

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PEOPLE'S COMMITTEE OF HO CHI MINH CITY (PCHCMC)

MINISTRY OF PLANNING AND INVESTMENT (MPI)

THE SOCIALIST REPUBLIC OF VIET NAM

**THE DETAILED DESIGN STUDY
ON
HO CHI MINH CITY
WATER ENVIRONMENT IMPROVEMENT PROJECT
IN
THE SOCIALIST REPUBLIC OF VIET NAM**

FINAL REPORT

DRAFT BIDDING DOCUMENTS

**PACKAGE A :
TAU HU - BEN NGHE CANAL IMPROVEMENT**

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DIVISION A
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SECTION 1. GENERAL SPECIFICATION

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SECTION 1. GENERAL SPECIFICATION

1.1 DESCRIPTION OF THE PROJECT

1.1.1 Overview of the Project

Ho Chi Minh City has been rapidly urbanized and expanded over the last 20 years without development of city infrastructure, particularly urban drainage and sewerage systems. Water pollution in canals and rivers, caused by direct discharge of domestic and industrial sewage, has resulted in an unsanitary, unhealthy environment. Solid waste dumping, housing development along canals and sludge accumulation have led to obstruction of waterway transportation. Low ground level combined with inadequate drainage systems result in periodic flooding of certain areas.

The Ho Chi Minh City Water Environment Improvement Project, in addressing the above problems, aims to contribute to the improvement of urban drainage and sewerage system of Ho Chi Minh City.

The project area covers an area of 3,065 ha which includes the central part of the City as well as the outlying areas of Thanh Da and Ben Me Coc. Certain elements of the overall project have been deferred to a future phase which, in the case of sewerage development, will integrate with works to be completed under the present project.

The main elements of the project are:

- Tau Hu – Ben Nghe canal improvement of 7.3 km
- Pump drainage improvement at Thanh Da (15.4 ha) , Ben Me Coc (1) (70.9 ha) and Ben Me Coc (2) (46.0 ha)
- Existing combined sewer improvement of 9.5 km
- Interceptor sewer of 12.2 km
- Conveyance sewer of 3.5 km
- Intermediate wastewater pumping station with a total pumping capacity of 133 m³/min
- Wastewater treatment plant with a capacity of 141,000 m³/day

1.1.2 Contract Packages

The project has been divided into packages for the purposes of implementation as follows :

Package A:	Tau Hu – Ben Nghe Canal Improvement
Package B:	Pump Drainage Improvement
Package C:	Interceptor Sewer Construction, Intermediate Wastewater Pumping Station Construction and Procurement of Sewer Cleaning Equipment
Package D:	Conveyance Sewer Construction and Existing Combined Sewer Improvement
Package E:	Construction of Wastewater Treatment Plant

1.1.3 Interfaces with Other Packages

The Works for Package A are independent of the works of other packages in the project and do not have common interfaces. However, it should be noted that pipe jacking works under Package C pass beneath the bed of the Tau Hu Canal.

1.1.4 Scope of Work for Package A

The purpose of the Works is to improve storm water drainage, waterway transportation and water environment in the Tau Hu and Ben Nghe canals.

This is to be achieved by canal training through improvement of alignment, profile and cross-sections by means of dredging, filling, excavation, construction of dike embankment and stone masonry bank protection in the canals and roadworks and landscaping along their banks.

The main elements of the work include, but are not limited to, the following:

- Excavation and dredging of Ben Nghe and Tau Hu canal for a length of 7.3 km.
- Filling of portions of Ben Nghe canal and Tau Hu (downstream) canals
- Construction of 13.8 km of stone masonry revetments along the canal banks
- Construction of 13.8 km operation and maintenance roads adjacent to improved canal banks
- Landscaping along Ben Nghe canal and Tau Hu canal (downstream)
- Sewers and Drainage Works

Complete descriptions of the requirement are included in Drawings, the Specification, the Bill of Quantities and other documents comprising the Contract.

1.1.5 Concurrent Contracts

The Employer has planned the construction of the East-West Highway project, the site of which is immediately adjacent to the site of Package A on the North side of the Tau Hu and Ben Nghe canals with bridges crossing the canals.

In the event of the East-West Highway Project being implemented concurrently with the works for Package A the Contractor shall co-operate with the contractor for those works in all respects with regard to smooth implementation of the works of both contracts. To assist in co-ordinating his operations with the work being done by others, the Contractor shall establish direct site liaison and communications as necessary with the Engineer and other contractors employed by the Employer for all purposes associated with his proposed operations. In the event that the requirements of the Contractor, the Employer and other contractors conflict at any stage of the work, the Engineer shall decide the order in which work shall proceed.

The Engineer shall be given reasonable notice of all meetings between the Contractor and other contractors employed by the Employer and the Engineer shall be entitled to be present at such meetings. The Contractor is to submit to the Engineer copies of all written communications issued to other contractors at the time of issue or received from other contractors at the time of receipt if it bears direct relation to the Contract and the Works.

Subject to the rights of the Contractor under the Contract, the decision of the Engineer shall be final in the event of any disagreement between the Contractor and other contractors employed by the Employer referred to in this Clause, which cannot be resolved mutually.

1.2 GENERAL INFORMATION

1.2.1 Site Conditions

The Tau Hu and Ben Nghe canals are tidal waterways which carry a considerable amount of waterborne traffic.

Water in the Tau Hu – Ben Nghe canals is highly polluted by domestic sewage and has BOD in the range 100 – 250 mg/l, is black in colour and emanates an offensive odour.

The population density in the vicinity of the canals is high.

Soil at the site is alluvial and details are shown in the Drawings.

1.2.2 Climate

Ho Chi Minh City is located in the tropical monsoon zone and its climatic characteristics are almost uniform temperature, high humidity, and heavy precipitation. Meteorological observation has been carried out at Tan Son Nhat station since 1915.

Meteorological characteristics as recorded at the Tan Son Nhat station from 1976 to 1977 station are as follows:

- The annual average temperature and relative humidity are 27.4 °C and 77.2 % respectively;
- Annual sunshine hours are 2,508 hours,

Annual average rainfall is 1,929 mm, of which about 93 % (1,788 mm) occurs during the rainy season starting from May to November with maximum monthly rainfall of 308 mm occurring in the month of August. Only about 7 % (141 mm) of annual rainfall occurs during the dry season from December to April.

1.2.3 Access to the Site

1.2.3.1 Location of Site

The Site of the Works is located in Ho Chi Minh City in the Socialist Republic of Vietnam and generally comprises a portion of the Tau Hu Canal, the Ben Nghe Canal, the canal banks and adjacent areas.

1.2.3.2 Existing Roads and Waterways

Public roads exist along both banks of the canals.

The Tau Hu and Ben Nghe canals are connected to the Saigon River and a network of waterways for the purposes of navigation. The port of Saigon is located near the confluence of the Ben Nghe Canal and the Saigon River.

The Contractor shall fully inform himself of the conditions of roads, traffic conditions, traffic regulations, waterway conditions and regulations governing navigation with respect to gaining access to the Site for the purposes of performing the Works and shall take all necessary actions to ensure availability of access to the Site as required.

1.2.3.3 Load Limits

In the event that the Contractor uses existing roads and bridges during the course of the Works the following provisions shall apply.

- (a) The public roads and bridges have various load limits and the Contractor shall be responsible for determining the load limits existing at the time and ensuring that his Equipment does not exceed such limits. Before moving any heavy construction equipment into public roads and bridges, the Contractor shall make suitable arrangements with the appropriate Government authorities and obtain their approval for the passage of such traffic.
- (b) The Contractor shall use every possible means to prevent any of public roads or bridges connecting with or on the road to the Site from the being damaged by any traffic of the Contractor or his subcontractors.

1.2.3.4 Tracked Vehicles

The Contractor shall not travel tracked vehicles on any bituminous sealed road surface or bridge. Rubber tired vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed roads and bridges.

1.2.3.5 Safety

The Contractor shall take necessary care at all times to ensure the convenience and safety of residents along or nearby the roads and streets used to access the Site.

1.2.3.6 Construction of Additional Access Roads

All additional roads required by the Contractor as temporary road on the Site shall be provided by the Contractor at his expense.

1.2.3.7 Maintenance

All damage caused to the public roads or bridges used by the Contractor for access to the Site shall be promptly repaired by the Contractor at his expense.

1.2.4 Sources of Materials

The following sources of materials are listed for information only. The Contractor shall satisfy himself as to the suitability of such sources.

Material	Source	Approx. Distance from Site
Sand and Gravel	Long Thanh District, Dong Nai Province	60 km
Sand Fill	Dong Nai River	40 km
Concrete Aggregate	Bien Hoa City, Dong Nai Province	30 km
Cement	Thu Duc District, HCMC	15 km
Concrete Reinforcement	Long Thanh District, Dong Nai Province	60 km
Precast Concrete Piles	Thuan An District, Binh Duong Province	25 km
Precast Concrete Pipes	Thu Duc District, HCMC	15 km

1.2.5 Spoil Disposal Area

Excavated material unsuitable for reuse as fill or surplus to requirements shall be disposed of in the area designated as a spoil disposal area shown on the Drawings.

1.2.6 Water Supply, Power and Telephone Facilities

The above utilities are readily available in the vicinity of the site and the Contractor shall make his own arrangements for procurement of such utilities.

1.2 CONTRACT DOCUMENTS AND DRAWINGS

1.2.1 Contract Documents

The Contractor will be provided with a maximum of five (5) sets of Contract Documents for his own use. Bid Documents in the Contractor's possession shall be marked superseded or returned to the Employer after issue of the Contract Documents and will not be recognised in the administration of the Contract. Further instructions issued by the Engineer shall be kept at all times on the Site by the Contractor and shall be available to the Engineer and his staff.

1.2.2 Bid Drawings

The Drawings included in the Bidding Documents are to be used for bidding purposes only. The Drawings show the work to be carried out in accordance with the Contract as definitely and in as much detail as is possible at the time of bidding. The Contractor may use the Bid Drawings for placing preliminary orders for materials or for preparing Drawings of Temporary Works. However, the Bid Drawings shall not be used as a basis for fabrication of equipment or for construction of the Works.

1.2.3 Construction Drawings

Bid Drawings will be supplemented or superseded by such Construction Drawings as necessary for the purpose of the proper and adequate execution of the Works. Two (2) full size prints of such Construction Drawings will be issued by the Engineer to the Contractor in accordance with the construction programme required under the provisions of Clause 1.4. On receipt of the Construction Drawings, the Contractor shall check them carefully and advise the Engineer in writing of any discrepancies, errors or omissions and full instructions will be furnished to the Contractor should any discrepancies, errors or omissions be found. The Contractor shall be required to perform the Work in accordance with such Construction Drawings at the applicable rates bid in the Bill of Quantities for such work or work of a similar nature. Although the Drawings are prepared to scale, work shall be based upon dimensions shown on the Drawings and not on dimensions scaled from the Drawings.

