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Land and Marine Environmental Resource Group
LAMER Group Pvt. Ltd

HDH NOLHIVARANFARU ISLAND INFILTRATION GALLERY

CONTRACT NUMBER 3100004903

DETAILED DESIGN REPORT (ACTIVITY 3.2)

Produced For Maldives Ministry of Environment, Climate Change and Technology

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1 INTRODUCTION

1.1 General

The Nolhivaranfaru Island infiltration gallery site was assessed in August 2022 and the preferred location was determined and agreed to be the Central Road in the agricultural area of the island as shown below:

Figure 1-1 Location of Infiltration Gallery

Full details of the assessment and agreed location are contained in the "Preliminary Investigation and Concept Design Report".

This Design Report provides the following key items:

- Design Standards,
- Hydraulic Calculations,
- Construction Specifications; and
- Engineering Drawings.

2 DESIGN STANDARDS

2.1 Applicable Standards

Design work will be generally in accordance with Australian and New Zealand standards and supplemented by any local requirements, standards and conditions.

2.2 Reference Documents

The following key reference sources are relevant:

- Structural design is generally in accordance with New Zealand Standards
- Specific New Zealand Standards which are used as a means of compliance with the NZBC are:
- AS 1170 (parts 0-5) Loading Standard
- AS 1170.2:2002 Wind Loadings
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:2009 Steel Structures Standard
- NZS 3603:1993 Timber Structures Standard

2.3 Pipeline Design Codes

The water supply system will generally be design in accordance with the Water Services Association of Australia Design Code and supplemented by other specific design components specifically developed by the Consultant.

3 DESIGN COMPONENTS

3.1 Design Flow, Gallery Length and Gallery Pipe Invert Level

The following items were confirmed in the "Preliminary Investigation and Concept Design Report":

- Design Flow – 55 m3/day
- Infiltration Gallery Length – 250m

The Reduced Level (RL) of the bottom of the infiltration gallery slotted pipeline has been confirmed at RL -0.3m (approximately 1.2m below ground level).

The Consultant undertook a land survey of the gallery area and the levels have been included in the engineering design drawings.

3.2 Pipeline Materials

The Consultant has adopted Polyvinyl Chloride (PVC) as the preferred pipe material. The reasons for the adoption of this pipe material is as follows:

- Non corrosive leading to long asset life;
- Robust pipe material for proposed application;
- Has been successfully adopted in other similar projects; and
- Readily available in the Maldives.

3.3 Pipeline Size, Length, Slots, Velocity and Hydraulic Calculations

The Consultant has proposed a DN100 gallery pipe size based on the design flow. This pipe will be slotted according to the pattern shown in Detail 5 of Figure 210003/20/02. A short length of non-slotted DN150 pipework will connects the DN100 infiltration gallery pipework to the pump well as shown in Detail 7 of Figure 210003/20/02.

It is noted that the gallery is proposed to be operated continuously (24 hours) to minimize impact on the groundwater lens.

a) DN100 Infiltration Gallery Pipework Length and Velocity

The DN100 gallery pipework extends 125m in each direction from the pump well. Accordingly half of the design flow (22.5 m3/day) flows in each direction through the gallery pipework towards the pump well.

b) DN150 Pump Well Pipeline

A short (approximately 6m) length of DN150 pipework will convey the full design flow (55 m3/day) from the gallery pipework to the pump well.

The pipeline velocities are shown in the table below:

Table 3-1 Summary of Pipeline Velocities and Headloss

Diameter (mm)	Flow (m^3/day)	Velocity (m/s)	Length of pipework (m)	Headloss (m)
100	27.5	0.041	125 (each side of pump well)	0.004
150	55	0.036	allow 6m	0.002

At these very low velocities, the headloss through the pipelines is minimal. The use of very low velocities through the pipework has the effect of:

- Reducing the risk of sand being pulled into the gallery pipework when the pump is operated; and
- Reducing impact on the top of the groundwater lens (drawdown). Based on galleries in other atoll islands with similar pumping rates the maximum drawdown due to the pump is likely to be less than 30 mm.

The slotting pattern for the gallery pipes, as shown in Detail 5 of Figure 210003/20/02 is

- 2 slots on each side of the pipe w
- 1.5mm width,
- 50mm length
- 25mm spacing

It is noted that the velocity through these slots in the gallery pipes would be very low and hence the head loss would be minimal.

3.4 Gravel Pack around Gallery Pipes

The particle size of the gravel pack around the gallery pipes should be in the range 6-13mm. This size has been used in successful galleries constructed in other atoll islands (e.g. Tarawa and Kiritimati in Kiribati).

The gravel pack should extend 150 mm below, to the sides and above the gallery pipes as shown in Detail 4 of Figure 210003/20/02.

The gravel should be thoroughly washed with fresh groundwater prior to installation.

3.5 Pump Well and Pump

One pump well will be installed. This will be made of polyethylene as shown in the photo in Figure 210003/20/01.

The pump well will be offset to the east of the gallery pipeline on a vacant block as shown in the images in Figure 210003/10/02. The connection of the pump well to the gallery pipeline will be as described in section 3.3 and shown in Detail 7 of Figure 210003/20/02.

A pump will be purchased locally in the Maldives and will be sufficiently sized to provide the design flow of 55m^3/day. As recommended previously by the consultant, an electrical pump is to be provided at this location. The electrical supply will need to be provided by the Ministry prior to commencement of construction activities. In the event that an electrical supply hasn't been installed at the site prior to works commencing, the Consultant shall purchase a petrol/diesel pump and proceed accordingly.

3.6 Other construction details

- Heavy duty (200 micron) polythene sheet should be laid flat on top of the gravel to prevent sand and fine sediment moving downwards into the gravel. The width of the polythene sheet should be 1,000mm. Refer to Detail 4 in Figure 210003/20/02.
- Above the polythene sheeting, the trench should be backfilled with material excavated from the trench.
- At both ends of the gallery pipes, PVC DN 100 riser pipes (not slotted) should be joined to the PVC DN 100 gallery pipes using PVC DN 100 long radius bends. These riser pipes should terminate just below ground level with a PVC DN 100 end cap. Refer to Detail 1 in Figure 210003/20/01 and Detail 6 in Figure 210003/20/02. The reason for these riser pipes is to allow maintenance of the gallery pipes should this be necessary. Further details are provided in section 3.8.
- Above the polythene sheeting, the trench should be backfilled with material excavated from the trench.

3.7 Development of the gallery

"Development" of a gallery, following construction, is intended to draw any fine sediment around the gallery pipes away by pumping at a higher rate than the normal operational pump rate over a short period of time. The intended result is to position the more permeable and stable sediment around the gallery pipes which cannot enter through the slots but will allow the easy passage of water through the slots.

As has been done with other galleries on atoll islands, it is recommended that a larger pump (e.g. flexdrive dewatering pump with a flow rate of about 3 L/s be inserted in the pump well and pumping be done to a large container (e.g. plastic rubbish bin with a capacity of about 70-80 L)) and then discharged to the ground. Pumping should continue for one or more hours until no fine sediment can be detected in the outflow to the bucket

3.8 Provision for future maintenance of gallery

As mentioned in section 3.6, riser pipes will be installed at each end of the gallery. These can allow entry of flushing water using additional temporary pumps. This can be used to remove any fine sand within the gallery by pumping with another high capacity pump at the pumping well. Based on past experience with

galleries in Kiribati and the Cocos (Keeling) Islands (Australia), the amount of fine sediment removed is very small and it may not be necessary to implement this procedure within the lifetime of the gallery.

The riser pipes also enable a down-hole camera to be used to inspect the gallery condition. Again, this may not be necessary within the lifetime of the gallery.

4 SUMMARY

The report provides the design of the infiltration gallery with the details provided in the engineering drawings and specifications.

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APPENDIX A

Engineering Specifications

TS1: Pipelaying

TS2: Concrete Works

TS-1. CONSTRUCTION OF WATER SUPPLY PIPELINES

1. GENERAL

1.1 This specification is based on the Water Supply Code of Australia (WSA 03 – 2002) and covers the construction of DN 100 to DN 1200 water supply mains, and associated appurtenances where the maximum operating pressure is not more than 1600 kPa. For Test pressure refer to Clause 33 herein.

1.2 This specification covers pipelines which are not to be tapped. All mains located within the road shall generally be DICL unless shown otherwise on the drawings.

1.3 The Contractor is to note that unless specifically amended or supplemented in this specification, or in the event of any ambiguity, uncertainty, deficiency in detail provided or any other reason that may affect the nature of the works to be constructed, the Water Supply Code of Australia (WSA 03 – 2002, Second Edition, Version 2.3) shall then prevail.

2. ACTS, REGULATIONS & LOCAL-LAWS

2.1 The Contractor shall comply with all Acts, Local-Laws and Regulations having jurisdiction over work under the Contract and shall be fully responsible for any breaches thereof.

2.2 Maldives "Guide to health and safety at construction site" published by MACI (Maldives association of construction industry)

2.2.1 The Contractor shall comply with the above-mentioned document in all regards.

2.2.2 The Contractor and his agents and employees shall ensure that all work under this Contract is performed in such a manner that no hazard or risk of injury or damage exists to the Principal's employees or any person affected by the work undertaken including the general public.

The Contractor shall obey any reasonable safety direction given by the Principal or the Engineer. No action by the Principal or the Engineer shall relieve the Contractor of any obligation under this Contract or at law.

Wherever practicable, the Contractor shall safely and securely fence the works area and limit access to that area to authorised persons, including the relevant staff.

Contractor's staff entering any of the Principal's operational areas shall obey all of the Principal's safety rules for that area and any safety direction given by the Principal or its agents.

2.3 Principal expects the Contractor to fully adhere to his responsibilities under the Maldives Regulations

2.3.1 All excavations must be backfilled prior to the Contractor leaving the works unattended. No excavation shall be allowed to remain open overnight unless approved by the Engineer and adequately protected. Approval by the Engineer shall not mitigate the Contractor's liability in any way and is simply intended to ensure that key works may be completed in a timely but safe manner. Refusal by the

Engineer to permit overnight excavations shall also not be a reason to claim for delays as the Contractor is expected to have accommodated this factor in its timing.

Where it is an absolutely necessity for excavations to remain open while the site is unattended and the excavation is in an area which is considered accessible by the public (as determined by the Engineer), a fence must be erected around the excavation to discourage and prevent access.

3. EXISTING SERVICES

3.1 It shall be the Contractors responsibility to contact all public utility authorities to ascertain the location of services prior to commencing the work under the Contract. In carrying out the Works the Contractor shall be responsible for all damage caused to any public utility whatever.

3.2 It should be noted that the Contractor is required to satisfy itself as to the exact location of the existing services and a sum has been allowed for this purpose in the Bill of Quantities. It should be noted that while every effort has been taken to acquire the best available information regarding these services, the exact location is not confirmed and trial holes etc will be required to confirm the locations. Any costs associated with the possible pipeline realignment of alterations related to existing services shall be at the Contractors expense and are considered to have been included in its Lump Sum Price.

3.3 Before undertaking any work which may interfere with any public utility, railway, road, watercourse or tidal waters or with any structure, the Contractor shall give the required notice in writing to the Department or Authority concerned. The Contractor shall not commence the work until it has received the necessary permits and it shall carry out the work in accordance with the conditions set out in these permits.

3.4 If the Contractor damages any existing services it shall arrange for the relevant service authority to make good such damage and the cost thereof shall be borne by the Contractor.

4. MATERIALS

4.1 General

All materials used in the Works shall be handled, transported and stored in accordance with the relevant Australian/New Zealand Standard and the manufacturer's recommendations. Materials in contact with potable water shall comply with AS/NZS 4020.

4.2 Concrete Structures, Reinforcing, Timber, Formwork

The grade of concrete to be used in the Works shall be as shown on the drawings or detailed in the relevant specifications. The manufacture, supply, handling and placing of concrete shall comply with the requirements of AS1379 and AS3600.

Steel reinforcing bars and Welded wire reinforcing fabric shall comply with AS/NZS4671.

Structural steel shall comply with the requirement of AS/NZS3678 and AS/NZS3679.

Galvanising shall comply with the requirements of AS1397, AS/NZS4680 and AS/NZS4792.

All structural timber shall comply with the requirements of AS1720 and timber species shall conform to unseasoned stress Grade F17.

Formwork shall comply with the requirements of AS3610.

5. WATER MAIN PRESSURE PIPES

5.1 General

In the case of the Nolhivaranfaru Island Infiltration Gallery, Contractor to refer to Engineering Drawings for the pipework materials.

Pipes used for water mains shall comply with Table 1 herein:-

Table 1 Water Main Specification

Type of Pipe	**Class of Pipe**
Steel	Rated Pressure – 1.4 MPa
Ductile Iron	PN35
Lead Free uPVC – "PVC –U"	Series 2, RRJ, PN12 and PN 16 as applicable
"PVC – M"	Series 2, RRJ, PN12 and PN16 as applicable
"PVC – O"	Series 2, RRJ, PN12 and PN16 as applicable

5.2 Steel

Steel pipes shall comply with AS1579.

The minimum wall thickness shall be 5 mm.

Pipes shall be either cement lined in accordance with AS1281 or lined with a fusion bonded medium density polyethylene (FBMDPE) coating in accordance with AS4321.

The pipes shall be coated with a fusion bonded medium density polyethylene (FBMDPE) coating in accordance with AS4321.

Pipe joints shall be either welded slip-in, welded butt, welded ball and socket, welded collar, flanged or elastomeric ring as specified. Elastomeric rings shall be as specified in **Clause** 8 herein.

When cathodic protection is required on elastomeric ring jointed pipelines, cable attachment lugs shall be provided on all pipe ends approximately 125 mm from the end of the coating.

5.3 Ductile Iron (DI)

DI pipes shall comply with AS/NZS2280.

DI pipes shall be internally lined with cement mortar as set out in Table 2.1 of AS/NZS2280.

DI pipes shall be acrylic or bitumen coated externally in accordance with Section 2.4of AS/NZS2280 and all DI pipe and fittings shall be sleeved as specified in **Clause** 7 herein.

Rubber rings shall be as specified in **Clause** 8 herein.

5.4 UPVC

uPVC pipes shall comply with AS/NZS1477.uPVC pipe shall be laid in accordance with the drawings, specification, AS/NZS 2566.2.2002 and the manufacturer's installation recommendations.

No PVC pipe socket shall be joined to a Ductile Iron Spigot.

Rubber rings shall be as specified in **Clause** 8 herein.

Pipes used for potable water shall be blue in colour.

5.5 MPVC

PVC - M pipes shall comply with Australia/New Zealand Standard AS/NZS 4765 "Modified PVC (PVC-M) pipes for pressure applications.mPVC pipe shall be laid in accordance with the drawings, specification, and the manufacturer's installation recommendations.

PVC-M pipes and associated materials are manufactured to relevant Australian Standards under third party accredited quality assurance programs complying with AS/NZS ISO 9001

Rubber ring seals

Sealing rings comply with AS1646 'Elastomeric seals for waterworks purposes' and are to be manufactured from SBR or EPDM polymer as applicable.

Certification

PVC-M pipes are Standards Mark licensed to AS/NZS 4765.

No mPVC pipe socket shall be joined to a Ductile Iron Spigot.

5.6 Steel Flanged Pipe

Steel flanged pipework shall be manufactured from AS1579 pipe to which has been fitted plate flanges in accordance with AS4087.

Pipes may be of flange/flange, flange/socket or flange/spigot configuration as specified. All flange faces shall be machined at right angles to and concentric with the axis of the internal diameter of the pipe. For all new work flanges shall be drilled in accordance with AS4087 - Figure B.7 unless connecting on to existing mains where the connecting flange shall match existing. All pipes shall be cement mortar lined and coated as specified in clause 5.2.

Prior to welding the flange to the pipe, the FBMDPE coating shall be cut back to a neat edge 50 mm clear of the weld. After the completion of welding and inspection, the pipe barrel and exposed parts of the flange shall be coated with an epoxy painted coating as specified in **Clause 10.7.2** herein.

The joint between the coatings shall be covered using a U.V. stabilised heat shrink sleeve.

5.7 DI Flanged Pipe

DI flanged pipework shall be manufactured as "Flange Class" (refer AS/NZS 2280:2004 Figure H1) wall thickness ductile iron pipe to which has been fitted screw on flanges in accordance with AS4087 PN16.

Pipes may be of flange/flange, flange/socket or flange/spigot configuration as specified. All flange faces shall be machined at right angles to and concentric with the axis of the internal diameter of the pipe. For all new work flanges shall be drilled in accordance with AS4087 - Figure B.5 unless connecting on to existing mains where the connecting flange shall match existing. All pipes shall be cement mortar lined. Pipes shall be coated with an acrylic or bituminous compound in accordance with AS/NZS2280 Section 2.4 and sleeved as specified in **Clause** 7 herein.

6. WATER MAIN PRESSURE PIPE FITTINGS

6.1 Steel Fittings

Steel fittings shall comply with AS1579 with a rated pressure of 1.4 MPa.

Fittings shall be manufactured from sections of pipe which have been cement lined in accordance with AS1281 and coated with fusion bonded medium density polyethylene in accordance with AS4321.

Fittings shall have square plain ends for collar jointing.

Fittings shall generally comply with the suggested configurations and dimensions shown in Appendix G of AS1579.

Fittings such as wyes, tees, angle branches, etc shall be reinforced in accordance with the provisions of American Water Works Association Manual M11, Section 13.

At all welds, the FBMDPE coating shall be cut back to a neat edge 50mm clear of the weld. After the completion of welding and inspection, the exposed surface shall be coated with a spray application of the FB or FBMDPE coating material. Any gap in the cement mortar lining shall be packed with cement mortar as specified.

6.2 DI Socket Fittings

DI socketed fittings shall comply with AS/NZS2280 and shall be PN35 rated.

DI fittings shall be rubber ring jointed as specified in **Clause** 8 herein and shall be internally lined with cement mortar as set out in Table 2.1 of AS/NZS2280. DI fittings shall be thermal bonded coated epoxy to 300mmdiamter and nylon for larger diameters. Larger fittings of greater than or equal to 375mm diameter shall cement mortar lined internally and acrylic or bitumen coated externally in accordance with AS/NZS2280 Section 2.4.

Sockets shall be of a design which provides an effective sealing length. Care shall be taken when cutting pipes that the pipe ends are cut square and evenly, not excessively bevelled and that the end is fully inserted into the socket by use of the witness mark.

6.3 DI Flanged Fittings

Flanged Pipe Fittings shall be manufactured in accordance with AS/NZS2280 - and flanges shall be in accordance with AS4087 – Figure B.5 unless connecting onto existing mains, where the connecting flange shall match existing. Fittings shall be either bitumen coated and cement mortar lined or thermal bonded coated and lined. Fittings for use underground shall be coated externally with a bituminous compound in accordance with AS/NZS2280 Section 2.4 or internally lined and externally coated with a factory applied thermal bonded polymeric coating as specified in **Clause 10.7.1** herein.

