

9.1.8

**ELECTRICAL WORKS FOR BUILDING
SERVICES**

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9.1.8 ELECTRICAL WORKS FOR BUILDING SERVICES

9.1.8.1 GENERAL REQUIREMENTS FOR ELECTRICAL WORKS (LIGHTING SYSTEM AND SMALL POWER OUTLETS)

9.1.8.1.1 Power Supply System

The power supply system at all sites will be three (3) phase, 4-wire, 50 Hz system, with the phase and line voltages at 230 V and 400 V respectively. This L.V. supply system will be effectively earthed at the sub-station.

The client will arrange with the Supply Authority to provide the required power at the above stated voltage, at a point in the premises. The Supply Authority will install their own metering equipment and isolating apparatus at this point.

The Equipment Contractor under the other Contract will provide all required arrangements to receive, control and to distribute the supply within the premises where pumping facilities will be provided. For other sites where pumping facilities will not be provided the Contractor shall make all required arrangements including the main cables, brackets, conduits, meter boxes etc., specified by the Supply Authority.

The Main Switch Board to be provided by the Equipment Contractor to receive and distribute power within the premises, will incorporate a separate switch of the specified rating, to control the feeder to the 'BUILDING SERVICES BOARD'. This feeder and the 'BUILDING SERVICES BOARD' shall be supplied and installed by the Contractor as part of the this Contract.

The Contractor shall make his own arrangements for power supply during the period of construction.

9.1.8.1.2 General Requirements

All equipment shall be designed to work satisfactorily in a damp tropical climate, at high humidity averaging 95 percent, and in a dusty environment. The tropicalisation of all equipment to perform satisfactorily and to withstand tropical conditions, is of paramount importance.

The enclosures of all equipment, including switch board cubicles, motor control centres etc., shall be completely insect and vermin proof.

The design of the equipment and their layout shall take into consideration the high 'ISOKERAUNIC LEVEL' (of over 90 days) in the locality.

The maximum ambient temperature may be taken as 40 degree Celsius.

All equipment and their components shall meet the requirements of the latest edition of IEC standards, Sri Lanka standards, JIS or the British standards, where such standards Exist (irrespective of whether they are quoted documents or not).

If equipment complying to other standards are offered an English translations of such standards shall be made available, if so requested. Acceptance of such other standards would be decided by the Engineer.

The electrical system shall be installed and tested in accordance with the requirements of BS 7671.

9.1.8.1.3 Switches and Isolators

For ratings above 63 Amps, Moulded Case Circuit Breakers (MCCB's) shall be used as switches or Isolators. These shall comply with the stipulations in sub-section 9.1.8.1.14.

For ratings below 63 Amps, Miniature Circuit Breakers (MCB's) may be used as Switches/Isolators provided that their short circuit rupturing capacities are adequate. These shall comply with the stipulations in sub-section 9.1.8.1.15.

Fuse switches and Switch fuses shall comply with BS 5419, and shall have fault rating above 30 KA. Fuses shall be of the HRC cartridge type complying to BS 88 or its equivalent.

Earth Leakage protection shall be provided by Residual Current operated devices, complying to sub-section 9.1.8.1.16.

9.1.8.1.4 Consumer Units (Distribution Boards)

Consumer units or Distribution boards shall comply with BS EN 60439-2, 60947-3, 4752 and 88, or their equivalents.

Consumer units or Distribution Boards shall be assembled using an appropriately rated RCCB for incoming control and suitably rated MCB's for each outgoing circuit. The Phase bus, the Neutral bar and the Earthling bar shall all be adequately rated. All these components shall be housed in a water-proof steel enclosure with a spring closed front door. Provision shall be made to record names of each circuit inside the enclosure. Insulated conductors shall be used for all internal wiring inside the Distribution Boards.

9.1.8.1.5 Wiring Accessories

All wiring accessories such as switches, socket outlets, lamp holders etc. shall comply with the relevant British Standards or other equivalent internationally recognised standards.

9.1.8.1.6 Socket Outlets

Socket Outlets for 16 Amp and below shall comply with BS 1363 or its equivalent.

They shall be of the switched type, with interlocked shutters and shall be housed in water-proof galvanised steel box, with screwed on cover.

The socket outlet shall be supplied complete with a fused plug having an HRC fuse cartridge.

Higher rated socket outlets shall comply with BS 4343 or its equivalent.

9.1.8.1.7 Wiring Cables

PVC insulated and sheathed copper conductor cables are to be used throughout the system.

Flexible Cords in final sub-circuits shall have PVC insulated cores with a PVC oversheath.

Colour coding of cables and flexible shall be as stipulated in the BS 7671.

Underground cables laid direct in ground shall be of the armoured type.

Cable sizes shall be selected for continuous operation, at maximum estimated circuit current, with maximum ambient temperature. The effects of grouping of cables and the method of installation shall be taken into account, as required in the BS 7671.

9.1.8.1.8 Lamp Fittings (Luminaries)

All lamp fittings shall comply with BS 4533 and 6500 or to their equivalents. Each fitting shall be complete with:

- (1) Fused terminal blocks to receive connection cables
- (2) Control gear appropriate to the type of lamp
- (3) Internal wiring well secured to the housing or other supports
- (4) Earthing terminals for metallic fittings
- (5) Lamp holders to suit the lamps used, and
- (6) Reflectors or diffusers as appropriate.

The design of the fittings shall ensure that the ingress of water and dust are well prevented. The fittings shall also be fully insect and vermin proof.

Control gear for fluorescent and discharge lamps shall incorporate power factor correction and radio interference suppression. The noise level of control gear shall be below the limits set in BS 2818.

Internal wiring shall employ heat resistant insulation material. Terminals and connections shall be unaffected by vibrations.

Diffusers shall be of extruded plastic or acrylic prismatic material having good resistance to aging in a damp atmosphere, in the presence of high levels of ultra violet radiation.

9.1.8.1.9 Types of Lamp Fittings (Luminaries)

The following types of lamp fittings are to be used in general. The tenderer is free to propose other standard types of fittings, if he so desires subject to the approval of the Engineer.

Luminaire Construction

- U1 Batten Type, with or without reflectors, suitable for fixing on walls or ceilings (indoor use)
- U2 Similar to above, but suspended type.
- U3 Dust Insect-Proof, Round or square for fixing on ceilings or under floor slabs (indoor use)
- U4 Similar to above, but weather-proof for use out-doors.
- U5 Wall lamps with decorative reflector-shades for use indoor.
- U6 Bulk-Head type, weather-proof for fixing on walls or under concrete hoods.
- U7 Industrial type with covered water-proof diffuser.
- U8 Similar to above, but with material suitable for use in corrosive atmosphere.
- U9 Weather-proof street lamps, "Cobra Hood Type" with all fixing accessories in hot-dipped Galvanized steel, complete with all control accessories.
- U10 Emergency lamp, with in-built battery and charger.

Each luminaire is denoted in the drawings by a Luminaire Type Member, derived as follows:

Construction of Luminaire	Type of Lamp Used								
	L1	L2	L3	L4	L5	L6	L7	L8	L9
U1	9	10	13	14					
U2	8	11	12	15	1	2			
U3					3	4	18		
U4					5		16		
U5					6		17		
U6					7		24		
U7	25	26	19	20					
U8			21						
U9								22	23
U10					25				

In the above table, the designation of lamp types and the type of luminaire construction are as follows:

Lamp Types

- L1 - 20W Fluorescent tube, Single
- L2 - 20W Fluorescent tube, Double
- L3 - 40W Fluorescent tube, Single
- L4 - 40W Fluorescent tube, Double
- L5 - Compact Fluorescent lamp, 20W
- L6 - Round Fluorescent lamp, 20W
- L7 - Incandescent lamp, 60W
- L8 - Mercury Vapour lamp, 125W
- L9 - Mercury Vapour lamp, 250W

Emergency Lamp

Type E(1): An Emergency lamp of the automatic self charging type, as described in Clause 9.1.10.

9.1.8.1.10 Emergency Lighting Luminaries:

These shall be of the non-maintained type and shall consist of the lamp, rechargeable sealed nickel-cadmium dry cells, electronic battery charger and mounting gear.

One or two fluorescent lamps rated not less than 20 W, shall be used in any one luminary.

A mains failure relay shall hold DC contacts open when AC supply is on.

The charger shall be designed to fully charge the cells within 12 hours after a complete discharge and then to keep the cells on float charge after recharging.

The combined Ampere-Hour capacity of the cells in any luminaries shall be sufficient for one hour lighting of the lamps continuously before full discharge.

The luminaries shall have proper indication and test facilities in an easily accessible location. It shall be wall mounted at selected positions to be approved by the Engineer.

9.1.8.1.11 Instruments and Meters

All instruments and meters shall comply with the requirements of BS 5685, 89 and/or 90 (or their equivalents).

Meters shall be adequately rated with range of scale at least 25 percent over their full estimated reading under all conditions of operation.

Protection shall be provided to all meters and instruments against voltage and current surges. In particular, their design shall take into account the maximum starting currents to be encountered in motor circuits.

External means of zero adjustment shall be provided where necessary.

9.1.8.1.12 Indicating Lamps

Indicating lamps are to be rated well above their intended use, to obtain long life in service.

Their location on Switch Boards and their method of installation shall take into account their visibility from the front and sides of the Switch Boards. They shall be protected against accidental damage, and be easily replaceable.

9.1.8.1.13 Circuit Breakers (LV)

These shall be manufactured to meet the requirements of BS EN 60947-2 (or its equivalent).

All circuit breakers shall incorporate a "Trip-Free" mechanism.

The contacts shall be suitably designed and adequately sized to handle the rated currents over intended service life of the circuit breaker.

ON/OFF state of the circuit breaker shall be clearly indicated on its front face. Where necessary, locking arrangements are to be provided to secure against unauthorised operation.

Operating characteristics of the protective system used, along with Test Reports in support of them shall be furnished with the bid offer.

9.1.8.1.14 Moulded Case Circuit Breakers (MCCB)

These shall comply with the requirements of BS EN 60947-2 or its equivalent.

Thermal overload tripping and Magnetic short circuit tripping shall be provided in every case. Time delay devices shall be provided where necessary. The tripping "Time-Current" characteristics of the tripping devices shall be submitted for approval of the Engineer. Where adjustable settings are provided, adjustments shall be possible externally.

The contacts shall be of silver alloy or similar material having good current carrying and arc resisting properties.

The enclosing case shall be of non-hygroscopic, arc resisting material with adequate impact strength and suitable for use in tropical climate conditions.

The breakers shall be capable of interrupting short circuit currents up to the specified limit, without any permanent damage to any component of the breaker.

9.1.8.1.15 Miniature Circuit Breakers (MCB)

MCB's shall comply with the requirements of BS 3871 (or its equivalent).

They shall be selected to have short circuit breaking capacities adequate to handle the estimated short circuit currents at the locations where they are used.

The minimum short circuit current rating shall be 8 kA.

9.1.8.1.16 Residual Current Circuit Breakers (RCCB)

Residual current operated type of circuit breakers conforming to BS 4293 (or to its equivalent) shall be used throughout the installation.

The operating current may be selected between 100 mA and 500 mA, depending on the estimated earth leakage current at the location where they are used.

Mal-operation due to lightning surge or switching surge shall be prevented.

External means of test operation of tripping shall be provided.

