputs and outputs
- Instrument loop tests
- Testing of interlocks
- Testing control system logic and sequence control
- Direction testing of motors (preferably uncoupled)

14.4 Equipment Commissioning

The objective of this stage is to prove correct mechanical and electrical operation of individual pieces of equipment. Various disciplines (electrical, mechanical, process etc.) must be involved where appropriate.

Equipment commissioning shall consist of the following:

- Running drive systems and checking motor currents, bearing temperatures, etc.
- Checking instruments readings.
- Comprehensive testing of control systems.
14.5 Process Commissioning

The complete system or process shall operate correctly under load conditions and with accordance with design parameters.

Process commissioning shall consist of the following:

- Start up and shutdown performance.
- Proving operation at rated capacity.
- Proving that the performance meets design parameters.
## REVISION HISTORY

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<th>Description</th>
<th>Prepared By</th>
<th>Approved By</th>
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<td>1</td>
<td>10/09/2011</td>
<td>Original Issue</td>
<td>J. Hickey</td>
<td>C. Swanton</td>
</tr>
<tr>
<td>2</td>
<td>24/01/2017</td>
<td>Revised and Updated</td>
<td>B. James</td>
<td>C. Swanton</td>
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1 PURPOSE

The purpose of this Engineering Standard is to describe preferred electrical, instrumentation, control system and data communications equipment in various categories to promote a consistent approach to system design.

2 SCOPE

This Engineering Standard is applicable to all Gladstone Regional Council projects where it is necessary to select electrical, instrumentation, control system and data communications equipment.

This document includes components currently available as new equipment that shall be used for new installation work. Many components currently in use at GRC sites may not appear in the component lists. This may be because they are no longer available (obsolete), no longer meet the design criteria for modern installations, or are no longer commercially attractive (too expensive).

Where existing components fail or associated systems are to be modified or replaced, these components shall be replaced, when it is practical to do so, with the modern equivalents provided in this document.

This document is not an exhaustive list, and provides details of commonly used components only. Where it is necessary to select equipment for which there is no preferred type, approval shall be obtained from GRC for the proposed components prior to implementing a design or purchasing components.

3 RESPONSIBILITIES

All persons involved in the purchasing, specifying, design, fabrication and supply of electrical components for use on any GRC site shall comply with this Engineering Standard.

Specifiers shall ensure that manufacturers of electronic equipment to be integrated with power equipment have designed their equipment to meet the requirements of AS 62103 – Electronic Equipment for use in Power Installations where no other specific product standard applies.

Any items of equipment that have not been nominated in this standard, or any variations proposed that are contrary to the requirements of this standard shall be specifically identified and referred to GRC, in writing, for approval.

The purchase or use of any proposed alternatives to the nominated components shall not proceed without the written approval of GRC.
4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACB</td>
<td>Air Circuit Breaker</td>
</tr>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>Distributor</td>
<td>The corporation or business appointed by a Manufacturer to sell some of the components described by this Standard.</td>
</tr>
<tr>
<td>FOBOT</td>
<td>Fibre Optic Breakout Tray</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>The corporation or business that manufactures and/or assembles some of the components or equipment described by this Standard.</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature Circuit Breaker</td>
</tr>
<tr>
<td>MCCB</td>
<td>Moulded Case Circuit Breaker</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
</tr>
<tr>
<td>RCBO</td>
<td>Residual current Circuit Breaker with Overload protection</td>
</tr>
<tr>
<td>Specifier</td>
<td>Any individual specifying equipment for use in electrical installations on a GRC site.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
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<tr>
<td>VSD</td>
<td>Variable Speed Drive</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
</tbody>
</table>

5 GENERAL REQUIREMENTS

5.1 Component Selection

Users of this Engineering Standard shall note that the nomination of a standard component for general plant use, or for a specific application does not relieve the Specifier of the responsibility to select components that are suitable for use in their particular application.

If a standard component is not suitable, it is the responsibility of the Specifier to identify a suitable component and obtain approval for its use as specified in Section 3 above.

5.2 Catalogue Details

The full catalogue number of a component has not been provided in many instances due to the extensive range of options available for some products. In these instances, the Specifier of a component shall select a suitable product from the approved manufacturers range and specify the required options.

GRC assumes no responsibility for the accuracy of Vendor provided catalogue numbers that are subject to uncontrolled changes or the availability of nominated components.
5.3 Alternatives

When alternatives from different manufacturers are specified for an item of equipment, this shall not be interpreted that it is permissible to mix alternative components from different manufacturers within an assembly. When adding components to an existing assembly every attempt shall be made to match the existing components unless the existing components are obsolete and/or are no longer available.

5.4 Exemptions

Exemptions from using the nominated components are subject to the written approval of GRC, normally through the Superintendent for that particular Contract.

Persons seeking exemptions shall provide technical details to support their reason for claiming exemption as well as complete details of the proposed replacement component.

Exemptions will be considered under the following situations:

a) The component forms part of a proprietary item of equipment and changing to the GRC nominated component may:
   - Seriously impact on the cost and/or delivery of the equipment.
   - Affect the manufacturers guarantee on the equipment.
   - Negate the validity of any type test certifications on the equipment.
   - Prevent the equipment from performing at peak efficiency.
   - Compromise the safe operation of the equipment.

b) The GRC preferred manufacturer does not have a component that meets the required functional or performance requirements.

Claims for exemptions based purely on cost for a possibly inferior or unproven component or the applicants’ personal preference will not be granted.

5.5 Prohibited Items

Components that contain asbestos, mercury, lead, cadmium, PCB’s, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short term effects on the health of personnel if they are inhaled, ingested or otherwise contacted shall not be supplied for use in electrical equipment or installations on any GRC site.

This requirement shall also apply to all fabrication tools and equipment used in the construction of the components covered by this Standard that could leave dangerous dust particles or other residues inside the components.
6 PREFERRED COMPONENTS

6.1 Cables and Accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Building Penetration Sealants</td>
<td>KBS Fire Protection</td>
<td>KBS Motor Seal or KBS Sealbags for temporary sealing</td>
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<tr>
<td></td>
<td></td>
<td>Hilti (Australia)</td>
<td>CP620</td>
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<td>2</td>
<td>Cable Coatings for Fire Protection</td>
<td>KBS Fire Protection</td>
<td>KBS Coating</td>
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<tr>
<td>3</td>
<td>Cables – LV Power</td>
<td>Olex, Prysmian Australia, General Cable Australia</td>
<td>Orange circular 0.6/1kV V90 PVC/PVC</td>
<td>XLPE/PVC may also be used, minimum size 2.5mm²</td>
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<td>4</td>
<td>Cables – LV Control</td>
<td>Olex, Prysmian Australia, General Cable Australia</td>
<td>Black circular 0.6/1kV V90 PVC/PVC control cable, white numbered cores</td>
<td>Minimum size 1.5mm²</td>
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<td>5</td>
<td>Cables – 11kV</td>
<td>Olex, Prysmian Australia</td>
<td>Black 6.35/11kV 3 core XLPE insulated, screened PVC sheathed</td>
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<td>Cables – 3.3kV</td>
<td>Olex, Prysmian Australia</td>
<td>Black 3.8/6.6kV 3 core XLPE insulated, screened PVC sheathed</td>
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<td>Cables – Screened VSD</td>
<td>Olex, Prysmian Australia</td>
<td>Black circular 0.6/1kV 3 core + 3 earth VSD/EMC screened XLPE/PVC</td>
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<td>8</td>
<td>Cables – Instrument</td>
<td>Olex, Prysmian Australia</td>
<td>V90 PVC insulated, black/white twisted pairs, individual and overall screened PVC sheathed</td>
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<td>9</td>
<td>Cables – Fibre Optic</td>
<td>Optimal Cable Services</td>
<td>Single Mode, Polyethylene Sheathed, Loose Tube</td>
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<td>10</td>
<td>Cable Markers</td>
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<td>Ph: (07) 4972 4212</td>
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<td>12</td>
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<td>Cable Ducts (Solid)</td>
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<td>14</td>
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<td>Panduit</td>
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<td>Cable Clamps (high fault level cables)</td>
<td>Intertec Engineering</td>
<td>Torgy Atlantic ASEPlas cable cleats types C, U or T. KOZ Clamps type TS and STC</td>
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<td>Cable Ties (Nylon)</td>
<td>Various</td>
<td>Black, heavy duty, UV stabilised nylon for indoor &amp; outdoor applications</td>
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<td>Cabac</td>
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<td>Siemens</td>
<td>EMC cable glands, nickel plated brass</td>
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<td>CCG Cable Terminations</td>
<td>CCG Posi Braid</td>
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<td>19</td>
<td>Cable Glands (General Purpose)</td>
<td>CMI Electrical Products</td>
<td>Surefit GWPSS and GWPMSS stainless steel and Surefit GWP and GWPM nickel plated brass</td>
<td>Use stainless steel glands for all HV installations. Do not use unplated brass glands externally. Do not use aluminium or nylon/plastic cable glands. All external glands must have shrouds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wattmaster</td>
<td>Alco UW/HUW nickel plated brass series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CCG Cable Terminations</td>
<td>CCG A2 and A2EX nickel plated brass, and Posi Grip Exe brass with non-corrosive body</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Manufacturer / Distributor</td>
<td>Type / Model / Requirements</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>----------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>20</td>
<td>Cable Lugs and Links</td>
<td>Cabac</td>
<td>Aluminium lugs – AL series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aluminium links – ALK series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal lugs – BL series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal crimp links – BLK series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal stalk lugs – BS series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Copper crimp lugs – CAL series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Copper crimp links – CAS series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Utilux</td>
<td>Aluminium lugs – H15100 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aluminium links – H15200 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal lugs – H15300 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal crimp links – H15400 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bi-metal stalk lugs – H15500 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Copper crimp lugs – H1400 series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Copper crimp links – H1400 series</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Bootlace Crimps</td>
<td>Cabac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Cable Splice / Termination Kits</td>
<td>Raychem</td>
<td>To suit application</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3M</td>
<td>To suit application</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Cable Ladder</td>
<td>Unistrut Australia</td>
<td></td>
<td>In accordance with GRC-ES001</td>
</tr>
<tr>
<td>24</td>
<td>Underground Conduit</td>
<td>Various</td>
<td>Orange HD PVC</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Flexible Conduit (non-metallic)</td>
<td>Adaptaflex</td>
<td>Type RF non-metallic</td>
<td>Use nickel plated brass or stainless steel fittings instead of nylon fittings.</td>
</tr>
<tr>
<td>26</td>
<td>Flexible Heavy Duty Hose</td>
<td>Various</td>
<td>Nylon spiral reinforced grey PVC</td>
<td></td>
</tr>
</tbody>
</table>
### 6.2 Cable Pits

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Light Duty Applications (Minimum vehicular traffic)</td>
<td>ACO Australia</td>
<td>HDPE Plastic with steel lid (Class B)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Medium Duty Applications (Light vehicular traffic, parking areas)</td>
<td>ACO Australia</td>
<td>Polymer Concrete with steel lid (Class B)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Heavy Duty Applications</td>
<td>ACO Australia</td>
<td>Polymer Concrete with Load Class to suit application</td>
<td>Consult manufacturer for cover and lid requirements to suit load class</td>
</tr>
</tbody>
</table>

### 6.3 Communications and Data Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ethernet Switch (Rack Mount)</td>
<td>Cisco</td>
<td>Catalyst 2960-X series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allen-Bradley / NHP</td>
<td>Stratix 5410 series</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Ethernet Switch (Din Rail Managed)</td>
<td>Allen-Bradley / NHP</td>
<td>Stratix 8000 series</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ethernet Switch (Din Rail Unmanaged)</td>
<td>Allen-Bradley / NHP</td>
<td>Stratix 2000 series</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FOBOT (DIN / Panel Mount)</td>
<td>Optical Fibre Systems</td>
<td>OFS-MOD-12</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>FOBOT (Rack Mount)</td>
<td>Optical Fibre Systems</td>
<td>OFS-900</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>FOBOT (Wall Mount)</td>
<td>Optical Fibre Systems</td>
<td>OFS-200</td>
<td></td>
</tr>
</tbody>
</table>
## 6.4 Control and Indication Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammeters</td>
<td>IME / NHP</td>
<td>72mm square, full current, 5x overload scale, 0-1A moving iron movement, quadrant scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crompton Instrument</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Indicating Lights</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>D7 series, integrated LED lamp block, 24VDC, plastic</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Pushbuttons</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>D7 series, 22.5mm flush, momentary push button, plastic, non-illuminated</td>
<td>Colour and contact arrangement to suit application</td>
</tr>
<tr>
<td>4</td>
<td>Emergency Stop</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>D7 series, 22.5mm twist to reset, plastic, non-illuminated</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Pushbutton Stations</td>
<td>NHP</td>
<td>Type SS, Size 1, 2 or 3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Selector Switches</td>
<td>Kraus &amp; Namier</td>
<td>CA10 series</td>
<td>Label and selector switch configuration to suit application</td>
</tr>
<tr>
<td>7</td>
<td>Control Relays</td>
<td>Finder / NHP</td>
<td>55 series + base</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Timer Relays</td>
<td>Carlo Gavazzi / NHP</td>
<td></td>
<td>Selected to suit application</td>
</tr>
<tr>
<td>9</td>
<td>Monitoring Relays</td>
<td>Carlo Gavazzi / NHP</td>
<td></td>
<td>Selected to suit application</td>
</tr>
<tr>
<td>10</td>
<td>Sirens (Motor Driven)</td>
<td>NHP / Klaxon</td>
<td>KL2108</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Sirens (Electronic)</td>
<td>NHP / Klaxon</td>
<td>KL980552, KL980546</td>
<td></td>
</tr>
</tbody>
</table>

## 6.5 Conveyor Protection Devices

<table>
<thead>
<tr>
<th>Item</th>
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<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lanyard Switches</td>
<td>R&amp;D Technology</td>
<td>Pull-Safe pull wire switch with lanyard kit &amp; poly coated stainless steel lanyard</td>
<td></td>
</tr>
</tbody>
</table>
### Drift Switches

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Drift Switches</td>
<td>R&amp;D Technology</td>
<td>Safe-T-Drift</td>
<td>Heavy duty applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schneider Electric</td>
<td>Square D 9007C62J multi-directional head with J type delrin extension</td>
<td>Light duty applications</td>
</tr>
</tbody>
</table>

### Under Speed Detection

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Under Speed Detection</td>
<td>Pepperl+Fuchs</td>
<td>KFD2-DWB-1.D Rotation Speed Monitor</td>
<td></td>
</tr>
</tbody>
</table>

### Enclosures

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small Indoor Enclosures</td>
<td>B&amp;R Enclosures</td>
<td>Monarch IP – Zinc Coated Steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rital</td>
<td>AE Series – Zinc Coated Steel</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Small Outdoor Enclosures</td>
<td>B&amp;R Enclosures</td>
<td>Monarch IP – Stainless steel with IPRH series stainless steel rain hood</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rital</td>
<td>AE Series – Stainless steel with rain hood</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Large Indoor Enclosures</td>
<td>B&amp;R Enclosures</td>
<td>Universal DD – Zinc Coated Steel or iLINQ bayable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rital</td>
<td>ES5000 or TS8 bayable</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Junction Boxes (Lighting Stanchions and Columns)</td>
<td>CCG Cable Terminations</td>
<td>CCG Utility Box</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Junction Boxes (General Purpose)</td>
<td>CCG Cable Terminations</td>
<td>CCG Utility Box</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clipsal</td>
<td>56JB series (grey)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Key Locking Handles</td>
<td>Schneider</td>
<td>TEELU9-AP11, lock code no. 92268</td>
<td></td>
</tr>
</tbody>
</table>
### 6.7 High Voltage Switchgear

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11kV Outdoor RMU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11kV Indoor Metal Clad Switchboards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3.3kV Indoor Metal Clad Switchboards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Protection Relays (3.3kV Motors)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Protection Relays (11kV Motors)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Protection Relays (11kV Circuit Breakers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Protection Relays (Generator Protection)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Bus Duct</td>
<td>ABB</td>
<td>SC-R Cast Resin IP68</td>
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</table>

### 6.8 Instrumentation

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Differential Pressure Transmitters</td>
<td>Endress &amp; Hauser</td>
<td>Deltabar</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Flow Switches</td>
<td>IFM Efector</td>
<td>SI5000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Limit Switches (Electromechanical)</td>
<td>Schneider Electric</td>
<td>Telemechanique (Square D) heavy duty types to suit application</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Limit Switches (Magnetic)</td>
<td>Ramelec</td>
<td>Go Electroswitch</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Magnetic Flow Meters</td>
<td>ABB</td>
<td>Watermaster</td>
<td>Potted Cable with fixed length</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Manufacturer / Distributor</td>
<td>Type / Model / Requirements</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>6</td>
<td>Pressure Gauges</td>
<td>Wika</td>
<td>233.50 series bourdon tube pressure gauge, stainless steel, 100mm</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Pressure Switches</td>
<td>Schneider Electric</td>
<td>Class 9012 to suit application</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NHP</td>
<td>IPS Series to suit application</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Pressure Transmitters</td>
<td>Endress &amp; Hauser</td>
<td>Cerabar</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Proximity Switches</td>
<td>Pepperl &amp; Fuchs / Control Logic</td>
<td>NCN15 Series, NJ10 Series</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Temperature Gauge</td>
<td>Wika</td>
<td>Model 53 bimetal thermometer, stainless steel</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Temperature Transmitter</td>
<td>Endress &amp; Hauser</td>
<td>Omnigrad M</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Temperature Switches</td>
<td>IFM Efector</td>
<td>TN2000 series</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Signal Isolators</td>
<td>Critech</td>
<td>DSD120</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Submersible Level Transmitters</td>
<td>Endress &amp; Hauser</td>
<td>Waterpilot FMX21</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Ultrasonic Level Transmitters</td>
<td>Endress &amp; Hauser</td>
<td>Prosonic FMU40/41</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Radar Level Transmitters</td>
<td>Endress &amp; Hauser</td>
<td>Micropilot FMR50/51</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Vibrating Level Switches</td>
<td>Endress &amp; Hauser</td>
<td>Liquiphant FTL51</td>
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</tr>
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### 6.9 Low Voltage Switchboards and Motor Control Centres

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>415 Switchboard / Motor Control Centre (&gt; 400A)</td>
<td>Wika</td>
<td></td>
<td>In accordance with GRC-ES004</td>
</tr>
<tr>
<td>2</td>
<td>415V Switchboard / Motor Control Centre (&lt; 400A)</td>
<td></td>
<td></td>
<td>In accordance with GRC-ES004</td>
</tr>
</tbody>
</table>
## 6.10 Lighting and Power Distribution

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Light &amp; Power Distribution Boards</td>
<td>NHP</td>
<td>Concept Premier Panelboard with Terasaki Din-T MCBs.</td>
<td>In accordance with GRC-ES005</td>
</tr>
<tr>
<td>2</td>
<td>ELV Distribution Boards</td>
<td>NHP</td>
<td>Concept Premier Panelboard with Terasaki 2 pole 10kA Din-T MCBs.</td>
<td>In accordance with GRC-ES005</td>
</tr>
<tr>
<td>3</td>
<td>Load Centres</td>
<td>NHP</td>
<td>NLC series surface mounted metal load centre with door</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Single Phase GPO (Office Building)</td>
<td>Clipsal</td>
<td>White 2000 Series double GPO</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Single Phase GPO (Plant Area)</td>
<td>Clipsal</td>
<td>56C310HD, RO / 56C315HD, RO</td>
<td>Use round earth pin for UPS distribution</td>
</tr>
<tr>
<td>6</td>
<td>Single Phase GPO (UPS)</td>
<td>Clipsal</td>
<td>Red 2000 Series double GPO 2025LRD</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3 Phase Outlet up to 50A (Plant Area)</td>
<td>Clipsal</td>
<td>56 Series, RO, 4/5 pin to suit application</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3 Phase Outlet 63A (Plant Area)</td>
<td>Clipsal</td>
<td>66CV Series, RO, 4/5 pin to suit application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lighting Switch (Office Building)</td>
<td>Clipsal</td>
<td>White 2000 Series</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Lighting</td>
<td>Eye Lighting</td>
<td>Pierlite</td>
<td></td>
</tr>
</tbody>
</table>
### 6.11 Motors

