

1.8.7 Materials

Unless otherwise specifically provided in this Contract, all items incorporated in the completed work, such as equipment, materials and other articles, are to be new and the most suitable grade for the purpose intended. Unless otherwise specifically provided in this Contract, reference to any equipment, material, article, or patented process, by trade name, make, or catalogue number, shall be regarded as establishing a standard or quality and shall not be construed as limiting competition, and the Contractor may at his option use any equipment material, article, or process which, in the judgement of the Engineer, is equal to that named. Unless otherwise specified or instructed all proprietary materials shall be used in accordance with the Manufacturer's instructions.

When required by the Engineer, the Contractor, before placing any order for materials or manufactured article to be incorporated in the Permanent Works, shall submit for approval a complete description of such items, the names of the firms from whom he proposes to obtain them, and a list of such of the items that he proposes the firms should supply. When so directed, the Contractor shall submit samples and certificates for approval.

1.8.8 Storage of Materials

Materials shall be stored so as to ensure preservation of their specified quality and fitness for the work. They shall be placed on a hard, clean surface and when required, they shall be placed under cover. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without written permission of the owner and lessee and payment to them, if necessary.

The stockpile site shall be prepared by clearing and levelling as directed by the Engineer.

The centre of all aggregate stockpile areas shall be raised and sloped to the sides as required so as to provide proper drainage of excess moisture. The material shall be stored in such manner as to prevent segregation and coning and to ensure proper gradation and moisture content. Coarse aggregate storage piles shall be built up and removed in layers not exceeding one meter. The height of such stockpiles shall be limited to five meters.

1.8.9 Royalties

The Contractor shall be responsible for all compensation and royalties due in respect of quarried materials. No separate payment shall be made for the compensation of royalties, but all such costs shall be included in the applicable unit price and total of the Tender Schedule.

1.8.10 Right-of-Way.

The right-of-way is the land to be acquired for and devoted to the Road. The right-of-way widths shown on the Drawings are approximate only the effective width to be established by the Engineer.

If any utility for water, electricity, drainage, etc., passing through the temporary site

will be affected by the Works the Contractor, at his own expense, shall provide a satisfactory alternative in full working order to the satisfaction of the owner of the utility and the Engineer, before the cutting or removal of the existing utility.

1.8.11 Location and Protection of Utilities

Before commencing construction work the Contractor shall undertake a survey to establish the detailed location of all utilities affected by the Works. Survey results shall be recorded in plan form to the satisfaction of the Engineer and surface pegs fixed on the site to indicate the location of all underground utilities. These pegs shall remain for the duration of the contract or until such time as the utility is diverted. Any utilities which are constructed on the Site shall be similarly marked.

Where works of either a temporary or permanent nature are to be undertaken by the Contractor in the vicinity of utilities, the Contractor shall adopt appropriate construction methods, provide adequate protective devices and take, precautionary measures in order to avoid damage to the utilities.

1.8.12 Templates and Straightedges

Sufficient metal templates shall be supplied by the Contractor and used by the Contractor or the Engineer to check the finished surface of the pavement structure. These templates shall be submitted to the Engineer for his approval. The templates used to control the work shall be maintained at all times in a condition to produce the correct cross-sectional profile, and shall be checked at intervals and, if necessary, repaired or adjusted as directed by the Engineer.

The Contractor shall make available sufficient straightedges, including one rolling straight edge, to check the surface of the pavement and other surfaces.

The furnishing of templates and straightedges shall not be paid for directly, but all costs shall be deemed to have been included in the various relevant items of the Tender Schedule.

1.8.13 Orders to Foreman

Whenever the Contractor or his Site Engineer is not present on any part of the work where the Engineer may decide to give orders or directions, such orders or directions shall be received and obeyed by the Foreman or other person who is in charge of the particular work concerned.

1.8.14 Drawings

The drawings of this project are issued and made part of this Specification and Contract Documents.

It shall be anticipated that minor revisions of alignment, location, section and details may be made during the work. The Contractor shall perform the work in accordance with the intent of the drawings and specifications, and shall take no advantage of any error or omission in the drawings or discrepancy between the drawings and specifications. The Engineer will give instructions regarding interpretations deemed necessary for the fulfilment of this Specification and drawings. Where dimensions

on drawings are given or can be computed, scaled measurements shall not be used except when approved by the Engineer. Any deviation from the drawings due to field conditions not anticipated will be determined by the Engineer and authorized in writing. Finished surfaces in all cases shall conform with the lines, grades, typical sections and dimensions shown on the drawings except when otherwise directed by the Engineer. Any deviation of a character not provided for in the drawings and specifications or working drawings that may be required by the exigencies of construction or otherwise will in all cases be determined by the Engineer and authorized by him in writing.

All drawings prepared by the Contractor and submitted to the Engineer for his approval shall conform to the standard format of the project and be produced using AutoCAD.

After the Engineer has give approval to a drawing, he shall require that the original be drawn on plastic and submitted together with a disk to his office in order to form part of the permanent record of the Works.

1.8.15 Contractor's Weighbridge

The Contractor shall provide a weighbridge of sufficient length to permit simultaneous weighing of all axle loads of each vehicle entering the Site. Each weighing device shall be accurate within 0.5 percent throughout the range of use, and shall be inspected, tested, and sealed as often as the Engineer may deem necessary to assure continued accuracy. The Engineer may permit the use of weighing devices for a reasonable period prior to sealing, provided field testing indicates consistent compliance with the limits of accuracy specified herein. The Contractor shall have on hand a necessary number of standard weights of twenty-five (25) kilograms to test the weighbridge over its full scale.

1.8.16 Maintenance of Existing Drainage

The Contractor shall maintain the existing, drainage entering, crossing or affecting the works. This shall include where required by the Engineer the cleaning of all existing channels, ditches and pipes upstream and downstream to an extent of 100 m beyond the construction limits and the right-of-way.

These requirements shall be met without additional payment and all costs thereof shall be included in the various items of the Tender Schedule under the Contract. However, should the maintenance work necessitate, in the opinion of the Engineer, repair, remedial or reconstruction work to the existing drainage, except where such work is due to damage caused by the Contractor, the Engineer will instruct the extent of such work required and the Contractor shall be entitled to payment under the appropriate pay item or items.

1.8.17 Provision of Survey Equipment and Personnel

The instruments will revert to the Contractor at the end of the Contract at a time to be agreed, not later than the end of the Defects Liability Period.

The Contractor shall maintain the instruments in good adjustment for the duration of

the Contract. The instruments, appliances, and equipment to be provided shall include, but not be limited to, the following:-

- Theodolite, Wild T2 with three tripods, two sets forced centring system incl. Tribach, carrier, two reflectors with prisma and case, 1 No.
- Theodolite, Wild T16 with two tripods, two plumrods, two plumrod tripods, two rods, and two reflectors with prisma, 1 No.
- Electronic distance measurement equipment,
- Wild DI 1001 complete with all necessary accessories 1 No.
- Levelling instrument, Wild NA2, with tripods, 2 No.
- Levelling staffs, Nedo, 4 m, or equiv. 2 No.
- Levelling staffs, Wild, 4 m, 2 No.
- Steel tapes, type prolon, 50 m 2 No.
- Fibre glass tapes, type procord, 30 m, 2 No.
- Steel tapes, 5 m, 6 No.
- Survey umbrellas 2 No.
- Plumb bobs 4 No.
- Ranging rods 8 No.

1.8.18 Assistance for Engineer

- (1) The Contractor shall provide labour, staging, ladders, wire ropes, lighting and other equipment, information and assistance required by the Engineer and his staff for inspecting, measuring and for the supervision of the Works.
- (2) When directed by the Engineer the Contractor shall provide for the exclusive use of the Engineer's Representative at any time up to the end of the latest Period of Maintenance, the following assistance for the execution of the Engineer's Representative's duties.

	Attendants	Package 1	Package 2	Package 3
(i)	field attendants	4	4	4
(ii)	office attendant	4	4	4
(iii)	night watchman	4	8	2
		12	16	10

The night watchman shall be provided with suitable accommodation.

- (3) The field, office and laboratory attendants shall be available on Site during the Contractor's site working hours (including any work carried out on Sunday and Public Holidays). Nevertheless the attendants may be required to work outside these hours when required by the Engineer's Representative.

1.8.19 Ground Investigation

The Contractor shall at any time up to the time for completion of the whole of the Works when ordered by the Engineer, undertake any of the following:-

- (1) additional ground investigation including drill holes, boreholes and trial pits;

- (2) the installation of measuring devices to observe vertical and horizontal movements;
- (3) the monitoring of such measuring devices;
- (4) the testing of soil samples to determine moisture content, density, grading etc.

The Contractor shall allow for any reduction of the efficiency of his operations and for delays or stoppage caused by any of the above items. The Contractor shall also take all necessary precautions to ensure that existing or new instrumentation is not disturbed or damaged.

The Contractor shall employ an acceptable sub-contractor with a properly trained and experienced English-speaking engineer, who shall be responsible for any ground investigation, instrumentation and soil testing.

On receipt of an instruction from the Engineer under this Clause, the Contractor shall prepare a programme and present to the Engineer his proposals for carrying out the investigation, including proposals for obtaining access etc. The Contractor shall not proceed with the field work until the Engineer has indicated he has no further comments on the Contractor's proposals.

The field work for each such instruction shall be programmed to finish within the time directed by the Engineer. For each such instruction, the Contractor shall provide the number of rigs and crews or other equipment, subject to the Engineer's Representative's prior agreement, required to complete the investigation within the time directed.

Notwithstanding the requirements above, the Contractor shall commence the field work for such instructions within one month of its issue, or as directed by the Engineer.

1.9 Method of Payment

- M.1.1.1 The item for conforming to Clause 10.1 of the Conditions of Contract (Performance Security) shall include for complying with the clause. Payment will be made when the Performance Security has been provided to the satisfaction of the Engineer.
- M.1.1.2 The item for conforming to Clauses 21.1, 22.1, 22.2, 23.1, 23.2, 23.3, 24.1 and 24.2 of the Conditions of Contract (Insurance and Indemnities) shall include for complying with the requirements of the Contract in this respect. Payment will be made by installments as determined by the Engineer when original receipts and original policy documents have been provided to the satisfaction of the Engineer.
- M.1.1.3 The item for Contractor's Superintendence during Execution of the Work shall provide, all necessary manpower, including management, supervisor, and administrative staff in both home office and the site required for executing the works.

This provision of Contractor's Superintendence shall include, but not be limited to, the following payments and provisions:

- Salaries, wages and bonus
- Hardship allowances and other necessary allowances
- Local travel expenses, transportation and commutation
- Board (meals) and lodging
- Recruitment, dismissal and retirement
- Safety gear, such as shoes, helmets, gloves, safety belt, goggles, etc.
- Medical care (including first aid care)
- All immigration services including arrangement of work permits and residence visa relating to bringing in personnel from overseas
- Acquisition of driving license
- Taxes and duties to be imposed in connection with personal income
- Social insurances and welfares
- Any other costs and expenses relevant with providing manpower

Payment will be made in equal monthly instalments over the period stated in the Appendix to Tender as the time for completion of the whole of the Works. In the event of completion of the whole of the Works in advance of the time for completion stated in the Appendix to Tender, then the balance of the monthly instalments not yet paid to the Contractor will be certified as payable upon the issue of the Certificate of Completion for the whole of the Works. Any extension of time granted under Clause 44.1 of the Conditions of Contract will not entitle to the Contractor to payment under this item unless such payments are specifically assessed by the Engineer.

M.1.1.4 The item for conforming to Clause of 1.2 of the Specification (Quality System) shall include for complying with the requirements of the Clause. The item for provision and maintenance of Contractor's quality system shall include for;

- (1) Submission of Project Quality Plan
- (2) Provision of Progress Photographs and Equipment
- (3) Environmental Management
- (4) Training Plan, etc.

M.1.1.5 The item for conforming to Clause 1.3 of the Specification (safety) shall include for complying with the Clause.

