



International
Labour
Organization

Employment Intensive Infrastructure Programme in Lebanon (EIIP)

BID DOCUMENT Annex E1 Specifications Road Maintenance

Lebanon, April 2019

SECTION E1

SPECIFICATIONS

CONTENTS

<i>General Specifications.....</i>	<i>Section E1-1</i>
<i>Specifications for Earth Works.....</i>	<i>Section E1-2</i>
<i>Specifications for Surfacing Works.....</i>	<i>Section E1-3</i>
<i>Specifications for Concrete Works.....</i>	<i>Section E1-4</i>
<i>Specifications for Road Furniture, Road Markings, Concrete Curbs and Tiling Works.....</i>	<i>Section E1-5</i>
<i>Specifications for Bio Engineering.....</i>	<i>Section E1-6</i>
<i>Hand Tools and OSH.....</i>	<i>Section E1-7</i>

E-1 General Specifications

GENERAL

Preamble

Each work item specified in section **E** corresponds to the same number in the Bill of Quantity.

Works specified under this contract shall include:

- preparatory and general works, materials and works of any kind necessary for the due and satisfactory rehabilitation, construction, completion and maintenance of the works to the intent and meaning of the Drawings and this Specification and any further drawings and orders that may be issued by the Project Chief Technical Advisor.
- compliance by the Contractor with all Conditions of Contract, whether specifically mentioned or not in this Specification;
- all materials, apparatus, plant, machinery, tools, fuel, water, strutting, timbering, and tackle of every description, transport, offices, stores, workshops, staff, labour;
- the provision of proper and sufficient protective works, temporary fencing, lighting, and watching required for the safety of the Public and the protection of the works and adjoining land;
- the provision and maintenance of first aid equipment, sanitary accommodation for the staff and workmen;
- the management and effecting of the payment of wages, salaries, fees, royalties, duties and other charges;
- the clearance of rubbish, reinstatement and clearing up and leaving the site in good condition.

These Specifications are written on the basis that the Works shall be constructed using a labour-based (light equipment supported) technology. The Contractor will be expected to maximise the use of labour for all operations where it can be effectively used to attain the required standards.

Provision of Land

The EIIP Project shall be based on agreement with the local authorities and the community make available free of charge to the Contractor all land on which the works are to be executed or carried out; all as indicated on the Drawings or as detailed in this Specification. Such land shall include the road reserve, road deviations, borrow pits outside of the road reserve and access roads thereto but shall exclude any land required by the Contractor for his own camps, offices, houses, other temporary works or any other purpose.

The Contractor shall be responsible for the payment of compensation for crops, structures and any other costs in respect of land temporarily acquired, including the Contractor's spoil areas outside of the road reserve, work areas outside of the road reserve for camps, offices, temporary works, etc. The Contractor should allow in his rates for making such compensation payments for land temporarily acquired as no separate payment will be made.

Programme of Work

The programme of work required in the scope of the Contract shall be submitted to the EIIP Project Engineer not later than 15 days after the issuing to the Contractor of the Notification of Award.

The programme shall be in the form of a time/location chart and shall clearly show the anticipated quantities of work to be performed each month, as well as a plan of labour inputs over the programme period. The contractor should update the programme each month. However, in cases where quantities fall substantially below targets, the parties shall establish in writing an amended work plan which shall be attached to the Contract.

If the programme is to be revised by reason of the Contractor falling behind his programme, he/she shall produce a revised programme showing the modifications to the original programme necessary to ensure completion of the works or any part thereof within the time for completion as defined in the Appendix to the Contract. Any proposal to increase the tempo of work must be accompanied by positive steps to increase production by providing more labour and plant on site, or by using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to work according to the programme or revised programmes, shall be a sufficient reason for the EIIP Project to take steps as provided for in the Conditions of Contract and shall be construed, as not executing the Works in accordance with the Contract.

The approval by the EIIP Project Engineer of any programme shall have no contractual significance other than that the EIIP Project Engineer would be satisfied if the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme, nor shall it limit the right of the EIIP Project Engineer to instruct the Contractor to vary the programme should circumstances make this necessary. The above shall not be taken to limit the right of the Contractor to claim for damages or extension of the time to which he/she may be fairly entitled to in accordance with the Contract for delay or disruption of his activities.

Should the EIIP Project request, and the Contractor undertakes to finish the whole or part of the Works ahead of the time originally required by the Contract, payment for accelerating the work shall only be made if agreed to beforehand by the parties in writing and according to the terms of such agreement.

Workmanship and Quality Control

The onus rests on the Contractor to produce work, which complies in quality and accuracy of detail with the requirements of the Specifications and Drawings. The Contractor must, at his/her own expense, institute a quality control system and provide experienced and qualified engineer and foremen, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the works at all times. The Contractor must provide assistance and labourers for the EIIP Project Engineer to carry out checks on the works.

The costs of all supervision and process control, including testing carried out by the Contractor, shall be deemed to be included in the rates tendered for the related items of work except that the cost of certain tests and the provision of certain items of testing and sampling equipment will be paid for separately as provided for in those sections of the Specifications where this applies.

The Contractor shall submit to the EIIP Project Engineer the results of all relevant tests, measurements and levels indicating compliance with the Specifications on completion of every part of the work and submission thereof to the EIIP Project Engineer for examination.

Liaison with Government Officials

The Contractor shall maintain close contact with the police and other responsible local authorities regarding their requirements as to the control of traffic and other matters and shall provide all assistance or facilities which may be required by such authorities in the execution of their duties.

Maintenance of Traffic

Prior to any works, the Contractor shall prepare and submit to the EIIP Project Engineer, a Traffic Management and Safety Plan (TMSP) for his operation during the maintenance and construction phase.

Throughout the duration of the Contract, traffic shall be maintained over a reasonable smooth travelled way which shall be marked in such a manner that any person who has no knowledge of the conditions may safely and with a minimum of inconvenience and discomfort, drive or walk, day or night, over all or any portion of the road under construction - provided that such a section of the road was passable to traffic prior to the Contractor having taken possession of the site.

Unless approval in writing has been obtained from the EIIP Project Engineer, no road shall be closed to traffic or public access.

The measurement for Traffic Management and Safety is paid at a lump sum amount and shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item. This amount is to be included in the general item 1.3.

Temporary Works

The Contractor shall allow in his/her rates where appropriate, for provision and maintenance of any temporary works including structures and deviations, and for the provision, erection and maintenance of the road signs for the safe passage of traffic during construction of the road and ancillary works.

Unless provided for separately the accommodation of traffic shall be included in the general rates except that any detours required and instructed by the EIIP Project Engineer shall be paid for under the appropriate items in the Bills of Quantities.

Land Compensation

The Contractor shall not take possession of the site, nor enter any land or commence any operations until such time as he/she receives formal confirmation from the EIIP Project Engineer. Should the Contractor enter land or commence any operations without first obtaining this confirmation he/she shall be solely liable for all additional costs and/or legal charges, which might arise there from.

The EIIP Project shall be responsible for negotiations with the community in respect of land to be permanently acquired and incorporated in the works within the road reserve, together with all buildings, crops, trees and any other properties so defined from the land.

The Contractor shall be responsible for payment of compensation in respect of land temporarily acquired, Contractor's spoil areas and working areas, sites for Contractor's accommodation, and land acquired for gravel quarries.

Measurement

(a) Units of measurements

All work shall be measured in accordance with the S.I. System of metric units.

(b) Bill of Quantities

The quantities set out in the Bill of Quantities are estimated quantities and are used for the comparison of Tenders and awarding the Contract. It must be clearly understood that only the actual quantities of work completed will be measured for payment, and that the billed quantities may be increased or decreased as provided for in the Conditions of Contract.

(c) Measurement of completed work

The work is measured for payment on the satisfaction completed basis

- (d) The contractor should allow in his/her rates for compliance with all requirements of this Specification for which separate payment is not made under the Contract.

Payment

- (a) Contract rates

In computing the final Contract price, payments shall be based on actual quantities only of authorised work done in accordance with the Specification and Drawings. The tendered and negotiated rates shall apply, subject to the provisions of the Conditions of Contract, irrespective of whether the actual quantities are more or less than the billed quantities.

- (b) Prices to be inclusive

The Contractor shall accept the payment provided in the Contract and represented by the prices tendered by him/her in the Bill of Quantities, as payment in full for executing and completing the work as specified, for procuring and furnishing all materials, labour, supervision, plant, tools and equipment, for wastage, transport, loading, offloading, handling, maintenance, temporary work, testing, quality control including process control, overheads, profit, risk and other obligations and for all other incidentals necessary for the completion of the works and maintenance during the Construction Period.

This Clause shall be applicable in full to all pay items except as these requirements may be specifically amended in each case.

- (c) Meaning of certain phrases in payment clauses.

- (i) where any of the words "supply", "procure" or "furnish" (material) are used in the description of a pay item it shall mean the supply and delivery to the point of use of all materials of any kinds required for the work covered by the particular pay items, including all taxes, (unless otherwise notified by the EIIP Project Engineer purchase costs, claims, damages, royalties and transport costs involved excluding overhaul. In the case of gravel, stone and sand, it shall also include all negotiations with owners concerned, royalties, excavating, producing, preparing, processing, testing, hauling and delivering the material to the point of use; the construction, repair, maintenance and making good after completion of all access roads, and all work required in opening, using and finishing borrow pits to ensure that soil and water from these do not interfere with the adjacent road or give rise to erosion more generally and in all respects do not have un-aesthetic appearances, which is not covered by other pay items in the Bill of Quantities.

- (ii) "Placing material"

The phrase "placing material" shall mean the off-loading, spreading, blending, processing, watering, mixing, shaping and compacting (where specified) the material in the location of the work as procuring, furnishing, applying and mixing of water; breaking down oversize material, removing which cannot be broken down, correcting irregular or uneven surfaces or deficient thickness, finishing off to within the specified tolerances, refilling test holes and maintaining the completed work.

- (d) Pay items

The descriptions under the pay items in the various sections of the Specifications, indicating the work to be allowed for in the tendered prices for such pay items, are for the guidance of the Contractor and do not necessarily repeat all the details of work and materials required by and described in the Specifications.

These descriptions shall be read in conjunction with the relevant Specifications and Drawings and the Contractor shall, when tendering, allow for his/her prices to be inclusive as specified in Sub-clause (b) above.

Guidance on the measurement method is also provided as follows;

1. Measured Before Construction (MBC)
2. Standard Design Drawings (SDD)
3. Actual Work Done (AWD)

1. Measured Before Construction (MBC)

This is the preferred quantity measurement method under EIIP and where ever feasible this approach shall be applied. All measurements under this category are based on a detailed Bill of Quantity prepared by EIIP during detailed survey of the work. In case of any discrepancy between quantities by EIIP Project Engineer and contractor a third joint-measurement shall be carried out. The EIIP Project Engineer and the contractor will then certify that these quantities are final by their signatures on revised BoQ prior to Possession of Site by the contractor.

2. Standard Design Drawings (SDD)

This measurement category applies for all pay items for which standard drawings have been prepared, primarily standardised structure items. The drawings shall be accurate enough to provide the contractor with all key dimensions and quantities so that he/she shall be able to cost an "all inclusive" price per pay item. The location of where a particular structure item shall be needed will be indicated in the Contract.

3. Actual Work Done (AWD)

This measurement category shall only be used for pay items that are difficult to assess accurately in advance of construction. Actual quantities of these pay items shall then be jointly measured by the EIIP Project Engineer and the contractor during construction and the measurement sheets be signed by both parties.

SECTION 1, GENERAL ITEMS

1.1 CONTRACTOR'S ESTABLISHMENT+ SITE CAMP

1. Description

This item is the mobilization and demobilize of equipment, plants and hand tools to and from the site and establishment of site camp. The lump sum figure in the BoQ is the maximum available amount for this activity, which has been fixed by the project

2. Details

- **Mobilization and demobilize of equipment, plants and hand tools.**

The Contractor shall mobilize equipment, plants and hand tools that listed in the equipment plan to the site of works. In no case shall the Contractor remove from the site, equipment, plant and tools without the written approval of the EIIP Project Engineer. The equipment and plants shall include roller, water, dump trucks, concrete mixers and hand tools. Quantity of the hand tools is vary depending on number of labour to be employed.

After completion of the contract the contractor shall demobilization of equipment, plants and hand tools from the work site to original locations

- **Establishment of site camp**

The Contractor must establish a site camp for the efficient operation of the contract. This can be by renting a local house or by constructing a temporary office. These buildings must include: site office for the Contractor's staff, adequate warehouses for cement, bitumen, fuel, tools and other materials, kitchen, toilets and sleeping accommodation if required. Establishment shall include security and operation of the site camp.

The buildings must be made of locally available durable materials. They must be well ventilated and protected against flooding. Toilets must be private and secure and within 500 metres of all work sites, beyond the camp limits as required.

Offices and warehouses must be lockable and secure against attempts to break in. Offices and first aid rooms must have adequate tables and chairs. The buildings should be kept in good condition during the contract. The location of each building will be selected by the contractor in consultation with the EIIP Project Engineer and community members before construction can start.

Upon completion of the Contract, and after receiving approval in writing from the EIIP Project Engineer, the Contractor shall take down and remove all structures forming part of his own camp, yard and workshops including removal of all drains and culverts, back-filling of trenches, filling of pit latrines, etc. and shall restore the site, as far as practicable, to its original condition and leave it neat and tidy.

- **Site camp facilities**

The Contractor shall also include pricing in the BOQ for the site camp facilities and operation. The site facilities include but not limited to, security guard, electricity power, lighting, ventilation and humidity control, sanitation facilities, fire extinguisher, and water service.

3. Payment

This item is paid in full after all the equipment, plants, hand tools mobilized and site camp has been established and all the required site camp facilities have been equipped.

1.2 INSURANCE

1. Description

This item is to cover injury or death of workers recruited by the contractor and third party liability for damage to property of third parties. The lump sum figure in the BoQ is the maximum available for this activity and fixed by the project. The amount is reimbursable upon contractor's submission of proof of payment of the insurance policy.