The Engineer may, from time to time during the construction, issue further Drawings to supplement or amend the Construction Drawings, if deemed necessary. Such further Drawings shall become part of the Construction Drawings.

The Contractor shall be governed by figure dimensions as given on the Drawings. Where the required dimensions are not shown in figures, the Contractor shall obtain such dimensions from the Engineer before proceeding with the construction of the portion of the Works to which they refer. In every case, detailed Drawings shall take precedence over general Drawings.

When additional information regarding foundation or other conditions becomes available as a result of excavation work, further testing or otherwise, and if it is found desirable to make changes in the alignment, cross section, dimensions or design of the Works to conform to such conditions, the Employer reserves the right to make such changes as in the opinion of the Engineer are necessary or desirable, and the Contractor shall forthwith comply with any such direction of the Engineer.

Bid drawing may be used as construction Drawings, as defined above, when authorised, in writing, by the Engineer.

1.2.4 Drawings to be furnished by the Contractor

1.2.4.1 General

All of the various types of Drawings as stated hereinafter shall be prepared in a form approved by the Engineer and submitted in advance to give the Engineer sufficient time to review and approve them without causing any delay to the field works. The Contractor shall provide qualified staff and a sufficient number of draftsmen/CAD operators and assistants capable of producing all Drawings required.

All Drawings and supporting computations to be submitted by the Contractor for the Engineer's approval shall be in English. All dimensions shall be given in the metric system. The Drawings shall be in JIS A1 size (594 mm by 841 mm) unless otherwise specified or approved by the Engineer.

The Contractor shall be held responsible for all Drawings and documents not submitted within the time limits stipulated in Clause 1.3.5. and for all costs involved for delays and damages consequent thereto. Contractor's Drawings approved by the Engineer are to be used for construction.

1.2.4.2 Working Drawings

The Contractor shall prepare the working Drawings for all items of the Permanent Works on the basis of the Construction Drawings issued by the Engineer. The working Drawings shall show sufficient details of the structure of the works or the construction methods or procedures such as, but not limited to, and as applicable, excavation and embankment fillings, concrete reinforcement bar arrangement including bending/cutting schedule and bar list, expansion joints, contraction joints, construction joints, concrete placement details, waterstop layout, equipment installation, etc., by which the Contractor will proceed with the field construction and operation. Further, Drawings presenting full details of items not to be incorporated into the Permanent Works but which affect the quality of work such as concrete forms, supports, etc., shall also be included in the working Drawings. All the working Drawings related to any section on the Works shall be approved by the Engineer prior to the time the Contractor plans to perform such section of work.

1.2.4.3 Shop Drawings

Shop Drawings, **if required**, shall be prepared by the Contractor, or the Contractor's materials/equipment supplier on behalf of the Contractor, to show the outline, dimensions, type of material, etc., of particular items indicated in the Drawings and/or Specifications and as directed by the Engineer. Such shop Drawings shall be submitted by the Contractor to the Engineer for approval.

1.2.4.4 Drawings of the Temporary Works

Thirty (30) days before starting any section of the temporary facilities specified in Clause **1.8** hereof, the Contractor shall submit to the Engineer for approval Drawings showing details of such facilities.

The Drawings for temporary facilities shall show the locations and other pertinent details of the principal components of the Contractor's Equipment, offices, quarters, warehouses, storage areas, workshops, labour camps and other temporary buildings and facilities which the Contractor proposes to construct in the Works area.

If any change is made in the items mentioned above during erection or after the items become operational, the Contractor shall submit revised Drawings showing such changes to the Engineer for approval.

1.2.4.5 As-Built Drawings

Throughout the period of construction, the Contractor shall maintain an up-to-date set of as-built Drawings for the various items of work completed. Such Drawings shall show all authorised changes to the Construction Drawings and Shop Drawings to the extent that they correctly portray the true "as-built" condition of each item of the Permanent Works. The format of the as-built Drawings shall be as approve by the Engineer.

The up-to-date set of as-built Drawings shall be subject to periodical inspection at the Site by the Engineer and if the Drawings are found unsatisfactory or not up-to-date the Contractor shall bring them up-to-date within fourteen (14) days after inspection. If any part of the permanent Works delineated on the Drawings is complete, the pertinent as-built Drawings, after approval by the Engineer, shall be signed by both the Engineer and the Contractor, or their representatives, and three (3) copies shall be kept by the Engineer.

The as-built Drawings shall be made on high quality reproducible paper so that clearly readable copies can be made. The finished set of as-built Drawings shall be submitted by the Contractor to the Engineer for his approval and transmittal to the Employer in the manner specified in Clause **1.3.5**.

1.2.4.6 Other Drawings

Drawings other than those mentioned above, which are of a general nature, such as the proposed construction methods, temporary works for construction purposes, schematic diagrams and outlines of how various types of work are to be performed shall, as directed by the Engineer or as stipulated in the Contract Conditions and Specification, be submitted to the Engineer for approval.

1.2.4.7 Form and Presentation of Drawings

(a) General

All shop Drawings and Working Drawings produced by the Contractor or his subcontractors for this Contract shall use a common system of sizes, title blocks and numbers in accordance with this Clause, regardless of who produces the Drawings.

(b) Drawing Sizes and Standards

All Drawings shall be drawn in the accordance with Clause 1.3.4.7.

(c) Title Blocks

(i) The Contractor shall submit a sample of the title block he proposes to use for approval by the Engineer. The general format of the title blocks shall follow those of this Specification.

(ii) The Contractor or his subcontractor's title blocks shall show the Contractor's and subcontractor's name, the date, the title, and number of the drawing and each new issue of the drawing shall be identified by a revision letter as a part of the number. In addition each drawing shall show the following details in the lower right hand corner:

HO CHI MINH CITY
WATER ENVIRONMENT IMPROVEMENT PROJECT
PACKAGE A: TAU HU – BEN NGHE CANAL IMPROVEMENT
DRAWING NO.

(d) Numbering System

(i) Primary reference to drawing numbers on all Drawings, correspondence, operation, and maintenance instructions and elsewhere, shall be the number from the Engineer's numbering system, which system will be notified to the Contractor.

(ii) The Contractor may, if he desires, insert his own reference number in the appropriate place on the title block.

(iii) Drawing number shall be as allocated by the Engineer.

(e) Quality

The quality of working Drawings, shop Drawings, "as-built" Drawings and Drawings for temporary works shall be in accordance with Clause 1.3.5.

(f) Drawing Index

The Contractor shall compile a drawing index for all Drawings produced by himself and his subcontractors. The Contractor shall submit an up-to-date copy of each sheet of the index to the Engineer at three monthly intervals or on request.

(g) Drawings on Site

Copies of the latest revisions of all Drawings shall be sent to the Contractor's site office as soon as possible after they are approved. The Drawings shall be available at all reasonable time for inspection by the Engineer.

1.2.5 Submittal and Approval of Contractor's Drawings

1.2.5.1 General

- (a) It is to the Contractor's advantage to prepare his Drawings and submit them to the Engineer at the earliest possible time to avoid delay in the fieldwork due to lack of approved Drawings on hand for the construction crew.
- (b) Any work done prior to the Engineer's approval of the Drawings shall be at the Contractor's risk. Approval by the Engineer of the Contractor's Drawings shall not relieve the Contractor from any of his obligations in the complying with the provisions of the Contract.

1.2.5.2 Procedure for Submittal and Approval

- (a) Unless otherwise specified the Contractor shall submit his working drawing, shop Drawings and other required Drawings to the Engineer for approval at least twenty eight (28) days prior to the commencement of construction of any particular item of work. Shop Drawings for any particular item which has to be fabricated outside of the Site shall be submitted early enough to allow adequate time for review, approval, fabrication, transportation and receipt at the Site.
- (b) Four (4) clearly readable print copies of each drawing shall be submitted to the Engineer by means of a standard transmittal sheet. The format of the transmittal sheet shall be as approved by the Engineer.
- (c) The Engineer shall have the right to direct the Contractor to provide additional details and change in the Drawings if they are necessary to ensure compliance with the provisions and intent of the Specifications. Within thirty (30) days after the receipt of the Drawings submitted by the Contractor, the Engineer shall return one (1) copy thereof to the Contractor marked "Approved for Construction", "Approved for Construction-Except as Noted", or "Not Approved Resubmit".
- (d) The return and receipt of any approved drawing shall be deemed to authorise the Contractor to proceed with the work covered by such drawing, but before proceeding with the work the Contractor shall first submit to the Engineer by logged transmittal sheet two (2) prints of each drawing. When requested by the Engineer, one (1) transparency of working Drawings and shop Drawings shall also be submitted together with two (2) prints. Copies of all approved Drawings shall be maintained at the Contractor's site office in proper order.
- (e) When correction or revision is directed on the Contractor's submitted Drawings, the Contractor shall make the necessary corrections and/or revisions in a timely manner and shall resubmit them in two (2) copies to the Engineer in the same manner as for new drawing. This procedure shall continue until the Drawings have been finally approved.

1.2.5.3 Other Information

All applicable requirements of this Clause shall apply equally to other submittals described in Clause [1.4](#).

1.2.5.4 As-Built Drawings

Within one (1) month following the issue of the Certificate of Completion of the Works, the Contractor shall furnish to the Engineer, for his approval; and transmittal to the Employer, the final version of as-built Drawings. These as-built Drawings shall consist of:

- (a) Two (2) sets of transparent polyethylene sheets ;
- (b) Three (3) sets of full-sized (A1 size) bound copy ; and
- (c) Ten (10) sets of reduced size (A3 size) bound copy.
- (d) Two (2) sets of CD ROM of all Drawings prepared by CAD

1.2.6 Language and Units

The English language shall be used for all Drawings, specifications and other submissions by the Contractor except that Operation and Maintenance Manuals shall be prepared in both English and Vietnamese.

SI Units shall be used on in all Drawings, specifications and other submissions by the Contractor. Where printed information uses other units the equivalent SI units shall be shown.

1.2.7 Payment

1.2.7.1 Working Drawings and Shop Drawings

Payment for shall be made at the Lump Sum price entered in the Bill of Quantities.