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>240V Single Phase</td>
<td>N/A</td>
<td>N/A</td>
<td>Single phase motors are not approved for any process/production related application.</td>
</tr>
<tr>
<td>2</td>
<td>415V 3 Phase</td>
<td>Teco</td>
<td>Cast iron TEFC type to suit application</td>
<td>4, 6 or 8 pole preferred</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toshiba</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>WEG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3.3kV 3 Phase</td>
<td>Teco</td>
<td>Cast iron TEFC type to suit application</td>
<td>4, 6 or 8 pole preferred</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toshiba</td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td>WEG</td>
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### 6.12 Power Supplies

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply – 24VDC</td>
<td>Allen-Bradley / NHP</td>
<td>1606-XL Series</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Puls / Control Logic</td>
<td>Dimension Q Series</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Power Supply – 12VDC UPS</td>
<td>Snaptec Australia</td>
<td>SRU Series</td>
<td>Individual sewerage pump stations</td>
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</table>

### 6.13 Programmable Logic Controllers and HMIs

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PLC System (Large PLC &gt; 150 IO Points)</td>
<td>Allen-Bradley / NHP</td>
<td>ControlLogix Series</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Processor (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-L72 – 1756-L7x</td>
<td>Processor selected to suit application requirements</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Manufacturer / Distributor</td>
<td>Type / Model / Requirements</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>3</td>
<td>Digital Input Module (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-IB32</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Digital Output Module (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-OB32</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Analog Input Module (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-IF16</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Analog Output Module (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-OF8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ethernet Communications Module (Large PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1756-EN2T, 1756-EN2TR</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Modbus Communications Module (Large PLC)</td>
<td>Prosoft Technology / NHP</td>
<td>MVI56E-MNET</td>
<td>Modbus TCP/IP communications interface with Pump Station RTU</td>
</tr>
<tr>
<td>9</td>
<td>PLC System (Small PLC &lt; 150 IO Points)</td>
<td>Allen-Bradley / NHP</td>
<td>CompactLogix Series</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Processor (Small PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1769-L30ER</td>
<td>Processor selected to suit application requirements</td>
</tr>
<tr>
<td>11</td>
<td>Digital Input Module (Small PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1769-IQ16</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Digital Output Module (Small PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1769-OB16</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Analog Input Module (Small PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1769-IF8</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Analog Output Module (Small PLC)</td>
<td>Allen-Bradley / NHP</td>
<td>1769-OF8C</td>
<td></td>
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<td>Item</td>
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<td>Type / Model / Requirements</td>
<td>Comments</td>
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<td>---------------------------------------</td>
<td>----------------------------------</td>
<td>----------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>15</td>
<td>Modbus Communications Module</td>
<td>Prosoft Technology / NHP</td>
<td>MVI69-MNET</td>
<td>Modbus TCP/IP communications interface with Pump Station RTU</td>
</tr>
<tr>
<td></td>
<td>(Small PLC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>RTU System (Remote Pump Stations)</td>
<td>Schneider Electric</td>
<td>SCADAPack 357E Part No. 5209 with I/O Expansion Module 5606</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>PLC and I/O Communications Network</td>
<td></td>
<td>Ethernet/IP</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>PLC to RTU Communications Network</td>
<td></td>
<td>Modbus TCP/IP</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Field I/O System</td>
<td>Allen-Bradley / NHP</td>
<td>Flex IO Series</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Field I/O Communications</td>
<td>Allen-Bradley / NHP</td>
<td>1794-AENT, 1794-AENTR</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Field I/O Digital Input</td>
<td>Allen-Bradley / NHP</td>
<td>1794-IB16 + 1794-TB3</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Field I/O Digital Output</td>
<td>Allen-Bradley / NHP</td>
<td>1794-OB16 + 1794-TB3</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Field I/O Analog Input</td>
<td>Allen-Bradley / NHP</td>
<td>1794-IE8 + 1794-TB3</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Field I/O Analog Output</td>
<td>Allen-Bradley / NHP</td>
<td>1794-OE4 + 1794-TB3</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>HMI</td>
<td>Allen-Bradley / NHP</td>
<td>Panelview Plus 7 series colour touchscreen terminal</td>
<td>Sized to suit application, minimum size 15 inch</td>
</tr>
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</table>
### 6.14 Switchgear and Controlgear

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Air Circuit Breakers</td>
<td>Terasaki / NHP</td>
<td>Tempower 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Current Transformers</td>
<td>Crompton</td>
<td>Rating &amp; specification in accordance with drawings</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stemar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Decontactors</td>
<td>Marechal Australia</td>
<td>DS Decontactor Range, 30° inclined wall box type</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Isolating Switches (up to 63A)</td>
<td>Clipsal</td>
<td>56SWH Series, Resistant Orange with Red/Yellow Operator/Collar</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Isolating Switches (25A – 200A)</td>
<td>NHP</td>
<td>ISO Switch 3 or 4 pole with Red/Yellow Operator/Collar</td>
<td>Polycarbonate for general purpose, stainless steel for heavy duty applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Terasaki / NHP</td>
<td>LY7 Series, polycarbonate enclosure with Red/Yellow Operator/Collar</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Isolating Switches (25 to 315A)</td>
<td>Kraus &amp; Naimer</td>
<td>KG Series with Red/Yellow Operator/Collar &amp; padlockable handle</td>
<td>Polycarbonate for general purpose, stainless steel for heavy duty applications</td>
</tr>
<tr>
<td>7</td>
<td>Moulded Case Circuit Breakers (MCCB)</td>
<td>Terasaki / NHP</td>
<td>Tembreak 2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Miniature Circuit Breakers (MCB)</td>
<td>Terasaki / NHP</td>
<td>Din-T10, C Curve type unless specified otherwise</td>
<td>Supplied with captive lock dog</td>
</tr>
<tr>
<td>9</td>
<td>Motor Circuit Breaker</td>
<td>Terasaki / NHP</td>
<td>KT7 Series</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>RCBO</td>
<td>Terasaki / NHP</td>
<td>Din-Safe 10kA</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Fuses (HRC)</td>
<td>IPD</td>
<td>HRC Type, 660V bolt in for power applications, 415V NS clip in type for control applications</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Manufacturer / Distributor</td>
<td>Type / Model / Requirements</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>12</td>
<td>Fuse Holders (HRC)</td>
<td>IPD</td>
<td>Red Spot for bolt in fuses, Safe Clip for NS clip in type</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Power Meter</td>
<td>Electrex / Control Logic</td>
<td>Electrex Flash D PFE430-00 with RS485 modbus communications</td>
<td>For connection to RTU systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allen-Bradley / NHP</td>
<td>Powermonitor 500 with Ethernet/IP communications</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Contactors</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>CA 7 and CA6, 24VDC coil</td>
<td>Shall be fitted with coil suppressor except for light and power DB’s.</td>
</tr>
<tr>
<td>15</td>
<td>General Purpose Relays</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>CS 7C, with CRV 7-55 suppressor module</td>
<td>Contact arrangement to suit application.</td>
</tr>
<tr>
<td>16</td>
<td>Overload Relays</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>CEP 7-EE</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Thermistor Relays</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>RT7-E2</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Phase Failure Relays</td>
<td>Carlo Gavazzi / NHP</td>
<td>DPA-01-D-M48</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Electronic Motor Protection Relays</td>
<td>Allen-Bradley / NHP</td>
<td>E300 series</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Test Links</td>
<td>Wago / NHP</td>
<td>282 series</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>DOL Motor Starters (&lt; 4kW Only)</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>CAT 7S series</td>
<td>Only to be used where there is no local MCC option available</td>
</tr>
<tr>
<td>22</td>
<td>Resistor Banks</td>
<td>Fortress Systems</td>
<td>Stainless steel enclosure type</td>
<td></td>
</tr>
</tbody>
</table>
## 6.15 Transfer Switches

<table>
<thead>
<tr>
<th>Item</th>
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<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Automatic Transfer Switches</td>
<td>Terasaki / NHP</td>
<td>Tembreak 2 MCCB type with ATL610NHP controller</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Manual Transfer Switches</td>
<td>Terasaki / NHP</td>
<td>Tembreak 2 MCCB type</td>
<td></td>
</tr>
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</table>

### 6.16 Transformers

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11kV / 3.3kV</td>
<td>Wilson Transformers</td>
<td>Schneider Electric</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>415V Distribution</td>
<td>Wilson Transformers</td>
<td>Schneider Electric</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Neutral Earthing Resistors</td>
<td>Fortress Systems</td>
<td>Stainless steel enclosure type</td>
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</tbody>
</table>

### 6.17 Terminals and Accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feed Through Terminals</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>V7-W4 + accessories</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fused Disconnect Terminals</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>V7-WFB4 + accessories</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Disconnect Terminals</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>V7-WKD3 + accessories</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Double Decker Feed Through Terminals</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>V7-WD4 + accessories</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Power Terminals (&gt; 10mm2)</td>
<td>Sprecher &amp; Schuh / NHP</td>
<td>V7-W35 + accessories</td>
<td></td>
</tr>
</tbody>
</table>
### 6.18 UPS and Battery Chargers

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UPS &gt; 1000VA</td>
<td>APC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>UPS &lt; 1000VA</td>
<td>APC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>DC Battery Chargers (Tripping Power Supplies)</td>
<td>Magellan Power</td>
<td>MCRII</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exide Technologies</td>
<td>GNB24/48/110VDC Series</td>
<td></td>
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</table>

### 6.19 Variable Speed Drives and Soft Starters

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Manufacturer / Distributor</th>
<th>Type / Model / Requirements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>415V Electronic Soft Starters</td>
<td>Schneider</td>
<td>Altistart 48</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>415V Variable Speed Drives</td>
<td>Fuji Electric</td>
<td>Frenic Mega with Modbus communications</td>
<td></td>
</tr>
</tbody>
</table>
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1 PURPOSE

The purpose of this Engineering Standard is to describe the requirements for the design, manufacture, supply, testing and delivery to site of Prefabricated Electrical Switchroom buildings for Gladstone Regional Council. This Engineering Standard shall be read in conjunction with the separate project specific scope of work document.

2 SCOPE

This Engineering Standard is applicable to all Gladstone Regional Council projects where prefabricated electrical switchroom buildings have been specified in the project documents to contain switchboards and motor control centres.

3 RESPONSIBILITIES

All persons involved in the purchasing, design, fabrication and supply of prefabricated electrical switchroom buildings for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage, Exceeding 32VAC or 115VDC but not exceeding 1000VAC or 1500VDC.</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>The corporation or business that manufactures and/or assembles the equipment described by this Engineering Standard.</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>Purchaser</td>
<td>The individual or corporation responsible for purchasing the equipment described by this Engineering Standard on behalf of GRC.</td>
</tr>
<tr>
<td>Specifier</td>
<td>Any individual specifying equipment for use in electrical installations on a GRC site.</td>
</tr>
<tr>
<td>Substation</td>
<td>Installations that convert high voltage to lower voltages to supply local equipment. The installation may include a fenced yard, buildings, transformers and switchboards.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
</tr>
<tr>
<td>Supplier</td>
<td>The individual or corporation with whom GRC enters an agreement to purchase the equipment described by this Engineering Standard. Note that in some instances, the Supplier may also be the Manufacturer.</td>
</tr>
<tr>
<td>Switchroom</td>
<td>Building that houses switchboards, motor control centres and other ancillary equipment.</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
</tbody>
</table>
5 REFERENCE DOCUMENTS

All equipment shall be designed, manufactured and tested in accordance with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

5.1 GRC Engineering Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>GRC-ES001</td>
<td>Electrical Work</td>
</tr>
<tr>
<td>GRC-ES002</td>
<td>Preferred Electrical Components</td>
</tr>
<tr>
<td>GRC-ES004</td>
<td>Motor Control Centres</td>
</tr>
<tr>
<td>GRC-ES005</td>
<td>Light &amp; Power Distribution Boards</td>
</tr>
<tr>
<td>GRC-ES008</td>
<td>Equipment Identification</td>
</tr>
<tr>
<td>GRC-ES015</td>
<td>Standard Provisions for Construction</td>
</tr>
</tbody>
</table>

5.2 Australian Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 1163</td>
<td>Cold-formed Structural Steel Hollow Sections</td>
</tr>
<tr>
<td>AS/NZS 1214</td>
<td>Hot-dip Galvanized Coatings of Threaded Fasteners</td>
</tr>
<tr>
<td>AS/NZS 1252</td>
<td>High Strength Steel Bolts With Associated Nuts and Washers for Structural Engineering</td>
</tr>
<tr>
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<td>Professional Engineers Regulation 2003</td>
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<tr>
<td>Work Health and Safety Act 2011</td>
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<td>Work Health and Safety Regulation 2011</td>
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6 TECHNICAL REQUIREMENTS

6.1 General

6.1.1 Quality Assurance

The Manufacturer shall have an integrated quality assurance system in place at the locations where the prefabricated switchroom buildings are designed, manufactured and assembled. The system shall be “third party accredited” to AS/NZS ISO 9001:2000 and frequently audited for compliance. The Manufacturer shall provide documentation proving any claims made with respect to the above if requested by the Purchaser.

6.1.2 Prohibited Materials

Components that contain asbestos, mercury, cadmium, PCB’s, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short term effects on the health of personnel if they are inhaled, ingested or otherwise contacted during normal and reasonable use are not permitted in electrical equipment to be used on the Purchaser’s site.

This requirement shall apply to all fabrication tools and equipment used that could leave dust particles or other residues inside the assemblies as well as components used in the construction of the MCC’s and associated components covered by this Standard.

6.1.3 Standardisation of Parts and Equipment

The Supplier shall select all components, parts and equipment used in the construction and fabrication of the switchboard from the Preferred Electrical Components List GRC-ES002.

If the Supplier wishes to utilise items not included in the preferred components list, approval shall be obtained from GRC in accordance with the requirements of GRC-ES002.

6.2 Service Conditions

The ambient conditions in the Gladstone Region are:

<table>
<thead>
<tr>
<th>Temperature:</th>
<th>Maximum</th>
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<tr>
<td></td>
<td>Daily average maximum hottest month</td>
<td>30°C</td>
</tr>
<tr>
<td></td>
<td>Mean daily average maximum hottest month</td>
<td>26°C</td>
</tr>
<tr>
<td></td>
<td>Mean yearly average</td>
<td>22°C</td>
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<tr>
<td></td>
<td>Minimum</td>
<td>3°C</td>
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<tr>
<td>Humidity:</td>
<td>Maximum</td>
<td>100%</td>
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<tr>
<td></td>
<td>Mean yearly average</td>
<td>73%</td>
</tr>
<tr>
<td>Altitude:</td>
<td>Essentially sea level</td>
<td></td>
</tr>
<tr>
<td>Atmosphere:</td>
<td>Coastal marine with heavy salt and dust (sand, dirt, coal)</td>
<td></td>
</tr>
</tbody>
</table>
6.3 Design Basis

The Switchroom building shall be designed to be transported to site while fitted out to minimize installation time on site. The equipment and switchgear to be installed and tested prior to dispatch to site is detailed in this Engineering Standard.

The Switchroom building shall be a weatherproof, prefabricated construction mounted on steel support columns in conjunction with a structural steel frame, and fitted with landing areas and access facilities.

The Switchroom building shall be provided with sufficient space to allow for future extensions of the switchgear and switchboards. Allowance shall be made for an extra tier at each end of switchgear and switchboards.

The building shall be air-conditioned and have lighting, power, communications and fire services installed as detailed in this Engineering Standard.

The building shall be as compact as practicable, to facilitate easy transportation around the site, whilst still providing space for future equipment as indicated in this document.

The Supplier shall size the building in accordance with the equipment installed, ensuring that all requirements of AS/NS 3000 and applicable Regulations are met. Specifically, clearances and exit space requirements shall be maintained around the equipment, especially with equipment doors opened to 90 degrees or switchgear withdrawn. Doors with pintle hinges that allow the door to be removed shall be considered as a hinged door (clearances should be measured with the door open to 90 degrees), as this is the normal method of operation.

The Supplier shall provide a suitable footing design to meet the individual site requirements. The Switchroom building shall be designed to achieve an operational life of 30 years. The design of the building, structural supports and concrete footings shall be carried out by, or under the direct supervision of a Registered Professional Engineer in accordance with the requirements of the Professional Engineers Act 2002.

Unless specified otherwise, the Switchroom building shall be designed for the following conditions:

a) The building floor and associated access platforms shall be designed for the actual loads imposed by the equipment, including provision for additional future panels. As a minimum, the building floors shall be designed for a live load of 5kPa.

b) The building floor shall be designed to withstand the dynamic forces associated with transport.

c) The building shall be designed for a wind loading to suit Region C, Terrain Category 2 in accordance with AS/NZS 1170.

d) The building shall be classified as having an Importance Level of 4 in accordance with the National Construction Code corresponding to an Annual Probability of Exceedance of 1:1500.

e) The building shall be classified as a Class 10a structure in accordance with the National Construction Code.

f) Earthquake design forces shall be determined based upon AS1170.4 (Earthquake load): Hazard factor of 0.15.

The Supplier shall provide documentation indicating compliance with the above conditions as specified in Section 10.
6.4 Construction Requirements

6.4.1 Structural Steel Work

The building shall be a steel framed skeletal structure with cladding and linings to suit the external environment and the internal function of the room.

a) The roof framing shall consist of Lysaght or Stramit purlin sections with flat sheet internally.
b) The structure shall provide a reasonable level of protection against malicious attack (i.e. vandal proof).
c) No external parts including cladding and fasteners shall be made of aluminium.
d) All stainless steel components shall be electrically insulated from galvanised or plain steel to avoid galvanic corrosion.
e) Removable lifting brackets that extend beyond the line of the wall to minimise damage during cranage shall be located to provide a balanced lift with all equipment assembled within the building.
f) Floor deflection during lifting shall be limited to the allowances specified for the installed switchboard.
g) Square hollow section (SHS) galvanised columns and cross bracing shall be provided to support the switchroom at a height of 900mm to the underside of the building chassis, unless otherwise specified.
h) The switchroom shall have a bolted connection to the stubs allowing convenient bolt fitment at building installation.
i) All wall and floor penetrations for the access of cable trays and bus ducts shall be reinforced to ensure building structural integrity is maintained.
j) Steel framing and joists shall not restrict any part of gland plates, cable tray or bus duct entry points to equipment to be installed or marked for future installation.
k) All structural steelwork and fixings shall be hot dipped galvanised to AS/NZS 2312.

6.4.2 Stairways and Platforms

Stairways and platforms shall be provided where shown on the drawings at the specified external door locations.