M.1.2.1 The item for the Provision of Contractor's Site establishment, unless itemised specifically elsewhere in the Bill for Quantities, shall include for:

- (i) The provision and transportation to the Site of plant, equipment, vehicles, stores and materials not to be incorporated in the Works, and all temporary buildings and accommodation for the Contractor's use necessary for the construction of the Works to commence.
- (ii) The erection of temporary buildings and accommodation for the Contractor's use.
- (iii) The provision and installation of electricity supply, water supply, sewerage and garbage disposal facilities appropriate for the Contractor's use.
- (iv) Any other expenses incurred by the Contractor in establishing himself on Site.

This Lump Sum item is payable upon the establishment of the Contractor on Site to the satisfaction of the Engineer.

M.1.2.2 The item for the Provision of contractor's temporary yard, shall be made in accordance with the Clause 6.2 of the Preamble.:

This Lump Sum item is payable upon the establishment of temporary yard on Site to the satisfaction of the Engineer.

M.1.2.3 The items for conforming to Clause 1.7.2 of the Specification (temporary road and bridge works) shall include for complying the Clause.

The rates for this work shall be made in accordance with the Clause 6.3 of the Preamble. This Lump Sum item is payable upon the provision of temporary road and bridge works on site in accordance with the Clause 6.5 of the Preamble.

M.1.2.4 The item for conforming to Sub Clause 1.77 of the Specification (Laboratory) shall include for complying with the Sub Clause.

M.1.2.5 The item for Maintenance of Contractor's Site establishment shall include for:

- (i) The provision and transportation to, and from the Site of plant, equipment, stores and materials not incorporated in the Works necessary for the continued construction of the Works.
- (ii) Expenses incurred in maintaining and running the Site services of the Contractor's Site establishment.
- (iii) Supervisory and superintendent staff costs including salaries, gratuities, leave pay, insurances, accommodation, travel and on Site vehicles.
- (iv) Management and administrative costs both on and off the Site.
- (v) Any other expenses incurred by the Contractor in running his Site establishment.

Payment will be made in equal monthly instalments over the period stated in the Appendix to Tender as the time for completion of the whole of the Works. In the event of completion of the whole of the Works in advance of the time for

completion stated in the Appendix to Tender, then the balance of the monthly instalments not yet paid to the Contractor will be certified as payable upon the issue of the Certificate of Completion for the whole of the Works. Any extension of time granted under Clause 44.1 of the Conditions of Contract will not entitle to the Contractor to payment under this item unless such payments are specifically assessed by the Engineer.

M.1.2.6 The item for the demobilisation and removal of Contractor's Site establishment shall include for:

- (i) The transportation from the Site of remaining plant, equipment, stores and materials, temporary buildings and accommodation.
- (ii) The dismantling of temporary buildings and accommodation.
- (iii) The disposal of stores and materials not removed from the Site.
- (iv) Any other expenses incurred by the Contractor in disestablishment from the Site.

This Lump Sum item is payable upon removal of the Site establishment to the satisfaction of the Engineer.

M.1.3.1 The item for Provision of the Engineer's office and laboratory including utility services shall include for:

- (a) clearing and grubbing, site formation and preparation;
- (b) foundations, flooring, structures, fencing, rainwater tanks, guttering, surface water drainage, sewage disposal, services including telephone electricity and water supply, fixtures, toilet facilities, air conditioners, security lighting, surfaced access;
- (c) painting.

Attention is drawn to the fact that, if the Engineer does not subsequently instruct the Contractor to remove the office and laboratory, no additional payment will be made in respect of anything described in this Clause. This item will be measured for payment when the facilities have been provided to the satisfaction of the Engineer.

M.1.3.2 The item for Maintenance of Engineer's office and laboratory shall be made on a monthly basis and shall include for:

- (a) cleaning and removal of waste;
- (b) general building maintenance and renovations;
- (c) electricity provided by generator;
- (d) water supply;

- (e) watching and guarding;
- (f) making good any losses or damage;
- (g) maintenance of services;
- (h) maintenance of facilities, furnitures and equipment;

The quantity measured under this item shall be the number of months from the date when, in the opinion of the Engineer, office and laboratory is ready for occupation until the date when the Engineer instructs its removal, or instructs that it is not to be removed and that maintenance is no longer required.

M.1.3.3 the item for Provision of the Engineer's housing accommodation including utility and services shall include for:

- (a) clearing and grubbing, site formation and preparation;
- (b) foundations, flooring, hardstanding, structures, fencing, rainwater tanks, guttering surface water drainage, sewage disposal, services including electricity and water supply, fixtures, solar water heater, toilet and bathroom facilities, fitted kitchen facilities including gas cooker and gas supply, air conditioner, security lighting, surfaced accesses, washing line;
- (c) painting.

Attention is drawn to the fact that, if the Engineer does not subsequently instruct the Contractor to remove the residences, no additional payment will be made in respect of anything described in this Clause. This item will be measured for payment when the facilities have been provided to the satisfaction of the Engineer.

M.1.3.4 The item for Maintenance of Engineer's housing accommodation shall be made on a monthly basis and shall include for:

- (a) clearing of compound, grass cutting and removal of waste;
- (b) general building maintenance and renovations;
- (c) electricity provided by generator;
- (d) water supply;
- (e) watching and guarding;
- (f) making good any losses or damage;
- (g) maintenance of services;
- (h) maintenance of facilities, furnitures and equipment;

The quantity measured under this item shall be the number of months from the date when, in the opinion of the Engineer, office and laboratory is ready for occupation until the date when the Engineer instructs its removal, or instructs that it is not to be

removed and that maintenance is no longer required.

M.1.3.5 A Provisional Sum is included in the bill of Quantities for the Provision of miscellaneous and equipment and supplies for the Engineer's office and laboratory. This item shall include for the provision of miscellaneous equipment and supplies in accordance with Specification Clause 1.6.3 (3).

M.1.3.6 An item is provided in the Bill of Quantities for the Contractor to enter a percentage charge to cover his costs and profits, in respect of the previous item.

M.1.3.7 The item for demobilisation and removal of the Engineer's office and laboratory shall include for:

- (a) demolishing or dismantling as necessary and removing from the Site the office and laboratory, the awnings, hardstanding, fencing, rainwater tanks, services, fixtures, toilet facilities, air conditioners, security lighting;
- (b) disconnecting all services and sealing off disused services;
- (c) reinstating any damaged or unfinished areas;
- (d) the credit value of reusable and salvageable items

M.1.3.8 The item for demobilisation and removal of the Engineer's housing accommodation shall include for:

- (a) demolishing and dismantling as necessary and removing from the Site the housing accommodation, fencing, rainwater tanks, services, fixtures, gas cooker, air conditioners, security lighting;
- (b) disconnecting all services and sealing off disused services;
- (c) reinstating any damaged or unfinished areas;
- (d) the credit value of reusable and salvageable items

M.1.4.1 The item for the Provision of vehicles including VHF transceivers for Engineer's staff shall include for:

- (a) supplying and delivering to the Site, the vehicle in proper working order, including VHF transceivers;
- (b) taxing the vehicle for use on public roads;
- (c) removing the vehicle off Site when instructed by the Engineer;

This item will be measured for payment on a number basis under each type of vehicle entered in the Bill of Quantities. This item will be measured for payment from the time when each vehicle is provided in proper working order to the satisfaction of the Engineer.

M.1.4.2 The item for maintenance of and fuel for Engineer's staff vehicles shall include for:

- (a) meeting the vehicle running costs including fuel, oil, lubricants, tyres, puncture repairs, licences, taxes, road tests, servicing and spare parts;
- (b) insuring the vehicle comprehensively to cover any qualified driver authorised by the Engineer together with authorised-passenger liability cover;
- (c) maintaining the vehicle in a roadworthy condition and in conformity with the vehicle manufacturer's recommendations;
- (d) cleaning the vehicle daily inside and outside;
- (e) providing a satisfactory replacement vehicle when the regular vehicle is unavailable or unserviceable.

M.1.4.3 The item for Provision of launch for the Engineer shall include for providing the furniture and equipment listed in Specification Clauses 1.6.5. This item will be measured for payment when the specified items have been provided to the satisfaction of the Engineer.

M.1.4.4 The item for maintenance of and fuel for Engineer's staff launches shall include for:

- (a) meeting the launch running costs including fuel, oil, lubricants, taxes, tests, servicing and spare parts;
- (b) providing a satisfactory replacement launch when the regular launch is unavailable or unserviceable.

M.1.4.5 The item for Provision and maintenance of radio and telephones for the Engineer shall include for providing the furniture and equipment listed in Specification Clauses 1.6.4 and 1.7.5. This item will be measured for payment when the specified items have been provided to the satisfaction of the Engineer.

M.1.4.6 A Provisional Sum is included in the Bill of Quantities for the payment of public utility charges and local authority charges for the Engineer's office and laboratory. This item shall include for:

- (a) the costs of telephone calls from the Engineer's office and laboratory;
- (b) any local authority charges for the Engineer's office and laboratory;
- (c) any other utility charges which the Engineer nominates for payment under this item;

Attention is drawn to the fact that costs of installation of utilities ie. telephone etc. are not measured for payment under this item. Payment under this item shall be made or production of the necessary accounts from the utility companies or local authorities.

M.1.4.7 An item is provided for in the Bill of Quantities for the Contractor to enter a

percentage charge to cover his costs and profits in respect of the previous item.

- M.1.4.8 Provisional Sum for Ground Investigation, etc.
- M.1.4.9 The item for assistance for the Engineer shall include for providing the field, office, laboratory attendants and watchman in accordance with Specification Clause 1.8.17. The payment shall be made on a monthly basis.
- M.1.4.10 The item for Provision and maintenance of survey equipment for the Engineer. This item shall include for complying with the Sub-clause 1.8.16 of the Specification.
- M.1.5.1 The item for conforming to Clause 1.5 of the Specification shall include for complying with that Clause.
- M.1.5.2 The item for conforming to Clause 1.5 of the Specification shall include for complying with the Clause.
- M.1.5.3 The item for conforming to Sub-Clause 1.7.11 of the Specification shall include for complying with the Clause.
- M.1.5.4 The item for conforming to Tender Schedule TS-6 of Form of Tender shall include for complying with the Tender Schedule.
- M.1.5.5 The item for conforming to Schedule 1 of the Specification not covered elsewhere shall include for complying with Schedule 1 of the Specification as appropriate. Payment will be made by monthly instalments.
- M.1.5.6 The item for conforming to the requirements of the Conditions of Contract not covered elsewhere shall include for complying with the Conditions of Contract as appropriate. Payment will be made by regular instalments as determined by the Engineer.
- M.1.5.7 No separate payment will be made for any other expenses or costs incurred in complying with the requirements of Schedule 1 General or the Conditions of Contract not itemised in Schedule 1 of the Bill of Quantities, as these be deemed to be included in the items in Schedule 1 or in the rates and prices entered in other Schedules of the Bill of Quantities.

2. SITE CLEARING AND DEMOLITION

2.1 Description

This work shall consist of the removal, wholly or in part and the satisfactory disposal of blocks of masonry of an individual size greater than 1 cubic meter, of all buildings, hedges, fences, structures, old pavements, kerbs, and any other obstructions which are not designated or permitted to remain, and of the clearing, grubbing, removing of top soil, and removing and disposing of all vegetation and debris within the limits of the site except such objects as are designated to remain in place or are to be removed and disposed of in accordance with other Clauses of this Specification.

This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

Prior to commencing work on site the Contractor shall submit his Environment Management Plan covering all environmental protection and control elements required.

2.2 Construction Requirements General

The Contractor shall perform the above work, within and adjacent to the roadway, on the right-of-way, as shown on the Drawings or as directed by the Engineer. The Engineer will establish the limits of work and designate all structures, trees, shrubs, plants and other things to remain. The Contractor shall preserve all items designated to remain.

