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PART 1 – INFRASTRUCTURE SPECIFICATIONS

SECTION 1 - EARTHWORK

1.01 Clearing and Grubbing

A. DESCRIPTION

This work shall consist of clearing, grubbing, removing and disposing of all vegetation and debris within the limits of the right-of-way. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain for the existing road.

B. CONSTRUCTION REQUIREMENTS

The Contractor shall establish construction limits and where applicable, the Engineer will designate all trees, shrubs plants, and other things to remain.

All surfaces objects and all trees, stumps, roots and other protruding obstructions, not designated to remain, shall be cleared and grubbed.

Trees and shrubs shall be cut or burnt down under strict control to ground level, the roots grubbed up to a depth of not less than 1.0m and removed from the area. All other scrub, vegetation, rubbish, etc., shall be cleared or burnt down to ground level and removed from the area to any distance.

The Contractor shall take particular care at all times to prevent erosion on every site and elsewhere on land which may be affected by his operations and the Engineer may impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances seem to him to warrant.

1.02 Road Excavation

A. DESCRIPTION

This work shall consist of excavating the roadways and borrow pits, removing and satisfactory disposing of all materials taken from within the limits of the

work, also such excavation for pipes, box culverts as necessary for ditches, trenches and channels, and shall include all excavation, shaping and sloping necessary for the construction, preparation and completion of all embankments, sub grade, sidewalks, slopes, intersections, approaches and private entrances; pumping and dewatering as necessary required, as directed and in conformity to the alignment, grades, and cross sections shown on the plans or established by the Engineer. The Contractor shall also remove the backfill material of the existing wall till the depth of 2m below the existing grade and to be replaced by suitable subgrade material.

B. CLASSIFICATION OF EXCAVATION

No classification of excavated materials will be made. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition or condition thereof.

C. SITE INVESTIGATION

The Contractor shall be deemed to have visited the site of Works and satisfied himself as to the nature of the ground and made him conversant with the local conditions to be encountered during the execution of the Contract.

D. CONSTRUCTION REQUIREMENTS

All materials removed from the excavation (Silty – Clay) shall be **declared unsuitable** and immediately removed, loaded and transported off the site area by the Contractor to approved dumps and he shall abide by the relevant local regulations No excavation material shall be wasted without written permission from the Engineer.

All areas of new road excavation, during the entire period of construction operations, shall be thoroughly drained. The excavated surfaces shall be kept smooth and sloped to side ditches until the sub grade is finished. Side ditches emptying from excavation to embankment shall be kept clean at all times and constructed to protect excavation and embankment from erosion.

The Contractor shall utilize equipment, tools and methods necessary to complete the work in accordance with the plans and specification.

Improved borrow material shall be utilized to supplement new road excavations as may be required to complete the layers of embankment.

If the Contractor locates a borrow pit on privately – owned property he shall secure the consent of the land owner and, if necessary and at his own expense, pay for the use of the material.

E. QUALITY ASSURANCE PROCEDURES

The total quantity of roadways excavation shall be evaluated and accepted in accordance with **Measured or Tested Conformance of General Conditions (FIDIC)**.

The Engineer shall perform or supervise the performance of all quality assurance measuring and testing including also, the verification that the roadways excavation conforms to the lines, grades and typical cross sections shown on the plans within the following tolerances:

- ❖ Slopes shall be uniformly finished and no point on the slope shall deviate from the staked slope by more than 15 cm.
- ❖ The total width between the ditch lines shall not be deficient by more than 30 cm
- ❖ The bottom of excavation shall be completed to within plus 1 cm of designated grade except that in rock, the tolerance shall be plus 2 cm.

The Contractor shall be responsible for the payment of any claims from property owners for excavation quantities removed from beyond the staked slope and right of way lines.

F. METHOD OF MEASUREMENT

The quantities of roadways excavation shall be computed by the Contractor and checked by the Engineer. Quantity computations shall be based on the original cross sections taken by the Contractor which were attested by the Engineer.

Any material removed or excavated before these measurements have been taken and approved by the Engineer will not be paid for.

The Engineer will check all the work to determine conformance to the lines, grades, elevations and cross sections submitted by the Contractor.

All slopes, lines and grades shall be true, correct, and accurate and according to those shown in the plans or otherwise directed by the Engineer.

The sub grade in cuts shall be accurate to profile grade for the sub grade to plus or minus 2 cm.

The pay quantities for roadways excavation and borrow excavation is in **cubic meter** and shall be that computed from the cross sections.

G. BASIS OF PAYMENT

The amount of completed and accepted work, measured as provided above, will be paid for at the unit prices per **cubic meter** for roadways excavation, borrow excavation and at the unit price per linear meter for side slope protection and ditches. These prices shall be full compensation for all excavation, the proper formation of embankment, trimming of slopes, clean up, disposal of materials, preparation and completion of sub grade, labor, equipment, tools, and all other items for the proper completion of the work including all surveying and quantity computations.