For the purposes of monthly progress payments the amount completed, expressed as a percentage of the total number of Working and Shop Drawings required to be completed by the Contractor, shall be determined. Payment shall be calculated by multiplying the percentage completed by the lump sum entered in Bill of Quantities. Payment for Drawings shall never exceed the lump sum entered in the Bill of Quantities.

1.2.7.2 As-Built Drawings

Payment for shall be made at the Lump Sum price entered in the Bill of Quantities.

For the purposes of monthly progress payments the amount completed, expressed as a percentage of the total number of As-Built Drawings required to be completed by the Contractor, shall be determined. Payment shall be calculated by multiplying the percentage completed by the lump sum entered in Bill of Quantities. Payment for Drawings shall never exceed the lump sum entered in the Bill of Quantities.

1.2.7.3 Other Drawings

No separate payment shall be made for other categories of Drawings describe in this Clause 1.3 and the cost of preparing such Drawings shall be deemed to be included in the rates and lump sum prices of other items in the Bill of Quantities.

1.3 CONSTRUCTION PROGRAMME, CONSTRUCTION PLAN, PROGRESS REPORTS AND OTHER SUBMITTALS

1.3.1 General

The Contractor shall prepare and submit a construction programme, a construction plan, progress reports and other required documents in the manner specified herein.

1.3.2 Construction Programme

1.3.2.1 General

The Contractor shall prepare a construction programme in accordance with Conditions of Contract, Part II, Sub-Clause 14.1.

1.3.2.2 Revision of Programme

If in the course of execution the rate of progress of the Works or any section thereof falls behind the Contractual Construction Programme the Contractor shall prepare a revised programme in accordance with Conditions of Contract, Part II, Sub-Clause 14.2.

1.3.3 Construction Plan

1.3.3.1 General

Within twenty eight days of receiving the notice to proceed in accordance with Sub-Clause 41.1 of the Conditions of Contract, the Contractor shall submit a revised general construction plan including a detailed list of equipment to be mobilised, particulars of Temporary Works and method statements for major items of work to the Engineer for approval. The plan shall be prepared on the basis of the Construction Schedule and Method Statement submitted by the Contractor with his Bid. Any instructions given by the Employer and/or the Engineer on and after award of the Contract shall be incorporated.

1.3.4 Weekly Schedule

The Contractor shall, at the end of each week, submit to the Engineer for his review and comments two (2) copies of a weekly schedule for the succeeding week in a form approved by the Engineer. The schedule shall contain appropriate comments with regard to the work to be performed on each major item as well as other construction work related to the execution of the Works including procurement of materials, transportation of materials and equipment, preparation of Drawings and other items required by the Engineer.

1.3.5 Monthly Progress Report

1.3.5.1 Written Report

The Contractor shall submit, before the tenth (10th) day of each month or at any time designated by the Engineer, five (5) copies of a monthly progress report in a form acceptable to the Engineer detailing the progress of the Works during the preceding month. The report shall contain, but not be limited to, the following items:

- (a) A brief but detailed description of all works executed during the reporting month together with a cumulative summary of progress to date for each main activity.
- (b) Total overall percentage of work completed up to the end of reporting month as well as the total overall schedule percentage completed and the forecast completion date computed by the critical path method (or other method previously approved by the Engineer) as of the end of the reporting month with appropriate comments on progress.
- (c) Actual percentage of each main work item completed, as well as their schedule percentage, with appropriate comments on their progress. The percentages shall be provided for each month and cumulatively.
- (d) Schedule of activities to be started within the succeeding two (2) months with the forecast starting and completion dates. If the dates are different from those shown on the approved Construction Programme an explanation shall be given.
- (e) List of manpower by trade, and supervisory personnel by position, employed during the reporting month.
- (f) List of Construction Equipment and materials on Site used in the execution of the Works including those that arrived at or were removed from the Site. The records shall include duration for which Equipment was not in working order.
- (g) General description of the weather conditions during the reporting month including records of each rainfall duration.
- (h) List of each accident involving, lost time, and/or death of any person, damage suffered by Works, properties and equipment.
- (i) Occurrence of any event or condition that might delay or prevent completion of the Works in accordance with the current, approved Construction Programme and the steps taken by the Contractor to correct the situation.
- (j) Schedule of the amount of payments received to date and the amount of any monthly invoice submitted but not yet paid.
- (k) Estimated amount of payment from the Employer to the Contractor for the succeeding month.
- (l) Colour photographs (not smaller than 8 cm x 12 cm) of the work progress of all major components of the Works from start to completion taken at locations directed by the Engineer. A brief description and date of each photograph shall be stated. The date shall be imprinted in each negative and photograph. A minimum of two photographs shall be taken of each major component under construction in the month including temporary works.
- (m) Any other matters which may be required under the Contract or statement concerning any matter arising from or relating to the execution of the Works during the reporting month.

1.3.5.2 Video Report

The Contractor shall make a video tape recording of the progress of the Works on a monthly basis and shall engage a professional recording company approved by the Engineer to carry out the work.

The monthly recording shall be of 10 minutes duration and shall be carried out throughout the duration of the Contract or as directed. Additional recordings may be necessary to record significant milestone events.

A copy of each monthly recording shall be submitted to the Engineer. The recording shall be accompanied with dialogue, in English, describing the events recorded.

At the completion of the Works the monthly recordings shall be compiled and edited into a single recording of one hours duration, or as directed, complete with approved dialogue and soundtrack and submitted to the Engineer.

1.3.6 Daily Report

The Contractor shall prepare daily and periodical reports in a form approved by the Engineer. The following items:

- (a) Weather conditions;
- (b) Staff and labour force employed on the work;
- (c) Materials and Equipment on Site;
- (d) Work in progress including locations and estimates of daily production;
- (e) Work in preparation;
- (f) Accident or any other reason causing a suspension of the work;
- (g) Occurrence of any event or condition that might delay the progress of work; and
- (h) All other information relevant to the progress of the Works.

1.3.7 Other Submittals

During the course of the Works the Contractor shall submit to the Engineer for approval construction programmes, design computations, financial schedules, construction plans, various plans of work, survey, tests and operation, reports on the results of survey, test and inspection, written description of equipment to be used, pamphlets, brochures and samples of materials and equipment, and other required documents and goods as prescribed in this Specification and as directed by the Engineer. Such submittal of documents and goods shall be made in advance to avoid causing any delay to the field works. The procedure for submittal and approval shall be in the same manner as specified in Clause 1.3.5.

1.3.8 Payment

Except as otherwise specified, separate payment will not be made for complying with the requirements of Clause 1.4 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.4 PROGRESS MEETINGS

1.4.1 General

A regular meeting between key personnel of the Engineer and the Contractor's authorised representative shall be held once a week at a time agreed upon by both parties to discuss the progress being made, the work proposed for the forthcoming week and any problem having a direct bearing on the immediate or near term work activities.

1.4.2 Payment

Except as otherwise specified, separate payment will not be made for complying with the requirements of Clause 1.5 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.5 STANDARDS AND TESTS

1.5.1 Standards and Specifications

All materials and equipment to be furnished and installed for the Works and all construction works to be executed under the Contract shall conform to the respective standards and specifications stated in the Specification. Where applicable standards and specifications for any material, equipment and construction are not stated in the Specification, they shall conform to the latest edition of the relevant standards of the following organizations:

JIS	:	Japanese Industrial Standard
ISO	:	International Standards Organization
AASHTO	:	American Association of State Highways and Transportation Officials
ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
TCVN	:	Vietnamese Standards
JEC	:	Japanese Electro-Technical Committee Standard
JEM	:	Japanese Electric Machine Industry Association Standard
JCS	:	Japanese Cable-Makers Association Standard
IEC	:	International Electrical Committee

If the Contractor proposes equivalent standards or specifications for materials and equipment, he shall state the exact nature of the proposed change and shall submit complete standards and specifications in English, including information and data on such materials and equipment, for approval of the Engineer. Such submittal shall be made in sufficient time for approval by the Engineer and failure to do so the purchase of any proposed equivalent materials and equipment prior to the approval of the Engineer shall be at the Contractor's risk.

The Contractor shall have available in his site office at all times at least one (1) copy of every standard referred to in this Specification or necessary for the execution of the Works.

[In the event of a Vietnamese standard being more stringent than the specified standard, the Vietnamese standard shall govern.](#)

1.5.2 Inspection, Examination and Testing of Materials and Equipment

Materials and equipment furnished by the Contractor, which will be incorporated in the Permanent Works, shall be subject to inspection, examination and test as provided in the Contract. To allow sufficient time to provide for inspection, examination and testing, the Contractor shall submit to the Engineer at the time of issue, copies in duplicate of all orders, including Drawings and other pertinent information covering the materials

and equipment to be furnished by the Contractor, or shall submit other evidence in the event of such orders being issued verbally or by letter. The inspection, examination and testing of materials and equipment or the waiving of inspection, examination and testing thereof shall in no way relieve the Contractor of the responsibility for furnishing materials and equipment meeting the requirements of this Specification.

All examinations and tests shall be carried out by the Contractor in the presence of the Engineer in accordance with the normal practice for such examination and tests. The Contractor may carry out the examinations and tests with his staff and equipment available at the Site. Examinations and tests carried out off the site shall be made at a laboratory approved by the Engineer.

The Engineer shall be at liberty to reject any material or item of Plant that does not comply with the requirements of the Contract notwithstanding any previous approval thereof. The Contractor shall not be entitled to any extra payment or extension of time for completion of the Works on account of the rejection of materials due to their non-compliance with the requirements of the Contract, or of the waiting time required for carrying out the examinations and tests.

The Contractor shall furnish test samples as requested and shall provide reasonable assistance and co-operation as necessary to permit tests to be performed on materials or work in place, including reasonable stoppage of work during testing.

1.5.3 Tests and Testing Laboratory

The Contractor shall provide a site laboratory equipped with sufficient apparatus and staffed by qualified personnel for the control of concrete placement and compaction of fill materials. Other testing, such as concrete cylinder testing, shall be carried out at a laboratory approved by the Engineer at the Contractor's expense.

The Contractor shall carry out all field tests such as compaction tests, concrete workability tests and so on in accordance with the manner and frequency prescribed in the Specification and shall provide the testing equipment and apparatus, testing staff, labour and consumables necessary for carrying out his field testing. The Contractor shall prepare schedules of his field and laboratory testings taking into account the work progress schedule and shall submit them to the Engineer for approval.

The Engineer will supervise the Contractor's testing for the purpose of adequate and sufficient quality control of the Works during its execution. The cost of all testing shall be borne by the Contractor.