Details of existing structures which are to be incorporated in the Works are shown on the drawings. When complete or partial removal of structures is required, full details of the Contractor's proposed working method shall be submitted to the Engineer for approval.

The Engineer may instruct that materials recovered from demolition shall remain the property of the Employer unless specifically provided otherwise in the Contract Documents. All designated saleable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places on the project as directed by the Engineer. Basements or cavities left by structure removal shall be filled with acceptable material to the level of the surrounding ground and, if within the prism of construction, shall be compacted in accordance with Clause 3.16.

Performance of these works under the Contract shall include salvage of materials removed; their custody, preservation, storage on the right-of-way or any other places as may be designated by the Engineer or the Employer, or disposal as provided herein.

The use of explosives shall not be permitted for the removal of existing masonry or concrete structures.

2.3 Removal of the Existing Bridges, Culverts, and other Structures

The existing bridges, culverts and other drainage structures in use by traffic shall not

be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise directed, the substructures of existing water structures shall be removed down to the natural stream bottom and those parts outside of a stream shall be removed to the extent necessary to avoid influence on new works.

Where portions of the existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure. Where only a section of the existing structure is to be demolished, the Contractor shall execute this work in such a way as to avoid damage to the section designated to remain. All details of the Contractor's proposed working method shall be submitted to the Engineer for approval.

Steel bridges and wood bridges, when specified by the Engineer to be salvaged, shall be carefully dismantled without damage. Steel members shall be match marked, unless such match marking is waived by the Engineer. All salvaged material shall be stored as requested by the Engineer.

Unless waived in writing by the Engineer, all concrete removed that is of suitable size for riprap and not needed for such use on the Project, shall be stockpiled at locations designated by the Engineer, for use by the Employer.

2.4 Removal of Kerb

Existing kerbs designated for removal, including their bases, shall be broken into pieces and shall be removed and stockpiled at designated locations on the site for use of the Employer or shall be otherwise disposed of as directed by the Engineer.

Removal of existing kerbs shall be undertaken in such a manner as to avoid damage to existing pavements and kerbs which are designated to remain.

2.5 Removal of Pavements, Footpaths, etc.

Existing pavements or structures shall be completely removed and this shall be dealt with under the Vietnamese Laws. Before laying of new pavements the Engineer will inspect the exposed existing surfaces and the Contractor should schedule his works to facilitate the Engineer's inspection.

Irrespective of thickness, all asphalt or concrete pavements, footpaths, or other hard surfaces designated for removal, shall be broken into pieces, and shall be removed and stockpiled at designated locations on the Site for use of the Employer, or otherwise disposed of as directed by the Engineer. Removal of pavement shall be carefully undertaken to avoid damage to abutting sections of pavement or structures designated to remain.

If removal of sections of old pavement, footpaths or other hard surfaces of an individual size less than 10 cubic meters or excavation of ballast, gravel or similar subbase or base material is necessary, this work shall be considered as Common Excavation, and shall conform to the requirements of Clause 3.10 of this Specification, for construction, measurement and payment.

2.6 Removal of Traffic Signs

Where directed, traffic signs including steel frames shall be carefully dismantled, removed and stored where directed by the Engineer.

Concrete foundations shall be broken into pieces removed and stockpiled at designated locations on the site for use of the Employer or shall be otherwise disposed of as directed by the Engineer.

2.7 Clearing and Grubbing and Tree Removal

All surface objects and all trees, down timber, rotten wood, stumps, roots, snags, brush, other vegetation, rubbish, and other protruding obstructions, not designated to remain, shall be cleared and/or grubbed, including disposal as required.

In areas under roadway embankments, from which top soil or unsuitable materials are to be removed or which are designated to be compacted, all stumps and roots shall be removed to a depth at least 50 cm below the original ground surface and at least 50 cm below the bottom of the lowest pavement layer.

In roadway cut areas, all stumps and roots shall be removed to a depth of not less than 50 cm below the finished subgrade level.

Clearing and grubbing of pits, channel changes, and ditches shall be required only to the depth necessitated by the excavation within those areas.

Voids left after removal of roots shall be filled with suitable compacted material.

2.8 Topsoil Stripping

In areas under roadway embankments or where designated by the Engineer, the Contractor shall remove topsoil, and dispose of it as directed by the Engineer.

In general the removal of topsoil shall include only the removal of soil which is sufficiently fertile to encourage or sustain a growth of vegetation.

Removal of topsoil over any designated area shall be executed to the depth as directed by the Engineer, and the topsoil shall be kept separate from other excavated material.

When the topsoil will be used for dressing of the slopes of the embankment, or other areas as directed by the Engineer or as indicated on the drawings, the work of topsoil stripping shall be deemed to include stockpiling the topsoil when necessary and removing therefrom and the placing and spreading of the topsoil in areas designated by the Engineer. After spreading, the topsoil shall be raked to form a smooth surface free from weeds, roots, sods and large stones.

2.9 Removal of other Unsuitable Material

The Contractor shall excavate turf, decayed vegetable matter, or other unsuitable matter to such depth as the Engineer may require.

2.10 Protection of Areas Designated to Remain

In areas designated by the Engineer, the Contractor shall be responsible for the protection and routine maintenance of existing shrubs, trees and grassed areas. On completion of the Works these areas shall be returned to the Employer in the same condition as before and any damage due directly or indirectly to the Contractor's operations shall be made good at his own expense.

2.11 Disposal of Cleared Material

The Contractor shall have the right to use unsaleable timber (or saleable timber when permission is granted in writing by the appropriate Government agency or authority) for his own purposes in connection with the Contract always provided that he has ascertained and complied with the requirements of the appropriate Government agency or authority.

Saleable timber shall be neatly stored in an approved accessible place within or near the right-of-way as directed and shall be trimmed and stacked in accordance with the requirements of the appropriate Government agency.

All other timber, except timber to be used, and all brush, stumps, roots, logs, and other refuse from the clearing and grubbing operation shall be disposed of at locations provided by the Contractor.

2.12 Measurement and Payment

The area measured for payment for "site clearing and demolition" shall be the plan area of clearing for:

- (a) land areas
- (b) bridge sites areas

Payment for limbing and thinning of trees and shrubbery shall be made under Sub-Clause 5.11 of the Preamble, Dayworks, for work instructed by the Engineer.

Attention is drawn to the fact that clearing and grubbing for:

- (a) fill borrow pit area
- (b) temporary yard area
- (c) subbase/base course borrow pits areas
- (d) quarry sites areas
- (e) river deposit sites areas
- (f) access roads areas

is not measured for payment under clearing and demolition, but under items in Schedules 3, 4 and 6.

The item for site clearing and demolition shall include for the clearing and demolition required and for everything furnished and done regardless of the nature of condition of "the Area" and including backfilling of stump holes and other holes from which obstructions are removed, with suitable material.

The rates and prices for site clearance and demolition shall be made in accordance with Clause 7 (Site Clearance and Demolition) of the Preamble.

3 EARTHWORKS

3.1 Scope of Earthworks

Earthworks shall consist of all necessary work for excavation, the incorporation of surplus material in the fill areas as required, the placing or disposing of unsuitable material, earth, rock or other material from or to structures, the roadway or adjacent thereto, the construction of waterways, ditches, lay-bys and approaches, the removal of unsuitable material, the removal of landslides, and the provision of all necessary materials and equipment for keeping the excavation or fill area free of surface run-off and groundwater all in accordance with the lines, grades, cross-sections shown on the Drawings or as established by the Engineer.

The Contractor shall not commence any work likely to generate dust until he has submitted, and received, approval for its proposals for dust control to the Engineer.

After each excavation is completed the Contractor shall notify the Engineer to that effect and no footing, bedding material or structure shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

3.2 Classification of the Earthworks

This work shall be divided into the following classes, which are hereinafter described in detail under separate headings.

- Excavation - Class - 1 - excavation for structure in any material over the water table.
- Excavation - Class - 2 - excavation for structure in any material below the water table.
- Excavation - Class - 3 - excavation for structure in river.
- Excavation - Class - 4 - excavation of any material over the water table other than the structure section
- Excavation - Class - 5 - excavation of any material below the water level other than the structure section

The rate per cubic metre for this item shall included for all expenses involved in providing, pumps, cofferdams, braced sheet piling.

- General fill including to road embankments;
- Waste;
- Areas of Special Fill;
- Granular Backfill;
- Permeable Backfill; and
- Underdrains

All earthworks shall be carried out in accordance with the Specifications for the classes as named above, and this Specification for other work items involved and in conformity with the lines grades, sections and dimensions, shown on the Drawings or required by the Engineer.

3.3 Preservation of Existing Streams and Channels

Unless otherwise permitted, no excavation in existing streams or channels shall be made outside of caissons, cribs, or sheet piling, and the natural stream bed adjacent to the structure shall not be disturbed without the approval of the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs, or cofferdams are sunk in place, the Contractor shall, after the foundation base is in place, backfill all such excavations to the original ground surface or stream bed with material satisfactory to the Engineer. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed and the stream area freed from obstruction.

3.4 Removal or Diversion of Water

The Contractor shall provide necessary facilities for dewatering, and for draining or diverting water-courses when necessary for the execution and protection of the work or where required by the Engineer.

The Contractor shall provide such temporary or permanent drainage outlet ditches as may be necessary to effect proper drainage before rain is to be expected.

3.5 Groundwater

Whenever groundwater is encountered during structure excavation, the Contractor shall take such measures to ensure that the excavation and footing are kept free of water.

Suitable and practically watertight cofferdams shall be used wherever water bearing strata are encountered above the elevation of the bottom of the excavation. The Contractor shall submit drawings showing his proposed method of cofferdam construction to the Engineer for his approval.

Cofferdams or cribs for foundation construction shall, in general, be carried out well below the bottoms of the footings and shall be well braced and as nearly water-tight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and, the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

When conditions are encountered which, as determined by the Engineer, render it impractical to dewater the, foundation before placing the footing, the Engineer may require the construction of a concrete foundation seal of such dimensions as he may consider necessary, and such seal shall be placed as shown on the Drawings or as directed by the Engineer. The foundation shall then be dewatered and the footing placed. When weighted cribs are employed and the weight is utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorages such as dowels or keys shall be provided to transfer the entire weight of the crib to the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level as directed.

Cofferdams shall be constructed so as to protect green concrete against damage from sudden rising of the water and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs, without the approval of the Engineer.

Any pumping that may be permitted from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. Any pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall be done from a suitable pump located outside the concrete forms. Pumping to dewater shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdam or cribs, with all sheeting and bracing involved therewith, shall be removed by the Contractor after the completion of the substructure. Removal shall be effected in such a manner as not to disturb or damage any finished work.

3.6 Ditches

The Contractor shall construct channels, side and interception ditches, inlet and outlet ditches as shown on the Drawings or where ordered by the Engineer, whether for temporary or permanent drainage. In order to keep water away from the embankment, subgrade, sub-base, and/or base during construction, the Contractor shall at all times ensure adequate drainage is operative before work is begun on the embankment and pavement structure. He shall clean and trim all such drainage ditches from time to time so that there may be a free flow of water throughout the whole Construction Period and Period of Warranty.

Damage to the work attributable to wetting through failure to provide adequate drainage shall result in an order to repair the damage at the Contractor's expense. Ditches shall first be trimmed short of the approved cross-sections, and final trimming, including the repair of any damage that may have been done during the construction work, shall be carried out after the completion of the construction work and shall be a condition for final approval and acceptance.

Irrigation of areas on which earthworks are to be executed shall have been halted at least two months in advance of the construction. All surface water shall be drained off and temporary and permanent ditches constructed in good time to allow the area to dry out.

3.7 Relocation of Stream Channels

Where indicated on the Drawings or where required by the Engineer, the Contractor shall take cross-sections of existing stream channels and, in collaboration with the Engineer, mark them with details of the excavation required for the relocation of the stream channel. The Contractor shall also take levels to allow the profile levels of box culverts and their extensions to be accurately fixed by the Engineer. Work shall not proceed without approval of the marked cross-sections by the Engineer.