6.4 Puddle Flanges

Puddle flanges shall comply with AS/NZS2280 - Clause 3.3 except that all nuts, bolts and washers used in the assembly of Puddle flanges shall be of grade 316 stainless steel.

Where puddle flanges are to be used simply for seepage control such as valve chambers these may be installed on site. Where puddle flanges are to be used for thrust restraint on DICL pipework, the pipe is to be factory grooved prior to pipe delivery and installation on site.

7. POLYETHYLENE PIPE SLEEVING

7.1 Polyethylene sleeving shall be manufactured to satisfy the requirements of AS3680.

7.2 Polyethylene sleeving shall be installed on DI pipes and fittings to satisfy the requirements of AS3681.

7.3 The colour of Polyethylene sleeving shall be blue in colour for potable water.

8. RUBBER RINGS

8.1 All socketed pipes shall be rubber ring joined.

8.2 Unless otherwise specified rubber rings shall be EPDM rubber and comply with AS1646.

8.3 Rubber rings for water reticulation shall not contain root inhibitor.

9. COUPLINGS

9.1 Gibault Joints

Only elongated gibault joints shall be used in the Works. They shall be approved by the Engineer.

9.2 Flexible Couplings

Flexible couplings shall be suitable for jointing the type of pipe used in the work.

Couplings shall be manufactured from Grade 316 stainless steel, with Grade 316 stainless steel fasteners and EPDM sealing sleeves. Alternatively the body and retaining rings may be made of ferrous metals and coated with special coating as specified in **Clause 10.7.1** herein. Washers shall be provided under all bolt head and nuts where rotation may occur to prevent damage to the coatings.

Couplings shall be suitable for in ground installation on pipelines laid in soils, which may be subject to ground movement. The couplings shall be tolerant of pipe axial deflection at the joint pipe and axial movement and forces applied perpendicular to the pipe axis.

9.3 Dismantling Joints

Dismantling joints shall be Class 16, either thrust type or non-thrust type depending on the pipeline arrangement.

They shall be manufactured from ductile iron with natural rubber seals to AS1646. Bolts shall comply with **Clause 11**herein. The ductile iron or mild steel components shall have a thermal bonded polymeric corrosion protective coating as specified in **Clause 10.7.1** herein.

10. VALVES

10.1 Sluice Valves

Unless otherwise specified all Sluice valves shall be buried in accordance with the drawings. Sluice valves shall comply with the requirements of AS2638: 2002.

<u>DN100, DN150, DN300, DN375, DN450, DN500, DN600 and DN750</u>

Valves shall be Class 16, unless specified otherwise, and resilient seated with double "O" ring stem seals. All nuts and bolts used in the assembly of Sluice valves shall be

of Grade 316 stainless steel. Fasteners other than stainless steel shall be of high grade steel and shall be isolated from the external environment.

Sluice valves shall be thermal bonded polymeric corrosion protective coating as specified in **Clause 10.7.1** herein. Wedges shall be fully encapsulated in an approved synthetic rubber in accordance with AS1646.

Sluice valves shall have anti-clockwise spindles for closing and shall be tested by the "closed end" method. Spindles shall be turned out of high tensile brass or stainless steel. End configurations shall be flanged unless specified otherwise. If Socketed, Sockets shall incorporate an elastomeric sealing ring as specified in **Clause** 8 herein.

By-pass DN600 and DN750 Valves

Valves shall be of the By-Pass type similar to AVK Series 55/30, unless specified otherwise the By-Pass Valve shall be a minimum of DN80. The bypass on 450mm diameter valves shall be 100mm diameter and on 600mm diameter mains shall be 150mm diameter. The valves shall have a 316 Stainless Steel tag attached and be clearly labelled indicating size of valve (lettering not smaller than 5mm in height). The valve spindles and valve cover and surround shall be colour coded, white for the larger primary valve and yellow for the smaller 80mm by-pass valve.

10.2 Extension Spindles

Extension spindles where required shall be turned out of either high tensile brass or stainless steel.

10.3 Scour Valves

Scour valves shall comply with the requirements of AS2638 and **Clause 10.1** herein for DN300 and smaller sluice valves except that they shall be tested to satisfy the requirements of the "open-end" test as specified in AS2638.

10.4 Butterfly Valves

Butterfly valves shall be installed in a pit in accordance with the drawings and be manufactured in accordance with AS4795 Double-flanged butterfly valves for waterworks purposes with replaceable resilient seat, disc of316 stainless steel, a one piece stainless steel shaft, ductile iron body, corrosion resistant bearings and shaft seals.

The valve shall be suitable for a pressure rating of PN16 (1600 kPa).

The valve shall be suitable for installing between AS4087, Fig. B5 flanges.

The valve seat shall be field replaceable, with integral O-rings moulded to it that cover the flange face, eliminating the need for gaskets.

It is to be retained by a bed groove design that fully encapsulates the wetted area of the valve body.

The valve shaft shall use the dry shaft principle, with self lubricating bearings and a rigid shaft/disc connection.

The valve shall be fitted with upper and lower bearings.

The valve shall not require routine gland adjustment or lubrication.

The butterfly valve bodies shall be thermal bonded polymeric coated as specified in **Clause 10.7.1** herein.

Where specified the butterfly valves shall be manually operated through a totally enclosed lubricated for life gearbox. The gearbox shall be of weatherproof ductile iron construction with carbon steel spur and worm gear, ductile iron segment gear, bronze bushes and ball thrust bearings. The gearbox shall have open-shut position indication. All bolts, nuts and screws including those to cover plates and end cap fixings shall be 316 Stainless Steel.

The butterfly valves shall be works tested.

The test shall include:-

a) A test to demonstrate that the valves will operate correctly from fully closed to fully open and return to fully closed.

b) A disc test with pressure applied on upstream side. No leakage. Check operation of actuator under this condition.

c) A body test with disc partly open. No leakage.

The Contractor shall check that there is adequate clearance between the valve disc and the adjacent pipes when the valve is opened and closed.

The sealing surfaces of the valves shall bed on the metal face of the pipework flanges, not on the cement lining. If the valve sealing surface does not bed on the metal face, the Contractor shall provide minimum 6mm thick Grade 316 stainless steel insertion rings and additional rubber insertion joint rings.

10.5 Air Valves

Air valves shall be used on potable water mains.

Small orifice air valves (25mm diameter) shall consist of either a combined lever and float or a float and EPDM rolling seal arrangement which seals off a small orifice vent. The valve shall be manufactured of high strength plastic or coated ductile iron. Each valve shall be supplied with a 25 mm 3-way tee port ball valve to allow for air valve isolation and water sampling. The air valve and ball valve shall be mounted on an 80 mm diameter flange.

Double air valves (100, 80 and 50mm)diameter shall consist of both small orifice and large orifice valves. The small orifice part of the valve shall be as specified above. The large orifice part of the valve shall consist of a body casing housing a float which rises onto the seat when water rises in the valve. The float shall remain stable under all air outflow and inflow conditions without any possibility of premature closing of the valve during air outflow. The float and seat ring shall be plastic.

The valve shall incorporate a gate valve to specification (with handwheel) as shown on the drawings. The valve shall be bolted to the flanged pipe branch (100 dia. for 100 valve and 80 dia. for the 80 dia. and 50 dia. valves) in a manner that will allow removal of the air valves without removing the valve. All 50 mm diameter air valves shall connect to the 80 mm diameter flanged pipe branches and the Contractor shall supply any necessary fittings to join between the valve and the pipe branch.

The surface of the cast iron body and cover of the air valves and the body of the butterfly valves shall be coated with a special coating as specified in **Clause 10.7.1** herein.

10.5.1 Gas Release Valve

Not applicable.

10.6 Check Valves

10.6.1 Flanged Check Valves (DN150, DN300, DN375, DN450, DN500 & DN600)

Flanged check valves shall comply with the requirements of AS3578 and shall incorporate a leverarm with counterweight and extended spindle or approved product similar to Valve-Matic swing flex type incorporating disc position indicator, with flanges in accordance with AS4087 Figure B.5. Check valves shall be coated internally and externally with an approved coating in accordance with **Clause 10.7.1** herein.

Valves shall be suitable to operate within the pressure ranges of the system within which they are being installed and shall be located within a suitably sized concrete pit of the style shown on the drawings.

10.6.2 Wafer Check Valves (DN150, DN300, DN400, DN500, DN600, DN750 & DN900)

Wafer check valves shall incorporate a wafer type ductile iron body suitable for installation between AS4087 (Fig. B5 or B7 appropriate) flanges, grade 316 stainless steel disc and EPDM seal. The body shall be epoxy painted in accordance with **Clause 10.7.2** herein.

10.6.3 The type and pressure rating of the Check valve shall be as shown on the drawings.

10.7 Protective Coatings

10.7.1 Thermal Bonded Polymeric Coatings

Where specified that Valves and other fittings are to be treated internally and externally with a factory applied thermal bonded polymeric corrosion protective coating this shall comply with the requirements of AS/NZS4158 and be applied by the fluidized bed technique.

10.7.2 Epoxy Painted Coatings

Where specified that ferrous fittings are to be painted with an epoxy painted coating, the surface shall be abrasive blast cleaned to AS1627.4 Class 2½ and painted with a 2 coat system of two pack high build, solvent free cycloaliphatic amine cured epoxy coating to a dry film thickness of 500 microns. All applications shall be strictly in accordance with the manufacturer's specification.

11. JOINTING BOLTS & FLANGE GASKETS

11.1 All nuts, bolts and washers (including Torque Table assembly nuts and bolts) shall be stainless steel to AS2837 and AS1449 respectively, Grade 316, with an anti-seizing paste used in assembly.

11.2 All stainless steel nuts and bolts other than bolts which form an integral part of an article shall comply with the metric standards AS/NZS1111 and AS/NZS1112.

11.3 Bolt length shall be equal to the sum of the thickness of the flanges, gaskets, nut and washer and rounded up to the nearest standard size.

11.4 Bolts shall exhibit a clean cut thread with no burrs or torn peaks on the thread. Nuts must turn freely on the threads without binding.

11.5 Torque used to tighten bolts with clean flat lubricated surfaces shall comply with **Table 2**.

Table 2 Torque Requirements

Bolt Diameter (mm)	Tightening Torque (Nm)
20	250
24	400
27	600
30	800
33	1100

11.6 Flange gaskets shall comply with Appendix D3 of AS4087.

12. VALVE BOXES & VALVE PITS

12.1 Valve Boxes

Cast iron valve boxes and lids shall be in accordance with the drawings.

12.2 Air Valve Pits

Reinforced concrete valve pits shall be constructed in accordance with the drawings.

13. GEOTEXTILE

13.1 Geotextile shall be used where shown on the drawings or as directed by the Engineer.

13.2 The geotextile shall have the following minimum properties:-

Nominal weight (as per AS3706)	180 g/m^2
Load (as per A.S.T.M. 1682)	750 N
Mean Trapezoidal Tear Strength (as per A.S.T.M.D. 1117)	350 N
Mean C.B.R. Puncture Resistance	2500 N
Percolation Rate (as per AS3706)	340 L/m^2/sec

13.3 The geotexile shall be a non-woven fabric made from continuous filament, synthetic fibres.

13.4 Minimum lap shall be 300mm.

13.5 Installation shall be to the manufacturer's recommendations.

14. SETTING OUT WORK

The Contractor shall be responsible for setting out the centre line of the main in accordance with the survey data supplied on the drawings prior to the commencement of work.

15. CARE OF REAL PROPERTY SURVEY PEGS

15.1 The Contractor shall take care not to distribute any real property survey pegs.

15.2 Any existing real property survey pegs beyond the limits of earthworks or excavations under this contract, which are disturbed by the Contractor, will be replaced by the Principal's Surveyors at the Contractor's expense.

16. CARE OF EXISTING FENCES

16.1 Fences, other than those specifically noted for removal, shall be maintained at all times with special care taken to prevent straying of stock if grazing is carried out on adjoining lands.

16.2 If fences are required to be cut or moved, the Contractor shall erect temporary fences, if necessary, for stock containment as directed by the Engineer.

Where fences are to be cut for access, wire shall be drawn tight to end posts, suitably strutted, and suitable gates provided, if directed, for closure after working hours or when no work is in hand on the site.

Any fence cut or removed during this execution of work shall be replaced and reinstated to its original alignment and form unless otherwise directed by the

Engineer. It is the Contractor's responsibility to ensure that the fence is located correctly.

17. WORK WITHIN PRIVATE PROPERTY

17.1 Activities outside the limits of the construction area shall not be permitted without the express permission of the Engineer.

17.2 It is the Contractor's responsibility to inform private property owners of any construction activities that may affect them or their property. Notification is to occur prior to commencing these activities.

18. TRAFFIC MANAGEMENT - WORK WITHIN ROAD RESERVES

All work within road reserves shall comply with the following:-

a) Work shall proceed without interruption to traffic and any steps necessary for the protection of the public during construction shall be taken.

b) Open trenches shall be constructed to the details shown on the drawings. Trenches shall not be left open overnight without the approval of the Engineer.

c) Work shall be carried so as not to detrimentally affect the existing drainage provisions of the roadway.

19. `CLEARING & GRUBBING

19.1 The Contractor shall take all necessary steps to preserve vegetation along the route of the main. These steps shall include:-

- Limiting the construction disturbance area to a minimum. As a general rule, the disturbance area shall be no greater than 10 m width. Job specific limitations may be imposed within the project specification as an environmental consideration.
- Engineer approval is required prior to clearing any tree with a diameter greater than 300 mm.
- All vegetation cleared in the course of constructing the works shall be mulched and spread over the disturbed area as part of the restoration works or disposed of off-site as directed by the Engineer at the Contractor’s expense. Any material that cannot be mulched due to its excessive size shall be removed to an approved dump site at the contractor’s expense. Burning off of timber shall be permitted.

20. COVER TO WATER MAINS

20.1 The minimum cover from finished ground level to the obvert of the main shall be 750mm and the maximum cover from finished ground level to the obvert of the main shall be 1500mm unless otherwise specified on the drawings.

20.2 In the event that the cover specified in **Clause 20.1** herein cannot be achieved in a particular location for any reason the Contractor shall seek written instructions from the Engineer prior to proceeding with construction of the water main at that location.

21. EROSION & SEDIMENT CONTROL

21.1 The following erosion and sediment control measures shall be taken to ensure that sediment is contained within the perimeter of the disturbed area.

- The area of disturbance shall be kept to an absolute minimum.
- Topsoil shall be retained for rehabilitation purposes, (NB Stockpiles should not exceed 2 metres height, as this decreases the seed viability).
- Runoff both external to the site and within the disturbed area shall be controlled. Clean water shall be redirected away from the disturbed area and into an overland flow path.
- The site shall be rehabilitated quickly, i.e. stabilise/vegetate within fourteen (14) days of completion of works. Rehabilitation shall proceed as each stage is completed. The disturbed area shall be seeded and landscaped.
- Stockpiled material spoiled from trenching operations shall be placed on the upslope side, away from any drainage lines.

22. EXCAVATION

22.1 Excavation for water mains shall be completed to the lines, levels and profiles shown on the drawings. When (in the Engineer's opinion) weather, soil conditions, or any contingency exists that may be detrimental to pipe laying the Engineer may limit the length of trench opening in advance of pipe laying. In any event, unless approved otherwise by the Engineer, the length of trench opening ahead of pipe laying shall not exceed 40 m.

22.2 The Contractor shall be deemed to have satisfied itself as to the nature and difficulties resulting from all obstructions on or in the vicinity of the pipeline and shall include these costs in its bid submission.

22.3 The Contractor shall not commence any excavation until all equipment and materials necessary to make the excavation safe are on site and available for use. This includes any necessary fencing and barriers, as well as trench support systems.

22.4 The excavation shall be performed by open trench with adequate side batters/shoring. Where necessary the ground shall be adequately braced and sheeted to ensure stability of vertical faces in compliance with the relevant statutory requirements

22.5 The method of excavation shall not weaken surrounding areas or damage structures or parts thereof that are completed or under construction. Existing structures and utilities adjacent to excavations shall be protected and supported to prevent settlement.

Work shall be conducted to avoid disturbance to existing utilities. Handwork shall be used in the vicinity of all known services. Particular care shall be exercised to avoid the cutting or breakage of water lines. Such lines, if broken, shall be restored promptly.

When active pipe lines are cut in the trenching operations, temporary pipe supports and/or conduits shall be provided across the trench, while open, and the line shall be restored when the back filling has progressed to the original bedding lines of the pipelines so cut. Any damage by the Contractor to the existing buildings and services during the duration of the Contract will be made good at cost to the Contractor.

Notwithstanding the above, breakage in main lines shall require immediate notification to the Engineer. Connections to existing lines shall only be by prior arrangement with the Engineer and Local Authority.

22.6 All trenches of depth 1.5 m or greater or in unstable ground strata shall be supported.

Support all excavations as the work proceeds to meet OH&S requirements. Ensure that adjacent structures and services are not subject to disturbance by the trench support system.

When removing, raising or withdrawing supports, prevent slips or falls and ensure that no damage, disturbance or displacement occurs to the pipes, fittings, geotextile filter fabric, pipe embedment and trench fill already installed. Fill the trench simultaneously with the raising or withdrawal of trench supports. Ensure that compaction of pipe embedment and trench fill material occurs below such trench support and against native ground.

Where specified, leave the trench support system in place as permanent support. Cut off the support system at a depth below ground surface that will satisfy the structural and development requirements of the site.

22.7 Where the Contractor over-excavates, it shall make good the over-excavation at its expense. The over excavation shall be made good with bedding material which satisfies the requirements of **Clause 23** herein and which is the material shown on the drawings.

22.8 The Contractor shall at its own expense do all things necessary to divert any water interfering with the progress of the Works, keep the excavations and trenches free from water while the Works are in progress and prevent any damage to the Works by water due to rain or other causes. The Contractor shall have approved pumping gear for keeping the excavation or trenches constantly dewatered during the times the Works are in progress. Any work or material damaged by water shall be made good by the Contractor.

22.9 The bottom of trenches or excavations shall have adequate compaction prior to the placing of any bedding or concrete materials. Should (in the opinion of the Engineer) the foundation material be incapable of effective compaction, the material shall be removed and replaced with bedding material as specified in **Clause 23** herein.

22.10 If approved by the Engineer excavated material may be used for backfill over pipes. This material shall remain the property of the Principal and any excess shall be spoiled or used as filling within the Site as directed by the Engineer.

All excavated material which is classified by the Engineer as unsuitable shall be removed from the Site.