These shall be of normal structural construction, using prefabricated steel components, suitable for bolted assembly at site and designed to comply with AS1657 – Fixed Platforms, Walkways and Ladders – Design Construction and Installation.

a) Stairways and platforms shall use Webforge or an approved equivalent grating. Removable guardrails shall be provided.
b) The platform for external equipment access doors shall be designed to withstand switchgear loads, and shall incorporate removable guardrails to facilitate the movement of equipment.
c) Gratings shall be banded at openings in platforms and around removable panels.
d) Gratings shall be neatly cut and fitted around columns, support legs, machinery, piping, ducts and other similar installations.
e) Gratings shall be fixed using multi-purpose clips, clamped or screwed to the support structure as per the manufacturers specification.
f) Guardrails, steps, handrails and platforms to be hot dipped galvanised after fabrication.
g) All stair treads shall be provided with a yellow visual abrasive nosing similar to Webforge “Webgrit”.
6.4.3 Roof, Walls and Ceilings

a) Walls and roof shall have a Fire Resistance Level of 120/120/120.

b) Walls and roof shall be a minimum of 75mm thick either in sandwich panel or framed construction. All materials used shall be non-combustible.

c) Walls and ceilings shall have a minimum 75 mm, R2.5 foil faced fibreglass blanket, non-flammable core.

d) All roof and wall cladding shall be Trimdek Hi-Ten Colorbond (Ultra Steel) cladding 0.48BMT fixed with cyclone washers screwed at every crest.

e) The colour of the roof sheeting shall match the colour of the external wall sheeting, unless otherwise specified.

f) External walls shall achieve a minimum total R-value of 1.9.

g) Internal walls and ceilings shall be finished with pre-painted flat steel sheet (painted both sides). Internal colour shall be “Off White”.

h) Unless otherwise specified, exterior wall colour shall be “Surfmist”.

i) The minimum ceiling height above floor level shall be the greater of:
   - 2800mm
   - 300mm higher than the switchgear height
   - Minimum height recommended by the switchgear manufacturer

j) Adequate clearance shall be provided for the installed equipment and any overhead items such as cable tray, cabling, air-conditioning ducting etc.

k) The roof shall be sloped and fitted with a suitable barge capping to provide a neat clean roof line. All joints shall be fully sealed using a flexible durable sealant to ensure a completely weatherproof enclosure.

l) All cladding, flashing and capping shall have an “XSE” heavy duty protective coating system.

m) Guttering, complete with downpipes, shall be provided around the complete building. A rain canopy shall be installed over the personnel access door using the same sheeting type as the roof.

6.4.4 Doors and Door Frames

a) The switchroom shall be provided with at least one single door for personnel access and one double door for equipment access.

b) All personal access doors shall be a minimum of 2040 mm x 1000 mm x 50 mm. Double doors should be at a minimum 2800mm high x 1600mm x 50 mm.

c) Doors shall be flush panel heavy duty external type, clad in `Colorbond' sheeting. They shall be dust tight and fit for purpose in operation within the sites environmental conditions.

d) External access doors shall open outwards from the switchroom.

e) Unless specified otherwise, doors and door frames shall be fitted with the following hardware:
   - **Hinges:** Three heavy duty stainless steel butt hinges (per door)
   - **Latches:** Lever type, heavy duty:
     - External: Kaba 601C-25SCP
     - Internal: Crash bar door latch
   - **Locksets:** Satin Chrome finish, Kaba MS2SCP
6.4.5 Floors and Penetrations

a) The floor shall consist of compressed fibre cement flooring (minimum thickness of 18mm) fixed to RHS steel joists and shall include penetrations as required for cable entry.

b) All interior floor surfaces shall be covered with 2.5 mm flexible sheet vinyl complying with AS 2055, glued to flooring in accordance with manufacturer’s recommendations. All joints shall be fully welded to form a waterproof seal. A 100 mm PVC skirting shall be glued to the floor-wall joint after the vinyl is laid. The floor covering shall be a hard wearing surface designed to resist scratching and gouging from equipment and personnel traffic. The floor covering shall be grey in colour.

c) A layer of 3mm plywood shall be installed over the vinyl flooring temporarily to protect the flooring during installation.

d) Switchroom floors shall have a minimum tolerance of ±1 mm in any one metre circular area and a tolerance of ±3 mm over the entire switchboard length.

e) The switchroom floors shall have a tighter tolerance if this is required to meet the switchboard requirements.

f) Reinforced floor or wall penetrations shall be positioned as dictated by the switchboard manufacturer and as required by all other equipment to be installed within the switchroom to facilitate connection of external cabling and cable trays.

g) 5mm brass gland plates shall be provided when appropriate by the switchboard manufacturer.

6.5 Heating, Ventilation and Air Conditioning (HVAC) Services

The Switchroom building shall be fitted with an air conditioning system with a capacity capable of maintaining the temperature at 25°C dry bulb with normal electrical equipment loadings and for the specified external ambient temperature range service conditions.

a) The air conditioning system shall incorporate a minimum of two split-system air conditioning units based on Mitsubishi inverter type units.

b) The air conditioning equipment shall control the temperature within the range specified taking into account the inside heat generated, outside ambient conditions and solar radiation. Where a building is air conditioned by more than one unit, the size of the plant shall be...
selected such that with one unit out of service, the room temperature shall be no more than 40°C all year round.

c) The evaporator shall have plumbing fitted to drain condensate water to an external drain using sewer grade PVC condensate pipe 40 mm NB discharging approximately 100 mm above a hard surface that does not drain under the switchroom. No drip trays or plumbing joints shall be installed above switchgear.

d) Ducted air conditioning systems are not preferred. Should the design requirements and conditions indicate that ducted air conditioning is the best solution, the Supplier shall provide a written design proposal to the Superintendent for approval.

e) The switchroom shall be provided with an isolator for each air conditioner mounted externally in a location easily seen from the normal pedestrian approach route to the switchroom. The isolators shall be clearly labelled with the names of the air conditioners.

f) Air conditioner units must have the facility for being automatically shutdown in the event of a fire in the Switchroom building.

g) A positive pressure of 15-20Pa shall be maintained within the room and an adjustable pressure relief damper shall be provided to allow regulation of this pressure without loss of cool air.

h) Openings on wall for inlet and return air ducts shall be provided with one and a half (1.5) hour fire rated dampers which shall be automatically closed if a fire is detected inside the room.

i) A separate room temperature sensor shall be provided to allow for connection to a local PLC for monitoring of the switchroom internal temperature via the site SCADA system.

j) Each air conditioning unit shall indicate its alarm status via voltage free contacts for connection to a local PLC for monitoring via the site SCADA system.

k) The system shall be installed by qualified gas fitters.

6.6 Fire Services

a) The Switchroom building, including doors, shall have 120/120/120 fire resistance level (FRL) in accordance with the National Construction Code unless otherwise specified.

b) 4.5kg carbon dioxide fire extinguishers complete with signage and a suitable wall bracket shall be provided inside and outside the building adjacent to each exit. Each fire extinguisher shall be installed in an approved UV stabilised plastic cabinet.

c) A fire detection and alarm system shall be installed in accordance with the requirements of AS1670.1 and shall include as a minimum:

   o Tyco Vigilant F3200 Fire Indicating Panel (FDCIE) installed indoors, adjacent to the main access door with 24 hour back up battery and voltage free contacts for remote indication and tripping of HVAC systems.

   o Tyco Series M614 smoke detectors.

   o Manual call points installed indoors adjacent to the main access door and externally next to each access door (complete with weatherproof kit).

   o Weather resistant strobe light and siren installed externally to the building.

   o Labelling and signage in accordance with AS1670.1.

d) The system shall be installed by qualified fire system installers.
6.7 Electrical Services

6.7.1 Distribution Board

The Supplier shall provide a 36 pole lighting and power Distribution Board in accordance with Engineering Standard GRC-ES005 – Light and Power Distribution Boards.

a) All circuits for lighting and small power shall be protected using 30mA RCD type circuit breakers to AS/NZS 3000.

b) The distribution board and all ancillary equipment shall be of types listed in Engineering Standard GRC-ES002 – Preferred Electrical Components.

c) All cabling for light and power circuits shall be concealed in ceiling and wall spaces and mechanically protected through penetrations with the use of ridged or flexible electrical conduit.

6.7.2 Lighting

The switchroom shall be provided with internal energy efficient LED lighting to provide a minimum illumination of 240 lux with a uniformity of 0.5.

a) Luminaires shall be positioned so that their output is not obstructed by overhead cable trays and air conditioning ducts and provides adequate illumination to the front of the switchgear.

b) Light fittings shall be surface mounted Pierlite PWP 236 or approved equivalent.

c) Internal lighting shall be controlled by two-way switching located at the main access doors.

d) An external luminaire shall be installed above each outside door and wired to the daylight controlled section of the Distribution Board.

e) Emergency and exit lighting shall be provided according to AS/NZS 2293.1.

f) Each light fitting shall be labelled in accordance with Engineering Standard GRC-ES-008 – Equipment Identification.

6.7.3 Small Power

The Switchroom shall be provided with a minimum of four RCD protected 10A general purpose outlets. These shall be spaced evenly throughout the switchroom. Two separate circuits containing two double GPOs each shall be installed.

6.8 Switchroom Earthing

a) The Switchroom building shall be provided with a main earth bar of minimum dimensions 40mm x 6mm x 1500mm mounted on stub insulators beneath the building.

b) The earth bar shall be drilled for M10 bolts every 50mm, for connection of main earth conductors and equipment earthing cables.

c) Two earth conductors shall be provided between opposite corners of the switchroom structure and the earth bar.

d) Two earth conductors shall be provided between the MCC earth bar and the switchroom earth bar.
6.9 Safety Equipment

a) The Switchroom building shall be supplied with a low voltage rescue kit comprising:
   - Insulating Gloves
   - Insulated Torch
   - Rescue Crook
   - Fire Blanket
   - Multi-trauma Dressing
   - Sign for attachment at the main switch reading “Isolate Here”

b) Storage locations for all these items shall be provided in the switchroom and shall be easily accessible and clearly marked.

c) An electrical resuscitation board, in compliance with relevant Australian standards shall be provided and mounted in the room.

6.10 Signage

As a minimum, the following signs shall be provided for each switchroom building:

a) Switchroom name, displayed adjacent to each access door. The labels shall be stainless steel 150mm high black lettering on high-visibility yellow background.

b) “Danger No Unauthorised Entry 415V”

c) “Doors To Be Locked At All Times”

d) Other equipment safety warning signs as required by regulations.

e) Resuscitation signage on the inside leaf of each door.

6.11 Other Equipment

Where specified, the following equipment shall be installed according to the appropriate manufacturer’s instructions:

- LV switchboards and MCC’s
- PLC cabinets
- Communications equipment cabinet
- Variable speed drives
- Cable ladder and associated supports
- Other miscellaneous equipment as shown on the layout drawing
7 INSPECTION AND TESTING

7.1 Routine Testing

The switchroom supplier shall carry out all routine tests or any tests required to prove compliance with this specification, the drawings and the relevant standards. The testing shall include the following as a minimum:

a) Continuity test of earthing systems.
b) Insulation resistance test of lighting and small power circuits.
c) Continuity and polarity tests on all circuits.
d) Functional and operation checks of complete installation including circuit breakers, residual current devices, general purpose outlets and light fittings.
e) Illumination level measurements.
f) Checks for installation compliance with drawings and specifications.

7.2 Test Certificates

The supplier shall provide test certificates for all routine testing carried out. These shall be forwarded to the purchaser within 7 days of completion of the tests.

7.3 Witnessing

In addition to the Routing Testing outlined above, the Supplier shall make allowance for factory acceptance testing (FAT). These tests shall be carried out to the satisfaction of, and if necessary, in the presence of the purchaser’s representative. The supplier shall provide 7 days’ notice to enable the purchaser’s representative to witness such tests.

8 TRANSPORTATION AND STORAGE

a) The switchboards and other equipment items fitted to the building shall be suitably braced and / or wrapped in ‘bubble wrap’ for protection against damage during loading, transport, unloading and storage.
b) Care shall be taken to ensure that packing tapes used to hold ‘bubble wrap’ or any other bracing in place are not secured to paintwork items that will be damaged upon removal of such tape upon the switchroom reaching site.
c) Where damage occurs in this regard, repairs on site required to be carried out are to be arranged by the Supplier at the Supplier’s cost.
d) Equipment sensitive to damage due to vibration such as plug-in relays and the like shall be removed and separately packed in clearly marked containers.
e) Heavy items that may dislodge during transportation shall be disconnected and packed separately.
f) Each container shall be clearly and indelibly labelled and shall contain all assembly fittings, accessories and instructions for refitting.

9 PAINTING AND SURFACE PROTECTION

Steelwork surface preparation, anti-corrosion protection and the surface coating system shall be to Australian Standards. Evidence shall be provided that these items meet Australian Standards.
10 DOCUMENTATION AND DRAWINGS

The Supplier shall provide full drawings and documentation for the Switchroom building. This shall include:

a) General arrangement drawings showing all equipment to be installed prior to construction.
b) Detailed structural drawings of the switchroom.
c) Lighting and power layout drawing.
d) Lighting and power distribution board single line diagram.
e) Heat loading calculations and HVAC system design.
f) Fire detection and alarm system design.
g) All relevant manuals/data sheets pertaining to all of the equipment installed inside the switchroom, including air conditioning and fire protection systems.
h) Evidence that surface protection and painting meets the requirements of Australian Standards.
i) Evidence that the design requirements outlined in Section 6.3 (a – f) have been met.

Final copies of all documentation shall be provided within two weeks of Factory Acceptance Testing.

The Supplier shall provide 2 paper copies of all documentation in hardbound folders, plus an electronic copy on CD in a structured folder arrangement.

All drawings shall be provided in AutoCAD electronic file format (.dwg) and in PDF format.
# ENGINEERING STANDARD

## Motor Control Centres

| Document: | GRC-ES004 | Revision: | 2 |

## REVISION HISTORY

<table>
<thead>
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<th>Date</th>
<th>Description</th>
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<th>Approved By</th>
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<tr>
<td>1</td>
<td>25/08/2011</td>
<td>First Issue</td>
<td>J. Hickey</td>
<td>C. Swanton</td>
</tr>
<tr>
<td>2</td>
<td>21/04/2017</td>
<td>Revised and Updated</td>
<td>B. James</td>
<td>C. Swanton</td>
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1 PURPOSE

The purpose of this Engineering Standard is to describe the requirements for the design, manufacture, supply, testing and delivery to site of 415V Motor Control Centre switchboards for Gladstone Regional Council. This Engineering Standard shall be read in conjunction with the attached Motor Control Centre data sheet.

2 SCOPE

This Engineering Standard is applicable to all 415V Motor Control Centre switchboards, for indoor and outdoor areas supplied for use at Gladstone Regional Council sites, where the primary supply is 415V three phase.

3 RESPONSIBILITIES

All persons involved in the purchasing, design, fabrication and supply of 415V Motor Control Centres for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

The Purchaser shall complete the attached Motor Control Centre data sheet for each switchboard required.
4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage, Exceeding 32VAC or 115VDC but not exceeding 1000VAC or 1500VDC.</td>
</tr>
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<td>Manufacturer</td>
<td>The corporation or business that manufactures and/or assembles the equipment described by this Engineering Standard.</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature Circuit Breaker</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>MCCB</td>
<td>Moulded Case Circuit Breaker</td>
</tr>
<tr>
<td>MEN System</td>
<td>Multiple Earthed Neutral. A system of earthing in which the parts of an electrical installation required to be earthed in accordance with AS/NZS 3000 are connected to the general mass of earth and, in addition are connected within the electrical installation to the neutral conductor of the supply system.</td>
</tr>
<tr>
<td>Purchaser</td>
<td>The individual or corporation responsible for purchasing the equipment described by this Engineering Standard on behalf of GRC.</td>
</tr>
<tr>
<td>RCBO</td>
<td>Residual current Circuit Breaker with Overload protection.</td>
</tr>
<tr>
<td>Specifier</td>
<td>Any individual specifying equipment for use in electrical installations on a GRC site.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
</tr>
<tr>
<td>Supplier</td>
<td>The individual or corporation with whom GRC enters an agreement to purchase the equipment described by this Engineering Standard. Note that in some instances, the Supplier may also be the Manufacturer.</td>
</tr>
<tr>
<td>TOL</td>
<td>Thermal Overload</td>
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5 REFERENCE DOCUMENTS

All equipment shall be designed, manufactured and tested in accordance with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

5.1 GRC Engineering Standards

<table>
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<tbody>
<tr>
<td>GRC-ES001</td>
<td>Electrical Work</td>
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6 TECHNICAL REQUIREMENTS

6.1 General

6.1.1 Quality Assurance

The Manufacturer shall have an integrated quality assurance system in place at the locations where the motor control centres are designed, manufactured and assembled. The system shall be ‘third party accredited’ to AS/NZS ISO 9001:2000 and frequently audited for compliance. The Manufacturer shall provide documentation proving any claims made with respect to the above if requested by the Purchaser.

6.1.2 Prohibited Materials

Components that contain asbestos, mercury, cadmium, PCB’s, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short term effects on the health of personnel if they are inhaled, ingested or otherwise contacted during normal and reasonable use are not permitted in electrical equipment to be used on the Purchaser’s site.

This requirement shall apply to all fabrication tools and equipment used that could leave dust particles or other residues inside the assemblies as well as components used in the construction of the MCC’s and associated components covered by this Standard.

6.1.3 Standardisation of Parts and Equipment

The Supplier shall select all components, parts and equipment used in the construction and fabrication of the switchboard from the Preferred Electrical Components List GRC-ES002.

If the Supplier wishes to utilise items not included in the preferred components list, approval shall be obtained from GRC in accordance with the requirements of GRC-ES002.

6.1.4 Service Conditions

The switchboard and associated equipment shall be designed to operate continuously, 24 hours per day, 365 days per year.

The switchboard shall be capable of continuously carrying the rated current at rated frequency without exceeding allowable temperatures, in accordance with the Manufacturer’s type tested rating.

All components and equipment within the Motor Control Centre shall have an ambient temperature rating of not less than 55°C. The thermal design shall be such that the maximum temperature within the switchboard when operating under an ambient temperature of 45°C shall not exceed 55°C. The thermal design shall be based on natural heat dissipation. Ventilation openings shall not be used unless specified.

6.2 Construction

a) The switchboard shall be of free standing, metal-clad type and shall be built to the Supplier’s latest verified design in accordance with AS/NZS 61439, the Drawings and Data Sheet.

b) The switchboard shall consist of modules arranged in vertical sections or tiers. The tiers shall be configured in an arrangement suitable for free standing installation on a concrete pad for outdoor installation and plinth mounted for indoor installation. The switchboard shall provide front access and front connection unless otherwise specified. Doors shall open 120°.
Escutcheon plates shall be provided to effectively shroud all live parts in panels when the access door is open.

c) Individual functional units shall be of demountable or withdrawable design and shall be a uniform width and depth with a combination of modular heights permitting new modules to be installed and interchange of existing modules post installation.

d) The switchboard height shall not exceed 2200mm.

e) The various compartments of the switchboard shall be designed and tested for arc fault containment in accordance with AS/NZS 61439.1 Appendix ZD.

f) Equipment and terminals shall be readily accessible in the cubicles and shall require a minimum of disturbance of associated and adjacent equipment for access.

g) Form of internal separation to AS/NZS 61439 shall be Form 3B. Form 3Bih will not be accepted.

h) Terminals, busbars and any components carrying voltages greater than extra low voltage shall be protected against accidental contact by personnel to an IP rating of IP2X to AS 60529. This shall be achieved by fitting proprietary shrouds or fabricating clear barriers. Shrouds shall be used on cable terminals in the cable zones.

i) Test certificates for the assemblies shall be submitted for review before construction commences.

j) The complete switchboard shall be vermin and insect proof.

k) Facilities shall be provided for lifting transportable sections without distortion.

6.2.1 Indoor Switchboards

Switchboards designated on the Data Sheet as indoor service, which will be installed within a dedicated electrical switchroom building shall be constructed from powder coated mild steel at least 1.6mm thick and shall have a minimum degree of protection of IP52.