3.8 Filling Existing Watercourses

Where watercourses have to be diverted from sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and the removed material replaced with general fill in accordance with Clause 3.16.

3.9 Commencement of Excavation

Prior to starting excavation operations in any area, the Contractor shall:

- regulate the natural drainage of the water flowing on the surface of the ground, to prevent flooding of excavations.
- ensure that all necessary Site Clearance and Demolition in that area has been performed in accordance with this Specification.
- take cross-sectional elevations and measurements of the undisturbed ground and obtain the agreement of the Engineer as to their accuracy.

3.10 Excavation Generally

Trenches or foundation pits for structures or structure footings shall be of sufficient size to permit the placing of structures or structure footings of the full width and length shown. The sides of trenches or pits shall be adequately supported at all times. The elevations of the bottoms of footings as shown on the Drawings shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.

The existing ground adjacent to excavations shall not be disturbed without the permission of the Engineer.

Boulders, logs, and any other unsuitable material encountered in excavation shall be removed from the site and shall not be used for backfilling purposes.

3.10.1 Piles beneath Excavations

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven or poured and any placing of blinding stone shall proceed after the piles are driven. However if for any reason it is impossible to drive the piles after excavation, piles shall be driven or bored and poured from the natural ground level, as directed by the Engineer.

3.10.2 Completion of Excavation

Excavation to final grade shall not be made until just before the footing is to be placed.

After the excavation and any pile driving or pouring are completed, all loose and displaced material shall be removed, leaving a smooth, solid bed to receive the footing. When the foundation material is soft or mucky or otherwise unsuitable, in the opinion of the Engineer, the Contractor shall remove the unsuitable material and replace it with granular backfill in accordance with Clause 3.16.

After each excavation is completed, the Contractor shall notify the Engineer to that effect, and no footing or bedding material shall be placed until the Engineer has approved the depth of excavation, and the character of the foundation material.

3.10.3 Excavation for Box Culverts

Where a box culvert is to be located in an embankment the Engineer may instruct that the excavation shall be performed after the embankment has been constructed to the proposed sub-grade level and compacted sufficiently.

3.10.4 Use and Disposal of Excavated Material

Any material except Unsuitable Material excavated within the limit and scope of the project shall, unless provision is expressly made to the contrary in this Specification, be used in the most effective manner for the formation of the embankment or otherwise as General Fill. Any material surplus to these requirements shall be treated as Unsuitable Material.

3.11 Unsuitable Material

Material shall be known as " Unsuitable Material " where it does not conform to the requirements of this Specification for General Fill or is declared in writing by the Engineer to be unsuitable for use in the embankment or other work.

Normally, highly organic clays and silts, peat, soil containing large amounts of roots, grass and other vegetable matter, domestic or industrial waste, are to be unsuitable. Materials that are soft or unsuitable merely because they are too wet or dry, are not to be classified as unsuitable unless otherwise directed by the Engineer.

3.12 Removal of Unsuitable Material

Unsuitable material shall be excavated below subgrade level in cut and below embankment foundation level to the depth shown on the Drawings or directed by the Engineer. Where unsuitable material is excavated below the normal subgrade level or below embankment foundation or for benching under embankments, the excavation shall be back filled with material and in a manner that conforms with Clause S4.05.

When unsuitable material below sub-grade level in cut or below embankment foundation level is ordered to be removed, the soil left in place after the removal of the unsuitable material shall be compacted, to a depth of 20 cm, to a density of 90 percent of the maximum dry density determined according to AASHTO T99. Payment for such compaction shall be included in the unit rate for Common Excavation.

In particular soft muds shall be removed from the base of ponds, paddies and other low-lying areas. The Contractor shall advise the Engineer that ponds have been cleared of soft muds, in sufficient time to allow for inspection before filling commences.

3.12.1 Disposal of Unsuitable Material

Unsuitable material shall be removed and disposed of in waste areas provided by the Contractor outside the right-of-way in such manner as to present a neat appearance and not to obstruct drainage to any highway nor to cause injury to highway works or property. If it becomes necessary for the Contractor to locate or relocate any waste areas, they shall be approved by the Engineer prior to spreading any unsuitable material.

Waste areas shall be left in a smooth, neat and drainable condition, as directed by the Engineer, and all unsuitable material shall be placed in such manner that adjacent property shall not be damaged or endangered.

Soil slopes shall not be steeper than 2:1, unless otherwise directed by the Engineer.

3.13 Horizontal and Vertical Alignment

The Engineer will supply the Contractor with the locations of all structures and the Points of Intersection of Tangents and Grade lines for roads. The Drawings will indicate the properties of horizontal and vertical curves, together with the rates of super elevation where required. The Contractor shall prepare cross-sections based upon the above properties, secure the Engineer's approval of his cross sections and stake out before proceeding with construction. If, in the opinion of the Engineer, any modification of the line or grade is advisable, either before or after stake-out, the Engineer will issue detailed instructions to the Contractor for such modifications and the Contractor shall revise the stake-out for further approval.

3.14 Formation of Embankment and Areas of Fill

This work shall consist of the construction of embankment and backfill not specified elsewhere by furnishing, placing, compacting and shaping suitable material of acceptable quality obtained from approved sources in accordance with this Specification, and to the lines, levels, grades, dimensions and cross-sections shown on the Drawings and as required by the Engineer.

3.15 Sources and Use of Material

Material for use in embankments and elsewhere shall, unless otherwise required, consist of General Fill material approved by the Engineer excavated from within the site or imported from outside or formed from a mixture of both on-site and imported material.

3.16 General Fill and Select Fill

General Fill shall be free from organic or any other deleterious material such as leaves, grass, roots and sewage.

Any material classified by the Unified Soil Classification System as OL, OH or Pt shall not be used.

General fill shall comprise local river sands or other equivalent material meeting the following gradings:

Percent passing 100mm sieve	100%
Percent passing 2mm sieve	50% – 100%
Percent passing 0.075mm sieve	<30%
Liquid limit of material after compaction in embankment	<26%
Plasticity index of material after compaction in embankment	<10%

Select fill shall comprise local river sands or other equivalent material meeting the following gradings.

Percent of sample passing 100mm sieve	100%
Percent of sample passing 19mm sieve	80 to 100%
Percent of sample passing 2mm sieve	40 to 100%
Percent of sample passing 0.6mm sieve	20 to 80%
Percent of sample passing 0.075mm sieve	<15%

3.16.1 Use of Borrow Pits

General Fill may be obtained from approved private sources. Permission to open borrow pits, including advice as to suitability, shall first be obtained in writing from the Engineer.

Where suitable material for embankments is available adjacent to the embankment the Engineer may order the excavation of drainage channels wider and deeper than normally required in which case such excavation shall be measured and included in cross-sections as Common Excavation.

3.16.2 Preparation of Foundation of Embankment

Before beginning the construction of Embankment the Contractor shall fill with General Fill all holes, etc. within all the areas which have been cleared and grubbed or where unsuitable material has been excavated, and such areas shall be suitably levelled at the level resulting after the removal of the topsoil. The fill shall be placed and compacted in accordance with the requirements of Clause 3.16.3.

3.16.3 Placing and Compaction

General Fill shall be placed in horizontal layers of uniform thickness over a width determined by the Engineer and in conformity with the lines, grades, sections and dimensions shown on the Drawings.

In the top 0.5 meter, horizontal layers shall not exceed 100 millimetres in depth before compaction. No layer below the top 0.5 meter shall exceed 200 millimeters in depth before compaction.

After adjustment of the moisture content to that required to obtain maximum density, each layer of the entire embankment shall be compacted to 95 percent of the maximum density as determined by compaction control tests.

The Contractor shall use compacting equipment approved by the Engineer. Any embankment inaccessible to large compacting equipment shall be compacted with small mechanical or vibratory compactors.

If any of the material reaches a condition such that it cannot be compacted in accordance with the requirements of the Contract, the Contractor shall either:

- make good by removing the material either to tip or elsewhere until it is in a suitable physical condition for re-use and replace it with suitable material; or
- make good the material by mechanical or chemical means; or
- cease work in the material until its physical condition is again such that it can be compacted as described in the Contract.

Where new fill is to be compacted against existing embankments or where fill is constructed on half width at a time, the original slope of the old or of the first half width fill, shall be cut into a distance sufficient to accommodate the width of the compacting equipment as the new fill is placed in horizontal layers, and this material cut shall be incorporated and compacted with the new fill.

To avoid interference with the construction of bridge abutments, wing walls and box culverts, the Contractor shall, at points to be determined by the Engineer, suspend work on embankment forming the approaches to any such structure until such time as the construction of the latter is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works.

Material for embankment at points inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 10 cm thick and thoroughly compacted by the use of mechanical rammers.

In carrying embankments up to or over culverts and where required in the Contract up to or over bridges, the Contractor shall bring the embankments up equally on both sides. If conditions require placing backfill or embankment appreciably higher on one side than on the opposite side, the additional material on the higher side shall not be placed until permission shall have been given by the Engineer and preferably not until the structure has been in place 14 days, and tests made by the laboratory under the supervision of the Engineer establish that the structure has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor.

Where special materials for filling adjacent to structures are described in the contract, filling may proceed over widths less than the full width of the embankment and in steps not exceeding the depth of one layer above the adjoining area of fill. In rock fill embankments the materials shall be carefully packed for such distance from the structure as is described in the Contract.

Special care shall be taken to prevent any wedging action against the structure and all slopes bounding or within the areas to be filled shall be benched or serrated to prevent wedge action. The placing of embankment and the benching of slopes shall continue in such a manner that at all times there shall be a horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to be backfilled against except in so far as undisturbed material intrudes upon the areas.

3.16.4 Compaction Trials

Before starting the formation of the embankment the Contractor shall construct trial lengths for compacting as directed by the Engineer. The soils used in the trials shall be those encountered along the roadway and the compacting equipment shall be the same equipment that the Contractor shall use for the main work accepted by the Engineer.

The object of these trials shall be to determine the optimum moisture content and the relationship between the number of passes of compacting equipment and density obtained for the soil types under trial.

3.16.5 Required Density

General Fill shall be compacted as follows:

Layers more than 20 cm. below subgrade level shall be compacted to 95 percent of the maximum dry density determined according to AASHTO T99. For all soils, except rock fill materials containing more than 10 percent oversize material retained on a 19.0 mm (3/4 inch) sieve, the maximum dry density thus obtained shall be adjusted for such oversize material as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the Engineer.

Layers 20 cm or less below subgrade level shall be compacted to 100 percent of the maximum dry density determined according to AASHTO T99.

3.16.6 Moisture Content

Embankment material that does not contain sufficient moisture to obtain the required compaction shall be given additional moisture by means of approved sprinklers and mixing. Material containing more than the amount of moisture necessary to obtain the required compaction may not, without approval of the Engineer, be incorporated in the embankment until it has been sufficiently dried out. The drying of wet material may be expedited by discing or other approved methods.

The compaction of the embankment shall be carried out at the optimum moisture content. In forming the embankment the Contractor shall take steps to ensure that the work can be drained free of rain water, and he shall make due allowance in the height and width of the work of swelling or shrinkage.

3.16.7 Finishing to Final Grade Level

The final grade level, to the profile indicated and adjusted for superelevation where required, shall conform to the requirements and tolerances of this Specification and the Drawings. Prior to adding any material to raise the level of any low spots, the existing surface shall be scarified.

3.16.8 Slopes

Side slopes shall be neatly trimmed to the lines and slopes shown on the Drawings or as directed by the Engineer, and finished work shall be left in a neat and acceptable

condition.

3.16.9 Stability

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that have been damaged or displaced due, in the opinion of the Engineer, to carelessness or neglect on the part of the Contractor, or to such natural causes as storms. The Contractor shall not be responsible for damage caused by unavoidable movements of the natural ground upon which the embankment is made. During construction the roadway shall be kept shaped to drain at all times. When unsuitable material has been placed in the embankment by the Contractor, he shall remove it and replace it using suitable material.