Any excess spoil and all unsuitable material shall be disposed of at a location where directed by the Engineer within a 10 km radius of the site at the Contractor's expense.

22.11 The Contractor shall be solely responsible for the maintenance of excavations and is liable for any damage which may be caused through the collapse of the excavation.

22.12 Unless a separate item is included in any applicable Bill of Quantities for rock excavation, the items entered in the Priced Bill of Quantities and the Lump Sum of the Contract generally shall be deemed to include full compensation for excavation of material of all types and subsequent backfill and compaction of the trench or excavation with approved material.

22.13 Excavation volumes shall be calculated using the relevant trench shown on the drawings.

23. PIPE EMBEDMENT & MATERIALS

23.1 General

The Contractor is to provide embedment and support of the type shown in the Design Drawings and Specification.

Embedment material shall be placed uniformly along and around the whole length of the pipe barrel, couplings and other appurtenances in a manner to ensure uniform density of side support (including haunch support) and overlay with no distortion, dislodgment or damage to the water main.

The Contractor is to ensure that the depth of bedding material below the pipe collar is not less than 50% of the minimum bedding specified for the pipe.

Where the water main is supported on concrete, do not place overlay material until the concrete has obtained its initial set.

23.2 Embedment Materials

Pipe embedment material shall be crushed rock material complying with AS2758.1 and AS1141 and of the nominal sizes as shown in **Table 3** below. Alternatively, where specified on the drawings, the embedment material shall be sand with a grading such that no more than 5% passes the No. 100 sieve. Where additional bedding is required, such as in the case of saturated trench conditions, the material shall be in accordance with the Right Hand Column of **Table 3**.

Table 3 Percentage Passing By Weight

AS Sieve (mm)	Percentage Passing By Weight		
	Crushed Rock Nom Size 5 - 7mm	Crushed Rock Nom Size 10mm	Crushed Rock Nom Size 30mm (Additional Bedding)
37.5			100
26.5			80 - 100
19.0			25 - 60
13.2		100	5 - 20
9.5	100	89 - 100	0 - 5
6.7	85 - 100	30 - 89	
4.75	30 - 85	5 - 30	
2.36	0 - 30	0 - 5	
1.18	0 - 5		

The Contractor shall use embedment materials that comply with the maximum particle sizes in the Table above or as specified on the drawings.

The Contractor shall treat single size coarse aggregates of sizes 7, 10 and 14 mm as "self-compacting" and do not compact (Clause 16.3.1), pre-qualify (Clause 16.3.2) and control (Clause 16.3.3) when using for pipe embedment. NB *Clause references from WSA 03 – 2002, Version 2.3, Part 3: Construction*.

24. TRENCH CONSTRUCTION

24.1 General

Construction types are detailed on the drawings. Embedment material shall comply with the requirements of the drawings failing which **Clause 23** herein shall apply. Excavated material shall not be used as bedding material without the approval of the Engineer.

Compaction of the various layers shall be as specified on the drawings or if not shown on drawings shall comply with WSA 03 – 2002, Version 2.3, Part 3: Construction, Table 19.1 as shown below.

TABLE 19.1

MINIMUM COMPACTION OF EMBEDMENT AND TRENCH / EMBANKMENT / OTHER FILLS

Material type	Test method	Minimum value (%)			
		Trafficable areas		Non-trafficable areas	
		Embedment	Trench/ embankment fill	Embedment	Trench/ embankment fill
Non-cohesive i.e. granular	Density index (I_D) AS 1289.5.6.1	70 (Note 1)	70 (Notes 2, 3)	60 (Note 3)	60 (Notes 4, 5)
Cohesive	Dry density ratio (R_D) AS 1289.5.4.1 and AS 1289.5.1.1 (Note 6)	95	95	90	90 (Notes 5, 6)

NOTES:

1 Single size coarse aggregates of sizes 7, 10 and 14 mm shall be deemed "self-compacting" and do not require compaction testing when used for pipe embedment (Refer to Clause 16.3.2).

2 *The road Owner may specify alternative values.*

3 *Degree of compaction of the trench fill in trafficable areas depends on:*

(a) the backfill zone – higher degrees of compaction is required in the zones closer to the surface; and

(b) the road type – freeways and arterial roads carrying greater loads require higher degrees of compaction.

4 *The value given is a default where excessive initial surface settlement is not permitted. Specification of an alternative degree of compaction of the trench fill in non-trafficable areas depends on the site requirements.*

5 Compaction shall be to the degree specified in the project Specification or the default value in Table 19.1 if not specified.

6 *Graded gravels and sands having fines (silts and clays) greater than 5% have their compaction determined by dry density ratio.*

24.2 Type 1 Construction – general open construction

The Embedment Zone shall consist of crushed rock material (nominal size 5-7mm) or sand as specified on the drawings and in **Clause 23** herein and shall be constructed to the details shown on the drawings.

Embedment zone material shall be carefully placed in the trench and compacted for the full width of the trench to achieve the required density as per specification.

24.3 Type 2 Construction – in roadways and footpaths

Type 2 Construction shall be used where, in the opinion of the Engineer, the trench bottom is too soft or too wet to provide sufficient support for the pipe. In these circumstances additional bedding (nominal size 30mm) complying with the requirements of **Clause 23** herein shall be placed and compacted immediately below the Embedment Zone material for the full width of the trench.

The depth of additional bedding shall be as directed by the Engineer but not less than 300mm. In all other respects Type 2 Construction shall be as for Type 1 Construction.

24.4 Type 3 Construction – where geotextile is specified

Type 3 Construction shall be used in locations where the additional bedding is to be wrapped with geotextile as shown on the drawings. The geotextile wrapping shall comply with the requirements of **Clause 13** herein.

In all other respects Type 3 Construction shall be as for Type 2 Construction.

24.5 Compaction of Embedment

24.5.1 Methods

Following placement, compact embedment material to achieve the density specified and to uniformly support the pipe. Compact in layers to achieve the required density uniformly throughout the depth of each layer and the degree of compaction specified in WSA 03 – 2002, Version 2.3, Part 3: Construction, Table 19.1.

When choosing compaction equipment, the number of passes and the thickness of layer to be compacted, take account of the material to be compacted and the pipe to be installed.

Do not employ compaction equipment or methods that produce horizontal or vertical earth pressures that may cause damage to or excessive distortion of the water main.

Do not use flooding compaction unless specifically authorised by the Engineer. **In the case of Nolhivaranfaru Infiltration Gallery, due to the non-cohesive nature of the terrain, flooding compaction is permitted.**

24.5.2 Compaction trials / Pre-qualification of embedment compaction method

24.5.2.1 General

With reference to Clause 19.3.3.1 of WSA03-2002, pre-qualification of the pipe embedment material and process, as detailed below, is an alternative to conducting embedment compaction testing of pipes of size ≤DN 450.

24.5.2.2 Test Method

Install a length of pipe, at least 4 m long, in a trench of minimum side clearance of 200 mm and in soil having a bearing pressure >50kPa. Bed the pipe and place and compact embedment in accordance with Clauses 16.1 to 16.3.1 of WSA03-2002 inclusive.

Record the Purchase Specification, or equivalent product specification, to which the embedment material conforms. Record the compaction method in a format suitable for use as an on-site work instruction.

Conduct compaction test at the spring line along the pipe length at its mid-point and at locations 1 m either side. Assess results of compaction tests for compliance with Table 19.1(WSA03-2002). Record compaction test results.

Retain records of the compaction method and trial reports.

24.5.2.3 Interpretation and applicability

Provided that all compaction test results conform to the requirements of Table 19.1(WSA03-2002), the test shall be deemed to pre-qualify the compaction method for pipelaying subject to:

a) The diameter of the pipe is the same as that used in the pre-qualification test.

b) The actual embedment material used in construction is as used in the pre-qualification test.

c) The documented pre-qualified compaction method is used.

d) The native soil has a bearing capacity >50 kPa. .

24.5.3 Compaction control

Compaction of the embedment zone shall comply with the drawings or if not specified on drawings then Table 19.1(WSA03-2002).

The extent of embedment compaction testing shall be as specified in Clause 19.3.3.2(WSA03-2002).

24.6 Special Bedding &Embedments / Geotextile Surround & Pillow

Install special embedment at locations as specified.

Reference Standard Drawings: WAT-1203 and WAT–1204.

24.7 Removal of Trench Supports

Except where the Design Drawings specify otherwise, lift temporary trench support systems progressively above each layer of embedment to ensure that each layer is compacted against undisturbed native soil (trench wall).

24.8 Concrete Embedment & Encasement

Concrete embed or encase pipes as specified and in accordance with WSA03-2002, Clause 12.5.

Set pipes to line and level on either bags of natural fibre filled with sand and cement mix or on concrete blocks or saddles cast to the outside diameter of the barrel and located near the socket. Ensure that pipes do not move, float or deform while pouring concrete.

Provide rubber-ring jointed pipe "shorts" 600–1000 mm long immediately upstream and downstream of the concrete embedment or encasement to allow for differential movement.

Reference Standard Drawings: WAT–1203, WAT–1204, WAT–1211, WAT-1212 and WAT–1213

24.9 Trench Fill

24.9.1 For the purposes of this specification, backfilling material shall consist of all material used in the trench above the Embedment Zone material as specified in **Clause 24.2** herein.

In addition to the requirements specified herein no backfill material shall contain rocks larger than 150mm diameter or lumps of material that may prevent the compaction specified herein.

24.9.2 In locations other than under roadways and footpaths (eg allotments, parks, rural lands, etc) the backfill material shall consist of either:-

a) the best of the material (selected and approved by the Engineer) from trench excavation, or

b) material from "on Site" earthworks selected and approved by the Engineer, or

c) imported material.

If, in the Engineer's opinion, material from item (a) above is not suitable for backfilling then material from item (b) above shall be used by the Contractor. Where, in the opinion of the Engineer, material from item (a) above and/or the "on Site" earthworks material is not suitable for use as backfill, the backfill material to be used shall be imported material which shall have a soaked CBR not less than 15%.

The backfill material shall be compacted to the standard specified in **Table 4** herein. Any settlement shall be made good by the Contractor, prior to the end of the Defects Liability Period.

Table 4 Trench Backfill

Area of Work	Required Result	Minimum Test Frequency	Test Method
Trench Backfill (Cohesive Material)			
Backfill to trenches under roadways	≥100% Density Ratio	1 test per 50m of pipeline	AS1289.5.5.1 (STD. Comp. Effort)

			AS1289.5.3.1 AS1289.5.4.1
Backfill to trenches elsewhere	≥95% Density Ratio	1 test per 100m of pipeline	AS1289.5.5.1 (STD. Comp. Effort) AS1289.5.3.1 AS1289.5.4.1
Trench Backfill (non-cohesive material)			
Backfill to trenches elsewhere	≥65% Density Ratio ***	1 test per 50m of pipeline And/or 3 cone penetrometer tests per lot	AS1289.5.3.1 AS1289.E5.1 AS1289.E6.1 AS1289.F3.2

* Unless directed otherwise by the Engineer.
** Non-cohesive material shall be defined as material which contains up to 5% by mass of plastic particles passing a 75 micron sieve, or up to 12% by mass of non-plastic fines passing a 75 micron sieve.
*** The acceptable result for penetration resistance to be established by the Engineer.

24.9.3 Under roadways, the backfill material shall be as shown on the drawings. The materials shall be compacted in layers 200mm maximum depth to the standard specified in **Table 4** herein.

24.10 Flowable Fill

24.10.1 Where approved by the Engineer, Flowable Fill may be used as an alternative backfill under roadways.

24.10.2 Flowable Fill shall comply with the following requirements:-

- Cement shall be Portland cement, Type GP or Type GB and shall conform to AS3972.
- If used, fly ash shall conform to AS3582.1.
- Fine aggregates shall conform to AS2758.1.
- If used, chemical admixtures shall conform to AS1478. Any chemical admixture must be approved by the Engineer.
- Minimum compressive strength @ 28 days – 0.5 MPa
- Maximum compressive strength @ 28 days – 1.5 MPa
- Maximum size aggregate- 4.75 mm
- Minimum cement/cementitious content – 5% by weight.
- The consistency of flowable fill shall suit the job application.
- Flowable fill shall have the ability of being placed by concrete pump when required.

- The mix design of flowable fill shall be such as not to cause segregation while being placed.
- Flowable fill will be required to produce the necessary flowability and self-compaction without the use of immersion vibrators.

24.11 Metallic Detection Tape

A 50 mm wide metallic detection tape (blue colour with wording "Buried Water Line Below") shall be buried in the backfill between 300 and 350 mm below the surface for all non metallic pipelines.

24.12 Notes on Backfill Placement

Place trench fill as specified. Use appropriate methods of compaction to achieve the compaction requirements of the Design Drawings and Specification.

Avoid impact loading of the water main during placement of trench fill material.

Do not place trench fill material within 24 hours of placing concrete embedment or encasement, or longer period if shown in the Design Drawings or Specification.

Fill voids behind timber ground support in close-timbered tunnels, drives and shafts by pressure grouting or other authorised means.

Take special care to prevent displacement of any valve or hydrant access cover assembly or supports.

Correct any deficiencies of trench filling exposed by settlement.

24.13 Material requirements

The trench fill material shall comply with the Specification and relevant Design Drawings.

Where the filled trench will be subjected to traffic loading, the fill material shall comply with the requirements as shown on the drawings. In the absence of a directive, use one of the following:

a) Compaction sand; or

b) Fine crushed rock; or

c) 75 mm crushed rock.

24.14 Compaction of Trench Fill

The degree of trench fill compaction shall conform to the relevant design drawings. In the absence of a directive compaction shall conform to Table 19.1(WSA03-2002) or **Table 4**.

The extent of trench fill compaction testing shall be as specified in Clause 19.3.4 of WSA 03-2002, Version2.3.

Compact trench fill material in layers to achieve the required density uniformly throughout the depth of each layer. Where settlement of the finished surface is to be controlled, use a fill material that can be compacted to the required high degree of compaction.

Do not commence mechanical compaction of fill material directly above the pipe until the total depth of cover above the pipe is adequate to prevent damage to the main.

The depth of fill material required before mechanical compaction can be used depends on the type of compaction device.

For hand-held or walk-behind equipment, provide at least 200 mm cover and for larger "ride-on" machines operating within the trench, increase this depth at least 300 mm.

24.15 Embankment Fill

Where the route of a main requires filling or construction of an embankment, provide fill along the route of the type shown in the Design Drawings.

Proceed as follows:

a) Prepare the foundation for the fill by cleaning away all debris, vegetation, organic material and topsoil for the full width of the fill area.

b) Compact the cleared soil surface to not less than 95% of its standard maximum dry density (AS 1289.5.1.1).

c) Place the fill in layers not exceeding 200 mm thickness and compact each layer to not less than 95% of its standard maximum dry density (AS1289.5.1.1). Bring the compacted fill level up to a height of at least 300 mm above the design level of the top of the pipe.

d) Place the remainder of the fill in layers not exceeding 300 mm thickness and compact each layer to not less than 95% of its standard maximum dry density (AS1289.5.1.1).

25. LAYING & JOINTING OF PIPES INCLUDING ASSOCIATED FITTINGS

25.1 Where materials are to be supplied by the Principal, the Contractor shall transfer pipes and materials from a single stockpile adjacent to the route of the main to the place of work. In the case of smaller fittings, the Contractor shall allow for the materials to be collected from the nearest depot.

All pipes must be laid in accordance with the manufacturer's specification.

All water main pipe laying shall be carried out by competent pipe-layers under the supervision of the Contractor's accredited personnel. All personnel are to be approved by the Engineer before pipe laying commences.

If, in the opinion of the Engineer, pipelayers are performing unsatisfactorily the Engineer may reject the work under the Contract and furthermore may instruct that the pipe-layers be removed from Site. All cost of rectification associated therewith shall be borne by the Contractor. Any other costs associated therewith by the Principal may be treated as a debt due from the Contractor to the Principal under the Contract and deducted by the Engineer from any Progress Certificate issued by the Engineer.

25.2 All pipelines shall be constructed of pipes of types and sizes specified in the drawings and laid in accordance with the prescribed construction tolerances and **Clause 39**herein.

25.3 Pipes shall be sorted and matched prior to laying and shall be laid so that the inverts are continuous and true to line and grade and no part of the pipeline shall be more than 6mm from its true position with respect to line. Spigots and sockets shall be cleaned and the interior of pipes shall be free from obstructions or any contaminate.

Water shall not be allowed to lie in the trenches while the pipes are being laid and the trench shall be kept free from all water until after the completed pipeline has been inspected and backfilling commenced.

25.4 Except as provided elsewhere in this specification, all joints shall be approved flexible joints, incorporating synthetic or natural rubber rings as specified in **Clause 8** herein. In jointing pipes with rubber ring joints, the pipes shall be cleaned before jointing and care shall be taken to ensure that the rubber ring is maintained in a plane at right angles to the axis of the pipe. Each pipe shall be jointed as recommended by the manufacturer and each joint checked with a feeler gauge to ensure that the ring is in place.

25.5 Where shown on the drawings, bends shall be used to effect horizontal or vertical changes of direction. Where bends are not shown on the drawings (and with the permission of the Engineer) changes of direction may be effected by angling the joints, by means of short lengths of pipes, or by means of cutting pipes and using thimbles or collars to join them. All such changes of direction shall be effected in curves of uniform radius.

No joint shall be angled to such an extent as to impair its effectiveness or tightness. Pipes shall be jointed in a straight line and the deflection effected after the joint has been made. The maximum deflection for any type of pipe approved for use shall not under any circumstance exceed the recommendation of the manufacturer.

25.6 All iron pipes and fittings regardless of the type of pipe system shall be sleeved in polyethylene in compliance with both the pipe manufacturer's recommendations and **Clause 7** herein. The sleeving shall be continuous over the iron based sections including gibault joints, bends, tees and other fittings except for those fittings coated as specified in **Clause 10.7.1** herein.

25.7 Fittings

The laying and jointing of water mains shall include the fixing in position of all valves, air valves, risers, scour valves, concrete anchor blocks, thrust blocks, concrete valve pits, swabbing pits and all other fittings including the supply and installation of concrete or brick supports, bedding and cast iron cover boxes and surrounds as specified or shown on the drawings.

The distance marked on the drawings and the position indicated thereon of pipes, valves and other fittings may be adjusted at the discretion of the Engineer. If necessary, pipes shall be cut in order to secure the fixing of valves and other fittings in the positions required and all costs associated therewith shall be deemed to be included in the relevant Bill Item and the Lump sum of the Contract generally.

All fittings shall be placed in position so as to be plumb and correct distance from the surface. Risers shall be installed where necessary at air valves and, if required, trenches shall be deepened and graded in the vicinity in order to achieve the correct depth below the surface.

