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6. SPECIFICATION FOR TRENCH EXCAVATION, BACKFILLING, CONCRETING AND ROAD REINSTATEMENT FOR PIPE LAYING OF STORM WATER LINE AND SEWAGE LINE AND CONSTRUCTION OF MANHOLES

6.1 Pipe Trench Excavation - General

Trench excavation means excavation in all materials of whatever nature encountered for trenches into which pipes are to be laid or pipe appurtenances constructed. Pipe shall mean pipe of all kinds and for whatever purposes.

The contractor would be required to provide shoring for the trenches in order to minimize damage to the roads and also other utilities. If the Contractor is required to excavate a trench, wider than the maximum trenches width, prior approval of the Engineer should be obtained. However, the contractor shall bear the total responsibility for damages to utilities, backfilling and compaction of the trench as per specifications and reinstatement of roads occurred as a result of collapse of side of the trench. Road reinstatement both temporary and permanent shall be measured in linear meters along the top surface of trenches for different diameters of pipes.

Disruption to traffic should be minimized. The Contractor should provide necessary measures for the safety of pedestrians, vehicles etc. All open trenches and backfilled areas should be protected by providing proper barricading, night lighting and also steel plates etc. when necessary. Road signs at either ends of the road warning motorists and pedestrians should be erected. Any damage to vehicles or injured to public and the damage to third party property due to the above excavation work or during movement of machinery should be the responsibility of the Contractor. It may be necessary to transport the excavated material temporarily to other locations. Required traffic control arrangements in concurrence with the traffic police and Local Authority should also be provided by the Contractor.

Contractor shall take every precaution to minimize damages to third party property due to excavation and backfilling of pipe trenches. Any damages to third party property shall be rectified and made to the good condition at the contractor's cost.

Trenches shall be carried out manually if excavation using machinery poses a potential danger to the roads and third-party property including other utilities. The trench shall be excavated to required depth and trimmed the bottom to specified gradient as shown in the drawings. Any excessive excavation shall be filled and compacted by the contractor at his own cost as directed by the Engineer.

Asphalt cutters should be used when damaging asphalt concrete and concrete paved roads.

Engineer along with the soil laboratory personnel will decide on the locations where the soil tests are to be carried out to determine the soil parameters and decide on the suitability of the

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excavated material for backfilling based on the test results and recommendations of the soil laboratory personnel.

If the excavated soil is found to be unsuitable, Engineer shall inform the Contractor of the sections of the pipeline trace to be backfilled with imported soil from the approved borrow pits.

6.1.1 Trench Alignment and Grade

Before starting excavation in any road the Contractor shall have obtained the approval of the Engineer and Engineer shall obtain the approval of the relevant Road Authority for Contractor's detailed work programme for the trench excavation in roads ahead of the particular work. This programme shall contain the names of the roads and chainages to be excavated, date of commencement and planned completion date of backfilling, planned dates of completion of temporary and permanent road reinstatement, and the dates of handing over to the relevant Road Authority. No excavation shall be permitted unless the Contractor shall have obtained approval of the said programme as aforesaid and can demonstrate that all necessary pipes fittings materials and plant are available on site for the speedy completion of all the work.

6.1.2 Construction Alignment and Grade

The line and level of trenches shall be as shown on the Drawings or as determined from the Drawings or as may be directed by the Engineer. Before commencing trench excavations, the route of the trench shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer. Strong sight rails shall then be fixed and maintained at each change of gradient, and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level to which the excavation is to be carried out, such rails being not more than 50 m. apart and at changes of direction and grade.

6.1.3 Changes in Line and Grade

In the event obstructions not shown on the plans are encountered during the progress of the work which will require alternations to the plans, the Engineer shall have the authority to change the plans and order the necessary deviation from the line and/or grade. The Contractor shall not make any deviation from the specified line and/or grade without approval by the Engineer. Should any deviations in line and/or grade be permitted by the Engineer in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs for thrust blocks, valves, air and vacuum assemblies, blow-off assemblies, extra pipe footage, manholes or other appurtenances shall be borne by the Contractor. The Contractor shall include in his unit rates in the contract provision to cover any deviation from the invert grade shown on the plans to facilitate extra depth required to eliminate possible conflicts between culverts and other utilities.

6.1.4 Trench widths

Trench excavation shall be carried out by such methods and to such lines, dimensions and depths as shall allow for the proper construction of the works, provided always that, unless the Engineer permits otherwise, for trench excavation, the Table 1 shall be referred for nominal trench widths and depths. Any changes, if necessary depending on the special conditions shall be authorized by the Engineer.

