



Technical Specification for Civil Works

TMS1437



Document Change History

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1 General

1.1 Scope

This Technical Specification applies to the design and construction of civil works for water and wastewater infrastructure assets by Queensland Urban Utilities. It is to be used in conjunction with the Project Brief.

The purpose of this Technical Specification:

- Is to maintain consistent designs, construction and durability, and appearance requirements for all water and wastewater infrastructure.
- It shall be read in conjunction with all relevant Australian and International standards, and legislative requirements.
- It does not relieve the designers' responsibilities for the design and construction of infrastructure.

The design and construction of civil works involves design, construction planning, fabrication and erection, construction and maintenance. The work, at each stage, shall be carried out in a manner that all requirements specified in an upstream stage are satisfied. These tasks must be performed consistently.

Civil works include:

- Excavation to the lines, grades and dimensions shown on the design drawings and as necessary for the construction of the works.
- Excavation, drainage, compaction or other works to provide sound foundations for the works including side support for pipelines.
- Confirm adjacent/nearby buildings, structures, services and other property are not destabilised, disturbed or damaged, including the provision of temporary ground support systems.

1.2 Design Requirements

The civil works in this Specification shall be designed for ultimate strength and limit states in accordance with the general principles for design specified in the relevant Australian Standards, Codes and is also permissible to carry out design checks for strength and serviceability by testing the civil works or component member.

Where the civil works are to be in extreme environments and the design is of a specialist's nature with specialist construction techniques, the Project Brief shall include the particular requirements as appropriate.

1.2.1 Basic Design Rules

- The design shall include the identification of performance requirements for the civil works, structural performance and detailing to meet these

performance requirements and the verification to confirm the performance requirements are met throughout the design service life of the civil works.

- All performance requirements that need to be met in order to meet the intended purpose of the civil works during construction and during the design service life of the civil works shall be determined at the design stage.
- The planning stage shall take into consideration factors such as structural characteristics, materials, construction method, maintenance method, and economy so that the performance requirements can be met.
- The detailing stage shall take into consideration factors such as shapes, dimensions and reinforcement patterns. These details are critical for constructability. It is necessary to take these details into consideration in advance so that the designed civil works do not fail to meet the constructability requirements.
- The performance verification requirements shall be verified in relation to durability, safety, serviceability, restorability, the impact on the environment and landscape throughout the design life. The performance verification refers to tasks of ascertaining, by an appropriate method, that the type of civil work, materials to be used, structural specifications, social conditions, constructability and economy meet the specified performance requirements.

1.3 Construction Requirements

The construction requirements in this Specification are for use where civil works have been designed to the relevant Australian Standards and Codes.

2 Performance Requirements

2.1 General

The design life shall be determined in consideration of the required service period of the structure, maintenance period, environmental conditions and economy.

All performance requirements during the construction and design life shall be specified for every element of the civil work. The performance requirements related to durability, safety, serviceability, restorability, environment compatibility, landscape compatibility, etc. shall be specified as appropriate. Detailed requirements related to these performance requirements have to be identified. It is necessary to give careful consideration to the relationship with the performance of each individual element so that the performance required for the entire structure is met.

2.2 Durability

Durability is the resistance of a structure to performance degradation over time resulting from the materials degradation in the structure under expected

deterioration actions. The durability shall be specified for the purpose of maintaining the required performance of safety, serviceability and restorability throughout the design life. Durability is not independent of performance requirements.

2.3 Safety

Safety shall mean the performance to prevent risks to users and others in the vicinity under all expected conditions. Safety includes the structural safety and functional safety. Performance requirements for both, structural safety and functional safety, must be specified.

Safety and stability of excavations includes:

- Confirm excavations are safe and stable.
- Provide temporary ground support as necessary.
- Confirm foundations are not over excavated, damaged, disturbed, or softened by water.
- Minimise any disturbance of other services.
- Prevent settlement of adjacent ground and structures.
- Provide drainage and erosion.
- Comply with all Regulations.

2.4 Serviceability

Serviceability of civil works shall mean the performance that enables users or others in the vicinity to use the structure comfortably and the functional performance required of the structure.

2.5 Maintenance and Repairs

Maintenance and repairs shall mean the performance in restoring the performance of the structure that has degraded due to continued use or accidental loads. It shall be specified as the degree of difficulty in repairing the civil works and all factors affected by the performance degradation.

2.6 Other Performance Requirements

Environmental compatibility and landscape compatibility performance requirements shall be specified on project specific basis. These performance requirements shall be carefully considered at the planning stage and confirmed with verifications.

2.7 Roads and Pavements

Specific site standards should be adhered to for roads and paths as detailed in the local authority requirements and Project Brief. It is to include road

construction, footpath construction, banded areas, joint requirement and drainage channels.

2.7.1 Road Access

All roads must be designed in accordance with the AustRoads Design Guidelines unless stated otherwise.