Except where the drawings show that concrete pits are required, cast iron cover boxes shall be fixed over all valves, air valves and scour valves. Cover boxes shall be in accordance with the drawings. Precast Concrete Surrounds shall be fixed around all cover boxes to the detail shown on the drawings. The bedding cover shall be increased locally to provide support to the brickwork, concrete surround or other supporting material on which the box is founded so as to minimise the transference of weight or shock to the pipe to the details shown on the drawings.

25.8 Wrapping of Flanges and Couplings

25.8.1 All materials and procedures shall be by a recognised manufacturer of corrosion protection systems and shall be acceptable to the pipe manufacturer.

The Contractor shall use only fully trained and experienced personnel for the wrapping of flanges and flexible couplings.

25.8.2 Flanges Wire brush loose dirt and loose rust from the flange and adjacent pipe and 100 mm onto the coating.

Apply primer to all metal surfaces.

Mould butyl mastic between individual bolts and nuts and over the heads of bolts, nuts and screw threads, with a minimum coverage of 5 mm. Taper onto flange face to provide a suitable contour for tape wrapping.

Apply section of flexible tape longitudinally over the flange, extending a minimum of 50 mm onto the pipe barrel. Ensure that each additional section overlaps the previous by 55% to ensure a double thickness of tape.

Finish each side with a circumferential wrap around the pipe to lock in the ends of the tape sections applied longitudinally and continue until 100 mm onto the factory applied coating.

25.8.3 Couplings

Wire brush loose dirt and loose rust from the joint and adjacent pipe.

Apply primer to all metal surfaces.

Fill between bolts and sleeve, and around bolts to top of the retaining rings with butyl mastic.

Cover bolt heads, nuts and any protruding thread with butyl mastic.

Commencing 100 mm clear of the butyl mastic and a minimum of 50 mm onto the factory applied coating apply flexible tape spirally with a 55% overlap and complete 100 mm past the butyl mastic on the other side or a minimum of 50 mm onto the factory applied coating.

25.8.4 Inspection

Thoroughly inspect the finished wrapping to ensure that all overlaps are sealed to prevent moisture and foreign material from working in under the tape.

26. ADDITIONAL REQUIREMENTS FOR LAYING & JOINTING OF STEEL PIPES & FITTINGS

Not applicable.

27. BORING & JACKING FOR WATER MAINS

Not applicable.

28. MARKINGS FOR LOCATION OF VALVES & THEIR FITTINGS

Markings for the location of valves, other fittings (bends etc) shall be installed at all airvalves, isolating valves, scour valves, bends and at additional locations where shown on the drawings.

29. GROUTED STONE PITCHING

29.1 Drains, channels and surfaces of slopes shall be stone pitched, where shown on the drawings or directed by the Engineer.

29.2 All stone pitching shall be of sound, durable rock not less than 150mm thick, properly bedded to a uniform surface on approved loam or sand. The exposed surface of each stone shall be approximately flat and of area not less than 0.03m2.

29.3 The stone pitching shall be set in mortar consisting of three (3) parts of clean fine sand (1) part of cement by volume. The sand shall comply with requirements specified for sand in **Clause 23.2** herein. The mortar shall be thoroughly rammed to the full depth of the stones.

30. CROSSINGS

30.1 Bridge Crossings

All bridge crossing pipe work shall be either DICL or SCL in accordance with the drawings.

30.2 Aerial Crossings

All bridge crossing pipe work shall be either DICL or SCL in accordance with the drawings. Each end of the bridge crossing shall be fitted with a protection grille as per drawing WAT- 1311 (Aerial Crossings Aqueduct Protection Grille).

30.3 Buried Crossings Under Obstructions

All buried crossing pipe work shall be DICL in accordance with Clause 5 herein and as shown on the drawings. Buried PE pipe is allowed to be used in river crossings only. The pipe shall be Series 1 PE100 SDR11 pipe. PE Crossings greater than DN450 are not allowed.

31. MAINS SWABBING FACILITIES

Not applicable.

32. FLUSHING OF MAINS

32.1 On completion of pipe laying and prior to hydraulic pressure testing and sterilisation of mains, the Contractor shall flush all mains. Where directed, batching pigs or spheres shall be used in the cleaning of mains, before the commencement of scouring with potable water. The rate of filling the mains with water shall be such that the water velocity therein shall nowhere exceed 0.05m/s.

32.2 Flushing of the entire system shall be done by scouring under pressure through scours. Flushing shall be carried out using a high velocity of at least 2 m/s or, if this is not possible, by a turbulent water change using batching pigs or spheres.

32.3 All defects which occur during or after testing shall be repaired. The Contractor shall then again flush the section of main. Where directed swabbing pigs shall be used to clean such sections of main in conjunction with flushing operations. The Contractor shall ensure that, when pigs are in use, the pipeline is effectively secured so as to prevent damage through vibration.

33. HYDRAULIC PRESSURE TESTING

33.1 Testing shall be carried out by a Certified NATA accredited person or representative approved by the Engineer. Pressure testing shall be undertaken as soon as possible after the concrete thrust blocks have developed their design strength.

Testing shall include the water main and fittings with the length of test section of main normally to be between 500m and 1,000m. Under no circumstances shall test lengths exceed 1,600m. All tests shall be carried out in a manner approved by the Engineer.

33.2 Hydraulic pressure testing of the pipeline shall be carried out at the lowest point of the line or lines being tested.

33.3 Care shall be taken to remove all air from mains under test when filling with test water. The rate of filling of the test section with water shall be such that the water velocity within the test section shall nowhere exceed 0.05 m/s. After filling the main shall stand for 48 hours.

33.4 The test head for water mains shall be 1350 kPa for DICL pipelines and for PVC mains is 1.5xWorking pressure.

33.5 The test pressure shall be maintained for 2 hours minimum and during this period the whole line shall be inspected for leakage or movement. Any defects shall be repaired and re-flushed and the main re-tested.

33.6 The length of main or mains under hydraulic pressure test shall be deemed to have passed the test if the quantity of water added during the test to maintain the test pressure does not exceed 0.0375 litres per millimetre of pipe internal diameter per kilometre of pipeline, and there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component and there is no visible leakage.

34. STERILISATION

Following satisfactory hydraulic pressure testing as specified in **Clause 34** herein watermains shall be sterilised by adding a sterilising agent to water drawn from the Principal's distribution system.

During the sterilisation process all valves, and other fittings shall be operated to ensure disinfection.

The sterilisation process shall ensure complete sterilisation of the mains and fittings to meet the requirements of **Clause 36** herein.

35. FLUSHING OF STERILISATION WATER

35.1 The chlorinated water used in the sterilisation process shall be scoured from the mains at the completion of the sterilisation process.

35.2 Flushing of the mains shall be continued until the chlorine concentration does not exceed 1.0 mg/L.

35.3 The Contractor shall take whatever steps are necessary to ensure that:

i. chlorinated water used in the sterilisation process does not enter the distribution system.

ii. during the process specified in **Clause 35** herein all measures are taken to protect the environment.

36. WATER QUALITY TESTING

36.1 At the completion of the flushing of the sterilisation water specified in **Clause 35** herein the system shall be tested by a laboratory approved by the Engineer. Tests

shall be considered satisfactory when they fall within the water quality limits specified in **Table 5** herein.

Table 5 Water Quality Testing

Analysis	Unit	Required Result Range
PH (not cement lined main)		6.5 - 8.5
(cement lined main)		6.5 - 9.2
Chlorine (free)	mg/L	0 - 1.0
Total Coliform count	cfu/100mL	<1
E.Coli count	cfu/100mL	<1
Heterotrophic Plate count	cfu/mL	0 - 100

36.2 Should any sample analysed not comply with the water quality limits shown in **Table 5**herein, the corresponding section of new main shall be re-sterilised, re-flushed and retested until the test results are satisfactory.

36.3 Notwithstanding the water quality limits set out in **Table 5** herein, test results of new sections of mains may be deemed satisfactory when the following conditions apply:-

i. water quality in the new sections of mains is no worse than in a sample of influent existing mains water, and

ii. the sample referred to in (i) above was collected by the NATA registered laboratory referred to in **Clause 36.1** herein at the same time as it sampled water from the new sections of mains.

37. RESTORATION WORKS

Restoration of existing developed areas shall be carried out to such a standard that the finished Works shall be as near as practicable to standard of the Site prior to commencement of Works.

The Contractor shall be responsible for all restoration works including, but not restricted to fences, concrete work, footpath and pavement repairs, gardens, edging, trees, shrubs and grass.

The restoration works shall be completed within forty-eight (48) hours of the initial work being undertaken on a particular property unless agreed otherwise by the Engineer.

Any excess material which has resulted from work under the Contract shall be removed from the Site at the Contractor's expense.

Should the Contractor fail to complete restoration to a satisfactory standard, within the specified time, then the Engineer shall arrange to have the restoration work completed by others at the Contractors expense.

38. LIVE CONNECTION, COMMISSIONING

Live connections to existing infrastructure are required to be undertaken by the Contractor. The Contractor shall make connection to existing water mains only under the Principal's supervision and in the Principal's attendance, and the Principal shall provide assistance to the Contractor for filling of the water main.

Prior approval of the Contractors proposed procedure for connection to existing infrastructure is required to be issued by the Engineer.

Where connections to existing infrastructure are to be undertaken by the Contractor the Contractor shall submit to the Engineer a detailed method statement of how each connection is proposed to be undertaken, including times of connection, materials and equipment to be used in undertaking the connection, and details of service interruptions anticipated to arise during the period of the connection. In all cases the method statement for the connection is to endeavour to minimise any disruption to existing customers and/or users of the affected infrastructure. The method statement is to be received by the Engineer not less than fourteen (14) days prior to the date scheduled for the connection works.

The Contractor shall further confirm the final arrangements with the Engineer not less than 48 hours before the proposed commencement of the connection works.

The Engineer shall within seven (7) days of receipt of the method statement either approve the method statement or return it to the Contractor requesting further consideration of issues raised.

Should resubmission of the method statement be required, the Engineer's approval to the revised method statement will still be required prior to proceeding with the connection works. In all cases the proposed date to undertake the connection works shall be not less than seven (7) days after receipt of written approval from the Engineer to the proposed method statement. No additional cost will be applicable arising from delays in obtaining the Engineer's approval to the connection method statement.

If in the opinion of the Engineer the Contractor does not have the necessary equipment and/or resources available to successfully complete the connections, the connection activities will be postponed to another day. No cost for this delay will be granted.

Connections to existing infrastructure are also to be undertaken outside normal working hours and not during peak periods Monday through to Friday to minimise disruption to customers. The Contractor shall therefore be required to undertake live connections during off-peak hours.

The Principal may postpone live connections during Major events eg Holidays, Festivals etc. If the contractor can ensure no such functions are affected, the Engineer will advise whether the live connection can take place.

Where the contractor can ensure disruption to customers is minimal, the Engineer may authorise connection during the above periods.

All costs associated with the connections to the existing water supply system shall be included in the lump sum.

39. ACCEPTANCE TESTING

39.1 Acceptance testing shall be carried out in accordance with WSA 03-2002 Version 2.3, "Part 3 "Construction", Section 19. For ease of reference this section has been attached as an Appendix to this document.

40. MEASUREMENT & PAYMENT

40.1 A Bill of Quantities has been developed as a guide to compare pricing and as a means of determination of value of possible future variations. The Bill of Quantities is not intended to form a detailed and accurate basis for payment (such as in a Schedule of Rates contract). The Lump Sum remains the sacrosanct measure for payment.

The Quantities in the Bill of Quantities were however computed on the following basis:

a) Water main - per plan linear metre including: - excavate, supply, lay, joint, bed and backfill including tees, thrust blocks, caps and bends.

b) Other items have been measured in the units indicated in the text of the items in the Bill and based on the dimensions shown on the drawings or specified elsewhere.

40.2 The cost of all work required by this specification including testing, supply of all materials, plant, tools, labour and all expenses necessary for the satisfactory completion of the Works, shall be deemed to be included in the relevant Bill Items (if part of the Contract) and/or the Lump Sum of the Contract generally.

41. STANDARDS & CODES

41.1 This specification makes reference to the following Australian Standards:

AS/NZS1111	ISO metric commercial hexagon bolts and screws
AS/NZS1112	ISO metric hexagon nuts, including thin nuts, slotted nuts and castle nuts
AS1141	Methods for sampling and testing aggregates
AS1281	Cement mortar lining of steel pipes and fittings
AS1289	Methods of testing soils for engineering purposes
AS1302	Steel reinforcing bars for concrete
AS1304	Welded wire reinforcing fabric for concrete
AS1379	The specification and manufacture of concrete
AS1397	Steel sheet and strip- hot dipped zinc-coated or aluminium/zinccoated

AS1449	Wrought alloy steels – stainless and heat resisting steel plate, sheet and strip
AS/NZS1477	PVC pipes and fittings for pressure applications
AS1478	Chemical admixtures for concrete
AS1579	Arc welded steel pipes and fittings for water and waste water
AS1627	Metal finishing – preparation and pretreatment of surfaces
AS1646	Elastomeric seals for waterworks purposes
AS1650	Hot-dipped galvanised coating on ferrous articles
AS1720	Timber structures (known as the SAA Timber Structures Code)
AS2187	Explosives – storage, transport and use (known as the SAA Explosives Code)
AS/NZS2280	Ductile iron pressure pipes and fittings
AS2638	Sluice valves for waterworks purposes
AS2758.1	Concrete aggregates
AS2837	Wrought alloy steels – Stainless steel bars and semi-finished products
AS/NZS2865	Safe working in a confined space
AS3571	Glass filament reinforced thermosetting plastics (GRP) pipes - Polyester based - Water supply, sewerage and drainage applications
AS3578	Cast iron non-return valves for general purposes
AS3582.1	Fly ash
AS3600	Concrete structures
AS3610	Formwork for concrete
AS/NZS3678	Structural steel - Hot-rolled plates, floor-plates and slabs
AS/NZS3679	Structural steel
AS3680	Polyethylene sleeving for ductile iron pipelines
AS3681	Guidelines for the application of polyethylene sleeving to ductile iron pipe lines and fittings
AS3706	Geotextiles - Methods of test
AS3894.1	Non-conductive coatings – continuity testing – high voltage (brush) method
AS3972	Portland and blended cements

AS4041	Pressure piping
AS4087	Metallic flanges for waterworks purposes
AS/NZS4158	Polymeric coatings on valves and fittings for water industry purposes
AS4321	Fusion bonded medium density polyethylene coating and lining for pipes and fittings.
AS/NZS4671	Steel reinforcing materials
AS/NZS4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS4792	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
WSA 03 – 2002	Water Supply Code of Australia WSA 03 – 2002, Second Edition, Version 2.3

41.2 In this specification Australian Standards are referred to only by their allocated AS number. The latest available edition at the date of close of Tenders shall be deemed to apply.

APPENDIX A.

Section 19 – Excerpt from WSA 03 – 2002, Version 2.3, Part 3: Construction

19.1 GENERAL

Acceptance testing is required to test the capability of the pipeline assembly to satisfy design requirements as specified. It is not intended to test the material capability. Testing is intended to:

(a) Reveal the existence of any assembly and structural faults.

(b) Ensure the water main can sustain pressures greater than the maximum operating pressure without leakage.

(c) Confirm the success of placement and compaction of pipe embedment and trench fill, design and placement of thrust and anchor blocks and installation of pipeline components.

Undertake acceptance testing of all water mains and structures in accordance with the Specification and in the following order:

1 Visual inspection.

2 Compaction testing.

3 Pressure testing.

4 Bacteriological testing.

Notification of acceptance testing and responsibilities for reporting shall be in accordance with the Water Agency's requirements. All test results, including unsatisfactory results, shall be documented and reported to the Engineer.

Where specified, clean pipes, fittings and structures before any test is performed.

Unless otherwise permitted by the Water Agency, arrange testing by a NATA accredited organisation that holds current listing for the relevant acceptance test.

If any of the tests prove to be unsatisfactory, detect and rectify the fault. Continue to rectify and retest the water main until a satisfactory test result is obtained. Even if testing produces satisfactory results, rectify any water main, structure or appurtenance that has a visible or detectable leak, blockage, malfunction or other defect.

19.2 VISUAL INSPECTION

Visually inspect all water mains and their component markers to ensure the pipeline assembly and the type and location of markers are as specified.

19.3 COMPACTION TESTING

19.3.1 General

Undertake field density tests of the embedment and fill zones at the frequency and locations nominated in Clauses 19.3.3 and 19.3.4.
Conduct testing of embedment compaction before trench filling.
For non-cohesive material, determine the density index (ID) in accordance with AS 1289.5.6.1.
For cohesive material, determine the dry density ratio (RD) in accordance with AS 1289.5.4.1, using standard compactive effort to determine maximum dry density in accordance with AS 1289.5.1.1.

19.3.2 Minimum compaction

Ensure compaction of embedment and fill is not less than the values given in Table 19.1

19.3.3 Embedment compaction testing

19.3.3.1 Applicable pipe sizes

Undertake compaction testing of pipeline embedment for mains >DN 375.
Except where the Engineer nominates random confirmatory tests, do not undertake compaction testing of pipeline embedment for mains ≤DN 375 where:

(a) the allowable bearing pressure of the native ground is ≥50 kPa when assessed in accordance with Standard Drawing WAT–1200;

(b) pipe laying and embedment compaction was carried out in accordance with this Code; and

(c) a pre-qualified compaction method was used in accordance with Clause 16.3.2.

19.3.3.2 Frequency and location of embedment tests

Except where the provisions of Clause 19.3.3.1 apply, test water mains ≤DN 375 at the spring line (±50 mm), in each 100 lineal metres of main or part thereof.
For water mains >DN 375,
19.3.3.3 Retesting
If one or more of the initial test results do not comply with Table 19.1, conduct two additional tests in the length of embedment represented by the initial test. If at least one of the repeat tests does not comply, recompact the full length of embedment and repeat testing. Continue recompaction and testing until the embedment compaction test results comply with Table 19.1.
19.3.4 Trench fill compaction testing
19.3.4.1 Trafficable areas test zone

For trenches in trafficable areas, the depth of trench shall be deemed to be the full depth of fill, i.e. from the surface of the trench to the top of the pipe embedment.
Reference: Standard Drawing WAT–1201.
19.3.4.2 Non-trafficable areas test zone

For trenches in non-trafficable areas, the length of trench represented by a test shall be deemed to extend 50 m either side of the location at which a test is made. The depth of trench shall be deemed to be the full depth of fill.
19.3.4.3 Property services

For property service trenches, test 1 of every 5 trenches in accordance with Clause 19.3.3.1 and Clause 19.3.3.2.
19.3.4.4 Frequency and location of tests

For trenches located in a trafficable zone, conduct one test in each 300 mm layer of fill and each 50 lineal metres of water main or part thereof.
For trenches located in a non-trafficable zone, conduct one test in each 900 mm of fill and each 100 lineal metres of water main or part thereof.
19.3.4.5 Retesting

If one or more of the initial test results do not comply with Table 19.1, conduct two additional tests in the length of that layer of trench fill represented by the initial test. If at least one of the repeat tests does not comply, recompact the full length of that layer of trench fill and repeat testing. Continue recompaction and testing until the trench fill compaction test results comply with Table 19.1.
19.3.5 Other fill compaction testing
19.3.5.1 General

Test other filled areas and embankments in accordance with this Clause. Choose test areas so as to be representative of the filled area or embankment. Drives and tunnel fill do not require compaction testing.