Trenches shall have vertical sides or battered trench as specified herein unless otherwise authorized by the Engineer.

Notwithstanding the foregoing, any rock in trench excavation shall be so excavated that the clearance between the pipe when laid and the rock sides and bottom of the trench is kept to the minimum limits necessary to provide for the specified thickness of bedding and concrete protection of the pipe. Bell holes and holes and depressions for couplings, valves and the like shall be excavated the same distance below these installations.

6.1.4 Working Space

Excavation for structures such as valve chambers etc. shall be allowed 30 cm working space for purposes of establishing Contractor's liability for permanent reinstatement costs.

6.1.6 Backfill Material

Soils used as backfilling material shall be naturally occurring soils and shall not be highly plastic clays, silts, peat or other organic soils or any soil that is mixed or contaminated with the top soil, vegetation and other deleterious matter. Material used for backfilling shall conform to the requirement of Type 1 materials as given below.

Type 1 material shall be soil having the maximum dry density under standard conditions of proctor compaction not less than 1600 Kg/m³ with the properties plastic limit <15, liquid limit (LL) < 40, CBR >20.

Materials excavated from the trenches may be used as backfill provided it meets the requirements specified for backfill material. Surplus materials from excavations shall be removed and disposed of by the Contractor as required by the Engineer and as specified on contractors cost. The trench shall be dug only so far in advance of pipe laying as the Engineer shall permit.

Where in the opinion of the Engineer sufficient supplies of the aforesaid material for trench refilling cannot reasonably be obtained from excavations, the Engineer may order the Contractor to carryout following.

a) Remove Stones

To carry out such work as may be necessary to sieve out stones, from the excavated material at contractors cost.

b) Borrow

If the excavated soil from trench is not satisfy the requirements, imported soil to be used for backfilling of trench. The Contractor shall take every steps to excavate suitable material from borrow areas and transport it to the length of trench to be backfilled, and the Contractor shall do any or all of these things as directed and as specified in the drawings and the specifications with own cost.

6.1.7 Trial Pits

Trial pits shall be excavated well ahead of the trench excavation to such depths as necessary to determine and confirm the alignment for the trench. Trial pits may also be required by the Contractor to determine the position of underground services, sub-soil drains or rock profile for any other reason. The Contractor shall obtain all necessary permissions from the Road Authorities for the excavation of trial pits. Trial pits shall be excavated at locations where approved by the Engineer.

6.1.8 Reinstatement of Trial Pits

The Contractor shall backfill and temporary reinstatement of trial pits to be carried out immediately after the required information is obtained. The temporary & permanent reinstatement of the surfaces of trial pits shall be carried out to the approval of the Engineer and condition of the relevant Roads Authority.

6.1.9 Trench Excavation in Roads

When excavating trenches along public roads, the Contractor shall comply with the requirements and conditions of the relevant road maintenance authority having jurisdiction over the particular road.

The information provided regarding jurisdictions in the drawings for Back filling sections is only as a guide and not to be taken as the final status. The Contractor shall obtain the information regarding the final status from the relevant authorities.

All trench excavation and other work carried out within the limits of any public road shall be completed as rapidly as possible and the Contractor shall make every effort to ensure that no more than half of the width of the carriageway shall be obstructed at one time. Road drains and curbs shall be kept free from obstruction. The Engineer may direct that trench excavation in highways shall be located in footpaths or in verges rather than in the carriageway. If that is the case, trench excavation shall wherever practicable be carried out in such a way that every part of the excavation is at least 1m clear of the existing edge of the carriageway. In any event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time when excavation is begun until the refilling of the trench is completed, to ensure that there is no disturbance of the adjacent road or road foundation. Where excavated material has temporarily been deposited on an adjacent surface, the surface shall on completion of refilling be restored entirely to its original condition and left free of loose stones.

6.1.10 Excavation in carriageway

The excavation of trenches in roads shall be in the shoulders as far as possible. However, when excavations are needed within the carriageway, the Contractor shall take all the necessary care to minimize the area of damage to the road surface. Before starting excavation, the Contractor shall use asphalt cutting apparatus comprising a diamond disc or similar, to cut the surface of the carriageway along the intended line of excavation. Necessary shoring and road barricades, traffic diversion etc shall be provided by the Contractor.

6.1.11 Security requirements

The Contractor shall inform the relevant local police station regarding the excavation in public road at least one week prior to commencement.