An all-weather granular pavement access road suitable for operations, maintenance, supply and emergency vehicles shall comply with this section. The design of the granular pavement shall comply with Brisbane City Council Urban Management Division, Subdivision and Development Guidelines Part B, Design Requirements Table B5.5.1. The access and egress design shall take account of potential bushfires.

The minimum design criteria for the vehicles shall be as follows:

- Vehicle pavement width 3 metres minimum.
- Pavement design life 40 years.
- Growth is not assumed for the 40 year design life.
- Class of road - Industrial Access Road.
- Pavement - Granular/Asphalt Type E.
- Design traffic ESA (Upper Limit) 1.5×10^6 .
- Design traffic DTN (Upper Limit) 200.

Concrete kerb and channel must be provided along the full frontage of every site fronting the road.

2.8 Concrete Work

Refer to Queensland Urban Utilities Technical Specification for Concrete Structures TMSXXX.

2.9 Structural Steelwork

Refer to Queensland Urban Utilities Technical Specification for Steel Structures TMSXXX.

2.10 Masonry Work

Refer to Queensland Urban Utilities Technical Specification for Concrete Structures TMSXXX.

2.11 Piling

Obtain a Site Investigation Report from a specialist firm in order to determine piling and foundation requirements. The choice of piles, driven or bored, will be dependent on vibration issues, ground conditions and settlement. A guideline

on settlement should be obtained with respect to using piles as existing site structures can suffer due to being ground bearing.

Piling will be carried out by a specialist piling sub-contractor after approval of the piling system by the design engineer.

Full records of all stages of the piling operation are to be supplied to the client.

3 Verification

3.1 General

The performance verification shall verify that the work as designed and detailed do not reach the limit state specified during construction and during the design life of the structure. The limit state shall be specified for durability, safety and serviceability.

The required verification requirements shall be specified at the planning stage and included in the Design Basis.

3.2 Verification Requirements

The performance verification prerequisite is that the detail requirements for performance verification, other structural detail requirements, construction method requirements and placement requirements and the maintenance procedure requirements are met.

3.3 Non-Rippable Material

The methods of measurement required to differentiate non-rippable material shall comply with the following criteria. Machine classification is to AS 2868.

Confined Excavation

Excavation of trenches and to broader areas less than 1,000 m² in extent. Material shall be classified as non-rippable if any of the nominated classes of crawler excavator fitted with a heavy duty bucket, cannot rip at a production rate (in situ volume) exceeding the nominated values. Fit bucket teeth with high penetration boots, approved by the machine manufacturer for use on the particular machine in rock.

- Class 55 crawler excavator fitted with a maximum 450 mm wide bucket. Maximum production rate 1.5 m³ per hour.
- Class 85 crawler excavator fitted with a maximum 600 mm wide bucket. Maximum production rate 3 m³ per hour.
- Class 115 crawler excavator fitted with a maximum 750 mm wide bucket. Maximum production rate 4.5 m³ per hour.
- Class 155 crawler excavator fitted with a maximum 900 mm wide bucket. Maximum production rate 7 m³ per hour.

- Class 200 crawler excavator fitted with a maximum 1050 mm wide bucket. Maximum production rate 10 m³ per hour.

Other Excavation

Classify material as non-rippable if the nominated classes of crawler tractor, equipped with a heavy duty, single tine parallelogram ripper (approved by the machine manufacturer for use on the particular machine in rock), cannot rip at a production rate (in situ volume) exceeding the nominated values.

- Class 150C crawler tractor. Maximum production rate of 50 m³ per hour.
- Class 200C crawler tractor. Maximum production rate of 75 m³ per hour.
- Class 300C crawler tractor. Maximum production rate of 90 m³ per hour.
- Class 400C crawler tractor. Maximum production rate of 105 m³ per hour.
- Class 500C crawler tractor. Maximum production rate of 120 m³ per hour.
- Class 600C crawler tractor. Maximum production rate of 135 m³ per hour.

3.4 Density Requirement

Minimum Density Schedule

Location	Minimum relative compaction (standard) (Cohesive soils generally) (see Notes 1, 2, 3, 4)	Minimum density index (Cohesionless soils) (see Notes 1, 5)
Single one or two storey residential dwelling sites		
Allotment fill	95%	65%
Building pad (see Note 6)	100%	80%
Commercial, industrial and multi-unit residential developments		
Allotment fill	98%	70%
Building pad (see Note 6)	100%	80%
Road and structural (other than building) formations including embankments, footpaths, paved areas and shoulders (see Note 7)		
> 0.3 m below subgrade level	95%	65%
≤ 0.3 m below subgrade level	100%	80%
All other areas e.g. parks		

> 0.3 m below design level	90%	62%
≤ 0.3 m below design level	95%	65%
Replacement of unsuitable or over-excavated subgrade material	100%	80%
Backfilling of grub holes	100%	80%