6.2.2 Outdoor Switchboards

Switchboards designated on the Data Sheet as outdoor service, which will be installed external to a building or within a corrosive and/or wet environment shall be constructed from powder coated 316 stainless steel at least 1.6mm thick or marine grade aluminium at least 3mm thick, and shall have a minimum degree of protection of IP56. In addition, outdoor switchboards shall also incorporate the following features:

a) Full height outer doors covering all functional units and controls. Doors shall be provided with lift of pintle hinges. Hinges shall permit the door to move through an arc of at least 120°. 

b) Outer doors shall be lockable and fitted with a stainless steel 3 point locking mechanism, with either 1 or 3 Dirak 207-9295 Swing Handles or equivalent with lock No. 92285.

c) Roof heat shields mounted on 50mm C section supports.

d) Side heat shield mounted on 20mm stand-offs.

6.3 Busbars

6.3.1 Main Busbars

The busbar system shall consist of a horizontal 3 phase set of rectangular hard drawn, high conductivity copper bars, air insulated and supported by suitable insulators. The busbars shall be bolted with high tensile, corrosion resistant steel bolts. Bolted busbar joints shall be tensioned in accordance with the manufacturer's recommendations. Flexible busbar connections are not
acceptable. Each section of busbar shall be colour coded at regular intervals and at termination points. Busbars shall be continuously rated for the maximum full load current per phase.

The busbars and support system shall be a tested and verified design able to withstand the prospective fault level as indicated on the Data Sheet. A physical barrier shall isolate live busbars from other sections.

Busbar temperature rise at full load shall be limited to 50°C with an ambient temperature of 40°C. Busbar temperature shall not exceed 90°C under full load conditions.

### 6.3.2 Vertical Busbars

Each tier shall have a 3 phase copper vertical busbar for the distribution of power from the main busbar to the individual modules. The busbar shall be designed to permit the connection of individual modules. The capacity of the vertical busbar shall not be less than 300A.

### 6.3.3 Neutral Busbars

A vertical neutral busbar shall be provided within each cable zone of the switchboard and shall provide adequate connection facilities for each incoming and outgoing circuit. The neutral busbar rating shall be 100% of the phase busbar rating. The switchboard shall be designed so that effects of eddy currents around neutral busbars are minimised.

### 6.3.4 Earth Busbars

A continuous, separate earth busbar shall be provided along the full length of the switchboard and shall provide adequate connection facilities for each incoming and outgoing circuit, with vertical droppers in each cable zone. Connections shall be provided at each end of the earth bar for earth cables to the site earth grid.

### 6.3.5 MEN Link

A removable MEN link of full size of the neutral shall be provided. The MEN link shall be easily accessible in the switchboard.

### 6.4 Earthing of Assemblies

All metal components of the assemblies shall be effectively earthed. Special attention shall be given to earthing of those components which are hinged, withdrawable or demountable.

All hinged doors shall have an earthing stud. Doors with electrical equipment installed on the door shall have an earthing cable installed from the earth stud on the door to an earth connection on the body of the main assembly.

### 6.5 Switchgear Assemblies

#### 6.5.1 Functional Units

Functional units shall be of demountable or withdrawable design and shall be a uniform width and depth with a combination of modular heights permitting interchange, and shall be in accordance with the following requirements:

a) Functional units shall include equipment shown on the Drawings. All equipment shall be in accordance with the relevant clauses of this Engineering Standard. Equipment shall be arranged within functional units to permit easy access and removal of all components without interference to the structure, other components or cable entry.
b) Functional unit power connection to main vertical busbars shall be via clamp or spring contact devices.

c) It shall not be possible to come into contact with any live wiring or components when the circuit breaker or isolator is in the “Off” position and module door is open, without deliberately removing covers. A fully insulated and shrouded installation is required.

6.5.2 Main Incomer Sections

The specific requirements for the incomer sections will be shown on the Drawings. Typical requirements shall include:

a) The main incomer section shall be equipped with a withdrawable air circuit breaker for switchboards rated greater than 800A or an MCCB for switchboards rated 800A or less, with a certified breaking capacity not less than the specified fault level. The circuit breaker shall have the following features:
   - Integral solid state protection relay incorporating time delayed overcurrent, instantaneous overcurrent and earth fault protection
   - Manual spring charge
   - Shunt trip
   - Manual Open Pushbutton
   - Manual Close Pushbutton
   - Lockable safety shutters
   - Isolation Padlock facility

b) The incomer section shall incorporate a digital power meter with metering CTs to provide indication for volts, amps, watts, apparent power, power factor and voltage harmonic content.

c) The incomer front panel shall have a cut away section such that the circuit breaker controls and indication are exposed.

d) The incomer section shall incorporate a surge diverter as specified on the Drawings.

6.5.3 Supply Authority Metering

If required on the Drawings, the switchboard shall incorporate a provision for a separate CT chamber and a panel for external supply authority metering equipment in accordance with the requirements of the latest version of the Queensland Electricity Connection and Metering Manual.

6.5.4 Emergency Generator Transfer Switches

If required on the Drawings, the switchboard shall incorporate either a manual or automatic transfer switch arrangement for switching an emergency generator.

The preferred transfer switch arrangement is to use dual circuit breaker incomers, with a mechanical interlock ensuring that only one of the incomer circuits can be closed.

a) The Emergency Generator incomer shall be identical to the Main incomer circuit, and shall also include the following:
   - 4 pole circuit breaker of the same size and rating as the main incomer
   - Phase rotation meter

b) Where a transfer switch is required, a separate Main Isolator shall be installed on the line side of the Main Incomer and Supply Authority metering CTs. The Main Isolator shall be the same size and rating as the incomer circuit breaker.
c) Where an automatic transfer switch is required with a permanent generator installation, a separate Generator Isolator shall also be installed on the line side of the Generator Incomer. The Generator Isolator shall be the same size and rating as the generator incomer circuit breaker.

6.5.5 Control Power Supply

The motor control centre shall incorporate a separate Control Power Supply module including the following:

a) Dual 24VDC switchmode power supplies with a minimum size of 20A per power supply.

b) The 24VDC power supplies shall incorporate an appropriate redundancy module allowing parallel operation.

c) The 24VDC power supplies shall be supplied separately from the plant UPS distribution board.

d) If there is no UPS supply available, a single 20A 24VDC battery backed power supply may be used, supplied from the motor control centre.

e) The power supplies shall incorporate voltage free contacts for fault status indication to the plant PLC system.

6.5.6 Motor Starter and Feeder Modules

The specific requirements for each motor starter and feeder module will be shown on the Drawings.

a) Moulded Case Circuit Breakers are the approved disconnect device on all motor starter and feeder modules. Fuses shall not be used.

b) Circuit breakers shall comply with AS 60947 with respect to construction and performance requirements. They shall be of the independent manual or stored-energy closing, air break type. Circuit breakers shall have a rated short circuit breaking capacity not less than the specified main busbar short-circuit current rating.

c) A rotary handle fitted to the front panel of each module shall be used to operate the circuit breaker. On and Off positions shall be clearly marked on the handle. The handle shall be padlockable and shall provide an interlock that prevents the module door being opened when the circuit breaker is in the On position or the circuit breaker is in the Off position and a padlock is fitted.

d) Main contactors for combination motor starters shall be air break type, 3 pole, 415VAC. Contactors shall conform to the requirements of AS 60947.4.1 with respect to both uninterrupted duty and Class 1 of intermittent duty (120 operating cycles per hour) with rated operational current and shall have a mechanical endurance level of one million no-load operating cycles. The condition for making and breaking shall be to utilization category AC3.

e) Auxiliary contacts shall be provided as required and the facility to field fit additional auxiliary contacts shall be a feature of the contactor.

f) Unless otherwise indicated on the drawings, each motor starter circuit shall incorporate conventional thermal overload protection (TOL). The trip class of the overload shall be suited to the starting characteristics of the motor/load combination. The TOL device shall have a minimum of 1 N/O and 1 N/C auxiliary contact.

g) Thermistor or RTD protection shall be provided for all motors larger than 37kW as indicated on the drawings.

h) The combination of short circuit protection device, contactor and thermal overload used in each motor starter circuit shall provide Type 2 co-ordination in accordance with AS 60947.4.1.
6.5.7 Variable Speed Drives

The specific requirements for each variable speed drive starter circuit will be shown on the Drawings.

a) Variable speed drives shall be installed within the motor control centre for all installations designated as outdoor service on the Data Sheet.

b) Variable speed drives up to 110kW shall be installed within the motor control centre for all installations designated as indoor service on the Data Sheet, where the MCC will be installed within a dedicated electrical switchroom building.

c) Variable speed drives larger than 110kW may alternatively be installed outside the motor control centre within the switchroom building and shall be rated to IP54.

d) Where variable speed drive units are installed within the MCC, care should be taken to ensure that adequate cooling is maintained in accordance with the manufacturer’s recommendations. A heat load calculation for each variable speed drive shall be provided.

e) Each module containing a variable speed drive unit shall incorporate a suitable ventilation fan and filter to draw in cooler external air and a corresponding filter to vent hot air out. The ventilation fan shall be started and stopped by an adjustable thermostat.

f) Variable speed drive HMI units shall be installed on the MCC module door where the variable speed drive is installed within the MCC.

g) Where the variable speed drive is installed external to the MCC, the HMI unit shall be installed on the IP54 enclosure such that the HMI unit can be accessed without opening the enclosure.

h) Variable speed drive starter circuits shall incorporate a line side contactor controlled by the emergency stop and LCS isolator circuits as indicated on the Drawings.

i) Variable speed drives shall incorporate a load side filter to comply with manufacturer cable length specifications if required.

j) Variable speed drives shall incorporate harmonic filtering to limit harmonic distortion to within the supply authority requirements for the specified site. Harmonic filtering shall consist of either passive or active filtering devices. Harmonic modelling calculations shall be provided to demonstrate compliance with supply authority requirements.

k) Where no supply authority requirements for harmonic distortion are provided, as a minimum all variable speed drives 22kW or larger shall incorporate passive filtering to provide <5% THD at rated load.

l) Where the Drawings indicate line or load side filters are required on the variable speed drive, the filter(s) shall be installed within the same enclosure as the variable speed drive unit.

6.6 Control and Indication Devices

The following devices shall be selected in accordance with Engineering Standard GRC-ES002 – Preferred Electrical Components.

6.6.1 Control Relays

General purpose control relays shall be Finder 55.34 series plug-in type. Relays shall have 240VAC or 24VDC coils as indicated on the Drawings. Each relay shall have a sufficient number of N/O and N/C contacts and incorporate flag indication and built in suppression for DC coils.
6.6.2 Indicating Lights

Indicating lights shall be 22mm in diameter, LED flush mount type suitable for 24VDC. The functions of the indicating lights shall be:

- Green – closed, running, ON
- Red – open, stopped, OFF
- Amber – tripped, fault

6.6.3 Control Switches

Control switches shall be 22mm diameter flush mounted type with an IP rating not less than the IP rating of the equipment upon which it is mounted.

6.6.4 Meters

Meters shall be provided as indicated on the Drawings and shall be positioned adjacent to the unit with which they are associated.

Analogue meters shall be accuracy class 1.5, have a 96mm casing and have insulated terminals. Analogue ammeters shall be 5 times over-scaled. CT operated ammeters shall be 5A with 5 times over-scale.

6.6.5 Current Transformers

Current transformers shall be fully encapsulated and shall comply with AS 60044.1 and the following:

a) Metering transformers shall have accuracy class and secondary output as specified on the Drawings.

b) Current transformers shall be installed in the circuit module and fitted with a nameplate that can be read from the front of the opened module.

6.6.6 Terminals

a) “Top Hat” type DIN rail mounted moulded terminal blocks shall be provided for termination of all control wiring. Terminals shall carry a numeric designation in accordance with the Drawings and shall be segregated according to function and voltage.

b) Terminal groups for the termination of control wiring external to the switchboard shall be arranged vertically and located within the vertical cable zone adjacent to their respective functional units. The terminal groups shall be spaced to facilitate easy connection of wiring and cables.

c) Access to individual terminals shall not be impeded by power cable connections.

d) A separate terminal shall be provided for the connection of each individual wire. Bridging links as supplied by the terminal manufacturer shall be used to interconnect ‘common’ terminals. Bridging links shall be recessed within the terminal strip with no part, bridging link or screws, being proud of the terminal strip.

6.6.7 Fuses and Test Blocks

a) All fuses used for protection of power and control circuits shall be G class to AS/NZS 60269.

b) Fuse holders shall be of the all insulated type with shrouded contacts.

c) Test blocks shall be as specified on the Drawings.
6.7 PLC Section

Unless specified otherwise, each Motor Control Centre shall incorporate a full height PLC section with a minimum width of 600mm and minimum depth of 400mm to accommodate PLC and communications equipment as shown on the Drawings.

Typically, the PLC section shall consist of remote I/O modules connecting to all PLC inputs and outputs within the motor control centre with a communications network connection to the plant PLC system. All PLC and communications hardware shall be selected in accordance with Engineering Standard GRC-ES002 – Preferred Electrical Components.

Unless specified otherwise on the Drawings, the PLC section shall include the following equipment:

a) Allen-Bradley 1794 Flex IO modules and terminal bases to suit the quantity of I/O required. A minimum of 20% spare capacity for each I/O type used shall be allowed.

b) Allen-Bradley 1794 Flex IO Ethernet/IP communications adapter for each Flex I/O rack.

c) DIN rail mount Ethernet switch.

d) 24VDC power distribution to each Flex I/O module.

e) PVC slotted cable ducts adjacent to each Flex I/O rack to accommodate control wiring.

6.8 Cable Zones

a) Vertical cable zones shall be provided adjacent to each tier of functional units and shall extend the full height of the tier. Zones shall be of sufficient size to accommodate terminal blocks as shown on the drawings and shall allow front entry via hinged doors. Vertical cable zones shall be located on the right-hand side of the modules to which they provide access.

b) Provision shall be made on the side of vertical cable zones furthest from the module entry points to secure incoming cables in place at intervals of 300mm. This shall be in the form of galvanised admiralty pattern perforated tray as wide as the cableway is deep installed for the full height of the cableway.

c) Horizontal cable zones shall be provided across the top and bottom of the entire motor control centre with removable bolted covers and shall connect with the vertical zones. The cable zone shall be fully accessible from the front of the switchboard.

d) Cable zones shall have provision for supporting cables between their point of entry and point of termination.

e) Cable zones shall be of sufficient size to accommodate the required power and control cables in one layer on the cable support provisions. Cable Zones for power cabling shall be a minimum of 300mm wide.

f) Cable zones shall be sized to allow power cables to be terminated whilst maintaining at least the minimum bending radius of the cabling as recommended by the cable manufacturer.

g) Slotted PVC wiring ducts shall be provided in the cable zones to neatly distribute control and communications wiring throughout the MCC.

6.9 Gland Plates

Undrilled brass gland plates of at least 5mm minimum thickness shall be provided within cable zones and shall be of sufficient size to accommodate all glands necessary for the termination of all power and control cables at the switchboard.

Gland plates shall be fixed by means of captive nuts and screws and shall have a suitable gasket fitted between the gland and the fixing surface. Gland plates shall be bonded to earth with a minimum 6mm² earth conductors.
6.10 Cable Entry and Termination

6.10.1 Power Cables

Cable entry into the switchboard and switchgear assemblies will be from the bottom unless otherwise specified. The Supplier shall ensure that cable entry and termination areas are adequate for the number and size of cables to be accommodated.

Power cables shall be terminated to devices using copper compression type crimp lugs or pins as appropriate. Lugs and pins shall be applied using overall crimping hexagonal dies. Lugs or pins applied using a single indent crimp are not acceptable.

Power cables shall be identified at both ends by applying phase coloured heat shrink sleeving over adjacent insulation and the barrel of the cable lugs.

6.10.2 Control Wiring

Control wiring for digital signals shall be PVC insulated, V90, 0.6/1kV, multi-stranded copper conductor with a minimum cross sectional area of 1.5mm².

Current transformer secondary wiring shall be PVC insulated, V90, 0.6/1kV, multi-stranded copper conductor with a minimum cross sectional area of 2.5mm².

Control wiring for analogue signals shall be PVC insulated, V90, multi-stranded copper conductor, twisted pair or triples with overall and individual screen and a minimum cross sectional area of 1.0 mm².

Wire colours shall be as follows:

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<th>Active Conductor</th>
<th>Common Conductor</th>
<th>Earth Conductor</th>
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<tr>
<td>415/240V AC</td>
<td>Red/White/Blue</td>
<td>Black</td>
<td>Green/Yellow</td>
</tr>
<tr>
<td>12/24V DC Supply</td>
<td>Brown</td>
<td>Grey</td>
<td>-</td>
</tr>
<tr>
<td>12/24V DCSwitched</td>
<td>Violet</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CT Wiring</td>
<td>Red/White/Blue</td>
<td>Black</td>
<td>Green/Yellow</td>
</tr>
</tbody>
</table>

a) All wires shall be identified at both ends by wire numbering ferrules, with wire numbers as shown on the Drawings. The same number shall appear at both ends of the wire.

b) Wiring shall be identified using a transparent sleeve that fits over the wire with provision for characters to be loaded into a second sleeve moulded with the first sleeve. The Grafoplast or Brady Multi-Mark systems shall be used.

c) All wires shall be terminated at both ends with a pre-insulated crimp lug, crimp pin or bootlace ferrule. No more than one wire shall be connected to any one terminal screw.

d) Terminals blocks shall be DIN rail mounted clip-on type. Barriers shall be installed between terminals at which cables of different voltages are terminated. There shall be 20% spare (unused) capacity on DIN rails to allow for future terminals and relays etc.

e) Terminal blocks shall be numbered as shown on the Drawings. Each terminal shall be numbered along with the group via a Marker Carrier.

f) Control wiring shall be installed in a neat and orderly fashion and shall be loomed or enclosed within slotted PVC wiring duct. The method of installation shall allow wires to be traced without removing cleats and ties. Wiring duct shall not be filled to more than 60% capacity.
6.11 Identification Labels

Labels shall be provided in accordance with the requirements of Engineering Standard GRC-ES008 – Electrical Equipment Identification Labels.

6.11.1 Nameplate

The motor control centre shall have one stainless steel nameplate fixed to the front of the switchboard with stainless steel screws. The switchboard nameplate shall have black paint filled letters and shall be engraved with the information specified in AS/NZS 61439.1.

The nameplate shall include the following information:

- Manufacturer
- Model or equipment designation
- Year of manufacture
- Compliance standards
- Testing approvals
- Ratings

6.11.2 Equipment Labelling

Identification labels shall be fixed to the exterior of each panel or module of the motor control centre. The label shall be engraved with the name and equipment number or function of that panel or module.

Equipment protruding through the front of the panels or doors shall have an identification label mounted on the panel or door below the piece of equipment. This label shall be engraved with the name and number of the equipment and any additional information required to explain the use of the equipment.

A second label shall be mounted inside the door or panel through which the device protrudes carrying the equipment number only.

Each piece of equipment mounted inside a panel shall have an identification label mounted as close as practicable to the piece of equipment. Interior labels shall typically carry the equipment or component identification number only. The interior labels shall be white traffolyte type labels engraved in black.

In addition, warning and danger labels shall be provided as per the requirements of AS/NZS 61439.1 and AS 1319.

Busbar chamber covers shall have warning labels as per the requirement of AS/NZS 61439.1.

6.12 Bolts and Nuts

Bolts, nuts, screws and washers shall be stainless steel in accordance with AS 1111. Spring and flat washers shall be fitted under all nuts and flat washers under bolt heads.

6.13 Hinges

Hinges shall be lift off pintle type manufactured from chrome plated brass or stainless steel with two fixing bolts. Where the motor control centre is designated as outdoor service on the Data Sheet, stainless steel shall be used.
6.13.1 Doors

Pan type doors shall be used for all modules and future spaces. Doors shall be hinged to the structure with pintle type hinges mounted on the left hand side of the door. Each door shall be connected to the main structure with a flexible earth lead.