2. Method

- The successful bidders shall take a workers compensation and third party liability insurance before mobilizing the works
- The insurance should cover injury or death of workers and damage to third parties properties
- A copy of the Insurance should be submitted to EIIP office for filing.
- The insurance should cover:
 - Personal accident insurance for the average number of workers and the duration of the contract with a maximum cover of insert appropriate amount and currency
 - Third party liability insurance with a maximum cover of insert appropriate amount and currency

3. Payment

The cost of the insurance will be reimbursed upon receipt of proof that the payment of the insurance premium has been paid in full.

1.3 SAFETY AND HEALTH

1. Description

This item is the provision of general safety and health measures for labourers on site. The lump sum figure in the BoQ is the maximum available for this activity and fixed by the project. However, specific safety measures may be included in other pay items.

2. Details

Safety Measures

- Carry out a safety briefing for all workers before works begin. Make sure work is organized so that each worker has enough space to carry out his or her task without endangering coworkers.
- The Contractor shall keep the entire length of the project in such condition that traffic shall be accommodated safely and road user's, Contractor's, Employer's shall be protected. The Contractor shall place warning signs or cones at each end of the work area. The warning signs should be placed 50-100 m away from the working areas.
- All equipment operators must be trained in the use of their equipment (trucks, rollers, mixers, etc). Equipment must be in good condition and safety covers for moving parts should be used.
- Deep excavations (more than 1.5 m) for foundations etc shall be clearly marked and fenced off in a way that people cannot fall into the excavation. The sides of excavations must be made safe, either by ensuring a sufficient angle of the slope or by shoring up the side walls with planks, so that they do not fall onto workers in the excavation. See also pay item 5.10 below.
- Reinforcement bars sticking out where concrete has not yet been poured must be clearly marked to avoid cutting or spearing accidents. The whole such area should be clearly marked and sealed off to make sure no one accidentally steps or falls into uncompleted structure works.
- No children are allowed enter in the work area.
- The contractor shall not allow the use of alcohol or drugs on the works site or in the site camp.

Drinking water: Drinking water must be available within 50 meters of all work sites approximately 2 liters should be available per worker per day

Safety Gear: The Contractor is responsible for safety on site and must explain clearly for all workers any potential danger of various work activities and what precautions to take to avoid any accidents on site. The Contractor shall provide appropriate safety gear in sufficient numbers. All workers must be instructed how and when to use safety gear and items shall be replaced when unusable or lost: The Contractor shall provide safety gear as listed below.

- Safety jackets in bright colors for supervisors and for all workers if working on a road that has frequent traffic
- Closed shoes and gloves for all workers for general works. Note that cotton gloves need to be replaced regularly
- Gum boots and good quality gloves when working with sharp tools (e.g. pick axes), Carrying heavy loads, masonry work, working in muddy places

- Hard hats (or helmets) for workers working in danger of falling objects, eg, in deep drains, in quarries, under a bridge, etc.
- Dust masks when working with activities that produces lot of dust or bad smell. Note that dust masks must be replaced regularly
- Safety goggles must be used when breaking rock or crushing stone or anytime there is a risk for eye injury

First Aid: A first aid box must be provided on site and must be regularly checked and restocked.

- Plasters
- Bandages
- Disinfectant
- Antiseptic cream
- Clean fresh water for washing eyes
- Saline
- Irrigation syringe
- Sterile dressings
- Adhesive tape
- Scissors
- Disposable gloves

3. Measurement and payment

This item is paid as lump sum amount when all measures described above are in place and available during site inspection.

1.4 REINSTATEMENT OF QUARRIES

1. Description

This item is used to quickly and simply reinstate quarries and other damaged sites, such as those where spoil is dumped. It will include trimming slopes, removing loose material, covering with topsoil, etc.

If the required works are more substantial, other activities in the BoQ (retaining walls, bio-engineering works, etc) will be used. The lump sum figure in the BoQ is the maximum available for this activity. It may not all be used.

2. Details

Each item of work will be agreed between the Contractor and the EIIP Project Engineer before the work starts. In many cases the work will follow activities in these specifications.

3. Measurement and payment

Approximate quantities and fixed unit rates for this activity will be agreed between the Contractor and the EIIP Project Engineer before each item of work starts. When the work is similar to other activities in the BoQ, those unit rates will be used.

The item will be paid based on unit rates agreed in advance of the activity and based on measured quantities after the work has been completed.

1.5 MATERIAL TESTING

1. Description

This item is the testing of material in a laboratory such as gravel for surfacing, compressive strength test for concrete for major structures and gradation test for aggregate and sand to be used for major structures. The lump sum figure in the BoQ is the maximum available amount for this activity and fixed by the project.

2. Details

- **Test for gravel:** This activity is the testing for gravel before selection of a gravel quarry. The contractor with the agreement of EIIP Project Engineer to identify a gravel quarry and take a sample of gravel of about 50 kg for the testing in a Laboratory. The test should include: Gradation test, Plasticity test, Proctor test and CBR test. The result of the test shall be submitted to the EIIP office before deciding whether or not to use the quarry.
- **Testing for concrete (compressive strength test):** This activity is the testing for concrete strength for major structures such as a bridge or drift or concrete for a big box culvert. The contractor with the agreement of EIIP Project Engineer to fill in minimum 3 molds (cube or cylinder) during mixing the concrete and curing for 7 days then send the moulds for compressive strength test. The result of the test shall be submitted to EIIP office.
- **Gradation test for aggregate or sand.** This activity is the gradation test in laboratory for aggregate or sand to use for concrete work or road base. When requested by the EIIP Project Engineer the contractor shall send a sample of aggregate or sand for the test. The result of the test shall be submitted to the EIIP office before deciding whether or not to use the quarry.

3. Measurement and payment

The cost of laboratory tests is reimbursed after receiving test results by the contractor.

1.6 SURVEYOR AND SETTING OUT

1. Description

This item is paid for the services to be provided the surveying engineer and setting out the locations, alignment, resection, and elevations of each activity, and location of the drainage structures to be carried out by the contractor. This provision sum is fixed and shall cover for the completion of the works. The EIIP Project Engineer will monitor the work and provide necessary instruction.

2. Payment

The cost of the surveyor and setting out in Lump sum up on satisfaction of the performance by the EIIP Engineer.

1.7 WORK PERMITS

1. Description

This item is paid for the work permits for all foreign skilled and unskilled workers who work for this contract. The contractor is responsible to apply and process the work permits. It is estimated that each worker will work for a minimum of two months. Therefore the work permits shall be in a minimum validity of two months

2. Payment

The cost of the work permits will be reimbursed upon receipt of the proof that the payment of the work permits has been paid in full.

1.8 AS BUILT DRAWING

1. Description

The Contractor shall (i) neatly and professionally prepare as-built drawings for all work completed, on reproducible copies of the drawings and on electronic media storage in a program stipulated by the Engineer for all the trades Architectural, Structural, Mechanical, Electrical, Environmental, Landscape and other utilities and such other “As Built” drawings as are called for by the Specification and (ii) submit them to the Engineer for approval, and shall (iii) provide additional drawings of those parts of the permanent work designed by the Contractor to clearly show details such as electrical signal line and wiring connections, piping and instrumentation diagram, and other applicable drawings and sketches prepared for the work as required (being drawings which the Contractor or any subcontractor has to prepare for the purpose of the Works) and shall (iv) transmit the As- Built drawings to the Engineer on a continuous basis before completion of construction and in all cases prior to issuance of the certificate of completion of the Works.

The Contractor shall maintain on site one complete set of the Contract drawings which shall be available to the Engineer at all times and upon which the Contractor shall record on a continuous basis all changes and field adjustments. On a continuous basis shall mean as the work is progressively accomplished in relation to each Drawing. As Built drawing progress prints shall be submitted to the Engineer for review and approval as each Contract drawing reaches the 50 percent, 75 percent, and 100 percent completion stages.

As Built Drawings shall be considered as part of the Contractor’s work effort. Failure to submit as-built drawings will result in delay of the Engineer’s issuance of the Certificate of Completion.

2. Measurement and payment

This item is paid a lump sum amount when all build drawings are submitted.

1.9 SHOP DRAWING

1. Description

The Contractor shall prepare and submit for approval, design and shop drawings, specifications, calculations, manufacturers' data etc. as required by the Engineer within 2 weeks days after receiving the instruction from the EIIP engineer. Drawings shall be carefully checked before submission to ensure that no conflict exists with other parts of the work.

2. Measurement and payment

This item is paid a lump sum amount when all build drawings are submitted.

1.10 DAY WORK

1. Description

This work consists of certain Engineer approved operations not originally envisaged during design but which become apparent during construction as being necessary for the satisfactory execution and completion of the project. The operations carried out under Day work may be of any kind whatsoever as directed or authorized by the EIIP Project Engineer, and may include additional drainage works, excavation, filling, stabilization, testing, restitution of line existing pavement, construction of overlays, structures or other works.

2. Execution of Day Work

Day Work Authorization

- a) Day work may be either requested in writing by the Contractor or ordered by the EIIP Project Engineer. In either case, the work shall not be commenced until the issue by the EIIP Project Engineer of a written Day work Authorization
- b) For work to be executed for which Day work Unit Prices are already established in the priced Bill of Quantities, this authorization will describe the extent and mixture of the work required with attachments of drawings or revised Contract Documents to define the details of the work, and shall designate the method of determining the eventual value of the Works ordered.
- c) For work to be executed for which new or additional Day work Unit Prices have to be agreed, this authorization shall also be cross referenced to, and be accompanied by, a Variation authorizing the agreed new or additional Unit Prices.
- d) The Engineer shall sign and date the Day work Authorization as authorization for the Contractor to proceed with the work.

Performance of work executed on a Day Work basis

Day works operations shall be carried out in accordance with the provisions of the relevant Sections of these Specifications governing the placement and finishing of maintenance of the work and rectification of any unsatisfactory work. In the case of work required to be carried out on a Day work basis which is not specified elsewhere in the Specifications, the work shall be performed as directed and approved by the EIIP Project Engineer.

3. Day Work claims

- Upon completion of each instruction for work executed on a Day work basis, the Contractor shall prepare an itemized payment claim for the labor costs incurred by him in carrying out the Day work, and he shall include this Day work Claim, together with all supporting data, in his next application for interim payment by Monthly Certificate. The supporting data for the Day work Claim shall include all of the daily records (Master roll) approved by the Engineer.
- The Engineer shall check and certify the Contractor's Day work Claim as part of the application for Monthly Certificate Payment in accordance with the relevant Clauses of the Conditions of Contract concerning certification and payment.

4. Measurement and payment for Day Work (labour)

Measurement of labor for payment under Day work shall be made for the actual certified day worked at the unit Prices for the various categories of labor entered in the Bill of Quantities, which price and payment shall constitute full compensation cost include, the laborer's wages, transportation to and from the site, taxes, other entitled allowances company overhead and profit.

E-2 Technical Specifications for Earth Works

2.1 EXCAVATE AND REMOVAL OF LANDSLIDE

1. DESCRIPTION

This item is the excavation, removal, load and disposal of land slide from road carriage way and road drainages. The material from the land slide excavation shall be disposed to a safe place as instructed by the EIIP Engineer.

2. MATERIALS

No additional materials are required.

3. Method

- The landslide should be excavated and loaded on a truck by labour where is appropriate as instructed by the EIIP Project Engineer and disposed to a safe place.
- Where the land slide is assessed in big quantity, the excavation and loading can be done by equipment and transport to dispose in a safe place.

4. EQUIPMENT

The activity requires hand tools, dump truck, excavator (shall be approved by the EIIP engineer)

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- Safety gear refers to item 1.3

6. CHECKING

The following will be checked

- The road carriage way and drainage structures are free from the land slide.
- The land slide is transported and disposed to a safe place.

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the volume of the land slide excavated and removed to a safe place, measured in m³

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

2.2 REPAIRING ROAD SIDE SLOPE

1. DESCRIPTION

The work includes the removal of spoilt soil and the filling of the eroded areas with selected soil, watering and compacting of the selected filled soil to recover the shape and height of the road slope. The performance standard required shall be road slope repaired to their original shape using approved selected soil and free draining at all times.

2. MATERIAL

To be of good quality, the soil should have the following characteristics:

- Well graded from fine to coarse with a maximum particle size of 60 mm
- The particles should be strong and not crumble under compaction equipment
- The particles should be angular and not rounded

- The soil should not contain organic soil, sticks, leaves, etc
- If the soil is to be covered with another layer, it should have very low plasticity
- If the soil is to be used as a riding surface, it should have some plasticity
- The EIIP Project Engineer must approve all soil before it is used.

3. METHOD

The following steps should be followed:

- Before delivering the selected soil, the source of the soil shall be approved by the EIIP Project Engineer
- Prepare and clean the eroded road slope area. The eroded areas should be cleaned of topsoil and other unsuitable soils such as soft clay and saturated soil,
- Fill and spread the selected soil in layers no thicker than 15 cm and to the required shape.
- Water the soil and allow it to soak until the entire layer is at optimum moisture water content. This is achieved when the soil can be squeezed into a ball but water does not drip out
- Compact the soil using compaction equipment until the point at which it does not compact any more under successive passes of the equipment (this is called 'refusal')
- After one layer has been fully compacted, spread, water and compact another layer as before until reaching the level of the road shoulder.
- If possible planting grass on the filled area.

4. EQUIPMENT

This item requires hand tools, dump truck, compactor and water carrying equipment (water truck).

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear refers to item 1.3

6. Checking

When available, simple tests should be used to test the soil for grading, particle strength, particle shape, absence of organic material and plasticity. If not available, the EIIP Project Engineer will assess the soil manually and visually.