The Contractor shall demonstrate in writing to the Engineer, the stability of the embankment before subsequent stage filling, and shall demonstrate the stabilisation of settlement and lateral movement before surcharge removal and piling.

3.17 Backfill and Embankments Adjacent to Structures

On completion of the structure, excavated areas if not otherwise required to be backfilled with granular backfill or permeable backfill shall be backfilled with General Fill in accordance with Clause 3.16.3 to the level of the finished ground surface.

3.18 Monitoring of Embankment Stability

The work shall consist of the installation of instrumentation for subsequent monitoring of consolidation, settlement, lateral movement and stability in the soft clay soils below fill embankments.

During settlement an additional 1m width of sand 1m deep may be instructed by the Engineer to be placed at the toe of the sand embankment to be later removed after settlement is complete.

28 days prior to installation the Contractor shall submit to the Engineer for approval full details of each particular type of instrumentation and installation method he proposes to use on the project. The Contractor shall submit to the Engineer for approval, a monitoring and remedial action plan, outlining frequency and construction method resources.

3.18.1 Surface Settlement Plates

Surface settlement plates with vertical rods shall be installed on a 10 cm thick level sand base in such a way that the top of the base plate is horizontal. Before placing any embankment material the Engineer will inspect the completed installation and take initial elevations on the top of the base plate and the top of the rod. A 30 cm thick layer of sand shall be, placed on the settlement plate base to eliminate bedding errors. As embankment construction advances the rods shall be extended as necessary.

3.18.2 Piezometers

Pneumatic type piezometers shall be installed in boreholes of an appropriate diameter and construction, drilled into the subsoil beneath the road embankment. Piezometers shall be installed midway between surrounding wick drains at the approximate locations indicated on the Drawings.

The piezometers shall be capable of measuring positive water pressures in the range of 0 to 50 metres head of water (0-500kPa), with an accuracy equal or better than 0.2m head of water (2kPa) and a resolution of 0.1m head of water (1kPa).

The piezometers shall consist of a sensitive measuring tip placed down the borehole and embedded in a uniformly graded filter sand. Pneumatic lines within a protective cable running from the tip up the borehole shall be connected to an appropriate digital readout unit. The readout units shall be housed within a secure and suitable shelter. An optional automatic data logger may be attached to the readout unit, with provision to transfer data to a computer.

The boreholes shall be capable of containing up to three piezometer tips installed at different levels below ground surface. The water pressure response between each tip shall be fully isolated down the borehole by cement or bentonite plugs.

3.18.3 Slope Inclinometers

A slope inclinometer monitoring systems shall be installed down boreholes through and beneath the road embankments of appropriate diameter and construction, drilled into the subsoil.

The system shall be capable of measuring lateral movements in two perpendicular directions down the length of the borehole to at least 25 metre depths, within the borehole inclination range at least 30° from the vertical, and within borehole curvatures of 3 metre radius or greater. The accuracy of lateral movement readings shall be within 0.02% with a resolution of 0.01mm over a temperature range of 0° to +70°C.

The system shall comprise access tubes fixed by grout or suitable filling within the boreholes, in sections which are flush jointed and containing longitudinal keyways in two perpendicular directions orientated perpendicular and parallel to the embankment direction. The base of the access tubes shall be at a depth down the borehole where lateral movements due to filling are not anticipated. At the collar of the borehole, the tubes shall be embedded in concrete and supplied with a lockable cap.

A torpedo probe capable of passing down the access tubes, shall be oriented by wheels travelling within the key ways. The torpedo shall have a sensing system, comprising accelerometers, which can determine the inclination in the two perpendicular directions. This information shall be transferred through electrical cables to an electronic readout unit where it is displayed in terms of horizontal displacement deviations, summed continuously up the borehole at 0.1 metre depth intervals from the fixed location at the base. The depth of measurements shall be repeatable to within 1mm.

A calibration frame shall be supplied to provide confirmatory checks that all components of the system are operational and readings are within the required accuracy range.

An automatic data logger system and computer for data capture may be provided.

A typical schematic of the inclinometer system is shown on the Drawings.

3.18.4 Magnetic Extensometers

Magnetic extensometer systems shall be installed within near vertical boreholes of an appropriate diameter drilled into the subsoil or within subsequently placed overlying road embankments.

These magnetic extensometers shall be capable of measuring settlement or heave at a number of depth levels down the system to a depth of 30 metres and to an accuracy of 1mm.

The system shall comprise flush-coupled PVC access tube installed centrally down the borehole. The access tube shall include a base end cap and an upper protective cover and shall be watertight and free of water within. The access tube shall be surrounded by magnetic targets at chosen locations down the borehole depth which shall be nominally of composite nickel-cobalt ferrous magnetic composition. Within the borehole the magnets may be of various structures, including leaf spring spider magnets (optionally pneumatically released), arrowhead magnets and datum ring magnets, but shall be engaged in the surrounding ground. Within the overlying fill the magnets shall be plate magnets embedded in the fill.

The target magnets in the borehole may either move independently of a continuous access tube which is released from the surrounding fill, or the magnets may be fixed to the access tubing which is allowed to compress or extend vertically by special coupling mechanisms.

The borehole annulus around the access tube is nominally backfilled by grouting.

The targets are located by passing a reed switch probe through the access tube. When the probe enters the targets magnetic field, an audible signal or other suitable signal shall be emitted at ground level.

Measurements made by an integral steel tape attached to the probe, shall employ a suitable system that allows repeatable depth measurements to the required accuracy.

A typical schematic of the extensometer system is shown on the Drawings.

3.18.5 Movement Monuments

Stable monuments shall be installed at locations on the surface of fill or natural ground.

The monuments shall contain targets which are capable of being levelled and coordinated to an accuracy of 1mm by means of precise survey equipment. Successive coordination shall measure settlements and lateral movements due to

earth fill loads.

The monuments shall comprise durable stakes or concrete piers, embedded at least 0.5 metres into the ground, or further as required to maintain stability of location under all forces other than fill loading, but including equipment and personnel disturbance.

3.18.6 Monitoring Frequency

The frequency of monitoring of all installations shall be determined by a number of factors including the rate of filling, the magnitude and rate of change of measurements, the consolidation periods, the estimated reduction and level of stability against slip failure and the presence of any observable or suspected distress in the embankments or underlying soils.

During critical periods, it is anticipated that monitoring readings may be required for every 0.2 metre lift in fill height, or two to three times per week, whichever is the smaller period. Reading of the surface monuments, supplemented by visual observations for embankment crest movement or toe heave, should be undertaken on a daily basis during these periods.

Notwithstanding this anticipated frequency, the Contractor shall increase the monitoring frequency as required to confirm an acceptable degree of safety against instability, represented by a minimum factor of safety against slip circle failure of 1.3. The frequency of monitoring shall also be sufficient to ensure that appropriate filling allowances are made for settlement, and that the design levels are attained on final construction of earthworks and roadworks. In this regard the rate of settlement before removal of surcharge shall be limited to 1mm per week maximum, and the estimated remaining consolidation settlement shall be no more than 5% of maximum. In addition to the above criteria removal of surcharge and piling at the abutments shall not take place until lateral movements measured by the slope indicator are less than 2mm/month.

The Contractor shall also be required to confirm the strength increase of subsoils due to consolidation under fill loading, by undertaking electronic friction cone probes or piezocone probes before each subsequent stage of filling. The fill staging is indicated on the Drawings. The extent of probing shall be up to 20 probes to 18 metre depth per stage under each embankment.

3.19 Granular Backfill

Granular Backfill shall consist of furnishing, placing and compacting granular backfill adjacent to structures. The areas in which this material is to be placed is the "Influence Zone" of certain structures and this shall be shown on the Drawings.

The material shall be well graded crushed or uncrushed gravel, stone, rockfill or natural sand or a well mixed combination of any of these. Grading requirements for the material are as follows:

Maximum size	10 cm
Passing 4.75 mm. sieve	25% to 90%

Passing 0.075 mm sieve	0% to 10%
Plasticity Index	10 max

3.19.1 Placing Granular Backfill

The granular backfill shall be placed in layers not exceeding 15 cm and compacted to a density of 95% of the maximum dry density), determined according to AASHTO T180.

3.20 Sand Compaction Piles

This work shall consist of the installation of a system of sand compaction piles and horizontal sand drains in areas of soft ground as shown on the Drawings or directed by the Engineer. The work shall be carried out in close conformity with the requirements which will be established by the Engineer after the carrying out of the necessary subsoil investigations by the Contractor.

The work shall include installation of sand compaction piles at the spacing and to the depth required, and placing of a sand blanket over the area intended to be drained.

Sand to be used for the sand drains shall be coarse sand of high permeability and shall conform to the following requirements:

ASTM Standard Sieve (mm)	Percentage Passing by Weight
25.0	100
9.5	90- 100
4.75	70- 100
2.00	35-90
0.850	12-70
0.425	4-40
0.180	2-8
0.075	0-11

All materials shall be free from lumps of dirt, organic matter or any other deleterious matter.

3.20.1 Construction

Unless otherwise approved by the Engineer, the method of construction shall be as given below:

Piles shall be installed by driving a pipe with a closed valve at its lower end, using vibratory pile hammer equipment with a minimum vibrating force of 1000kN, 400 - 600 vpm and frequency of 10Hz.

When it has penetrated to the required depth, the inside of the pipe is filled with dry coarse sand and the valve at the bottom of the pipe opened. The upper end of the pipe is closed, and compressed air applied inside of the pipe to raise the pipe out of the ground, simultaneously expelling the sand out of the bottom of the pipe. After the pipe has been raised the pile of loose sand shall be compacted by driving the pipe with the vibratory hammer to the specified depth and compaction. On completion

of all vertical piles to the spacing instructed by the Engineer.

3.21 Prefabricated Vertical Drains

This work shall consist of the installation of a system of vertical fibre drains and horizontal sand drains so as to accelerate settlement and improve the subsoil in areas of soft ground as shown on the drawings or directed by the Engineer.

Prior to the commencement of the work, subsoil investigations as directed by the Engineer shall be carried out by the Contractor and the Contractor shall submit his proposal for the vertical drain system including a complete description of the fibre drain type, calculations and work method, which shall demonstrate the capability of the drain to meet the requirements stated hereinafter. The proposal shall be based on the subsoil data available during the tender stage and on the results of the soil investigation required under the Contract. The proposal shall be approved by the Engineer before commencement of the work. The work shall be carried out in close conformity with the requirements which will be established by the Engineer.

The Contractor shall demonstrate, through the installation of trial drains at different locations on the Site, that the equipment, method and materials produce a satisfactory installation in accordance with this Specification. The sand blanket shall be laid to initially provide a base for equipment and to later form the horizontal sand drain.

If required by the Engineer a geotextile sheet shall be placed as a separator.

At least 2 weeks prior to the installation of the drains the Contractor shall submit to the Engineer for review and approval details of the sequence and method of installation. The submittal shall as a minimum include the dimensions of the mandrel, a detailed description of proposals to overcome obstructions and the proposed method of splicing the drains.

3.21.1 General Requirement for Prefabricated Vertical Drains

If directed by the Engineer a temporary earth dike shall be formed around the work area to protect the drains, filling materials and other related works from water.

The prefabricated vertical drain shall consist of a continuous band-shaped plastic drainage core enclosed in a non-woven geotextile filter jacket.

The drains shall be free from defects, rips, holes or flaws. During shipment and storage the drains shall be wrapped in a heavy duty protective coating. The storage area shall protect the drain material from sunlight, mud, dirt, dust, debris and detrimental substances. Manufacturer's certification shall be provided for all drains delivered to the Site.

Drains shall be staked by the Contractor and constructed prior to the embankment

The core shall form a three dimensional open labyrinth structure. The filter jacket shall be a non-woven polyester fabric or similar with effective opening size not bigger than $80 \mu\text{m}$ and minimum filter velocity of $6.5 \times 10^{-2} \text{ m/sec}$.