6.14 Handles and Latching Mechanisms

Latching mechanisms on all doors and hinged panels shall be of the recessed quarter turn type with 7mm square operating mechanisms. The Supplier shall supply a minimum 2 tools for operating the latch mechanism with each motor control centre. Where the motor control centre is designated as outdoor service on the Data Sheet, stainless steel mechanisms shall be used.

6.15 Gaskets and Seals

Formed in place polyurethane, neoprene or rubber shall be used to seal fixed sections of the switchboard and doors, to provide sealing to the required IP rating.

6.16 Accessories

The Supplier shall provide a complete set of all special spanners, tools and appliances including special slings and lifting equipment necessary for installing, adjusting and maintaining the equipment. All items supplied under this clause shall be new and shall not be used during manufacture, testing, or installation of the equipment without prior approval from the Purchaser. All such spanners, tools, and appliances shall be supplied prior to take-over of the work.

7 INSPECTION AND TESTING

7.1 Verification Testing

Test certificates shall be supplied for all tests that have been carried out on representative assemblies, sub-assemblies or components as applicable in accordance with the requirements of AS/NZS 61439.1.

7.2 Routine Testing

The switchboard supplier shall carry out all routine tests or any tests required to prove compliance with this specification, the drawings and the relevant standards. The testing shall include the following as a minimum:

a) Standard 50Hz high voltage withstand test on the complete assembly including the circuit breakers. Megger insulation before and after test.

b) Standard 50Hz insulation test on all small wiring, including switchboard and instrument transformer secondary wiring, at 2000V to earth for one minute.

c) Continuity and polarity tests on all coils and circuits.

d) Verification of current transformers; terminal markings, determination of errors, magnetising curve, CT polarity test and CT ratio test using primary current injection.

e) Functional tests on all relays, control circuits and interlocks.

f) Checking of electrical and mechanical interlocks.

g) Mechanical operation of circuit breakers, draw-out mechanisms, interlocks, auxiliary switches, manual devices, etc.

The switchboard supplier shall have suitably qualified labour readily available to rectify any defects or errors identified during testing, such that there is no delay in testing.
The switchboard supplier shall provide instructions for final installation inspection and tests after the switchgear has been installed. The instructions shall include a schedule of recommended site tests to establish correct operation, procedures for any adjustments to obtain correct operation, instructions for final inspection and putting in service.

7.3 Test Certificates

The supplier shall provide test certificates for all routine testing carried out. These shall be forwarded to the purchaser within 7 days of completion of the tests.

7.4 Witnessing

In addition to the Routing Testing outlined above, the switchboard manufacturer shall make allowance for factory acceptance testing (FAT). These tests shall be carried out to the satisfaction of, and if necessary, in the presence of the purchaser’s representative. The supplier shall provide 7 days’ notice to enable the purchaser’s representative to witness such tests.

8 TRANSPORTATION AND STORAGE

After completion of all testing, the switchboard supplier shall ensure that the switchboard sections and all components are suitably packed in separate crates for transportation to site by road transport and the unloading on site by a crane or forklift.

Packaging shall ensure that no dust or water enters the equipment during transportation or temporary storage outdoors. Silica gel desiccant shall be placed in individual sections of the switchboard. No loose items shall be transported in any part of the switchboard. Items packed in separate crates should be identified and a list provided to the Purchaser, for each individual crate. The Supplier shall provide suitable notice to the Purchaser for gaining access to site.

Upon arrival on site, the Supplier shall confirm with the Purchaser, the exact location(s) for offloading of the equipment.

9 PAINTING AND SURFACE PROTECTION

Steelwork surface preparation, anti-corrosion protection and the surface coating system shall be to Australian Standards. Evidence shall be provided that these items meet Australian Standards.

The painting system used for the motor control centre shall be powder coated to a total thickness of 70 microns. The standard painting system of the switchboard supplier may be used provided details of the system are submitted and approval for use is received from the Purchaser.

a) The colour and finish of Motor Control Centres for indoor service shall be X15 Gloss Orange.

b) The colour and finish of Motor Control Centres for outdoor service shall be X15 Gloss Orange.

c) Escutcheon panels and other interior surfaces shall be Gloss White.
10 MANUALS AND DRAWINGS

The Supplier shall provide full drawings and documentation for the equipment. This shall include:

a) General arrangement drawings showing the overall dimensions and MCC arrangement.

b) Module layout drawings showing the location of all equipment within each module, including an equipment list identifying each item of equipment, its part/model number and quantities.

c) Single line diagram.

d) Circuit diagrams and schematic drawings consisting of:
   o Individual schematic diagram for each motor and feeder circuit
   o Incomer schematic diagram
   o Control power distribution schematic

e) Recommended spares list.

f) Internal and External label drawings.

g) Certified Inspection and Test Plans and results.

h) All verification test certificates.

i) Equipment data sheets and manuals.

j) Installation, Operating and Maintenance Manuals.

Final copies of all documentation shall be provided within two weeks of Factory Acceptance Testing.

The Supplier shall provide 2 paper copies of all documentation in hardbound folders, plus an electronic copy on CD in a structured folder arrangement.

All drawings shall be provided in AutoCAD electronic file format (.dwg) and in PDF format.

11 DATA SHEETS

This Engineering Standard shall be read in conjunction with the attached Motor Control Centre data sheet. The Purchaser shall complete an individual data sheet for each Motor Control Centre. Each Motor Control Centre data sheet shall be provided to the Manufacturer in Microsoft .xls format for completion.
# ENGINEERING STANDARD

**Field Control Panels**

Document: GRC-ES006  
Revision: 1

## REVISION HISTORY

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<th>Date</th>
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<th>Approved By</th>
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<td>22/05/2017</td>
<td>First Issue – for Review</td>
<td>D Wilschefski</td>
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1 PURPOSE

The purpose of this Engineering Standard is to describe the requirements for the design, manufacture, supply, testing and delivery to site of Field Control Panels for use in low voltage and extra low voltage electrical systems for Gladstone Regional Council.

2 SCOPE

This Engineering Standard is applicable to all Field Control Panels, for indoor and outdoor areas supplied for use at Gladstone Regional Council sites, where the primary supply is 415V three phase or less.

Field Control Panels are free standing equipment panels that may be installed in public areas. They may include the following equipment:

- Circuit breakers and fuses.
- Motor starters.
- Lighting and power circuits.
- Power supplies.
- Instruments.
- Programmable logic controllers, their input and output cards and networking equipment.
- Radio telemetry equipment.
- Operator control stations and HMI panels.

3 RESPONSIBILITIES

All persons involved in the purchasing, design, fabrication and supply of Field Control Panels for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

The Purchaser shall complete the attached Field Control Panel data sheet for each panel required.
### DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>CT</td>
<td>Current transformer.</td>
</tr>
<tr>
<td>FCP</td>
<td>Field control panel.</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface.</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz.</td>
</tr>
<tr>
<td>LCP</td>
<td>Local control panel.</td>
</tr>
<tr>
<td>LV</td>
<td>Low voltage, exceeding 32VAC or 115VDC but not exceeding 1000VAC or 1500VDC.</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>The corporation or business that manufactures and/or assembles the equipment described by this Engineering Standard.</td>
</tr>
<tr>
<td>MCB</td>
<td>Miniature circuit breaker.</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor control centre.</td>
</tr>
<tr>
<td>MCCB</td>
<td>Moulded case circuit breaker.</td>
</tr>
<tr>
<td>MEN System</td>
<td>Multiple Earthed Neutral. A system of earthing in which the parts of an electrical installation required to be earthed in accordance with AS/NZS 3000 are connected to the general mass of earth and, in addition are connected within the electrical installation to the neutral conductor of the supply system.</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller.</td>
</tr>
<tr>
<td>Purchaser</td>
<td>The individual or corporation responsible for purchasing the equipment described by this Engineering Standard on behalf of GRC.</td>
</tr>
<tr>
<td>RCBO</td>
<td>Residual current circuit breaker with overload protection.</td>
</tr>
<tr>
<td>Specifier</td>
<td>Any individual specifying equipment for use in electrical installations on a GRC site.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
</tr>
<tr>
<td>Supplier</td>
<td>The individual or corporation with whom GRC enters an agreement to purchase the equipment described by this Engineering Standard. Note that in some instances, the Supplier may also be the Manufacturer.</td>
</tr>
<tr>
<td>TOL</td>
<td>Thermal overload.</td>
</tr>
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</table>
5 REFERENCE DOCUMENTS

All equipment shall be designed, manufactured and tested in accordance with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

5.1 GRC Engineering Standards

<table>
<thead>
<tr>
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<th>Title</th>
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<tbody>
<tr>
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<td>Electrical Work.</td>
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<tr>
<td>GRC-ES002</td>
<td>Preferred Electrical Components.</td>
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<tr>
<td>GRC-ES005</td>
<td>Light &amp; Power Distribution Boards.</td>
</tr>
<tr>
<td>GRC-ES008</td>
<td>Equipment Identification.</td>
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5.2 GRC Standard Drawings

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<td>GRC-ED-010</td>
<td>Typical Schematic &lt; 4kW DOL Starter.</td>
</tr>
<tr>
<td>GRC-ED-011</td>
<td>Typical Schematic 4-40kW Soft Starter.</td>
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<tr>
<td>GRC-ED-012</td>
<td>Typical Schematic &gt; 40kW VSD.</td>
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<tr>
<td>GRC-ED-013</td>
<td>Typical MCC DB, UPS, 24VDC Power Supply.</td>
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5.3 Australian Standards

<table>
<thead>
<tr>
<th>Standard</th>
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<tbody>
<tr>
<td>AS 1319</td>
<td>Safety Signs for the Occupational Environment.</td>
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<td>AS 2700</td>
<td>Colour Standards for General Purposes.</td>
</tr>
<tr>
<td>AS/NZS 3000</td>
<td>Wiring Rules.</td>
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<td>AS/NZS 3008</td>
<td>Electrical Installations – Selection of Cables.</td>
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<td>AS/NZS 3820</td>
<td>Essential Safety Requirements for Electrical Equipment.</td>
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<td>AS 60529</td>
<td>Degrees of Protection Provided by Enclosures (IP Code)</td>
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<td>AS/NZS 60947</td>
<td>Low-voltage Switchgear and Controlgear.</td>
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<td>AS/NZS 61439</td>
<td>Low Voltage Switchgear and Controlgear Assemblies.</td>
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<tr>
<td>AS 62103</td>
<td>Electronic Equipment for Use in Power Installations.</td>
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<tr>
<td>AS 60044</td>
<td>Instrument Transformers.</td>
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5.4 Acts and Regulations

<table>
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<tr>
<td>Electrical Safety Regulation 2002.</td>
</tr>
<tr>
<td>Work Health and Safety Regulation 2011.</td>
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</table>
6 TECHNICAL REQUIREMENTS

6.1 General

6.1.1 Quality Assurance

The Manufacturer shall have an integrated quality assurance system in place at the locations where the field control panels are designed, manufactured and assembled. The system shall be ‘third party accredited’ to AS/NZS ISO 9001:2000 and frequently audited for compliance. The Manufacturer shall provide documentation proving any claims made with respect to the above if requested by the Purchaser.

6.1.2 Prohibited Materials

Components that contain asbestos, mercury, cadmium, PCB’s, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short-term effects on the health of personnel if they are inhaled, ingested or otherwise contacted during normal and reasonable use are not permitted in electrical equipment to be used on the Purchaser’s site.

This requirement shall apply to all fabrication tools and equipment used that could leave dust particles or other residues inside the assemblies as well as components used in the construction of the panels and associated components covered by this Standard.

6.1.3 Standardisation of Parts and Equipment

The Supplier shall select all components, parts and equipment used in the construction and fabrication of the Field Control Panel from the Preferred Electrical Components List GRC-ES002.

If the Supplier wishes to utilise items not included in the preferred components list, approval shall be obtained from GRC in accordance with the requirements of GRC-ES002.

6.1.4 Service Conditions

The Field Control Panels shall be designed to operate continuously, 24 hours per day, 365 days per year.

All components and equipment within the Field Control Panels shall have an ambient temperature rating of not less than 55°C. The thermal design shall be such that the maximum temperature within the enclosure when operating under an ambient temperature of 45°C shall not exceed 55°C.

The thermal design shall be based on natural heat dissipation. Ventilation openings shall not be used unless specified.
6.2 Construction

a) This specification is intended to apply to diverse types of Field Control Panels. The enclosures may include any of the following equipment:

- Power distribution circuit breakers and busbars.
- PLC equipment.
- Operator controls and HMI.
- 24VDC power supplies (Single or dual-redundant)
- Battery backup equipment.
- Motor starters.
- Lighting supply and control.
- Instruments.

b) The Field Control Panels shall consist of a single metal enclosure. The enclosure shall be configured in an arrangement suitable for free standing installation on a concrete pad for outdoor installation and plinth mounted for indoor installation. Doors shall open 120°. The Field Control Panel height shall not exceed 2000mm. The Field Control Panel width shall be at least 800mm.

c) Field control panels shall be constructed as follows:

- External hinged lockable door.
- Internal hinged escutcheon fitted with operator controls (Push-buttons, control switches and HMI).
- At least 240mm clear internal space shall be provided between the escutcheon and the equipment gear tray inside the enclosure.
- Low voltage compartment, if specified. A separate low voltage compartment shall be fitted behind the escutcheon. The compartment shall be fitted in the lower section of the enclosure. The front of the compartment shall be fitted with a 3mm clear cover. The compartment shall provide a minimum enclosure rating of IP2X. Low voltage terminal blocks shall be fitted at the bottom of the low voltage compartment. Circuit breaker operating handles shall protrude through the clear cover, but shall remain behind the escutcheon. Electrical equipment in the low voltage compartment shall use Form 1 internal separation to SA/SNZ TR 61439.0 Annex B. Where a circuit breaker isolates power to the FCP, the incoming terminals of the circuit breaker shall be fully shrouded.
- 150mm vertical clear space shall be allowed in the bottom of the panel below the low voltage compartment for termination of cables.
- Internally on each side of the panel a vertical wiring duct shall be fitted to enclose internal wiring.
- Extra low voltage controls, power supplies, PLC and instruments shall be mounted on horizontal DIN rails above the low voltage compartment. Where equipment has a low voltage supply the low voltage terminals shall be fully shrouded.
- Horizontal wiring ducts shall be fitted adjacent to terminal blocks and instruments to enclose wiring. Ducting shall be fitted at least 50mm clear of terminals and equipment to allow room for termination and labelling of wires.
- All cables shall be bottom entry through a plated brass gland plate. At least 300mm clear space shall be provided below all gland plates for the termination of cables.
• The space under the panels shall be completely enclosed with screw on or similarly secured covers to prevent any unauthorised access to the cable zone.

d) Equipment and terminals shall be readily accessible and shall require a minimum of disturbance of associated and adjacent equipment for access.

e) Terminals, busbars and any components carrying voltages greater than extra low voltage shall be protected against accidental contact by personnel to an IP rating of IP2X to AS 60529. This shall be achieved by fitting proprietary shrouds or fabricating clear barriers. Shrouds shall be used on cable terminals in the cable zones.

f) The complete Field Control Panel shall be vermin and insect proof.

g) Facilities shall be provided for lifting transportable sections without distortion.

6.2.1 Indoor Field Control Panels

Field Control Panels designated on the Data Sheet as indoor service, which will be installed within a dedicated electrical switchroom building shall be constructed from powder coated mild steel at least 1.6mm thick and shall have a minimum degree of protection of IP52. Refer to section 9 for paint protection requirements.

6.2.2 Outdoor Field Control Panels

Field Control Panels designated on the Data Sheet as outdoor service, which will be installed external to a building or within a corrosive and/or wet environment shall be constructed from powder coated 316 stainless steel at least 1.6mm thick or marine grade aluminium at least 3mm thick, and shall have a minimum degree of protection of IP56. Refer to section 9 for paint protection requirements. In addition, outdoor Field Control Panels shall also incorporate the following features fitted:

a) Full height outer doors. Doors shall be provided with lift of pintle hinges. Hinges shall permit the door to move through an arc of at least 120°.

b) Internal escutcheon for mounting of operator accessible controls.

c) Roof heat shields mounted on 50mm C section supports.

d) Side heat shield mounted on 20mm stand-offs.

e) Rear heat shield mounted on 20mm stand-offs, if the rear of the cabinet faces west.

6.2.3 Doors

a) The Field Control Panel shall be provided with hinged doors having lift off, chromium plated, brass block hinges with stainless steel hinge pins. Concealed stainless steel hinges may be offered with stainless steel enclosures. Hinges shall permit the door to move through an arc of at least 120°.

b) Doors shall be lockable, with a DIRAK type 207-9295 stainless steel handle or equivalent with lock No. 92268. Two keys shall be provided, attached to the handle.

c) Doors 900mm high or less shall have single point locking. Doors greater than 900mm high shall have multiple point locking.

d) Doors on panels between 1000mm and 1600mm in height shall be provided with two handles and two-point locking. Doors on panels greater than 1600mm in height shall be provided with three handles and three-point locking.

e) The doors shall be of fully folded construction with sealing by a neoprene gasket in a metal channel. All seams shall be welded.

f) A top hat bracing section shall be fitted on the inside of each door to provide stiffening. Doors on panels greater than 1800mm in height shall be provided with three hinges.
g) A drawing holder shall be provided and fixed to the inside of the door on the door stiffener. The document holder shall be suitable for A4 documents up to 20mm thick.

6.2.4 Escutcheons

a) A hinged escutcheon and supporting frame manufactured from the same material used for the main enclosure shall be provided to cover wiring and prevent access to internally mounted components by non-electrical personnel.

b) The escutcheon shall be hinged with a minimum of two pintle-type hinges mounted on the same side of the enclosure as the door hinges, and shall be removable without requiring removal of the door.

c) The escutcheon shall be secured in the closed position with a minimum of three 6mm chrome plated acorn nuts and washers.

d) A top hat bracing section shall be fitted to the inside of the escutcheon to prevent deflection when the escutcheon is securely closed.

e) The escutcheon may be opened with circuit breaker lock out devices in place.

6.3 Fault Rating

The Field Control Panel shall have a fault current rating as specified on the attached Data Sheet. Where no fault current rating is specified, the Field Control Panel shall have a minimum fault current rating of 10kA.

6.4 Busbar System

a) If specified, the Field Control Panel shall include a single phase or three phase, fully insulated busbar assembly.

b) Busbar connections shall be provided for all circuit breaker pole positions whether they are filled or not. Busbars shall be fully insulated, with unused poles capped with insulating material.

c) The busbar rating shall be as specified on the Data Sheet.

6.5 Neutral and Earth Bars

Tunnel type neutral and earth terminal bars shall be provided.

a) The number of neutral and earth terminals in each Field Control Panel shall be not less than the number of circuits specified for that panel.

b) Neutral bars shall be insulated from earth and rated for 100% or the phase busbar rating.

c) Tunnels shall be numbered and able to accommodate 16mm² cables.

d) Neutral and earth bars shall each be provided with two 10mm hexagon head studs and spring washers to permit connection of the supply neutral and earth cables.

e) Tunnels shall use two-screw fixing for each tunnel, or one screw fixing where the screw outside diameter is not less than 80% of the tunnel diameter.

f) All wires and pins inserted into tunnels with two screw fixing shall be long enough to ensure that both screws secure the conductor.

g) All metallic non-current carrying parts of the Field Control Panel shall be bonded together and connected to the earth busbar.

h) Earth straps on the front door shall be secured using a method which allows the removal of the earth from the door without using a tool.
6.6 **Instrument Earth Bars**

a) Instrument earth bars shall be fitted adjacent to analog I/O cards.
b) Instrument earth bars shall be insulated and of similar design to the neutral earth bars.
c) The number of earth terminals shall be greater than the total number of analog inputs and outputs available on the installed PLC cards.
d) The earth connection for the instrument earth bar shall be detailed in the Drawings and Data Sheet.