- Layer thicknesses
- Moisture content before compaction
- Compaction to refusal
- Final shape of the fill, level of the filled and compacted soil

7. MEASUREMENT AND PAYMENT (AWD)

This item will be paid by the total volume filled, measured in m³ after compaction.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

2.3 REPAIRING AND FILLING ROAD SHOULDERS

1. DESCRIPTION

This item shall consist of a gravel (tout-en-on) composed of a mixture of crushed stone and stone dust materials, constructed on a compacted existing road shoulder. The activity is the supply of suitable gravel (tout-en-on) materials on site, spreading on an existing road shoulder and compaction. Materials selected for use should be with proper proportion of gradation and fine material that meet the requirements in the specification and shall be free of lumps of organic, or other deleterious materials.

2. MATERIALS

- The selected gravel (tout-en-on) for the filling road shoulders should meet required specifications as mentioned in (3.1 Re-graveling on the gravel road)

3. METHOD

The following steps should be followed:

- Before any gravel material is placed, the existing road shoulder shall be prepared and cleaned to the acceptant of the EIIP Project Engineer before placing and spreading operations are started.
- Spread the delivered gravel material by labour in layers as specified in the drawing, no thicker than 15 cm and to a slope downward to the side slope of 4-5 % cross fall. The material, as spread, shall be of uniform gradation with no pockets of fine or coarse materials. No material shall be placed on a soft or muddy course. During the placing and spreading, sufficient caution shall be taken to avoid segregation.
- After spreading the material shall be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers shall be furnished to adequately handle the rate of placing and spreading of the base course.
- The rolling shall continue until the material is thoroughly set and stable, and the gravel has been compacted to not less than 100% of maximum dry density at optimum moisture as determined by ASTM D 1557, Method D.
- Tests for field density shall be made in at least one location for every 500 square metres of each compacted layer in accordance with ASTM 1556. The gravel shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the underlying course. Water shall not be added in such a manner or quantity that free water will reach the underlying layer and cause it to become soft.

4. EQUIPMENT

This activity requires hand tools and haulage equipment (trucks) to carry the base material and compaction equipment (roller of minimum 6 tons capacity with vibration and water truck/water bowzer, mechanical stamper).

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear include closed shoes and gloves

6. CHECKING

A simple laboratory tests shall be carried out to test the gravel for grading, particle strength, particle shape and plasticity before using the quarry. The strength of the compacted layer should be checked by DCP.

Surface finish tests

After the course is completely compacted, the surface shall be tested for smoothness and accuracy of grade and level, any portion found to lack the required smoothness or to fail in accuracy of grade or level shall be scarified, reshaped, re-compacted, and otherwise manipulated as the EIIP Project Engineer may direct until the required smoothness and accuracy are obtained.

Thickness and finished levels

- The thickness of the completed road shoulders may be checked by depth tests or cores taken at intervals, so that each test shall represent no more than 400 square meters.
- Deficiencies in thickness are allowed between the tolerances for elevation of the underlying layer and the top of the constructed shoulders.

7. MEASUREMENT AND PAYMENT (AWD)

This activity will be paid by the volume of the material placed, measured in m³ after compaction and acceptable Laboratory testing result.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

E-3 Technical Specifications for Surfacing Works

3.1 RE-GRAVELLING, ON A GRAVEL ROAD SURFACE (and Base course for asphalt for surface)

1. DESCRIPTION

This item shall consist of a gravel (tout-venant) composed of a mixture of crushed stone and stone dust materials, constructed on a compacted existing road surface or sub base layer in accordance with this specification and in conformity with the dimensions shown on the drawings and with the lines and grades as established by the EIIP Engineer. The activity is the supply of suitable gravel (tout-enon) materials on site, spreading on a compacted existing surface or sub base layer and compaction. Materials selected for use as road gravel surface should be with proper proportion of gradation and fine material that meet the requirements in the specification and shall be free of lumps of organic, or other deleterious materials.

2. MATERIALS

- The aggregate shall be either crushed gravel or crushed stone. The fine aggregate shall be screenings obtained from crushed stone or crushed gravel.
- The crushed gravel and stone shall consist of hard durable stones, rock, boulders, large cobble stones etc. crushed to specified sizes and shall not contain more than 8% flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.
- A flat particle is one having a ratio of width to thickness greater than 3 and an elongated particle is one having a ratio of length to width greater than 3. The method used in production of crushed gravel and stone shall be such that the finished product shall be as uniform as practicable. The crushing shall result in a product, of which the material retained on a No. 4 sieve shall have at least 90% by weight of particles with at least one fracture face.

- Each fractured face shall have an area being at least equal to 75% of the smallest mid- sectional area of the particle. When two fractures are adjacent, the angle between the planes of the fracture must be at least 30° to count as two fractured faces.
- If so required gravel and rock etc. shall be screened before crushing to meet the requirements or to eliminate an excess of fine particles. All inferior materials and excess fine aggregates shall be wasted.
- The crushed aggregate shall have a percentage of wear of not more than 30 after 500 revolutions as determined by ASTM C 131 (Los Angeles Rattler Test).
- The gradation shall be within the limits of the gradations shown in the following table:

Gradation Requirements for Base Course or re-graveling

ASTM Sieve	Mass Percent Passing					
	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
1 in.	---	75-95	10	10	100	100
3/8 in.	30-65	40-75	50-85	60-100	--	---
No. 4	25-55	30-60	35-65	50-85	55-100	70-100
No. 10	15-40	20-45	25-50	40-70	40-100	55-100
No. 40	8-20	15-30	15-30	25-45	20-50	30-70
No. 200	2-8	5-20	5- 15	5-20	6-20	8-25

- The gradations in the table represent the limits which shall determine the suitability of aggregate. The final gradation decided on within the limits designated in the table shall be uniformly graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves, or vice versa.
- The amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one-half the fraction passing the No. 40 mesh sieve.
- The portion of the aggregate, including any blended material, passing No. 40 mesh sieve shall have a liquid limit of not more than 25% and a plasticity index of not more than 6% when tested in accordance with ASTM D 423 and D 424.
- The crushed aggregate base course material shall have a 4 days soaked CBR of not less than 80, when compacted at 100% of modified proctor according to ASTM D-1557 (method D) and tested in accordance with ASTM D-1883.

Additional fine material

- If additional fine material, in excess to that naturally present in the base course material is necessary for correcting the gradation to the limitations of the specified gradation, or for changing the soil constants of the material passing the No. 40 mesh sieve, it shall be uniformly blended and mixed with the base course material at the crushing plant or by an approved blending plant.
- There shall be no reworking of the base course material in place to obtain the specified gradation. The additional fine material for this purpose shall be obtained from the crushing of gravel and/or stone.

Plant mixing

The selected gravel shall be uniformly blended during crushing operations or mixed in an approved blending plant. The type of plant may be either a central proportioning and mixing plant or a travelling plant. The plant shall blend and mix the materials to meet these specifications and to secure the proper moisture content for compaction.

Whenever there is a change in the material source a full set of tests shall be required.

3. METHOD

The following steps should be followed:

- Before any gravel material is placed, the existing road surface or sub base layer shall be prepared and conditioned as specified. The prepared existing road surface or sub base layer shall be checked and accepted by the Engineer before placing and spreading operations are started.
- The gravel shall be constructed in layers. Spread the delivered gravel material by labour in layers as specified in the drawing, no thicker than 15 cm and to a camber of 4-6 %. . The material, as spread, shall be of uniform gradation with no pockets of fine or coarse materials. No material shall be placed on a soft or muddy course. During the placing and spreading, sufficient caution shall be taken to avoid segregation.
- After spreading the material shall be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers shall be furnished to adequately handle the rate of placing and spreading of the base course.
- Rolling shall progress gradually from the sides to the centre of the lane under construction, or from one side towards previously placed material, by lapping uniformly each preceding track by at least 300mm.
- The rolling shall continue until the material is thoroughly set and stable, and the course has been compacted to not less than 100% of maximum dry density at optimum moisture as determined by ASTM D 1557, Method D.
- Tests for field density shall be made in at least one location for every 500 square metres of each compacted layer in accordance with ASTM 1556. The gravel shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the underlying course. Water shall not be added in such a manner or quantity that free water will reach the underlying layer and cause it to become soft.
- Along places inaccessible to rollers, the material shall be tamped thoroughly with mechanical tampers, until satisfaction compaction is obtained. Each layer of base course must be completely compacted and approved by the Engineer.

4. EQUIPMENT

This activity requires hand tools and haulage equipment (trucks) to carry the base material and compaction equipment (roller of minimum 8 tons capacity with vibration and water truck/water truck, mechanical stamper).

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (water truck, roller, tampers). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear include closed shoes and gloves

6. CHECKING

A simple laboratory tests shall be carried out to test the gravel for grading, particle strength, particle shape and plasticity before using the quarry. The strength of the compacted layer should be checked by DCP.

Surface finish tests

After the course is completely compacted, the surface shall be tested for smoothness and accuracy of grade and level, any portion found to lack the required smoothness or to fail in accuracy of grade or level shall be scarified, reshaped, re compacted, and otherwise manipulated as the Engineer may direct until the required smoothness and accuracy are obtained. The finished surface shall not vary more than 10mm when tested with a 3 metre straightedge applied parallel with and at right angles to the centre line.

Thickness and finished levels

- The thickness of the completed road surface may be checked by depth tests or cores taken at intervals, so that each test shall represent no more than 400 square meters.
- Deficiencies in thickness are allowed between the tolerances for elevation of the underlying layer and the top of the constructed base course.
- The elevations of the finished surface shall not vary more than 10mm from the design elevations. The leveling of the finished road surface shall be performed by the Contractor in a grid as indicated by the Engineer. The Contractor shall submit all levels in due time to the Engineer for checking and approval. Any deviation of the finished elevations from the design elevations outside the tolerances, shall be corrected by the Contractor by scarifying, removing and/or adding material, sprinkling, rolling, reshaping, and finishing in accordance with these specifications. The Contractor shall replace at his expense the material when borings are taken for test purposes.

7. MEASUREMENT AND PAYMENT (AWD)

This activity will be paid by the volume of base material placed, measured in m³ after compaction and acceptable Laboratory testing result.

3.2 PATCHING POTHOLE (FOR ASPHALT PAVEMENT)

1. DESCRIPTION:

This item shall consist of cutting potholes to a rectangular shape, all material from the cut, unsuitable/degraded material shall be removed to a minimum depth of 15 cm. Fill the holes with the selected base course material (tout-enon), watered and compacted using a mechanical compactor or small roller, spray bituminous prime coat/tack coat and fill the final layer by Asphalt Concrete layer of min 5 cm. The final layer shall be compacted immediately by a pneumatic roller.

2. MATERIALS:

- Base course. The material shall be referred to the Section 3.1 of this specifications
- Bituminous prime coat/tack coat
- Asphalt Concrete

BITUMINOUS PRIME COAT/ TACK COAT

Unless otherwise specified, a prime coat of medium curing cut- back bitumen of grade MC- 70 shall be applied on top of finished base course, at the rate of 1.0 kg/m², and a tack coat of rapid curing cut-back bitumen of grade RC-250 shall be applied between asphalt concrete layers (where more than one wearing course is specified), at the rate of 0.25 kg/m².

Bituminous coats shall be applied one day before the next layer is placed on top of them. Prior to applying bituminous coats, the compacted base course shall be thoroughly cleaned of all dirt, oil, grease and other objectionable matter, to the satisfaction of the Engineer. The bitumen shall be heated in boilers of an approved type and spreading shall be carried out by means of mechanical pressure distributors.

ASPHALT CONCRETE

All aggregates and bituminous materials to be used in asphalt concrete shall be subject to approval by the EIIP Project Engineer. Samples of the materials shall be submitted to the EIIP Project Engineer at least 7 days prior to their use.

All aggregates, except natural sand, shall be obtained by crushing natural quarry stone, and the use of river gravel, whether crushed or not, will not be permitted. Coarse aggregate shall be of uniform quality, with the particles as nearly cubiform as possible, clean of dust or foreign matter, and shall comply with the requirements above for base course aggregate. The grading of the aggregates shall be if not specified in the Particular Specification as follows:

A.S.T.M.Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
$\frac{3}{4}$ "	100%
$\frac{1}{2}$ "	80-100
No. 4	50-70
No. 10	32-47
No. 40	16-26
No. 80	10-18
No. 200	4-10

Mix design shall be carried out as follows. The proposed aggregate mixture shall be mixed with 5.5% bitumen (if no other percentage is required in the Particular Specification). This sample shall be subjected to a set of Marshall tests (A.S.T.M.-D-1559 and A.S.T.M.-D-1188) at a laboratory in order to determine the optimum bitumen content. The Engineer may change the grading of the aggregates and the bitumen content according to the results of laboratory tests conducted on samples of materials supplied from time to time by the Contractor at the request of the Engineer.

3. METHOD

The following steps should be followed:

- Mark and then cut the potholes in rectangular shapes and remove all the excavated material and unsuitable material to a depth of not less than 15 cm reach to the firm base course or sub base layer.
- Level and compact the holes by mechanical compactor, fill the hole by selected base course material on layer by layer. Each layer shall not be greater than 10 cm, watering and compaction (see the Section 3.1). The compacted layer should be 50mm below the surrounding asphalt level.
- Spray bituminous prime coat/tack coat over the compacted base course layer. The application rate of the Prime coat is above mentioned. The Sprayed prime coat should be kept for 1 day before placing next layer (Asphalt concrete layer).
- Placing the Asphalt Concrete layer of a minimum 50mm and spread to level, ensuring that the final level of the Asphalt concrete shall be 5-10 mm above the surrounding asphalt level.

- Compaction shall start immediately by a pneumatic roller to reach a density not less than 97% of the Marshall density. The permissible variations of the top surface from the design levels shall be -0 or + 15 mm.

4. EQUIPMENT

This activity requires

- Hand tools
- Trucks to carry material
- Asphalt cutter
- Plate compactor, tamper
- Pneumatic roller

5. SAFETY ON SITE

- Workers must be well spaced to limit the risk of injury when using hand tools.
- All operators must be trained in the use of their equipment (truck, roller). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear include closed shoes and gloves

6. CHECKING

- Testing or base course shall refer to Section 3.1
- **Tests on asphalt concrete mixture**
 - Tests to determine the grading of aggregates and the bitumen content
 - Marshall tests to determine the stability and density of bitumen-covered aggregates.