9.1.8.1.17 Fuse Switches and Switch Fuses

Fuse switches and Switch fuses shall comply with BS EN 60947-3, and shall have fault rating above 30 kA. Fuses shall be of the HRC cartridge type conforming to BS 88 or its equivalent.

Fuses used in motor circuits shall have fusing characteristics to suit the starting currents of the motors.

9.1.8.1.18 Cables

PVC insulated and PVC sheathed copper conductor cables, complying with BS 6346/6360/6746 or their equivalents, are intended to be used in general, inside buildings.

When the cables are buried directly in ground, then XLPE insulated, PVC sheathed cables with Galvanised Steel Wire armouring will be required.

Other types of cables with characteristics not less favourable than those of the above mentioned type may be used. Details of the cables intended to be used shall be submitted for approval of the Engineer.

All cables shall be of the 600/1000V grade.

The maximum permissible current loading for the intended cables, under the specific conditions at site and for the method of installation to be adopted, shall be furnished to the Engineer prior to installation.

9.1.8.1.19 Lighting Posts (Poles)

These may be RC poles or galvanised tubular steel poles of standard design for street lighting subject to approval of the Engineer.

Their design and erection shall ensure stability under maximum wind forces with a factor of safety at least 2.5. The use of stays (guys) shall be avoided as far as possible.

All fixing bolts, brackets, etc., shall be of hot dipped galvanised steel.

9.1.8.1.20 Aircraft Warning Lights

The aircraft warning lights and their installation shall comply with the requirements of the Civil Aviation Department of Sri Lanka.

This shall be low intensity omni directional double obstruction lights of red colour, and shall conform to BS. 3324 part 6, BS 1376 and ICAO Annex 14.

The unit shall consist of two red glass domes made out of aviation red glass with prisms inside for symmetrical light distribution. The base shall be of Aluminium alloy, with anti corrosive epoxy finish. The gasket shall be Neoprene, and the entire unit shall be weather proof, and shall be able to withstand ambient temperature of 50°C. The degree of protection shall be not less than IP 54.

The two lamps shall be compact fluorescent bulbs mounted on 2 pin bayonet cap lamp holders. Both lamps shall be wired in parallel, and shall consist of photoelectric cell for automatic lighting. The unit shall operate on 230V, 50 Hz AC power supply.

9.1.8.1.21 Cabling

Cable sizes shall be so selected as to avoid overheating when carrying 15 percent overload current for sustained periods. Voltage drop along the cable at full load shall not exceed 5% of the standard voltage.

Cables in buildings shall be taken inside uPVC conduits of approved quality. These shall be concealed within the walls or concrete members unless otherwise approved by the Engineer. Cabling above ceilings may be taken inside uPVC conduits fixed to the structural members of the ceiling or the roof.

Cut ends of cables shall at all times be well sealed to prevent ingress of moisture.

No through joints are permissible in any run of cable.

Joints in conduits shall be of an approved type and shall be installed with care to ensure proper protection, alignment and seating. Junction Boxes, Draw-in Boxes and Inspection Boxes shall be provided to facilitate easy installation and subsequent withdrawal of cables.

After installation, ends of all conduits shall be sealed against ingress of moisture.

Cables installed underground outside the buildings shall be taken inside high strength uPVC pipes buried at a depth of 0.75m below ground level. The pipes shall be installed in such a manner so as to prevent ingress of water inside. These pipes are to be installed with a 50 mm sand bedding underneath them and a 50 mm sand fill over them. They shall be protected throughout their length, by placing approved type of RC cable protection tiles adjacent to each other and approximately 100mm above the pipe. A continuous imperishable warning tape shall be placed above the tiles.

9.1.8.1.22 Stand by Generator

The stand-by generator set shall be a self-contained diesel engine driven set with all equipment and accessories as described in the following paragraphs. The engine and generator shall be mounted on a common skid.

The engine control panel may be mounted on the engine with proper resilient fixing. The switch panel and instruments shall be housed in a steel cubicle and is either floor mounted or wall mounted in the engine room.

All equipment shall comply with the requirements for electrical equipment in the specifications.

(A) Engine

(i) General

The diesel engine shall be a four-stroke medium speed engine manufactured and tested in accordance with BS 5514 or its equivalent. It shall be direct coupled to the alternator by semi flexible coupling.

The engine and the alternator shall be mounted on a common skid frame. The mounts shall be of resilient anti-vibration design.

The engine and the alternator shall be mounted on a common skid frame. The mounts shall be of resilient anti-vibration design.

The engine and alternator assembly shall be easily detachable for removal and repair.

(ii) Ratings

The diesel generator set shall be rated for continuous output at the generator terminals as specified in this specification.

The engine and generator shall have a 10 percent overload capacity for one hour in a period of 12-hour operation.

(iii) Fuel

The engine will be required to run on commercially available auto diesel fuel.

The fuel tank on the engine shall have minimum capacity to hold sufficient fuel for 8 hours operation of the set at full load. In addition a reserve fuel tank with minimum capacity to hold sufficient fuel for 150 hours full load operation shall also be provided on both fuel tanks. The reserve fuel tank may be accommodated inside the engine room or just outside.

(iv) Engine Cooling

The engine shall be radiator cooled. The radiator capacity shall be selected considering outside ambient temperature as stated in the specification. The radiator tubes and fins shall be specially treated against corrosion. Resilient anti-vibration type mountings shall be used for the radiator.

(v) Engine Exhaust

The exhaust piping and silencer shall be fully heat insulated. The silencer capacity shall be sufficient to limit the noise level to be below 85 DB at a distance of 10 meters. Exhaust pipes shall be directed away from the capacity of the set in such a manner as to prevent them being drawn in by the radiator fan.

(vi) Engine Starting

Starting shall be by a DC motor supplied from a bank of heavy duty lead acid batteries static type battery charger to be connected to the AC 230 V single phase supply of the building shall be

provided. The battery charging equipment shall have both quick charging and trickle charging facilities.

(vii) Engine Governor

The Governor shall be the mechanical or electronic type meeting the requirements of class A2 of BS 5514. An over-riding manual control, capable of varying the speed within +/- 2.5 percent of rated speed shall also be provided.

(viii) Engine Protection

The following protective systems shall be provided on the engine for the following parameters.

- (a) Low lubricating oil pressure
- (b) High cooling water temperature and
- (c) Engine over speed.

The protective systems (a) and (b) required above shall be have two stages with an audible alarm being activated at the first stage and the engine being shut down at the second stage.

(ix) Instruments

The following instruments shall be provided as a minimum requirement

- (a) Tachometer indicating the speed of the engine and also the cumulative hours.
- (b) Lubricating oil pressure gauge, with the working pressure range clearly marked on the dial.
- (c) Lubricating oil and cooling water temperature indicators with the working ranges of temperatures clearly marked on the respective dials.
- (d) Ammeter to indicate battery charging current.

(x) Engine Control Panel

The engine control panel shall include the following

- (a) Manually operated "Start/Stop" Switch
- (b) Manually operated "Emergency Stop" button.

B Generator

(i) General

The generator shall be a 3-phase, 4 wire, star connected alternator having output voltage 230/400 V at 50 Hz.

The insulation of all windings shall be fully tropicalised to inhibit deterioration under high humidity and ambient temperature stated in the specification.

The alternator shall comply with the requirements of BS 5000 part 99 or its equivalent.

(ii) Excitation

Brushless type three phase exciter, with self exciting and self regulating characteristics shall be used. Special precautions shall be taken to ensure that exciter characteristics are not liable to change due aging under tropical conditions.

(iii) Voltage Regulations

The output voltage of the generator shall be regulated to be within ± 3 percent of the rated voltage for all loading upto the rated load and at all power factors ranging from unity to 0.8. an over-riding manual voltage regulator capable of adjusting voltage over the same range shall be provided on the generator control panel.

(iv) Alternator Windings

The alternator windings shall be star connected with the neutral point brought out to a separate terminal for earthing. The windings shall have insulation class F or better and be fully tropicalised. The windings shall be designed with adequate short time overload capability for satisfactory motor starting operations.

A thermostatically controlled space heater shall be provided to maintain the temperature of the windings about 5 degrees Celsius above the ambient temperature. The supply to the space heater shall be automatically switched off when the generator is in operation.

C Other Equipments

(i) Switch Board

A generator switch board shall be mounted within the engine room and this shall accommodate all instruments and controls for the engine generator set.

This switch board shall also accommodate the following:

A suitably rated MCCB with overload and earth leakage protection to control the feeders to the outside load.

Ammeters and Voltmeters to measure the output from the generator.

(ii) Accessories

The following accessories shall be included in the offer.

Complete set of equipment for "Automatic Mains Failure" operation of the set, including automatic transfer switch.

(iii) Spares and Tools

The offer shall include a priced list of spares estimated by the manufacturer to be required for 3000 hours operation of the engine generator set.

The above required spare parts with accompanying list of identifying part numbers and illustrative diagrams shall be supplied with the engine generator set. The spare parts shall be properly identified and specially packed for long storage.

A complete set of tools required for the dismantling and maintenance of the engine – generator set together with a comprehensive operation and maintenance Manual and spare parts list shall be included in the offer.

9.1.8.2 LIGHTNING PROTECTION

9.1.8.2.1 General Requirements

A complete lightning protection system for the water tower structure shall be supplied and installed. All components of the system and their installation shall comply with BS 6651 or its equivalent.

The earthing station for the lightning system shall be separate from that of the general electrical installation in the premises.

If different metals are used in the system, adequate precaution shall be taken against electrolytic corrosion at the interfaces.

The location of the water towers have high Isokeraunic Level and hence the entire lightning protection system shall be designed and installed to have high reliability.

9.1.8.2.2 Air Terminations (Finials)

The lightning conductor air termination shall incorporate means to promote excitation at lower values of electrostatic fields. Certified type test reports from a recognised independent laboratory shall be submitted to substantiate the efficiency and coverage of the air termination device.

9.1.8.2.3 Down Conductors

Connection from the finials to the earthing station shall have a *minimum* sectional area of 50 sq. mm and shall be securely fixed to the rod supporting the finials, and to the tank structure. All fixing materials used are to be fully weather proof requiring no maintenance after installation. The part of the down conductor upto 3 m from ground level shall be encased in high strength PVC pipe of adequate internal diameter.

9.1.8.2.4 Testing Point

Every down conductor shall be provided with a Testing Point close to, and before connection to, the Earthing Station. The testing point shall be conveniently located and shall be guarded against inadvertent or unauthorised tampering. At the testing point it shall be possible to conveniently detach the down conductor from the Earth Termination for purposes of resistance measurements. No additional joints are permissible between the testing point and the earthing station. The joint at the testing station shall be well protected against adverse effects of the weather.

9.1.8.2.5 Earth Station

The earth station shall consist of a single or a set of interconnected earth pipes, rods or plates, buried as close as possible to the testing point. The materials used shall be long lasting without the need for periodic maintenance after installation. The earth resistance of the station under dry weather conditions shall not exceed 10 Ohms.