All test reports shall be submitted to the Engineer as soon as possible and within 24 hours of their completion.

1.5.4 Payment

Separate payment will not be made for complying with the requirements of this Clause 1.6 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities for the items to which the standards and tests apply.

1.6 MOBILISATION AND DEMOBILISATION

1.6.1 General

Mobilisation shall refer to the transportation of Contractor's Equipment, based on the construction programme submitted by the Contractor in accordance with Clause 14 of the Conditions of Contract, from the place of origin to the Site where they are to be used. When the mobilisation has been substantially completed to the extent the Works can be effectively performed and obtain the scheduled progress, the Contractor shall submit the required documentation for the Engineer's approval and certification. Subject to the authorisation of the Engineer the Contractor may at any time during the execution of the Works, make alteration, reduction and/or improvement to the Equipment.

Demobilisation shall be made after the written approval of the Engineer and shall include the removal of the Contractor's Equipment from the Site.

1.6.2 Equipment

The Contractor shall furnish the necessary Contractor's Equipment, as defined in Clause 1.1.(f) (v) of the Conditions of Contract, required for the execution of the Works. The Engineer may, if he consider it necessary for the execution of the Works in accordance with the Contract, instruct the Contractor to furnish additional Equipment. All equipment to be furnished by the Contractor shall be complete with all spare parts and the Contractor shall maintain a sufficient stock of such spare parts to ensure the efficient execution of the Works.

1.6.3 Programme and Notice of Transportation

Concurrently with the submittal of the programme in accordance with Clause 14 of the Conditions of Contract, the Contractor shall furnish the Engineer with a complete transportation programme for Equipment, showing, in detail, the sequence of transportation and delivery on the Site to comply with his proposed construction programme.

The Contractor shall keep the Engineer informed of the arrival of Contractor's Equipment and materials at the Site.

1.6.4 Payment

Payment for mobilisation and demobilisation will be made at the lump sum price tendered therefore in the Bill of Quantities. Progress payment will be made in the following manner :

- (a) Seventy percent (70 %) of each approved Sub-item of the lump sum price tendered in the Bill of Quantities will be paid upon certification by the Engineer that mobilisation has been substantially completed for each item of equipment shown in the Contractor's breakdown submitted with his bid.
- (b) The remaining thirty percent (30 %) of each approved Sub-item of the lump sum price tendered in the Bill of Quantities will be paid upon certification by the Engineer that the demobilisation of concerned equipment has been completed for each of the items of plant or equipment mentioned above.

Monthly estimates of progress for payments of mobilisation and demobilisation shall be supported with appropriate records and documents showing that mobilisation or demobilisation for each item of equipment as mentioned above has been completed during the month for which the estimate is prepared.

1.7 TEMPORARY FACILITIES

1.7.1 General

1.7.1.1 Extent of Temporary Facilities

For the purposes of this Clause temporary facilities shall mean those parts of the Temporary Works required for the purposes of the establishment, gaining and maintaining access to the site and continuing obligations for managing the site as described hereunder. Other Temporary Works which are associated with the executions of the Works such as shoring, formwork, etc. are addressed elsewhere.

All Temporary Facilities shall be provided, installed, operated, maintained and subsequently removed by the Contractor, except as otherwise provided in the Contract.

1.7.1.2 Approval of Temporary Facilities

The Contractor's proposal for the erection of all Temporary Facilities shall be in accordance with the proposals submitted with his Bid or with such modifications as approved by the Engineer from time to time.

The Contractor shall submit to the Engineer for approval, twenty eight (28) days from the receipt of the notice to proceed, the revised general plan of Temporary Works, based on the proposals in the Bid, layout, dimension, installation programme and schedule. The Engineer may direct the Contractor to modify or change the proposals, if in the opinion of the Engineer it is deemed necessary. Such direction of the Engineer shall not relieve the Contractor from any of his obligations and responsibilities under the Contract.

Before starting any part of Temporary Facilities the Contractor shall, at least twenty eight (28) days before starting construction, submit to the Engineer for the approval the detailed proposal for such part of the Temporary Works including plans, Drawings, schedules, and other information as specified in Clauses 1.3 and 1.4 of the General Specification which will supplement or modify the general plan of the Temporary Works already submitted by him.

1.7.1.3 Removal of Temporary Facilities

Unless otherwise directed or approved by the Engineer, all Temporary Works constructed by the Contractor shall be removed and the area made safe, vegetation and natural drainage reinstated all to the satisfaction of the Engineer prior to the end of the Defects Liability Period.

1.7.1.4 Payment

Separate payment will not be made for Temporary Facilities and all the costs thereof shall be deemed to be included in the lump sum prices entered in the Bill of Quantities for Establishment.

1.7.2 Use of Construction Facilities and Work Areas

1.7.2.1 Location of Temporary Facilities

The Contractor shall, as far as practicable, lay out the Temporary Works within the Site.

1.7.2.2 Restoration of Temporary Facilities Areas

Before acceptance of the Works by the Employer the Contractor shall restore the land occupied by the Temporary Works as nearly as practicable to its original condition or to a condition to the satisfaction of the Engineer.

1.7.2.3 Rights of Others to Use Construction Facilities

Other contractors employed by the Employer and their workmen and workmen of the Employer and of other Government authorities who will be carrying out work on or near the Site of the Works shall have the right to use, without charge, the access facilities, including bridges and roads, of which the Employer has given possession to the Contractor or which have been constructed or acquired by the Contractor for use in constructing the Works. Other contractors requiring to use such facilities shall be required to make application to and receive the approval of the Engineer before use.

1.7.3 Establishment

1.7.3.1 General

An item has been included in the Bill of Quantities for Establishment which item shall be deemed to include the cost of provision, erection and removal if required, of all Temporary Facilities at the Site including the Engineer's site office, the Contractor's site office, buildings, temporary fences, sanitary facilities, medical facilities, fixed construction facilities including but not limited to workshops, electric power supply, water supply, telecommunications, temporary roads, bridges and jetties, traffic control (including waterway traffic) and other temporary facilities required for the execution of the works and cleaning-up and restoration of the Site on completion.111

1.7.3.2 Payment

The Contractor shall provide a breakdown of the lump sum for Establishment in accordance with Sub-Clause 57.2 of the General Conditions of Contract. The breakdown shall be arranged such that it includes not more than ten (10) sub-items which can be readily recognised and measured for payment purposes.

Payment for Establishment will be made at the lump sum price entered in the Bill of Quantities. Progress payments for work under each sub-item will be made as follows:

- (a) Sixty percent upon certification by the Engineer that work under each sub-item is substantially complete.
- (b) Ten percent upon certification by the Engineer that the facility under each sub-item has been removed.
- (c) Thirty percent to be distributed uniformly over the duration of the Contract.

1.7.4 Utilities

1.7.4.1 Water Supply System

The Contractor shall ensure that there is an adequate supply of water to the Engineer's Site Office as specified in Sub-Clause 1.8.7, his offices, laboratory, labour quarters, workshops, batching plant and other places on the Site where water is required in accordance with the Contractor's proposal in his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer. Water for the human use shall be of a standard equal to the domestic town water supply in Ho Chi Minh City.

The Contractor shall supply to the Engineer's Site Office and Facilities, and to all work areas, an adequate supply of purified, bottled water

1.7.4.2 Electric Power Supply

The Contractor shall be responsible for providing at the Site, all electric power required for his construction activities, his site office, his labour camps, the Engineer's site office and any other areas where electric power is required.

The method of supplying such electrical power to the various parts of the Site shall be as proposed by the Contractor in his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer.

The Contractor shall design and install the electrical power supply system in accordance with the requirements of the relevant Vietnamese codes of practice and the requirements of the power supply authority.

1.7.4.3 Telecommunication System

(a) General

The contractor shall supply, install and maintain telephone (fixed line and mobile) and facsimile facilities for the purposes of communication between the Engineer and the Contractor and in the various parts of the site.

(b) Telephone Requirements for Engineer's Office

Three external lines shall be provided to the Engineer's site office for the exclusive use of the Engineer. All external lines shall be capable of international direct dialling.

Separate metering shall be provided for the external lines and the Contractor may charge the Employer for international calls but not for calls made within Vietnam.

(c) Telephone Requirements for the Contractor's Site Office

The Contractor shall provide the quantity and type of communications facilities he deems necessary for the execution of the Works which shall not be less than two external telephone lines.

(d) Payment

Separate payment will not be made for complying with the requirements of this Sub-Clause and all costs shall be deemed to be included in the lump sum price for Establishment in the Bill of Quantities.

1.7.5 Temporary Roads and Bridges

1.7.5.1 General

The Contractor shall construct and maintain temporary construction roads, including haul and access roads, bridges, jetties and the associated drainage and watercourse crossing facilities necessary for the execution of the Works.

The Contractor shall make the necessary arrangements with the appropriate Local Government Authorities and private landowners where new temporary access and haul roads are required through private land.

Not less than thirty (30) days before the Contractor intends to commence construction of any part of the temporary construction roads, the Contractor shall submit to the Engineer for approval a detailed construction plan including:

- (a) The location and design of the temporary construction roads, including the associated drainage and stream crossing facilities; and
- (b) The construction method and construction time schedule of such temporary construction roads,

The location of these roads shall be in accordance with the Contractor's proposals submitted with his Bid and approved in the Letter of Acceptance or as otherwise approved by the Engineer.

1.7.5.2 Design Requirements for Temporary Roads and Bridges

The temporary construction roads shall be designed so as to generally have a driveway width of not less than 6.0 m

The Contractor shall provide a gravel pavement or other measures in stretches where trafficability is in the opinion of the Engineer, not sufficient for the efficient transportation of Contractor's Equipment and materials.

Where the temporary construction roads cross existing watercourses, the Constructor shall provide an appropriate section of concrete or steel pipe or other means to allow water discharge. The Contractor shall be responsible for the repair at his own expense of any damage to the temporary construction roads caused by the passage of heavy equipment and trucks used by the Contractor or his subcontractors for the execution of the Works. On the completion of the Works, such temporary construction roads shall be removed and the land restored to its original condition to the satisfaction of the Engineer.

1.7.6 Contractor's Site Office and Facilities

1.7.6.1 General

The Contractor shall provide, maintain and operate the Contractor's Site office and construction facilities which include, among other things, staff quarters, warehouse, workshop, laboratory, labour camp and other temporary buildings and facilities necessary for the execution of the Works, and shall remove them upon the completion of the Works except as otherwise specified in the Contract or directed by the Engineer. The Contractor shall be solely responsible for providing the land for his site office and facilities.