19.3.5.2 Trafficable areas test zone

For filled areas located in a trafficable zone, the area of fill represented by a test shall be 300 m2 in area with its centre at the spot where the test is made. The depth of the filled area represented by the test shall be deemed to be the full depth of fill i.e. from the surface of the filled area to the top of the foundation or native ground.

19.3.5.3 Non-trafficable areas test zone

For filled areas located in a non-trafficable zone, the area of trench represented by a test shall be 1200 m2 with its centre at a spot where the test is made. The depth of the filled area shall be deemed to be the full depth of fill i.e. from the surface of the filled area to the top of the foundation or native ground.

19.3.5.4 Frequency and location of tests

For filled areas located in a trafficable zone, conduct one test in each 300 mm layer of fill and each 300 m2 or part thereof.

For trenches located in a non-trafficable zone, conduct one test in each 900 mm layer of fill and each 1200 m2 or part thereof.

The Engineer may carry out random confirmatory tests.

19.3.5.5 Retesting

If one or more of the initial test results do not comply with Table 19.1, conduct two additional tests in the area of that layer of fill represented by the initial test. If one or more of the repeat tests does not comply, recompact the full zone and continue repeat testing. Continue this cycle until the embedment compaction test results comply with Table 19.1.

19.4 PRESSURE TESTING

19.4.1 General

Pressure test all water mains after trench filling and compaction, and not before any concrete has cured for at least 7 days.

If any of the tests prove to be unsatisfactory, detect and rectify the fault, and re-test. Continue to rectify and re-test until a satisfactory test result is achieved. Even if testing produces satisfactory results, rectify any water main or conduit in which there is a visible or detectable leak or blockage.

Test polyethylene water mains in accordance with WSA 01—2001.

Base the rate of filling on a maximum velocity of 0.05 m/s.

Allow between 3 and 24 hours for the test water temperature to stabilise and dissolved air to vent from the system. Fill cement-lined pipes 24 hours prior to testing to allow for saturation of the lining.

Unless otherwise permitted by the Engineer, adopt a maximum test length of 1000 m.

Acceptance testing may be conducted progressively with the authorisation of the Engineer. Testing may be carried out as soon as the Works are completed and where thrust restraint curing times have lapsed.

Where isolation is available, the water main may be progressively tested in sections of at least 100 m, or in its entirety if the main is less than 100 m.

Visual detection of leaks may be adversely affected by wet weather.

19.4.2 System test pressure

Determine an appropriate system test pressure (STP) based on the design pressure (DP) such that each section of the water main being tested is subjected to a STP within the range:

$$DP<STP<1.25 \times DP$$

Given that the water main will be undulating, the system test pressure is chosen such that:

(a) at the highest point in the test section, STP>DP.

(b) at the lowest point in the test section, STP = 1.25 x DP.

Thus, for a given section of water main, the actual pressure at any point in the test section will depend on its relative level.

19.4.3 Maximum allowable loss

Calculate the maximum allowable loss by:

$(0.14 \times d_i \times L_P \times H) / 1000$ (L/h)

where: d_i = internal pipe diameter, mm

L_P = length of water main under test (km)

H = average value of test head (m)

19.4.4 Test procedure

Use a test rig that has two calibrated pressure gauges. Each gauge shall have a range of 0–2500 kPa and shall have a current calibration certificate. Both gauges shall read within ±5% of the test head and 5% of each other. Use the gauge recording the lower of the two readings. Before testing a water main section, clean the section and then slowly fill it with water, ensuring that air has been completely expelled.

With the exception of polyethylene, which is to be tested in accordance with WSA 01—2001, test all water mains as follows:

(a) Install blank flanges or caps at each end of the test section. Do not test against closed valves unless they are fully restrained and it is possible to check for leakage past the valve seat. Temporarily strut or anchor mechanical ends that are not end load resistant to withstand the test pressures without movement.

(b) Clearly inform all personnel of the loading limits on temporary fittings and supports.

(c) Pressurise the line to 75% of the test pressure and leave for a minimum of 12 hours.

The preliminary pressurisation is intended to:

(i) stabilise the water main by allowing most of the time-dependent movement to occur;

(ii) achieve saturation in absorbent materials; and

(iii) allow pressure-dependent increase in volume of flexible pipes prior to the main test.

(d) Provided there is no obvious leak in the water main, steadily raise the pressure in the water main until the specified test pressure is reached.

(e) Maintain the test pressure for four (4) hours. Measure and record, at half hour intervals, the quantity of water added in order to maintain the pressure during the period of testing.

(f) Visually inspect the line for leaks. If a leak is suspected but is not visible, use aural or electronic assistance.

(g) Do not remove temporary supports until the test section has been depressurised.

(h) Dispose of test water in accordance with the relevant environmental Regulator and Water Agency requirements.

19.4.5 Satisfactory pressure test

Accept the pressure test on a section of water main 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;

(c) The measured loss rate for the relevant test period of the pressure testing does not exceed the maximum allowable loss rate as determined in accordance with Clause 19.4.3; and

(d) For polyethylene water mains, compliance with the requirements of Clause 2.13.5 of WSA 01—2001 is achieved for all mains except property services, which shall comply with the requirements of Clause 2.13.4 or Clause 2.13.5 of WSA 01—2001.

TS-2 CONCRETE SPECIFICATION

MANUFACTURE, PLACEMENT, CURING & TESTING OF CONCRETE

1.0 GENERAL

This Technical Specification establishes the quality of materials and workmanship and defines how quality is measured for the supply, testing, placing and curing of the concrete.

2.0 ABBREVIATIONS

The abbreviations listed below, where used in this Specification, shall have the following meanings.

NZS	-	New Zealand Standard
ASTM	-	American Society for Testing and Materials
AS	-	Australian Standard

3.0 CODES AND STANDARDS

Unless otherwise specified or shown, the current editions and revisions of the following codes, standards and references to other documents therein, shall apply.

NZS 3109 : 1997	Specification for Concrete Construction.
NZS 3113: 1979	Chemical Admixtures for Concrete.
NZS 3121: 1986	Water and Aggregate for Concrete.
NZS 3122: 1995	Portland Cement and blended cements (General and Special Purpose)
AS 1478.1: 2000	Chemical Additives for Concrete, Mortar and Grout
AS/NZS 4200	Pliable Building Membranes and Underlays

4.0 MATERIALS

4.1 It shall be the Contractor's responsibility to show that the materials used in the concrete comply with the requirements of the appropriate New Zealand, Australian or other approved Standard.

4.2 Cement

Cement shall be ordinary Portland Cement complying with the requirements of NZS 3122:1995. Rapid Hardening Portland Cement shall be used only with the Engineer's written approval. High Alumina Cement shall not be used under this Specification.

4.3 Aggregates

Fine and coarse aggregates shall comply with the requirements of NZS 3111 and 3121. The nominal maximum size of coarse aggregate shall not exceed 19mm for normal structural concrete or 10 mm for block filling.

4.4 Mixing Water

The mixing water shall be from the nearest public domestic supply or equal and shall be free or organic matter or other deleterious substances. If required, the Contractor shall drink a glass of the water to assure purity.

4.5 Additives

Concrete may contain an air entraining agent complying with ASTM C260-69T, and used strictly in accordance with the Manufacturer's instructions to produce a maximum of 4.5% entrained air.

The use of proprietary dispersing and plasticising agents which facilitate concrete placing and the production of the specified concrete surface finishes will be permitted subject to written approval by the Engineer.

5.0 PROPORTIONING CONCRETE

5.1 Proportioning of concrete shall be the responsibility of the Contractor. The Contractor shall establish the proportions, including the water-cement ratio and shall submit the mix designs to the Engineer for review prior to the initial manufacture of Concrete.

5.2 The specified slump may be changed only with prior consent. Slump shall be adjusted only by changing mix design and not merely by the water content.

5.3 Concrete shall be delivered to the placing point in the following grades designated by strength, coarse aggregate size and minimum cement content as shown in TABLE 1:

TABLE 1 - CONCRETE GRADE & COMPONENT DESIGNATIONS

Strength Mpa at 28 Days	Min Cement Content kg/m^3	Coarse Aggregate max size mm
20	265 (for salt water 340)	19
25	300	19
30	345	19
35	385	10 (for shotcrete)
17.5	260	19
17.5 (Conc block filling)	260	10

The concrete to be used in various positions on the project shall be as designated in TABLE 2

TABLE 2 - STRENGTHS OF CONCRETE REQUIRED IN THE PROJECT

Position of Concrete	Concrete Strength at 28 Days	Slump

Blinding concrete	17.5 MPa	100mm
Foundations to Buildings	20 Mpa	80mm
Water Retaining Structures	30 MPa	30mm
Anchor and Thrust Block	25 MPa	80mm
Pipe bedding	17.5 MPa	100mm
Pipe surrounds	17.5 MPa	100mm
Conc block filling	17.5 MPa	150mm * see note 1
Ordinary Sructural Concrete (buildings etc)	20 MPa	80mm
Floor Slabs	20MPa	70mm

Note 1: Super plasticiser may be used with permission of the Engineer.

6.0 PRODUCTION AND DELIVERY TO SITE OF READY MIXED CONCRETE

6.1 Concrete shall be manufactured and supplied to site by an approved and graded member of the Fiji Ready Mixed Concrete Association.

Alternatively the Contractor may establish his own batch plant subject to the Engineer's approval and in conformance to the requirements of the following clauses.

6.2 Batching, mixing and the quality control of Ready Mixed Concrete shall conform to NZS 3104: 2003 Concrete Production.

6.3 Concrete shall be either plant-mixed or truck-mixed. Plant-mixed concrete shall be transported to the delivery point either in a truck agitator or in a truck mixer operating at agitating speed. Both plant-mixer or truck-mixer plant shall conform to NZS 3104: 2003 Concrete Production.

6.4 The rate of hardening of concrete shall be retarded by using an Engineer approved retarding admixture when the average ambient air temperature on the project site during periods of concrete placement exceeds 25^{o}C.

6.5 The total elapsed time between the introduction of the cement to the concrete aggregate and depositing the completed mix at the delivery point shall not exceed one hour.

6.6 With each load of concrete delivered to the project work site, the Contractor shall submit delivery tickets in triplicate listing the following information:

a. Date
b. Name of ready-mixed concrete plant
c. Job location
d. Contractor
e. Type and brand name of cement
f. Class and specified cement content in kilograms per cubic metre of concrete
g. Type of concrete
h. Truck number
i. Time dispatched and time water introduced
j. Amount of concrete in load in cubic metres
k. Admixtures in concrete, if any specify

l. Maximum size of aggregate
m. Water added at job, if any.

7.0 TESTING AND EVALUATION OF MATERIALS AND CONCRETE

7.1 All testing of concrete shall be carried out in accordance with NZS 3112: 1986 Methods of Test for Concrete. All equipment used shall be subject to review by the Engineer.

7.2 The Contractor shall be responsible for the carrying out and for the arranging of all testing as specified herein and shall pay all testing costs and incidental expenses attached thereto. Tests on material and compression test specimens shall be carried out by an Authority approved by the Engineer.

7.3 The Contractor shall provide and permanently maintain on site in good order, sufficient testing equipment for Slump Cone Testing and the preparations of concrete cylinders for testing.

7.4 Concrete samples for slump, compressive strengths and air content tests shall be taken at the point of delivery.

7.5 Slump tests shall be taken for each batch of concrete produced and as required by the Engineer and maximum slump allowance shall be consistent with that specified.

7.6 The Frequency of Sampling for Compressive Strength Tests shall be in accordance with the following table:

TABLE 3 - FREQUENCY OF SAMPLE

Number of batches per day	Number of Samples
1	1
2 to 5	2
6 to 10	3
11 to 20	4

For each additional 10 batches, one additional sample shall be taken.

From each sample, three cylinders shall be made, one shall be crushed at 7 days and one at 28 days; the third to be kept in reserve for check testing to the Engineer's order.

7.7 Test cylinders shall be prepared by the Contractor at the site and shall be cured in standard laboratory conditions as provided by the Contractor complying with NZS 3112: 1974 and to the satisfaction of the Engineer.

7.8 The Engineer may direct that test cylinders be site cured in lieu of laboratory curing in order to determine stripping times.

7.9 Results of all tests shall be documented and submitted to the Engineer on the day of execution or within 24 hours of execution.

7.10 All technicians and workmen engaged on the operations of equipment by the Contractor for the testing of concrete shall be trained and experienced and shall be supervised by a qualified engineer, experienced in the taking of samples and laboratory techniques.

7.11 Concrete shall be suspect if the results of the seven (7) day tests of the laboratory cured cylinders indicate that the strength will be less than that specified in the tables of Section 5.3 of this Specification.

The Statistical appreciation of NZS 3109 :1997 shall be used to determine confirmation.

Should the tests show that the specified strengths have not been attained, the Engineer may direct the Contractor not to place any further concrete above the suspect concrete until the results of the twenty eight (28) day tests are known.

8.0 REJECTION OF FAULTY CONCRETE

8.1 Should the result of any twenty eight (28) day test on standard laboratory cured test cylinders indicate that concrete had failed to reach it's specified strength, the Engineer shall require the concrete covered by this particular test to be cut out and removed from the site and the work made good at the Contractor's expense.

8.2 Hardened concrete deemed not to comply may be further tested for compressive strength by an approved method of core sampling. The point from which the cores are taken shall be at the discretion of the Engineer and shall be representative of the whole of the concrete concerned, but in no case shall fewer than three cores to be tested.

8.3 All cores shall be tested dry unless the concrete concerned is more than superficially wet in service.

8.4 Should these test cores indicate the specified strength has not been achieved, the Engineer shall require the concrete be cut out and removed from site and the work made good at the Contractor's expense.

8.5 Should hardened concrete meet with specified strength criteria but in the opinion of the Engineer be insufficiently compacted or segregated during placing or fails to meet the specified surface finish, the concrete shall be replaced in accordance with this Specification.

9.0 HANDLING AND PLACING CONCRETE

9.1 A minimum of 24 hours prior notice shall be required from the Contractor before forms and reinforcing etc. will be inspected by the Engineer and approved for concreting. “A CONCRETE POUR SHEET” shown as *Appendix 1* is added to this Tech Spec for the information of the Contractor.

9.2 A concrete placing schedule showing the number, size and sequence of placements proposed shall be prepared and shall be subject to approval prior to starting concrete work.

Concrete for slabs shall be placed in a checkerboard pattern unless otherwise approved.

9.3 Prior to starting any concrete work, all equipment surfaces that will be in contact with fresh concrete shall be satisfactorily cleaned.

9.4 An approved means of communicating with the ready-mixed concrete supplier during placing operations shall be provided before starting any concrete placing.

9.5 The piping arrangements for pumping or pneumatic conveying of concrete shall not have branch lines unless a valve is provided at the branch point which will direct the flow into only one branch at a time.

9.6 Concrete may be placed during rain provided satisfactory protection is furnished to prevent rainwater from increasing mixing water or damaging fresh concrete surfaces.

9.7 Water shall be removed from excavations or forms before concrete is deposited, unless otherwise approved. Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other approved methods which will avoid washing the freshly deposited concrete.

9.8 Concrete shall not be dropped through dense reinforcing steel which might cause segregation of the coarse aggregate. In such cases, spouts, flexible drop chutes or other satisfactory means shall be employed. In any event, concrete shall not be dropped free through a height of more than 2 metres unless otherwise approved.

Concrete shall be placed in EVEN HORIZONTAL LAYERS not exceeding 300 mm in thickness except where expressly permitted by the Engineer. Thoroughly compact each layer as specified below before placing further concrete. Place and compact each layer of concrete before the preceding layer has taken its initial set. If the preceding layer of concrete has taken it initial set, then further placing shall cease until the placed concrete is set. The Contractor shall then form, at his own expense, a construction joint.

9.9 Concrete shall not be allowed or caused to flow laterally a distance of more than 1.5 m from point of deposit.

9.10 Concrete which has not reached it's final position in forms within 15 minutes after discharge from the mixer or agitator truck shall be removed from the site.

9.11 Generally the placing of concrete to finished surface levels for vertical members, such as walls and columns shall be placed to a level approximately 25 mm above the soffit of the deepest beams, girders, tops of walls, or other superimposed construction and then struck off to true level after settlement has taken place. For construction joints to vertical members refer to clause 12.2 of this Specification.

9.12 Concrete shall be consolidated by mechanical vibrators. The vibrators shall be internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all concrete. The duration of vibration shall be limited to the time necessary to produce satisfactory consolidation without

causing objectionable segregation. In consolidating each layer of concrete the vibrator shall be operated in a near vertical position and the vibrating head shall be allowed to penetrate under the action of its own weight and revibrate the concrete in the upper portion of the underlying layer.

Neither form nor surface vibrators shall be used unless specifically approved. Vibrators shall not be used to move or spread concrete. A ratio of not less than one spare vibrator in good working condition to each three vibrators required for satisfactory vibration of the concrete being placed shall be kept available for immediate use at the point of placing.

Auxiliary power to provide continuity of vibration in case of power failure from the principal sources shall be provided. Experienced and competent operators shall be provided for each vibrator being used.

9.13 Should the interval of time between the completion of the placing of one batch of concrete and the commencement of placing of a subsequent batch be greater than 60 minutes, then concrete placing shall cease. Should concrete have taken it's initial set or because the time between placing of adjacent batches has exceeded 60 minutes, then the Contractor shall form at his own expense, a construction joint as specified below.

9.14 Formwork shall not be jarred or strained after concrete has taken its initial set. Projecting reinforcement is to be securely braced so that movement is prevented.

9.15 Prevent spilling or splashing mortar on to reinforcing steel or boxing where it will become dry before being covered with concrete.

10.0 PROTECTION AGAINST WEATHER

10.1 In hot weather protect the concrete from the direct rays of the sun and from drying winds.

10.2 Concreting of beams and walls will be permitted when rain is falling provided that rainwater does not collect on the surfaces of fresh concrete either in the forms or during handling. Protect the top surface of the work against damage by rain.