6.1.12 Safety precautions

The Contractor shall erect and continuously maintain road signs and adequate lighting throughout the night ahead of each end of excavation of trenches, warning about the excavation, until the temporary and Permanent reinstatement are completed. The road signs should be written in red luminous paint on white background so that they are visible at night to the vehicle drivers.

Safety precautions of workers and public shall always be taken during day time and also in night if night works are done.

Contractor shall take all precautions to protect workers, public and third party property during or in the process of rock excavation. In case of rock blasting, all precautions specified in the safety guidelines or Manuals or any other acceptable Manuals to the Employer by the Department of Labour, Sri Lanka shall be strictly followed. Suitable blasting technique shall be selected. Any damages to workers, public, third party property shall be compensated by the contractor at his cost.

Adequate protection shall be provided along the trench excavation to the approval of the Engineer. The excavated material shall not be deposited or dumped along the trench so that it will obstruct the movement of vehicles or pedestrians. If the Engineer or the Road Maintenance Authority directs so, Contractor shall remove the excavated material and store it elsewhere, until it is used for backfilling, at his own cost.

The Contractor shall maintain warning lights and barricades throughout the night at the road crossings until it is temporarily reinstated, or at the trench excavations if it has to be kept open overnight, or at any road excavation as directed by the Engineer.

The Contractor shall supply any reasonable materials and/or manpower necessary to maintain a smooth traffic flow as required and as directed by the Engineer.

6.1.13 Road Closure

The Contractor shall make every effort to avoid complete closure of the roads for traffic due to the Construction activities.

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In any event that this is unavoidable, the Contractor shall obtain the approval of the Engineer to that effect, furnishing all the details of the work. Contractor shall also obtain the permission from the Road Maintenance Authority, Local Government Authorities (MC, UC, PS) the Local Police Station and any other relevant authority, and shall abide by their requirements. The Contractor shall allow in his work programme for any delays which may arise in obtaining such permissions.

Contractor shall obtain necessary Insurance coverage or any other means to compensate the loss of Revenue of the Third Party Business Men, Transport Agencies, Bus Services etc. contractor shall relieve the Employer from any claims what so ever arising out of the closure of road.

6.1.15 Trench Excavation in Surfaces Other than Roads

Trench excavation in surfaces other than roads shall include all surfaces except those asphalt surfaces which require road reinstatement. These surfaces include but are not limited to fields, paddy fields, pasture land and the like, footpaths, verges, non-asphalted roads, lanes, alleys, bund embankment and all public and private lands.

Trench excavation located in fields shall, if the Engineer so requires, have temporary fencing erected around that length. Temporary fencing shall not normally be removed until the trench excavation has been refilled and reinstated. The Contractor is hereby notified that generally pipe alignments not in streets are covered with a vegetation growth which must be removed and disposed off the site of work. The Contractor shall have particular regard to the safety of livestock which may be in the area, and shall ensure that all open excavations, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected. After the erection of temporary fencing where required, the Contractor shall remove top soil to such depth and over such area as may be necessary to provide sufficient material to ensure adequate surface reinstatement of the working areas occupied by the Contractor for construction of the pipeline.

Excavation in Asphalt roads and concrete paved roads shall be done using Asphalt cutter and concrete cutter to avoid damages to other parts of the road. Contractor shall remove re-concrete and Asphalt parts of the excavated soil as directed by the Engineer at this own cost.

6.1.16 Temporary Buildings

Temporary buildings sites (squatters) may also occupy pipeline rights-of-way. The Employer will remove the occupants and the Contractor may demolish the buildings as directed by the Engineer. The Employer, under the laws of Sri Lanka, is not required to obtain easements or be liable for loss of business for construction of water pipelines and appurtenances. However, the Contractor is required to limit the damage to any existing improvement and to make full compensation for any damage done as a result of the construction activities.

6.1.17 Bedding & Surrounding

It should be ensured that the trench bed is levelled in conformity with the levels as indicated in the drawing. The pipe bedding and surrounding material shall be Sea sand/River sand or Manufactured sand.

When sand is used as bedding material, 100mm wide RCC grade 20 barriers at 50m intervals across the trench to cover full widths of the trench and full depth of the bedding shall be provided.

The trench shall have special protection when the soil condition is unfavourable in such a way the bearing capacity is less than 75 KN/m² the Geotextiles shall be used to wrap bedding & surrounding to bear the loads above or directed by the Engineer. The Table 2 given below shall be referred for the properties of Geotextiles.

The Geotextiles shall be wholly synthetic and is tropic fibrous material. It shall have properties not inferior to those listed in Table 2.