The Contractor shall submit revised [Drawings showing the site](#), layout plans and general particulars of such temporary buildings and facilities to the Engineer for his approval. The construction of any buildings or facility shall not be started until the Contractor's proposals have been finally approved by the Engineer.

1.7.6.2 Construction Camp

The Contractors shall construct his construction camp as proposed in his Bid and approved in the Letter of Acceptance. It shall include housing camps and other facilities and amenities for his employees and for the employees of his subcontractors.

The Contractor's staff quarters and labour camp shall be provided with all the necessary services for drainage, electricity, lighting, roads, paths, parking spaces, fencing, sanitation including sewage treatment, water supply, kitchen, fire prevention and fire fighting equipment.

1.7.6.3 Contractor's Site Office

The Contractor shall provide the Site office as soon as the preparatory work at the Site takes place. The Site office shall be constructed with all the necessary facilities for drainage, lighting, sanitation, parking spaces, etc.

1.7.6.4 Completion of Contractor's Site Office and Construction Facilities

The Contractor shall notify the Engineer in writing as soon as the temporary buildings and facilities have been constructed and are ready for operation. The Engineer shall certify that such buildings and facilities have been constructed in accordance with the approved plans.

1.7.7 Engineer's Site Office

1.7.7.1 General

The Contractor shall design, construct, operate, maintain and demolish after completion of the Works, the Engineer's site office.

The office shall have a gross floor area of not less than 200 m²

The Engineer's site office shall be constructed at a location in close proximity to the Contractor's office and shall comply with the general design requirements included or referred to in the [Appendix to the General Specification](#).

The buildings shall be fully air conditioned and provided with the utility services as specified in Sub-Clause 1.8.4. and with the furniture and office equipment listed in [the Appendix to the General Specification](#)

1.7.7.2 Technical Requirements and Standards

The Engineers Office shall be constructed to a good quality standard and shall be fit for its intended purpose. All work shall comply with Vietnamese Codes, Standard and local authority requirements.

1.7.7.3 Submissions

The Contractor shall make detailed proposals for the provision of the facilities included in Sub-Clause 1.8.7 in the form of detailed design

Drawings, schedules of finishes, materials lists, construction programme and specifications, all of which shall be subject to the Engineers approval. Procedures shall be in accordance with Sub-Clause 1.3.

1.7.7.4 Time for Completion

The Engineer's Site Office shall be completed within 3 months of the Commencement Date

1.7.7.5 Maintenance and Operation

The Contractor shall ensure that the Engineer's Site Office and Facilities are at all times maintained in good order and provided with the utility services specified in Sub-Clause 1.8.4.

1.7.7.6 Removal and Hand-over

At the conclusion of the Contract the Contractor shall remove all of the buildings and facilities provided under this Clause and reinstate the area to the satisfaction of the Engineer and all items of furniture and equipment shall be handed over to the Employer.

1.7.7.7 Alternative Option of Rented Office Space

As an alternative to the above, the Contractor may propose to provide equivalent rented office space in a modern, air conditioned building in District 1 or 5 of Ho Chi Minh City. Acceptance of the an alternative option is at the sole discretion of the Engineer.

1.7.7.8 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.8.7 and all costs shall be deemed to be included in the lump sum price for Establishment in the Bill of Quantities.

1.7.8 Transport Facilities for the Engineer

1.7.8.1 General

The Contractor shall provide transport facilities as specified hereunder for the exclusive use by the Engineer and his staff for the purpose of construction supervision throughout the duration of the Contract commencing within 56 days of the issue of the Letter of Acceptance.

The transport facilities shall include the following:

- (a) One (1) New, four-door four-wheel drive, Toyota Land Cruiser or equivalent including driver;
- (b) One (1) New two-wheel drive Toyota Previa van or equivalent;
- (c) Two (2) New Honda Dream motor cycles or equivalent.

The Contractor shall arrange for payment of all vehicle registration and comprehensive insurance fees for each vehicle.

All vehicles shall be registered and ownership shall be vested with the Employer.

In the event that the above facilities cannot be provided within the said 56 days, the Contractor shall arrange temporary vehicles for the Engineer's use for interim period until the specified facilities have been provided.

Following completion of the Contract the vehicles shall be handed over to the Employer in good condition.

1.7.8.2 Maintenance of the Engineer's Transport Facilities

The Contractor shall arrange to service and repair vehicles at regular intervals in accordance with the manufacturers' recommendations and provide all necessary spare parts to maintain the vehicles in a proper and safe running condition.

All consumables, including fuel, oil, filters, etc., required for the vehicles shall be provided by the Contractor.

If any vehicle requires maintenance for a period exceeding 2 days, the Contractor shall provide an alternative vehicle to the vehicle being repaired for the use of the Engineer.

1.7.8.3 Measurement and Payment

Payment for the provision of transport of the Engineer shall be made at the Lump Sum Price entered in the Bill of Quantities and shall include full compensation for the cost of providing the vehicles, drivers, maintenance, insurance, consumables and any other incidental costs.

Payment shall be made as follows:

60 % of the lump sum shall be paid upon delivery of all of the specified vehicles

The remaining 30 %, representing operation cost, shall be made in uniform monthly payments over the duration of the Contract.

1.7.9 Engineer's Accommodation

1.7.9.1 General

The Contractor shall provide accommodation for the Engineer commencing 28 days after the date of the Letter of Acceptance and extending to the date of Completion plus 1 month in accordance with the following requirements.

Type of Accommodation: One (1) two-bedroom, fully-furnished, air conditioned, serviced apartment

Location: Located in a modern apartment building situated in District 1,2, or 3 of Ho Chi Minh City

1.7.9.2 Payment

Payment shall be made at the monthly rate entered in the Bill of Quantities which shall be full compensation for all cost of providing the said accommodation.

1.7.10 Boat

1.7.10.1 General

The Contractor shall maintain a boat for the purpose of access to work areas within the site. The service shall be operate at all times when construction work is in progress and shall be available for the use of the Engineer or his staff for the purposes of inspection of the Works.

1.7.10.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.8.10 and all costs shall be deemed to be included in the lump sum price for Establishment in the Bill of Quantities

1.7.11 Garbage Disposal

1.7.11.1 Scope

The Contractor shall undertake the collection of and disposal of all garbage from within the Contractor's Site office, the Contractor's Temporary Facilities, the Engineer's Site office and other areas used in connection with the Works. Garbage collections shall be made at least twice each week and shall continue until completion of the Works.

Garbage shall be disposed of in a manner acceptable to the relevant local authority.

1.7.11.2 Payment

Separate payment will not be made for the provision for garbage disposal and the cost of this work shall be deemed to be included in the lump sum price entered in the Bill of Quantities for Establishment.

1.7.12 Maintenance of Existing Public Roads

1.7.12.1 General

The Contractor shall maintain all roads within the vicinity which he uses for purposes of carrying out the Works required by this Contract

1.7.12.2 Contractor's Operations

If the Contractor's operations obstruct or hinder the passage of traffic on the roads described in Sub-Clause 1.8.12, the Contractor shall provide and maintain for the duration of such disruption an alternative route, approved by the Engineer, of a standard not less than that of the road so affected.

Existing roads and bridges have load limits which the Contractor shall be responsible for determining. Before moving any heavy construction traffic into highways, roads, and bridges, the Contractor shall make suitable arrangements with the relevant authorities and obtain their approval for the passage of such traffic.

The Contractor shall not travel tracked vehicles or equipment on any bituminous sealed road surface. Rubber-tired vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed road surfaces.

All the work of improvements or modifications on the existing public roads made by the Contractor for his own convenience shall be at the Contractor's own risk and expense.

1.7.12.3 Maintenance of Roads

The Contractor shall nominate public roads to be used by him during the execution of the Works in his construction plan. Prior to the commencement of the use of such roads, a joint inspection shall be carried out by the Engineer and the Contractor to document their conditions.

All damage caused by the Contractor's operations to the nominated roads shall be promptly repaired by the Contractor. At the end of the use by the Contractor of any particular section of public road, or completion of the Contract, whichever is the earlier, the Contractor shall ensure that the nominated roads used by him are reinstated to a condition equal to or better than the condition documented in the pre-commencement joint inspection referred to above. All expenses relating to the maintenance of public roads shall be borne by the Contractor.

In fulfilling his obligation for maintaining roads the Contractor shall:

- (i) reinforce to pass his traffic, if necessary, and keep in good working condition at all times all road structures, bridges, culverts, drains and other waterways;
- (ii) patch potholes with approved materials, keep the road surfaces in good repair, and perform all grading and necessary resurfacing;
- (iii) maintain all fenders, posts, guideposts, guard posts, rails, fencing, signs, signposts and other roadside structures;
- (iv) keep road surfaces and shoulders free from all earth, mud, stones, timber, rubbish, and other debris and materials removed from the Works;
- (v) adequately maintain cut-slopes and fill-slopes of the roads and appurtenant drainage ditches; and
- (vi) keep the road surface watered where dust is likely to be a safety or health problem.

1.7.12.4 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.8.12, and the cost of this work shall be deemed to be included in the various rates and lump sum prices entered in the Bill of Quantities.

1.8 SOIL INVESTIGATION

1.8.1 General

The Contractor shall, when directed by the Engineer, carry out test drilling with core recovery and in situ testing for the purpose of determining sub-surface geological conditions along the banks of the Tau Hu and Ben Nghe canals at locations directed by the Engineer. Each test hole shall be bored to a depth of 10 m.

1.8.2 Soil Tests Required

In situ and laboratory testing and the relevant standards to which tests shall be performed shall be in accordance with the following:

TEST	TESTING FREQUENCY
Standard Penetration (ASTM D 1586) 2m	every 1 m
Vane Shear Test (ASTM D 2573)	3 per hole
Specific Gravity (ASTM D 854)	3 per hole
Natural Water Content (ASTM D 2216)	3 per hole
Grain Size Analysis (ASTM D 422)	3 per hole
Liquid Limit Test (ASTM D 423)	3 per hole
Plastic Limit Test (ASTM D 424)	3 per hole
Wet Density Test (Calliper method)	3 per hole
Unconfined Compression (ASTM D 2166)	3 per hole
Consolidation Test (ASTM D 2435)	3 per hole

1.8.3 Reporting

Upon completion of testing, the Contractor shall prepare and submit to the Engineer five (5) copies of a Soil Testing Report in a format to the Engineer's approval.

1.8.4 Measurement and Payment

Payment test drilling will be made at the unit rate per metre depth of bore hole entered in the Bill of Quantities, which rate shall constitute full compensation for the cost of all labour, tools, equipment and materials for the test drilling, performing standard penetration tests, vane tests, recovering cores, laboratory testing, analysis, preparation of report, and preparation other items necessary to complete the work.