Pay Item

Pay Unit

Roads Excavation

Cubic Meter

1.03 Sub grade

A. DESCRIPTION

This work shall consist of blending; mixing, loading, transporting and placing acceptable materials imported from borrow pits in horizontal of uniform thickness for the full width of the sub grade, compacting each layer, and finishing the top of the sub grade to specified tolerances.

B. SUB GRADE MATERIAL REQUIREMENTS

Materials from imported borrow meeting the appropriate quality requirements shall be used to construct sub grade in accordance with the typical sections shown in the plans.

Sub grade layer materials shall be a minimum of 25 cm thick after compaction in both embankment and cut areas using materials meeting the following requirements:

- Materials shall be A-1-a (0), A-1-b (0) and A-2-4 (0) having no rock fragments larger than 75mm.
- Materials having a minimum 4-day soaked CBR of 25 when tested in accordance with AASHTO T 193 when compacted at 100% of modified proctor AASHTO T180-D.
- Material should be reasonably well-graded with sufficient fines to permit compaction and without gap grading. Percent of fines passing No.200 sieve (0.075mm) shall not exceed 18% and the PI of the sub grade material shall not exceed 12%.
- Materials shall be placed in horizontal layers not exceeding 15 cm (compacted thickness) and shall be compacted as specified and approved by the Engineer before the next layer is placed.

C. CONSTRUCTION

- Equipment: The Contractor shall provide all types, sizes and numbers of equipment which are necessary for handling, mixing, loading, hauling, spreading, watering, compacting and finishing material to form the sub grad layer in accordance with the plans, the special specification, and as directed by the Engineer.
- The Contractor shall use imported borrow material to complete the sub grade layer to the lines, grades and cross sections. The Contractor shall perform testing of all proposed sources of imported material for sub grade. This testing shall include classification, Proctor if appropriate and CBR.

D. PLACEMENT OF MATERIAL

The Contractor shall have in operation a motor grader or tractor to properly smooth and maintain the surface of each layer of freshly placed sub grade prior and during rolling and compaction operations.

E. SUB GRADE IN CUTS

1. Where the sub grade is on in-situ soil which is of a quality and CBR value at least equal to those specified for sub grade, the 300 mm depth of such material immediately below top of sub grade shall be scarified and all roots, sod, vegetable and other undesirable matter and stones larger than 75 mm in any dimension shall be removed. The material shall then be brought to uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.
2. Where the sub grade is on in-situ soil which is unsuitable for retention as the sub grade layer, such material immediately below the top of sub grade layer shall be sub-excavated to a depth of 250 mm, hauled away and disposed of unless approved for use as embankment fill. The sub grade layer shall then be constructed using approved sub grade material, as specified for sub grade in embankment. If the material below sub grade does not consist of suitable materials satisfying the requirements of top 600mm, it shall be excavated for further 200mm and replaced by suitable material to satisfy the requirements of the top 600mm of the embankment.
3. The underlying natural material shall be scarified, leveled and rolled. The surface of the natural soil shall be approved by the Engineer before placement of suitable material.

F. SUB GRADE IN EMBANKMENTS

The 250 mm minimum depth of embankment immediately below top of sub grade shall consist of selected, approved sub grade material. The material shall be spread over the full width of the top of embankment, brought to uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.

G. SUB GRADE STABILITY

The Contractor shall be responsible for the stability of all sub grade lifts and shall replace all sections which have been damaged or displaced.

H. SUB GRADE ON EXISTING ROAD SURFACES

When an existing road surface is shown on the plans, the adjustment of the elevation on which the sub base is to be placed shall be made by a bituminous concrete leveling course.

When the width of the sub grade of that road under construction is greater than the surface width of the existing roadway, that part of the sub grade which falls on the surface of the existing road surface shall be constructed according to this paragraph, and that part of the sub grade which falls outside the limits of the existing road surface shall be constructed as a new construction and meet all the requirements thereof.

I. FINISHING TOLERANCES AND REQUIREMENTS

Quality Assurance measuring or testing shall involve verification that the sub grade is constructed, timely finished and trimmed in a neat, workmanlike manner to the lines, grades and typical cross sections within the following tolerances:

- Sub grade slopes shall not vary more than 1 cm from the designated slope
- The finished top of sub grade at any point shall not vary more than 2 cm above or below the grade shown on the plans.
- The Contractor must continue to maintain the surface of the sub grade; including the application of the necessary water, until such time as the next surfacing is applied.

J. METHOD OF MEASUREMENT

When payment is specified on a volume basis, the quantities of sub grade layer shall be computed by the contractor and checked by the Engineer. Quantity computations shall be based on the original cross sections taken by the Contractor which were attested by the Engineer.