**9.2 PARTICULAR SPECIFICATIONS
– CIVIL WORKS**

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9.2 PARTICULAR SPECIFICATIONS – CIVIL WORKS

9.2.1 LOCATION AND SCOPE OF WORK

9.2.1.1. SCOPE OF WORK

This CONTRACT FOR CIVIL WORKS (Contract No.....) under the PROJECT FOR REDUCTION OF NON-REVENUE WATER comprises the construction works of the following:

- a. Construction and Rehabilitation of Reservoirs
- b. Water Supply Enhancement in Kotikawatta and Mulleriyawa area
- c. Rehabilitation & Reinforcement of Medium and Large Diameter Mains in CMC
- d. Rehabilitation & Replacement of Small Diameter Pipe Network in CB1
- e. Supply of equipment and materials for implementation of NRW Reduction Action Plan

This contract also includes supply, installation and commissioning of electrical pumping plant, electrical power and instrumentation equipment in addition to Civil Engineering works.

9.2.1.2 LOCATION OF WORK

The Works under this Contract are located within the Colombo Municipal Council (CMC) Area and within Kotikawatte and Mulleriyawa Pradeshiya Sabha (PS) area.

9.2.1.3 CONSTRUCTION AND REHABILITATION OF RESERVOIRS

The work includes construction and rehabilitation of the following facilities including supply and installation of all materials and equipment required for completion of the work.

9.2.1.3.1 Maligakanda New Office Building

Construction of a four-storeyed RC building with a total floor area of approximately 3,100 m², including the provision of basic services and utilities.

9.2.1.3.2 Maligakanda New Reservoir

Construction of a circular post-tensioned clear water ground reservoir with a capacity of 22,000 m³. The reservoir has an internal diameter of 53 m and a water height of 10 m, and will be constructed using segmental post-tensioned concrete for the walls and a reinforced concrete flat slab supported on columns for the roof.

9.2.1.3.3 Rehabilitation of the Roof Structure of the Existing Maligakanda Reservoir

Rehabilitation of the roof structure of an existing clear water reservoir (57 m x 57.5 m x 10.9 m deep) built in 1885. The work includes the demolition of the existing un-reinforced multi-span barrel

vault roof structure and the construction of a new reinforced concrete flat slab roof structure with a set of supporting reinforced concrete columns built on a new set of reinforced concrete pad footings.

9.2.1.3.4 Ellie House Reservoir

The work comprises the demolition of an existing reservoir (109 m x 59 m x 6 m deep) built in 1905 and the construction of a new reinforced concrete clear water reservoir. The new reservoir has a total capacity of 36,600 m³ with a plan dimension of approximately 63 m x 110 m and a water height of 5.25 m, and is divided into three cells: 2 x 13,000 m³ and 1 x 10,600 m³.

9.2.1.4 WATER SUPPLY ENHANCEMENT IN KOTIKAWATTE AND MULLERIYAWA AREA

The work includes construction of the following facilities, including supply and installation of all materials and equipment required for completion of the work.

9.2.1.4.1 Gothatuwa – Kolonnawa Pump House

Construction of a pump house within the premises of the Ambatale Water Treatment Plant. The pump house has a plan dimension of 20.5 m x 14 m and accommodates 3 units of double suction horizontal shaft volute pumps, each having a capacity of 14 m³/min x 50 m x 165 kW.

9.2.1.4.2 Gothatuwa Transmission Main

Construction of ductile iron main from the Gothatuwa-Kolonnawa Pump House to the Gothatuwa Ground Reservoir, for clear water transmission, with a total length of 4.36 km, comprising 2.54 km and 1.82 km sections of 800 mm and 500 mm diameter respectively.

9.2.1.4.3 Gothatuwa Ground Reservoir and Pump House

The work comprises the construction of a 4,400 m³ reinforced concrete ground clear water reservoir (27.3 m x 33.3 m x 5.2 m deep) and a pump house to be built attached to the ground reservoir. The pump house has a plan dimension of 9.5 m x 19.5 m and accommodates 2 units of double suction horizontal shaft volute pumps, each having a capacity of 18 m³/min x 30 m x 130 kW. A diesel generator is provided for stand-by power.

9.2.1.4.4 Gothatuwa New Water Tower

Construction of a 1,500 m³ reinforced concrete water tower of the Intz-type design with a cylindrical water tank having an effective water depth of 5 m supported on a circular reinforced concrete shaft bearing onto a raft foundation. The low water level in the tank is set at approximately 18.5 m above the ground to match the existing water tower which will be inter-connected with the new tank.

9.2.1.4.5 Distribution Mains in Kotikawatte and Mulleriyawa Area

Construction of distribution mains with a total length of approximately 39.7 km, ranging from 100 to 500 mm in size; comprising 23.3 km of PVC mains (200 mm and smaller in diameter) and 16.4 km of ductile iron mains (250 mm and larger in diameter).

These rehabilitation and pipelines are located mostly along public roads, and will include canal crossings which will require the Contractor's co-operation and co-ordination with the concerned authorities. The canal crossings of 300 mm DI mains along Angoda Road and Delgahawatta Road where separate supporting structures on piers will have to be constructed.

9.2.1.5 REHABILITATION & REINFORCEMENT OF MEDIUM AND LARGE DIAMETER PIPE NETWORK IN CMC AREA

The work includes rehabilitation and reinforcement of medium and large diameter main pipe network in CMC area, including supply of all pipes, fittings, valves and other ancillary materials required for completion of the work.

9.2.1.5.1 Rehabilitation of Medium and Large Diameter Mains

Rehabilitation of existing un-lined cast iron distribution mains (250 to 450 mm in diameter) with a total length of 27.9 km by means of scraping and cement mortar lining. The work also includes the replacement of existing valves, which have been attached to the distribution mains to be rehabilitated and to other existing distribution mains.

9.2.1.5.2 Reinforcement of Medium and Large Diameter Mains

Construction of new ductile iron mains (300 to 500 mm in diameter) with a total length of 9.3 km.

9.2.1.6 REHABILITATION & REPLACEMENT OF SMALL DIAMETER DISTRIBUTION MAINS IN CB1 AREA

The work includes replacement of existing cast iron mains (3, 4 & 5 inches in diameter) with PVC mains (110 to 225 mm in diameter) for a total length of 32.6 km, including replacement of existing valves and service connections, which have been attached both to the cast iron mains to be replaced and to other existing distribution mains. In addition, the work includes rehabilitation of existing 6-inch mains for a total length of 7.5 km by means of scraping and cement mortar lining. The work also includes supply of all pipes, fittings, valves and other ancillary materials required for completion of the work.

9.2.1.7 SUPPLY OF EQUIPMENT AND MATERIALS FOR IMPLEMENTATION OF NON-REVENUE WATER REDUCTION ACTION PLAN

The work includes supply of water meters, leak repair materials, leak detection equipment, and other materials and equipment which will be used for implementation of non-revenue water reduction action plan.

9.2.1.8 INTENT OF CONTRACT DOCUMENTS

It is the intent of the Contract Documents to provide for the execution and completion of all details of the work described in the Contract Documents, and it is to be understood that the Contractor, will furnish all labour, material, equipment, tools, transportation and necessary supplies required to execute the Contract in a satisfactory manner and in accordance with the Contract Documents.

9.2.1.9 PROGRAMME

The Contractor's construction programme shall comply with the requirements set out in Sub-section 9.2.3.1 of the specification and the Contractor shall also accommodate the following particular requirements in the preparation of his programme.

- (a) Entry into roads for the purpose of the contract will depend on permission from the Roads Authorities. This will in the first place depend on the submission and approval of the Contractor's programme for work in each section of road from first cutting through to hydraulic testing, completion of backfill to approval of Road Authority, temporary reinstatement where necessary and hand over to the Roads Authorities on completion.
- (b) Demolition of building work at Maligakanda site to be carried out in stages and shifting of underground services with the approval of the relevant authorities.
- (c) Pipe work required for building into reservoirs and other water retaining structures shall be scheduled for early delivery so that they may be built-in one operation with the construction of the related structures.
- (d) Construction work at Ambatale needs to be very cautiously planned in order not to disrupt the pumping operations. Some float must be allowed for this activity to cater to unforeseen delays due to any operational problems. Before commencing any construction work specially at Ambatale, the Contractor is expected to identify and locate the existing underground services within the proposed area of construction.

9.2.1.10 INTERCHANGEABILITY OF STANDARDS

Whenever reference standards appear in these specifications, they are intended to be the latest available. However, in case of materials meeting other internationally accepted standards, must ensure an equal or higher quality than the reference standards, the Contractor shall provide and prove that the substituted materials and standards are better than or equal to those specified in the Specification. The Engineer have the right to accept or reject the Contractor's proposal.

9.2.1.11 MINIMUM STANDARD

The Specifications and Contract Drawings define a minimum standards for materials, manufacture and workmanship. The Contractor shall include in his bid the cost of any additional work or improvements in the quality of the work, that he may consider necessary to unconditionally guarantee the performance of the completed work in conformity with the Contract. All such proposals shall be given in

the form of an annex as per clause 9.1 (iv) of Instruction for bidding but there is no obligation on the part of the Employer to accept any of the Bidder's proposal.

9.2.1.12 WORKMANSHIP

The quality of the workmanship and materials shall be compatible with BS EN ISO 9000 Series Quality Assurance Standards.

9.2.1.13 SPECIFICATIONS TO BE KEPT ON SITE

The Contractor shall have a copy of these specifications and all other standard specifications or parts of specifications referred to herein on the site at all times. All specifications shall be produced upon demand by the Engineer. Failure to have copies of all specifications on site will be considered as an infraction to the Contract and delays caused to the works as a result will be the Contractor's responsibility.

9.2.1.14 PRE-CONSTRUCTION CONFERENCE

Prior to the start of Work at site, a pre-construction meeting will be held at a mutually agreed time and place, attended by representatives of;

- The Contractor, the Engineer and/or his representatives
- Representatives of other Agency or Authority as appropriate, and
- Others as requested by the Contractor, the Employer or the Engineer

Before the meeting, the Contractor shall submit to the Engineer, his tentative proposals for each of the following:

- Administrative and Technical Organisation, Key Positions and Curriculum Vitae of the key staff to be employed for this project on full time basis locally and overseas.
- Overall Construction Programme and Progress (see 9.2.3.1)
- List of work intended to be sub contracted and details of sub contractors,
- List of Contractor's equipment including use, numbers, type and capacity,
- Proposal for location and size of the camps, offices, work shops and stores etc.,
- Computer system and soft ware to be used in producing detail programmes and sub programmes and for monitoring and updating the progress, and resources through out the project,
- Details of normal hours of working (as per Clause 45.1 of the Conditions of particular application),
- Forms of shop drawings for materials and other submittals for approval
- Procurement of imported materials
- Procurement of local materials such as Ready mix concrete, Steel, Cement, Pipes & Fittings, Valves & Specials etc,
- Values for progress (running) payment purposes – Cash flow
- Format of monthly interim statement

The purpose of the meeting is to designate responsible personnel and establish a working relationship. Matters requiring co-ordination will be discussed and procedures for handling such matters will be established. The agenda will include:

- Contractor's tentative overall programme and sub programmes
 - Contractor's proposed method of work and site organisation
 - Transmittal, review and distribution of Contractor's submittals
 - Processing applications for payment & payment procedures
 - Maintaining record documents
 - Critical work sequencing
 - Field decisions and variations
 - Use of office and storage areas, security, and the Employer's needs
 - Major procured items, deliveries and priorities
 - Contractor's assignments for safety and first aid
 - Co-ordinate with outside agencies.
- Any other relevant matters

9.2.1.15 PROGRESS MEETINGS

The Engineer shall schedule and hold regular progress meetings at least monthly and at other times as required by the progress of the work, to review the progress of the work, maintain co-ordination of efforts, discuss programme changes, and resolve other problems which may develop.