The drain shall have a minimum water discharge capacity of 40×10^{-6} lt/sec after being compressed under 350 kN/m^2 for four weeks, and sufficient strength-elongation characteristic to withstand the installation operation and due forces.

3.21.2 Sand for Prefabricated Vertical Drains (Sand Blanket)

Sand to be used for the horizontal sand drain shall be coarse sand of high permeability and shall conform to the following requirements:

ASTM Standard Sieve (mm)	Percentage Passing by Weight
25.0	100
9.5	90-100
4.75	70-100
2.00	35-90
0.850	12-70
0.425	4-40
0.180	2-8
0.075	0-11

All materials shall be free from lumps of dirt, organic matter or any other deleterious matter.

Samples and sieve test results of sand shall be submitted by the Contractor to the Engineer for approval.

3.21.3 Geotextile Separator Sheet for Prefabricated Vertical Drains

The geotextile separator sheet shall be UV-stabilized and made of polypropylene yarns woven in the same strength for both warp and weft directions. The coefficient of permeability shall be $30 \text{ lt/m}^2/\text{sec}$ or more. The ultimate tensile strength shall be 40 kN/m at the breaking elongation of minimum 20%.

3.21.4 Construction of Prefabricated Vertical Drains

Drains shall be installed with approved equipment to the specified depth in the spacing and arrangement as shown on the plans or as otherwise directed by the Engineer.

Prior to installation of the drains a sand drainage blanket of uncompacted material and a minimum thickness of 600mm shall be placed on the ground surface as a working platform.

Installation of the drains shall consider and be coordinated with the instrumentation shown in the drawings. Special care shall be taken when installing drains near to instrumentation already in place and any damage shall be made good.

The drains installation equipment shall be the type which shall cause a minimum disturbance to the subsoil during the installation operation. Constant load or constant rate of advancement method or the so-called 'static' method are preferred. Vibrator, falling weight impact hammers, and jetting shall not be allowed unless otherwise approved by the Engineer and restricted only for assistance in penetration in areas

where the design depths cannot be achieved by static method.

A mandrel or sleeve shall be advanced through the subsoil using vibratory, constant load, or constant rate of advance methods. The mandrel shall have a maximum cross-sectional area of 9000 square millimeters, shall protect the prefabricated drain material from tears, cuts, and abrasions during installation, and shall be provided with an "anchor" plate or rod. The "anchor" plate or rod shall provide sufficient strength to prevent the soil from entering the bottom during installation and shall anchor the bottom of the drain at the required depth when the mandrel is removed. Use of falling weight impact hammers or jetting will not be allowed within the compressible subsoil to be drained.

The prefabricated drains shall be installed vertically from the working surface to the required elevations and in a sequence that will not require equipment to travel over previously installed drains. The Contractor shall provide the Engineer with a suitable means of verifying the plumbness of the equipment and determining the depth of the drain at any time. The equipment shall not deviate more than 20 millimeters per meter from vertical.

Splices or connections in the prefabricated drain material shall be done in a professional manner to ensure continuity of the wick material. The prefabricated drain shall be cut to leave at least 150 millimeters protruding above the working platform at each drain location.

Where obstructions are encountered which cannot be penetrated the Contractor shall abandon the hole. A maximum of two attempts shall be made to install a new drain within 0.5 meter of the obstructed hole. Drains that otherwise deviate from the plan location by more than 150 millimeters, or that are damaged or improperly installed, will be rejected.

The drains shall be installed using a mandrel or steel sleeve that shall be advanced through the soil to the required depth. The mandrel shall protect the drain material from tears, cuts and abrasions during installation and shall be withdrawn after installation of the drain. The mandrel shall be rectangular or rhombic in shape and of maximum cross sectional area not to exceed 110 cm².

Prior to the installation the Contractor shall submit details of the sequence and method of installation to the Engineer for review, and approval.

The equipment shall be carefully checked for plumbness prior to advancing of each drain. Drains that are out of their proper location by more than 150 mm, drains that are damaged in construction, and drains that are improperly completed shall not be accepted, and no compensation shall be allowed for any materials furnished or for any works performed on such drains.

During installation of the drains, the Contractor shall provide suitable means for determining the depth of the drain at any given time. Joins or connections in the drain material shall be made in an approved workmanlike manner so as to insure continuity of the material. Minimum length of overlap in the join shall be 300 mm. The drain material shall be cut neatly at its upper end and there shall be a 200 mm top cutting tip length of drain material protruding above the working ground at each

installation.

The Contractor shall keep an accurate record of each drain driven, including location, date, starting and finishing time, installation number, grid coordinate and length of the drain being driven. Information regarding penetration of any harder layer which requires other type of equipment rather than the static type, together with the installation number, etc., shall also be recorded.

The record shall also include all joins required for drain make-up and length of each drain segment.

3.22 Geotextile Sheet Materials

The geotextile separator sheets shall be UV-stabilized and made of polypropylene yarns woven in the same strength for both warp and weft directions for each type of geotextile the coefficient of permeability shall be greater than 0.5×10^{-6} m/sec. The ultimate tensile strength shall be greater than 200kg/3 sq.cm in each direction and weight a minimum of 0.20 kg/sq.m.

3.22.1 Installation of Geotextile Sheet

Geotextiles shall be installed at the specified location in the arrangement as shown on the plans or as otherwise directed by Engineer.

The ground surface where the geotextiles shall be laid shall be cleared from all sharp objects such as tree stumps, stones, etc. that could cause puncture or tear to the fabrics.

The ground surface shall be flat and level. Unevenness of the ground surface shall not be more than 10 cm and, inclination across the road shall not be more than 5%.

Jointing of geotextile shall be by a double seam, each at the distance of 50 mm and 100 mm from the edges of joined sheets.

The fill placement after the installation of geotextile shall be in such a way so that the fabrics shall not be partially over-stretched. The fill shall be well distributed in a layer not thicker than 50 cm, and the distribution of fill shall be carried out in one direction without any alteration, started from one point.

Maximum fill size for the first layer should be less than half the initial layer thickness.

The Contractor shall keep an accurate record of each sheet of geotextile installed, including location, date, starting and finishing time, and size of the geotextile being installed. The record shall also include all the joins of the geotextile sheets, whether across or along the road axis.

3.23 Surcharge

Surcharge material shall be General Fill as specified constructed to the dimensions shown on the drawings or as directed by the Engineer.

The contractor shall check the level of the surface of the completed surcharge daily and maintain detailed records of settlement, shrinkage and expansion. Check points shall be located on the center of the roadline and on both the top and the toe of the embankment slope at 20m transverse intervals.

Surcharge shall not be removed until the Contractor has demonstrated, to the satisfaction of the Engineer, that the remaining long-term settlement will be limited to 100mm.

3.24 Underdrains

Underdrains shall consist of the installation of a system of underdrains, using pipe and granular filter material, underdrain pipe outlets and blind drains using Granular Material in accordance with this Specification and in conformity with the lines and grades shown on the drawings or as directed by the Engineer.

Other materials shall meet the requirements specified in the following documents.

- Zinc Coated (galvanised) corrugated iron or steel culverts and underdrains AASHTO M36
- Extra strength and standard strength clay pipe and perforated clay pipe AASHTO M65
- Perforated concrete pipe, AASHTO M175
- Porous concrete pipe, AASHTO M176
- Bituminised-fibre non-pressure sewer drain and under-drainage pipe systems, AASHTO M177
- Asbestos cement perforated under drain pipe, AASHTO M189
- Unplasticised Poly-vinyl-chloride (UPVC) drainage pipework AASHTO M267

3.24.1 Construction of Underdrains

Pipe installation trenches shall be excavated to the dimensions shown on the drawings or as directed by the Engineer. A minimum of 15 cm bedding layer of granular backfill material shall be placed and compacted at the bottom of the trench for its full width and length.

Sub-drainage pipe of the type and size specified shall be embedded firmly in the bedding material.

Perforated pipe shall normally be placed with the perforations down and the pipe sections shall be joined securely with the appropriate coupling, fitting or bands.

After the pipe installation has been approved granular backfill material shall be placed to a height of 20 cm above the top of the pipe.

Trenches for underdrain outlets shall be excavated to the width and depth shown on the drawings or as otherwise directed by the Engineer. Pipes shall be laid in the trench with all ends firmly jointed by the applicable methods.

After approval the trench shall be backfilled.

Trenches for blind -drains shall be excavated to the width and depth shown on the

drawings or as otherwise directed by the Engineer. The trench shall be filled with granular backfill material to the depth required by the drawings. Any remaining upper portion of trench shall be filled with either granular or impervious material as directed.

3.25 Blinding Stone

Blinding stone for use as a foundation for structures shall be provided as shown on the Drawings or instructed by the Engineer.

The main component of the blinding stone shall be approved cobble-stone or crushed rock, of the maximum size compatible with the thickness of blinding stone as shown on the Drawings. The minimum height of any stone as placed shall be 7 cm. Stone shall be closely packed by hand placing, to the dimensions shown on the Drawings, and then thoroughly rammed by mechanical rammer. Smaller stone pieces of minimum size 3 mm shall then be placed between the larger stones and the upper surface brought up to the finished level shown on the Drawings or instructed by the Engineer. The complete surface shall then be thoroughly compacted to the satisfaction of the Engineer using a mechanical rammer or vibrating roller.

The Contractor may propose an alternative to the above process, based on the use of graded, crushed stone of maximum size less than 5 cm. The Engineer's acceptance of this alternative, and the maximum thickness to be laid in one layer shall be dependant on the proposed compacting plant and its suitability for the restricted working area available.

3.26 Measurement and Payment

3.26.1 Embankments

- (1) Finally accepted embankment shall be measured in cubic metres from cross-sections taken as shown on the Drawings. The volume shall be determined by the formula:

$$\frac{1}{2}(A + B)L$$

where A and B are areas separated by a length L measured horizontally along the centreline of the road.

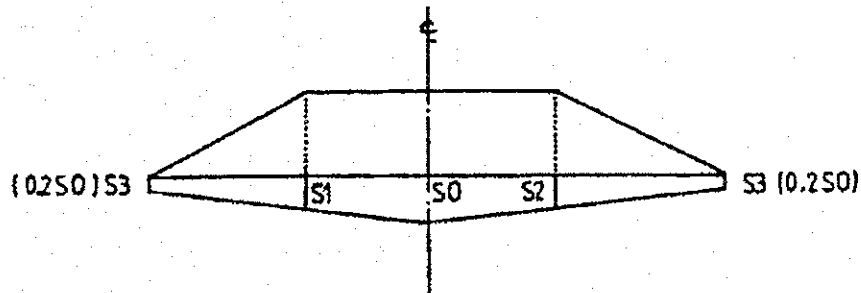
In cases where the Contractor is required to replace unsuitable material excavated in accordance with Clause 3.11 and 3.12 the volume shall be measured on site by an appropriate method. Deductions from the measured volume shall be made for culverts, bridges and for all volumes separately measured and paid for where they lie within the measured volume.

In addition the embankment volume on soft ground shall be measured by the above net volume plus settlement volume. The settlement volume shall be calculated in accordance with Specification Clause 3.26(4).

- (2) The rate shall be full compensation for performing all work required including

preparation of foundations, benching, spreading, carrying out drying trials, carrying out compaction trials, processing, drying, watering, compacting, trimming and furnishing labour, materials, tools, equipment.

- (3) An interim payment may be made on the measured volumes of required embankment actually constructed before final shaping at a rate of 80% of the scheduled rate provided that the Contractor's intention to complete is clear in the opinion of the Engineer.
- (4) Net embankment volume will be calculated from the final cross-sections. Original ground level shall be surveyed on the sand blanket surface just after spreading and compacting the sand blanket material. The settlement volume shall be calculated by the following figures and actual settlement at the end of the period of suspended duration in accordance with Specification Clause 3.18 or starting time of subbase work as approved by the Engineer.