Notes:

1. Field dry density to AS 1289.5.3.1, AS 1289.5.3.5 or AS 1289.5.8.1. If using AS 1289.5.8.1, calibrate the surface moisture-density gauge in accordance with AS 1289.5.8.4 before use on site.
2. Standard maximum dry density to AS 1289.5.1.1.
3. Relative compaction (% of maximum dry density) to AS 1289.5.4.1.
4. For plastic soils, compact soils designated under the unified classifications system as OH CH MH to not less than 92% nor greater than 96% of standard maximum dry density at moisture contents of between 90% and 120% of optimum moisture content.
5. Density index to AS 1289.5.6.1. Maximum and minimum dry densities to AS 1289.5.5.1.
6. Average imposed bearing pressure of floor slab not to exceed 20 kPa. Imposed bearing pressures of strip and pad footings not to exceed 100 kPa.
7. In the context of this specification, road formation is deemed to include all the area within the designated road reserve. Structural formation is deemed to include the area under the paving plus a nominal 1 m from the edge of the paved area.

3.5 Compaction Methods

Compaction methods shall comply with the following table.

Compaction Method Table

Material category	Compaction Method	Density Compliance Tests
Cohesionless sand	Compacted layer method	Relative dry density or density index (if RDD gives meaningless answers)
Soils other than above which, after compaction, have less than 20% of stone retained on the 37.5 mm sieve	Compacted layer method	Relative dry density
Coarse granular soils with more than 70% of stone retained on the 37.5 mm sieve	Mechanical interlock method	Nil on material in general
Soils other than above	Compacted layer	Relative dry density.

which, after compaction, have 20% to 70% of stone retained on the 37.5 mm sieve	method; or Mechanical interlock method	Relative dry density where appropriate on the finer grained materials which completely fill the voids between rocks
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4 Products

All materials used shall comply with the Project Brief and the current Australian Standards. Specific samples may require testing. The constructor shall arrange for the samples to be supplied, identified, stored and tested, and the results issued.

Propriety products and materials shall be used in accordance with the manufacturer's written requirements and instructions.

4.1 Geotextiles

Base materials shall be polyamide, polyolefines, polyester and polyvinyl materials, either singly or in combination complying with AS 3706. Filament properties shall be rot-proof, chemically stable and with low water absorbency. Non-woven geotextiles must have the filaments bonded by needle punching, heat or chemical bonding processes. Woven geotextiles must have the filaments interlaced in two sets, mutually at right angles. One set must be parallel to the longitudinal direction of the geotextile.

Ultraviolet radiation resistance shall comply with:

- Exposed conditions - Retain 90% of its original strength after three months exposure to sunlight.
- Unexposed conditions - Retain 90% of its original strength after one month exposure to sunlight.

4.2 Formwork and False Work

The design, materials and construction shall be in accordance with AS 3610. Timber, wood and metal products certified for formwork and falsework shall be used. Permanent formwork may be used subject to the approval of the designer. The formwork shall be clear of all debris, oils, water and other contaminants.

Release agents shall be chosen to suit the method of construction and the finish required. They shall not be affected by the weather. Refer to Queensland Urban Utilities Concrete Technical Specification.

4.3 Concrete

The required strength of concrete shall be designed in accordance with the Project Brief. Refer to Queensland Urban Utilities Concrete Structures Technical Specification.

4.4 Reinforcement

All reinforcement shall comply with the requirements of the appropriate Australian Standard. All reinforcement suppliers shall hold a valid Certificate of

Approval for manufacture and/or fabrication in compliance to the Australian Standards or equivalent. A supplier Certificate of Approval reference shall be stated on all documents.

Pre-assembled welded fabricated reinforcement delivered to site shall have approved certification for the manufacture of pre-assembled welded fabrication using welded semi-structural and/or structural joints or equivalent.

4.5 Reinforcement Accessories

Spacers

The materials and workmanship of spacers shall be in accordance with the relevant Australian Standard for spacers and chairs for steel reinforcement. The spacers shall have the required performance characteristics.

Continuity Strips

Propriety continuity strips manufactured to Australian Standards with approved certification or equivalent shall be used.

Fibre Reinforcement

Fibre reinforcement is not to be used unless approved. Details of the proposed fibres, source and suppliers shall be forwarded if its application is approved.

4.6 Curing Materials

Curing compounds must comply with AS 3799. Use only wax-based (AS 3799, Class A), resin based (AS 3799, Class B), and water-borne (AS 3799, Class Z) curing compounds. Do not use wax-based or chlorinated rubber-based curing compounds on surfaces forming substrates to concrete toppings, painted surfaces, cement-based render or similar. For each curing compound proposed, provide a current Certificate of Compliance from the supplier. For each batch delivered, provide a Certificate of Uniformity from the supplier.