The Contractor and the Engineer shall be represented at each meeting. The Contractor may at his discretion request the attendance of representatives of his suppliers, manufacturers, and other sub-contractors. The Engineer shall preside at the meetings and the Engineer shall provide for keeping and distribution of the minutes.

9.2.1.16 SITE ADMINISTRATION

The Contractor shall be responsible for all areas of the site used by him, and all his sub-contractors in the performance of the work. He will exert full control over the actions of all his employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to the Engineer or others. The Contractor has the right to exclude from the site all persons who have no purpose related to the Work or its inspection or to operations related to dominant rights to the site.

The contractor shall provide a sufficient number of interpreters at sites to facilitate effective communication, to the satisfaction of the Engineer.

9.2.1.17 REQUIREMENTS OF AUTHORITIES AND AGENCIES

The Contractor shall be responsible for full compliance with the requirements of all duly constituted Authorities and Agencies concerned with any or all of the work under this Contract. The

Contractor shall give to the Engineer copies of all written notices required by the authority and the responses given.

Specific requirements for dealing with the Road Authorities and with Authorities concerned with river crossings are included in this specification but this shall not relieve the Contractor of his general obligations under this clause.

The Contractor shall have early discussions with this authorities as regards their requirements and procedures and seek the assistance of the Engineer where necessary to arrange such discussions.

9.2.2 CONTROL OF WORK

9.2.2.1 LAND FOR CONSTRUCTION PURPOSES

(1) Public Property

Permits or approval for work to proceed shall be obtained by the Contractor from relevant agencies with the assistance of the Employer. All works performed and all operations of the Contractor, his employees or sub-contractors, within the limit of the public property, shall be in conformity with the requirements and be under the control (through the Employer) of such agencies owning or having jurisdiction over and control of the right-of-way in each case. Those relevant agencies include but not limited to the following:

- Road Development Authority (RDA)
- Provincial Road Development Authority (PRDA)
- Sri Lanka Ports Authority
- Colombo Municipal Council (CMC)
- Kotikawatta Mulleriyawa Pradeshiya Sabha
- Survey Department
- Ceylon Electricity Board (CEB) and/or Lanka Electricity Company (LECO),
- Sri Lanka Telecom (SLT)

Materials or equipment shall not be placed on the property until the relevant agency has agreed to the location to be used for storage. The locations and extents of the areas so used shall be within the property line directed by relevant agencies. The Contractor shall immediately move stored materials or equipment at his own cost, if any occasion arises or when requested by the relevant agency, as instructed by the Engineer.

Utilities and other concerned agencies shall be contacted and permission shall be obtained prior to cutting or closing roads, streets or other traffic areas or excavating near underground utilities or pole lines.

(2) Private Property

The contractor shall not enter for any deliveries or occupy for any other purpose with men, tools, equipment, construction materials, or with materials excavated from any trench or pit, any private property outside the designated construction easement boundaries without written permission from the owner and/or tenant of the property.

Whenever the easement is occupied by crops which will be damaged by construction operations, the Contractor shall notify the Engineer and owner or tenant sufficiently in advance so that where possible the crops may be removed before excavation or trenching is started. The Contractor shall be responsible for all damage outside of the easement, and shall make satisfactory settlement at his own cost for the damage directly with the property owner and/or tenant involved. The Contractor shall prepare Condition Report of the area likely to be affected by the works to be agreed with the owner/tenant and the Engineer.

(3) Access to Private Property

When it is necessary to temporarily deny access to owners or tenants to their property, or when any utility service connection must be interrupted, the Contractor shall give notice as prescribed herein or by the relevant Authority sufficiently in advance to enable the affected persons to provide for their needs. Notices will include appropriate information concerning the interruption and instructions on how to limit their inconvenience.

9.2.2.2 SURVEYING AND SETTING OUT

All Work shall be done to the lines, grades, and elevations shown on the Drawings.

Basic horizontal and vertical control points will be established by the Contractor from the points designated by the Engineer on the drawings. These points shall be checked by the Contractor and shall be used as datum for the work. All additional survey, layout, and measurement work shall be performed by the Contractor as a part of the work without any additional cost to the Employer.

The Contractor shall provide experienced surveyors and instrument men, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout and measurement work. In addition, the Contractor shall furnish, without charge, competent men from his force and such tools, stakes, and other materials as the Engineer may require in establishing or designating control points, in establishing construction easement boundaries, or in checking survey, layout, and measurement work performed by the Contractor.

The Contractor shall keep the Engineer informed, with a reasonable time in advance, of the times and places at which he wishes to do work, so that horizontal and vertical control points may be checked by the Engineer with minimum inconvenience to him and minimum delay.

The Contractor shall remove and reconstruct work which is improperly located.

9.2.2.3 CONSTRUCTION PLANT

The Contractor shall furnish constructional plant and equipment which will be appropriate type and capacity to secure a satisfactory quality of work and rate of progress to ensure completion of the work within the time stipulated in the Contract. The Contractor shall also furnish to the Engineer list of all constructional plant and equipment that he intends to deploy at site before commencement of work.

9.2.2.4 LOCATIONS OF WORK

Pipelines and structures will be located substantially as indicated on the Drawings. The Engineer reserves the right to modify locations to avoid interference with existing structures and utilities or for other reasons.

9.2.2.5 OPEN TRENCH SAFETY

The length of open trench will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer which may include overnight closure.

9.2.2.6 UNCOVERING WORK FOR INSPECTION & CORRECTION OF DEFECTIVE WORKS

Contractor shall perform all cutting, removal, patching and repairs required for the work as may be necessary in connection with uncovering work for inspection or for the correction of defective works for the installation of improperly timed work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or the installation of new work in existing construction.

Except when the cutting or removal of existing construction is specified or indicated, the contractor shall not undertake any cutting or removal which may affect the structural stability of the Work or existing facilities without Engineer's concurrence.

The Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all works and existing facilities during cutting, removal, patching and repair operations.

Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the work. Materials shall be removed in a careful manner with no damage to adjacent facilities or materials. Materials which are not salvageable shall be removed from the site by the Contractor.

All works and existing facilities affected by cutting & patching operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be redone and refinished.

9.2.2.7 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

The Contractor shall assume full responsibility at no additional cost to the Employer for the protection of all buildings, structures, natural embankment and utilities, public or private including poles, signs, services to buildings, utilities in the street, water pipes, hydrants, drains and electric and telephone ducts and conduits, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind.

The Contractor shall bear full responsibility for obtaining all locations of underground structures and utilities. Services to buildings shall be maintained. Prior to commencement of work in the vicinity of structures likely to be affected by the works, the Contractor shall prepare a condition report of such structures to be agreed with owner and the Engineer.

Some details of existing utility services are available and may be inspected at the office of the Engineer. The Employer accepted no responsibility whatsoever for any omissions or for the correct representative on the drawings of these services.

In collaboration with the Engineer, the Contractor shall contact the local officials of each of the Statutory Authorities responsible for buried services and shall maintain close liaison with them throughout the construction. Under the co-ordination of the Engineer the positions of all main services liable to interference by the construction shall be established prior to commencement of work, trial holes being made at the Contractor's expense where the information cannot be derived from records or surface indications. Apart from verifying positions to avoid damage, scrutiny is needed to clarify those main

services which might conflict with the drawings. Where conflicts arise the Engineer will consider whether an amendment to the design can be made or a diversion of the existing main service is needed.

Early scrutiny of these services is essential to enable any such diversions to be made in advance of the construction.

In addition to the scrutiny referred to above the Contractor shall take all reasonable precautions to prevent damage to existing buried main services and connections to buildings.

The Engineer may be able to extend assistance by writing only to the various authorities and requesting them to give information to the Contractor.

Where service connections conflict with the Permanent Works, their diversions will be agreed in detail by the Engineer when the connections are encountered. Drain and sewer diversions shall be made by the Contractor and other diversions by the Statutory Authority unless prior agreement is obtained from them for the work to be done by the Contractor. Engineer will co-ordinate this work and will issue detailed instructions for each diversion.

Crossings under service connections to individual premises or properties, for water services and for sewerage and drains, shall be deemed to be included in the Contractor's rates for excavation.

The Contractor shall in any case provide adequate temporary support to all existing services and connections that are exposed or partially exposed or otherwise weakened by the excavation, and should any damage occur shall immediately notify the Engineer and Statutory Authority and afford every facility for the repair of the affected service. Such repairs shall be at the expense of the Contractor.

In addition to the precautions to be taken with buried services the Contractor shall ensure that his plant and equipment do not damage pipeline or pipe supports above ground or any overhead electricity or telephone cables. He shall also take all precautions to prevent his plant from operating too closely to overhead high tension cables, and he shall in conjunction with the Engineer and Electricity Authority, establish all necessary precautions for crossings under such cables. No mechanical excavation will be permitted within 2 meters of the established positions of high voltage cables. If power lines need to be diverted, the Contractor will have to initiate such action prior to commencement of work through the agency concerned in liaison with the Engineer.

9.2.2.8 OBSTRUCTION OF UTILITY SERVICES

The Contractor shall ensure that all existing hydrants, valves, or other utility controls shall remain unobstructed and accessible during the construction of the work.

9.2.2.9 OPERATION OF UTILITY SERVICES

The Contractor shall obtain written approval from the Authorities concerned before operating any valve, switch, or other control on existing utility services.

All consumers affected by such operation shall be notified by the Contractor, before the operation of the date, time and probable length of time of service interruption.

9.2.2.10 MAINTENANCE OF FLOW

The Contractor shall provide alternative arrangement for the flow of drains and water courses interrupted during the progress of the work, and shall immediately remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer well in advance of the interference of any flow.

9.2.2.11 PROVISIONS FOR TRAFFIC AND DETOURS

The Contractor shall conduct his construction so that interference with the flow of traffic is kept to a minimum. He shall construct temporary bridging across his trenches where necessary for traffic including access to private property and to pedestrians. Road shall not be closed unless permitted by the relevant road authority. Where detours are permitted the Contractor shall provide all luminous barricades, red warning lights, and traffic signs required to divert the flow of traffic and shall expedite construction operations to minimise disruption.

9.2.2.12 CO-OPERATION WITH OTHER SUB CONTRACTORS

The Contractor shall plan, schedule, and co-ordinate his operations in a manner which will facilitate simultaneous progress of the work with other sub contractors , and shall be responsible for ensuring co-operation and co-ordination is maintained.

9.2.2.13 CLEAN-UP WORK TO BE DONE

The Contractor shall bear full responsibility for the protection of all finished exterior and interior surfaces, fixtures and equipment from stains, marks, dirt or damage of any kind, from the time of their construction, finishing, or installation until the time of final handing over the fully completed work to the Employer.

Before requesting an inspection of the completed works with the intent of final acceptance, the Contractor shall do all necessary cleaning, making good, and touching up that may be required to leave all finished surfaces, fixtures and equipment in acceptable condition, in accordance with the full intent and meaning of these specifications. The Contractor shall observe the following particular requirements which shall be recognised as setting the standard for the final condition of the work.

(1) Building Sites

Remove all surplus material, leave the site in a clean neat and satisfactory condition to the approval of the Engineer.