6.7 **Switchgear and Controlgear**

6.7.1 **Main Isolating Switch**

a) Where an enclosure contains equipment at voltages in excess of extra low voltage, an isolating switch shall be provided, mechanically interlocked with a door-mounted operating mechanism to prevent access into the enclosure with the switch closed. The interlock shall be capable of being defeated externally with a tool such as a screwdriver.
b) Any metalwork within the enclosure which remains energised above extra low voltage with the door open shall be shrouded against inadvertent contact to IP2X as per AS 60529 and danger labelling installed.
c) The isolating switch shall be an isolator or circuit breaker in accordance with the drawings and data sheet.
d) The isolation switch operating mechanism shall have ‘on/off’ indication and be lockable in the ‘off’ position.
e) The isolating switch handle shall be located on the escutcheon.
f) The isolating switch handle shall allow opening of the escutcheon when in the ‘OFF’ position.

6.7.2 **Miniature Circuit Breakers**

a) Circuit breakers shall be C curve type, 10 kA fault rating unless otherwise specified on the Data Sheet.
b) Circuit breakers shall comply with AS 3111 and AS 60947.2 as applied by the definition given in AS 3111, Appendix A, Type Tested in accordance with Schedule B.
c) Circuit breakers shall provide full Selectivity with the upstream circuit breaker or fuse, up to the fault rating of the Field Control Panel as specified on the Data Sheet.
d) Circuit breakers from more than one manufacturer shall not be mixed within the same Field Control Panel.
e) Circuit breakers shall protrude through the escutcheon to allow manual operation.

6.7.3 **Circuit Breaker Lock-out Devices**

a) Each miniature circuit breaker shall be fitted with a means of padlocking it in the OFF position. The lock-out device and padlocking shall prevent the movement of the operating toggle from the OFF to the ON position.
b) The means of padlocking shall be achieved by the operation of a captive device fixed to the circuit breaker or escutcheon that is not supplied loose and does not require the use of a tool to attach it.
c) Sufficient space shall be provided so that when a six-way padlocking scissor and three padlocks are attached to a lock-out device, it will still be possible to completely close and lock the escutcheon without contact being made with the locks and the door.

d) This may be achieved either by making the enclosure deep enough to provide the necessary clearance or by recessing the breaker assembly.

e) This assembly shall be located clear of the circuit breakers so that lock-out scissors and padlocks when attached to the devices at the same time do not interfere with each other.

f) It shall still be possible to completely close and lock the enclosure door without contact being made with the attached scissors and locks and the door.

6.7.4 Earth Leakage Circuit Breakers

a) Circuit breakers for all lighting and power outlets, or other circuits requiring RCD protection shall be the RCBO type providing overload, short circuit and earth leakage protection, with a rated residual operating current of 30mA.

b) RCBO’s for single phase applications shall be single pole width.

c) RCD protected zones, where a whole section of the bus system or a number of individual circuits are protected by an upstream single or multi-phase RCD shall NOT be used on any Field Control Panel.

6.7.5 Surge Diverters

Surge diverters where specified shall be three phase and neutral, plug in type Shunt Surge diverter with a minimum protection level of 1200V with a short time withstand capacity (8/20 us) of 40kA. Surge diverters are only required on certain Field Control Panels as specified on the Data Sheet.

6.7.6 Control Power Supply

The FCP may incorporate a separate control power supply including the following, where specified on the data sheet:

a) Dual 24VDC switchmode power supplies with a size specified on the data sheet.

b) The 24VDC power supplies shall incorporate an appropriate redundancy module allowing parallel operation.

c) Single 20A 24VDC battery backed power supply where PLC equipment is fitted.

d) Where the FCP includes a PLC system, the power supplies shall incorporate voltage free contacts for fault status indication to the PLC system.

6.7.7 Motor Starter Circuits

All motors shall be protected against short circuit and over current. Motor protection circuit breakers incorporating both short circuit and over current protection are the preferred protection device. Motor starters shall provide Type '2' short circuit coordination in accordance with AS 61947.4. Contactors shall be suitable for AC-3 utilisation category in accordance with AS 61947.

Contactor coil voltage shall be as per the drawings. Control circuits for switching or sensing devices located external to the enclosures shall be extra low voltage.
6.7.8 Control Equipment

Field Control Panels shall be provided with all necessary manual control equipment such as STOP/START push buttons, selector switches, ON/OFF, tripped or other indicating lamps as required for safe operation of the equipment.

Control relays, PLC's, control switches, alarm and indicator equipment, etc. shall be, segregated from power equipment components.

6.7.9 Relays

Relays shall be Finder 55 series plug-in type or equivalent. Relays shall have 24VDC coils as indicated on the drawings.

Each relay shall have a sufficient number of N/O and N/C contacts and incorporate flag indication and built in suppression for DC coils.

6.7.10 HMI

Where specified on the data sheet a HMI panel shall be provided. The HMI shall be mounted on the escutcheon and must be accessible without opening the escutcheon.

6.7.11 Indicating Lights

Indicating lights shall be 22mm diameter, LED flush mounted type suitable for 24VDC.

The functions of the indicating lights shall be:

a) Green – closed, running, ON.
b) Red – open, stopped, OFF.
c) Amber – tripped, fault.

6.7.12 Control Switches

Control switches shall be K&N CA10 series with a sufficient number of N/O and N/C contacts.

6.7.13 Pushbuttons

Pushbuttons shall be NHP D7 series. Except for emergency stop pushbuttons, all pushbuttons shall be mounted on the escutcheon.

Where externally accessible emergency stop pushbuttons are required, they shall be mounted on a fixed forward-facing surface of the enclosure. The surface shall be obtained by either reducing the dimensions of the door and escutcheon to permit the pushbutton to be mounted or fixing a metal enclosure to the side of the LCP.

The functions of the pushbuttons shall be:

a) Green – Start.
b) Red – Stop, Emergency stop.
c) Blue – Reset.

6.7.14 PLC Section

Where a PLC is specified for control of the equipment or process, the PLC system and associated equipment shall be selected in accordance with GRC-ES002 – Preferred Electrical Components. The following minimum requirements shall apply:
a) PLCs shall be Allen-Bradley CompactLogix type unless specified otherwise, incorporating Ethernet/IP communications capability.
b) Power supplies shall be suitable for 24VDC operation.
c) Digital inputs shall be 24VDC current sinking type.
d) Digital outputs shall be 24VDC current sourcing type.
e) Analogue inputs and outputs shall be 4-20mA type suitable for 24VDC operation.
f) All PLC inputs and outputs shall be wired to marshalling terminal strips within the enclosure for the termination of field cabling. This includes all unused inputs and outputs.

6.7.15 Lighting Control Circuits

A lighting control circuit is required for Field Control Panels where a proportion of lighting is only required at low levels of natural light.

a) Where specified, lighting circuits shall be switched by a three-pole contactor in response to the operation of a photo-electric (PE) switch, which operates a changeover contactor when the outside light level falls below a threshold.
b) A three-way selector switch shall enable the PE cell controlled contactor to be BYPASSED (always on), AUTOMATIC (PE cell controlled) or OFF (contactor de-energised).
c) The minimum contactor size shall be 32A.
d) The contactor shall be mounted in the low voltage compartment.
e) The externally mounted PE cell shall be terminated to DIN rail mounted terminals mounted in the low voltage compartment.
f) The lighting control circuit shall be supplied from a 6A MCB.

6.8 Cable Entries

Sufficient space shall be provided for the glancing, spreading, routing and termination of the number of field cables to be terminated in the Field Control Panel.

Gland plates shall be provided for all cable entries. Gland plates shall be 5mm thick plated brass and shall be fixed to the enclosure with a minimum of 10 external equi-spaced M6 316 stainless steel bolts and washers into threaded inserts, welded nuts or captive nuts. For enclosures greater than 800mm wide, two gland plates shall be fitted.

6.9 Internal Wiring

Wiring shall be in accordance with AS 3000 and the following requirements:

a) Different wiring systems, e.g. control, transducer output, CT, VT, 110V AC, 240/415 V AC. shall be segregated and separated in accordance with the requirements of AS 3000.
b) All internal wiring shall be carried out in flexible copper cables, 0.6/1 kV, V75 grade PVC and terminated with insulated compression type lugs or connectors.
c) The minimum size of flexible cable shall be as follows:
   - Control Wiring 1.5 mm²
   - Protection 4.0 mm²
   - Metering 2.5 mm²
d) All internal wiring shall be neatly arranged and wherever practicable, shall be contained in capped plastic ducting. Elsewhere, groups of wires shall be strapped together with nylon or other strong plastic ties or spiral binding to form neat wire bundles.
e) Wiring identification shall be by numbered and/or lettered ferrules, of insulating material adjacent to the terminals. Wires shall be identified in accordance with IEC 60445. The ferrules shall be indelibly marked and removal without disconnecting the wire from its terminal shall not be possible.

f) All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.

g) All busbar and wiring colours shall be as follows:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Active Conductor</th>
<th>Common Conductor</th>
<th>Earth Conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>415/240V AC</td>
<td>Red/White/Blue</td>
<td>Black</td>
<td>Green/Yellow</td>
</tr>
<tr>
<td>12/24V DC Supply</td>
<td>Brown</td>
<td>Grey</td>
<td>-</td>
</tr>
<tr>
<td>12/24V DC Switched</td>
<td>Violet</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CT Wiring</td>
<td>Red/White/Blue</td>
<td>Black</td>
<td>Green/Yellow</td>
</tr>
</tbody>
</table>

6.10 Terminations

a) Cable terminating facilities and terminals shall be suitable for the cable type, gland and conductor size.

a) DIN rail mounting moulded polyamide terminal blocks shall be provided for termination of all control wiring external to switchboards. Terminals shall carry numeric designation in accordance with the Drawings and shall be segregated according to function and voltage.

b) Terminal groups shall be arranged and spaced to facilitate easy connection of wiring and cables. Spare space shall be available on each terminal rail to accommodate additional terminals.

c) A separate terminal shall be provided for the connection of each individual wire. Bridging links as supplied by the terminal manufacturer shall be used to interconnect ‘common’ terminals.

d) Terminal blocks shall avoid obstruction of other cable terminations, removable covers, etc. and positioned to afford easy access for carrying out external cable termination, testing, inspection and maintenance. There shall be clear space allowed between the terminals and the gland plate for the spreading and termination of external conductors.

e) Terminal blocks shall be mounted in a single deck arrangement.

f) The panel wiring shall be connected to one side of the terminal block only.

g) Terminals serving voltage circuits exceeding “Extra Low voltage”, as defined in AS 3000, shall be segregated from other terminals, shrouded, voltage identified and Danger labelled. All other differing voltages shall be separated by partitions.

h) Cable supports shall be provided (where practicable) to avoid undue strain on the cable termination.

i) Separate terminal arrangements shall be provided for power and control cables.

j) All access to wiring shall be from ground level. Terminals shall not be located on top of equipment.

6.11 Identification Labels

Identification labels shall be provided in accordance with the requirements of Engineering Standard GRC-ES008 – Equipment Identification.

a) All labels shall be engraved traffolyte using black upper-case characters on a white background unless otherwise indicated.
b) Labels for emergency equipment (e.g. fire alarms, emergency lighting etc.) shall be engraved traffolyte using white upper-case characters on a red background.

c) All labels shall be fastened to the metalwork with stainless steel M3 metal threads and nuts or stainless steel self-tapping screws.

d) Adhesive or double-sided adhesive tape shall not be used as a means of fixing labels.

e) Each Field Control Panel shall have a 220 x 40mm label mounted externally and centrally on the door 300mm from the top edge of the door.

f) Each earth and neutral bar shall have a 40 x 10mm label mounted adjacent to it indicating 'EARTH' and 'NEUTRAL' as appropriate.

g) Each component in the FCP shall be have a Device Identification Label indicating the number of the component in accordance with GRC-ES008.

h) Control equipment mounted on the escutcheon for operator use shall be identified by both the device number and its description.

i) On circuit breaker busbar systems, a number shall identify every circuit breaker. This shall be achieved by vertically mounting two long strips of traffolyte 20mm wide on the escutcheon plate adjacent to the two rows of circuit breakers and engraving the breaker number opposite the appropriate circuit breaker in 6mm high characters. All pole positions shall be numbered. This means that two and three-pole circuit breakers shall have a number opposite each pole. The numbering shall match the numbering shown on the Drawings. The traffolyte shall be screw fixed in several positions along its length to prevent it from buckling.

j) Each RCD test outlet, its protection circuit breaker and each RCD test selector switch shall be provided with labels as detailed on drawing GRC-ED-005.

k) All other electrical control components such as the incoming main circuit breaker/s, contactors, timers, relays, etc. contained within the enclosure shall be provided with an identifying traffolyte label with 6mm high characters.

6.12 Fastenings

Nuts, bolts and other fastenings for panels designated on the Data Sheet as indoor service shall be cadmium plated. Nuts, bolts and other fastenings for panels designated on the Data Sheet as outdoor service shall be stainless steel. All nuts, bolts, screws and studs shall have ISO metric threads. Washers shall be fitted under bolt heads and nuts to prevent damage to the surface in contact with the bolt head or nut. The threads of all bolts shall project beyond the nut by at least one full thread.

6.13 PVC Cable Ducts

Grey slotted PVC cable duct such as the Iboco T1 series complete with covers shall be installed internally down both sides of each Field Control Panel and elsewhere as required to contain internal control, test circuit wiring and cables to be connected by others to the outgoing circuit breakers.

a) Field Control Panels shall be fitted with minimum 60mm wide grey slotted PVC wiring ducts complete with covers on the left and right-hand side of the Field Control Panel to accommodate incoming and outgoing cables and internal wiring.

b) Each duct shall stop 200mm short of the bottom of the enclosure to permit entry of cables to the board. The ducts shall be positioned sufficiently clear of the side walls for easy removal and replacement of covers.
7 INSPECTION AND TESTING

7.1 Verification Testing

Test certificates shall be supplied for all tests that have been carried out on the FCP as applicable in accordance with the requirements of AS/NZS 61439.1.

7.2 Routine Testing

The FCP supplier shall carry out all routine tests or any tests required to prove compliance with this specification, the drawings and the relevant standards. The testing shall include the following as a minimum:

a) Standard 50Hz high voltage withstand test on the complete assembly including the circuit breakers. Insulation resistance tests shall be conducted before and after the high voltage test.

b) Standard 50Hz insulation test on all small wiring, including switchboard and instrument transformer secondary wiring, at 2000V to earth for one minute.

c) Continuity and polarity tests on all coils and circuits.

d) Verification of current transformers; terminal markings, determination of errors, magnetising curve, CT polarity test and CT ratio test using primary current injection.

e) Functional tests on all relays, control circuits and interlocks.

f) Checking of electrical and mechanical interlocks.

g) Mechanical operation of circuit breakers, interlocks, auxiliary switches, manual devices, etc.

The FCP supplier shall have suitably qualified labour readily available to rectify any defects or errors identified during testing, such that there is no delay in testing.

The FCP supplier shall provide instructions for final installation inspection and tests after the switchgear has been installed. The instructions shall include a schedule of recommended site tests to establish correct operation, procedures for any adjustments to obtain correct operation, instructions for final inspection and putting in service.

7.3 Test Certificates

The supplier shall provide test certificates for all routine testing carried out. These shall be forwarded to the purchaser within 7 days of completion of the tests.

7.4 Witnessing

In addition to the Routine Testing outlined above, the Field Control Panel manufacturer shall make allowance for factory acceptance testing (FAT). These tests shall be carried out to the satisfaction of, and if necessary, in the presence of the purchaser’s representative. The supplier shall provide 7 days’ notice to enable the purchaser’s representative to witness such tests.

8 TRANSPORTATION AND STORAGE

a) Preparation for shipment shall protect the Field Control Panels against corrosion, dampness, breakage or vibration injury during transportation and handling.

b) Each Field Control Panel shall be wrapped in heavy duty clear plastic and weatherproofed and then contained in a wooden framed crate and shall be securely bolted to the floor of the crate.
c) Packing shall include a suitable desiccant to prevent corrosion of equipment during shipment and storage.
d) The base of the crate shall be suitable for forklift handling.
e) Each shipping package shall be clearly and indelibly identified with the contents, purchase order number and item number.

9 PAINTING AND SURFACE PROTECTION

Steelwork surface preparation, anti-corrosion protection and the surface coating system shall be to Australian Standards. Evidence shall be provided that these items meet Australian Standards.

The painting system used for the Field Control Panel shall be powder coated to a total thickness of 70 microns. The standard painting system of the switchboard supplier may be used provided details of the system are submitted and approval for use is received from the Purchaser.
a) The colour and finish of Field Control Panels for indoor service shall be X15 Gloss Orange.
b) The colour and finish of Field Control Panels for outdoor service shall be X15 Gloss Orange.
c) Escutcheon panels shall be Gloss White.

10 MANUALS AND DRAWINGS

The Supplier shall provide full drawings and documentation for the equipment. This shall include:
a) General arrangement drawings showing the overall dimensions and equipment arrangement.
b) Circuit diagrams and schematic drawings for all equipment installed in the Field Control Panel.
c) Full parts list of every component in the equipment.
d) Recommended spares list.
e) Internal and External label drawings.
f) Certified Inspection and Test Plans and results.
g) All verification test certificates.
h) Equipment data sheets and manuals.
i) Installation, Operating and Maintenance Manuals.

Final copies of all documentation shall be provided within two weeks of Factory Acceptance Testing.

The Supplier shall provide 2 paper copies of all documentation in hardbound folders, plus an electronic copy on CD in a structured folder arrangement.

All drawings shall be provided in AutoCAD electronic file format (.dwg) and in PDF format.

11 DATA SHEET

This Engineering Standard shall be read in conjunction with the attached Field Control Panel data sheet. The Purchaser shall complete an individual data sheet for each Field Control Panel. Each Field Control Panel data sheet shall be provided to the Manufacturer in Microsoft .xls format for completion.
ENGINEERING STANDARD

Electrical Equipment Identification Labels

Document: GRC-ES008  Revision: 2

REVISION HISTORY

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Description</th>
<th>Prepared By</th>
<th>Approved By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23/08/2011</td>
<td>First Issue</td>
<td>J. Hickey</td>
<td>C. Swanton</td>
</tr>
<tr>
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<td>Revised and Updated</td>
<td>B. James</td>
<td>C. Swanton</td>
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1 PURPOSE

The purpose of this Engineering Standard is to define the requirements for engraved traffolyte labels used to identify electrical equipment at Gladstone Regional Council sites.

2 SCOPE

This Engineering Standard is applicable to all Gladstone Regional Council projects where it is necessary to provide electrical equipment identification labels.

This Engineering Standard does not define requirements for non-electrical signs, safety signs (e.g. hearing protection, hazardous chemicals), street signs, building identification signs etc.