The actual settlement shall be measured at S0, S1 and S2 in accordance with Specification Clause 4.30. Settlement at both embankment toes will be calculated at $0.2 \times S0$.

- (5) An interim payment shall be made on the measured volumes of required embankments but before final shaping at a rate of 80% of the scheduled rate provided the Contractor's intention to complete is clear.

3.26.2 Excavation

- (1) Finally accepted road excavation shall be measured in its original position from the ground line as it exists after clearing and grubbing operations have been completed and the volume determined in cubic metres from original and final cross-sections of required work by the formula:

$$\frac{1}{2}(A + B)L$$

Where A and B are end areas separated by a length L measured horizontally along the road centreline. The frequency of cross-sections shall be as shown on the Drawings or as provided in the Construction Tables or as specified by the Engineer. The area of the cross-section to be measured as roadway excavation shall be that area bounded by the ground line as it exists after clearing and grubbing operations, the required cut slopes and the underside of required subbase or such lower levels specified or instructed to be excavated. Excavation of unsuitable material, and isolated volumes of other required

excavation which it is impractical to measure by the cross-section method shall be measured by taking appropriate measurements on Site.

- (2) The quantities of excavation measured in (1) shall be paid for at the scheduled rates per cubic metre for the various types of materials excavated. These rates shall include full compensation for loosening, breaking up, removal, loading, haulage and satisfactory disposal of excavated materials and for draining, drying out as necessary and keeping earthworks free from water and for shaping, and for finishing subgrade surfaces and for furnishing all labour, materials, tools, equipment and incidentals necessary to complete the work in this Specification and as directed by the Engineer.
- (3) An interim payment may be made on the measured volumes of required excavation actually excavated but before final shaping at a rate of 70% of the scheduled rate provided the Contractor's intention to complete is clear.

The rates and prices for earthworks shall be made in accordance with Clause 8 (Earthworks) of the Preamble.

3.26.3 Excavation for structural foundation

The quantities of excavation given in the Bill of Quantities are calculated from projected area of the footing plus one metre each side for working space and excavation slopes are calculated a slope of 45 degrees from the bottom of the foundation levels as shown Fig. 1.

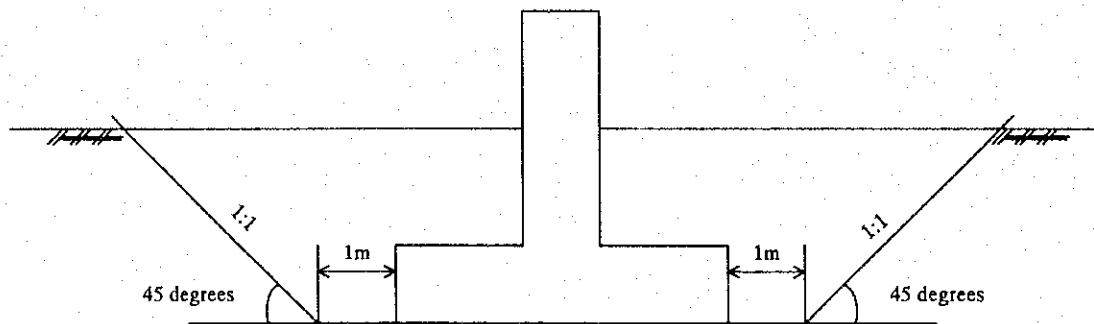


Fig. 1

The Contractor will be deemed to have included in his rate for shoring or battering of excavation. Provided that no payment will be made for over-excavation.

In the event of alterations of the foundation levels, quantities shall be calculated by the same method, but the vertical dimensions shall be measured from the cleared surface level. In addition, if the plan dimension of footings are changed by the Engineer, quantities shall be calculated by multiplying the variation of the plan area the average vertical depth from the natural surface to the approval foundation level.

- a) The rate for structure excavation in river shall include full compensation for loosening, breaking up, removal, cofferdam, sheet pile work, blinding work, rip lap work, draining, loading, haulage and satisfactory disposal of excavated

materials and for furnishing all labour, materials, tools, equipment and incidentals necessary to complete the work in this Specification and as directed by the Engineer.

- b) The rate for excavation in any material for structure over the water table shall include full compensation for loosening, breaking up, removal, loading, haulage and satisfactory disposal of excavated materials and for furnishing all labour, materials, tools, equipment and incidentals necessary to complete the work in this Specification and as directed by the Engineer.
- c) The rate for excavation in any material for structure below the water table shall include full compensation for loosening, blasting, breaking up, removal, drainage, pumping, loading, haulage and satisfactory disposal of excavated materials and for furnishing all labour, materials, tools, equipment and incidentals necessary to complete the work in this Specification and as directed by the Engineer.

4 SLOPE PROTECTION

Slope protection shall be furnished and constructed in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Drawings or required by the Engineer.

4.1 Clay Fill for Slope Protection

Clay suitable for use as fill for erosion protection of embankment slopes shall satisfy the following test requirements:

- Liquid limit of fines produced by compaction in embankment <50%
- Plasticity index of fines produced by compaction in embankment <20%
- pH of soil >5
and
- pH of soil <7

4.2 Placing and Compaction

Special care shall be taken to prevent any wedging action against the slopes bounding or within the areas to be filled shall be benched or serrated to prevent wedge action. The placing of slopes shall continue in such a manner that the all times there shall be a horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to be backfilled against except in so far as undisturbed materials intrudes upon the areas.

The compaction on the slope shall be carried out at the optimum moisture content. In forming the embankment the Contractor shall take steps to ensure that the work can be drained free of rain water, and he shall make due allowance in the height and width of the work of swelling or shrinkage.

When material used for fill is of variable quality, the Contractor shall schedule and execute his works so that the material designated as better quality by the Engineer, is used in the upper layers of the fill.

4.3 Sodding

This work shall consist of furnishing grass turf as required and planting it to give a healthy, stable covering of grass which shall maintain its growth in any weather and prevent erosion of the material in which it is planted.

The species of grass shall be axonopus compressus (rumpu paetan). It shall be rapid spreading, free of disease and noxious weeds and shall be deep rooted. The Contractor shall notify the Engineer not less than 3 days before cutting of sods begins. The source of turf shall be approved by the Engineer before cutting and delivery to the Project.

Sod shall be planted with its root system substantially undamaged and cut into blocks with moist earth in which they have grown. Turf shall be laid within 5 days of cutting. Turf blocks shall be hauled and stored in such manner that they shall be protected from direct sun rays, provided with air circulation, and prevented against drying.

Sod shall not take place until tree planting in the area has been completed.

Surfaces on which turf is to be placed shall be scarified and shaped after removing debris, gravel and weeds. All stones of more than 3 cm diameter shall be removed. The surface below the turf shall be made up as necessary with good quality topsoil so as to ensure that the turf and topsoil together form a finished thickness of not less than 20 cm consisting of 5 cm humus and 15 cm. existing soil as shown on the drawings. Every square metre of soil shall be implanted with lime or other approved materials totalling approximately 3 gm to a depth of 20 cm and a final layer of topsoil 10 cm thick placed on top. The purpose of the lime is to neutralize any existing sour condition of the soil. The Contractor shall be responsible for ensuring a healthy growth in sodded areas and the necessary fertilizer used before or after turfing shall be at the Contractor's own expense. Urea or NPK fertilizer shall be used.

Sod shall be placed so as to cover 50% of the surface by forming turf strips at intervals of 30 cm (this will be called "Strip Turfing"), or to cover entire surfaces (which shall be called "Solid Turfing"), as noted in the Drawings or directed by the Engineer. In strip turfing, joints shall be staggered to form a broken bond. Joints between adjacent turf blocks shall not exceed 0.5 cm. Turf blocks shall be placed in smooth finish and compacted by roller of 100 kg weight or by tamper plate. Sand shall be spread over the turf already laid and into the joints and the whole area shall be watered twice daily until the grass has taken firm root.

Sufficient bamboo stakes shall be used to prevent the turf blocks slipping when turf is provided on slopes.

For least six months after completion of turfing, the Contractor shall maintain watering and other incidental operations. Turfed areas shall be subject to special checks, 2 and 12 months after they have been laid. Any areas in which sods are not maintaining a healthy growth shall be refurnished and returfed by the Contractor at his own expense.

The Contractor shall be responsible for cutting and keeping clean any turfed area until completion of the Period of Warranty.

4.4 Stone Masonry Slope Protection

Stone placed below the water line shall be distributed and compacted so that the thickness of riprap is not less than that specified. Stone placed above the water line shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with ends in contact. Smaller stones shall be first laid on the slope and larger stones shall be used as surface cover. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be chinked with spalls firmly rammed into place.

Unless otherwise provided, riprap shall be at least 60 cm in thickness, measured perpendicular to the slope. The surface of riprap placed above the water line shall not vary from the theoretical surface by more than 8 cm at any point.

4.5 Preparation of Surfaces

Slope surface on which slope protection is to be placed shall be compacted and properly smoothed after removing all vegetation.

Placing slope protection shall not begin until the finishing stakes are set according to the Drawings and have been inspected and approved by the Engineer.

4.6 Materials

Stone for riprap shall consist of field stone or unhewn quarry stone as nearly rectangular in section as is practical. The stone shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended. Adobe blocks shall not be used for riprap work.

Stone pieces for protecting slopes shall range in weight from a minimum of 2 kg to a maximum of 20 kg with not less than 60 percent of the stones weighing more than 12 kg.

The wire mesh for gabion baskets shall be galvanised steel having a minimum size of 3.05 mm diameter and a tensile strength in the range of 4220 - 5980 kg/cm. The minimum zinc coating of the wire shall be 0.24 kg/m² of wire surface as determined by AASHTO T65.

4.7 Cement Mortar Generally

This work shall consist of preparing and furnishing cement mortar in accordance with this Specification, for masonry and for any other incidental work.

Unless otherwise instructed by the Engineer, masonry mortar shall be composed of one part Portland cement and three parts fine aggregate by volume to which hydrated lime may be added in an amount equal to 10 percent of the cement by weight.

4.8 Materials for Mortar

Type I Portland cement conforming to TCVN 2682 - 1992 Portland Cement, AASHTO M85 or JIS R5210 shall be used unless the Engineer gives approval for the use of another type.

Fine aggregate shall conform to the requirements of AASHTO M45. Hydrated lime shall meet the requirements of residue popping and pitting, and water retention shown for type N lime in ASTM C207. Water shall be of suitable quality for concrete works as defined by this Specifications.

4.9 Mixing of Mortar

All the materials except water shall be mixed in an approved mortar mixer until the mixture assumes a uniform colour, after which water shall be added and the mixing continued. Mortar shall be mixed only in those quantities required for immediate use. Mortar that is not used within 45 minutes after water has been added shall be discarded in an approved manner.

4.10 Mortared Rubble

This work shall consist of open ditches lined with mortared rubble furnished and constructed in accordance with this Specification and in conformity, with lines, grades, and dimensions shown on the Drawings, or required by the Engineer.

4.11 Materials for Mortared Rubble

Stone shall consist of field stone or rough unhewn quarry stone, as nearly rectangular in section as is practical. The stone shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended.

Quality and dimensions of stone shall be approved by the Engineer prior to use. Unless otherwise provided by the Drawings or Specifications all stone shall be more than 0.008 cu.m in volume.

Mortar shall conform to the requirements of Clause S4.8 of the Specification.

4.12 Construction of Mortared Rubble

Earthworks shall be completed and the foundation tamped prior to placing the class E foundation concrete. Stone shall be securely placed by hand, and voids shall be avoided. The face surfaces of all stones shall form a smooth regular surface conforming to the shape of the ditch. No stone surface shall extend more than one and a half centimeters above or below the general level of the ditch.

All voids between stones shall be filled and flushed with mortar but the face surface of the stone shall be left exposed. Mortar shall be placed from bottom to top and the surface swept with a stiff broom. The surface shall be cured as specified in this Specification for a period of at least three days.