4.7 Drainage

Materials used for drainage shall comply with the SEQ Design and Construction Code and the relevant local authority requirements.

5 Construction

5.1 General

Set out civil works to approved design drawings, remove all loose rubbish, etc., grub up shrubs and roots, remove all vegetation and soil to a depth of 300 mm or as necessary, stockpile good topsoil for future use, cart away remainder and leave site ready for excavation.

Break up, remove and cart away any existing obstruction, concrete paths, base or foundations which affect excavation for the new work.

Temporarily seal off maintenance holes, drains etc. where route affects new work, divert or make temporary arrangements as necessary for duration of new work.

Adequate provision must be made to confirm the stability and protection of existing nearby structures before new works are started which involves demolition of existing structures or excavating. Markers to be fixed, levels taken and agreed with the design engineer.

Provision is to be made for weather protection of any exposed sections for projects involving existing structures.

5.2 Permanent Survey Marks

Locate and confirm the location of all permanent survey marks in the area before commencing construction. The contractor shall confirm that all permanent survey marks are clearly indicated throughout the period of the contract and shall confirm that no permanent survey mark is interfered with in any way.

5.3 Existing Services

Locate and mark existing underground services in the areas which will be affected by the civil works operations including clearing, excavating and trenching before commencing civil works.

5.4 Adjacent Structures

Provide supports to adjacent structures where necessary, sufficient to prevent damage arising from the works. This applies to all structures where the line of influence is interfered with by the proposed excavation works. Provide lateral support using shoring. Provide vertical support where necessary using piling or underpinning or both.

If permanent supports for adjacent structures are necessary and are not described, advise the design engineer and obtain written instructions.

5.5 Clearing and Grubbing

Clear only the site areas to be occupied by works such as buildings, paving, excavation, regrading and landscaping. Clear generally to the extent necessary for the performance of the works and any other areas that the contract specifically requires to be cleared.

Clearing and grubbing shall consist of the removal and disposal of all trees, brush, stumps, logs, grass weeds, roots and all decayed vegetable matter, pole stumps, refuse dumps, and all other objectionable matter resting on or protruding through the surface of the original ground from the specified area. It shall also include the removal of concrete paving and foundations from all areas, and the removal and proper disposal of all obstructions including kerbs, kerbs and channel, drainage pits, fences and any old or incidental structures within the specified area which will conflict or interfere with construction.

The method of clearing, grubbing and disposal of the material cleared and grubbed from the specified area shall be in accordance with the provisions and requirements of design documents.

Trees shall not be removed or trimmed without prior approval and permits of the relevant authority. Trees shall be felled within the area to be cleared in such a manner as to avoid damage to vegetation or any property outside this area.

All matter and material to be grubbed shall be removed to a depth of not less than 600 mm below the existing surface. All holes shall be backfilled with approved material in accordance with the requirements of the Project Brief.

All debris including tree trunks, rubbish and concrete collected in clearing and grubbing shall be removed from the site of the work in advance of construction operations. The site and adjacent areas shall be left with a neat and tidy finished appearance free from unsightly debris. No accumulation of inflammable material shall be permitted to remain on or adjacent to the site. Cleared and grubbed material shall not be stacked or burned on site.

Care shall be taken not to disturb any benchmarks, survey or level pegs during clearing and grubbing. Any survey pegs lost shall be replaced by a licenced surveyor. Damage to fences shall be repaired immediately.

5.6 Topsoil

Remove topsoil from areas to be affected by the works. Stockpile topsoil separately from other excavated material and retain for reinstatement. In cut and fill areas, a sufficient quantity of the best topsoil available from the site shall be removed before commencing excavation.

Topsoil shall be fertile, dark coloured loam, friable soil containing organic matter and shall be free from subsoil, refuse, tree roots, noxious weeds, clay lumps and stones.

Remove excess topsoil once reinstatement and landscaping works have been completed.

5.7 Excavation

Excavate over the site to give correct levels for construction, pavements, filling and landscaping. Excavate for footings, pits and shafts, to the required sizes and depths. Confirm that bearing capacity is adequate.

Carry out all necessary support measures to retain sides of excavation as required under risk assessment. Stockpile good topsoil for future use and cart away remainder to approved tip after soil sampling. Keep excavations free of standing water. Level and ram bottom of excavations.

Excavate in bulk as necessary for the works. Use a competent person to determine the stability of slopes, berms, stockpiles, services and structures at the site and on adjacent properties. Address temporary drainage design, testing for potentially acid sulphate soils and environmental requirements. Manage and take responsibility for all aspects of bulk excavation not withstanding any approvals.

Excavation shall consist of excavation, removal and satisfactory disposal of all materials from within the limits of the work. Excavation operations shall be so conducted that the material outside the limits of the batters is not disturbed.