3 RESPONSIBILITIES

All persons involved in the purchasing, specifying, design, fabrication and supply of electrical equipment for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

4 DEFINITIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>Person or company carrying out the electrical and instrumentation works.</td>
</tr>
<tr>
<td>Contractor’s Representative</td>
<td>Person authorized to act on behalf of the Contractor.</td>
</tr>
<tr>
<td>Council</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>GRC</td>
<td>Gladstone Regional Council or its nominated representative or agent.</td>
</tr>
<tr>
<td>Specifier</td>
<td>Any individual specifying equipment for use in electrical installations on a GRC site.</td>
</tr>
<tr>
<td>Superintendent</td>
<td>Person authorised to act on behalf of GRC with respect to the Contract works.</td>
</tr>
<tr>
<td>Traffolyte</td>
<td>Traffolyte is a brand name that has become a generic term used to describe adhesive bonded, multi-layered, rigid plastic sheets suitable for engraving. Sheets are usually two coloured. Each layer has a different colour so letters or shapes engraved deep enough to penetrate the level below will be displayed as a different colour to the un-engraved portions.</td>
</tr>
</tbody>
</table>
5 REFERENCE DOCUMENTS

All equipment shall be designed, manufactured and tested in accordance with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

5.1 GRC Engineering Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
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<tbody>
<tr>
<td>GRC-ES001</td>
<td>Electrical Work</td>
</tr>
<tr>
<td>GRC-ES002</td>
<td>Preferred Electrical Components</td>
</tr>
<tr>
<td>GRC-ES003</td>
<td>Prefabricated Electrical Switchrooms</td>
</tr>
<tr>
<td>GRC-ES004</td>
<td>Motor Control Centres</td>
</tr>
<tr>
<td>GRC-ES005</td>
<td>Light &amp; Power Distribution Boards</td>
</tr>
</tbody>
</table>

5.2 Australian Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 1319</td>
<td>Safety Signs for the Occupational Environment</td>
</tr>
</tbody>
</table>

5.3 Acts and Regulations

<table>
<thead>
<tr>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>Electricity Act 1994</td>
</tr>
<tr>
<td>Electricity Regulation 2006</td>
</tr>
<tr>
<td>Electrical Safety Act 2002</td>
</tr>
<tr>
<td>Electrical Safety Regulation 2002</td>
</tr>
<tr>
<td>Work Health and Safety Act 2001</td>
</tr>
<tr>
<td>Work Health and Safety Regulation 2011</td>
</tr>
</tbody>
</table>
6 GENERAL REQUIREMENTS

6.1 Context

a) Appropriate identification labels shall be fitted to all electrical equipment in order to clearly and uniquely identify equipment, facilitate the safe operation and maintenance of that equipment and avoid incorrect operation of equipment.

b) Adequate identification of equipment is a requirement of the Work Health and Safety Act and other statutory authorities. GRC has additional identification requirements that in some instances exceed the requirements of the statutory authorities. These requirements are included in this standard and shall be applied for all installations where appropriate.

c) The labelling material selected shall provide long-term durability of all labels in GRC sites where high UV (Ultra Violet) light, high temperatures, process spillages, heavy dust and salt laden environments exist.

d) The type and size of identification labels shall be selected to ensure clarity and good visibility under all weather conditions, lighting conditions and process conditions. Human factors such as the inability of people to see small or obscured text if they are visually impaired or are wearing mono-goggles shall be taken into account when determining text sizes.

e) Label and character dimensions stated are the minimum acceptable sizes. If characters required on a label do not fit, the label shall be made larger to fit the characters rather than reduced character height or abbreviations.

f) Note that while others may install large painted identification signs or profile-cut lettered signs adjacent to field equipment it is still a requirement to provide the field labels for electrical equipment as detailed in this Standard.

g) Temporary identification using “paint pens” or similar methods are not acceptable as permanent signs. No electrical equipment shall be defaced using this type of marking.

6.2 Label Requirements

a) Engraved traffolyte labels using a system of numerals and all upper case letters arranged in a logical manner shall identify all equipment and components as indicated on the drawings. The labels shall be based on the plant standard numbering system as indicated on the drawings and in the relevant standards.

b) The exposed edges of all labels shall have 45 degree bevelled edges so that no sharp edges or corners are exposed.

6.3 Equipment to be Labelled

a) Each item of electrical equipment and all internal and external components and accessories shall be clearly identified by an engraved label. Labels shall be marked with the equipment identification number and name of the equipment.

b) The number of the circuit assigned to each fuse or circuit breaker in all types of distribution boards shall be engraved on the label. Boards that supply lighting and general-purpose outlets, instrumentation and DC circuits are all included in this category.

c) Distribution boards shall be marked with the board number, the MCC, battery charger or power supply that supplies it and its location. The incoming supply isolator/s shall also be identified.

d) Labels identifying electric motor field controls shall be located immediately adjacent to the motor Local Control Station.
6.4 Label Wording Consistency

a) Label wording shall generally follow the details provided on the drawings.

b) Where equipment is described and labelled in a number of locations, for example at the MCC, at the field pushbutton and at the field isolator, the same equipment number, format and description shall be used at all locations to avoid confusion.

6.5 Use of Terms Normal, Alternate and Emergency Generator

The following defined terms are the only ones to be used:

Normal: The original designed reticulation of power from the designated Supply Authority through the allocated feeders to the plant equipment.

Emergency Generator: The supply is sourced at a diesel generator and power is being provided through a jumper cable to the plant distribution or control system.

6.6 Label Colours

a) General identification labels shall be engraved traffolyte material using a system of **black** characters on a **white** background. These labels may be referred to as W/B/W labels.

b) Danger and warning labels shall be engraved traffolyte material using a system of **white** characters on a **red** background. These labels may be referred to as R/W/R labels.

c) Caution or advisory labels shall be engraved traffolyte material using a system of **black** characters on a **yellow** background. These labels may be referred to as Y/B/Y labels.

6.7 Label Dimensions

a) All labels shall clearly identify the equipment and be of appropriate dimensions and size equivalent to suit the application.

b) The minimum height of label characters shall be 5mm. All label wording and dimensions shall be presented to GRC for approval before manufacture.

c) Label details may be presented in sketch form, or by using the attached Label Schedule.

d) When adding, modifying or replacing labels on existing equipment the Contractor shall ensure that all labels provided maintain the standard size, position on the equipment, format and colours of existing similar labels on the equipment.

6.8 Method of Fixing Labels

a) All labels shall be installed prior to energising of the equipment and shall be fixed in place with a minimum of two (2) stainless steel self-tapping screws or stainless steel screws, nuts and flat washers.

b) Double-sided adhesive tape, glue or silicone shall not be used to mount external labels or even hold them in place while screws are installed. This is because some of these methods are so effective they make later label removal difficult and time consuming often resulting in damage to adjacent painted surfaces.

c) Conversely, some are so poor that labels may fall off when they become wet or slip from position when surfaces become warm. However, these methods may be used to install small labels inside equipment where limited space is available for screw fixing.
6.9 Label Placement

a) Labels shall be located in close proximity to the equipment they are associated with and adequately supported and protected so that there can be no doubt as to their association and purpose.

b) Labels shall not be installed where they may become damaged or obscured by process spills, mechanical damage from cranes and vehicles, storage of other equipment etc.

c) Labels that identify components that are subject to replacement, components where the attachment of the label to the component may degrade the IP rating of the component or where the label is not fully supported due to the construction of the component shall not be mounted on the component.

d) These labels shall be mounted above, below or adjacent to the component on either a flat existing surface or a support or bracket specially installed to fully support the label. Examples of components that fall into this category are:
   - Internal and external GPO’s and switches
   - Pushbutton stations
   - Limit and proximity switches
   - Solenoid valves, etc

6.10 Electrical Signs for Substation Yards

a) Each side of the fence perimeter and each access gate of all fenced electrical yards shall be fitted with external danger signs warning that the yard contains equipment operating at the highest voltage present in the yard.

b) The signs shall be attached centrally to the chain-wire fence sections at approximately 1.5 metres above ground level.

c) Signs shall be galvanised wire tied at each corner.

d) Long yards shall be fitted with a sign at least at every third fence panel.

e) Signs shall be spaced equal distances apart.

f) All signs shall meet the following requirements:
   - Signs shall have reflective sheeting on a backing of aluminium.
   - Minimum sign size shall be 300mm x 225mm with the first line to read ‘DANGER’ in white print on a red oval shaped background and the second line ‘11,000 VOLTS’ (or the highest voltage present in the yard) in black print on a reflective white rectangular background.
   - Signs shall be similar to the Seton Mining Site Sign Cat No S6712 and shall comply with AS 1319 requirements for this sign type.

6.11 Plastic Adhesive Backed Tape Labels

a) This refers to labels where the thermal transfer of characters onto thin, coloured, adhesive-backed plastic tapes creates the label. These products are sold by companies such as Dymo and Brother and are extensively used in indoor applications such as in offices.

b) The use of this type of labelling to identify electrical equipment on GRC sites is limited to indoor use to identify non-critical equipment that does not need to satisfy any statutory requirement. One example of this is switchgear panel numbering.

c) This labelling may also be used for temporary or emergency labelling in preference to hand-written labels.
7 TYPICAL LABEL DETAILS

The following section provides typical label details for different types of equipment. Labelling for equipment types not shown below shall be based on these typical requirements and developed to suit the specific application.

The following label details are not drawn to scale.

7.1 Typical MCC Labels

7.1.1 Module Identification Labels

- Dimensions: 170mm x 40mm
- Text: 6mm high bold black characters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

a) Typical Motor Module

```
W-MV-TP-BACK-PMP-001
BACKWASH PUMP 1
7.5kW
```

b) Typical Distribution Board Module

```
MVWTP-DB-01
SITE SERVICES DISTRIBUTION BOARD
100A
```

7.1.2 MCC Incomer Label

- Dimensions: 200mm x 50mm
- Text: 8mm high bold black characters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

```
MAIN INCOMER
SUPPLIED FROM
PAD MOUNT SUBSTATION XXXX
```
7.1.3 Typical MCC

- Dimensions: 200mm x 50mm
- Text: 25mm high bold black characters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

![MVWTP-MCC-01]

7.1.4 Multiple Supply Label

- Dimensions: 120mm x 40mm.
- First Line: 8mm high bold white characters on red traffolyte for the first line.
- Other Lines: 5mm high white characters on red traffolyte for the other lines.
- Mounting: 2 x 3mm diameter mounting holes drilled as shown.

![WARNING]

7.1.5 24 VDC Supply Module Warning Label

- Dimensions: 170mm x 60mm
- First Line: 8mm high bold black characters on yellow traffolyte for the first line
- Other Lines: 5mm high black characters on yellow traffolyte for lines 2, 3 and 4
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

![WARNING]

TURNING OFF SUPPLY BREAKER BEHIND THIS PANEL WILL TRIP ALL MOTORS ON THIS MCC ELECTRICIANS ONLY TO OPERATE
7.1.6 MCC Module Numbering Label

- Dimensions: 30mm x 30mm
- Text: 10mm high bold black characters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Module Number: TIER/MODULE e.g. Tier 2 Module B = 2/B

7.2 Typical 415VAC Switchboard Labels

7.2.1 Main switchboard Label

- Dimensions: 400mm x 100mm
- Text: 60mm high bold black characters on white traffolyte
- Mounting: 6 x 3mm diameter mounting holes drilled as shown

```
  415V MAIN SWITCHBOARD
```

7.2.2 Main Incomer

- Dimensions: 250mm x 50mm
- Text: 25mm high bold black characters on yellow traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- fixed to the front cubicle doors as well as the rear access doors or covers

```
MAIN INCOMER
```
7.2.3 MCC Outgoing Feeder

- Dimensions: 200mm x 60mm
- Text: 10mm high bold black characters on white traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- fixed to the front cubicle doors as well as the rear access doors or covers

```
MVWTP-MCC-01 FEEDER
IN WTP SWITCHROOM
```

7.2.4 Busbar Danger Label

- Dimensions: 120mm x 40mm
- First Line: 8mm high bold white characters on red traffolyte for the first line
- Other Lines: 5mm high white characters on red traffolyte for the other lines
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the covers protecting the dangerous equipment

```
WARNING
LIVE 415 VOLT BUS BARS
BEHIND COVER
```

7.2.5 Terminals Wiring Danger Label

- Dimensions: 120mm x 40mm
- First Line: 8mm high bold white characters on red traffolyte for the first line
- Other Lines: 5mm high white characters on red traffolyte for the other lines
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the covers protecting the dangerous equipment

```
DANGER
LIVE 415 VOLT WIRING AND TERMINALS BEHIND COVER
```
7.2.6 MEN Link Labels

- Dimensions: 120mm x 40mm
- First Line: 8mm high bold white characters on red traffolyte for the first line
- Other Lines: 5mm high white characters on red traffolyte for the other lines
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the covers protecting the dangerous equipment

![MEN Neutral-Earth Link Labels]

7.2.7 VSD Caution Label

- Dimensions: 170mm x 60mm
- First Line: 10mm high bold black characters on yellow traffolyte for the first line
- Other Lines: 5mm high black characters on yellow traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

![VSD Caution Label]

CAUTION

AN ELECTRONIC VARIABLE SPEED DRIVE CONTROLS THIS MOTOR. DO NOT TOUCH ANY CONNECTED WIRING FOR 15 MINUTES AFTER OPENING MAIN ISOLATOR AS UNDISCHARGED VOLTAGES MAY BE PRESENT.
7.2.8 Typical Switchboard Transformer Full Load Current Label

- Dimensions: 100mm x 20mm
- Text: 6mm high bold black characters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to each incomer front cubicle door below the main identification label. Amperage number shall be derived from supply transformer nameplate

○ TRANSFORMER FLC 102A ○

7.3 Typical Battery Charger Labels

- Dimensions: 220 x 50mm
- First Line: 8mm high bold black letters on white traffolyte
- Other Lines: 6mm high black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to outer door of the battery charger cabinet

EQUIPMENT No. XXXXX
SUBSTATION XX TRIP SUPPLY BATTERY CHARGER
ISOLATE 240V SUPPLY AT DB-XXX CIRCUIT XX

7.4 Typical Distribution Board labels

7.4.1 Typical L&P Distribution Board Identification Label

- Dimensions: 200 x 40mm
- Text: 8mm high bold black letters on white traffolyte
- Bottom Line: 6mm high black letters on white traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to the front door of the distribution board

○ LIGHT & POWER DISTRIBUTION BOARD DB-123 ○
SUPPLIED FROM MVWTP-MCC-01 MODULE 2/B ○
7.4.2 Neutral and Earth Bar Labels

- Dimensions: 40 x 10mm
- Text: 6mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown or mounted using adhesive
- Fixed to the distribution board equipment plate adjacent to neutral and earth bars

![Neutral and Earth Bar Labels](image)

7.4.3 Typical DC Power Distribution Board Identification Label

- Dimensions: 200 x 40mm
- Text: 8mm high bold black letters on white traffolyte
- Bottom Line: 6mm high black letters on white traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to the front door of the distribution board

![Typical DC Power Distribution Board Identification Label](image)

7.5 Typical Labels for General Use

7.5.1 Typical Local Control Station Label

- Dimensions: 170 x 80mm
- Text: 8mm high bold black letters on white traffolyte
- Bottom Line: 6mm high black letters on white traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to the front door of the local control station

![Typical Local Control Station Label](image)
7.5.2 Typical Marshalling Cabinet Label

- Dimensions: 160 x 30mm
- Text: 8mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the front door of the marshalling cabinet

7.5.3 Typical Device Identification Labels

- Dimensions: L x 10mm, where L = length of letters plus 5mm at each end
- Text: 5mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown, or for internal installation only, mounted using high bond adhesive
- Fixed to the panel below or adjacent to the equipment they are identifying
- E.g. Relays, timers, circuit breakers, terminal strips etc
7.5.4 Typical Indoor GPO Identification Labels

- Dimensions: 100 x 40mm
- Text: 5mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Mounted adjacent to the GPO (not on the GPO)

![GPO Identification Label Example](image)

7.5.5 Typical Indoor Lighting Identification Labels

- Dimensions: 100 x 40mm
- Text: 5mm high bold black letters on white traffolyte
- Mounting: Double sided tape
- Mounted eastern side of light fitting (not on the light fitting)

![Light Identification Label Example](image)

7.5.6 Typical Indoor Lighting Switch Identification Labels

- Dimensions: 100 x 40mm
- Text: 5mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Mounted above the light switch (not on the light switch)
- Note: Inside Mayors Office and Council Chambers, labels shall be stainless steel

![Light Switch Identification Label Example](image)
7.5.7 LV Rescue Enclosure Label

- Dimensions: 270 x 100mm
- First Line: 12mm high bold black letters on yellow traffolyte
- Other Lines: 10mm high black letters on yellow traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to centre of external door of LV kit enclosure

![LV Rescue Enclosure Label Image]

7.5.8 Fire Alarm Warning Label

- Dimensions: 160 x 120mm.
- First Line: 8mm high bold red letters on white traffolyte.
- Other Lines: 6mm high red letters on white traffolyte.
- Mounting: 4 x 3mm diameter mounting holes drilled as shown.
- Mounted centrally to external door of building/rooms protected by fire alarm system.

![Fire Alarm Warning Label Image]
7.6 Typical Stainless Steel Engraved labels

7.6.1 Typical Transformer Identification Label

- Dimensions: 480 x 100mm
- Text: 50mm high letters engraved on polished 316 grade stainless steel with engraved text backfilled with black gloss enamel paint
- Mounting: 6 x 6mm diameter mounting holes drilled as shown

![Transformer TX1 label]

7.6.2 Typical Outdoor Stainless Steel GPO Identification Labels

- Dimensions: 100 x 40mm
- Text: 5mm high letters engraved on polished 316 grade stainless steel with engraved text backfilled with black gloss enamel paint
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Mounted adjacent to the GPO (not on the GPO)

![GPO 56 Remote RCD label]

7.6.3 Typical Outdoor Lighting Identification Labels

- Dimensions: 100 x 40mm
- Text: 5mm high letters engraved on polished 316 grade stainless steel with engraved text backfilled with black gloss enamel paint
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Mounted adjacent to both sides of the light fitting

![Light 56 Remote RCD label]
7.6.4 Typical Outdoor Lighting Switch Identification Labels (E.g. Substation)

- Dimensions: 100 x 40mm
- Text: 5mm high letters engraved on polished 316 grade stainless steel with engraved text backfilled with black gloss enamel paint
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Mounted above the light switch (not on the light switch)

```
LIGHT SWITCH 56 REMOTE RCD
○ SUPPLIED FROM DB-123 CCT 12
○ LOCATED IN DOSING ROOM
```

7.6.5 Motor Heater Label

- Dimensions: 90 x 25mm
- Text: 5mm high letters engraved on polished 316 grade stainless steel with engraved text backfilled with black gloss enamel paint
- Mounting: 2 x 3mm diameter mounting holes drilled as shown

```
240V HEATER TERMINALS
○ LIVE WHEN MOTOR IS OFF
○ ISOLATE ELSEWHERE
```

7.7 Typical Outdoor 11kV Switchgear Labels

7.7.1 Typical Cubicle Identification Label

- Dimensions: 200 x 50mm
- Text: 10mm high bold black letters on white traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to the front cubicle doors as well as the rear roof lip above the rear covers

```
40AS2A4
```

Revision 2, 21 April 2017
7.7.2 Switch Identification Labels

- Dimensions: 150 x 25mm
- Text: 8mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the front cubicle doors above respective switches

![Fuse Switch]

![Earth Switch]

7.7.3 Switch Position Labels

- Dimensions: 100 x 25mm
- Text: 8mm high bold black letters on white traffolyte
- Mounting: 2 x 3mm diameter mounting holes drilled as shown
- Fixed to the front cubicle doors adjacent to respective switch positions

![Not Earthed]

![Earthed]

![Open]

![Closed]
7.7.4 Cubicle Danger Label

- Dimensions: 200 x 50mm
- Text: 10mm high bold white letters on red traffolyte
- Mounting: 4 x 3mm diameter mounting holes drilled as shown
- Fixed to the front and rear cubicle doors and covers
Polyethylene Pipe Welding Specifications

GRC-ES017 Rev: 1

Date: February 2012
Prepared by: B. Heinrich
Approved by: P. Boshoff

REVISION APPROVALS

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Prepared by</th>
<th>Approved by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17 May 2012</td>
<td>B. Heinrich</td>
<td>P. Boshoff</td>
</tr>
</tbody>
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1 PREAMBLE

1.1 General
This document highlights the minimum general requirements for welding of Polyethylene (PE) pipes that should be adopted for works undertaken for Gladstone Regional Council on water and sewerage main services.