1.9 SAFETY, HEALTH CONTROL AND SECURITY

1.9.3 General

The Contractor shall be responsible for all safety, health controls and security and shall submit to the Engineer details of the organization and regulations for these purposes.

1.9.4 Safety Precautions

1.9.4.1 General

The Contractor shall comply with any safety instruction given by the Engineer. In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect from injury persons or property. The Contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, signs and lights and provide fire alarm, fire extinguishing and fire fighting services at strategic points on the Site and adequate ventilation, lighting and safe working conditions for his workmen engaged in the performance of the Works. The Contractor shall adopt and enforce such rules and regulations as may be necessary and desirable in the work and in its supervision. Safety measures shall include but shall not be limited to those measures mentioned in this Clause.

The Contractor shall comply with the International Regulations for Prevention of Collision at Sea and any special requirements applicable to marine vessels engaged in activities related to the Contract.

1.9.4.2 Safety Officer

[In amplification of the requirements of the General Conditions of Contract Part II, Sub-Clause 34.10](#), the Contractor shall constantly employ during the progress of the Works an employee qualified in safety, and familiar with the type of work being performed, whose assignment shall include initiation of measures for the protection of health and the prevention of accidents and who shall see, by personal inspection, that all safety rules and regulations are enforced. The Contractor shall hold regularly scheduled safety meetings at least once each month with his engineers, supervisors and foremen and, when directed, with the Engineer. The Contractor shall keep the Engineer advised as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda.

1.9.4.3 Temporary Fencing

The Contractor shall erect, maintain and remove suitable and approved temporary fencing to enclose such areas of the Permanent Works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract in approved manner. Where any temporary fence has to be erected, it shall be of the type required by and shall be erected to the satisfaction of, the Government authority concerned.

1.9.4.4 Lighting

- a. In the event of night work being carried out, the Contractor shall provide sufficient lighting to ensure that in all places where work is in progress :
- (i) safe working conditions are provided for the Contractor's personnel and the Engineer;
 - (ii) the Works can be constructed in complete compliance with the Contract; and
 - (iii) a complete inspection of all Works in progress can be made by the Engineer.
 - (iv) Lighting of vessels shall be in accordance with the International Regulations for Prevention of Collision at Sea and any special requirements applicable to vessels engaged in activities related to the Contract. In addition adequate deck lighting shall be provided on all dredgers, barges and tugs operating at night.
- b. Unless otherwise directed by the Engineer, the minimum illuminance on ground or working surfaces to be provided for the various operations or work areas shall be as tabulated below :

ILLUMINANCE		
OPERATION OR AREA	Design Value (Lux)	Minimum Measured Value (Lux)
Construction Site in General	50	20
Concrete placing	100	50
Maintenance shops and Auxiliary Buildings	300	200
Deck Lighting	50	20

- c. All moving equipment or plant used during night operations shall be equipped with sufficient lights and reflectors.
- d. Not less than fourteen (14) days before the start of any night operations, the Contractor shall submit to the Engineer his proposals for lighting in the areas in which he proposes to work at night. The Contractor shall modify the proposals if directed and shall not begin operations at night, until the proposals for lighting have been approved.
- e. The submission to or approval by the Engineer of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

1.9.4.5 Signs

- a. The Contractor shall provide all necessary signs for the Works. These shall include, but not be limited to
 - standard road signs;
 - warning signs;
 - danger signs;
 - control signs;
 - safety signs; and
 - direction signs.
- b. Wording on all signs shall be in the Vietnamese and English languages. The size, colour, lettering and location of all signs will be subject to approval, and attention shall be paid to international system of signs.
- c. The Contractor shall maintain all signs placed by himself as well as those placed by the Employer.
- d. If the Engineer considers that the system of signs provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to the satisfaction of the Engineer.

1.9.4.6 Other Safety Measures

- (a) When working in the vicinity of electrical equipment and in the interest of safety and security, the Contractor shall complete the erection of any safety fencing around electrical and mechanical equipment by the time that the said apparatus is connected to any electrical supply.
- (b) Use of Lasers - The use of lasers on the Site shall be done with due regard to eye hazard and all personnel working on the site shall be warned accordingly.
- (c) Safety instructions - Within 56 days of receiving the notice to proceed the Contractor shall, at his own cost, supply and issue to his employees, those of his subcontractors and the Engineer, in English, Vietnamese and in other languages used by his employees at the Site, a booklet containing safety regulations based on good practice. The booklet shall be pocket size and issued to each person employed at the Site. Proof copies of the booklet shall be submitted to the Engineer for approval before printing and amendments shall be made to the booklet to his entire satisfaction. The Contractor shall issue the booklet immediately after printing and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety including but not limited to the following items where relevant to the Works :
 - (i) operation of vessels
 - (ii) protective clothing, headgear and footwear;
 - (iii) use of lifting equipment;
 - (iv) earthmoving;
 - (v) formwork and reinforcement erection;
 - (vi) concreting;
 - (vii) routine for accidents or fires; and
 - (viii) watchman, warning notices and barriers
 - (ix) electrical safety

The Contractors shall allow for ten (10) booklets in the English language for the use of the Engineer.

- (d) Accident Report - The Contractor shall promptly report to the Engineer, in a form to be prescribed, all accidents involving death or serious injury to staff or workmen, and shall furnish monthly reports of all accidents to staff or workmen involving loss of time, giving such information as may be directed.

1.9.4.7 Provision of Safety Equipment

All persons employed on the Works are to be provided with safety equipment appropriate to the tasks upon which they are engaged such as helmets and safety equipment shall be compulsory as deemed necessary by the Engineer.

1.9.4.8 Payment

Separate payment will not be made for complying with the provisions of Sub-Clause 1.10.2 and all costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.9.5 Sanitary Arrangements

1.9.5.1 Scope of Work

The Contractor shall keep the Site in a clean and hygienic condition, and shall provide and maintain sanitary conveniences for use of the persons employed in the Works to the extent, in the manner and at such places as approved by the Engineer and by any Government health authority concerned. All persons connected with the Works shall be enjoined to use these conveniences. Sewage shall be disposed of in a hygienic manner.

1.9.5.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.10.3 and all costs shall be deemed to be included in the item in the Bill of Quantities for Establishment

1.9.6 Fuel Storage

1.9.6.1 General

- (a) The Contractor shall make arrangement for the transportation, storage and handling of fuels in a safe manner to protect the public in accordance with the laws and security regulations of the Socialist Republic of Vietnam.
- (b) Above-ground gasoline and liquefied petroleum gas storage tanks shall not be located within 100 meters of any building.

1.9.6.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.10.4 and all costs shall be deemed to be included in the item in the Bill of Quantities for Establishment.

1.9.7 Fire Prevention

1.9.7.1 General

The Contractor shall take every precaution to prevent fire occurring on or about the Site. The Contractor shall comply with the laws and regulations of the appropriate Government authority relating to fires and shall provide fire fighting equipment, which the Engineer considers to be suitable and adequate, ready to use in all structures, buildings or the works under construction, including his labour camps and ancillary buildings. The Contractor shall maintain such equipment and such additional fire fighting equipment as may be required, in good working condition until the Works are accepted by the Employer.

The Contractor shall extinguish promptly any fire which may occur on the Site wherever the fire may originate. In this regard, he shall employ all requisite equipment and manpower for fire fighting up to the limits of his equipment and manpower employed at the Site including the equipment and manpower of his subcontractors.

1.9.7.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.10.5 and all costs shall be deemed to be included in the various rates and lump sums entered in the Bill of Quantities.

1.9.8 Earthing

1.9.8.1 General

All appliance and facilities which are possibly subject to lightning strikes shall be electrically grounded and the effectiveness of such grounding shall be periodically checked by the Contractor.

1.9.8.2 Payment

Separate payment will not be made for complying with the requirements of Sub-Clause 1.10.6 and all costs shall be deemed to be included in the various lump sums and rates entered in the Bill of Quantities.

1.9.9 Medical and Health Services

1.9.9.1 General

- (a) The Contractor shall provide a person qualified in first aid at all working hours on the Site.
- (b) The Contractor shall provide a first aid unit on the Site for treatment of casualties in conformity with the requirements of all duly constituted medical and health authorities. The Contractor shall provide such first aid units and shall be responsible for and bear all costs in connection with the first aid services including removal by ambulance of injured or sick employees to hospital in Ho Chi Minh City or other places.
- (c) The Contractor shall provide first aid services for the Employer's and Engineer's staff working on the Site.

1.9.9.2 Payment

Separate payment will not be made for medical and health facilities provided by the Contractor for his employees, for his subcontractors and the Employer's and Engineer's staff, as required by this Clause, and all costs shall be deemed to be included in the various rates and lump sums entered in the Bill of Quantities.

1.9.10 Security

1.9.10.1 Responsibility of the Contractor

- (a) The Employer will specify overall security requirements for the project and the Contractor shall perform to such requirements and be responsible for such action of his personnel in respect of such requirements.
- (b) The Contractor shall be responsible for the security of the Works and the at Site and shall provide and maintain continuously and adequate security force to fulfil these obligations. The duties of the Contractor's security force shall include, but not be limited to, maintenance of order on the Site, provision of all lighting, fencing, guards, flagmen, all other measures necessary for the protection of the Works within the Site, all material delivered to the Site, the public, and all persons employed in connection with the Works, continuously throughout working and non-working periods, including nights, Sundays and holidays, for the duration of the Contract.

1.9.10.2 Payment

- (a) Separate payment will not be made for the provisions of security services and all costs shall be deemed to be included in the various rates and lump sum prices entered in the Bill of Quantities.

1.10 SURVEY AND MEASUREMENT OF THE WORKS

1.10.1 General

1.10.1.1 Bench Mark and Reference Points

Reference points have been established on the Site by the Employer as shown on the Drawings or as advised by the Engineer. The Contractor shall use the co-ordinates and elevations of such reference points in setting out the Works. Any reference points damaged as the result of action by the Contractor shall be replaced by the Contractor at his own expense.

The Contractor may establish temporary reference points for his own convenience but each point shall be of a design and at a location approved by the Engineer. Each point shall be accurately related to the points established by the Employer.

1.10.1.2 Responsibility for Setting Out

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced and qualified surveyors approved by the Engineer.

The Contractor shall furnish all materials, labour and equipment including stakes, templates, patterns, platforms and special labour that may be required by the Contractor in setting out any part of the Works. The Contractor shall use survey equipment of the type and accuracy to permit correct setting out and control of the Works.