10.3 Concreting of slabs shall not commence when rain is falling or threatening. Should rain commence during a pour, the Contractor shall adequately protect the work against damage, and provide shelter so that all finishing operations may be completed in the dry.

11.0 CURING OF IN-SITU CONCRETE

11.1 All in situ concrete shall be moist cured. Membrane curing compounds will not be permitted, unless there is no surface finish to be applied to the concrete and then the Engineer's approval is required.

After concrete has set sufficiently, all boxing and exposed surfaces shall be kept continuously moist for a period of at least 7 days with approved mist water sprays, lawn sprinklers etc. Hessian sheets and sand will not be approved.

12.0 JOINTS

12.1 Construction joints shall be located as shown on the drawings. Where construction joint locations are not shown, the Contractor shall obtain the prior written consent of the Engineer of proposed pouring sequence and joint locations.

12.2 Generally, construction joints, unless otherwise shown, shall be located at the 1/4 span point of the span and so that pours do not exceed 10 metres in either direction for beams and slabs.

Joints in columns and walls shall be at a point 25 mm above beam and slab soffits.

12.3 Vertical lifts of concrete shall not be less than 75 mm and shall not exceed 3000 mm unless approved by the Engineer.

12.4 Preparation of Construction Joints

The surface of the fresh concrete of horizontal and vertical construction joints shall be cut with either a high velocity air/water jet or an approved surface retarding agent to remove the laitance and to expose the larger aggregate. No undercutting will be permitted. The surface shall be protected from contamination after cutting.

12.5 The larger aggregate of vertical construction joints shall be exposed by coating the stop and before concreting with an approved surface retarding agent. Boxing shall be removed as soon as practicable after concrete has set hard and the retarded surface layer cut off. Ensure that all traces of retarder are removed from the joint.

12.6 Construction joints shall be kept continuously wet for 24 hours preceding the placing of fresh concrete.

12.7 All reinforcement shall be continued across the construction joints unless shown otherwise. Dowels at construction joints shall be as shown on the drawings.

12.8 Location and size of waterstops shall be as shown on the drawings. Installation shall be in accordance with the Manufacturer's recommendations.

12.9 Cleanliness

At the time of concreting, the joints shall be free of all foreign material, ie. sawdust, shavings, nails, tie wire, etc.

13.0 CONCRETE SURFACE FINISHES

TABLE 4 - SURFACE FINISHES

FLOOR AREAS	U1 (Lightly Broomed)
Floor areas to receive special surfaces	U2
Concrete exposed to view above ground floor level	F1
Concrete below ground floor level exposed to view	F2
Concrete foundations not exposed	F3
Concrete to be plastered	F3
Concrete to Water Retaining Structures	F1

13.1 Surface finishes and locations shall be as shown in Table 4.

14.0 FOUNDATION INSPECTION

14.1 Before any foundation concrete is poured, the Contractor shall ensure that the foundation has been inspected and approved by the Engineer.

15.0 BLINDING CONCRETE

15.1 Whenever the footing base cannot be maintained in a firm condition as established by the Engineer, the Contractor shall lay blinding concrete to a minimum thickness of 50 mm and screeded to the correct level.

In general, footings and slabs on grade will be cast without the use of blinding concrete, unless specifically required on the drawings.

16.0 GROUTING OF BASES AND BEARING PLATES

16.1 Machine and equipment bases, structural bearing places and other items requiring grout as shown shall be grouted after setting and levelling by others has been completed.

16.2 The concrete surface under the base or bearing plate shall be brought to the level shown and given a scratched finish.

16.3 Prior to the base or bearing plate being set, all defective concrete and laitance shall be removed from the concrete surface to be grouted by chipping or other approved means.

The resulting surface shall be rough and free of oil, grease, dirt and loose particles.

16.4 Temporary shims or wedges which are designated to be removed after grout has hardened shall be coated with a thin coat of grease to facilitate removal.

16.5 Prior to beginning grouting, the concrete surface shall be saturated with water for a minimum of 6 hours. Just before grouting, all free water shall be removed from the surfaces, keys and sleeves which are to be grouted.

16.6 Grouting procedures shall be placement of grout under entire surface of base or bearing plate and avoiding any possibility of air pockets or voids by sufficient compaction. Grouting procedures shall be subject to approval.

16.7 Grout shall be either standard cement-sand grout or non-shrink grout as specified and or detailed on the drawings.

16.8 Standard cement-sand grout shall be composed of one part Portland cement and two parts of well-graded concrete sand by volume, thoroughly mixed with just sufficient water to produce a mix that can be placed by hand. Freshly placed grout shall be protected and cured in the same manner as concrete in accordance with the provisions in Clause 11.0 hereinbefore.

16.9 Non-shrink grout shall be pre-mixed product of approved, standard manufacture or job mixed grout utilising an approved, expanding-type aggregate of standard manufacture.

Grout shall be mixed, placed and cured in accordance with the grout or aggregate manufacturer's instructions. Grout shall be non-staining and shall be suitable for the intended purpose.

17.0 MEMBRANE

17.1 All slabs on grade unless noted otherwise on the drawings shall require a waterproof membrane at the interface of concrete and compacted surface.

17.2 The membrane shall comprise of a black, high impact Polyethylene film manufactured in accordance with AS/NZS 4200.

The membrane laps and any tears shall be sealed with pressure sensitive tape approved by the film manufacturer.

18.0 LAYOUT OF THE WORK

18.1 The Contractor shall employ a Registered Surveyor to lay out his work from the base lines and bench marks, and shall be solely responsible for the location and accuracy of his construction. The following layout tolerances shall be used during construction of the plant facilities.

18.2 Tolerances for concrete work shall be in accordance with Table 5

TABLE 5 - TOLERANCES FOR CONCRETE WORK

ITEM	HORIZONTAL	VERTICAL
Concrete forms	± 3.0mm	± 3.0mm
Concrete Pedestals	± 3.0mm	± 6.0mm
Earthwork	± 30.0mm	± 30.0mm

Slab Subgrades	± 9.0mm	± 9.0mm
Slab Screed Boards	± 9.0mm	± 3.0mm
Piping, above ground	± 6.0mm	± 6.0mm
Piping, under ground	± 6.0mm	± 6.0mm
Precast concrete column and centre plate	± 6.0mm	± 6.0mm
Anchor Bolts		
Bolts less than 25mm diameter	± 3.0mm	± 6.0mm
Bolts greater than 25mm diameter	± 4.5mm	± 6.0mm

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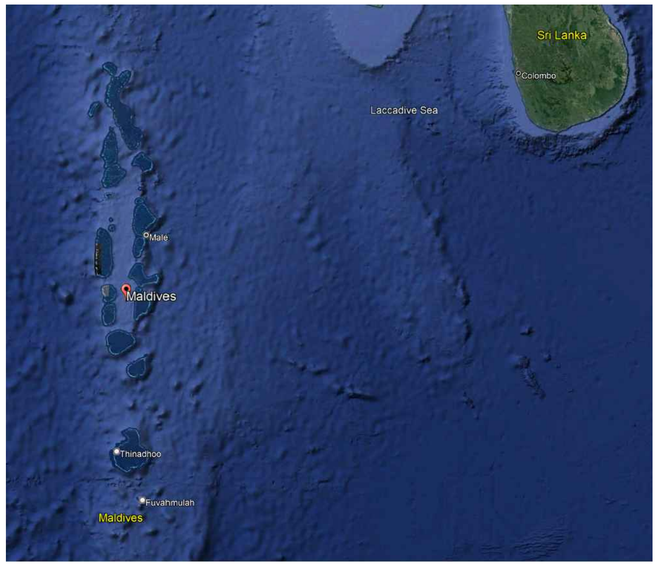
APPENDIX B

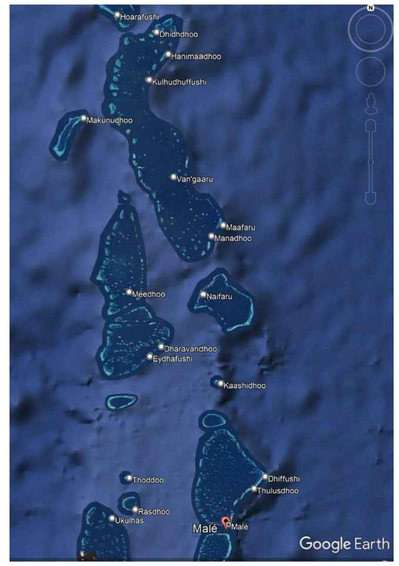
Engineering Drawings

MINISTRY OF ENVIRONMENT AND ENERGY

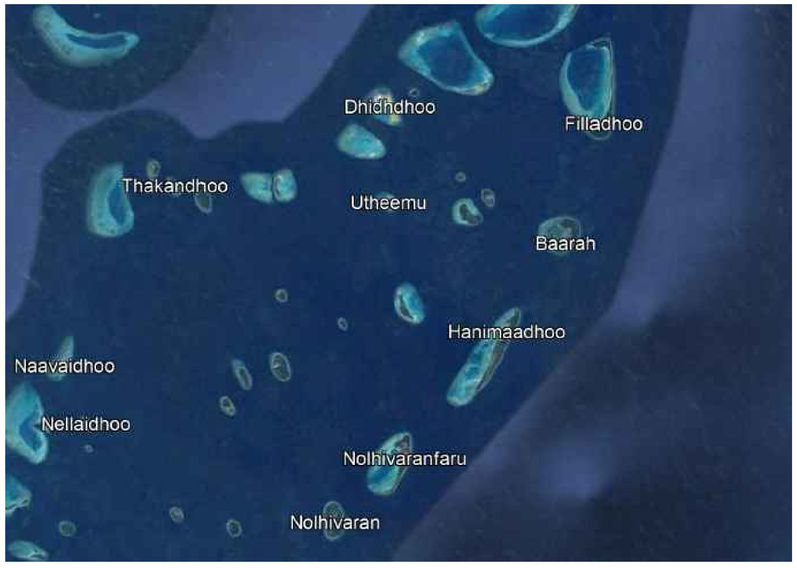
NOLHINVARANFARU ISLAND INFILTRATION GALLERY PROJECT



MALDIVES



NORTHERN ATOLLS



HAA DHAALU ATOLL

NOLHIVARANFARU ISLAND (PROJECT SITE)

PRELIMINARY

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.2023

DRAWN: UK
DESIGNED: AF/DC
VERIFIED: DC
APPROVED: DC

CLIENT: Ministry of Environment and Energy, Republic of Maldives

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Every drop counts
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P.O.Box 762, SANCTUARY COVE,
QLD 4212
AUSTRALIA
TELEPHONE: (+61) 775467123
EMAIL: infor@nrwspecialists.com.au

PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: PROJECT COVER SHEET

DATUM: -
SCALE:
SIZE: A1
DWG. NO: 210003/01/01
REV. NO: A

DRAWING NO.	DRAWING TITLE	STATUS	REVISION	DATE
210003/01/01	PROJECT COVER SHEET	PRELIMINARY	A	17.02.2023
210003/01/02	DRAWING LIST	PRELIMINARY	A	17.02.2023
210003/10/01	PROJECT AREA	PRELIMINARY	A	17.02.2023
210003/10/02	INFILTRATION GALLERY LAYOUT	PRELIMINARY	A	17.02.2023
210003/20/01	GALLERY WELL AND PIPEWORK DETAILS (1 OF 2)	PRELIMINARY	A	17.02.2023
210003/20/02	GALLERY WELL AND PIPEWORK DETAILS (2 OF 2)	PRELIMINARY	A	17.02.2023
	STANDARD ENGINEERING DETAILS			
SD/SN/01	STANDARD STRUCTURAL NOTES (1 OF 2)	PRELIMINARY	A	17.02.2023
SD/SN/02	STANDARD STRUCTURAL NOTES (2 OF 2)	PRELIMINARY	A	17.02.2023

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.2023

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PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: DRAWING LIST

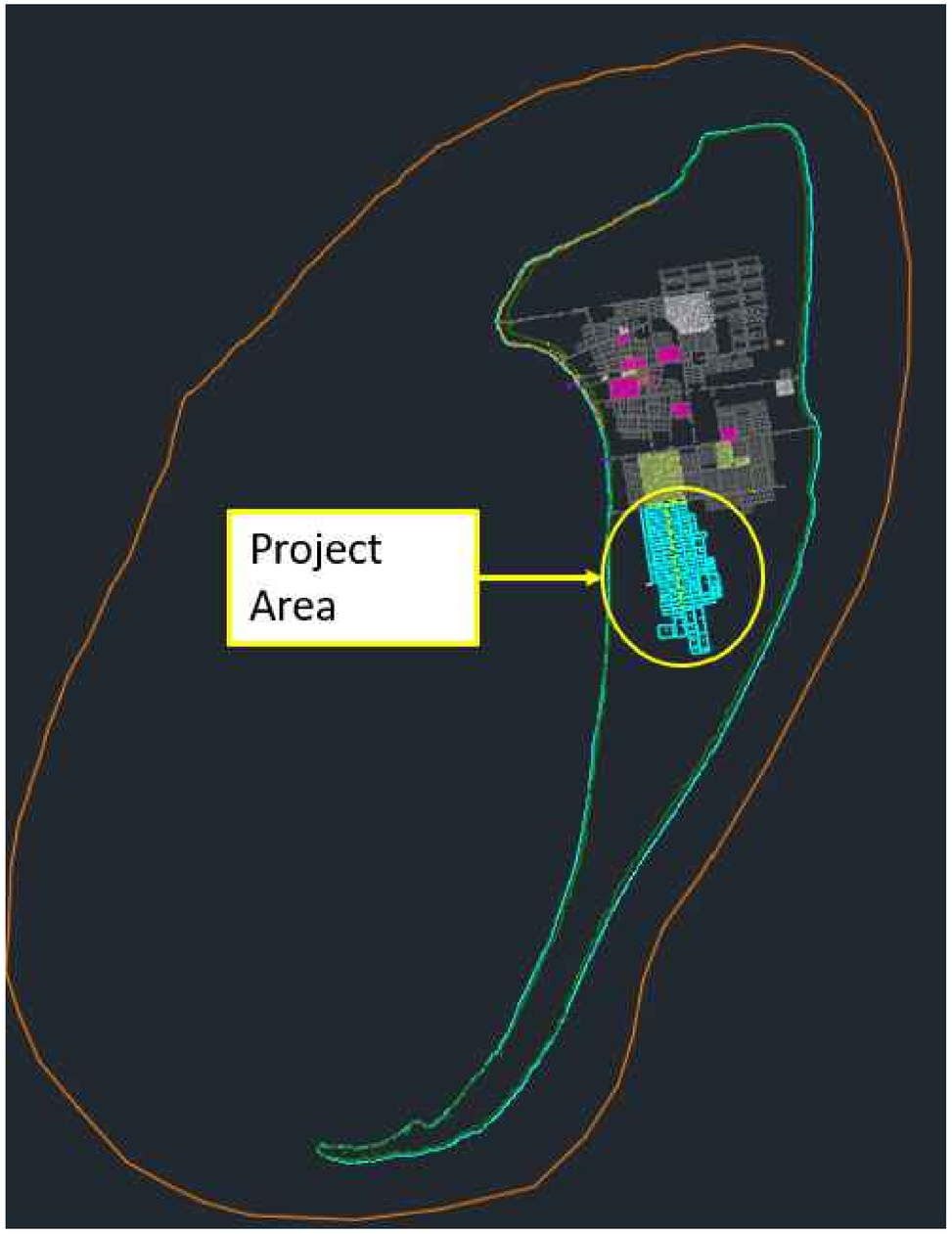
DATUM: -

SCALE:

SIZE: A1

DWG. NO: 210003/01/02

REV. NO: A



AGRICULTURAL AREA OF ISLAND

AERIAL VIEW OF PROJECT AREA

WESTERN, CENTRAL AND EASTERN ROADS IN AGRICULTURAL AREA

CENTRAL ROAD, LOCATION OF INFILTRATION GALLERY

PRELIMINARY

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.2023

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DESIGNED: AF/DC
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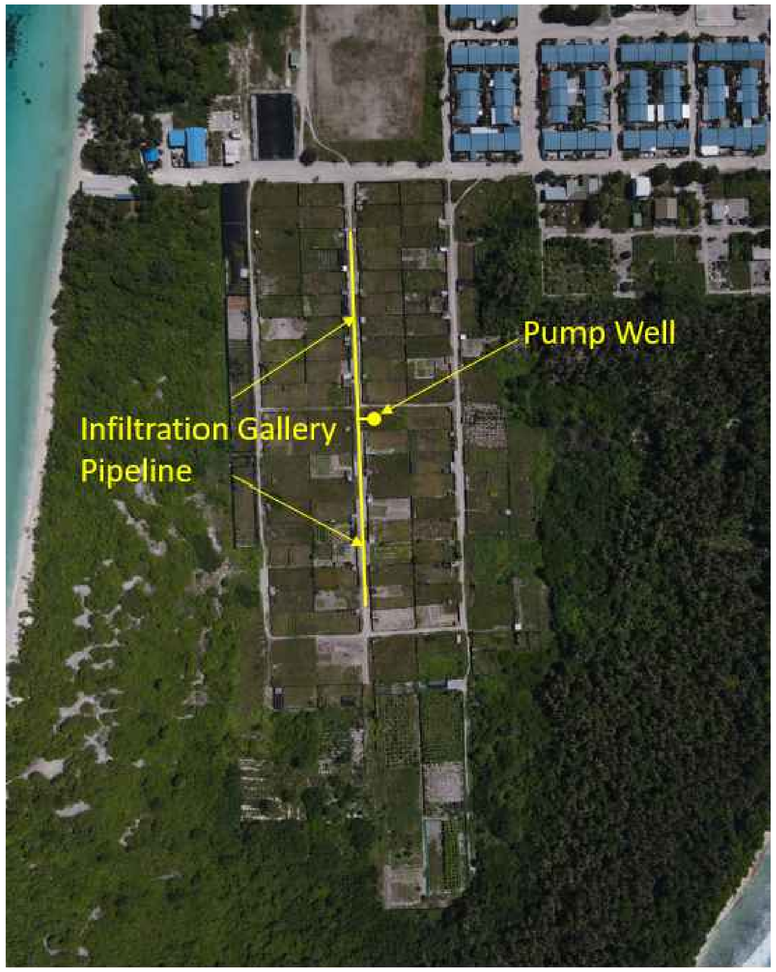
EMAIL: infor@nrwspecialists.com.au

PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: PROJECT AREA

DATUM: -
SCALE:
SIZE: A1
DWG. NO: 210003/10/01
REV. NO: A



INFILTRATION GALLERY GENERAL ARRANGEMENT

INFILTRATION GALLERY PIPEWORK SETOUT

POINT TABLE		
EASTING	NORTHING	DESCRIPTION
8139690.247	747224.462	P1
8139710.139	747101.055	P2
8139718.764	747102.457	P3
8139730.031	746977.648	P4

NOTE: COORDINATE SYSTEM
BASED ON WGS84.PseudoMercator

NOTES:

1. FOR PIPEWORK DETAILS AT POINTS P1 AND P4, REFER DETAIL 1 AND 6.
2. FOR PIPEWORK CONNECTION DETAIL AT P2, REFER DETAIL 7.
3. FOR PIPEWORK CONNECTION DETAIL AT P3 PUMP WELL, REFER DETAIL 2 AND 3.