Should excavations not remain free draining during the currency of the work or where material has become unsuitable to any depth, it shall be excavated and replaced.

Where excavation exceeds the required extent, whether as a result of bad ground (and where footing levels or the like are not varied) or as a result of excess excavation, reinstate to the correct depth and required bearing value. Refill over-excavation with concrete of strength appropriate to the loading or a minimum of 15 MPa within the 'line of influence' of footings, beams or other structural elements or as specified by the design engineer.

5.8 Foundations

Foundations shall be carried to good bearing soil specified in the design drawings and to the minimum depth below finish grade as indicated on the design drawings. Provide flat bearing surfaces for loadbearing elements including footings. Step to suit changes in levels. Make the steps to the appropriate courses if supporting masonry. If the requisite bearing is not encountered at the indicated minimum depth, or should over-excavation occur, the following shall be complied with the approval of the design engineer:

- Minor variations shall be corrected by the use of a lean concrete strength in excess of 7 MPa.
- Major variations shall be referred to the design engineer.

The final work of soil excavating and earth filling shall be completed just prior to the placing of the reinforcing steel and concrete. In order to prevent excessive moisture changes in the foundation supporting soil, the following options are recommended for all spread footing, mat foundation, and mass excavations with the approval of the design engineer:

- Foundations shall be poured within 24 hours of excavation.
- Water shall be sprayed as required to maintain insitu soil moisture.
- A 50 mm thick lean concrete slab may be poured as soon as practical after excavation. This slab may also be used to provide a good working surface for construction activities. Lean concrete shall have strength in excess of 7 MPa.

Prior to pouring the seal slab (or foundation concrete if seal slab is not necessary) the geotechnical engineer shall inspect the foundation subgrades material to confirm it is suitable for supporting footings. Should the material/s be different than those revealed by the geotechnical investigation, the design engineer shall decide on corrective measures to confirm the satisfactory performance of the foundation soils. The corrective measures may consist of one or more of the following as specified by the design engineer:

- Removal of the foundation subgrades material to a certain depth and replacing it with compacted structural fill/lean concrete.
- Pumping out ground water from or around the foundation excavation.
- Sprinkling of water on dry competent subgrades soils, etc.

If the bearing surface deteriorates after approval, excavate further to a sound surface before placing the load bearing element.

5.9 Trench Excavation

Excavate for underground services, to required levels and grades. Generally make the trenches straight between inspection points and junctions, with vertical sides and uniform grades. Keep trench widths to the minimum required for laying and bedding of the relevant service and construction of pits. Excavate trenches for pipelines as required. Trench width excludes trench supports. Shoring for trenches shall be designed by a competent and experienced person.

If excavation is necessary below the zone of influence of the underside of adjacent footings, advise the design engineer, and provide support for the footings as instructed by the design engineer. Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised as directed by the design engineer.

Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

Backfill service trenches as soon as possible after the service has been laid and bedded, if possible on the same working day. Place the backfill in layers maximum 150 mm thick and compact to approval of design drawings.

General fill shall have no stones greater than 25 mm occurring within 150 mm of the service, or other materials as required for particular services or locations. Complete the backfilling with topsoil for at least the top 100 mm where existing ground surfaces are not required to be varied as part of the works.

Reinstate existing surfaces removed or disturbed by trench excavations to match existing and adjacent work.

5.10 Excavation by Hand

Excavate by hand where the use of mechanical excavators may cause damage to property, trees, buried services, buildings, and other structures, for safety or to avoid unreasonable disruption of the community.

5.11 Excavation by Blasting

The use of explosives for excavation is not permitted.

5.11.1 Temporary Stockpiling of Materials

Temporary stockpiling of materials includes:

- Locating stockpiles in suitable pre-approved areas.
- Obtaining approval from land owners, occupiers and responsible authorities.
- Arranging and managing stockpiles safely and in accordance with relevant regulations.
- Meet the requirements of environmental management compliance in respect of dust, runoff etc.

5.12 Over-Excavation

Over-excavation is where excavation exceeds the required extent, whether as a result of poor ground, excess excavation by the contractor, the presence of voids, fissures and the like. Reinstate over-excavation to the correct depth and required bearing capacity using accepted methods to achieve at least, the following with the approval of the design engineer:

- Where over-excavation is below or within the "line of influence" of footings, beams, or other structural elements, place concrete of strength equal to the structural element or a minimum strength of 15 MPa.
- Where over-excavation is below slabs or pavements, place selected fill compacted to the density specified for the placement of fill. In cut sub

grades if the over excavation is less than 100 mm, do not backfill, but make good by increasing the thickness of the layer above. Backfill rock depressions and over excavation of subsoil drains with coarse subsoil filter material.

- Where over-excavation is in the invert of trench excavations, place 15 MPa concrete or approved compacted pipe bedding material as directed by the design engineer.