The Engineer will check all the work to determine conformance to the lines, grades, elevations and cross sections submitted by the Contractor.

Total volume of sub grade shall include the sub grade layer constructed in earth cut, rock cut, and on embankment and will be measured by the **cubic meter**.

Sub grade preparation will be measure by the **square meter** of completed and accepted work, on the basis of approved cross-sections. Measurement shall be to the nearest tenth of a square meter along the longitudinal profile of the road.

K. BASIS OF PAYMENT

The amount of completed and accepted work for sub grade work, measured as provided above, will be paid per **cubic meter**, which price shall be full compensation for all loading, hauling and the proper formation of sub grade, trimming of slopes, cleanup, preparation, compaction and completion of sub grade

The amount of completed and accepted work for sub grade preparation, measured as provided above, will be paid for at the unit prices bid in the Bill of Quantities per **square meter**.

This price shall be full compensation for all materials, water, labor, equipment, tools, and all other items for the proper completion of the work. Payment for the different classifications of sub grade preparation will made only after the sub base is in place.

| <u>Pay Item</u> | <u>Pay Unit</u> |
|------------------------------|------------------------|
| Sub grade layer | Cubic Meter |
| Sub grade Preparation | Square Meter |

SECTION 2 - CONCRETE STRUCTURE CONSTRUCTION

A. DESCRIPTION

This work consists of constructing of structures such as manholes, sidewalks, curbs, and other concrete structures in accordance with the lines, grades, details and locations shown on the plans or established by the Engineer.

B. MATERIALS

1-Portland cement conform to “Standard Specifications for Portland Cement”, Type II, ASTM Designation C150. Use one brand and source of cement throughout the project. Cement shall be furnished in undamaged 1500kg/m³ sacks.

2-Concrete Coarse Aggregate for “Severe Weathering Region” hard durable carefully graded to the requirements of ASTM C 33. Provide aggregates from a single source.

- Nominal Maximum Coarse-Aggregate Size: 20 mm.
- Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on 0.3-mm sieve, and less than 8 percent may be retained on sieves finer than 0.3 mm.
- Material passing the 0.075-mm sieve must not, in any case, exceed 3 percent, by weight, of the combined aggregate.
- Maximum water absorption of 2%, for all types of aggregates , when tested according to ASTM C127.
- Free of material causing staining or reacting with cement and with less than 5% magnesium, sulfate soundness loss.
- Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement obtained from natural sand.
- All sand shall be screened and washed. Beach sand is not allowed.

3-Concrete Coarse Aggregate

- The lightweight aggregates shall be composed predominately of lightweight cellular and granular inorganic material.
- For insulating concrete: Unless otherwise specified, the lightweight aggregates for insulating concrete shall comply in all respects with ASTM C332

4-Water: All sources of water shall be approved by the Engineer.

5-Reinforcement:

- All reinforcing bars shall be a deformed type in accordance with AASHTO M31.
- Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- Weld reinforcing bars according to AWS D1.4 only, where indicated and allowed by the Supervision Consultant.
- Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- Unless otherwise noted, splice lengths shall be 50 x Bar diameter.
- Reinforcement shall not be in contact with pipework.
- Bending dimensions for scheduling of bars for the reinforcement shall be in accordance with ASTM A615 or BS 8666.
- Unless otherwise shown on drawings, the minimum concrete protective cover for reinforcement shall be 2 cm

C- CONCRETE MIXES FOR CONCRETE ELEMENTS

1. Proportion normal-weight concrete mixture.
2. The Contractor shall submit for approval concrete mix designs for each class of concrete to be used in the works.
3. The concrete compressive strength is defined in terms of the 28 day characteristic strength for 15x30 standard cylinder. The compressive strengths listed below are the design compressive strengths. The average of all cylinder crushing strengths obtained on site for each of the sections of the Project shall exceed the required design characteristics strength f'_c as recommended by concrete conformity procedures in British Standards.
4. Classes of Concrete
 - Classe A for structural elements $f'_c = 30$ MPa
 - Classe B for Blinding: $f'_c = 15$ MPa.Where f'_c is the compressive strength on cylinder 15x30cm after 28 days.
5. Water Cement Ratio and Minimum Cement Content
 - For structural concrete classe A with $f'_c = 30$ MPa, water cement ratio shall be 0.5, the minimum cement content shall be 350 Kg/m³.
 - For blinding concrete $f'_c = 15$ MPa, maximum water-cement ratio shall be 0.7, the minimum cement content shall be 250 Kg/m³.
6. Chloride Permeability of underground concrete structure shall not exceed 2000 coulomb tested in accordance with ASTM C1202.
7. Contract design has been produced on the basis of a design compressive strength on cylinder at 28 days.
8. All concrete are to be normal weight (2500 Kg/m³), well compacted and in accordance with the specification.