These tests shall be carried out before the commencement of works and repeated to the satisfaction of the Engineer.

- **Control of placing asphalt concrete**
 - Throughout placing and compacting aggregates works, the temperature shall be controlled permanently in order to be $\geq 135^{\circ}\text{C}$.
 - After compaction, density shall be equal to 98% of the Marshall density; one core sample shall be taken of each 1000 m² of finished layer. These samples shall also be used to control the layer thickness.
 - No layer shall be executed by the Contractor unless the under laying one has been duly taken over by the Engineer.

7. MEASUREMENT AND PAYMENT (AWD)

Measurement: This item will be paid by the m² of the completed potholes patching and acceptable to the EIIP Project engineer.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

E-4 Technical Specifications for Concrete Works

4.1 CONSTRUCTION OF REINFORCED CONCRETE SIDE DRAIN

1. DESCRIPTION

This Item consists of trench excavation for foundation, preparation of bedding and lean concrete, construction of reinforced concrete side drain or storm water drain and back filling.

2. MATERIAL

- Material for concrete work construction as mentioned in section concrete and reinforced steel bars items (crushed stone, sand, cement, and steel bars)

3. METHOD

- Excavate and shape trench to the depth as specified in the drawing.
- Prepare bedding to a slope minimum 1-2% gradient or in accordant to the road gradient → establish levels or as described by the drawings.
- The disposal of surplus material shall be done at locations approved by the EIIP Project Engineers.
- Mix and cast blind concrete bedding as specified in the detailed drawing. The concrete shall be mixed by small concrete mixer and cast in situ
- Prepare formwork and fixing and placing the steel bars as dimensioned and spacing specified in the drawing.
- Mixing and cast concrete class of the concrete specified in the drawing. The concrete should mixed in situ by small concrete mixer.
- Back fill by selected soil/gravel and compact in layer of not more than 10 cm by mechanical tamper to the refusal. The back filling should not be done before 14 days of casting the concrete

4. EQUIPMENT

- The activity requires hand tools, truck, mechanical tamper, concrete mixer with capacity 1-3 bags of cement per 1 mix

5. SAFETY ON SITE

- Safety gear refers to item 1.3
- Adequate traffic signs shall be provided

6. CHECKING

The following will be checked:

- Ensure the foundation is well prepared and appropriate gradient as per drawing
- Ensuring the concrete pipes are in good condition before and after laying on the foundation
- Concrete work refers to quality check in section “concrete” and “reinforced steel bars” and “backfill”

7. MEASUREMENT AND PAYMENT (AWD)

Measurement Unit = LM of the completed reinforce concrete side drain /storm water drain completed.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.3 CONSTRUCTION OF REINFORCED CONCRETE RETAINING WALL

1. DESCRIPTION

This Item consists of excavation for foundation, preparation of bedding and lean concrete, prepare formwork and construct reinforced concrete retaining wall and back filling,

2. MATERIAL

- Material for concrete work construction as mentioned in section concrete and reinforced steel bars items (crushed stone, sand, cement, and steel bars)

3. METHOD

- Excavate for foundation to the depth and width as specified in the drawing,
- The disposal of surplus material shall be done at locations approved by the EIIP Project Engineers.
- Mix and cast blind concrete bedding as specified in the detailed drawing. The concrete shall be mixed by small concrete mixer and cast in situ
- Prepare formwork and fixing and placing the steel bars as dimensioned and spacing specified in the drawing.
- Mixing and cast concrete class of the concrete specified in the drawing. The concrete should mixed in situ by small concrete mixer.
- Back fill by selected soil/gravel and compact in layer of not more than 10 cm by mechanical stamper to the refusal. The back filling should not be done before 14 days of casting the concrete

4. EQUIPMENT

- The activity requires hand tools, truck, mechanical tamper, concrete mixer with capacity 1-3 bags of cement per 1 mix

5. SAFETY ON SITE

- Safety gear refers to item 1.3
- Adequate traffic signs shall be provided

6. CHECKING

The following will be checked:

- Ensure the foundation is well prepared and appropriate gradient as per drawing
- Ensuring the concrete pipes are in good condition before and after laying on the foundation
- Concrete work refers to quality check in section “concrete” and “reinforced steel bars” and “backfill”

7. MEASUREMENT AND PAYMENT (AWD)

Measurement Unit = M^3 of the completed channel or storm water draina.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.4 CONSTRUCTION OF REINFORCED CONCRETE PIPE CULVERT DIAMETER (60 CM, 80 CM, 100 CM)

1. DESCRIPTION

This Item consists of supplying the concrete pipe rings, laying and joining the rings. Excavation and back filling, preparing bedding and construction of reinforced concrete headwall and wing walls and aprons.

2. MATERIAL

- The pipe rings shall be of reinforced concrete with ogee (male and female) joints, of concrete Class 20, at least 28 days cured, and where possible, manufactured on site.
- If the pipe rings are not manufactured on site the supplier must be approved by the EIIP Project Engineers. The ring shall in standard length of 2.5 m.
- The culvert gradient including the outlet shall be minimum 2%.
- Culvert joints shall be sealed with mortar of 1:3.
- Reinforced concrete for head walls and wing walls construction

3. METHOD

- Supply or manufacture reinforced concrete culvert pipe rings, cure concrete pipes for not less than 28 days, transport culvert pipes to the locations of work,
- excavate and shape trench, place pipes and join them, lay to minimum 2% gradient → establish levels or as described by the drawings.
- The disposal of surplus material shall be done at locations approved by the EIIP Project Engineers.
- Prepare concrete bedding as specified in the detailed drawing,
- Where there is traffic, excavation of trench(s) and laying of pipe rings shall be carried out in stages to allow vehicles to pass.
- Installation work shall wherever possible start from the outlet side.
- Construction of concrete head walls, wing wall and apron as details dimension shown in the drawing.
- Back fill by selected soil/gravel and compact in layer of not more than 10 cm by mechanical tamper to the refusal.

4. EQUIPMENT

- The activity requires hand tools, truck, mechanical tamper, concrete mixer with capacity 1-3 bags of cement per 1 mix and excavator

5. SAFETY ON SITE

- Safety gear refers to item 1.3
- Adequate traffic signs shall be provided

6. CHECKING

The following will be checked:

- Quality of the concrete culvert pipe comply to AASHTO M86
- Ensure the foundation is well prepared and appropriate gradient as per drawing
- Ensuring the concrete pipes are in good condition before and after laying on the foundation
- Concrete work refers to quality check in section “concrete” and “backfill”

7. MEASUREMENT AND PAYMENT (AWD)

Measurement Unit = LM of the completed culvert line completed.

Payment: The unit rate shall be the full compensation for labour, tools, materials, equipment and any other incidentals that may be required in carrying out the work for this item.

4.5 CONCRETE

1. DESCRIPTION

This item is the supply and construct a concrete structure using structural concrete. Structural concrete is used in situations where high strength is required, such as high walls or the deck slabs of a water crossing structure. Steel reinforcement is normally fixed in structural concrete.

2. MATERIALS

This activity requires structural concrete.

The structural concrete should:

- Be made from fresh cement, clean angular sand and clean hard aggregate (stones 20 mm down) mixed by volume in the ratio 1:1.5:3
- Ideally the aggregate should be angular, but this may not be possible if the aggregate is taken from a river
- Have clean fresh water added to give a workable mix
- The strength of the concrete after 28 days, if it can be measured, should be 28 N/mm²

Structural concrete normally includes reinforcement steel. All details relating to reinforcement steel are given in the specification Section 4.6

The EIIP Project Engineer must approve all cement, sand and aggregate before it is used. All sand and aggregate must be obtained with minimum environmental damage.

Table below show Gradations of Aggregate for the concrete work

Sieve Size		Weight per cent of which passes aggregate					
Inch (in)	Standard (mm)	Fine	Coarse				
			Size max. 37.5 mm	Size max. 25 mm	Size max. 19 mm	Size max. 12.5 mm	Size max. 10 mm
2	50.8	-	100	-	-	-	-
1.5	38.1	-	95-100	100	-	-	-
1	25.4	-	-	95-100	100	-	-
0.75	19	-	35-70	-	90-100	100	-
0.5	12.7	-	-	25-60	-	90-100	100
3/8	9.5	100	10-30	-	20-55	40-70	95-100
#4	4.75	95-100	0-5	0-10	0-10	0-15	30-65
#8	2.36	80-100	-	0-5	0-5	0-5	20-50
#16	1.18	50-85	-	-	-	-	15-40
#50	0.300	10-30	-	-	-	-	5-15
#100	0.150	2-10	-	-	-	-	0-8

3. METHOD

- The layer on which the structural concrete will be constructed should be prepared and strong and clean
- Side formwork, underside formwork and all necessary falsework/scaffolding should be fixed in place as shown on the contract drawings

- Reinforcement should be fixed as shown on the contract drawings
- The concrete should be mixed by labour using small concrete mixer of a capacity of 0.2 to 0.4 m³
- The concrete should be used within 30 minutes of the water being added
- The concrete should be placed within the formwork and then compacted until no more air bubbles are seen
- Place the concrete in layers no thicker than 30 cm, remove the air from this layer before placing more concrete
- The concrete should be protected from use for 5 days after which the side formwork can be removed, and should be cured for 5 days by keeping it wet and covered with dampened sand, cloths or sacks
- The underside formwork can be removed after 21 days

4. EQUIPMENT

This activity requires hand tools and mechanical or manual concrete mixing equipment.

5. SAFETY ON SITE

- Attention must be paid when mixing concrete. Workers must use boots and strong gloves. When moving or transporting heavy materials such as cement bags, aggregates for mixing the concrete etc, either use a wheelbarrow or make sure that two lift together.
- All operators must be trained in the use of their equipment (concrete mixers, truck, rollers). Equipment must be in good condition and safety covers for moving parts should be used.
- Safety gear refers to item 1.3

6. CHECKING

The following will be checked:

- Quality of the layer on which the structural concrete will be constructed
- Quality of the side and underside formwork and the falsework, the absence of leaks and its rigidity against movement
- Quality of materials used including cement, sand, aggregate and steel
- Quality of the reinforcement (see 5.10)
- Quality of the structural concrete during after mixing and after curing
- Protection of the concrete while it is curing
- When possible concrete cubes will be made and tested for strength after 28 days

Table below show Compressive strength and Slump test requirement for concrete reference concrete mix (minor works)

Mixed Minimum	Minimum Compressive Strength				Permitted Slump (mm)	Purpose
	Cube 15 cm		Cylinder 15 x 30 cm			
	7 days	28 days	7 days	28 days		
1 : 1.5 : 3	175	260	145	215	50-125	Culvert or bridge slab. Reinforced Structure
1 : 2 : 4	150	210	125	175	50-125	Culvert slab. Lightly Reinforced Structure
1 : 3 : 6	-	-	-	-	25-100	Non-reinforced Structure

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the volume of structure concrete constructed, measured in m^3 . The unit rate include curing, cost of the formwork and supports. The cost reinforcement steel bar is not included in this item.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

4.6 REINFORCEMENT STEEL BAR

1. DESCRIPTION

This item is the supplying, cutting, bending and fixing of reinforcement steel bars within a space into which concrete will be poured, typically to form part of a structure.

2. MATERIALS

All reinforcement steel bars is shown on the contract drawings, either high tensile or mild steel. All reinforcement steel should be bought from a known and good quality source. Reinforcement steel normally rusts slightly when in storage so it should be cleaned before use with a wire brush. It should be stored in as dry a place as possible.

Good quality fixing wire is required.

It is also necessary to make spacer blocks in advance, normally from cement/sand mortar with a length of fixing wire embedded in the block. These blocks will be fixed to the outer surface of the steel mesh so that it does not move close to formwork when the concrete is being poured.

3. METHOD

- The reinforcement steel should be cut and bent to match each bar as shown on the contract drawings
- Each bend should be made around a post of 5 times the diameter of the steel so that the reinforcement steel is not excessively deformed
- Steel should not be heated as it is being bent
- These bars should be fixed together to match the mesh as shown on the concrete drawings
- Spacer blocks should be fixed to the reinforcement steel to prevent it moving close to the formwork when the concrete is being poured
- All fixing wire should be bent inwards away from the formwork
- At no point may the reinforcement steel or the fixing wire be closer to the formwork than the cover as given on the concrete drawings, usually the cover must be at least 30mm.
- The entire mesh should be fixed tightly so that it does not bend or move closer to the formwork when concrete is being poured or when workers walk on the mesh
- If necessary a length of reinforcement bent into a shape which can keep the top and bottom mat of a deck mesh at the required separation when concrete is being poured or when workers walk on the mesh

A single length of reinforcement steel is not long enough to form an entire bar as shown on the contract drawings, two lengths can be used with an overlap equal to 40 times to the diameter of the steel for rounded bar and 28 times to the diameter of the steel for deformed bar (at least 30 cm). The overlap must be fixed with at least three separate loops of fixing wire.

The reinforcement steel must be checked and approved by the EIIP Project Engineer before the concrete is poured.

4. EQUIPMENT

This activity requires hand tools to clean, cut and bend the reinforcement steel and fix it securely in place.

5. SAFETY ON SITE

- Care must be taken when cutting and bending reinforcement bars.
- Reinforcement bars sticking out where concrete has not yet been poured must be clearly marked to avoid cutting or spearing accidents. The whole such area should be clearly marked and sealed off to make sure no one accidentally steps or falls into uncompleted structure works
- Reinforcement bars are sometimes used as offset pegs. In such cases they must be clearly marked and the end pointing upwards must be bent to avoid cutting or spearing accidents;
- Safety gear refers to item 1.3

6. CHECKING

The following will be checked:

- The quality of the reinforcement steel
- The correctness of the fixing to match the contract drawings
- Cleanliness of the reinforcement steel
- Adequacy of the overlaps
- Placement of spacer blocks
- Adequacy of the cover
- Strength of the fixing so that the reinforcement steel does not move when the concrete is being poured

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the weight of reinforcement fixed, measured in kg. The unit rate includes the cost of the overlaps, fixing wire and spacer blocks.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

4.7 BACK FILLING FOR STRUCTURES

1. DESCRIPTION

Backfilling is required for structures, foundation walls, abutment walls, retaining walls, culvert, gabion works and shall be done in accordance with the Drawings. This item includes supply selected material, backfilling, levelling, shaping and compacting the approaches of constructed structures to a required length as directed by the EIIP Project Engineer.