When the minimum specified cover to the pipe line from the surface cannot be maintained due to some special reason, the Contractor shall adopt the special protection type using concrete pre-cast slabs as specified in the relevant type drawing and as instructed by the Engineer.

TABLE 2

Property	Test Method	Value	Unit
Tensile strength (wet and dry) under uniform applied stress		7500	N/m ²
Grab tensile strength	ASTM 1682 100m	660	N
Trapezoidal tear strength	ASTM 117	300	N
CBR Puncture resistance	DIN 54307E	1600	N
Burst Strength	ASTM 3786	1400	KPA
Pore Size		> 0.03 < 0.10	mm mm
Permeability to water under 100mm head		50	l/m ² /sec

6.1.18 Supporting Trench Excavation

The Contractor shall effectively support the sides of all trench excavations which shall include the use of steel sheet piles where necessary to prevent any fall or sliding of the embankments or run from any portion of the ground outside the excavation into the trench and to prevent settlement of or damage to structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for shoring up the sides of trenches, any extra excavation

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necessary to provide space for such support and for any other working space. If for any reason any portion of trench excavation shall give away, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed.

6.1.19 Battered Trench Sides

Where the Contractor elects and is permitted by the Engineer to execute trench excavations with battered sides instead of providing support as aforesaid they shall be excavated to stable slopes and heights as a slope of not steeper than one to one from a point of 30 cm above the top of the pipe. The toe shall be set back not less than 30 cm from the vertical face of the trench.

6.1.20 Trimming Trench Excavation

When excavating to specified levels for trench excavation or to specified limits for the face of any structure therein required to about undisturbed ground, the Contractor shall not excavate the last 15 cm until the Engineer permits otherwise. Should the Contractor have excavated to within 15 cm above these specified levels or to within 15 cm of these specified limits before he is ready or able to commence the constructional work he shall where required by the Engineer excavate further so as to remove not less than 15 cm and any such further excavation and additional foundation material ordered by the Engineer shall be at the cost of the Contractor. The bottom of trench excavations shall be carefully boned in and trimmed true to grade with the aid of a straight edge at least 6 m long as to ensure a continuous support for the pipes. Any stones or flints either likely to cause the pipe to bed unevenly or to damage the pipe and its coating of greater than 15 mm in size shall be picked out of the trench bottom and any holes so formed shall be filled in with soft material and trimmed to the correct level. All shattered and loose material shall be removed from the bottom of the trench excavations so that the bedding material rests on a solid and clean foundation.

6.1.21 Inspection by Engineer

When the specified levels of trench excavation are reached the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable, he may direct the Contractor to excavate further and to refill the further excavation with such materials as he may direct. Should the bottom of any trench excavation while acceptable to the Engineer at the time of the inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddled, soft or loose during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. In this case the cost of the extra excavation and of the additional foundation materials required will be the Contractor's responsibility.

6.1.22 Disposing Material from Trench Excavation

Subject to any specific requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material which is required for use in refilling trench excavations, including any necessary double handling. In this connection the Contractor shall have regard to the working areas available to him for the construction of the pipeline particularly where this is located in roads or in other places to which the public has free

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access. Any temporary tips alongside the trench excavations shall be to stable slopes and heights. Where the nature the excavated materials is suitable, the Contractor's temporary storage as aforesaid shall include for separate storage as the Engineer may direct of any of the various grades of material hereinafter specified for the refilling and surface reinstatement of trench excavation, namely, soft material, coarse material, hard material and topsoil.

Excavated material which is not required for or is unsuitable for re-use in the Works shall be disposed off-site to locations designated by the Engineer.

Material ordered to be disposed to Employer's tip where locations are within CMC area, shall remain the property of the Employer. Material so deposited shall be shaped up or spread and levelled as directed by the Engineer.

Tippers used for transporting of un-usable excavated material for disposal outside the site shall be covered with tarpaulin or other suitable cloth to prevent spilling of loose material on to the roads. The number of Tippers operated shall be determined so as not to unduly disturb the normal traffic or pedestrians. All the tippers at the entrance to public roads shall pass through a wheel washing bay where all the wheels shall be washed free of the soil stuck to the wheels.

6.1.23 Trenches not to be Left Open

Trench excavation shall be carried out expeditiously and; subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations shall be commenced and completed as soon as reasonably practicable after the pipes have been laid and jointed. Pipe laying shall follow closely upon the progress of trench excavation, and the Contractor shall not permit more than 20 m of trench excavation ahead of pipe laying to remain open. The Contractor shall take precautions to prevent floatation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial refilling of the trench. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation. The Contractor shall not excavate trenches in more than one location in any one road at a given time without the Engineer's permission.