D-Mixing:

1-Cast in Situ concrete: Concrete shall be mixed in quantities required for immediate use. Concrete shall be used and placed maximum in ½ hour after the water has been added. Concrete that is not within the specified slump limits at the time of placement shall not be used and shall be disposed of as directed.

The concrete may be mixed at the site, in a central-mix plant, or in truck mixer.

The mixing time shall not be less than 50 seconds nor more than 90 seconds.

The Contractor may offer to furnish admixture at his own expense when admixtures are not specified. The Engineer shall consider the offer and approve or disapprove the use.

2-Ready mixed concrete: Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information. Each load shall be accompanied by a delivery note stamped with the time of mixing and stating the concrete grade and quantities of each material including water additives.

When air temperature is between 30 and 32 deg C, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 32 deg C, reduce mixing and delivery time to 60 minutes.

E-Placing Concrete:

The forms and foundation shall be moistened immediately before placing concrete. Concrete shall be handled and placed to avoid segregation

F-Curing Concrete: Concrete shall be cured a minimum of 7 days.

G-Acceptance: Concrete will be subject to acceptance or rejection by visual inspection and review of the load certification at the placement site. The Engineer will take or supervise the taking of slump tests, test cylinders or cores for strength determination checks.

H-Blinding Concrete

The thickness of the blinding concrete shall be as shown on the drawing, but shall in no instance be less than 50 mm.

All blinding surfaces must be finished fair faced or trowel smooth and cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust and impurities prior to subsequent concrete placement.

J-Method of Measurement

The Completed and accepted concrete works shall be full compensation for furnishing all materials, equipment, labor, tools, incidentals and all other work

necessary to complete the work as specified above and shall be measured in **cubic meter**.

No separate measurement or payment shall be made for blinding concrete, such work being considered subsidiary to relevant pay items.

K-BASIS OF PAYMENT

The Completed and accepted concrete works shall be full compensation for furnishing all materials, equipment, labor, tools, incidentals and all other work necessary to complete the work as specified above and shall paid in **cubic meter** .

SECTION 3 - STORM WATER DRAINAGE CHANNELS

A. DESCRIPTION

This work shall consist of the construction of storm water drainage channels, Reinforced concrete box culverts and pipes in conformity with the lines and grades shown on the drawings or established by the Engineer.

B. MATERIALS

- Concrete shall be class A and conform to the requirements.
- Reinforcement shall conform to the requirements of AASHTO M 31.
- Reinforced concrete pipes shall conform to the requirements of AASHTO M 170 M.
- The type of cement to be used in the manufacture (or in situ construction) of all concrete pipes and in mortar intended for application to pipe joints shall be as specified in the Project Specifications or as shown on the Drawings.
- Concrete for cradles, hunching and pipe encasement shall be Class B, unless shown otherwise on the Drawings.
- Concrete bedding shall be Class B.
- Approved types of proprietary bitumastic or plastic sealants or flexible elastomeric gaskets may be used in lieu of mortar for concrete pipe jointing.
- Where flexible joints are required at pipe joints in concrete bedding, hunching and pipe encasement, they shall consist of an approved type compressible fibrous board of 20 mm thickness.
- Bedding:
 - Granular material for bedding shall be composed of 14 mm maximum size natural gravel, crushed gravel or crushed rock, free from dirt, clay, roots, organics and other deleterious material mixed with sufficient sand to fill the voids, about 30 to 35% by volume.
 - Granular bedding shall conform to the following:

| Standard size (mm) | Sieve | % By Weight Passing | |
|-----------------------|-----------|------------------------------------|----------|
| | | for rigid pipes (DI or AC etc.) | PE pipes |
| 19.0 | (3/4 in) | 100 | |
| 4.76 | (No. 4) | 25-100 | 100 |
| 1.19 | (No. 16) | 10-75 | 25-75 |
| 0.300 | (No. 50) | 5-30 | 10-30 |
| 0.177 | (No. 80) | 3-10 | 3-10 |
| 0.075 | (No. 200) | 0-5 | 0-5 |

- Sand bedding and fill, up to 300 mm minimum above crown of the pipe shall be non-plastic, natural well graded sand having hard, strong, durable angular particles. It shall be clean and free from extraneous materials, clay balls, organic matter or other detrimental material. The amount of fines passing sieve No. 200 shall not exceed 15% or according to the standard specifications (ASTM C33).
- Backfill over a pipe shall consist of two different layers: Initial or selected backfill and main backfill.
- Backfill in contact with the pipes and up to 300 mm minimum above crown of the pipe shall be selected material.
- Selected fill material shall comply with ASTM D 2487.
- Selected fill material shall not contain ashes, cinder, refuse, rubbish, organic material, or the like. The material shall be

capable of being compacted without the use of heavy rammers.