(2) All Exposed Concrete, Masonry and Sheet Metal

Thoroughly clean all exposed concrete masonry and sheet metal to eliminate mortar droppings.

(3) Glass

If necessary repair, wash and thoroughly clean glass on all faces and free it from excess glazing compound, paint and scratches. Air spaces of double-glazed sash shall be absolutely free from shavings, sawdust or dirt of any kind.

(4) Painted, Enamelled and Varnished Surfaces

Clean all such surfaces of all marks, stains, scratches, fingerprints or other damage.

(5) Floor Surfaces

Remove all temporary protective coverings and shall leave all surfaces clean, unmarked and free from stains, and where specified, properly waxed and polished.

(6) Glazed Walls

Clean all glazed wall surfaces of stains or spattered paint.

(7) Finish Hardware, Lighting Fixtures and Electrical Outlet Plates

Clean and polish and leave free from paint, dirt or dust, particularly all hinges which shall be oiled.

(8) Duct Work

Remove dust and debris from all duct work.

(9) Roof Surfaces

Ensure that Roof topping, where shown on the drawings, is evenly spread, intact and free from construction debris, nails or any other foreign matter.

(10) Electrical Equipment, Appurtenances

Ensure that all equipment is properly operating and maintained to the satisfaction of the Engineer, is equipped with all necessary fittings and controls and that the applicable operating and maintenance manuals for all equipment have been furnished to the Engineer.

(11) Plumbing and Plumbing Fixtures

Free all pipes and fittings from dirt and debris, clean and polish all fixtures and ensure that facilities are in proper working order.

(12) Pipe Work

(13) Check all piping works for sufficient supports, water tightness, and cleanliness.

Control and Safety Equipment

Ensure that all such equipment is properly operating, calibrated and maintained for the service intended and left in a clean condition.

9.2.2.14 FLOTATION

The Contractor shall take all necessary precautions against the flotation of any structures or pipelines whatever during construction. The Contractor shall be responsible for any damage caused by flotation and for making good such damage.

9.2.2.15 INCONVENIENCE AND RIGHT OF ACCESS

The construction of the works shall be carried out avoiding inconvenience as far as possible to the owners and occupants of properties adjacent to the works.

9.2.2.16 PREVENTIVE MEASURES FOR WATER INTERRUPTION

The Contractor shall also ensure that he has stocks of repair fittings and pipe at each pipe laying gang location to be able immediately to effect repairs and minimise interruption of supplies in event of accidental pipe severance.

9.2.2.17 EXCESS FILL MATERIAL

The Contractor shall be responsible making all arrangements for the disposal of all excess fill material from any excavation not considered for use in the grading and other purposes and for handling of this excess material over whole distance from the point of excavation to the point of disposal.

9.2.2.18 PUMPING AND DRAINAGE

The Contractor shall dispose of all groundwater and surface runoff to existing water courses with all measures needed to prevent excessive solid materials being discharged, all in a manner approved by the Engineer.

9.2.2.19 OVERHEAD CONSTRUCTION

No machinery shall be employed which, in the opinion of the Engineer, will unduly interfere with wires and other overhead construction.

9.2.2.20 UNFAVOURABLE CONSTRUCTION CONDITIONS

During unfavourable weather, wet ground, or other unsuitable construction conditions, the Contractor shall confine his operations to work which will not be affected adversely by such conditions. No portion of the work shall be constructed under conditions which would adversely affect the quality or efficiency thereof, unless special means or precautions are taken by the Contractor to perform the work in a proper and satisfactory manner to the approval of the Engineer.

9.2.2.21 PUBLIC NOTICE OF STARTING WORK

The Contractor shall provide and distribute to all residents in the area which may be affected by the work, a printed notice in Sinhala, Tamil and English languages in full page size with wording similar to that shown in the next page.

NOTICE

TO THE PEOPLE IN THIS AREA

WITHIN THE NEXT FEW DAYS, WORK WILL BE STARTED ON THE CONSTRUCTION OF NEW WATER SUPPLY FACILITIES.

This work may cause some inconvenience but will be of permanent benefit.

We shall appreciate your co-operation on the following matters:

1. Please be alert when driving or walking in or near the Construction area.
2. Tools, materials, and equipment are attractive to children. For the safety of the children, please keep them away.
3. Please report all inconvenience to the Foreman on the job, or call the office at the number given below.

The work is being performed for the National Water Supply and Drainage Board, by:

(Insert Firm Name, Address, and Telephone Number of the Contractor in this space)

In the case complaint you may contact us on the above telephone.

We will endeavour to complete this work as rapidly as possible and with a minimum of inconvenience to you.

Date of Notice :

Signed:

Title :

9.2.3 SUBMITTALS

9.2.3.1 CONSTRUCTION PROGRAMME

The Contractor shall submit six (06) copies of his overall construction programme within twenty-eight (28) days of Contract Award. The Contractor shall comply with the following in the preparation and presentation of his programme:

- (a) Use appropriate computer based project management software. The system used shall clearly show the Contractor's construction programme, resources, procurement and cash-flow requirements, and during the course of the contract be capable of clearly showing progress compared to the programme.
- (b) The overall construction programme submitted shall be in bar chart form and shall show the start and finish dates of the principal preparatory and construction operations, including mobilisation, approvals of materials and equipment, procurement and delivery of imported materials and equipment, construction and installation, testing commissioning and hand-over.
- (c) A graph showing the build-up of staff and labour resources related to the tasks and work identified in the Construction Programme.
- (d) A schedule of major plant and their time on site related to the Construction Programme.
- (e) A Critical Path Network (CPN) showing the optimum order of work, available time for each activity and effects of delays. The CPN shall be updated during the course of the contract to show construction sequence changes that may arise, together with the changes in resources needed to maintain the overall schedule for completion of the contract on time.
- (f) Programming shall take into account.
 - The Notice to Commence Work
 - The periods for approval of the programme or subsequent revisions thereto
 - The periods for approvals procurement and delivery to site of Materials and equipment required for incorporation in the permanent works.

Approval of the programme and of the materials and of shop drawings shall not relieve the Contractor of any of his responsibilities under the contract.

- (g) Six copies of programme revisions that become necessary during the course of the work shall be submitted to the Engineer for approval of the details at least three days before the proposed revision is to be implemented. Six copies of the revised programme as approved shall be supplied to the Engineer within three (03) days of approval being given.

- (h) The overall programme shall be based on sub-programmes for each sub-project. The sub-programmes shall include all the principal tasks envisaged to be required for the proper execution of the sub-project.

In the case of pipe-laying in roads the periods required to obtain permission from the relevant authorities for entry into the roads and for the execution of the work until completion of testing and hand-over to the authorities for final reinstatement work shall be included. The Contractor will be required to discuss the sub-programmes for each section of road with the Engineer and the relevant roads authorities prior to entry, and will be expected to make such changes to the order of work as the authorities may impose.

9.2.3.2 PHOTOGRAPHIC RECORD

The Engineer will maintain the photographic record every month during the construction work. The Contractor shall submit a report in duplicate to the Engineer with Photo Prints using a digital camera.

9.2.3.3 SURVEY DATA

All field books, notes, and other data developed by the Contractor in performing surveys required as part of the work shall be made available to the Engineer for examination throughout the construction period. All such data shall be submitted to the Engineer with the other documentation required for final acceptance of the work. Where measurement for payment is required, the survey shall be done in the presence of the Engineer.

9.2.3.4 SHOP DRAWINGS AND ENGINEERING DATA

All shop drawings, regardless of origin, shall be stamped bearing the approval of the Contractor and identified with the name and number of this Contract, Contractor's name, and references to applicable specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the work. When catalogue pages are submitted, applicable items shall be clearly identified. The current revision, issue number and/or date shall be indicated on all shop drawings and other descriptive data.

Shop drawings for tower crane shall be signed and sealed by a chartered structural engineer. Design loads, foundation details, details showing interface with permanent structures and construction sequence as effected by the installation of crane shall be submitted.

The Contractor's stamp of approval will be representation to the Employer and the Engineer that the Contractor has assumed full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalogue numbers, and similar data, and that he has reviewed or co-ordinated each submittal with the requirements of the work and the Contract Documents.

The Engineer will accept no shop drawing or other submittal from anyone but the Contractor. The Contractor shall be responsible for any submittals from suppliers and manufacturers.

Engineering data covering all equipment and fabricated materials to be furnished under this contract shall be submitted to the Engineer for review. These data shall include drawings and descriptive

information in sufficient detail to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorage, and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment.

At the time of each submission, the Contractor shall indicate in writing all deviations that the submittal may have from the Contract Documents. Such submittals shall as pertinent to the deviation, include drawings showing essential details of any changes proposed by the Contractor and all required wiring and piping layouts.

When corrected copies are resubmitted, the Contractor shall in writing direct specific attention to revision other than those called for by the Engineer on previous submissions.

No Work shall be performed in connection with the fabrication or manufacture of materials and equipment, nor shall any accessory or appurtenance be purchased, until the shop drawings and data therefore have been reviewed, except at Contractor's own risk and responsibility.

Four (4) copies (or at the option of Engineer, one (1) reproducible copy), of each shop drawing and necessary data shall be submitted to the Engineer. When the shop drawings and data (two (2) copies) are returned to the Contractor marked EXCEPTIONS NOTED the corrections shall be made as noted thereon and as instructed by the Engineer and not less than two (2) additional copies of all such shop drawings and data shall be furnished after final review.

When the drawings and data are returned marked NO EXCEPTIONS NOTED, not less than two (2) additional copies shall be furnished.

The Engineer's review of shop drawings and data submitted by the Contractor will cover only general conformity to the Drawings and specifications, external connections, and dimensions which affect the layout. The Engineer's review of shop drawings returned marked NO EXCEPTIONS NOTED or EXCEPTIONS NOTED does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device, or items shown.

All shop drawings and data, after final processing by the Engineer, shall become a part of the Contract Documents and work shall conform to the shop drawings and data unless otherwise authorised by the Engineer.

Any need for more than one (1) re-submission, or any other delay in obtaining the Engineer's review of submittals, will not entitle the Contractor to extension of the Contract Time unless delay of the work is directly caused by failure of the Engineer to return any submittal within twenty eight (28) days after its receipt in his office.

9.2.3.5 "AS-BUILT" DRAWINGS

As each portion of work is completed the Contractor shall submit one copy of the draft "As-Built" drawings for Engineer's approval. "As-Built" Drawings are required as a record of all work carried out. "As-Built" drawings to be furnished the Original in Drafting Film Paper, two negatives on sepia papers and photocopy prints. In these drawings necessary to indicate "As-Built" conditions, including field modifications, and furnish additional copies for insertion in equipment instruction books or

operation and maintenance manuals as required. All such copies shall be clearly marked "AS-BUILT". Production of "As-Built" Drawings shall proceed with the construction work and will be considered as part of the completed product.

In the case of the Distribution System and Transmission Mains, the "As-Built" Drawings shall indicate at least three (3) tie measurements for each and every tee junction, sluice valve, washout valve, air valve, non-return valve, fire hydrants and bends facilitating subsequent identification of buried installations. If such locations occur more than 200m apart along the pipeline, tie measurements for additional locations on pipeline shall be provided so that the locations with tie measurements are not more than 200m apart. Where pipelines are laid to curvature with deflection at joints, tie measurements shall be indicated at closer intervals to the approval of the Engineer.