If the contractor is necessary to keep trench without backfilling in carriageway, the steel deck shall be designed and use to allow for the traffic during day time.

6.1.24 Control of Water

All excavation and placement of backfill and fill shall be carried out in the dry. The Contractor shall furnish, install and operate all necessary machinery, appliances and equipment to keep excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property, or to cause a nuisance or a menace to the public. He shall at all times have on hand sufficient pumping equipment, portable Generators and other machinery in good working condition for all ordinary emergencies, including power outage, and shall have available at all times competent workmen for the operation of the pumping equipment. During excavation, construction of pits, etc. installation of pipelines and fittings, placing of structure and trench backfill and the placing and setting of concrete, excavations shall be kept free of water. The Contractor shall control surface runoff so as to

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prevent entry or collection of water in excavations. The static water level shall be drawn down a minimum of one foot below the bottom of the excavation so as to maintain the undisturbed state of the foundations soils and allow the placement of any fill or backfill. The dewatering system shall be installed and operated so that the ground water level outside the excavation is not reduced to the extent that would damage or endanger adjacent structure or property. The dewatering system shall be designed by a qualified engineer to maintain ground water level.

i Submittals

The Contractor shall submit for the Engineer's approval a detailed description of the sequence of dewatering operations.

The description shall include but not be limited to:

- Plans showing the methods and location of dewatering and discharge. The drawings shall include sufficient details to clearly illustrate the work.
- Lists of materials and equipment to be used.
- Calculations for the design of the dewatering system. The Engineer's review shall be made to verify that the general scope of work is adequate and that the Contractor is qualified to perform the work as shown on the drawings. Review of the Contractor's plans and methods of construction by the Engineer shall not be construed to relieve the Contractor in any way from his responsibility for the successful performance of the dewatering work.

In addition, any submittals required under Clause for excavation support shall also be applicable.

The Contractor shall also submit daily operating logs which shall include results from water quality tests for suspended matter at the discharge point including time of day and elapsed times of tests, daily discharge rates, installation and removal of wells and general observations on the system such as equipment running times and failure.

ii Release of Ground water

The release of ground water to its static level shall be performed so as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill and prevent flotation or movement of structures, pipelines and sewers.

6.1.25 Backfilling Trench Excavations and Compaction

The backfilling material to be used shall be as specified above and indicated in drawings for type of pipes at different level in trench. Accordingly, the backfill material which shall be used up to 300mm from the top of the pipe shall be a sandy material free of stones, hard objects etc. For the remaining backfill quarry dust / excavated earth could be used if suitable. However the backfill material shall be free of particle size as specified in drawings for different level of layers in trench. If excavated material is not suitable the Contractor should bring specified material from outside.

During wet condition, if the excavated material from the trench cannot be compacted to the required degree, the Contractor may be required to use imported materials as backfilling. However if the excavated material have been spoiled by the Contractor due to his negligence,

the Contractor shall be required to use imported material as directed by the Engineer at his own cost.

The standard compaction test shall be carried out as per test 12 of BS 1377 – 75 or ASTM D 698 – 98.

The backfill material shall be placed in layers of 200mm thick and well compacted. Where necessary the Contractor shall adjust the moisture content of the fill material either by drying out or by adding water to assist the compaction of the materials. During the compaction the backfill shall have a uniform moisture content equal to or a little above the optimum moisture content recorded in the compaction test. Backfill shall be compacted to a dry density of not less than 98% [or as indicated in the relevant drawing / as per relevant authority requirement at different layers in the trench] of the maximum dry density. Suitable approved mechanical rammers shall be used for compaction.

The remainder of the refilling may consist of coarse material including broken rock from excavation not greater than 25mm, free and clods of earth larger than 15 cm hereof provided that the compacted backfill is, in the opinion of the Engineer, sufficiently dense to prevent material from the superimposed layers being washed into the voids in such backfill. This coarse material shall be spread in layers of not greater depth than 20 cm and be thoroughly rammed by an approved mechanical rammer.

The coarse filling is to be carried up to the surface level existed before the commencement of the Works (in roads and footpaths) or (elsewhere) to such level as with the surface reinstatement. Hard material such as broken rock and original road metalling shall not be used for the reinstatement of road.

i. Compaction

Where necessary, the Contractor shall adjust the moisture content of the refill material either by drying out or by adding water to assist the compaction of the materials. During the compaction, the backfill shall have a uniform moisture content equal to or a little above the optimum moisture content recorded in the Compaction Test. Backfill shall be compacted to a dry density of not less than 98% of the Laboratory Proctor Density when tested in accordance with these specifications. The Contractor shall carry out a minimum of one compaction test for each layer in each working day or minimum 25m intervals that back filling is taking place. The Contractor is advised to use clean sand or other clean granular material approved by the Engineer to obtain the required compaction in the presence of wet conditions, if the excavated materials or selected backfill materials cannot be compacted and the compaction work is held up.