- The main backfill (for the remainder of the trench) shall be done with suitable material either from material removed in the course of excavating the trench, or imported from approved borrow pit.
 - When required by the plans or ordered by the Engineer, manhole shall be installed on a bedding course of the thickness shown on the plans or ordered by the Engineer. The bedding course shall be compacted to Type ninety (90) compaction.
-
- Wrought iron plates and shapes shall conform to the dimensions shown on the Drawings. Rolled wrought iron bars and shapes shall conform to the requirements of ASTM A207. Wrought iron plates shall conform to ASTM A42.
 - Safety steps and hand bars shall be manufactured of 20mm diameter mild steel deformed reinforcing bars and hot dip galvanized in accordance with ASTM A 153.

C. TECHNICAL REQUIREMENTS AND TESTING

1. Tests shall be performed in accordance with AASHTO T 280 on at least 0.5% of all pipes furnished to determine the external load crushing strength (by 3-edge bearing method). The minimum D loads to produce a 0.3 mm crack and to produce the ultimate load shall be as per Table 4 of AASHTO M 170M.
2. Absorption tests shall be performed in accordance with AASHTO T 280M on samples from at least 0.5% of all pipes furnished. Sampling procedures and the maximum acceptable absorption shall be as specified in AASHTO M 170M.
3. If the Contractor elects to cast pipes in-situ, details of the casting yard, and proposed plant and equipment and methods shall be submitted for approval before precasting commences.

4. Crushing strength tests shall be performed in accordance with AASHTO T33.
5. Precast pipes represented by sets of test samples which have an average strength less than 85% of the specified strength, shall not be incorporated in the Works. Such pipes shall either be destroyed or permanently scored or marked as directed and removed from the Site by the Contractor.
6. Precast pipes represented by sets of test samples which have an average strength 85-90% of the specified strength, may be incorporated in the Works, provided they are laid on a concrete cradle and haunched. The cradle shall cover the full trench width and extend below the underside of the pipe to a depth of at least 0.25x external pipe diameter. The concrete haunching shall extend above the underside of the pipe to a height of 0.5 x external pipe diameter and be keyed into the surface of the cradle in an approved manner.
7. All pipe and material testing shall be carried out at an approved laboratory.

Note: Testing and Certification: the Contractor shall submit to the Engineer all specified test coupons and Manufacturers' Certificates of Guarantee for all structural steel, cast iron, cast steel and wrought iron parts stating that the materials supplied meet the appropriate AASHTO or ASTM specification. The submission of such test certificates shall not relieve the Contractor of his obligations to carry out independent tests at an approved laboratory, as directed by the Engineer, at his own expense.

D. CONSTRUCTION REQUIREMENTS

1. Excavation

Trenches shall be excavated to the Details shown on the Drawings, and in no case shall the trench width up to the level specified exceed that shown on the Drawings. The Contractor shall ensure that at any point the width of the pipe trench is sufficient to permit the pipeline to be laid, jointed, bedded/surrounded and backfilling to be placed and compacted around the pipeline to the Engineer's satisfaction.

Trenches for drainage channels shall be excavated to a smooth surface parallel to the proposed finished surface and to a depth sufficient for the full thickness of casting as shown on the Details Drawings, Soft, unstable subgrade material shall be removed and replaced with suitable materials approved by the Engineer. The subgrade shall be compacted to Type 95 compaction.

Trench Excavation for concrete box culverts and miscellaneous structures shall be performed to the limits required for construction and to the depth required for bedding material or removal of unsuitable material.

4. Construction of Cast in place concrete box culverts

- Cast in place concrete Box culverts shall be constructed in accordance with the details shown on the plans or in an alternate manner, proposed by the Contractor and approved by the Engineer. The pipe shall be carefully formed true to the lines and grades given.
- Longitudinal construction joints will only be permitted as shown on the plans. Transverse construction joints will be permitted provided prior written approval is obtained from the Engineer. Continuance of such approval shall be contingent on the construction of the joints in a satisfactory and acceptable manner.
- All forms for Cast-in-Place Reinforced Concrete Box culverts shall be approved by the Engineer prior to their use. The inside box culverts forms shall be of metal suitably stiffened and supported to be unyielding during the placement of the concrete. The face of the forms shall be such to provide a smooth and even interior pipe surface.
- Concrete used for bedding, concrete cradles and concrete used to compensate for overdepth or overwidth trench excavation will not be paid for separately, but will be considered subsidiary to the items of Concrete Box culverts appearing in the Bill of Quantities.