2. MATERIAL

To be of good quality, the soil should have the following characteristics:

- Well graded from fine to coarse with a maximum particle size of 50 mm
- The particles should be strong and not crush under compaction equipment
- The particles should be angular and not rounded
- The soil should not contain organic soil, sticks, leaves, etc
- If the soil is to be covered with another layer, it should have very low plasticity
- If the soil is to be used as a riding surface, it should have some plasticity

The EIIP Project Engineer must approve all soil before it is used. All soil should be obtained with minimum environmental damage.

3. METHOD

The following steps should be followed:

- Find a source of good quality soil
- Obtain approval from the EIIP Project Engineer for the soil. Excavate, load and carry the soil to the construction site
- All excavated foundations shall be backfilled around the permanent structure to original ground level.
- Any protective supports, bracing or shoring shall be removed as the backfilling progresses
- After one layer has been fully compacted, spread, water and compact another layer as before to reach level as instructed by EIIP Project Engineer.
- The back of abutment and wing walls with weep holes shall be provided with a vertical layer of granular fill materials in the specified thick to serve as a filter.
- Back filling of the foundation shall be filled in layer of not thicker than 100mm, watering and compaction by using compaction equipment (mechanical tamper).
- The backfill for embankment for approach road, soil shall be laid and compacted in layer of not thicker than 150mm. Compact the soil using compaction equipment until the point at which it does not compact any more under successive passes of the equipment

4. EQUIPMENT

The activity requires hand tools, truck and compaction equipment (roller, mechanical tamper and water truck)

5. SAFETY ON SITE

- Safety gear refers to item 1.3.

6. CHECKING

When available, simple tests should be used to test the soil for grading, particle strength, particle shape, absence of organic material and plasticity. If not available, the EIIP Project Engineer will assess the soil manually and visually.

- Layer thicknesses.
- Filter material is used for vertical fill layer for the abutment walls and wing walls
- Compaction to refusal
- Final shape and level of the fill and compacted soil

7. MEASUREMENT AND PAYMENT

The payment for this item shall be deemed to be included by the contractor in his unit rates for the various items for concrete work and shall not be paid for separately.

4.8 FORMWORK AND SUPPORT

1. DESCRIPTION

Formwork shall include all temporary forms required for forming the concrete slab of bridges, culverts or building together with all temporary construction required for their support. This item include supply, cut and fix timber for the formworks, place timber or wooden supports for the formworks and fix necessary wooden / bamboo bracing for the supports

2. MATERIALS

All timbers for the formwork must be approved by the EIIP Project Engineer before fixing. Timber plank should be of quality medium to good timber and thickness should not be less than 20 mm. Size of timber for poles should be 50 mm x 50 mm. Size of timber for beam should be 100mm x 50 mm. The supports can be timber of size of 50 mm x 50 mm or wooden poles of 70 - 100 mm diameter.

3. METHOD

- Place poles for the supports on solid ground. If the ground is not firm enough put the poles on a rock or piece of timber/wood. The space from one pole to another should be between 40-50 cm. If the height of the poles is more than 2 m bracing is required to connect from one pole to other. The bracing should be placed at the middle of the poles
- Timber beams are placed for each row of the support poles and fixed by nails. The timber beams should be placed and align with the abutment wall of a bridge, culvert or building
- Place timber poles and cross the beams with spacing from one to other not larger than 50 cm. The crossbeams must be fixed by nails
- Place timber planks on and cross the poles as close as possible to minimize gap at joint between each plank. The planks must be fixed by nails
- Place side formworks of all edges and fix by nails.
- Removal of formwork. The formwork must be removed after minimum 21 days after the concrete is poured. The EIIP Project Engineer shall be informed in advance by the Contractor of his/her intention to remove any formwork.

4. EQUIPMENT

This activity requires carpentry tools.

5. SAFETY ON SITE

- Safety gear refers to item 1.3.

6. CHECKING

The following will be checked:

- The quality of the timber and wooden poles
- The correctness of the fixing to match the instruction of the EIIP Project Engineer
- Spacing between the support poles and ensuring the support poles are placed on firm ground. Ensure bracing are place and nails properly
- Level of surface of the timber planks after placing and ensuring minimum gaps at the joint of each timber plank

The formworks and support must be checked by the EIIP Project Engineer before placing steel bars

7. MEASUREMENT AND PAYMENT

The work prescribed in this section shall not be measured for direct payment. The payment for this item shall be deemed to be included by the contractor in his unit rates for the various items for the concrete work and shall not be paid for separately.

E-5 Technical Specifications for Road Furniture**SECTION 5, ROAD FURNITURE****5.1 PROJECT SIGN BOARD****1. DESCRIPTION**

This item involves the supply and construction of a durable signboard to present information on the contract, funding and contractor to passing road users.

ILO will provide the contractor with the final template. Contractor should follow attached visibly plans and submit all documents for approval before execution. Contractor must not change, add, distort or edit ILO template without ILO approval.

2. MATERIALS

This activity requires steel and normal concrete. The EIIP Project Engineer must approve all materials before they are used.

Contractor shall supply and install one frame printing- two post sign Direct print UV ink Full color printing, eco-friendly, weather resistant and abrasion resistant with 120x80 cm board dimensions.

Signage shall be made of galvanized metal sheet thickness 1mm, with two metal posts rounded and painted with anti-corrosion paint, length 2 m. Posts shall be 7 cm in diameter and should be dug underground and poured with concrete, and they should be welded together with the sign board fixed with clips.

3. METHOD

The design of the signboard will be given to the contractor after award of the contract. It will present information about the contract and the contractor and will include logos of the various parties.

The location of each signboard should be agreed with the EIIP Project Engineer at the start of the work on site.

The Contractor is to:

- Construct the signboard
- Install the signboards at each location with a concrete foundation, usually at the start of the contract section and at the Contractor's camp
- Ensure the signboard face is 1.2 m x 0.8 m
- Ensure the lower edge of the signboard is 1.5 metres above the ground.

The following information will be provided and shall be included on each signboard:

- Project Name:
- Funding:
- Activity by who:
- Project name:
- Duration: [start date-end date]

4. EQUIPMENT

This activity requires hand tools and either mechanical or manual concrete mixing.

5. SAFETY ON SITE

- Safety gear refers to item 1.3 of the General Specifications (starting on page E7)

6. CHECKING

The following will be checked:

- Durability of the signboard
- Correctness of the signboard design
- Quality of the structure

If the signboard and structure deteriorates during the contract period or is removed, it must be replaced.

7. MEASUREMENT AND PAYMENT (AWD)

This item will be paid by the as a lump sum when agreed number of signboards have been erected and approved.

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

5.2 TRAFFIC SIGNS

1. SCOPE

This item shall consist of furnishing and installing all road signs complete with footings, bases, posts, and all other parts and appurtenances necessary for installation in accordance with this Specification and Drawings and/or as directed by the EIIP Engineer.

2. PRODUCTS

The Contractor shall submit a written request to the Engineer for approval of all traffic sign materials, giving makes, types, and specification details, including samples of complete traffic signs, to be used in the Works. Approval of material shall be obtained by the Contractor before ordering any traffic signs.

3 MATERIALS

- **Concrete Bases** (for Road Signs). Sign base dimensions shall be as shown on the detail drawings. Concrete shall be in accordance with the requirements of the Specification using 2.5cm maximum aggregate size. The quality shall be that of reinforced concrete.
- **Bolts:** Bolts, nuts and washers shall be of stainless steel conforming to ASTM A-276 chroming-nickel grade with a minimum yield strength of 2400 kg/sq.cm.
- **Ordinary and Break-Away Posts** (for Road Signs)

Posts shall be manufactured from one of the following materials:

- steel in the form of structural hollow sections or rolled steel joists hot-dip galvanized after fabrication. The weight of the zinc-coating shall be a minimum of 450 grammes per square meter.
- aluminium in the form of drawn tubes complying with grades 6063 – TF or 6082 – TF of BS 1471 or bars or extruded tubes or sections complying with grades 6063 – TF or 6082 – TF of BS 1474

Posts shall have dimensions and thicknesses as shown and detailed on the Drawings. The top of posts shall be closed or capped with a PVC cap.

Sign Plates

Sign plates shall be constructed from one or more of the following materials: -

- Galvanized sheet steel or strip of minimum thickness 1.5 mm for road signs. The weight of the galvanized zinc-coating shall be a minimum of 350 grams per square meter.
- Sheet aluminum and sheet aluminum alloy of minimum thickness 3.0 mm for unstiffened signs or 2.5 mm for bent- edged stiffened signs

Sign plates shall be non-porous, smooth, flat, rigid, weather-proof and shall not rust or deteriorate. They shall be so cut that there are no sharp edges and that the corners are rounded off to a radius of 30 mm for road signs. Any trade mark or other printing shall be carefully removed with a lacquer thinner.

Sign Sheeting and Sign Face Construction

- The sign faces shall be made with wide angle reflective high intensity sheeting which shall be processed onto the plate. The Manufacturer's trade mark or name and sheeting grade shall be clearly shown as a non-removable built-in mark on the sheeting. Sheeting material shall be accompanied by certificate of compliance listing its detailed specifications and identifying the standards to which it complies (ASTM D-4956 or approved equivalent)
- The base of the sign shall be normally of white, blue or yellow wide angle high intensity reflective sheeting or as described in the foregoing paragraphs, but the particular sign message shall be indicated on the Drawings.
- Prior to application of reflective film, the signs shall be cleaned and shall be wax free. They shall be greased by vapor or by alkaline immersion and etched by scrubbing with abrasive cleaners, such as medium fine steel wool. They shall be rinsed thoroughly and dried with hot air before applying any reflective material.
- The sheeting shall be cut by any standard method by a band saw or a power guillotine. The cutting tool shall be clean and sharp. The sheeting shall be cut from face side and held securely during cutting to avoid shattering and edge chipping.
- The sheeting after application to the sign base shall not come off the edges nor shall it peel off nor warp. The surface shall be smooth, flat and free from any bubbles, pimples, edge chipping or edge shattering. It shall be washable and weatherproof.
- The sheeting of different colors reflective shall have a life of 10 years after application to the face of the sign.
- This life of 10 years shall be the outdoor at-site life during which period it shall not fade in color or its reflectivity, nor shall it deteriorate in any way.
- The backface of the sign plate shall be painted with medium gray color so that the life of the two faces remains the same, i.e. 10 years.

4 METHOD**Erection of Signs**

- All signs shall be mounted approximately at right angles to the direction of, and facing, the traffic they are intended to serve.

- To get maximum effectiveness from reflecting sheeting, the sign must be properly located and should be faced slightly towards the road.
- To avoid specular glare, the sign face should be titled back two or three degrees (about 1 cm per 26 cm of sign height).
- Signs shall be installed at the locations and in accordance with details shown on the drawings and in accordance with the approved samples and materials.
- All sign material shall withstand a wind load of 150 kg per square meter of sign surface without permanent deformation. Sign plates not exceeding 1 m in width shall be supported on single posts. Sign plates exceeding 1m in width shall be supported on double posts, with or without bracing.
- Sign plates shall be attached to the posts with stiffeners, bolts, and screws which shall be painted in the same color as the corresponding area of the sign plate.
- For single post- mounted signs a locking pin shall be incorporated into the sign plate attachment system to prevent rotation of the sign plate around the axis of the post.
- The exact location of the sign shall be designated by the Engineer.
- Holes for posts shall be provided to a depth, which will permit the installation of the post and the base to the depth indicated on the Drawings or required by the Engineer. All loose material shall be removed from excavation and bearing surface of footings and excavation shall be cleaned and cut to a first surface prior to the placement of concrete base. Approved backfill material shall be used. The adjacent surface shall be neatly graded and compacted.

5. SAFETY ON SITE

- Safety gear refers to item 1.3.

6. CHECKING

- Ensure the signs are located as shown on the plans. These are tentative locations subject to field adjustments by the Engineer. No sign shall be erected prior to the Engineer's final approval of the location.

7. MEASUREMENT AND PAYMENT (AWD)

This item is paid by the number of the completed road sign inclusive. The unit rate includes the cost of the sign plate, galvanized steel post, concrete base, lettering....

Payment: The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

5.3 CRASH BARRIER (guardrail)

1. SCOPE

The crash barriers are mainly used for separating and defining aisle way, walkway or road edges.

This item shall consist of furnishing and installing or replacing road crash barriers complete with footings, bases, posts, and all other parts and appurtenances necessary for installation in accordance with this Specification and Drawings and/or as directed by the EIIP Engineer.



2. PRODUCTS

The Contractor shall submit a written request to the Engineer for approval of all crash barriers material, giving makes, types, and specification details, including samples of complete crash barriers to be used in the Works. Approval of material shall be obtained by the Contractor before ordering any traffic signs.

3 MATERIALS

- **Concrete Bases** (for crash barrier post) shall be as shown on the detail drawings. Concrete shall be in accordance with the requirements of the Specification using 2.5cm maximum aggregate size. The quality shall be that of reinforced concrete.
- Steel shall be Galvanized as per ISO 1461 bolt class 8.8; W beams: 4.13m overall length 3.81 m center to center length, 2.74 mm thickness,
- Posts: HR 120 “U” 120x53x5.5x9 mm, 1.5m long and “ C” 100x50x25x5mm.
- Bolts: M16x35mm+nut, M16x40mm + nuts, M16x50mm+nuts, and 75x45x5mm flat plate washes
- Reflectors: Red/White.