5.13 Dewatering

Keep groundwork's free of water. Provide and maintain slopes and drains on excavations and embankments to confirm free drainage. Prevent water flow over freshly laid work.

5.14 Sub-grade Preparation

Trim the subgrade to an even surface free from loose material. Compact, or re-compact, subgrade material to obtain the density specified.

Perform one or more of the following where the subgrade is unable to support construction equipment or it is not possible to compact the overlying pavement because of high subgrade moisture content:

- 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 re-compact when the moisture content approximates the optimum.
- Excavate the wet material and replace with select fill.
- Treat the material with lime mixed in by approved specialised plant.

5.15 Geotextiles

Store geotextiles under protective cover or wrapped with a waterproof and ultraviolet protective sheeting. Do not store geotextile directly on the ground or expose them to excessive heat.

Before placing geotextile, trim the ground to a smooth surface free from cavities and projecting rocks. Lay the material flat, but not stretched tight, and secure it with anchor pins. Overlap joints at 300 mm minimum.

Do not allow vehicles and construction equipment on the geotextile until it has been covered with a layer of fill or pavement material at least 150 mm thick. Do not expose the material to sunlight for more than 14 days.

5.16 Fill

Fill material shall be inorganic, non-perishable material. Do not use fill with sulphur content exceeding 0.5% within 0.5 m of cement bound elements (for

example concrete structures or masonry), unless such elements are protected by impermeable membranes or by other suitable means approved by the design engineer.

General fill shall be well graded material with a maximum particle size of 75 mm and plasticity index $\leq 55\%$. Select fill shall be granular material with a particle size of 75 mm maximum, proportion passing 0.075 mm sieve at 25%. Plasticity index between $\geq 2\%$, $\leq 15\%$. Soaked CBR not less than 15.

Suitable excavated material or imported fill material to be used in accordance with the Project Brief. Adjust the moisture content of fill as follows:

- Add water to cohesionless soil fill to assist with compaction.
- Moisture condition cohesive soil fill at the time of compaction within the range of 85% to 115% of the optimum moisture content determined by AS 1289 as appropriate so as to permit the specified density to be attained.

5.17 Placement of Fill

Prepare excavated surfaces for the placement of fill by compacting to not less than 100% standard maximum dry density as per AS 1289.5.1.1. Place and compact pipe embedment in accordance with the SEQ Design and Construction Code and in accordance with the local authority requirements.

Place fill in uniform loose layers not exceeding 200 mm thickness and so the compacted fill surface is self-draining. Place and compact fill to:

- The lines, levels and details shown on the design drawings.
- The required density specified in the Project Brief.
- The requirements of road authorities and/or Local Authority.

Material to be used for fill construction shall consist of approved materials free from logs, stumps, weeds or other perishable matter. Areas upon which fills are to be constructed shall first be grubbed, cleared and stripped as specified in the design drawings.

The surface areas to be filled shall be test rolled prior to filling. Any unstable area detected by test rolling shall be rectified using methods agreed with the design engineer and shall be re-presented for test rolling.

All filled areas shall be constructed in layers of uniform thickness not exceeding 200 mm loose depth. Each layer shall contain material size and loose compaction depth as specified the design drawings.

Fill over and around pipes, culverts, bridges and other structures shall be placed in such a manner that will avoid unbalanced loading and that will not cause movement or place undue strain on any structure. Any rocky material present in the fill for any layer shall be uniformly distributed within the layer and shall be compacted as specified.

The surface of each layer shall be kept generally parallel to the surface of the subgrade during the filling operation, except where necessary the outer 1 m of the fill shall be raised so as to prevent uncontrolled flow of water down a batter. The top of the fill shall be shaped and compacted to minimise damage resulting from wet weather prior to the cessation of work each day.

Densities shall be checked in situ and fill not meeting the required density shall be re-excavated and re-compacted.

5.18 Placement Adjacent to Concrete Structures

Place fill adjacent to concrete structures in accordance with the design drawings. Do not place fill against concrete until:

- Concrete curing has been completed.
- The concrete has been in place for sufficient time to achieve its nominated strength.
- Such time as specified in the design drawings.
- The requirements of road authorities and/or local authorities.

Place and compact fill in layers simultaneously on both sides of structures or pipelines to avoid uneven loading.

5.19 Density and Moisture Content

Density Requirements

Compact fill and unbound subgrade material to the relevant standards specified in the design drawings.

Moisture Content

Adjust moisture content of fill and unbound subgrade material as necessary to within 80% to 100% of the optimum moisture content (determined by AS 1289.5.1.1) to achieve the required compaction unless specified otherwise. Maintain moisture content of the compacted material within the specified range until covered with subsequent layers.

Adjust the moisture content of fill during compaction in order to achieve the required density. Do not allow subgrade or fill layers to dry out after compaction before placing subsequent layers of fill. Do not over water filling to greater than moisture content of adjoining undisturbed ground.