5. Construction of concrete storm water drainage channel

- The bedding course, if required by the plans, shall be placed to the minimum specified dimensions in layers not exceeding one hundred fifty (200) millimeters compacted depth and compacted to Type 90 compaction.
- Forms for concrete channels, shall be full typical section depth constructed of metal, wood, or other suitable material. All forms shall be free from warp, and of sufficient strength to resist the pressure of the concrete without displacement. They shall be securely staked, and supported firmly to the required line and grade.
- Placement of concrete shall begin at the lower end of the portion of the channel to be casted and progress toward the upper end. If shown on the plans, the concrete shall be reinforced with the type of reinforcement and in the manner indicated.
- The surface shall be finished with a wooden float. Facilities for workmen shall be provided to avoid them walking in the fresh concrete.
- Immediately after the finishing operations are completed, the concrete shall be protected.

7. Concrete

- Class A concrete shall be used unless otherwise shown on the Drawings or ordered by the Engineer.

8. Reinforcement

The method of reinforcing shall conform to the requirements of AASHTO M 31

9. Placing Castings

Castings shall be set in full mortar beds or otherwise secured as shown on the Drawings and approved by the Engineer. Castings shall be set accurately to correct elevation so that no subsequent adjustment is necessary.

10. Backfilling

Backfilling shall conform to the requirements.

12. Painting

Structural steel cover plates shall be painted with one shop coat of Paint Number 2 Basic Lead Silico Chromate Primer in accordance with FSS TT-R-226, one field coat of Paint Number 6 Basic Lead Silico Chromate Maroon field coat in accordance with FSS TT-R type III, and one field coat of Paint Number 7 Basic Lead Silico Chromate Dark Green finishing coat in accordance with FSS TT-T-291 grade 2.

13. Tests for Leakage and Structural Integrity

- Low pressure air tests and water tests shall be carried out by the Contractor on sections of storm drain whenever deemed appropriate by the Engineer, in order to check for significant leaks and to verify generally the structural integrity of those sections of storm drain which may or could be subjected to appreciable surcharge of storm water when in service. Testing shall be performed as follows:
- Preliminary Test before Backfilling: The pipeline shall be plugged and air pumped in until a stable pressure of 100 mm head of water is achieved over a 5-minute period. Thereafter, this pressure shall not drop below 70 mm during the following 5-minute period.
- Final Test after Backfilling: The pipeline shall be plugged and filled with water to a height of 1.5 m above the top of pipe at the upstream end and left standing for 30 minutes after which it shall be topped up. Thereafter, the loss of water over a period of 60 minutes shall not exceed 25 liter/100 m length/m diameter of pipe.

- All such testing shall be carried out in the presence of the Engineer. The Contractor shall provide and install all necessary anchor and thrust blocks, struts, etc prior to testing.
- Any pipeline section failing to meet the pressure test requirements shall be repaired as necessary, leaking joints sealed or defective pipes replaced. The pipeline shall then be cleaned, re-inspected by the Engineer.

E. Measurement

The quantities of the various pay items which constitute the completed and accepted work shall be measured as follows:

1. Concrete Drainage channel shall be measured by m3 of each size and type furnished, installed or constructed, backfilled, completed, and accepted.
2. No separate payment shall be made for painting, coating equipment, forms, tools, furnishing and placing materials, labor, or any other item necessary for the proper completion of the work.

F. BASIS OF PAYMENT

The quantities, measured as provided above, will be paid for at the unit prices bid for the several pay items. Such prices shall be full compensation for furnishing hauling, and placing all materials, for all labor, equipment, forms, tools and all other items necessary for the proper completion of the work. Such payment shall constitute full payment for the completed work, and no allowance will be made for any item not specifically provided for or any other incidental expense.

| PAY ITEM | UNIT OF MEASUREMENT |
|-----------------------------------|----------------------------|
| Perforated Precast concrete cover | Lin.m |
| Concrete for Channels | m3 |
| Blinding concrete | m3 |
| Steel Reinforcement | ton |
| Excavation | m3 |
| Bedding (Granular material) | m3 |
| Reinforced Concrete Box culvert | m3 |

SECTION 4 - TRENCHING AND REINSTATEMENT

A. SCOPE OF WORK

The purpose of this section is to clearly outline requirements for trenches excavation, backfilling and reinstatement works in accordance with the plans.

B. OBJECTIVES

The Contractor must ensure that all trenching and excavation works meet the following objectives:

- Safety of the public as been ensured
- All practicable steps have been taken to minimize the level of disruption
- Any affected or potentially affected persons should be notified in advance by the concerned parties
- Reinstatement works shall be completed to the same or higher standard than prior to the initiation of works
- The Contractor should take care of all utilities including, water supply, sewage, stormwater drainage network and telecommunications and electricity cables, fittings and equipment in the road reserve, if any
- Prior to start the works of trenching, the Contractor should advise the local authorities of proposed construction works. The local authorities shall issue a **Work Approval Notice**. No works may commence in advance of the **Work Approval Notice** being issued.