4. METHOD:

- Excavate for foundation of the post as size of the foundation is shown in the drawing,
- Install the posts in the excavated foundation and pour concrete to support the posts. The posts shall be ensured vertically installed. The concrete shall be cured before commence next activity.
- Fixing guardrails (W) beams.

5. CHECKING

- The contractor shall submit sample of all material for the barriers to the EIIP project engineer for approval before making purchase order.
- All the material shall be checked and approved by the EIIP project engineer before delivering on site.

6. MEASUREMENT AND PAYMENT (AWD)

- **Measurement:** This item shall be measured in linear meter completed and accepted by EIIP project engineer.

- **Payment:** The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

5.4 ROAD MARKING

1. SCOPE

This item includes supply and pain white and yellow thermoplastic painted markings of road centerlines, lane lines, border (edge) lines, pedestrian crossing lines, stop lines, chevron striping (at gore areas), directional arrows, lettering, and symbols using thermoplastic reflectorized paint (TRP) as shown on the Drawings or instructed by the EIIP Project Engineer.

2. MATERIALS

THERMOPLASTIC REFLECTORIZED PAINT (TRP)

- A. TRP shall consist of a mixture of alkyd binder, white or yellow pigment, glass spheres, filler, and other materials in granular form specially compounded for traffic paint that is to be applied to the pavement in a molten state by mechanical means with surface application of glass beads. Upon cooling to normal pavement temperature, this material shall produce an adherent, reflectorized paint line of specified thickness capable of resisting deformation and impervious to the effects of dust, oil and grease.
- B. White and yellow TRP shall conform to AASHTO M-249.
- C. Surface application glass spheres (beads) shall conform to AASHTO M-247, type I, except for the gradation which shall be as follows:

<u>Standard Sieve Size</u>	<u>Passing by Weight</u>
1.70 mm (No. 12)	100
0.600 mm (No. 30)	85 - 100
0.425 mm (No. 40)	45 - 100
0.300 mm (No. 50)	0 - 20
0.075 mm (No. 200)	0 - 5

The beads shall be transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits or excessive air bubbles.

- D. Pre-mixed glass spheres shall occupy a minimum of 30% by weight of the TRP mixture and shall conform with the following requirements:
 - D1. Crushing Resistance: An 18 kg dead weight for No. 20 to No. 30 mesh spheres shall be the average resistance when tested in accordance with ASTM D-1213.
 - D2. Roundness: A minimum of 75% shall be true spheres when tested in accordance with ASTM D-1155. Not less than 70% of the spheres of each sieve size shall be free from imperfections of all types, including film, scratches, pits, clusters, and opaqueness.
 - D3. Index of Refraction: When tested by the liquid immersion method at 25 degrees C, the spheres that will be mixed into the material shall have a minimum index of refraction of 1.65 and the spheres that will be applied to the TRP line shall have a minimum index of refraction of 1.5.
 - D4. Gradation: When tested in accordance with ASTM D-1214, the spheres used in the TRP shall have the following gradation:

- | <u>Standard Sieve Size</u> | <u>% Passing by Weight</u> |
|----------------------------|----------------------------|
| 1.70 mm (No. 12) | 100 |
| 0.180 mm (No. 80) | 0 - 5 |
- D5. Chemical Resistance: The glass spheres shall withstand immersion in water and acids without noticeable corrosion or etching, and shall not be darkened or otherwise decomposed by sulfides. A 3 to 5 gm sample shall be placed in each of 3 glass beakers or porcelain dishes, one covered with distilled water, the second with a 3 N solution of sulphuric acid and the third with a solution of 50% sodium sulphide, 48% distilled water and 2% aerosol 1B or similar wetting agent. No darkening, hazing, or other evidence of instability shall be noticeable in the glass spheres when examined microscopically, after one hour immersion.
- D6. Silica Content: The silica content (SiO₂) of the spheres shall be 60% plus or minus 5% when tested in accordance with Federal Test Method 141a.
- D7. Moisture Resistance-Flow Characteristics - The beads shall not absorb moisture in storage. They shall remain free of clusters and lumps and shall flow freely from dispensing equipment.
- E. Glass beads shall be furnished in lots and packaged in moisture- proofed bags. Containers are to be guaranteed to furnish dry and undamaged beads. Each package shall contain the following information: name, and address of manufacturer, shipping point, trademark or name, the wording "glass beads", the specification number, number of the lot or batch number and the month and year of manufacture.
- F. The material upon heating to application temperature shall not exude fumes which are toxic, or injurious to persons or property. The pigment beads and filler shall be well dispersed in the resin. The material shall be free from all skin, dirt, and foreign objects.
- G. The pigment, beads, and filler shall be uniformly dispersed in the resin. The material shall be free from all skin, dirt, and foreign objects and shall comply with requirements according to Table 1.

Table 1 – Composition (% by Weight)

Component	White	Yellow
Binder	18.0 min	18.0 min
Glass beads	30 - 40	30 - 40
Titanium dioxide	10.0 min	-
Calcium carbonate and inert fillers	42.0 max	*
Yellow pigments	-	*

* : Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing all other requirements of this specification are met.

- H. Storage Life: The material shall meet the requirements of this specification for a period of 1 year. The thermoplastic must also melt uniformly with no evidence of skin or unmelted particles for this 1-year time period. Any material not meeting the above requirements shall be replaced by the Contractor at his own expense.

The following tables show respectively the characteristics, composition of pigment and quantitative requirements of yellow paint

Table 2 - Characteristics of Alkyd Resin Solutions

Characteristics	Alkyd Resin Type F
Solids, mass percent	60 +/- 1
Phthalic acid, mass percent	33 - 37
Oil acids, mass percent	48 - 55
Iodine No.	115 min
Color, gardner (max.)	9
Acid number (max.)	8
Viscosity: Reduced to 45-mass-percent solids	to G

Table 3 - Composition of Pigment Yellow Traffic Paint

Pigments Ingredients	Type F	
	Min.	Max.
Lead chromate	34.0	36.0
Magnesium silicate	11.0	13.0
Calcium carbonate	53.0	55.0

Table 4 - Quantitative Requirements of Yellow Paint

Characteristics	Type F	
	Min.	Max.
Pigment, percent	50.0	52.0
Total solids, percent	70.5	-
Nonvolatile vehicle, percent by mass of vehicle	40.5	-
Density, kg/m ³	1486	-
Viscosity, Krebs units	70	80
Fineness, Hegman	4	-
Drying time, minutes	-	6

3. EQUIPMENT

A. EQUIPMENT FOR MARKING

- A1. The equipment used for pavement marking shall consist of approved types of truck-mounted units, or motorized equipment, or manually operated equipment, depending on the type of markings required. The truck-mounted or motorized unit for centerlines, lane lines, and edge lines shall consist of a mobile, self-contained unit carrying its own material and capable of operating at a maximum speed of 10 km/h while applying paint. The hand applicator equipment shall be sufficiently maneuverable to install centerlines, lane lines, edge lines, gore striping, turn lines, crosswalks, stop lines, arrows and legends.

- A2. Spraying equipment shall be capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly on the pavement. Each paint tank shall be equipped with cut-off valves which will enable broken (skip) lines to be sprayed automatically. Each nozzle shall have a mechanical bead dispenser that will operate simultaneously with the spray nozzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides and shall provide a method for cleaning the surface of dust just prior to paint application.
- A3. Equipment for application of thermoplastic reflectorized paint lines and of markings shall deposit the plastic material in a hot molten state on the pavement, utililising either an extrusion or spray method. Equipment shall be capable of providing continuous mixing and agitation of the material which will be maintained at the proper application temperature. The use of direct flame heat will not be allowed.
- A4. An automatic glass sphere dispenser with synchronized automatic cut-off shall be attached to the applicator machine. The dispenser shall utilize pressure type spray guns which will embed the spheres into the surface to at least 0.5 times the sphere diameter. The dispenser shall also be equipped with an automatic cut-off synchronized with the cut-off of the thermoplastic material.
- A5. Hand equipment shall be used only for painted markings, and it shall hold a minimum of 25 kg and not more than 100 kg of molten material unless otherwise agreed between the Engineer and the Supplier.

4. METHOD

B. SETTING OUT AND PAVEMENT PREPARATION

- B1. The Contractor shall set out all control points necessary for locating paint lines and markings. On irregular widths of roadway, the locations of border (edge) lines shall be adjusted to provide a smooth alignment on the pavement surface. The locations of all painted markings and each location for raised pavement markers and studs shall be accurately established and shall be subject to approval before application and installation commence. Markers and studs shall not be located over longitudinal or transverse pavement joints.
- B2. The area of roadway surface on which marking is to take place shall be free of dirt, existing paint lines if directed, curing compound, grease, oil, moisture, loose or unsound layers, and any other material which could adversely affect the bond. The areas shall be thoroughly cleaned to the satisfaction of the Engineer before proceeding with painting or installation of markers and studs.
- B3. Pavement marking shall not proceed when there is moisture on the pavement surface or the air is misty, or the surface temperature of the pavement is below 10°C; or when wind or other conditions may cause a film of dust to be deposited on the surface, or in other conditions that, in the opinion of the Engineer, could displace, damage, or adversely affect the bonding of the material to the pavement surface. Any markings damaged due to water or rain within 20 minutes of application, shall be removed and replaced at the Contractor's expense.

C. THERMOPLASTIC REFLECTORIZED PAINT (TRP) APPLICATION

- C1. In addition to normal pavement cleaning requirements specified, the surface of bituminous concrete pavements shall be washed with high pressure water application. Oil and grease must be removed by a detergent solution followed by a water rinse.

- C2. To ensure optimum adhesion, the thermoplastic paint shall be applied in a molten state at a temperature range recommended by the manufacturer.
- C3. The minimum overall average thickness of thermoplastic shall be 2 mm. The completed lines shall have a continuous and uniform cross-section, and shall have clean, sharp dimensions. The width of paint line specified shall be applied in one application. The lines shall be laid to the following thickness unless otherwise agreed between the Engineer and the Supplier:

Method of Application	Bi- Directional Daily Traffic (PCU per Day)		
	<20000	20000-60000	60000>
Screed	2mm	2.5mm	3mm
Spray*	2mm	2.5mm	3mm
* In two or more applications			

- C4. A glass sphere top dressing shall be applied to the completed thermoplastic paint immediately after it has been placed by the automatic glass sphere dispenser attached to the painting machine. The sphere dispenser shall embed at least half the sphere diameter into the surface. The application rate of spheres shall be 0.4 to 0.5 kg/sq.m.
- C5. A second application of TRP shall be applied approximately six months after opening of the road. The timing of the second application will be determined by the Engineer.

5. CHECK

SAMPLING AND TESTING

- All material shall be shipped to the job site in undamaged, sealed original packaging, clearly identifying each material as to name, color, manufacturer, batch number and date of manufacture. All material shall be accompanied by certified test results verifying compliance with all specified physical and chemical requirements conforming mainly to latest AASHTO M-247, M-248 and M-249. Otherwise the Engineer shall reject the material and the Contractor is fully responsible for providing all materials conforming to the required specifications.
- All paint products and other materials designated by the Engineer shall be the same for testing. Sampling shall be performed by the Contractor in the presence of the Engineer. Materials shall be sampled in their original containers and the containers resealed as approved by the Engineer. All samples shall be packaged for shipment as approved by the Engineer. Samples shall be transported to an independent laboratory as directed and approved by the Engineer. Paint materials shall not be used until approved by the Engineer.
- The Contractor shall install, at his expense, at a test site all types of pavement markings in order to be verified and tested for compliance with the Specifications, as required by the Engineer.

TYPES OF PAVEMENT MARKINGS

- A. White “Stop” Line.** A transverse solid white line, 40 cm wide.
- B. Broken White “Give Way” Line.** A transverse broken white line, 40 cm wide. The broken or “skip” pattern shall be based on a 1 m unit, consisting of a 0.5 m line and a 0.5 m gap.
- C. Broken White Line (Type MR9 -A).** A transverse broken white line, 10 cm wide used at junctions, crossroads and roundabouts. The broken or “skip” pattern shall be based on a 1 m unit, consisting of a 0.5 m line and a 0.5 m gap.
- D. Continuous White Line (Type MR10).** A continuous longitudinal white line 12 cm wide.

E. Continuous Yellow Line (Type MR11). A continuous longitudinal yellow line 12 cm wide.

F. Traffic Arrow. A white marking conforming to details shown on the Drawings.

G. Pedestrian Crossing. A 60 cm x 200 cm white lines, with a 60 cm gap between them, as shown on the drawings.

6. MEASUREMENT/PAYMENT

- **Measurement:** This item shall be measured and paid in linear meter completed and accepted by EIIP project engineer.
- **Payment:** The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

SECTION 6, CONCRETE CURBS and GUTTERS

6.0 CONCRETE CURBS AND GUTTERS and CONCRETE TILES

1 SCOPE

The item covered preparation of bedding, furnishing materials and construction of concrete Curbs, gutters, and concrete tiles paving to sidewalks using precast concrete as and where shown on the Drawings.

The concrete curbs proposed in this project include:

- Precast Raised Concrete Curbs 150 mm X 250mm.
- Precast Flush Gutter 100mm X 400mm.
- Precast concrete tiles 100mm x 100mm x 60mm

2 MATERIALS. PRECAST MANUFACTURE

A. Concrete

Portland cement concrete shall be Class 210/20 for all in-situ and precast concrete, except for base course and backing concrete which shall be Class 110/25. All concrete shall conform to the relevant requirements of Section 5.01: Concrete Mixes and Testing and shall be produced by commercial ready-mix plant approved by the Engineer.

B. Mortar

Mortar shall consist of cement and fine aggregate having the same proportions as used in the concrete construction and shall conform to all relevant requirements of Section 5.01: Concrete Mixes and Testing.

C. Reinforcement

Reinforcing steel shall conform to the requirements of Section of Steel Reinforcement.