1.2 Applicable Standards
Compliance with the requirements under current relevant codes, regulation and/or standards is required under this specification. Where an Australian Standard does not exist, the current relevant ISO, DIN, US or British Standards together with the requirements of Authorities having jurisdiction over all or part for the works shall be adopted. Where conflict exists between different applicable codes, standards or regulations the requirements of this specification shall apply. Where this specification is not applicable the higher requirement shall apply. Do not deviate from the provisions for the relevant standard without first obtaining approval in writing from the appropriate authority.

Table 1 details the general codes and legislation that shall be adopted when installing PE pipes for Gladstone Regional Council. Subordinate codes and legislation of the ones listed in the table below shall be taken as included and relevant. These codes and legislation set out the minimum requirements; however where this specification or associated contract documents require higher level requirements, the higher level is to be achieved.

Table 1 Applicable Standard and Codes

<table>
<thead>
<tr>
<th>Abbreviations</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS 2033</td>
<td>Installation of polyethylene pipe systems</td>
</tr>
<tr>
<td>AS/NZS 2566 (Parts 1 and 2)</td>
<td>Buried flexible pipelines (design and installation)</td>
</tr>
<tr>
<td>AS/NZS 4129</td>
<td>Fittings for polyethylene (PE) pipes for pressure applications</td>
</tr>
<tr>
<td>AS/NZS 4130</td>
<td>Polyethylene (PE) pipes for pressure applications</td>
</tr>
<tr>
<td>AS/NZS 4131</td>
<td>Polyethylene (PE) compounds for pressure pipe and fittings</td>
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<tr>
<td>ISO 9624</td>
<td>Thermoplastic Pipes for Fluids Under Pressure – Mating Dimensions of Flange Adapters and Loose Backing Flanges</td>
</tr>
<tr>
<td>ISO 13953</td>
<td>Polyethylene (PE) pipes and fittings – Determination of the tensile strength and failure mode of test pieces from a butt fused joint</td>
</tr>
<tr>
<td>ISO 13954</td>
<td>Plastic Pipes and Fittings – Peel Decohesion Test for Polyethylene(PE) Electrofusion Assemblies of Nominal Outside Diameter Greater Than or Equal to 90 mm</td>
</tr>
<tr>
<td>WSA 01</td>
<td>Polyethylene pipeline code</td>
</tr>
<tr>
<td>PIPA POP003</td>
<td>Butt fusion jointing of PE pipes and fittings – Recommended Parameters</td>
</tr>
<tr>
<td>PIPA POP004</td>
<td>Polyethylene Pipe Compounds</td>
</tr>
</tbody>
</table>
2 MATERIALS

2.1 General
Pipes and Fittings shall comply with AS/NZS 4130 and AS/NZS 4129 respectively.
PE 80B or PE 100 compounds to AS/NZS 4131 shall be used for all pressure pipe applications.

2.1.1 Construction of New Pipelines
For the construction of new pipelines PE pipe DN110 and larger shall be butt-welded. Electrofusion couplers or mechanical couplers shall not be used unless specified by GRC or the Superintendent.
PE pipe smaller than DN110 may be welded using electrofusion couplers.

2.1.2 Maintenance Repairs of Existing Pipelines
Electrofusion couplers or mechanical couplers may be used to repair existing PE pipelines where specified by GRC or the Superintendent.

3 WELD PRE-QUALIFICATION
Before factory and field welding occurs, weld pre-qualification shall be obtained on all pipe diameters where butt welding is being proposed.
Generally weld pre-qualification shall be undertaken in accordance with WSA 01. The number of pre-qualification test welds shall be as per this this specification.

3.1 Confirmation of Welding Equipment and Qualified Welders
The following information shall be submitted to Gladstone Regional Council (or Superintendent) for approval prior to the undertaking of any field welding:
- All details of the works for approval prior to commencing work
- The welding procedure to be used (including specific parts from this specification)
- The welding equipment to be used (including machines condition, maintenance history and calibration)
- The name and certification details of the certified welder

3.2 Pre-Qualification Test Welds
Before any construction welding is undertaken the Contractor shall complete Pre-Qualifying test welds to the satisfaction of GRC (or Superintendent).
To be satisfactory the pre-qualification test welds shall meet the acceptance criteria set out in this specification.

3.2.1 Test Welds
All pre-qualifying test welds shall be completed under on-site conditions, using the welding equipment proposed to be used to make the construction welds.
Pre-qualifying test welds shall be welded by the qualified Welding Operators proposed to be used to make the construction welds.

3.2.2 Number of Pre-Qualifying Test Welds
Three (3) test welds shall be undertaken for each welding machine, pipe diameter, wall thickness and material type with a record of the parameter values used.
Where welding machines are similar (such as all the same manufacture and model) then Welding Operators shall be required to qualify on one machine only.
Where welding machines are substantially different, each Welding Operator shall be required to qualify on all machines they will operate.
3.2.3 Additional Pipe Batches
Where additional pipe is supplied to the contract and the additional pipe is not from the same Pipe Batch then additional pre-qualifying test welding will be required for the additional pipe.

Three pre-qualification test welds joining pipe from the new Pipe Batch shall be completed.

Pipe from a second batch shall be welded as a single string to the end of the first batch, to ensure there is only one joint between pipes of different batches.

3.2.4 Supervision of the Test Weld Process
Test welds shall be completed in the presence of the Superintendent.

Test welds shall be marked in the machine with orientation and identification markings before being cut out for testing.

Test welds shall be inspected by the Superintendent before being sent for testing.

3.2.5 Testing of Pre-Qualification Test Welds
Test welds shall be destructively tested by a NATA approved laboratory. Welds must satisfy the acceptance criteria stated in this specification to be acceptable.

No site welding shall take place until the Superintendent is satisfied with the outcomes of the pre-qualification test weld process.

3.2.6 Weld Test Reports
Attached to each Test Report shall be a graph of load versus extension.

The Test Report is not required to be limited to the items specified in the standard.

3.2.7 Acceptance Criteria for Butt Welds
Butt-welds shall be free of visual defects. Unacceptable visual defects include:

- miss alignment equal to or greater than 10% of the pipe wall thickness
- undersized weld beads
- weld beads of different sizes
- pitting or bubbling in the weld bead
- discolouration of the weld bead

Where a butt-weld has any of these visual defects it shall be considered unacceptable and shall be cut out and replaced at the Contractor’s cost.

Notwithstanding visual appearance, butt welds shall be shown to be fully ductile by destructive testing.

To be acceptable the butt-weld shall:

- have a strength not less than 95% of the strength of the unaffected parent wall, and
- be fully ductile (100% ductile)

Testing shall be in accordance with the latest revision of ISO 13953. Testing shall be conducted by a NATA accredited laboratory.

3.2.8 Acceptance Criteria for Electrofusion Welds
Electrofusion welds shall be free of visual defects. Visual defects include:

- miss alignment
- melt rise indicators not rising, or are unequal
- eruption of melt material past the melt rise indicator
- hand scraping
- mechanical scraping which does not extend past the area covered by the coupler (including area covered during assembly)
• witness marks not evident
• loss of melt material past the cold zone
• element wires extending past the cold zone

Where an electrofusion weld has any of these visual defects it shall be considered not acceptable and shall be cut-out and replaced at the Contractor’s cost.

Notwithstanding their visual appearance electrofusion couplers shall be shown, by destructive testing, to fail by ductile rupture of the weld plane. Some brittle rupture of the weld plane shall be allowed and the total length of brittle rupture shall not exceed 33% of length of the fusion zone.

Testing shall be in accordance with the latest revision of ISO 13954. Testing shall be conducted by a NATA accredited laboratory.

Notwithstanding their visual appearance electrofusion tapping saddles shall not rupture, de-bond from the pipe, or fail a pressure test following application of the impact test.

Testing shall be in accordance with the latest revision of ISO 13957. Testing shall be conducted by a NATA accredited laboratory.

4 WELDING PARAMETERS

4.1 General

All butt-welds shall comply with the parameters outlined in PIPA POP003 2011 Issue 6.1 Single Pressure and Low Fusion Jointing Pressure and as modified in Table 2 below. The contractor shall submit full welding parameters for each pipe material and size for approval prior to commencement of any onsite field welding.

**Table 2** PIPA POP003 Welding Parameters

<table>
<thead>
<tr>
<th>Butt Fusion Parameter</th>
<th>Single Pressure and Low Fusion Jointing Pressure Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Plate Temperature</td>
<td>Units</td>
</tr>
<tr>
<td>Initial Bead up Pressure</td>
<td>MPa</td>
</tr>
<tr>
<td>Bead up Time</td>
<td>second</td>
</tr>
<tr>
<td>Min. Bead size after T1</td>
<td>mm</td>
</tr>
<tr>
<td>Bead size after T2 (b)</td>
<td>mm</td>
</tr>
<tr>
<td>Heat Soak Pressure</td>
<td>MPa</td>
</tr>
<tr>
<td>Minimum Heat Soak Time</td>
<td>second</td>
</tr>
<tr>
<td>Maximum Heater Plate Removal Time</td>
<td>second</td>
</tr>
<tr>
<td>Fusion Jointing Pressure</td>
<td>MPa</td>
</tr>
<tr>
<td>Max. Time to Achieve Welding Pressure</td>
<td>second</td>
</tr>
<tr>
<td>Minimum Cooling Time in Machine Under Pressure</td>
<td>minute</td>
</tr>
<tr>
<td>Minimum Cooling Time Out of the Machine</td>
<td>minute</td>
</tr>
</tbody>
</table>
a) Additional cooling period that may be required after the cooling time under pressure to ensure optimum joint strength, particularly when working at high ambient temperature. T5 and T6 shall be completed prior to rough handling or pipe installation.

(b) ISO 21307 refers to this value as either “minimum initial beak-up size” or “minimum bead size after heating”.

en represents mean pipe wall thickness calculated from AS 4130 min/max values rounded to the nearest mm.

Rough handling means any action other than careful removal of the joint from the machine. Rough handling would include the application of bending or tensile load on the joint and T6 must be completed before the pipe is installed or placed in service.

Where a mobile welding position is used the pipe may be lifted out of the welding carriage and lowered gently onto pipe supports that are positioned so that the cooling weld does not flex, or extend. The lifting arrangement shall not flex or bend the cooling weld. This applies for all pipe diameters.

5 WELDING PROCEDURE

5.1 General
The contractor shall submit complete welding procedures and works method statements (WMS) for all PE welding. The following sections provide a guide to the minimum requirements necessary by Gladstone Regional Council.

5.2 Prestart Checks
The WMS requires a number of daily prestart and maintenance checks on each machine. These shall be recorded on a daily form that can be reviewed by the Contractor and the Superintendent.

5.2.1 Dust Suppression Measures
All welding shall be conducted in an enclosure to prevent dust contamination of the welds.

In addition to cover over the welding site, a floor shall be used to prevent dust becoming airborne inside the shelter from foot traffic.

The pipe ends shall be securely blocked by a cover being tied / taped securely in place. Simply inserting an object into the pipe end will not sufficient, unless the object is a tight fit so as to exclude any draught entering the pipe.

5.3 Cleaning of Pipe and Welding Equipment
Where the pipe is heavily caked, in dirt, mud or other contamination, this shall be removed so that the pipe clamps can effectively and securely grip the pipe.

Heavily caked pipe shall be cleaned with water and rags first.

Isopropyl Alcohol (IPA) and clean cloths shall be used to thoroughly clean the heater plate, the cutter plate and the pipe ends before each weld. The pipe shall be thoroughly cleaned inside and outside with IPA solution and a clean, dry, lint free cotton cloth.

The concentration of IPA shall not be less than 90% by volume and be suitable for PE pressure pipe welding.

The cloths shall be unbleached and lint-free cotton and should be discarded after each wipe of a pipe end, the heater plate or the facing plate.

IPA should be sprayed directly on the pipe ends before cleaning with a clean cloth. Cleaning of pipe ends shall extend at least 50 mm back from the cut end of the pipe.

Pipe end faces must not be wiped with cloths after shaving unless there has been surface contamination after the shaving has been completed.
The cleanliness of the heater plate, the cutter plate and the pipe ends shall be verified before proceeding.

5.4 Alignment of the Pipe

The pipe ends after facing shall be brought together at the initial welding pressure and the alignment of the outside diameters checked. Where the alignment step is greater than 10% of the pipe wall thickness, the pipe shall be adjusted in the welding machine so that any misalignment is below this value.

When pipe ends are brought together at initial welding pressure, the gaps between the ends of the pipes shall be checked with a feeler gauge. The feeler gauges shall be cleaned with 90% IPA before each use.

The maximum gap shall be:
- 0.3 mm up to and including DN250 mm
- 0.5 mm for DN280 mm to DN450 mm

Where gaps are greater than these values the ends of the pipes shall be refaced.

5.5 Operator Cleanliness

Operators shall remove gloves and clean hands before handling cloths for cleaning of cutting face, heater plate and pipe ends.

5.6 De-beading

Any weld beads removed may be requested by the Superintendent’s staff for inspection. The Contractor shall not dispose of weld beads that have been removed until the Superintendent advises that they are not required for inspection.

De-beading tools shall be kept clean and not be left on the ground. Cutters shall be regularly replaced and be correctly adjusted. De-beading tools shall remove the bead cleanly. Jagged cuts caused by chattering of the tool shall not be acceptable. The de-beading tool shall not over-cut, or gouge material that is below flush with the pipe wall.

5.6.1 Removing Internal Weld Beads

Internal weld beads shall not be removed unless instructed by the Superintendent.

The Contractor shall submit a method for de-beading after the full cool period has elapsed.

The Contractor shall submit a second method for de-beading approximately fifteen minutes after the cool down period in the clamps has commenced.

The time that de-beading shall occur will be reviewed during the pre-qualifying test weld process, after a weld that has been de-beaded when warm shall be sectioned.

Welds joining pipe strings together shall not be internally de-beaded.

5.6.2 Removing External Weld Beads

External weld beads shall not be removed unless instructed by the Superintendent.

Weld de-beading shall not occur until completion of the weld cool times.

Welds joining pipe strings together shall be externally de-beaded only.

5.7 Cutting of Pipe and Removal of Welds

PE pipe shall be cut where required to remove:
- Weld samples
- Defective Welds
- Damage greater than 10% of the wall thickness

Petrol chainsaws, or any other cutting device that could leave a hydrocarbon residue on the pipe, shall not be used to cut the PE pipe.

Electric chainsaws or electric reciprocating saws shall be acceptable for cutting the PE pipe.
Specialist PE pipe cutting tools such as those sold by George Fischer and other pipe or fitting manufacturers shall be preferred for cutting PE pipe less than DN250.

Where electric chainsaws are used to cut the PE pipe the chain shall not deposit any oil or other substance on the pipe that may cause a brittle weld.

Not less than 100 mm of pipe either side of the weld shall be removed when defective welds are cut-out.

Not less than 300 mm of pipe either side of the weld shall be removed when the weld is cut-out for destructive testing.

All cuts in PE pipe shall be accurate and square. Saw cuts shall be dressed before installation of electrofusion couplers.

5.8 Pipe Rollers
The use of purpose designed pipe rollers is mandatory on both sides of the welding site.
Pipe rollers shall be suitable to support each size of pipe.
Pipe rollers shall allow the pipe move freely along the entire pipe string.
The pipe rollers on the pull-off side of the welding site shall be placed at close centres to prevent sagging of the pipe, and bending or other stress on the new weld. Rollers within two pipe lengths of the pull-off side of the welding machine shall be at the same height as the welding carriage. Pipes can then drop to low level rollers as required.
The Contractor shall ensure that the new weld is not damaged by the rollers until the full cool time has expired.

5.9 Additional Pipe Batches
Where additional pipe from a different Pipe Batch is supplied to the contract this pipe shall be quarantined, and shall not be incorporated in the works as single lengths.
Pipe from a second batch shall be welded as a single string to the end of the first batch, to ensure there is only one joint between pipes of different batches.

5.10 Sampling of Construction Welds
On commencement of site welding 1 in 10 construction welds shall be removed for destructive testing.
The Superintendent shall indicate which welds shall be removed for testing.
Wherever possible welds for removal shall be selected immediately after the clamps have been removed.
The Contractor shall take all care not to disturb the warm weld during removal. They shall detail their proposed methodology to achieve this in their Work Method Statement.
Where construction welds are found to be brittle by destructive testing all welds completed since the previous weld, that has been shown to be ductile by destructive testing, shall be considered suspect.
As construction welding progresses and welds removed for testing are shown to be ductile, the frequency of weld sampling shall decrease. The frequency of construction weld sampling may reduce to 1 in 20 construction welds at the discretion of the Superintendent.

5.11 Minimum Dimension of Weld Samples removed for Destructive Testing
Where welds are removed for destructive testing, the specimen shall not be shorter than 300 mm on either side of the weld.

5.12 Welding Quality Assurance and Records

5.12.1 General
The contractor shall provide weld records for each weld. The Contractor shall submit all data logs to the Superintendent no later than 72 hours prior to commencement of trenching.
Manual data logging shall be acceptable, however electronic data logging is preferred.
The Contractor shall supply rates for providing manual data logging and rates to supply electronic data logging.
5.12.2 Requirements for Electronic Data Logging

The electronic data log output shall be in a form that can be uploaded to Microsoft Excel version 2010.

The output of electronic data logging should include the following details:

- time
- date
- weld identifying number
- weld location
- welding machine
- welder ID
- pipe details (size and SDR)
- time and pressure data sufficient to produce a graph of time versus pressure in Excel
- time and heater plate temperature data sufficient to produce a graph of time versus heater plate in Excel

* Where it is not possible to produce a graph of heater plate temperature, the welder shall manually record the heater plate temperature at four locations on each side the plate for each weld.

The sampling rate for electronic data logging shall not be greater than five seconds or less than one second.

5.12.3 Requirements for Physical Marking of Each Weld

Adjacent to each weld, the Contractor shall mark the weld number and the date - time of the weld.

5.12.4 Access of Superintendent’s Welding Inspector

The Superintendent may require that a Welding Inspector (to be employed by the Superintendent) shall be on-site to observe some or all of the welding.

The Inspector will be required to witness pressures and bead behaviour during critical stages of the weld process, which requires they “look over the shoulder” of the operator while not impeding his work. The inspector will be an observer only and will not direct or instructed the welding crew. The inspector will inform the Superintendent of any departure to the Welding Work Method Statement.

The Contractor shall provide reasonable access to the Superintendent’s welding inspector. During the pre-qualification process suitable access for the inspector shall be agreed.

The provision of a welding inspector shall not remove the obligation of the contractor to maintain QA records or to provide work in compliance with the specification.

6 REPAIR OF DAMAGED PIPE WALL

Where damage exceeding 10% of the pipe wall thickness is detected before welding, and the damage is mid pipe length, the damage shall be cut-out and the pipe welded together.

Where damage exceeding 10% of the pipe wall thickness is detected before welding, and occurs close to the pipe end, it shall be cut-out and the short length of pipe discarded.

The contractor shall be vigilant to ensure pipe strings are not damaged prior to pipe installation. Immediately prior to insertion, before pipe strings are welded together and lifted into place, pipes shall be thoroughly inspected for damage. Where damage exceeding 10% of the pipe wall thickness is detected, the damage shall be cut-out and the pipe string welded back together.

Where damage exceeding 10% of the pipe wall thickness is detected during pipe installation, the damage shall be cut out and the pipe strings rewelded. The use of extrusion welding to repair damage shall not be permitted.