PRELIMINARY

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EMAIL: infor@nrwspecialists.com.au

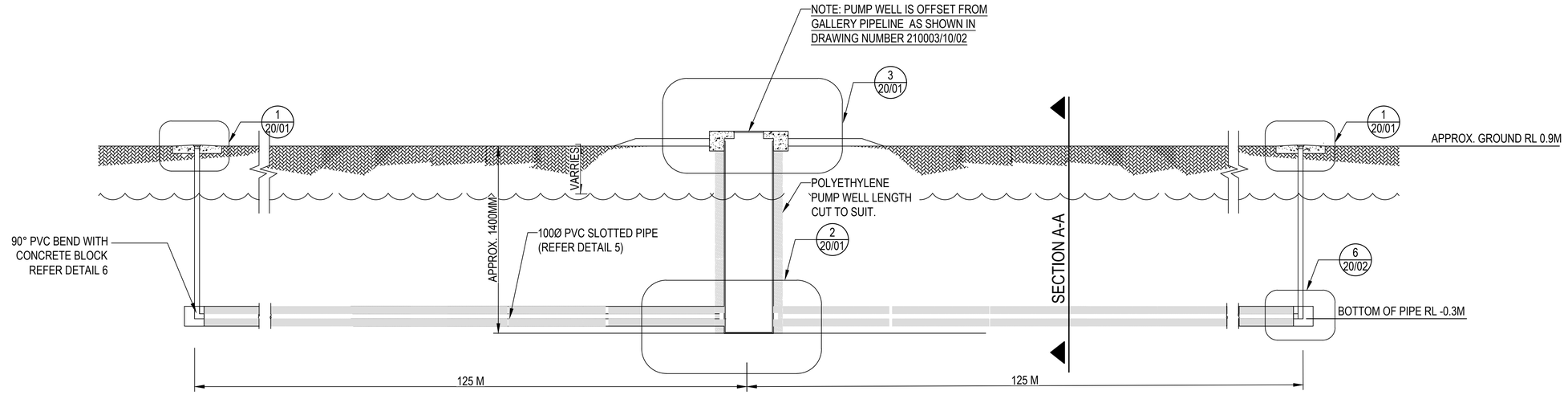
PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: PROJECT AREA

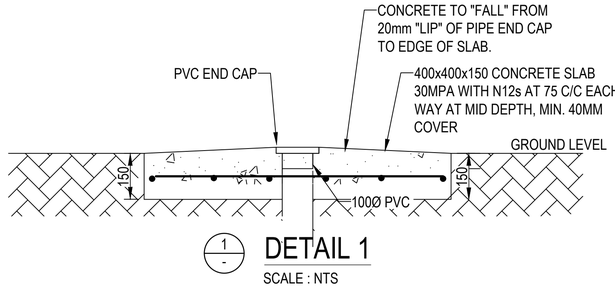
DATUM: -
SCALE:
SIZE: A1

DWG. NO: 210003/10/02
REV. NO: A



INFILTRATION GALLERY GENERAL ELEVATION

SCALE : NTS



1 - DETAIL 1

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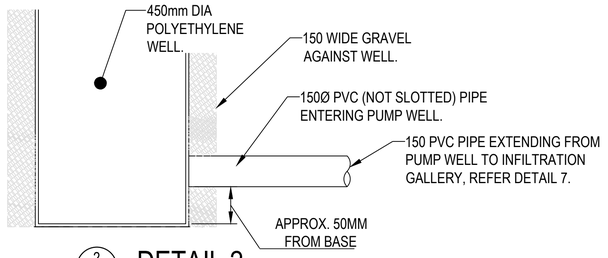

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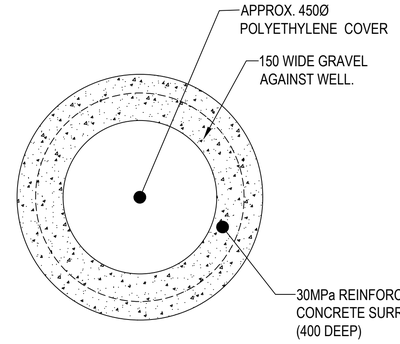
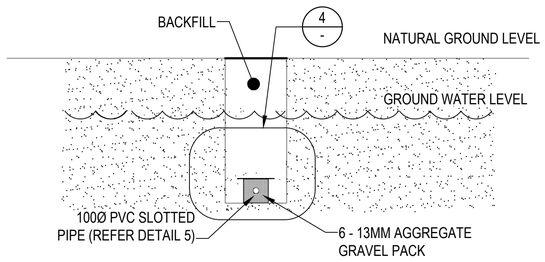




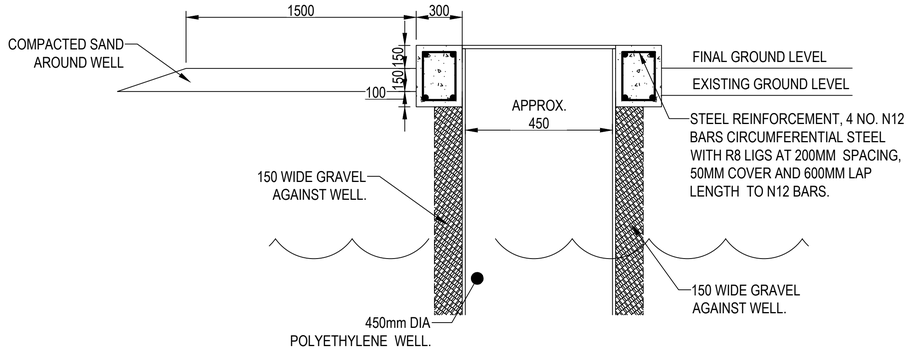
TYPICAL TRENCH DETAIL - SECTION A-A

SCALE : NTS

TRENCH NOTES:

1. EXCAVATED MATERIAL FREE OF ROCKS IS ACCEPTABLE TO BE USED AS BACKFILL.
2. WHERE TRENCH IN EXISTING ROAD, ROAD SURFACE TO BE REINSTATED TO ORIGINAL THICKNESS/LEVELS.

PHOTOGRAPH OF TYPICAL PREFABRICATED PUMP WELL



DETAIL 3 PREFABRICATED POLYETHYLENE PUMP WELL

3 -

SCALE : NTS

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.2023

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PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: GALLERY WELL AND PIPEWORK DETAILS (1 OF 2)

DATUM: - | SCALE: | SIZE: A1

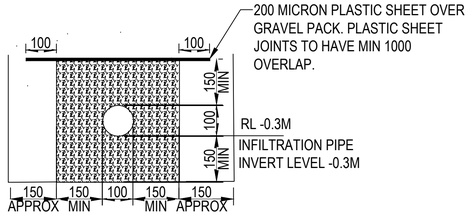
DWG. NO: 210003/20/01 | REV. NO: A

DO NOT SCALE - IF IN DOUBT, ASK

DATE PLOTTED: 6 March 2023 8:20 PM

CAD File: P:\210003\210003-20-01.dwg

XREFs: XR-TBLOCK_details



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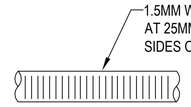
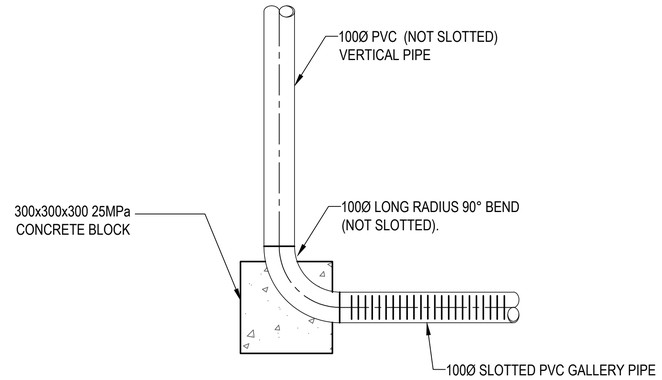


5 / - DETAIL 5

PIPE SLOT DETAIL

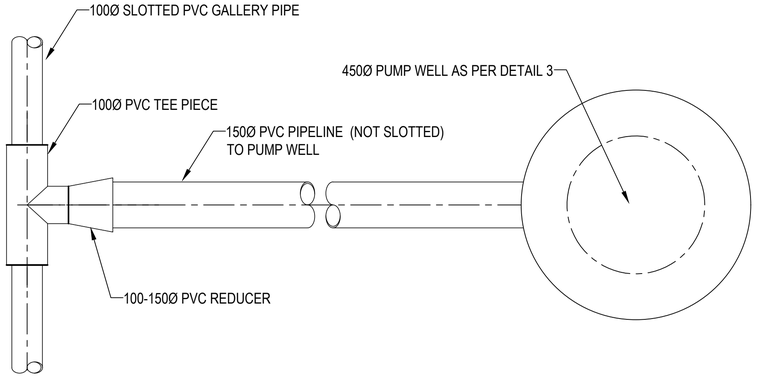
SCALE : NTS



6 / - DETAIL 6

VERTICAL PIPE BEND DETAIL

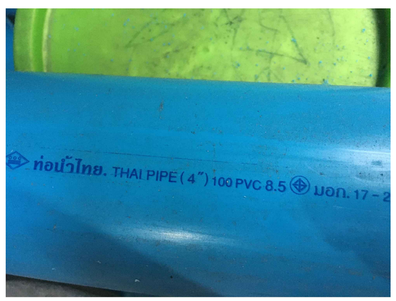
SCALE : NTS



7 / - DETAIL 7

PIPEWORK CONNECTION DETAIL TO PUMP WELL

SCALE : NTS



PVC PIPE (CLASS 8.5)

TYPICAL LOW PRESSURE PIPE JOINTING

PIPELINE NOTES:

1. SLOTTED 100Ø PVC GALLERY PIPES TO BE LAID WITH SLOTS ALIGNED AT SIDES OF PIPE NOT TOP AND BOTTOM OF PIPE.
2. LOCALLY AVAILABLE "THAI PIPE" PVC CLASS 8.5 IS ACCEPTABLE.
3. DUE TO LOW PRESSURE SITUATION FOR INFILTRATION GALLERY, LOCAL PRACTICE OF JOINING "THAI PIPE" TO PIPE COLLARS USING SCREWS IS ACCEPTABLE.

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.2023

DRAWN: UK
DESIGNED: AF/DC
VERIFIED: DC
APPROVED: DC

CLIENT: Ministry of Environment and Energy, Republic of Maldives

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PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: GALLERY WELL AND PIPEWORK DETAILS (2 OF 2)

DATUM: -
SCALE:
SIZE: A1
DWG. NO: 210003/20/02
REV. NO: A

GENERAL NOTES

GENERAL

G1. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL AND OTHER CONSULTANTS' DRAWINGS, SPECIFICATIONS AND WITH SUCH OTHER WRITTEN INSTRUCTIONS AS MAY BE ISSUED DURING THE COURSE OF THE CONTRACT. ANY DISCREPANCY SHALL BE REFERRED TO THE SUPERINTENDENTS FOR DECISION BEFORE PROCEEDING WITH THE WORK.

G2. ALL DIMENSIONS ARE IN MILLIMETRES. DIMENSIONS SHALL NOT BE OBTAINED BY SCALING THE STRUCTURAL DRAWINGS. LEVELS SHOWN ON THE STRUCTURAL DRAWINGS ARE TO THE TOP OF STRUCTURAL CONCRETE OR STRUCTURAL STEELWORK UNLESS NOTED OTHERWISE.

G3. SETTING OUT DIMENSIONS SHOWN ON THE DRAWINGS SHALL BE VERIFIED BY THE BUILDER.

G4. DURING CONSTRUCTION THE STRUCTURE SHALL BE MAINTAINED IN A STABLE CONDITION AND NO PART SHALL BE OVERSTRESSED. TEMPORARY BRACING SHALL BE PROVIDED BY THE BUILDER AS REQUIRED.

G5. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE AS AND NZS CODES AND THE BY-LAWS AND ORDINANCES OF THE RELEVANT BUILDING AUTHORITIES.

G6. REFER TO ARCHITECTURAL DRAWINGS FOR BLOCK WALL THICKNESS WHERE NOT MENTIONED ON THESE DRAWINGS AND FOR FALLS IN SLABS, EXTRA PACKING, WATERPROOFING MEMBRANES, CONTRACTION JOINT FILLING MATERIALS AND ALL OTHER ARCHITECTURAL FEATURES SUCH AS DRIP GROOVES, POUR BREAKS IN OFF-FORM CONCRETE, FILLETS AND THE LIKE.

G7. THE STRUCTURAL WORK SHOWN ON THESE DRAWINGS HAS BEEN DESIGNED FOR THE FOLLOWING LIVE LOADS IN ACCORDANCE WITH NZS 4203.

FLOOR USAGE	LIVE LOAD (TONNES)
BRIDHGE DECKING	GROSS ALLOWABLE WEIGHT = 16 TONNES

NOTE: A SUPERIMPOSED DEAD LOAD OF 1.0KPA HAS BEEN ALLOWED FOR PARTITIONS & SERVICES.

G8. THE STRUCTURAL WORK SHOWN ON THESE DRAWINGS HAS BEEN DESIGNED FOR THE FOLLOWING WIND LOAD IN ACCORDANCE WITH AS 1170 PART 2.
BASIC WIND VELOCITY: 73.5 M/S
TERRAIN CATEGORY: VP = 1.5

G9. THE STRUCTURAL WORK SHOWN ON THESE DRAWINGS HAS BEEN DESIGNED FOR EARTHQUAKE LOADS IN ACCORDANCE WITH NZ 4203: 1992 WITH ZONE FACTOR Z = 0.13

G9. CONTRACTOR TO VERIFY ANY AMBIGUOUS OR NON-PRESENT DETAILS WITH THE ENGINEER PRIOR TO COMMENCEMENT OF WORKS

CIVIL NOTES

BEARING CAPACITY OF SOIL
THE FOLLOWING VALUES HAVE BEEN ASSUMED FOR SOIL STRENGTH AT SITE:
- MINIMUM CBR VALUE OF 5%
- ALLOWABLE BEARING CAPACITY OF 75KPa

DIMENSIONS

ALL DIMENSIONS ARE IN MILLIMETRES, EXCEPT, LEVELS AND COORDINATES WHICH ARE IN METRES. THE DECIMAL SEPERATOR USED IS THE POINT (DOT) NOT COMMA. USE GIVEN DIMENSIONS. DO NOT SCALE OR MEASURE OFF DRAWINGS OR CAD FILES. IF IN DOUBT, ASK.

STABILITY

MAINTAIN THE STRUCTURE IN A STABLE CONDITION DURING CONSTRUCTION. DO NOT EXCEED DESIGN LOADS SHOWN ON SPECIFIC DRAWINGS OR CAUSE ANY ELEMENT TO BE OVERSTRESSED. PROVIDE TEMPORARY BRACING AS REQUIRED.

CONCRETE

C1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH NZS 3109 PART 1 CURRENT EDITION WITH AMENDMENTS, EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.

C2. CONCRETE QUALITY: –

ELEMENT	SLUMP	CONCRETE TYPE	MAX. AGG. SIZE	MINIMUM CONCRETE STRENGTH F'c MPa
FOOTINGS	80	A	20	32 MPa
SLABS ON GROUND	80	A	20	32 MPa
COLUMNS	80	A	20	32 MPa
BEAMS	80	A	20	32 MPa
WALLS	80	A	20	32 MPa

C2.1. ALL CONCRETE WORKS FOR WATER FEATURE SHALL HAVE A MINIMUM COMPRESSIVE F'c OF 40MPa

CONCRETE CONT.

REFER TO SLAB NOTES FOR GENERAL SLAB THICKNESS AND COVERS.
THIS SYMBOL APPLIES ELSEWHERE.

ELEMENT	CONCRETE COVER		
	CAST AGAINST & EXPOSED TO EARTH	EXPOSED TO EARTH OR WEATHER	NOT EXPOSED TO WEATHER OR EARTH
a) Pad footings	65	–	–
b) Strip footings	65	–	–
c) Slabs, walls, & ribs 20mm bars or wire and smaller	65	65	30
d) Beams			
Longitudinal reinf.	75	55	40
Ties and stirrups	65	65	25
e) Columns			
Longitudinal reinf.	75	55	40
Ties and stirrups	65	65	25

C4. SIZES OF CONCRETE ELEMENTS DO NOT INCLUDE THICKNESS OF APPLIED FINISHES.

C5. CONSTRUCTION JOINTS WHERE SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE WELL SCABBLED AND PAINTED WITH EPOXY PRIOR TO POURING OF FRESH CONCRETE.

C6. CONSTRUCTION JOINTS WHERE NOT SHOWN SHALL BE LOCATED TO THE APPROVAL OF THE ENGINEER.

C7. BEAM DEPTHS ARE WRITTEN FIRST AND INCLUDE SLAB THICKNESS, IF ANY.

C8. PROVIDE 20 CHAMFERS TO ALL COLUMNS & BEAMS UNLESS VARIED BY ARCHITECTS DRAWING.

C9. PROVIDE 20 DRIP GROVES TO SOFFITS OF ALL EXTERNAL SLABS & BEAMS.

C10. NO PENETRATIONS, RECESSES, SLEEVES, ETC OTHER THAN THOSE SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE MADE IN CONCRETE MEMBERS WITHOUT THE PRIOR APPROVAL OF THE ENGINEER.

C11. PIPES OR CONDUITS SHALL NOT BE PLACED WITHIN THE CONCRETE COVER TO REINFORCEMENT WITHOUT THE APPROVAL OF THE ENGINEER. THE CONCRETE COVER TO EMBEDDED PIPES OR CONDUITS SHALL BE A MINIMUM OF 20 MM.

REINFORCEMENT

R1. REINFORCEMENT IS REPRESENTED DIAGRAMMATICALLY. IT IS NOT NECESSARILY SHOWN IN TRUE PROJECTION.

R2. SPLICES IN THE REINFORCEMENT SHALL BE MADE ONLY IN THE POSITIONS SHOWN. THE WRITTEN APPROVAL OF THE ENGINEER SHALL BE OBTAINED FOR ANY OTHER SPLICES. LAP LENGTH FOR DEFORMED BARS SHALL BE AS TABULATED BELOW.