D. Precast Concrete Units

D.1 All precast units shall be manufactured to the dimensions shown on the Drawings. Manufacturing tolerances shall be 3 mm in any one dimension. End and edge faces shall be perpendicular to the base.

D.2 Each precast curb or gutter unit shall normally be 0.5 metres in length and this length shall be reduced to 0.25 metres, or as indicated on the Drawings, where units are to be installed along curves of less than 10 m radius.

D.3 For horizontal curves of radius less than 10 metres, kerb and gutter units shall be manufactured to the radius shown and in such circumstances straight elements or portions of straight elements shall not be used. Bullnoses and curved faces shall be of constant radius with a smooth transition from a radius to a plain face.

D.4 Unless shown otherwise on the Drawings, precast concrete tiles (paving slabs) shall be 100 mm by 100 mm by 60 mm thickness with a 5 mm edge bevel. The tile face shall be grooved in squares of a size agreed by the Engineer as appropriate to the tile dimensions. Coloring of the top layer, where required, shall be achieved using mineral oxides.

D.5 Surfaces of precast units that will be exposed to view after installation shall be true and even, with a dense finish of uniform texture and color, free from cracks, holes, fins, staining or other blemishes or defects. Units failing to meet these requirements shall be rejected. Surfaces that are not exposed to view after installation shall have all fins and irregular projections removed and all cavities, minor honeycombing and other defects made good with mortar after the units have been saturated with water for at least 3 hours.

D.6 Precast units shall be cast with the upper face down in approved steel moulds under conditions of controlled temperature and humidity. The units shall be steam cured or any other method approved by the Engineer until the concrete attains the full specified 28-day strength.

D.7 The Contractor shall submit for approval samples of each of the proposed units together with the manufacturer's certificates and details of the method of manufacture and materials to be used. The Engineer's approval of the samples shall not be considered final and the Engineer shall reject any precast units delivered to the Site, which do not meet the required standards.

E. Preformed expansion joint filler shall conform to AASHTO M 33.

F. Epoxy adhesive (for use in attaching precast units to existing concrete pavement surfaces) shall conform to the relevant requirements of Section 6.10: Raised Pavement Markers.

G. Ducts. Ducts (if required under sidewalks or medians) shall consist of uPVC plastic pipe conforming to ASTM D 2750, Type II. If jacking is required, duct shall be galvanized steel tube approved by the Engineer.

H. Bedding material shall conform to the relevant requirements of Section: Granular Sub-Base Courses for Class A or Class B Granular Material.

3. METHOD

CONSTRUCTION AND INSTALLATION

A. Precast Concrete Curbs and Gutters

A.1 Subgrade for the concrete base shall be constructed as for in-situ Curbs and gutters.

A.2 Forms for the concrete base shall be wood or steel. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use. If approved beforehand by the Engineer, forms for the concrete base may be omitted and the concrete placed directly against undisturbed excavated faces.

A.3 Base concrete shall be placed, compacted and shaped to the sections shown on the Drawings. Concrete shall be compacted to the satisfaction of the Engineer with an internal type vibrator or by manual means. Edges shall be rounded if necessary by the use of wood moulding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least seven days before precast units are placed thereon.

A.4 Precast units shall be soaked in water immediately before installation. Units shall be set accurately in position in mortar on the concrete base. Joints between precast units shall not be mortared unless otherwise shown on the Drawings. Units shall be closely spaced and expansion joints provided every 10 metres.

A.5 Where Curbs or gutters are installed on existing concrete pavement using epoxy resin adhesive, the installation procedures shall conform to those specified for raised pavement markers in Section: Pavement Markings for Traffic.

A.6 After Curbs have been installed concrete backing shall be placed as shown on the Drawings. Pavement courses shall not be laid against Curbs until the concrete backing has been membrane or water cured for at least 14 days.

A.7 The tolerances on the alignment of completed precast units shall be as specified for in-situ concrete construction.

A.8 Backfilling shall be carried out as specified for in- situ Curbs and gutters.

B. Precast Concrete Tiles

B.1 Excavation and placing of bedding material shall be as specified for in-situ concrete paving. The surface of the completed bedding shall be dampened and base course concrete placed and finished to the thickness as shown on the Drawings or, if not shown, 40 mm minimum thickness.

B.2 Base course concrete, if specified, shall be water or membrane cured as specified for in situ concrete paving, for a period of not less than 7 days before placing precast tiles. Immediately prior to laying of tiles, the concrete base course shall be dampened and the concrete tiles shall be immersed in water. Tiles shall then be laid true to line and grade on a 10 mm to 20 mm thickness of mortar. Joints shall be 3 mm wide.

B.3 The tolerance on smoothness of precast concrete tiled areas and removal and replacement of defective tiling shall be as specified for in situ concrete paving.

B.4 Tiles shall be cleaned 24 to 36 hours after laying and, if specified, joints shall be mortared using a plasticizer in the mortar to improve workability and to enable the mortar to be readily smoothed and finished. As soon as the mortar has partially set, all mortar material shall be raked from the top 3 mm depth of the joint, using a grooving tool to produce a smooth circular section. When the mortar is sufficiently set, the surface shall be sprinkled with water and covered with plastic or nylon sheets during the curing period. The sheets shall be left in place until final hardening of the mortar or as directed by the Engineer. All foreign matter, wood, concrete, mortar lumps, etc., shall then be removed and the surface cleaned of staining, discoloration and other blemishes.

B.5 In cases where tiles are required to be cut at the boundaries of tiled areas, or due to the presence of obstacles, poles, hydrants, etc., or in the construction of the driveways or side roads, the Contractor shall cut the tiles or substitute in situ concrete of at least the same quality as the tile concrete. The Engineer shall decide, after trials, on the method to be adopted. Cutting of tiles or substitution of in-situ concrete shall be kept to a minimum. The Contractor shall complete the areas using uncut precast tiles to the maximum extent practicable.

B.6 The method of construction and sequence of operations for areas constructed using precast tiles shall be the same as for areas constructed using in situ concrete. The Contractor shall ensure that the final appearance of such surfaces, regardless of the method of construction, is substantially the same for all types of construction.

B.7 Where a sidewalk crosses the entrance to a shop or a house, etc., which is higher than the sidewalk, the Contractor shall construct steps, formed by a kerb and a complete or partial tile. Steps shall be backfilled with concrete of the same quality as specified for concrete base course.

4. MEASUREMENT/PAYMENT

Measurement

A. Precast Concrete Curbs and Gutters shall be measured by the linear metre of each type furnished, constructed or installed, **completed**, and accepted.

B. Precast Concrete Tiling shall be measured by the square metre of the plan area of each type furnished, constructed or installed, **completed**, and accepted.

Payment:

The unit rate shall be the full compensation for labour, tools, materials and any other incidentals that may be required in carrying out the work for this item.

E-6 Technical Specifications for Bio Engineering

7.0 BIO ENGINEERING

TREE AND SHRUB PLANTATION

1. DESCRIPTION

The planting of trees and shrubs is intended to replace or restore something of the natural vegetation on the slope to be treated. The Contractor is required to carry out the planting of seedlings to the eiip Project engineer's specific instruction.

2. MATERIALS

Tree and shrub seedlings and green mulch

3. METHOD

Planting should be started from the top of the slope and under no circumstances should new plants be walked on or otherwise disturbed.

- Ensure that the site will already have been prepared for planting. The condition of the site must be good enough for the successful establishment of delicate young plants.
- The spacing of the plants will be determined according to the individual site conditions and nature of plants. However, it will normally be at two meter center unless otherwise specified.
- The plants should be at least 300 mm in height above the soil surface and hardened off in the normal way.
- Keep plant moist ensure that the soil around the roots does not dry out. Under any circumstances all plants supplied must be planted within three days of removal from the nursery.

- A planting pit wide and deep enough for the main root to be buried in without bending it and wide enough for all the roots and surrounding soil ball should be made at the time of planting.
- The polypots must be removed from the seedling by cutting it away with a razor blade. The plant should then be carefully placed into the hole the compost and soil packed in, and all surrounding soil firmed up taking care not to cause any damage to the plant and its roots. The surface over and around the pit should then be mulched using any appropriate locally available material such as manure compost dead leaves or cut herbage.
- The EIIP Project engineer may specify bigger seedlings for areas such as those to be used intensively for amenity purposes. These will normally have been growing in a nursery for at least a year and should have well developed roots as well as aerial parts. They will be provided either as bare root stock with a substantial root ball or in pots of a minimum of 100 mm x 180 mm laid flat dimensions. When these larger seedlings are planted the pits will be of 300 mm diameter and 300 mm in depth. In additions well-rotted compost will be mixed with the soil backfill in a ratio of at least one part compost to ten parts soil.

4. EQUIPMENT AND TOOLS

Measuring tape, planting bar

5. SAFETY ON SITE

- Safety gear include closed shoes and gloves.

6. CHECKING

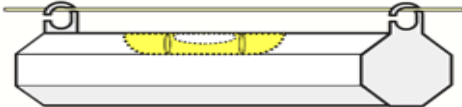
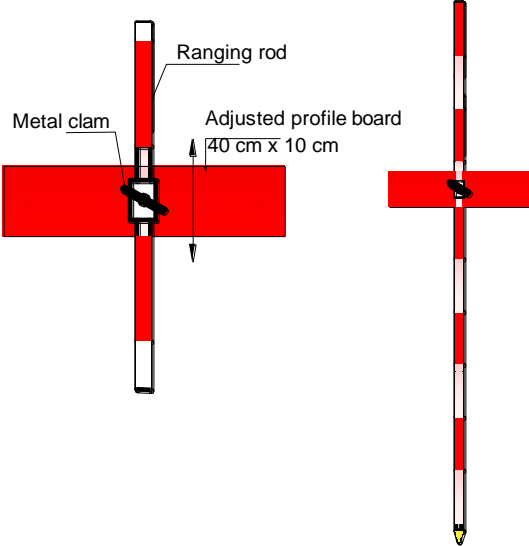
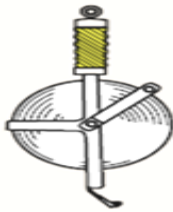
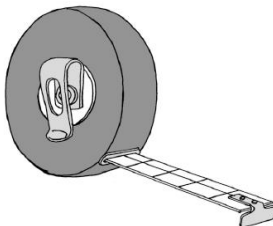
The following will be checked:

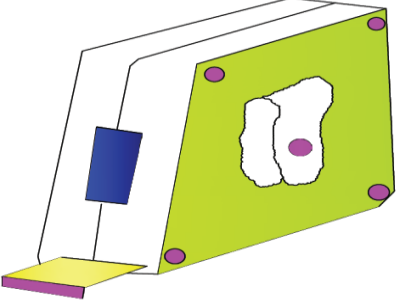




- The number of trees and shrubs planted
- The quality of the planting
- Spacing from one tree to another

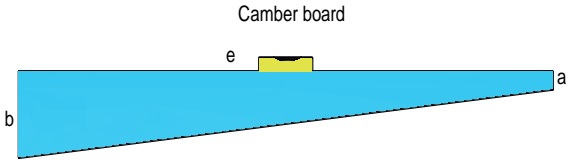
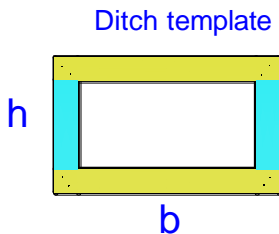
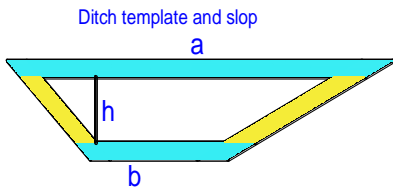
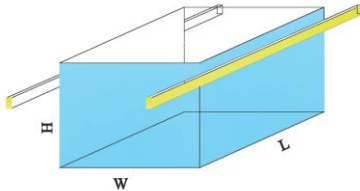
6. MEASUREMENT AND PAYMENT


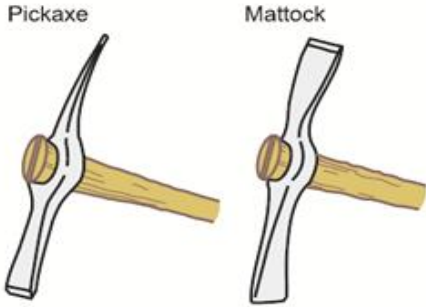
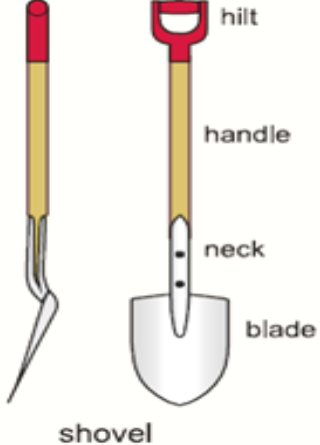
This activity will be paid by the number of trees and shrubs planted

E-7 Technical Specifications for Hand Tools

Description	Setting out tools
<p>Line level is used with a clear nylon string to transfer the exact level of one location to another point. The line level is a short spirit level (about 100mm long) with a hook at each end to hang it from a smooth nylon string. This instrument needs two persons to operate – one at the end of the line, and the second to watch the spirit level.</p>	
<p>Ranging rod and profile board: Ranging rods are used to set out the straight and curve lines and to support profile boards on both straight and curved sections of the road.</p> <p>Ranging rods are made of hollow metal tube, often 20-25mm diameter galvanized pipes, with a pointed end of sharpened reinforcement steel and have 2m long. They are painted alternately red and white to make them easy to see during setting out. The length of red/white sections is 250mm.</p> <p>Profile boards are used to set out the road profile in straight grade, sag or crest sections. A profile board is used to attach to a ranging rod. It has a screw mechanism that enables the profile board to slide up and down on the ranging rod and be fixed at any desired point simply by tightening the screw.</p>	
<p>Measuring tape: The most common length of tape measures used for setting out are: Long tape 30-50m and short tape 5-7.5m.</p> <p>The measuring tapes are made of steel or linen. The long tape is used for measuring long distance especially for measuring longitudinal alignment while short tape is used for measuring short distance and cross section of a road.</p> <p>The numbers/markings on the tape becomes unreadable after a period of use. Important is to keep tape clean and avoid dirt from entering the dust.</p>	<div style="display: flex; justify-content: space-around;">   </div>