C. CONSTRUCTION REQUIREMENTS

- Working hours shall be as approved by the local authorities
- The disruption to the public and adjacent residents shall be kept to a minimum
- Noise created by the construction shall be kept to a minimum
- Arrangements shall be made to damp down work areas and excavated materials as may be required from time to time to eliminate any dust nuisance
- The Contractor shall be responsible for supply, erection and maintenance of all necessary barricades, lights, warning notices, traffic control signs

- Failure by the Contractor to provide adequate safety measures may result in a work suspension notice being issued by the Client
- At least half of the carriageway should be open to traffic during hours of darkness if possible
- The Contractor is strongly advised to be fully aware of the position of all underground services before commencing work
- Where existing services, if any, are damaged as result of the construction work, the Contractor shall immediately advise the owner. The cost of repair shall be borne by the Contractor
- The Contractor shall be responsible for the cost of any road markings damaged
- The maximum permitted length of trench to be open shall be 100 m unless otherwise authorized. Notwithstanding this the Contractor shall not exceed any length that is not capable of being backfilled and opened to traffic in the same day
- Open trenches shall not be permitted overnight
- All open trenches shall be maintained in a dewatered condition
- Where damage occurs to existing kerb, the damage shall be made good to the satisfaction of the local authorities. Where any kerb requires replacing this shall be done at the Contractor expense
- Special conditions when working near traffic signals may be imposed by the local authorities to protect the operation of the signals. The Contractor shall liaise with the local authorities to locate this network, if any.

D. EXCAVATION

When an excavation is required to be made through any cement concrete, asphaltic concrete surface, the proposed edges of the excavation or trench shall be cut with a power saw prior to the excavation of the trench. The cut shall be 150 mm beyond and parallel to the edge of the trench.

All excavated material shall be removed from the site immediately as excavation proceeds.

Trench widths shall be kept to the minimum necessary to lay the pipes and correctly compact the backfill.

E. BACKFILLING

Materials shall be placed in horizontal layers and shall be compacted in accordance with AASHTO T 180 (Method D).

F. SUB BASE AND BASE COURSES

Materials for sub base and base courses shall be similar to the existing pavement if available.

H. METHOD OF MEASUREMENT

Trenching and reinstatement shall be measured in linear meter including excavation, backfilling, all layers of pavement and asphalt course except for the storm water pipes. Only accepted work trenching and reinstatement shall be included and the dimensions shall be those shown on the plans or ordered in writing by the Engineer.

I. PAYMENT

The quantities, measured as provide above, shall be paid for at the unit price bid per linear meter as specified in the BOQ. Such price and payment shall be full compensation for furnishing all materials, excavation, backfilling and all layers of pavement, asphalt course, equipment, labor, tools, incidentals and all other work necessary to complete the work as specified.

| PAY ITEM | PAY UNIT |
|-----------------|-----------------|
| Trenching | cubic meter . |

SECTION 5 – ROCK FILLED GABION AND MATTRESSES WORKS

A. SCOPE OF WORK

The work consists of furnishing, assembling, and installing rock filled wire mesh gabion baskets and mattresses. This work shall consist of the construction of miscellaneous erosion protection to be composed of stone filled wire mesh gabions, mattresses and geotextiles.

B. MATERIALS

1. Mattresses

Mattresses must be flexible, woven, galvanized wire mesh boxes of dimensions as shown on the Drawing confirming to ASTM A975-97.

The galvanizing coating must be a 95% Zinc, 5% Aluminium Mischmetal alloy confirming to the requirements of ASTM A975-97. The physical properties of the wire and PVC coating must conform to the requirements of ASTM A975-97.

The boxes must be divided by diaphragms across the width of the unit and not more than 1m centers, or as shown on the drawings.

Diaphragms may be formed by folding the base layer of mattress, provided that the bottom of each of the diaphragm halves is securely tied together so that the transmission of tensile forces in the mesh of the base layer is not impeded.

Mattresses must have a mesh size of 60mm x 80mm. For mattresses less than 350 mm thick, the minimum diameter of mesh wire must be 2.0mm and the minimum diameter of galvanized selvedge wire must be 2.4mm. For mattresses with thickness between 350mm and 550mm, the minimum diameter of mesh wire must be 2.4 mm and the minimum diameter of galvanized selvedge wire must be 3.0 mm.

2. SELVEDGES

All edges of the gabions, mattresses, diaphragms and end panels must be selvedged with a continuous wire in accordance with ASTM A975-97.

The selvedging must be such that the mesh will not unravel and such that the strength of the connection between the selvedge wire and the mesh must be equal to or greater than the breaking strength of the mesh.