The Contractor is advised to consider the cost of such materials in his rates. Sand backfilling shall only be laid on level areas and water jetted to consolidate completely.

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If quarry dust is used for backfilling, it shall be saturated and mechanical vibrator shall be used to compact. When sand or clean granular materials are used, they shall be protected from washing away by capping with 150 mm of lateritic soil with proper moisture content compacted to 98%.

ii Miscellaneous

Should the material being placed as backfill, while acceptable at the time when approved, become unacceptable to the Engineer due to exposure to weather conditions or due to flooding or have become puddled, soft or segregated during the progress of works, the Contractor shall at his own expense remove such damaged, softened or segregated material and replace it with fresh approved material. To permit the proper consolidation of backfill into the voids behind trench sheeting and supports, trench sheeting shall be withdrawn gradually as backfill progresses in depth and along the trench. On no account shall any excavated material be dozed back when refilling trenches in roads and no backfilling shall be carried out unless in the opinion of the Engineer, sufficient mechanical rammers are in operation on that portion of the work. Where directed by the Engineer, trench excavations shall be refilled with concrete.

6.1.26 Road Reinstatement

Road reinstatement shall be done as stated in the drawing and as specified in the ICTAD Specification for Construction and Maintenance of Roads and Bridges.

6.1.27 Manhole construction

The Manhole construction can be pre-cast or in-situ cast. Engineer's prior approval should be obtained for shop drawing of form work, bar bending schedule and concrete mix design and materials. The ready-mix concrete from reputed supplier shall be used to cast the chamber. All the materials shall be satisfied the parameters given in ICTAD specifications for building works. The cement shall be Sulphate resistant cement. The details dimensions, r/f and placing are given in the drawings and complied to following conditions also.

- i. Structural concrete shall be designed in accordance with BS8110.
- ii. Concrete shall comply with the relevant requirements in BS 5911
- iii. Structural Concrete for manholes a strength grade not less than Grade 35A unless otherwise specified.
- iv. Concrete for purposes other than structural shall have a strength grade not less than Grade 25 where unreinforced.
- v. Aggregates shall comply with BS882 /BS EN 12620:2002+A1:2008 and shall be coarse aggregate of 20 mm (nominal maximum size)
- vi. All sands required to comply for concrete or cement mortar shall comply to the BS 1199 and 1200:1976, comply with the relevant provisions of BS 882.
- vii. Steel reinforcement shall comply with:

- BS 4449:2005+A2:2009 Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and de-coiled product.
- viii. BS EN 10020 Definition and classification of grades of steel
 - ix. BS EN 10080 Steel for the reinforcement for concrete. Weldable reinforcing steel. General.
 - x. Scheduling, dimensioning, bending and cutting of steel reinforcement shall be in accordance with BS 4466/ BS EN ISO 4066:2000, BS 8666:2000.
 - xi. Tying wire for steel reinforcement shall complying with BS 1052.
 - xii. Formwork shall be in accordance with BS 5975:2008+A1:2011

6.2 Specifications, Standards Applicable

Applicability of specifications and standards: Employer's Requirements provided in here mainly focused on key area of work such as micro tunnelling, manhole installation. Thus this ERQ may not adequately describe the requirements and specifications for all the components (or parts thereof) of work associated with this contract. Specifications and standards identified in this document as applicable to a particular work, workmanship, material, methodology, testing procedure, etc., take the precedence over any other specification and/or standard. For all other circumstances work, material, workmanship, methodology, testing shall comply with one of the following specifications/standards. If the standards and/or specifications described in the recommended applicable specifications/standards differs and/or conflicting, then the Contractor shall make a written request to the Engineer, to resolve the matter and recommend the applicable specifications/standards. Applicable specifications or standards will be chosen using the recommended specification (list of recommended specifications and standards).