Fill shall have, during compaction, a moisture content within the range 85% to 115% of the optimum moisture content as determined in the standard compaction test unless otherwise specified. The moisture content of the material in the layer shall be maintained within the range specified until the layer has been test rolled after completion of compaction.

Fill materials which have been satisfactorily compacted, but which become wet beyond 130% of optimum moisture content, shall be removed, dried and re-compacted.

5.20 Soft Spots

Any soft, wet or unstable areas of depths exceeding 150 mm below the designed levels of the subgrade which exists or develop during construction shall be excavated and replaced with approved material in layers not exceeding 150 mm loose thickness compacted. The depth to which soft spots shall be dug out shall be determined on-site by the design engineer.

5.21 Compaction

Compact the subgrade exposed by excavation to a minimum depth of 150 mm. Compact each layer of fill to the required depth and density, as a systematic construction operation. Shape surfaces to provide drainage and prevent ponding. Density of all layers of filling are to be approved by the design engineer before subsequent layers are placed. Maximum rock and lump size in layer after compaction is 2/3 compacted layer thickness.

Monitor the density of compacted fill using field density testing in accordance with Australian Standards and the SEQ Design and Construction Code. Compaction of civil works shall include the compaction of the subgrade in cuttings, the compaction of areas upon which fill is to be placed and the compaction of all fill material to the standard indicated in the design drawings. All compaction shall be carried out using approved rollers.

The top 150 mm of the subgrade shall be compacted to a dry density not less than 100% of the maximum value obtained in the standard compaction test carried out in accordance with AS 1289.

Areas upon which fill is to be placed shall be compacted to produce a dry density not less than 98% of the minimum density required under in the top 150 mm of the area.

Construction equipment and traffic shall not be allowed on the subgrade or fill while it is in a wet condition. Material which has become excessively wet shall be dried or removed and replaced by material of suitable moisture content for compaction.

5.22 Proof Rolling

Proof roll excavations for pavements, filling and non-spanning slabs on ground to determine the extent of any bad ground.

All layers shall be test rolled prior to the placement of any subsequent layers. The finished surface of filled areas shall also be test rolled. Any unstable area detected shall be rectified using methods agreed with the design engineer.

All layers shall be compacted such that no visible deformation or springing is visible under the action of test rolling.

5.23 Soil Erosion

The Contractor shall take necessary measures required during construction to control runoff from the land. Such measures may include the use of contour and cut-off drains and sediment traps and shall confirm that polluted or sediment laden runoff does not enter directly or indirectly any drainage systems, creek or water course.

5.24 Reinstatement

Restore ground surfaces to the condition existing at the commencement of the work under the contract where existing ground surfaces are not required to be varied as part of the works.

5.25 Landscape -Walls and Fences

All hardwood in timber fences is to be best quality without any rot, significant knots, twists, or other defects which may affect its strength. Provide only timbers with preservative treatment painted on the timbers surface where the timber is in the ground, or confirm that all timber is highly resistant to rot.

All steel tubes and channels used for posts, rails, stays are to be heavy duty hot dip galvanised to confirm the maximum lifetime for the item without significant maintenance.

Chain wire, cable wire, tie wire and barbed wire are to be galvanised or other suitable metallic finish for maximum lifetime. Refer Queensland Urban Utilities standard drawings.

Concrete walls and concrete foundations are to be constructed as shown on the design drawings.

Crib Walls shall be a proprietary system of interlocking precast concrete units with selected backfill placed and compacted progressively to form a retaining wall.

5.26 Formwork

Any clashes between holes, cast in items and reinforcement shall be resolved with the design engineer before concrete is placed. Methods of fixing the formwork that result in holes through the concrete section when formwork is removed shall not be used unless approved by the engineer. Formwork ties shall be of a type to maintain water resistance of the concrete. Ferrous metals shall not be used in the concrete cover zones.

5.26.1 Removing and Re-using Formwork

Formwork and false work shall be removed at a time determined by the contractor in compliance with the design. The formwork shall be removed in a procedure that shall not damage the concrete surface.

The sequence of propping, back propping and re-propping for the structure shall be specified in a method statement by the contractor and approved by the engineer. It shall not have any damaging effects on the permanent structure.

5.27 Reinforcement

Reinforcement shall be delivered to site in properly identifiable tagged bundles, mats or prefabricated assembly. It shall be stored on site so as not to become contaminated by deleterious materials or otherwise damaged. Fabric shall be stored flat.

Reinforcement shall not be dropped from height, mechanically damaged or shock loaded in any way.

Reinforcement shall be fixed in position in accordance with the reinforcement detail drawings and reinforcement schedules. Any alterations of reinforcement shall be carried out after written approval.

Tying

All tying of reinforcement shall be carried out with black annealed mild steel tying wire unless otherwise approved. All ends shall be bent away from the concrete surface and all loose ends removed prior to placing concrete.