<p>Note: The zero point is not always located at the same place on different tape measures.</p>	
<p>String line is used with pegs for setting out activity and quality control for road work and drainage structure works. The string line is commonly made of nylon string of diameter 3-4 mm.</p>	 <p>String Line</p>
<p>Hammer: There are difference size and weight of hammers that are used for difference purposes. Big hammer is made of solid steel with wooden handle. Weight of the hammer between 3-5 kgs fixed with wooden handle of length between 50-70cm depends on weight of the hammer. This big hammer is commonly used for breaking stone. Small hammer is also made of solid steel with wooden handle. Weight of the hammer between 1-3 kgs. Length of the wooden handle between 30-40 depends on weight of the hammer. This small is commonly use for hammering pegs, metal spike for setting out activity. It is also used for carpentry work for structure works.</p>	 <p>Club Hammer</p>
<p>Peg: is a locally made material for setting out. The peg is made from bamboo / wood stick. The length is required to be within 30 cm to 50 cm. The stick can be diameter between 3-5 cm and bamboo strip of 3-5 cm and has one shape pointed end. When setting out on a hard soil metal peg should be used. The metal peg can be a deformed bar of 12-14 mm diameter.</p>	
<p>Metal spike/pointed chisel: The metal spike / pointed chisel is usually manufactured either as round or octagonal section rods. For the setting out the diameter should be minimum 20mm. The length is required to be within 30 cm to 40 cm. The spike is made of carbon steel and should have one pointed end.</p> <p>This instruments is used with hammer to make a hole before placing the ranging rods or pegs in the ground, when the setting out is carried out in hard and compact</p>	 <p>Metal Spike</p>

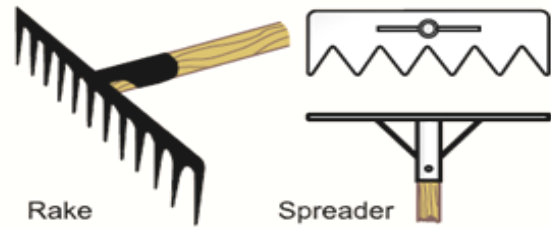
<p>soils.</p>	
<p>Camber board is used for setting out of a road camber or checking camber of a road. The camber board consists of timber plank of trapezium shape. The longer side of the plank is designed of half width road carriage way. Thickness of the plank between 2-3 cm. Dimensions of a, b and e as shown in the right hand side figure depend on designed width of the road and cross slope of the camber:</p> <p><i>Example width of road is 4 m and camber 10%, $a=5$ cm so $e=200$cm and $b=5+200/10=25$cm.</i></p> <p>A spirit level is placed at middle of the plank as shown in the figure right hand side to ensure the plank is horizontally placed during checking or setting out for camber.</p>	
<p>Ditch template is used for checking ditch of a road side drain before allowing to cut slop of the side drain.</p> <p>The ditch template is made of timber frame of rectangular shape. Width of the timber frame between 5-7 cm and thickness 2-3 cm.</p> <p>Size of the template depends on side drain design. Commonly size of the ditch template is $b=50-60$ cm and $h=30-50$ cm</p>	
<p>Side drain template is used for checking earth side drain of a road. The side drain template is made of timber frame of trapezium shape. Width of the timber frame between 5-7 cm and thickness 2-3 cm.</p> <p>Size of the template is commonly: $b=50-60$ cm and $h=30-50$ cm and $a=140-150$ cm</p>	
<p>Gauge boxes are used to batch, or measure volumes of the material, to control the mix proportions of concrete. The gauge box should be prepared based on quantity of 1 bag of cement</p> <p>The gauge box must be filled level with the top so that the volume of the sand and stone measured out is equal to the volume of a bag of cement. The sand and stone in the gauge box must not be compacted when filled up.</p> <p>For 1 bag of cement (40 kg) $W=30$ cm, $H=30$ cm, $L=32$ cm $Volume=0.029\text{ m}^3$</p>	

Description	Hand tools
<p>Hoe is used for excavation of soil, spread gravel, mix concrete or mortar. It consists of a blade and a handle.</p> <p>The blade of the common hoe has a straight cutting edge. The eye can be round or oval, although for road works the oval eye is recommended. The round eye makes it easier to replace the handle but the blade tends to turn while working. The hoe should have a suitable length handle (1.2-1.5m) so that the labourer can work standing upright.</p>	
<p>Pickaxes and mattocks are used for excavating stony, hard soils which are difficult to penetrate with hoes. These tools have an oval eye so that the handle cannot turn in the eye. Weights of the pickaxe is between 2.7 and 3.6kg and the mattock between 1.8 and 2.7kg. They have double edge striking tools and have straight handle with an elliptical rather than circular cross-section. The handle should be provided with a raised safety grip which prevents the handle slipping out of worker's hands.</p>	
<p>Shovel is used for scooping up material and throwing it on to a truck, wheelbarrow or directly to where the material is needed and use for mixing concrete and mortar. The shovel has a rounded or pointed blade.</p> <p>The handle for the shovel should be long enough to allow the worker to throw the soil with little effort. Shovels should not have sharp joints which damage the hands of user.</p>	

Spreader and rake

Rake is used in road works for collecting vegetation from loose soil when grubbing, but can also be used for spreading if the soil is not stony. Rakes have 10 to 16 teeth, each about 75-100mm long, with an overall width of about 400-450mm. They require straight handles made of hard wood or metal tubes.

Spreader is used for spreading out the soil on fills. A spreader can be a heavy-duty rake. The spreader is very useful when forming the camber and for spreading gravel. It is made of sheet metal (3-4mm thick) and have a ridge for crushing lumps of soil. Spreader can be pointed or flat, depending upon the nature of the gravel to be spread.

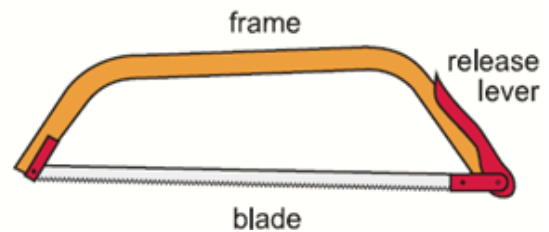
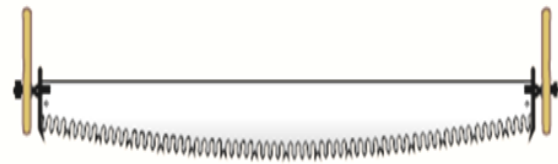


Saws are used to cut trees, branch of tree, bush and wood. There are difference type of saws are used for cutting difference size of tree, bush or wood.

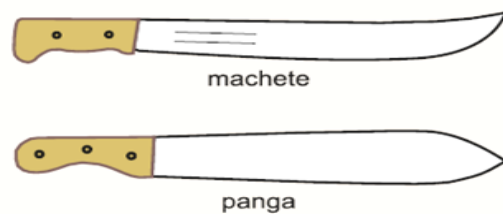
Big saw is used to cut big tree or wood operate with two persons while small saw (steel frame bow saw)can be sue single person.

Big saw is made from steel blade of 1.5-2 m long with wooden handles fixed at both end of the blade.

Small saw (steel framed bow saws) is used for cutting small trees, tree branches and bush. A narrow blade is held in tension by the frame. A quick release lever applies tension to the blade. The lever, combined with an oval sectioned frame, provides a comfortable handgrip. Blades are 20-25mm wide and are produced in a standard length. The frame is made of mild steel and the blade is made of high carbon alloy steel.



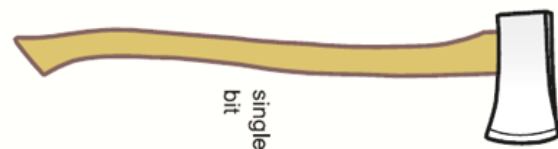
Bush knives: Bush knife is used for clearing the bush and cutting tree branches along the road alignment. It is also used for cutting and sharpening peg. The bush knife is made of steel shape blade and wooden round handle.




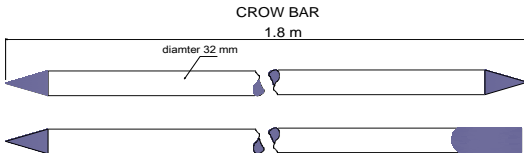


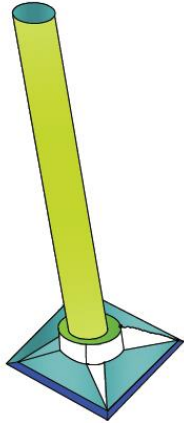
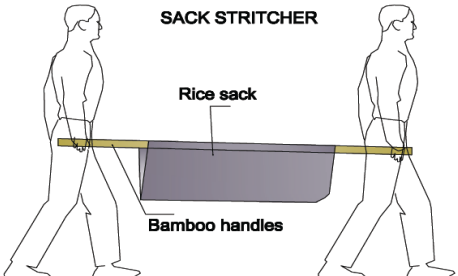
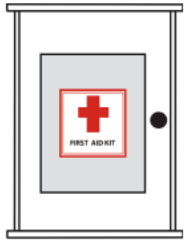

Axe is used to cut bush, tree, branch and stripping branches of felled trees. The axe can be shaped as cutting edge (blade) while the head of the axe can be used instead of hammer.

The eye of the axe is oval and is fixed to the handle with a wedge. Handles are normally 70 to 90cm long made from seasoned hardwood shaped in an ergonomically sound fashion.

Smaller axes, also referred to as hatchets, are often used for cutting small trees and branches instead of a



<p>bush knife. They are also used for producing setting out pegs.</p>	
<p>Wheelbarrow: The wheelbarrow can be a useful piece of transportation equipment over short distance (up to 200 metres). Wheelbarrows are used at sites in earthworks and structure construction for transport the construction material such as soil, sand, aggregate, stone, concrete etc.</p> <p>Wheelbarrows are made in many different types and qualities. A good wheelbarrow should take a big load (struck capacity approximately 60 to 70 litres) and be easy to balance and tip. The common wheelbarrow is a single front rubber tyre.</p>	
<p>Basket is used for carrying soil or gravel for a short distance. A typical basket has a pay-load of 5 to 6 kilograms of soil. Basket can be made from local basket making materials (bamboo) or used tyres or manufactured in plastic. Baskets are very suitable for dry soil, and although they are not as durable, they can be fixed with local materials and cost about half the price.</p> <p>Plastic and Rubber Tyre baskets are most suitable for wet soils. Baskets can be carried individually or two can be balanced on a shoulder pole, at the end of ropes, like a scale, depending upon the workers strength and preference.</p>	 
<p>Crow bar is used mostly for digging stony, very hard soils or moving the boulders or heavy things when used in the right way as a lever. The crowbar looks like a simple tool, but it has to be of very strong material that does not bend easily and be well designed to function properly.</p> <p>Crowbar is manufactured either as round or octagonal section rods. For infrastructure work the diameter should be minimum 30mm. The length is required to be within 1.5 to 1.8 meters. The bar is made of carbon steel and should have one pointed and one chisel end</p>	

<p>Hand rammer is used for compacting soil and gravel and consists of a weight with a long handle. The weight can be made of various materials such as steel, concrete or solid wood. Ideally the weight should be as large as possible and the area as small as possible. A rammer which can be handed by a worker should therefore have a weight of some 6– 8kg and a bitumen surface size: 13 cm x13 cm or 15cm x 15 cm. The handle must be long enough between 1.5 to 2 m.</p> <p>Hand rammer is used to compact in small and confined areas such as around culverts, potholes and other places where it is impractical or difficult to access with rollers.</p>	<p style="text-align: center;">HAND RAMMER</p> 
<p>Sack Stretcher: A Sack Stretcher is a locally made for carrying soil and gravel. An empty rice sack is cut open. Two thick straight bamboo poles about 1.5 meters long are sewn along the length of either side of the cloth, to make a stretcher.</p> <p>The Soil to be carried is placed on the sack carry by two persons.</p>	<p style="text-align: center;">SACK STRITCHER</p> 
Description	Safety measures and safety gear
<p>First aid kit must include items like plasters, bandages, disinfectant, antiseptic cream, clean fresh water for washing eyes, saline, irrigation syringe, sterile dressings, adhesive tape, scissors, disposable gloves.</p> <p>The First Aid Kit must be available on site, regularly checked and restocked</p>	
<p>Markings and detours Warning signs or cones must be placed at each end of the work area. The warning signs should be placed 50-100 m away from the working areas. The text on the warning signs should read: "KUIDADU" or " HALAI NENEIK"</p> <p>Deep excavations (more than 1.5 m) for foundations etc shall be clearly marked and fenced off in a way that people cannot drive or fall into the excavation.</p>	

<p><u>Safety Goggles</u> should be used when there is a risk for eye injury, eg when:</p> <ul style="list-style-type: none"> • breaking rocks • welding 	
<p><u>Boots</u> should be used when:</p> <ul style="list-style-type: none"> • mixing concrete and mortar • working in wet or muddy places • working with sharp tools <p><u>Closed shoes</u> should be worn at all other times</p>	
<p><u>Gloves</u> should be used when:</p> <ul style="list-style-type: none"> • carrying heavy load and when using hand tools • working with concrete and masonry work (rubber gloves) • bending and fixing steel bars • breaking rocks 	
<p><u>Safety hat or helmet</u> should be used when working in dangerous of falling objects like:</p> <ul style="list-style-type: none"> • in deep drain or foundation excavation • under bridge • under tall tree 	
<p><u>Bright vest</u> are to be used by site supervisors to easily identifying who is responsible on the worksite. If working on a road with frequent traffic then all workers must wear a safety vest.</p>	
<p><u>Masks</u> are used when working in places that produce a lot of dust or bad smell.</p>	