6.2.1 Applicable specifications/standards:

- a) The other standard technical specifications for the works shall be relevant sections of the following ICTAD specifications.
 - SCA/3/2 – Water supply Sewerage and Storm water Drainage Works
 - SCA/4/1 & 2 – Building Works
 - SCA/5 – SSCM of Roads and Bridges
- b) Relevant British (BS) or British European (BSEN) Standards

Note: ICTAD is recently renamed as Construction Industry Development Authority (CIDA)

6.3 Reinforced Concrete Pipes

a) Pipe specifications

Reinforced concrete pipe shall be used for main gravity sewers, and all sewers. Reinforced concrete pipes shall conform to following standards:

- a) 1. BS EN 1916:2002: Concrete pipes and fittings, unreinforced, steel fiber and reinforced
- b) 2. BS 5911-1:2002: Concrete pipes and ancillary concrete products. Specification for unreinforced and reinforced concrete pipes (including jacking pipes) and fittings with flexible joints (complimentary to BSEN 1916:2002)
- c) 3. BS 4027 or EN197-1 Sulphate resistance cement

The pipe interior shall be smooth and even, free from roughness, projections, indentations, offsets, irregularities of any kind. The concrete mass shall be dense and uniform. Concrete pipes shall be substantially free from fracture, large or deep cracks, and surface roughness.

The planes of the ends of the pipe shall be perpendicular to their longitudinal axis.

Reinforced concrete pipes shall have a minimum nominal length of 2.0 m except as otherwise specified or required for special purposes such as curves, closures or built in pipes. The maximum nominal length shall be 6m.

Pipe joints shall be spigot and socket type with flexible water tight confined "O-ring" synthetic rubber gasket with neoprene elastomer conforming to BS EN 681-2:2000 or ISO 23711:2003. Joint details shall be submitted to the Engineer for review before starting pipe manufacture.

6.4 MANHOLE CONSTRUCTION

6.4.1 Manholes Types

6.4.1.1 Type of Manhole

Manhole types shown in the drawings.

6.4.1.2 Submittals

6.4.1.3 Product data

Data sheets/catalogues related to products used in manholes such as frame, cover, plastic encapsulated steps, ladder, etc., shall be provided to the Engineer prior to ordering any product for approval.

6.4.1.4 Material data and test reports

Contractor shall submit following information with respect to construction of manholes.

- Ready concrete manufacturer (if applicable); quality certificates
- Cement used – with test results to prove the cement characteristics; quality certificates of manufacturer
- Aggregates – source; necessary permits and test results
- Concrete strength tests
- Steel (rebar) manufacturer; quality certificates; strength test results
- Admixtures; chemicals used – manufacturer; MSDS; test data

All tests must be performed at laboratories acceptable to the Engineer.

Above requirements apply to each supply and/or each supplier separately as deemed necessary

6.4.2 Precast Reinforced Concrete Manhole Components**6.4.2.1 Material and Fabrication**

Pre-cast concrete manhole sections shall conform in all respects to BS EN 1917:2002. All joints in pre-cast manhole sections shall be made with cement mortar. Manhole floors shall be constructed with concrete formed to the required shapes with concrete channel inverts including half round concrete channels, bends, tapers, junctions and double junctions. The top of the in-situ benching shall be sloped back at 1 in 12. Pre-cast manholes shall be encased with concrete with minimum of 100 mm thickness shuttering shall be used for the concrete surround to manholes. Surrounding concrete shall be 35A MPa, Portland cement concrete of required characteristics. Inner surface of the manhole shall be lined with 20 mm minimum internal lining of high Pre-cast concrete manhole sections shall conform in all respects to BS 556 and BS 5911. All joints in pre-cast manhole sections shall be made with cement mortar. Rough shuttering shall be used for the concrete surround to manholes. Internal lining will not be required in case the manholes are made of sulphur resistant cement and appropriate cover to reinforcement is provided.

6.4.2.2 Concrete

Refer to ICTAD specification for manufacture and placing of concrete.

Use sulphate resistance cement for the concrete. Concrete mix design to produce 30 MPa for pre-cast manholes, catch basins and ditch inlets and 25 MPa for cast-in place manholes. Maximum size aggregate shall be 40 mm except 28 mm for pre-cast units. The water/cement ratio shall be 0.45. Structural concrete work shall be in accordance with BS8110 and BS 8007 and non-structural concrete shall comply with the relevant requirements in BS 5911.

6.4.2.3 Precast concrete manhole bases

Pre-cast reinforced concrete bases shall normally be used in lieu of cast-in-place concrete bases and constructed in accordance with ASTM C-478. The base, for either type, shall extend 150 mm beyond the outside face of the manhole wall and shall be at least 200 mm thick.

Pre-cast bases shall have factory installed pipe seals. Pre-poured flow lines in base will be approved only after inspection of a completed example. Pre-cast Joints has to be made watertight using rubber ring/gaskets.