Copings shall be as shown on the Drawings. Where copings are not called for the upper surface of the mortared rubble shall be mortared and finished smooth by wooden float.

4.13 Placing of Stone Masonry

Placing of stone masonry shall not begin until the finishing stakes set according to the design have been inspected and approved by the Engineer. Stones shall be washed with water before placing. A mortar bed shall be spread on the sides of adjacent stones before the next stone is laid. The thickness of the mortar shall be the minimum necessary to ensure that there is no direct contact between stones. Stones shall be thoroughly hammered into place and any stone whose face is deviating more than 20 mm from the true face or more than 30 mm from the face of the adjacent stone, shall immediately be made good by lifting and relaying. Face joints between stones shall be flush-pointed as work proceeds.

4.14 Weep Holes

Walls of stone masonry shall be provided with weep holes. Unless otherwise shown on the Drawings or directed by the Engineer, the weep holes shall be spaced not more than 2 meters centre to centre and shall be 50 mm in diameter.

4.15 Coping

Coping shall be as shown on the Drawings. Where copings are not called for, the upper surfaces of masonry shall be mortared and finished smooth by wooden float.

4.16 Joints

Expansion joints shall be formed at a maximum spacing of 20 meters. Joints shall be 30 mm in width and shall extend through the complete wall including the footing and backing concrete. Stones used for joint forming shall be selected so as to form a clean vertical joint of the dimensions specified above.

4.17 Curing

In hot or dry weather the masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

4.18 Measurement and Payment

This work measured as provided above shall be paid for at the scheduled rate for the appropriate items listed above.

The rate for trim side slopes by bulldozer shall include full compensation for trimming, compacting and finishing by bulldozer and all labour, equipment, tools other incidentals necessary to complete the work specified in Clause 4.2 of the Specification.

The rates for clay material fill and masonry slope protection shall be made in accordance with the Clause 23.1 and 23.2 of the Preamble.

The rate for sodding shall include full compensation for supply of sod, loading, transportation to site and sodding and all labour, equipment, tools other incidentals necessary to complete the work specified in Clause 4.3 of the Specification.

The rate for revetment shall be made in accordance with the Clause 23.2 of Preamble.

The rate for footing for masonry stone slope protection shall include full compensation for supply of wood pile, PVC pipe, concrete, backfilling material and gravel, loading, transportation to site, excavation and all labour, equipment, tools other incidentals necessary to complete the work.

5 DRAINAGE

5.1 Drainage Scope

This work shall consist of the construction of drainage pipes, culverts, U-ditches, and other drainage facilities in accordance with this Specification and the specifications for other work items involved, all in conformity with the lines, grades and dimensions instructed by the Engineer.

The cost of working in, or dealing with all ground water encountered in executing the work of this section shall be deemed to be included in the unit price for the pay item being installed or constructed.

The Engineer reserves the right to inspect and test all pre-cast concrete items before their delivery to the site and at any time prior to and during laying.

5.2 Drainage General

The types and characteristics of the drainage pipes and other drainage structures shown on the Drawings and their estimated total quantities entered in the Tender Schedule are not to be taken as final. To assist the Engineer in his review of the contract drawings, the Contractor shall undertake a survey of the site to determine the location, pipe or channel size, invert level and estimated discharge of all storm water or foul sewer flows entering the Site. On the basis of the results of this survey the final types, lines, characteristics and quantities will be decided by the Engineer, who will inform the Contractor of them in writing in due time in relation to the approved schedule of work submitted by the Contractor. Responsibility for accurately locating all existing flows shall rest with the Contractor and the cost of this survey shall be deemed to be included in the various pay items of this Section.

5.3 Drainage Sequence of Work

The Contractor shall so schedule the construction of drainage works that the discharge of runoff from rain or other sources, both during and after construction, is properly provided for. To avoid damage to works in course of construction the Contractor shall provide in due time adequate means of protection, including all necessary temporary outlet, ditches, dams, or diversion channels. Culverts or other drainage works for the discharge of run off water either during or after construction shall not be built until adequate facilities for the inflow and outflow of the water have been completed and they shall be kept clear of all obstructions that might impede the flow of water. All culverts ditches and other drainage works shall be fully operative before work is begun on the construction of subgrade, sub-base or shoulders. These requirements shall be met without additional payment and all costs thereof shall be included in the various pay items of this Section.

5.4 Box Culverts

The work shall consist of reinforced concrete box culverts furnished and installed in accordance with the relevant Clauses of this Specification in conformity with the lines, levels, grades and dimensions shown on the Drawings or instructed by the Engineer.

5.5 Drainage Pipes

Drainage pipes shall consist of reinforced concrete pipes furnished and installed in accordance with this Specification and in conformity with the lines, levels and other details shown on the drawings or determined by the Engineer.

All concrete and reinforcement shall comply with the relevant requirements of this Specification and in accordance with JIS A 5302 Centrifugal Reinforcement Concrete Pipe or equivalent. Pipe details shall be as shown on the Drawings and the Contractor shall submit for the Engineer's approval, full details of his proposed arrangements for the manufacture, curing and handling of reinforced concrete pipes. Formwork used in the manufacture shall be steel and of rigid construction.

5.6 Excavation for Drainage Pipes

Prior to starting excavation the Contractor shall take all necessary measures to keep the excavation free from free-surface water or surface water run-off. In areas of fill, filling shall be completed to a depth of one pipe diameter above the top of the pipe, before excavation begins. All excavation shall be carried out so as to minimize damage to existing surfaces.

The sides of pits and trenches shall be adequately supported at all times. Except where otherwise described in the Contract, they shall not be battered. The supports shall be left in pits or trenches only where described in the Contract. Excavated material not required for backfilling shall be dealt with in accordance with this Specification.

Soft spots in the bottom of drainage excavation shall be removed and the resulting void immediately backfilled with Granular Backfill to Clause S4.08. When the Engineer instructs this additional treatment it shall be paid for under the relevant clauses of this Specification. Where the Engineer considers that soft spots are due to the contractor's failure to fulfill his obligations under any clause of this Specification then the Contractor shall, at his own expense, undertake the additional excavation and replacement with Granular Backfill to the satisfaction of the Engineer. Any suitable material below the level of the concrete pipe bed which is removed unnecessarily shall be replaced at the Contractor's expense with Granular Backfill in accordance with Clause 3.19 of this Specification.

5.7 Bedding, Laying and Surrounding of Pipes

All pipes and fittings shall be installed in accordance with the general requirements for installation of pipelines and with the provisions for rubber gasket jointing and jointing procedures of the concrete pipe manufacturer's installation manual.

Joints shall be made with the gaskets specified for joints with this piping. All surfaces to receive lubricants, cements or adhesives shall be clean and dry and gaskets shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe.

Gaskets shall be protected from sun, airborne dust and other deleterious agents at all times. Before installation of the pipe gaskets shall be inspected and all loose or improperly affixed gaskets shall be removed and replaced.

Each pipe section shall be aligned with the previously installed pipe section, and the joint pulled together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess as the pipe is pulled up to within 25mm of closure, the pipe shall be removed and the joint remade.

All pipes shall be laid using cradles if necessary, to the true line and level as directed by the Engineer. Joints shall be sealed with 1:2 cement mortar, except where otherwise specified, so that water shall not leak. The inside of the joint shall be wiped and finished smooth and the outside shall be protected for two days or as otherwise directed by the Engineer to prevent cracking.

After the Engineer has checked and approved the pipes and joints, the Contractor shall complete the concrete bedding and haunching or surrounding as instructed by the Engineer. Concrete shall be thoroughly compacted below and around the pipe to the dimensions shown on the Drawings, but special care should be taken to avoid dislodging the pipes or damaging the joints.

5.8 Backfilling and Reinstatement

Backfilling shall not commence until in the opinion of the Engineer, the concrete has achieved sufficient strength. Backfilling shall be carried out in accordance with the requirements of Clause 3.17, except that the maximum thickness of loose material shall not exceed 15 cm. Where insufficient suitable material is available from any particular pipe excavation, surplus material from any other excavation shall be used. On completion of backfilling, the area excavated shall be reinstated to its original condition but the Engineer may waive or modify this requirement if the area is, to be overlaid or reconstructed under other Clauses of this Contract.

Backfill shall be performed in accordance with the requirements of this Specification. Backfill shall be placed and compacted so as to obtain a bearing capacity equal to that of the adjacent subgrade. In compacting subbase or base course in contact with drainage structures, rammers or small compactors shall be used and care taken to prevent damage to the adjacent structures. Backfill shall be carefully constructed so as to prevent erosion by overflow of drain water or rain.

5.9 U-Ditch, Inlets Headwalls and Joint Boxes, etc,

This item shall consist of all work in connection with the construction of ditches, inlets, pipe headwalls and joint boxes along the shoulders, footpaths and where shown on the Drawings or where instructed by the Engineer.

All work shall be done in accordance with this Specification and in conformity with the lines, levels, grades and dimensions shown on the Drawings or as directed by the Engineer.

Materials shall be as shown on the Drawings and shall comply with the relevant clauses of this Specification. Information about units which require reinforcement are shown on the drawings.

5.10 Construction of U-Ditch, Inlets Headwalls and Joint Boxes, etc,

Excavation shall be performed in accordance with the general requirements of this Specification and the relevant requirements of Clause 3.10.

The foundation shall be prepared with blinding stone in accordance with Clause 3.14 except where otherwise required on the drawings.

All work on U-ditches, inlets, pipe headwalls and joint boxes shall be carefully set out and constructed with due recognition being taken of the fact that the upper surfaces must be incorporated exactly into kerbs, footpaths, etc. The Engineer may reject any item of work under this Clause when the upper surfaces do not meet the tolerances for kerb and footpath given elsewhere in this Specification.

Bottom surface of ditches shall be smoothly and neatly finished. Unless otherwise specified, joints of precast blocks shall be made using cement mortar of 1 part cement and 2 parts sand.

Cast-in-place concrete for waterways, drainage ditches, joint boxes, manholes, pipe headwalls, inlet and outlet of waterways, shall be constructed according to the requirements of Clause 8.2 of this Specification. These structures shall be as shown on the Drawings and as directed by the Engineer. The top portions of catch basins or inlets on which covers are to be placed shall be set exactly, and carefully and smoothly finished.

To ensure uniformity in the horizontal and vertical alignment of the kerb, the Engineer may instruct that work on the upper sections of inlets, catch basins and U-ditches be deferred and carried out immediately before or during work on the adjacent kerb.

5.11 Timber Pile of Box Culvert

5.11.1 Pile shall conform to the requirement directed by the Engineer and as showed on the drawings.

5.11.2 Material of piles shall be machine-peeled and all inner skin shall be removed. All branch stubs and partially overgrown knots shall be neatly trimmed flush with the surface, and the butts and tips shall be sawed square with the longitudinal axis of the pile

No cracks will be permitted in any pile. Splits, shakes, and checks will be permitted only to the extent provided herein. A crack is defined as a break or fracture across the grain of the wood extending from surface to surface through the pile, a shake as a separation of the wood along the annual rings, and a check as a

lengthwise separation of the wood across the rings of annual growth. A through check or compound check is a check extending from surface to surface, either through the pith center or shunted around by a shake.

Splits in piles shall be not longer than the butt diameter. The length of any shake or combination of shakes in the outer half of the radius of the butt of the pile, when measured along the curve of the annual ring, shall not exceed one-third of the circumference of the butt of the pile.

- 5.11.3 Construction of pile driving equipment shall be approved by the Engineer or in accordance with Viet Nam Construction Specification.

5.12 Measurement and Payment

Drainage shall be measured as the length of each separate barrel, nominal size, type, class and plate thickness, complete in place and accepted, as shown on the Drawings or as directed by the Engineer. The length of the drawings shown on the Drawings or directed by the Engineer. Payment shall be made at the rates entered in the Bill of Quantities per metre for each drainage depending on size, type, class.

The rates and prices for drainage shall be made in accordance with Clause 9 (Drainage) of the Preamble.