Before performing the pre-construction surveys as described below, the Contractor shall give the Engineer at least 7 days notice before commencing such survey in order that the Engineer or his representative can witness and verify levels and other data so determined. The original surface level determined shall be subject to the Engineer's approval.

The Contractor shall co-operate with the Engineer in checking the setting-out and in performing the measurement surveys for record and payment purposes. The Contractor shall render all necessary assistance to the Engineer and shall provide, as required for the use of the Engineer, sufficient quantities of pegs, poles, straight edges, stagings, moulds, templates, profiles, survey assistants, labourers and transport (including boats where required) for checking the Contractor's setting-out and for measurement of the Works.

1.10.2 Pre-Construction Survey

1.10.2.1 General

Owing to works having been carried out on the site by others in the period following completion of the detailed design and prior to commencement of the Works it is required that the Contractor carries out a supplementary topographical survey of the canal banks and cross section surveys of the canals.

The data so recorded shall be included in the working Drawings and shall be in the form of updated versions of the plans and cross sections of the works included in the Bid Drawings. For the purpose of this work the Employer shall supply the Contractor with digitised data used for the Bid Drawings and the Contractor shall use the same system of CAD for updating and preparing the working Drawings.

Procedures for preparation of Drawings shall be in accordance with Clause [1.3.5](#). In addition the Contractor shall provide the Engineer with all digitised files all data used for preparing the approved Drawings.

1.10.2.2 Supplementary Topographical Survey

The Contractor shall carry out topographical surveys of the areas between the existing canal-side roads and the canals. The information to be observed and recorded shall include all features which will have an influence on the construction of the works or for the payment thereof and shall include, but not be limited to the following:

- Edge of canal
- Existing revetments or walls
- Existing sewer outlets
- Buildings or structures

The scale of the updated plans shall be 1:500.

1.10.2.3 Cross Section Survey

The Contractor shall survey cross sections of the canals at intervals of approximately 25 m. Cross sections shall be re-surveyed at the same locations as shown on the bid Drawings (which were approximately 50 m centres) and at locations midway between such locations.

The survey shall record the location and elevation of the following points on each cross section:

- Edge of the Site
- Top of bank
- Bottom of bank
- Bed elevations at all significant changes of slope and at a maximum of 20 m spacing.
- Any existing structure

Cross sections shall be plotted to scale of 1:100

1.10.3 Survey Data and Calculations

The Contractor shall submit all survey data, information, calculations, results and records to the Engineer as soon as they are available.

1.10.4 Payment

1.10.4.1 Supplementary Topographical Survey:

Measurement shall be made of the area of topographical survey made and for which the results have been approved by the Engineer.

Payment shall be made at the unit rate per hectare entered in the Bill of Quantities which shall include all equipment and labour for making the survey, recording, computations and summarizing the data in a format to the Engineer's approval. Payment for preparing Drawings shall be paid elsewhere.

1.10.4.2 Cross Section Survey

Payment for cross section survey shall be made at the rate per cross section entered in the Bill of Quantities which shall include all equipment and labour for making the survey, recording, computations and summarizing the data in a format to the Engineer's approval. Payment for preparing Drawings shall be paid elsewhere

1.10.4.3 Other Surveying

Separate payment will not be made for all other obligations of the Contractor under the Contract for surveying and all costs shall be deemed to be included in the rates and lump sums for the various items entered in the Bill of Quantities.

1.11 UTILITY SERVICES SURVEY

1.11.1 General

The Tau Hu canal is to be realigned in the region of sections 77 to 84. Water supply, electrical and telephone utilities will have been relocated by others prior to the commencement of the Works, however, the location of underground sewers and stormwater drains is required to be determined by the Contractor.

1.11.2 Scope of Work

The Engineer shall direct the Contractor to certain locations where investigations are required and the Contractor shall consult with relevant local authorities to obtain existing data then excavate test pits to determine the exact nature and location of underground services. Excavation shall be by hand when in close proximity to existing services.

Following determination of the presence and location of such utility services, the Engineer may issue further construction Drawings in accordance with Clause 1.3.3.

All exploratory pits or trenches shall be backfilled in accordance with the requirements of Section 3, Earthworks.

1.11.3 Measurement and Payment

1.11.3.1 Test Pits

Measurement shall be made of the volume of test pits excavated and subsequently backfilled.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for consulting with public utility authorities, excavating test pits and their backfilling on completion and shall include the cost of all materials, labour and equipment and all other things necessary to complete the work.

1.12 OTHER ITEMS

1.13.1 Information Board

The Contractor shall provide two free-standing boards for the purpose of providing information in English and Vietnamese about the project to the public.

The boards shall be not less than 2500 x 2500 and shall be of galvanized steel construction. The lower edge of the board shall be 1200 above adjacent ground level and shall be mounted on suitable posts with struts in concrete footings. The paint to be used shall be sunshine resistant. The Contractor shall be responsible for the repair and maintenance of the boards until completion of the Works.

The information to be displayed and the locations shall be directed by the Engineer and the design of the supporting structures shall be subject to the Engineer's approval.

1.13.2 Securities and Insurance

1.13.2.1 Performance Security and Advance Payment Security

The Contractor shall furnish an Advance Payment Security and a Performance Security and in accordance with Sub-Clauses 60.7 and 10.1 of the Conditions of Contract to ensure the refund of the Advance Payment and for the due performance of the Contract respectively.

1.13.2.2 Insurance

The Contractor shall effect certain insurances relating to the Contract in accordance with of the Conditions of Contract.

In handling compensation to workmen under the above Clauses, the Contractor shall arrange that any compensation amount determined shall be paid without delay by the Contractor to the workmen entitled to such compensation irrespective of the time for payment of insured amount from the Insurance company to the Contractor.

1.13.2.3 Payment

Separate payment will not be made for complying with Sub-Clause 1.13.2 and the Conditions of Contract and all costs shall be deemed to be included in the rates and lump sums for the various items entered in the Bill of Quantities.

1.13.3 Audits by the Employer

1.13.3.1 General

The Employer shall be entitled at his discretion to conduct audits as necessary for his own investigation in connection with :

Costs incurred in the event of termination of the Contract as provided in Clause 65 and 66 of the Conditions of Contract;

Other costs that the Contractor may claim to the Employer, which are not specifically covered by the terms of the Contract.

1.13.3.2 Records

The Contractor is obligated to keep accurate and up-to-date accounts and records concerning the above items.

1.13.3.3 Payment

Separate payment will not be made for complying with the requirements of this Clause and all costs shall be deemed to be included in the rates and lump sums entered in the Bill of Quantities.

1.13.4 Liquidated Damages

1.13.4.1 Amount of Liquidated Damages

If the Contractor should fail to complete the Works within the Time of Completion as stated in the Appendix to Bid, the Contractor shall pay to the Employer liquidated damages pursuant to Clause 47 of the Conditions of Contract.

1.13.4.2 Maximum Damages

The maximum amount of liquidated damages payable or allowable to the Employer will be limited to the amount stated in the Appendix to Bid.

1.13.4.3 Other Rights of the Employer

Nothing contained in this Clause shall prejudice or affect any other rights of the Employer under the Contract.

1.13.5 Monthly Statement

1.13.5.1 General

The Contractor shall submit a monthly statement in accordance with the requirements of **Clause 60** of the Conditions of Contract. The monthly statement shall be accompanied by copies of all survey notes, records of measurements and calculation which the Engineer has directed to be prepared by the Contractor in support of the amounts claimed for the work executed.

1.13.5.2 Payment

All costs associated with the submission of the monthly statement shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.13.6 Hours and Days of Working

Before commencement of work on the Contract, the Contractor shall notify the Engineer, in writing, of the days, hours and of the number of shifts that he proposes to work and shall give at least 48 hours notice to the Engineer of any changes to such hours of working and/or number of shifts that may be necessary during the currency of the Contract.

1.13.7 Prevention of Water Pollution

1.13.7.1 Scope

The Contractor's construction activities shall be performed by methods that prevent entrance or accidental spillage of solid matter, contaminants, debris and other objectionable pollutants and wastes into streams, flowing or dry water courses and underground water sources. Such pollutants and wastes include but not restricted to refuse, garbage, cement, concrete, sewage effluent, industrial waste, oil and other petroleum products. The Contractor shall submit his plan showing the location and design of the water pollution prevention systems and facilities to the Engineer for approval.

1.13.7.2 Payment

Separate payment will not be made for complying with the provisions of Sub-Clause 1.13.7, and the costs shall be deemed to be included in the rates and lump sum prices entered in the Bill of Quantities.

1.13 MEASUREMENT AND PAYMENT (GENERAL)

1.13.1 General

The method of measurement shall be in accordance with the methods and procedures stipulated in the particular Clauses and as set forth herein.

The various unit rates and lump sums for each work item entered in the Bill of Quantities shall be deemed to have included full compensation for supplying all materials, labour, equipment consisting of owning, operation and repair costs, and other expenses necessary to complete the work in accordance with the Drawings, the Specifications, the instructions of the Engineer and compliance with all other obligations, including rectification of defects, as required under the Contract.

1.13.2 Measurement and Tolerances

This Clause explains the tolerance for measuring the dimensions of the work and the method of calculation of the quantity of the work completed in the following categories:

Category - 1 (linear metres, m)

The work item shall be measured to the second decimal place of a metre and be approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured length by the unit rate and then rounding the result to the nearest integer.

Category - 2 (square metres, m²)

The work item shall be measured to the second decimal place of a square metre by multiplying the two dimensions, measured to two decimal places, and rounded off, and approved by the Engineer at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the measured area by the unit rate and then rounding the result to the nearest integer.

Category - 3 (Hectare, ha)

Not used

Category – 4 (cubic metres, m³)

The work item shall be measured to the second decimal place of a cubic metre by multiplying the three dimensions, measured to two decimal places of a metre, and rounded off and approved by the Engineer at every work stage on an inspection Sheet.

The amount of payment will be determined by multiplying the measured volume by the unit rate and then rounding the result to the nearest integer.

Category - 5 (Lump Sum Item)

The method of measurement and payment shall be as set out in the respective payment Clause for each of the following items for which payment is by lump sum.

Category - 6 (mass)

a) (Mass in kg)

The work item shall be measured to the second decimal place of a metre and multiplied by the approved mass per metre at every work stage on an inspection sheet.