6.4.2.4 Precast Concrete Rings

Ladder rungs/steps shall be of 19 mm diameter (minimum), polypropylene coated galvanized steel, made to following BS EN 13101:2002 standard– Steps for underground man entry chambers.

- Place all steps on 300 mm centres.
- Portion of steps embedded in concrete shall be given a coat of heavy bodied bituminous paint.
- Steps and installation shall meet ASTM C-478 requirements.

ORIGINAL

6.4.2.5 Precast Concrete Top Section

Top sections of eccentric cones or flat tops shall have an offset opening of 750 mm for vertical ladder installation. Top sections shall have four (4) anchoring devices, equally spaced to receive 75 mm frame anchor bolts on flange B.C. pattern.

6.4.2.6 Pre-cast grade rings

All pre-cast concrete ring sections and top sections shall fit together readily to permit effective jointing. Joints between adjacent sections of all manholes shall be made with two (2) strips of approved preformed joint sealing compound. All material squeezed out on inside shall be cut off.

6.4.2. 7 Cast in-situ Manhole Components

6.4.2.7.1 Cast in-situ manhole bases

Cast in-situ bases shall be constructed in accordance with ASTM C-478. Cast in-situ bases for up to 400 mm sewers shall have one mat of No. 4 deformed Grade 60 reinforcing steel on 300 mm centers placed midway in minimum 200 mm thick base.

6.4.2.7.2 Cast in-situ surrounding to pre-cast manholes

Contractor shall provide cast in situ surrounding to the pre-cast concrete rings as shown in the standard drawings.

6.4.3 Pipe Opening Seals

ORIGINAL

6.4.3.1 Specifications

Seals shall meet the requirements of ASTM C-923.

6.4.3.2 Performed plastic sealing compounds

Sealing compound shall be of either bituminous or butyl rubber base. Material shall be in rope form, supplied with a two-piece cover to preclude adhesion until use.

6.4.3.3 Rubber compression gaskets

ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Pipe.

6.4.3.4 Sleeve type pipe seals

Pipe opening seals shall be cast integrally with manhole section, sized to fit pipe specified, and set at correct elevation and location.

6.4.3.5 Water stops

Water stops shall be composed of virgin Polyvinyl chloride (PVC) or rubber with stainless steel bolts and nuts, sized for respective pipe.

6.4.4 Manhole Steps

6.4.4.1 Type

Plastic encapsulated steel steps.

1. 6.4.4.2 Specifications

ASTM-478 -Co-polymer polypropylene steel reinforced manhole steps.

6.4.4.3 Installation

Manhole steps shall be placed in equal distance and have sufficient load bearing capacity.

6.4.5 Manhole Benching

The benching shall comply with the provided drawings unless otherwise specified.

6.4.6 Manhole Frames and Covers

6.4.6.1 Specifications

All manhole frames and covers shall be manufactured in accordance with BS EN 124 class D 400; or Manhole covers and frames shall comply, with the specifications in European Standard, EN 124:1994 and have a minimum clear opening of 600 mm.

6.4.6.2 Dimensions

All dimensions shall be accordance with the drawings provided. Tolerance on dimensions shown in the drawings shall be ± 1 mm.

6.4.6.3 Finish level

The Contractor shall be responsible to adjust the finishing level to the new paving elevation to provide a smooth even transition from pavement to manhole cover.

6.4.6.4 Identification

Manhole Covers shall have markings "CMC"; "SEWAGE" (whichever is applicable) with Letter Size 50 mm Frame hold-down bolts.

6.4.6.5 O-ring cover gasket

The "O" ring material shall be of elastomeric material conforming to BS EN 681-2:2000 or ISO 23711:2003.

6.4.6.6 Watertight manhole frame and cover

The cover shall have a neoprene gasket contained in a factory machined dovetail or rectangular groove in the bearing side of cover.

Cover shall have hold-down bolts and washers of stainless steel or bronze.

6.4.7 Manhole Construction

6.4.7.1 Setting out

The contractor shall be responsible of setting out the manholes as per the drawings and shall give the Engineer sufficient notice (not less than 24 hours) to enable the Engineer also to satisfy himself to the correctness of the setting out, before the Contractor commences excavations.

6.4.7.2 Manhole height

- a) Manholes in roads and pavements Manholes covers generally shall be set to the road profile and be flush with the road surface.
- b) Manholes outside road and pavements Manhole covers located in unimproved areas shall be constructed at an elevation 6mm above the grade to prevent the entry of surface water.