Welding

Tack welding on site is not permitted unless approved in exceptional circumstances. Evidence of component welders and details of welding procedures will be required for approval. Welding shall comply with the Australian Standard for welding reinforcement.

Projecting Reinforcement

Reinforcement ends left projecting from the cast concrete shall be free of release agents and shall be protected against damage and corrosion. Light surface rusting will be acceptable unless detrimental to the finished structure or causing rust straining to adjacent exposed concrete or formwork.

Site Bending

A method statement must be submitted for approval for site bending. The following conditions apply to site bending:

- Bending of reinforcement, including straightening, is not permitted at temperatures below 5 degrees Celsius.

- The curvature shall be as constant as possible.
- Bending shall be in one operation at a constant rate.
- Reinforcement shall not be heated to more than 100 degrees Celsius.
- The bent radius shall not exceed the maximum permitted in the Australian Standards.
- Each bar bent shall be inspected for signs of fracture. Any fractured bars shall be non-conforming.

5.28 Water Stops

The method to maintain the water stops in the correct position and prevent movement or damage while concrete is placed, during or after removal of formwork is to be agreed with the design engineer. Where centre section water stops are proposed, details of full compaction of concrete around the water stop are required.

5.29 Concrete Placement

Submit as appropriate, details of the proposed concrete in accordance with the Project Brief. Daily maximum and minimum atmospheric shade temperatures shall be recorded using a calibrated thermometer located close to the structure.

Suitable arrangements for premature cessation of a pour shall be agreed and in place before work starts and shall include the extend of, and timing of any remedial work before resumption of placing concrete.

Concrete shall not be placed in extreme weather conditions. Written approved arrangements to be prepared if the air temperature is below 5 degrees Celsius or above 30 degrees Celsius.

Water is not to be added on site to the concrete and if it is added to the concrete mixer drum, before discharge on site, the concrete shall be deemed non-confirming. The concrete producer shall carry out testing of the concrete in accordance with Australian Standards. When the producer identifies a non-conformity that was not obvious at the time of delivery, this shall be reported to the engineer within 24 hours.

Concrete tests prepared by the constructor or their authorised agent, shall be manufactured, initially cured and transported to an approved NATA laboratory.

Concrete shall not be cast directly against existing construction or faces of excavations without prior approval from the engineer. The temporary or permanent support from the ground shall be firm enough for concreting operations where structural concrete is poured directly against the ground.

Placing and Compaction

Concrete shall be placed and fully compacted to avoid cold joints, honey combing and to minimise segregation, excessive blemishes or other defects in

the hardened concrete. Compaction shall be carried out without causing damage or displacement of the formwork, reinforcement, tendon, ducts, anchors, inserts, etc.

The surface of the concrete shall be cured to avoid premature drying. Methods of curing shall be agreed with the design engineer. Curing membranes shall be compatible with the finishes to be applied subsequently.

Measures shall be adopted that minimise the risk of early age thermal cracking when concrete is placed in conditions or in an element where early age thermal cracking is likely.

Curing

Apply the curing compound to unformed surfaces immediately after completion of all finishing operations, and to formed surfaces within 30 minutes of removal of the formwork. Use a pressurised sprayer to give uniform cover. Incorporate a device for continuous agitation and mixing of the compound during spraying. Use a fine spray at the rate recommended by the supplier. Provide a continuous flexible coating without visible breaks or pinholes. Maintain an unbroken curing membrane for the specified curing period and repair any damage by re-spraying.

In hot weather, commence curing immediately after concrete placement, cover the concrete with an impervious membrane or continuously wet hessian. As an alternative to immediate covering, where the temperature exceeds 25° C or where not protected against drying winds, protect the concrete with a fog spray application of aliphatic alcohol evaporation retardant.

Post Concrete Inspection

The relevant work shall be inspected by the constructor and inspector at the end of the specified curing period.

5.30 Surface Finishes

A plain concrete finish is to be provided unless otherwise specified. It will require careful selection of the concrete, release agent and the use of good quality formwork. The concrete must be thoroughly compacted and all surfaces must be true with clean arises. Very minor inherent surface blemishes should occur, with no discoloration from the release agent or grout run off to adjutant pours. The struck surface should be of a consistent colour from the materials used. The arrangement of the formwork panels and tie holes should be in a regular pattern. Steps at joints between forms is to be a maximum of 1 mm. This surface finish should not require any further work to make them good.

Unformed Finish

The concrete shall be finished by trowelling, or a similar process, to produce a dense, smooth, level, uniform surface unless specified otherwise.

5.31 Joint Sealants

Joint sealant works shall not commence until the concrete has had adequate time to cure in accordance with the manufacturer's recommendations (minimum 28 days).

Joint filler shall be non-absorbent, semi-rigid, polyethylene joint filler.