3. LACING AND CONNECTING WIRE

Lacing and connecting wire must be supplied with the gabions, mattresses and mesh panels to perform all the wiring operations to be carried out in construction of gabions or mattresses.

Materials must conform to ASTM A975-97. The minimum diameter of the wire (or wire core in the case of PVC coated wires) must be 2.2mm.

An alternative fastener system such as “C” clips in place of lacing and connecting wire are

permitted but must conform to the requirements of ASTM A975-97.

4. ROCK FILL

Rock fill must be dense, hard, durable and clean rock.

4.1 Aggregate Wet/Dry Strength

Rock from all sources must have a wet strength of at least 100KN and a maximum wet/dry strength variation of 35%.

4.2 Size

For gabions, the minimum and maximum rock size must be 100mm and 250mm respectively.

For mattresses, the minimum rock size must be 75mm, and the maximum rock size must be two thirds of the thickness of the mattress or 250mm, whichever is lesser.

5. INSTALLATION- GENERAL

Assemble and install all mattresses and geotextile panels in accordance with the requirements of this specification and the manufacturer's recommendations.

Carry out the excavation shown in the Drawings prior to the installation of mattresses and/or geotextile panels.

6. INSTALLATION OF MATTRESSES

6.1 Assembly

Prior to assembly, open the wire mesh out flat on the ground and stretch it to remove all kinks and bends.

Assemble the mattresses individually, by raising the sides, ends and diaphragms, ensuring that all creases are in the correct position and that the tops of all four sides and the diaphragms are even. If the height of the sides is different, adjust the position of the diaphragms so that the sides hinge up on the thicker wire woven in the mesh.

Attach the diaphragms in place by twisting the short lengths of selvedge wire firmly over the

tops of the sides. Helical wire connecting the diaphragm to the base is to be pulled out only enough to wire up the sides. Wiring must be done as a continuous operation through each mesh in turn and securely tied off at the top. Turn the ends of all lacing wires to the inside of the mattress on completion of each lacing operation. Use lacing wire to lace up the four corners.

In all cases, commence the lacing by twisting the end of the lacing wire around the selvedge(s), then passing it round the two edges being joined using alternate single and double loops through each mesh in turn and tie it off securely at the bottom. Maintain tightness of the mesh and wiring at all times.

6.2 Erection

Only assembled mattress or groups of mattresses may be positioned in the structure, with each mattress being securely laced to the surrounding ones along the perimeter.

When mattress is laid on a slope steeper than 1(V) in 1.5 (H), secure the upper edge by

galvanized star pickets driven at 1m centers a minimum of 900 mm in to the ground, or as shown on the Drawings.

6.3 Filling

Mechanical filling equipment may be used provided that the adequate precautions are taken to protect any PVC coating from abrasion during filling operations.

Redistribute the filling materials by hand to ensure that all the diaphragms compartments are

fully filled and to produce a neat and level top surface.

Mattress units must be overfilled by 25 to 50mm to allow subsequent settlement.

6.4 Final Lacing

Closing and lacing down of lids must proceed as soon as practicable after the filling operations have been completed.

Stretch the lids tightly over the filling with suitably designed closing tools and lace down securely through each mesh along all edges, ends and diaphragms. The ends of all lacing wires must be turned into the mattress on completion of all lacing operations.

7 GEOTEXTILE FOR GABIONS AND MATTRESSES

7.1 Geotextile

Before laying out mattresses, place the geotextile between the wire cage and the material being protected or retained. The geotextile must be a non-woven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

Grab tensile strength : 490 N (ASTM D 4632)

Tear strength : 178 N (ASTM D 4533)

Puncture resistance : 222 N (ASTM D 4833)

Water flow rate : 100 l/sec/m² (ASTM D 4491)

Apparent opening size : 0.3 mm (ASTM D 4751)

7.2 Installation of Geotextile

Place the geotextile at the back of each mattress layer and extend it 1.0m along the upper panel perpendicular to the back of mattress to prevent migration of fines.

8.7 MEASUREMENT AND PAYMENT

Payment associated for activities with completing the work detailed in the Mattress and Geotextile will be made in accordance with the pay Item as below.

8.7.1 Rock Filled wire mattresses

The unit of measurement is the **square meter** of rock filled mattress. The area is determined from the actual area of the completed work. The schedule rate includes the supply and installation of mattresses, rock filling, filter fabric and star pickets.

8.7.2 Geotextiles

The unit of measurement is the **square meter** of geotextile panel. The area is determined from the actual area of panel placed including the area between gabions. The schedule rate includes the supply and installation of panel

| <u>Pay Item</u> | <u>Pay Unit</u> |
|-----------------------------|-----------------|
| Rock filled wire mattresses | Square Meter |
| Geotextile | Square Meter |