The "As-Built" Drawings at the pipeline junctions and interconnections showing the schematic arrangements (Junction Details) shall be presented on A1 size (841mm x 594mm) sheets, arranged in sequential order along each pipeline. Lettering shall be sized and arranged to enable A3 size reductions to be legible. The Drafting Film shall be "Ozadraft drafting film 70" or equivalent quality approved by the Engineer.

9.2.3.6 OPERATION AND MAINTENANCE DATA AND MANUALS

Adequate operation and maintenance information shall be supplied for all equipment requiring operation and maintenance or other attention. The equipment supplier shall prepare an operation and maintenance manual for each type of equipment indicated herein. Parts lists and operation and maintenance instructions shall be furnished for other equipment not listed in this schedule when requested by the Engineer.

Operation and maintenance manuals shall generally include but not limited to the following as relevant:

- Equipment function, normal operating characteristics, and limiting conditions
- Assembly, installation, alignment, adjustment, and checking instructions
- Safety precautions for operation and maintenance
- Lubrication and maintenance instructions
- Schematic job guides showing operation procedures for major equipment and system (copy of sketch or other proper presentation shall be suitably displayed on equipment side on plastic panel)
- Guide to "troubleshooting"
- Parts lists with part numbers and predicted life of parts subject to wear
- Outline, cross section, and assembly drawings, engineering data, and wiring diagrams
- Test data and performance curves, where applicable
- Contact organisations / persons for after sale services

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by the Contractor.

Manuals and other data shall be printed on heavy, first quality paper, A4 size with standard 2-hole punching with ring binder with a punching interval of 8 cm. Drawings and diagrams shall be reduced to A4 or A3 size or where reduction is not practicable, larger drawings shall be folded to A4 size

separately and placed in envelopes which are bound into the manuals. Each envelope shall bear suitable identification on the outside.

One (1) preliminary copy of each manual, temporarily bound in heavy paper covers bearing suitable identification, shall be submitted to the Engineer prior to the date of shipment of the equipment. After review by the Engineer, the approved final of each operation and maintenance manual together with three (3) copies shall be prepared and delivered to the Engineer not later than thirty (30) days prior to placing the equipment in operation.

Final manuals and all parts lists and information shall be assembled in substantial and permanent, two-ring or two-post binders in one or separate volumes as instructed by the Engineer. As much as possible, material shall be assembled and bound in the same order as specified, and each volume shall have a table of contents and suitable index tabs.

All material shall be marked with Project identification, and inapplicable information shall be marked out or deleted.

Operation and maintenance manuals shall be prepared for the following but not limited to:

Type of Equipment
Pumps
Gate Valve
Butterfly Valve
Air Valve
Non-Return Valve
Ductile Iron Pipes & fittings
PVC Pipes & fittings
Steel Pipes & fittings
Pressure Control Valve
Fire Hydrant

9.2.3.7 LAYOUT DATA

The Contractor shall keep neat and legible notes of measurements and calculations made by him in connection with the layout of the work. Copies of such data shall be furnished to the Engineer for use in checking the Contractor's layout as provided under Lines and Grades. All such data considered of value to the Employer will be transmitted to the Employer by the Engineer with other records upon completion of the work.

9.2.3.8 STANDARDS AND SPECIFICATIONS

The Contractors shall provide the Engineer with two sets of each standard and specification referred to in this specification concerning equipment, materials and workmanship.

9.2.4 CONTROL OF MATERIALS

9.2.4.1 APPROVAL OF MATERIALS AND EQUIPMENT

Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and approval of the Engineer. No material shall be incorporated into the work without approval of the Engineer.

The Contractor shall submit to the Engineer data relating to materials and equipment he proposes to furnish for the work. Such data shall be of sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.

Facilities and labour for the handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit samples of materials for such special tests to demonstrate that they conform to the specifications. Such samples shall be furnished, stored and tested as directed at the Contractor's expense.

The Contractor shall submit data and samples sufficiently early but not less than twenty one (21) days prior to the approval required date to permit consideration and approval before materials are ordered. Any delay of approval resulting from the Contractor's failure to submit samples or data timely shall not be used as a basis of a claim against the Employer.

In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes, and surfaces the Contractor shall provide such samples of workmanship of finish as may be required by the Engineer.

9.2.4.2 INSPECTION AND TESTING

All items of pipe materials shall be subject to formal inspection and testing before despatch. Unless otherwise authorised by the Engineer the Contractor shall arrange routine and functional tests to demonstrate to the Engineer conformity with the Specification. The Employer may, under a separate contract, employ the services of a specialist firm to assist the Engineer as he may require in any matter connected with inspection and testing.

No material shall be delivered to the site without formal inspection and testing unless otherwise waived in writing by the Engineer with a certificate issued by the Contractor which is endorsed by the Engineer that the item conforms to the requirement of the Contract in all respects.

When requested by the Engineer, and in his presence, the Contractor shall perform or make arrangements for all tests and analysis of materials, equipment, and structures in accordance with the relevant clauses of the specifications. All facilities, labour, and materials required for the satisfactory performance of these tests, analysis, and inspections, whether on the site, at the place of delivery, at the manufacturer's laboratory, or at an independent testing laboratory shall be supplied by the Contractor at his own expense.

The Employer and/or Engineer may make surprise inspections at any of the manufacturing or shipping points at any time in addition to the schedule provided in this specification at the cost of the Employer. However, during such inspection, if it is found that any of the items is not being manufactured or shipped in accordance with the specifications, the Contractor shall bear all expenses including fees incurred by the Employer and/or Engineer in respect of such inspections.

The Engineer may require the Contractor to submit the material testing results for his approval before the material is used. The testing shall be performed at an independent laboratory approved by the Engineer.

The Contractor shall furnish the required samples together with test results when requested at least three (3) weeks before he anticipates ordering them to allow time for the Engineer to make a decision.

The following inspection and shop tests shall be made:

Specification Section	Item	Required Number of Inspection
Section 9.1.3	Ductile Iron Pipes and fittings	one time before each shipment
Section 9.1.3	Steels Pipes and fittings	one time before each shipment
Section 9.1.3	PVC fittings	one time before each shipment
Section 9.1.3	Valves & Fire Hydrants & Other Specials	one time before each shipment

Any inspections carried out by the Engineer shall not relieve the Contractor of his obligations under the Contract.

9.2.4.3 EQUIVALENT MATERIALS AND EQUIPMENT

Whenever a material is specified by using the name of the standard and/or class internationally accepted, the specified item mentioned shall be understood as the minimum acceptable standard. Other material may be accepted provided that sufficient information is submitted as specified in Sub-section 9.2.1.10 of this Specification to allow the Engineer to determine that the materials proposed are equivalent to or better than those named. Such items shall be submitted for review by the procedure set forth in Section 9.2.3 of this Specification "Submittals".

9.2.4.4 HANDLING AND STORAGE OF MATERIALS

All materials and equipment to be incorporated in the work shall be handled and stored by the manufacturer, supplier, and the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, and any injury, theft or damage of any kind whatsoever to the material or equipment.

Pipe shall be stored & handle as per the relevant Clauses in the Section 9.1.3 of this Specification.

Cement and lime shall be stored, covered and off the ground, and shall be kept completely dry at all times. All structural steel, miscellaneous steel, and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and in a position to prevent accumulations of standing water and to minimise rusting. Beams shall be stored with the webs vertical. Pre-cast concrete elements shall be handled and stored in a manner to prevent accumulations of dirt, and stagnation of water, staining, chipping or cracking. Masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, and spilling to a minimum.

All equipment subject to corrosive damage by the atmosphere if stored outdoors (even though covered) shall be stored in a building to prevent damage. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer.

Any materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the replacement of the damaged material or its removal.

Manufactured materials shall be delivered and stored in their original containers, plainly marked, with identification of material and manufacturer, provided that original containers are fit for storage under local conditions.

9.2.4.5 MATERIALS STOCK CONTROL

The Contractor shall store all goods in a methodical and systematic manner, so that he can control his work efficiently and in particular in the case of materials to be used in the permanent works, the Engineer can physically monitor the amounts in stock.

Each month or at such other times as may be requested by the Engineer the Contractor shall submit his up-to-date stock list of imported materials required for the permanent works. In any case such list must be submitted with the Contractor's monthly valuation.

9.2.4.6 SALVAGE OF MATERIALS AND EQUIPMENT

Existing materials and equipment removed, and not reused, as a part of the work shall remain property of the relevant agency.

The Contractor shall carefully remove, in a manner to prevent damage, all materials and equipment specified or indicated to be salvaged and reused or to remain property of the relevant agency. He shall store and protect salvaged items specified or indicated to be reused in the work.

Salvaged items not to be reused in the work, but to remain property of the relevant agency, shall be transported and delivered by the Contractor in good condition to the owner as may be decided by the Engineer.

Any items damaged in removal, storage, handling or transportation through carelessness or improper procedures shall be replaced by the Contractor in kind with new items.

The Contractor may, at his option and expense furnish and install new items acceptable to the Engineer without additional cost in lieu of those specified or indicated to be salvaged and reused, in which case such removed items will become the Contractor's property.

Existing materials and equipment removed by the Contractor shall not be reused in the work except where so specified or indicated.

9.2.4.7 MANUFACTURER'S FIELD SERVICES

(1) **Services Furnished Under This Contract**

An experienced, competent, and authorized representative of the manufacturer of equipment and/or system indicated in the Field Services Schedule below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall visit the job site as often as necessary until all troubles are corrected and the equipment installation and operation are performed to satisfaction of the Engineer.

Each manufacturer's representative shall furnish to the Engineer, through the Contractor, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free of any undue stress imposed by connecting pipe or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be borne by the Contractor.

(2) **Field Service Schedule**

The Contractor shall provide the necessary field service of the manufacturers, at his own cost.

9.2.5 GENERAL EQUIPMENT STIPULATIONS

9.2.5.1 SCOPE

All equipment furnished and installed under this Contract shall conform to the general stipulations set forth in this Section except as otherwise specified in other sections of the Specifications.

9.2.5.2 CO-ORDINATION

The Contractor shall co-ordinate all details of the equipment with other related parts of the work, including verification that all structures, piping, wiring, and equipment components are compatible. The Contractor shall be responsible for all structural and other alterations in the work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

9.2.5.3 MANUFACTURER'S EXPERIENCE

Manufacturers shall have expressed as specified in Appendix to Bid Schedule IV, Volume 1.

9.2.5.4 WORKMANSHIP AND MATERIALS

The Contractor shall furnish guarantees from manufacturers for all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage or other failure for a period of two (2) years, unless otherwise specified. Under this guarantee the Contractor agrees to have replaced, correct without delay at no expense to the Employer any such fault including the failure of any equipment or any part thereof to successfully perform within the limits of the specifications and further shall make good any damage caused by such failure. The Engineer will give prompt written notice of observed defects to the Contractor. If after notice, the manufacturer fails to proceed promptly to comply with the terms of his guarantee, the Contractor will be held liable for all expenses incurred by the Employer in replacing or getting the defects remedied and for all other losses.

All equipment shall be designed, fabricated, assembled, and installed in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that spare parts, furnished at any time can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

9.2.5.5 ANCHOR BOLTS

Equipment suppliers shall furnish suitable anchor bolts with nuts, washers and sleeves of adequate design as required for proper anchorage of the bases and bed plates to the concrete base for each item of equipment. Anchor bolts, together with templates and setting drawings, shall be delivered in a timely manner to permit setting the anchor bolts when the structural concrete is placed.

Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on base plates shall be long enough to permit a minimum 40 mm of grout beneath the base plate and to provide adequate anchorage into structural concrete.

Anchor bolts, nuts, washers and sleeves for use under submerged or intermittently submerged condition shall be of stainless steel.

9.2.5.6 EQUIPMENT BASES

The Contractor shall provide the base for pumps and other equipment.

Unless otherwise specified all equipment shall be installed on concrete bases at least 100 mm high.

9.2.5.7 SPECIAL TOOLS AND ACCESSORIES

Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

9.2.5.8 SHOP PAINTING

All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth uniform base for painting. Surfaces to be painted after installation shall be shop painted with one or more coats of a primer which will adequately protect the equipment until finish coats are applied.

Machined, polished, and non-ferrous surfaces which are not to be painted shall be coated with rust preventive compound.

9.2.5.9 PREPARATION FOR SHIPMENT

All equipment and materials shall be suitably packaged, sea-worthy where required, to facilitate handling and protect against damage during transit and storage. All equipment and material shall be boxed, crated, or otherwise completely enclosed and/or protected during shipment, handling, and storage. All equipment shall be protected from exposure to the detrimental elements and shall be kept thoroughly dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment and material shall be tagged or marked as identified in the delivery schedule and/or on the shop drawings. *Complete packing lists and bills of material shall be included with each shipment.*

9.2.5.10 STORAGE

Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the work.

Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage *when installed in the work.*

9.2.5.11 INSTALLATION AND OPERATION

All equipment installed under this Contract shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other start-up activity shall be provided by or through the Contractor.

9.2.6 TEMPORARY FACILITIES

9.2.6.1 CONTRACTOR'S FIELD OFFICE

A Contractor's field office shall be established in proximity to each job site at the location approved by the Engineer, and shall be maintained in a clean, orderly condition by the Contractor for the duration of construction unless earlier removal is authorised by the Engineer. The Contractor or his authorised representative shall be present in the office at all times while work is in progress. Instructions received there from the Engineer shall be considered as delivered to the Contractor.

The Contractor shall also provide mobile offices for each pipeline work site.

9.2.6.2 TEMPORARY WORKSHOP AND DWELLINGS FOR EMPLOYEE'S

Prior to constructing workshop or dwellings at the job site, permission shall be obtained from the Engineer. Workshops shall be constructed in such a manner that they will not be an obstacle to the movements of the general public, shall not cause noise pollution and shall be aesthetically acceptable. The area shall be kept clean at all times. If the Contractor provides living accommodation for those employed by him, the dwellings shall be maintained in a clean and sanitary condition. Each dwelling unit shall be provided with lights, water supply and sanitary facilities and properly furnished.

9.2.6.3 ENGINEER'S FIELD OFFICES

(1) General

The Contractor shall provide one (1) main field office, five (5) sub field offices and mobile type field offices for each pipeline sites for the use of the Engineer, as specified in this section.

Within thirty (30) calendar days after signing of the contract agreement, the Contractor shall have completed the installation and furnishing of the Engineer's main field office and sub-field offices at locations approved by the Engineer. The field offices may be rented houses provided they conform with the requirements specified.

All office equipment and furnishings shall be for the exclusive use of the Engineer. The office shall be maintained by the Contractor until the Engineer moves from the temporary offices and in to the newly constructed facilities within a reasonable time after the issue of the Certificate of Completion of the works, at which time the office by the Engineer will cease, and equipment and furnishings of the main office and sub field offices shall be handed over to the Employer which will become the property of the Employer thereafter. The structures shall be removed to the satisfaction of the Engineer.

The Contractor shall provide the Engineer with mobile field offices for inspection of the pipeline construction work, not later than the commencement of the pipe laying work at site. The mobile office shall be maintain by the Contractor until the completion of pipe laying works. Equipment and furnishing of the mobile field offices shall become the property of the Contractor thereafter.

The offices and the equipment and furnishings installed therein shall be provided and well maintained during the above period by the Contractor.

The main field office and sub offices shall be weather proofed, insulated, and painted internally and externally. Floor to ceiling height shall be at least 2.7 metres. Each external wall of each room shall have at least one screened window. All windows shall have curtains. The office shall have at least two external lockable doors with screened storm doors.

The Contractor shall provide janitorial services to maintain a good working environment and security service at each office.

Water and electricity supply including receptacles shall be provided. The offices shall be well lighted, equipped with ceiling fans and air conditioners with temperature control capable of maintaining a constant temperature of about 25°C. The Contractor shall provide all wiring, receptacles and fixtures in accordance with relevant codes and regulations.

The Contractor shall pay cost of utilities for Engineer's Field Offices until the such time the Engineer moves into newly constructed facility.

Offices in general shall comply with local building ordinances and be provided with all necessary fire extinguishers and an approved first-aid kit.

(2) Engineers Main Field Office

The Engineer's Main Field Office shall be made up as follows:

Room	Approximate Area (sq. m)
Project Manager's Room	25
Chief Resident Engineer's Room	25
Resident Engineers Room	15 x 3 rooms
Other Staff Room	15 x 4 rooms
Conference Room/Space	40
Minor Staff Room	25
Storage Room	15
Equipment Room (Photo Copy Machine etc.)	25
Kitchen	10
Wash Room	10
Toilet (Water Closet)	2
Total Plan Area	300 approx.

The kitchen shall contain a sink, 7/10 cu.m refrigerator, one burner gas cooker with a 13.5 kg gas cylinder, lockable cupboard (approx. 1.9 x 0.7 x 0.9 m high) with formica top.

The wash room shall contain low level suite complete with fittings, 550 x 375 mm wash basin, 500 x 400 mm mirror, a shower, towel racks, soap holder etc. All plumbing fittings shall be porcelain and all plumbing including pipes shall comply with local laws and regulations.

Parking shed shall be constructed and maintained for at least five (5) motor vehicles for the Engineer's use.

(3) Furnishing and Equipment for the Engineer's Main Field Office

At the Main Field Office specified above, new furniture and equipment as shown below shall be provided to approval of the Engineer:

Item	Quantity
Steel tables 1.6 m x 0.9 m with six lockable drawers	2
Steel tables 1.5 m x 0.75m with six lockable drawers	12
Conference table 1.8 m x 3.6 m with 10 chairs	1
Typist Table with a drawer , 1.2 m x 0.6 m	1
Swivel medium back executive chairs	10
Arm chairs	30
Steel Cupboard 1.8 m x 0.9 m x 0.45 m	2
4-drawer steel filing cabinet	8
3-drawer steel drawing cabinet.	2
Steel book shelf 1.8 m x 1.2 m	8
White board 1.0 m x 1.5 m	2
Telephone Line (with 10 extensions)	1
Electric Typewriter (IBM Selectric or equivalent)	1
Scientific calculators	16
Heavy duty photocopy machine A 3 size with 10 bin sorter	1
Dry-type photocopy machine , A1 size	1
Scanner IBM compatible A4 size high resolution colour	1
High quality digital camera	1
Steel cash box	1
File trays	20
Waste paper baskets	10
Water filter	2

(4) Engineer's Field Sub Offices

The Contractor shall provide Four (4) sub offices within the project area, in the locations as specified below;

- at Maligakanda - close to the new Reservoir Site
 - at Ellie House - close to the Reservoir Site
 - at Ambatale - close to proposed Gothatuwa-Kolonnawa Pump House
 - at Gothatuwa - close to the Ground Reservoir and Tower Site
- within CB1 area of CMC

Each of these sub offices shall be made up as follows;

Room	Approximate Area (sq. m)
Resident Engineer's Room	12
Other Staff Room	15
Minor Staff Room	12
Wash Room	6
Kitchen	10
Total Plan Area	55

The wash room shall contain low level suite complete with fittings, wash basin, a mirror, a shower, towel racks etc. All plumbing fittings shall be porcelain and all plumbing including pipes shall comply with local laws and regulations.

Parking shed shall be available for 2 motor vehicles.

(5) Furnishing and Equipment for Engineer's Field Sub Office

Following new furniture and equipment shall be provided in each of the field sub offices'.

Item	No
Steel tables 1.5 m x 0.75 m with three lockable drawers	1
Steel tables 1.2 m x 0.6 m with one lockable drawer	1
Arm chairs	6
4-drawer steel filing cabinet	1
3-drawer steel drawing cabinet.	1
Steel book shelf 1.8 m x 1.2 m	1
Water filters	1
File Trays	2

(6) Mobile Field Offices

The Contractor shall provide the Engineer, mobile type offices for each pipe laying work etc.

Each of the mobile office shall be of caravan type, with a space of 15m². Adequate ventilation and sanitation facilities shall be provided to the approval of the Engineer.

Each Mobile Office shall be supplied with the following new furniture,

Item	No
Steel tables 1.2 m x 0.6 m with one lockable drawers	1
Arm chairs	2
Drawing rack.	1
Water filters	1
File Trays	2

(7) Telephone facilities

The Contractor shall install in the Engineer's Main field office a new telephone line with 8 extensions, and each sub office a telephone in the name of Employer for the Engineer's use and maintain it in good working order. In addition, the Contractor shall supply the Engineer two mobile telephones and maintain it until reverts to the Contractor on completion of the project..

9.2.6.4 SURVEY AND MEASURING INSTRUMENTS

The Contractor shall provide all survey and measuring instruments of every kind necessary for his own use in the execution of the Works and others as required by and for the exclusive use of the Engineer. Each item shall be approved in writing by the Engineer before being accepted and shall be new at the start of the Contract or reconditioned by the manufacturer with a comprehensive test certificate which shall be available for inspection by the Engineer. These instruments shall remain the property of the Contractor.

The Contractor shall provide for the Engineer's Representative and his staff such waterproof clothing, safety helmets, rubber boots, torches, and the like as may reasonably be required by them.

9.2.6.5 FIELD LABORATORY

The Contractor shall construct the Field Laboratory and maintain it during the construction period to the satisfaction of the Engineer. The Field Laboratory is for the use of the Engineer. The Field Laboratory shall be located in the vicinity of the site which shall be proposed by the Contractor and approved by the Engineer.

The Field Laboratory building have effective floor area of not less than 40 sq.m and shall be designed, proposed and constructed by the Contractor after securing the approval of the Engineer.

The Contractor shall supply and furnish the Field Laboratory with the following new furniture and equipment:

Description	Quantity
Table 1.5 m x 0.75 m with six lockable drawers	1
Straight chair	4
Table 1.8 m x 3.6 m	2
Waste basket large, solid sides, no wire	2
Wall Board, not smaller than 2.5 m x 1.5 m	2
Cupboard with shelves and locks	2
File cabinet four drawers, lock type	1
12,500 BTU air conditioner	2

The Contractor shall furnish enough equipment and apparatus for the purpose of carrying out the required concrete and soil tests. The laboratory equipment and apparatus shall be of approved types and shall be adequate in the opinion of the Engineer to carry out all the tests as listed in the Specifications.

The following minimum equipment and apparatus shall be furnished to the laboratory by the Contractor.