–ALL LAPS ARE TO BE IN ACCORDANCE WITH NZS 3101:2000

CONC. 30 MPA STEEL GR. 500	BAR DIAMETER					
	HD10	HD12	HD16	HD20	HD25	HD32
ALL BARS EXCEPT AS BELOW	600	720	930	1200	1500	1900
FOR – COLUMNS. VERT WALL BARS. BOTTOM OF BEAMS. SLABS < 300MM	460	550	740	920	1150	1470

CONC. 30 MPA STEEL GR. 300	BAR DIAMETER					
	D10	D12	D16	D20	D25	
ALL BARS EXCEPT AS BELOW	360	430	570	720	900	
FOR – COLUMNS. VERT WALL BARS. BOTTOM OF BEAMS. SLABS < 300MM	280	350	450	550	700	

CONC. 25 MPA STEEL GR. 500	BAR DIAMETER					
	HD10	HD12	HD16	HD20	HD25	HD32
ALL BARS EXCEPT AS BELOW	650	780	1040	1300	1630	2080
FOR – COLUMNS. VERT WALL BARS. BOTTOM OF BEAMS. SLABS < 300MM	500	600	800	1000	1250	1600

CONC. 25 MPA STEEL GR. 300	BAR DIAMETER					
	D10	D12	D16	D20	D25	
ALL BARS EXCEPT AS BELOW	390	470	630	780	1250	
FOR – COLUMNS. VERT WALL BARS. BOTTOM OF BEAMS. SLABS < 300MM	300	360	480	600	750	

– STAGGER LAPS AS MUCH AS PRACTICABLE. TOP STEEL SHALL BE LAPPED WITHIN CENTRAL HALF OF THE OF THE BEAM SPAN & BOTTOM BEAM BARS WITHIN 1/4 ON EITHER SIDE OF SUPPORT UNO.

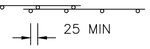
– FOR PLAIN BARS, LAP LENGTHS SHALL BE TWICE THE LENGTHS AS SHOWN ABOVE.

R3. WELDING OF REINFORCEMENT WILL NOT BE PERMITTED UNLESS SHOWN ON THE STRUCTURAL DRAWINGS.

REINFORCEMENT CONT.

R4. ALL REINFORCEMENT FABRIC SHALL COMPLY WITH NZS 3402P AND SHALL BE SUPPLIED AS FLAT SHEETS.

TYPICAL FABRIC LAP: –



R5. PLACE SUFFICIENT BAR CHAIRS UNDER BOTTOM REINFORCING RODS AND TOP CROSSRODS IN SLABS TO ALLOW THEM TO BE SUPPORTED IN THEIR CORRECT POSITIONS DURING CONCRETING (NOT GREATER THAN 900 MM CENTRES BOTH WAYS).

R6. REINFORCEMENT LAYERS DENOTED THUS: –

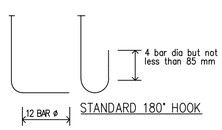
TT - DENOTES TOP BARS LAID LAST
T – DENOTES TOP BARS LAID THIRD
B – DENOTES BOTTOM BARS LAID SECOND
BB – DENOTES BOTTOM BARS LAID FIRST

R7. BENDING OF REINFOREMENT

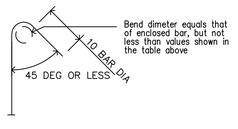
BARS PARTIALLY EMBEDDED IN CONCRETE SHALL NOT BE SITE BENT, UNLESS NOTED OR SHOWN ON THE DRAWINGS OR SPECIFICALLY APPROVED BY THE ENGINEER

THE MINMUM INTERNAL DIAMETER OF BEND OF ALL BARS SHALL BE AS FOLLOWS UNO.

STEEL GRADE	MINIMUM DIAMETER OF BEND			
	MAIN REINFORCEMENT		STIRRUPS & TIES	
	BAR ø	MIN. ø OF BEND	BAR ø.	MIN.ø. OF BEND
GRADE 300 & GRADE 500	10	50	10	40
	12	60	12	50
	16	80	16	70
	20	100	20	80
	25	150		
	32	200		



STANDARD HOOK



STANDARD STIRRUP ANCHORAGE

STEELWORK

S1. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS 4100 AND AS 1554 EXCEPT WHERE VARIED BY THE CONTRACT DOCUMENTS.

S2. UNLESS OTHERWISE NOTED, ALL STEEL SHALL BE IN ACCORDANCE WITH: –

AS 1204 GRADE 350 FOR ROLLED SECTIONS
AS 1163 GRADE 350 or 450 FOR S.H.S AND R.H.S. SECTIONS
AS 1163 GRADE 350 FOR C.H.S. SECTIONS
AS 1204 GRADE 350 FOR ALL HIGH STRENGTH STEEL.

S3. THE BUILDER SHALL PREPARE WORKSHOP DRAWINGS AND SHALL SUBMIT THREE COPIES OF EACH DRAWING FOR APPROVAL. FABRICATION SHALL NOT COMMENCE UNTIL APPROVAL HAS BEEN RECEIVED. APPROVAL DOES NOT INCLUDE DIMENSIONS.

S4. UNLESS NOTED OTHERWISE, ALL BOLTS TO BE 16 DIAMETER COMMERCIAL GRADE STRUCTURAL BOLTS OF GRADE 4.6 SNUG TIGHT (M16–4.6/S) CONFORMING TO AS 1111. ALL BOLTS SHALL BE GRADE 316 STAINLESS STEEL. U.N.O
BOLTS – DESIGNATED BY THE NUMBER, DIAMETER, GRADE AND TIGHTENING PROCEDURE. E.G.
4–M16 4.6/S MEANS 4 16 DIA. COMMERCIAL GRADE BOLTS SNUG TIGHT. 6–M20 8.8TF MEANS 6M20 HIGH STRENGTH STRUCTURAL BOLTS FULLY TENSIONED IN A FRICTION JOINT.
6–M24 8.8TB MEANS 6M24 HIGH STRENGTH STRUCTURAL BOLTS FULLY TENSIONED IN A BEARING JOINT. (SOME SLIP ALLOWED.)

ALL HOLES SHALL BE DRILLED AND SHALL BE 2MM LARGER THAN THE BOLT DIAMETER U.N.O. HOLES IN BASEPLATES MAY BE 5MM LARGER THAN THE BOLT DIAMETER U.N.O. ALL BOLTS SHALL HAVE AT LEAST ONE THREAD PROJECTING THROUGH BOTH SIDES OF THE NUT. BOLT SPACING, EDGE DISTANCES, GAUGE LINES, BEAM COPES ETC, TO CONFORM TO A.I.S.C STANDARDISED CONNECTIONS U.N.O. REMOVE ALL SHARP EDGES AND BURRS.

S5. UNLESS OTHERWISE NOTED, ALL WELDS TO BE 6 MM CONTINUOUS FILLET FROM E41XX ELECTRODES. ALL WELDS SHALL BE GENERAL PURPOSE WELDS UNLESS NOTED OTHERWISE. STRUCTURAL PURPOSE WELDS SHALL BE DENOTED THUS 'SP'. BUTT WELDS WHERE INDICATED IN THE DRAWINGS ARE TO BE COMPLETE PENETRATION BUTT WELDS AS DEFINED IN AS 1554. WELDING SYMBOLS TO AS 1101 PART 3.

S6. CONCRETE ENCASED STEELWORK SHALL BE WRAPPED WITH 665 MESH AND HAVE A MINIMUM OF 50 COVER UNLESS NOTED OTHERWISE.

S7. REFER STRUCTURAL SHEET S01 FOR PAINT OPTIONS

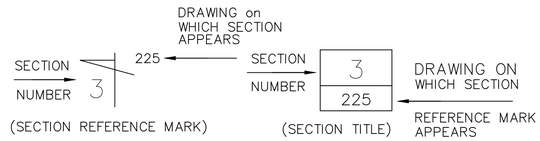
S8. ALL STEEL BOLTS SHALL BE HOT DIPPED GLAVANISED (HDG) AND PAINTED AS PER S7.

STEELWORK CONT.

S9. HIGH STRENGTH FRICTION GRIP BOLTS, NUTS AND WASHERS SHALL COMPLY WITH THE RELEVANT REQUIREMENTS OF AS 1252, SHALL BE INSTALLED IN ACCORDANCE WITH AS 1511 AND SHALL BE TIGHTENED TO THE CORRECT TENSION USING APPROVED LOAD INDICATING WASHERS. CONTACT SURFACES OF ALL HIGH STRENGTH FRICTION GRIP BOLTED CONNECTIONS SHALL BE LEFT UNPAINTED.

S10. THE BUILDER SHALL PROVIDE ALL CLEATS AND DRILL ALL HOLES NECESSARY FOR FIXING STEEL TO STEEL AND TIMBER TO STEEL WHETHER OR NOT DETAILED IN THE DRAWINGS.

DESIGNATION OF CROSS SECTIONS



PRELIMINARY

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.23

DRAWN: UK
DESIGNED: AF/DC
VERIFIED: DC
APPROVED: DC

CLIENT: Ministry of Environment and Energy, Republic of Maldives

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PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

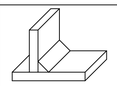
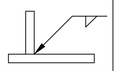
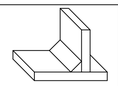
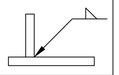
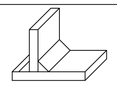
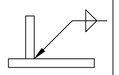
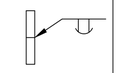
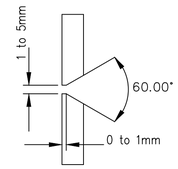
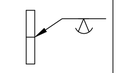
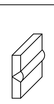
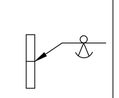
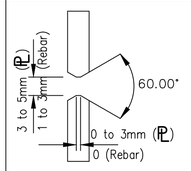
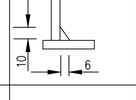
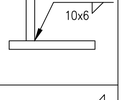
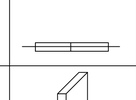
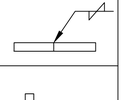
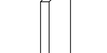
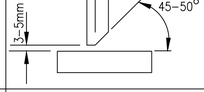
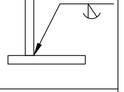
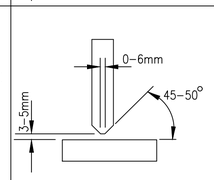
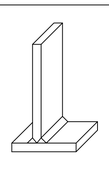
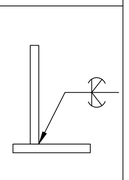
JOB. NO: 210003

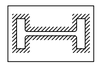
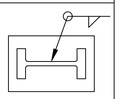
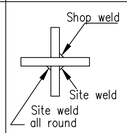
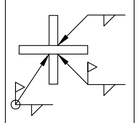
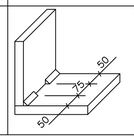
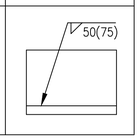
TITLE: STANDARD STRUCTURAL NOTES (1 of 2)

DATUM: - AS SHOWN | SCALE: | SIZE: A1

DWG. NO: SD/SN/01 | REV. NO: A

WELDING SYMBOLS

FORM OF TEXT	NOTES	SKETCH OF WELD	SYMBOLIC REPRESENTATION
FILLET	WHEN THE SYMBOL IS BELOW THE REFERENCE LINE, IT REFERS TO A WELD ON THE "ARROW SIDE" OF THE JOINT.		
FILLET	WHEN THE SYMBOL IS ABOVE THE REFERENCE LINE IT REFERS TO A WELD ON THE "OTHER SIDE" OF THE JOINT.		
DOUBLE FILLET	WHEN THE SYMBOL IS BOTH SIDES OF THE REFERENCE LINE IT REFERS TO WELDS ON "BOTH SIDES" OF THE JOINT.		
SQUARE BUTT	WHEN THIS TYPE OF WELD IS USED COVERING NOTES WILL BE GIVEN.		
SINGLE V BUTT			
SINGLE V BUTT WITH SEALING RUN.			
DOUBLE V BUTT			
SIZE & LENGTH OF FILLET WELDS	SIZE OF WELDS (MM) BEFORE SYMBOL, LENGTH OF WELD (MM) AFTER SYMBOL.		
FILLET WITH UNEQUAL LEG LENGTH	VERTICAL LEG LENGTH (MM) GIVEN FIRST, HORIZONTAL LEG LENGTH (MM) FOLLOWS.		
FLASH BUTT	FOR REINFORCING BAR		
SINGLE BEVEL BUTT			
DOUBLE BEVEL BUTT			

FORM OF TEXT	NOTES	SKETCH OF WELD	SYMBOLIC REPRESENTATION
SHOP WELD ALL ROUND	A CIRCLE AT THE JOINT IN THE REFERENCE LINE INDICATES A CONTINUOUS SHOP WELD ALL AROUND THE JOINT.		
SHOP AND SITE WELD	SITE WELD INDICATED BY FLAG AT THE JOINT IN THE REFERENCE LINE. WITH THE ADDITION OF AN OUTER CIRCLE AT JOINT IN REFERENCE LINE INDICATES A CONTINUOUS SITE WELD ALL ROUND.		
INTER-MITTENT WELDS: LENGTH AND SPACING	WELDED LENGTH GIVEN BY UNBRACKETED NUMBER (MM) SPACE BETWEEN WELD (MM) GIVEN BY BRACKETED NUMBER EG 50(75)		

DRAFTING ABBREVIATIONS

ALT.	ALTERNATE
APPROX.	APPROXIMATE
ADDN	ADDITIONAL
B	BOTTOM
BLK	BLOCKWALL
B.S	BOTH SIDES
BW	BOTHWAYS
C	CENTRE
C/L	CENTRE LINE
C/C	CENTRE TO CENTRE
C/S	COURSES
C.A.R	COVER ALL AROUND
CHS	CIRCULAR HOLLOW SECTION
C.J.	CONTROL JOINT
COL	COLUMN
CONC.	CONCRETE
CONN.	CONNECTION
C.O.S.	CHECK ON SITE
CVR	COVER
CRS	CENTRES
D	DEFORMED BAR GRADE 300E
db	BAR DIAMETER
DET	DETAIL
DIA	DIAMETER
D.J.	DOWELLED JOINT
DPC	DAMP PROOF COURSE
DWG/DRG	DRAWING
EGL	EXISTING GROUND LEVEL
EXTG	EXISTING
EF	EACH FACE
EW	EACH WAY
EL	ELEVATION
EX	OUT OF
FF	FAR FACE
FFL	FINISHED FLOOR LEVEL
FGL	FINISHED GROUND LEVEL
FL	FLAT
GALV'D.	GALVANISED
G.L	GROUND LEVEL
G.P.C.	GROUT PROOF COURSE
HORZ.	HORIZONTAL
H.D	GRADE 500E DEFORMED BARS
I.D	INSIDE DIAMETER
I.L	INVERT LEVEL
I.P	INTERSECTION POINT
KJ	KEYED JOINT
LAR	LAP AT RANDOM
JL	DOUBLE RSA (BACK TO BACK)
LG	LONG
MAX.	MAXIMUM
D	GRADE 300E DEFORMED BARS
MIN.	MINIMUM
MS	MILD STEEL
{N}	NEW
N.D.T	NON-DESTRUCTIVE TESTING
NF	NEAR FACE
NOM.	NOMINAL
No.	NUMBER
NTS	NOT TO SCALE
O/A	OUTSIDE OVERALL
O.D	OUTSIDE DIAMETER
PL.	PLATE
PC	PRECAST CONCRETE
PSC	PRESTRESSED CONCRETE
R	PLAIN BAR GRADE 300
RC	REINFORCED CONCRETE
REINF	REINFORCEMENT
RHS	RECTANGULAR HOLLOW SECTION
SHT	SHEET
SPEC	SPECIFICATION
RSC	ROLLED STEEL CHANNEL
RSJ	ROLLED STEEL JOIST
STIFF	STIFFENER
SIM	SIMILAR
SJ	SAWCUT JOINT
STG	STAGGER
STIR	STIRRUP
STA	STARTER
SHS	SQUARE HOLLOW SECTION
STR, STA	STARTER
SYM.	SYMMETRICAL
T	TOP
TBC	TO BE CONFIRM
TFB	TAPER FLANGE BEAM
THK	THICK
TOC	TOP OF CONCRETE
TOS	TOP OF STEEL
TRM	TRIMMER
TYP	TYPICAL
UB	UNIVERSAL BEAM
UC	UNIVERSAL COLUMN
UNO	UNLESS NOTED OR SHOWN OTHERWISE
U/S	UNDERSIDE
VERT.	VERTICAL
L	SINGLE RSA
VJ	VERTICAL JOINT
VL	VARYING LENGHT
VERT.	VERTICAL

STEELWORK

S7.

PAINT OPTION 1

DESIGN LIFE ≈ 25+ YEARS

SYSTEM NO.	ISO DESIGNATION	SURFACE PREPARATION	FIRST COAT			SECOND COAT			THIRD COAT			TOTAL Nom NDFT µm
			PRODUCT	PRN	Nom NDFT µm	TYPE	PRN	Nom NDFT µm	TYPE	PRN	Nom NDFT µm	
PUR5	A1.23	Sa 2½	Durezinc i90	C01	75	Duremax GPE MIO Ferreko No.3	C13	200	WEATHER MAX. HBR	C15	75	350
			Zincanode 402	C02								

OR PAINT OPTION 2 – DULUX EHB6

DESIGN LIFE ≈ 25 YEARS
STEEL WORK SHALL BE REPAINTED AFTER 25 YEARS
TO OBTAIN A DESIGN LIFE OF 50 YEARS

SYSTEM NO.	ISO DESIGNATION	SURFACE PREPARATION	FIRST COAT			SECOND COAT			THIRD COAT			TOTAL Nom NDFT µm
			PRODUCT	PRN	Nom NDFT µm	TYPE	PRN	Nom NDFT µm	TYPE	PRN	Nom NDFT µm	
EHB6	A1.21	Sa 2½	Durezinc i90	C01	75	Duremax GPE MIO Ferreko No.3	C13	125	Duremax GPE MIO Ferreko No.3	C13	125	325
			Zincanode 402	C02								

NOTE: CONCRETE ENCASED STEELWORK SHALL BE LEFT UNPAINTED.

PRELIMINARY

ISSUE	DESCRIPTION	DESIGNED	DATE
A	PRELIMINARY	AF/DC	17.02.23

DRAWN: UK
DESIGNED: AF/DC
VERIFIED: DC
APPROVED: DC

CLIENT: Ministry of Environment and Energy, Republic of Maldives

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PROJECT: NOLHIVARANFARU ISLAND INFILTRATION GALLERY

JOB. NO: 210003

TITLE: STANDARD STRUCTURAL NOTES (2 of 2)

DATUM: - AS SHOWN | SCALE: | SIZE: A1

DWG. NO: SD/SN/02 | REV. NO: A