Laboratory Equipment

Designation	Specifications	Quantity
1. Modified Proctor Compaction	ASTM-D-1557	2 sets
2. Moisture Content	ASTM-D-2216	2 sets
3. Particle Size Analysis	ASTM-D-422	1 set
4. Specific Gravity	ASTM-D-854-58	1 set
5. In-situ Density		1 set
6. Concrete Slump	BS - 1881	4 sets
7. Concrete Cube moulds	BS - 1881	96
8. Cube crushing machine		1
9. Temperature controlled water bath for cube curing		1

The tank for curing shall be of adequate size of accommodate all test cubes at Contractor's highest rate of production of concrete.

The Contractor shall maintain the Field Laboratory and assist the Engineer for operation of the laboratory throughout the course of the Contract. The Contractor shall supply one English Speaking competent laboratory technician, and two labourers for operation of the Laboratory under the Engineer.

The power, water, and gas shall be supplied to the Field laboratory by the Contractor. The daily laboratory supplies shall also be supplied by the Contractor.

At the end of the Contract, all equipment, apparatus and furniture of the Field Laboratory shall become the property of the Contractor, and shall be removed from the site.

9.2.6.6 WATER

The responsibility shall be upon the Contractor to provide and maintain at his own expense an adequate supply of potable water for his use and his subcontractor's work for construction and domestic consumption and to install and maintain necessary supply connections and piping for the same, but only at such locations and in such a manner as may be approved by the Engineer. Before final acceptance, temporary connections and piping, installed by the Contractor, shall be removed to the satisfaction of the Engineer, unless requested by the Engineer to be left, upon agreement on price.

9.2.6.7 ELECTRICITY

All electrical current required by the Contractor shall be furnished at his own expense. All temporary connections for electricity shall be subject to the approval of the Engineer. All temporary lines shall be furnished, installed, connected and maintained by the Contractor in a workmanlike manner satisfactory to the Engineer, and shall be removed by the Contractor in like manner, at his expense, prior to final acceptance of the works, unless requested by the Engineer to be left, upon agreement on price.

9.2.6.8 SANITARY ARRANGEMENTS

The Contractor shall provide and maintain temporary sanitary facilities such as pour flush latrines and septic tank on the site for the use of all persons connected with the work. The Contractor shall keep the site in a clean and sanitary condition, and shall post notices and take such precautions as may be necessary to keep the site clean. The Contractor shall carry out any cleaning whatsoever as may be directed by the Engineer to maintain such sanitary conditions.

9.2.6.9 FIRST AID

The Contractor shall provide all necessary first aid facilities, attendants and supplies for his labour force, all sub-contractors and suppliers, in accordance with all government rules and regulations and all other statutory requirements and/or to the satisfaction of the appropriate government departments, the Employer and the Engineer. First aid boxes with adequate supplies shall be maintained at all the Engineer's field offices.

9.2.6.10 BARRICADES AND LIGHTS

All streets, roads, highways, and other public thoroughfares which are allowed by the authorities to be closed to traffic shall be protected by effective barricades on which light and acceptable warning signs shall be placed. Barricades shall be located at the nearest intersecting public highway or street on each side of the blocked section.

All open trenches and other excavations shall have suitable barricades, signs, and lights to provide adequate protection to the public. Obstructions such as material piles and equipment shall be provided with similar warning signs and lights.

All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the work on or alongside public streets and highways shall cause the minimum obstruction and inconvenience to the travelling public.

All barricades, traffic cones, warning tapes, signs, lights and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within railroad and highway right-of-way, as required by the agency having jurisdiction thereupon.

9.2.6.11 FENCES

All existing fences affected by the work shall be maintained by the Contractor until completion of the work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across the construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

On completion of the work across any tract of land, the Contractor shall restore all fences to their original or to a better condition and to their original location.

9.2.6.12 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

The Contractor shall protect, shore, brace, support, and maintain all structures, underground pipes, conduits, drains, and other underground constructions uncovered or otherwise affected by his construction operations. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all sod and shrubs in yards and parking, shall be restored to their original condition, whether within or outside the easement. All replacements shall be made with new materials.

The Contractor shall be responsible for all damage to structures, streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or men to or from the work or any part or site thereof, whether by him or his sub-contractors. The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction thereupon, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

The Contractor shall minimise the cutting and removal of trees and other vegetation. All cutting and removal shall be to the approval of the Engineer.

9.2.6.13 SECURITY

The Contractor shall be responsible for protection of the site, and all works, materials, equipment, and existing facilities thereof, against vandals and other unauthorised persons.

No claim shall be made against the Employer by reason of any act of an employee or trespasser, and the Contractor shall make good all damage to the property of the owner resulting from his failure to provide security measures as specified.

Security measures shall be at least equal to those usually provided by the NWSDB to protect the similar existing facilities during normal operation, but shall also include any additional security fencing, barricades, lighting, watchman services, or other measures as required to protect the site.

9.2.6.14 ACCESS ROADS

The Contractor shall arrange with property owners to establish and maintain temporary access roads to various parts of his site as required to complete the Project at his cost. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project. Existing public access roads in use by the Contractor in connection with the execution of the Contract shall also be maintained by the Contractor.

9.2.6.15 PARKING

The Contractor shall provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the contract at the site, as

required to avoid parking personal vehicles where they may interfere with public traffic, property owner's operations, or construction activities.

The Contractor shall provide and maintain suitable parking areas with roofing at each site for at least two (2) vehicles for the use of the Engineer.

9.2.6.16 NOISE CONTROL

The Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate to maintain the legal noise levels applicable to each area. All construction machinery and vehicles shall be equipped with practical sound muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the work.

During construction activities on or adjacent to occupied buildings, and when appropriate, the Contractor shall erect screens or barriers effective in reducing noise in the building; and shall conduct his operations to avoid unnecessary noise which might interfere with the activities of building occupants.

9.2.6.17 DUST AND MOSQUITO CONTROL

The Contractor shall take reasonable measures to control air pollution due to dust from his activities. Earth surfaces causing the emission of dust shall be kept moist with water or by application of a chemical dust suppressant. Dusty materials in piles or in transit shall be covered as practicable as possible to prevent blowing.

Buildings or operating facilities which may be affected adversely by dust shall be adequately protected from dust. Existing or new machinery, motors, instrument panels or similar equipment, shall be protected by suitable dust screens. Proper ventilation shall be provided with dust screens.

No open receptacles capable of collecting water and forming breeding places for mosquitoes are to be left in the open and the Contractor is responsible during the course of the work for all measures necessary to prevent the breeding of mosquitoes on the site.

9.2.6.18 TEMPORARY DRAINAGE PROVISIONS

The Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

Existing drainage channels and conduits shall be cleaned, enlarged or supplemented as necessary to carry all increased runoff attributable to the Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect property owner's facilities and the work and to direct water to drainage channels or conduits. Stilling Pool shall be provided as necessary to prevent downstream flooding.

9.2.6.19 EROSION CONTROL

The Contractor shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operation that will disturb the natural protection.

Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation preserved to the greatest extent practicable. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimise erosion. Temporary fast growing vegetation or other suitable ground cover shall be provided as necessary to control runoff.

9.2.6.20 POLLUTION CONTROL

The Contractor shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris and other substances resulting from construction activities. No sanitary wastes will be permitted to enter any drain or watercourse other than sanitary sewers unless satisfactorily treated to the approval of the Engineer. No sediment, debris or other substance will be permitted to enter sanitary sewers and reasonable measures will be taken to prevent such materials from entering any drain or watercourses.

9.2.7 POST TENSIONING

9.2.7.1 PRE-STRESSING STEEL

a. General

Pre-stressing and related items of works shall be carried out according to BS 8110 Pre-stressing tendons should comply with BS 4486 and BS 5896.

b. Surface condition

All prestressing tendons internal and external surfaces of sheaths or ducts should be free from loose rust, oil, paint, soap or any other lubricants, or other harmful matters at the time of incorporation in structural member. Cleaning of wires or tendons should be carried out by wire brushing.

c. Straightness

Low relaxation and normal relaxation wire should be in sufficiently large diameter coils to ensure that the wire pays off straight. Prestressing strand however manufactured should be in sufficiently large diameter coils to ensure that the strand pays off reasonably straight.

d. Cutting

All cutting to length and trimming of ends should be by either

- High speed abrasive cutting wheel, friction saw or any other mechanical method approved by the engineer; or
- Oxy-acetylene cutting flame, using excess oxygen to ensure cutting rather than a melting action.

Care should be taken that neither the flame nor splashes come in contact with either the anchorage or other wires or tendons.

In post-tensioning systems, the cutting action should not be less than 25 mm from the anchorage, and the heating temperature adjacent to the anchor should be not greater than 200deg. C.

e. Positioning of tendons (wires or strand) and ducts (sheaths).

The wires and sheaths should be accurately located and maintained in position both vertically and horizontally as shown on drawings. The permitted deviation in the location of tendon or sheath should be + or – 5. mm. The method of supporting and fixing should be such that they will not be displaced due to prolonged vibration or by pressure of wet concrete. Joints in sheaths should be securely taped to prevent penetration of the duct by concrete or laitence and sealed and end of ducts should be sealed and protected after the stressing and grouting operation.

9.2.7.2 TENSIONING THE TENDONS OR WIRES

a. General

Tendons or wires should be stressed by post-tensioning and according to the particular needs of the construction. All wires or strands stressed in one operation should be taken, where possible, from the same parcel.

b. Safety precautions

All possible precautions should be taken during and after tensioning to safeguard persons from injury and equipment from damage which may be caused by the sudden release of stored energy in a tensioned wire or tendon.

c. Tensioning apparatus

Hydraulic jacks should be used for tensioning. They should meet the following

- The means of attachment of the wires or tendons to the jack should be safe
- When two or more wires or strands are stressed simultaneously, they are of approximately equal length between the anchorage points.
- The hydraulic jack should be able to impose a controlled total force .
- The force in the wires should be measured by direct reading load cells or obtained from dial gauges fitted in the hydraulic system. The load measuring device should have an accuracy of + or – 2%
- There should be facility of re-tensioning the wires or strands because the design is as such that 50 % of the post tensioning should be done on all wires in the order given and the balance 50 % after that.

d. Arrangement of tendons

The wires or strands in a cable are not stressed simultaneously spacers should be sufficiently rigid not to be displaced during the successive tensioning operation.

e. Anchorages

All anchorages should comply with BS 4447. Split wedge and barrel type anchors should be such that under the loads imposed during the tensioning operation the strain in the barrel should not allow movement of the wedges that the wedges reach the limit of their travel before causing sufficient lateral force to grip the anchor.

Any allowance for draw-in of the wires during anchoring should be in accordance with the engineer's instructions.

9.2.7.3 TENSIONING PROCEDURE

Before tensioning it should be demonstrated that all wires are free to move in the ducts. Stressing should continue until the required extension and/or load is reached. The extension should allow for any

draw-in of wires or strands at the non-jacking end and measurement should not commence until any slack in the wires or tendon has been taken up. Full record should be kept of all tensioning operations.

Tensioned wires or tendons anchorages and any other exposed part should be effectively protected against corrosion during the period between stressing and covering with cement grout and concrete.

9.2.7.4 PROTECTION OF INTERNAL WIRES OR TENDONS

The wires should be protected and bonded to the perimeter wall by cement grout or cement sand grout. The grout should remain alkaline and should completely cover the wires and should not contain any additive or material that may promote corrosion.