The amount of payment will be determined by multiplying the calculated quantity by the unit rate and then rounding the result to the nearest integer.

b) (Mass in tonne, Note: 1 tonne = 1000 kg mass)

The mass shall be determined by reference to delivery notes from the specialised supplier, duly approved by the Engineer or his representative, to the accuracy of the third decimal place of a tonne (1 kg).

The amount of payment will be determined by multiplying the approved quantity by the unit rate and then rounding the result to the nearest integer.

Category - 7 Number (No.) or set

The work item shall be measured to the exact number of items installed (or item of work performed) and approved by the Engineer at every work stage on an Inspection Sheet.

The amount of payment will be determined by multiplying the number by the unit rate.

This Clause shall be read in conjunction with individual payment Clauses.

Category – 8 Litre

The volume shall be determined by reference to dip sticks before and at the end of spraying work and shall be recorded on an inspection sheet and approval by the Engineer at every stage of the work.

The amount of payment will be determined by multiplying the whole number of litres by the unit rate.

Category – 9 Month

The applicable time shall be measured in months. Fractions of a month shall be calculated on the basis of 1 day equals 1/30 month.

The amount of payment will be determined by multiplying number of months, expressed to 3 decimal places by the unit rate.

APPENDIX: REQUIREMENTS FOR ENGINEER'S OFFICE

Location	For a purpose-built office, in close proximity to the Contractor's office. For rented office space, in District 1 or 5 in Ho Chi Minh City
Gross Area (minimum)	200 m ²
Air Conditioning	Required throughout
Utility Rooms	Kitchen fitted with sink and tea and coffee making facilities, Male and female toilets Store room fitted with shelving
External Works	Paving, lighting, car parking area, security fencing
Office Furniture and Equipment, general	All shall be new and of good quality
Office furniture required	Desks with lockable drawers complete with chairs for 20 persons Meeting table with 10 chairs Book shelves (4 units) Filing cabinets (4 units)
Equipment Required	10 Desktop computers (IBM-type, 700 MHz or greater, 128 Mb DRAM, 30 GB Hard disk plus all devices for network operation) 1 Server (complete with all necessary software) and local area network connecting all computers and output devices. Each desktop computer shall be loaded with the following software: <ul style="list-style-type: none"> • Microsoft Windows latest version. • Microsoft Office latest version • Virus Protection Program latest version • AutoCAD latest version • Any other software necessary for proper network operation 1 Laser Jet Printer capable of printing A3 size, complete with all accessories and consumables 1 Inkjet Plotter capable of plotting A1 size Drawings complete with all accessories and consumables 1 Inkjet Colour Printer capable of printing A3 size 1 Photo copy machine of commercial quality capable of copying A3 size and collating 1 facsimile machine 1 Potable water cooler/dispenser Miscellaneous office equipment including hole punches, scissors, staplers etc.

DIVISION B

TECHNICAL SPECIFICATION

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SECTION 2. PREPARATORY WORKS

2.1 GENERAL

This section covers the general and specific requirements for preparatory works including care of water, clearing and grubbing and demolition works

2.2 CARE OF WATER

2.2.1 General

The Contractor shall be responsible for the removal of all water encountered during the execution of the whole of the Works.

The Contractor shall design, construct and maintain all temporary diversion and protective works which are necessary for construction and to prevent surface, drainage and groundwater from entering excavations and shall furnish all materials required therefore.

The Contractor shall be responsible for and shall repair, at his expense, any damage to foundations, excavation slopes or any other parts of the Works caused by water, floods or by his failure to protect the Works in accordance with the requirements of this clause

2.2.2 Dealing with Water

Where it is required that construction shall proceed with flow of water in rivers, canals, sewers etc. it shall be necessary to isolate the site of the structure to be constructed from the flow of water. Suitable coffer dams, canals, flumes, drains or other temporary diversion and protection works shall be constructed without interruption or interference with the flow of water in the rivers, canals, sewers etc. The Contractor shall construct sufficient temporary works as described above to deal adequately with surface and groundwater sources to enable the construction of the Permanent Works to the satisfaction of the Engineer.

Where it is required to work in an operational storm water sewer or connection to existing sewer, it will be necessary to divert the existing flows in the sewers to isolate the working area. Where gravity diversion is not possible, the Contractor may be required to utilize over pumping at these locations.

The Contractor shall submit for the approval of the Engineer the location, size, diversion flow requirement and other relevant details including materials proposed for the construction of the temporary works described above. In the case of over pumping, the Contractor shall maintain one (1) stand-by pump of capacity at least equal to the largest duty pump available on site at all times. The Contractor shall include provisions for maintaining flows during rainstorms by means of over topping, removal of flow barriers or otherwise to prevent artificial flooding at the upstream locations of the particular site.

The Contractor shall submit drawings and calculations showing his proposed method, dimensions and sizes of cofferdam construction. Approval of the drawings and calculations by the Engineer will not in any way relieve the Contractor of the responsibility for the adequacy of the design for strength and stability or for the safety of the people working therein.

The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and removal of any required forms and the inspection of the interior and to permit pumping outside the forms.

Cofferdams that tilt or move laterally during construction shall be corrected as necessary at the expense of the Contractor. In case the structure is damaged it shall be repaired as directed by the Engineer at the expense of the Contractor.

Unless otherwise provided, cofferdams shall be removed after the completion of the structure in a manner so as not to disturb or mar the finished work.

2.2.3 Removal of Water

Much of the slope protection structures and sewer invert levels included in the Works are located below the normal water level in the canals (which are tidal) and removal of water from excavations is required in order to carry out all construction operations under dry conditions. The Contractor's method of removal of water from foundation excavations shall be subjected to the approval of the Engineer.

Subject to approval of the Engineer, water from excavations shall be disposed of by pumping or gravity diversion directly to the canals.

Before commencement of excavation for foundation works for the structures of the Works and/or related structures, the Contractor shall submit the method for removal of water, installation and details of the proposed dewatering system he proposes to use.

Any dewatering system adopted by the Contractor shall be operated in such a way that the ground water level outside the excavation is not reduced to the extent that would cause damage or endanger adjacent structures or property or loss of fines from adjacent ground which could cause adverse effects.

The Contractor shall be required to ensure that the bottom of excavations are free of water prior to placement of concrete or embankment/filling material. Such controls may require supplementary approved dewatering methods by the use of perforated pipe, under drains leading to sumps from which water shall be pumped. The water pumped out from the foundation shall be diverted directly to canals or through existing drains or pipes without allowing to flow overland causing inundation of properties, etc.

Cofferdams shall be constructed so as to protect newly cast concrete from sudden rising of the water and to prevent damage to the foundation by erosion.

Pumping and dewatering from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through or alongside any concrete being placed. No pumping or dewatering will be permitted during the placing of concrete nor for a period of at least 24 hours thereafter unless it is done from a suitable sump separated from the concrete work by a water tight wall. The wall shall be extended sufficiently far below the bottom of the sump so that no material from the concrete can penetrate into the well. The design of this sump shall be made to the Engineer's satisfaction.

Excavations shall be kept dry down to at least 100 mm below foundation level prior to and during placing concrete. Placing concrete under water will only be permitted if indicated on the Drawings or permitted by the Engineer.

2.3 CLEARING AND GRUBBING

2.3.1 General

The Contractor shall carry out clearing and grubbing of the areas directed by the Engineer in accordance with this clause.

2.3.2 Definition of Extent

The extent of the area for clearing and grubbing shall be agreed by the Engineer prior to commencement by the Contractor.

2.3.3 Requirements

The Contractor shall remove and dispose of all stumps, veins, brush, grass, roots, vegetation, fences, rocks, masonry, trash, debris, building rubble, building foundations and other objectionable matter within the area to be occupied by the permanent works.

Where directed by the Engineer, the holes resulting from grubbing operations shall be filled with approved materials which shall be placed and compacted to the same density as the adjoining soil.

All waste materials resulting from the clearing and grubbing work shall be transported to the designated spoil disposal area then spread and buried to the approval of the Engineer.

Any combustible material shall be removed from the site and burnt. Burning on site shall not be permitted.

All salvageable materials shall remain the property of the Employer and shall be transported and stacked at locations as directed by the Engineer.

2.4 DEMOLITION WORKS

2.4.1 General

The Contractor shall carry out demolition works in accordance with the requirements of this clause.

2.4.2 Scope

The work consists of the complete demolition and removal of existing concrete and masonry and timber structures which are required to be removed for the purpose of clearing the site for the construction of the revetments and sewer outlets, paving and landscaping works along the banks of the Tau Hu and Ben Nghe canals.

2.4.3 Method of Execution

Structures to be demolished shall be broken into units of sufficiently small size so as to be safely handled and removed from the site.

All waste materials resulting from the demolition work shall be transported to the designated spoil disposal area then buried to the approval of the Engineer.

Any combustible material shall be removed from the site and burnt. Burning on site shall not be permitted.

All salvageable materials shall remain the property of the Employer and shall be transported and stacked at locations as directed by the Engineer.

2.5 MEASUREMENT AND PAYMENT

2.5.1 Care of Water

The Contractor shall provide a breakdown of the lump sum for Care of Water in accordance with Sub-Clause 57.2 of the General Conditions of Contract. The breakdown shall be arranged such that it includes not more than six (6) sub-items which can be readily recognised and measured for payment purposes. The breakdown shall include at least sub items for coffering and dewatering for Ben Nghe canal, coffering and dewatering for Tau Hu canal and care of water for Sewer Outlets.

Payment for Care of Water will be made at the lump sum price entered in the Bill of Quantities. Progress payments for work under each sub-item will be made as follows:

(a) Coffering and Dewatering

Payment shall be made for a section of coffering according to the approved breakdown and for the dewatering of the its enclosed area and the subsequent removal of the section of cofferdam and all associated equipment to the approval of the Engineer.

Payment of the relevant breakdown component of the lump sum shall be made as follows:

- 40 % on completion of the cofferdam
- 30 % on completion of all dewatering following completion of the permanent works protected by the cofferdam
- 30 % on the complete removal of the section of cofferdam to the approval of the Engineer

(b) Other Items

Other items included in the Contractor's breakdown of the lump sum for Care of Water shall be paid in proportion to their completion.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.1 3.1.1	Care of Water	L.S.

2.5.2 Clearing and Grubbing

Measurement for payment will be made in square metres (m²) of the area actually cleared and grubbed and approved by the Engineer.

Payment will be made at the rate entered in the Bill of quantities and include the entire cost of completing the work including materials, labour, equipment, transportation and disposal of material and all associated costs. Clearing in excess of the approved area shall not be paid for.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.2 3.1.2	Clearing and Grubbing	m ²

2.5.3 Demolition Works

Measurement shall be made of volume of existing structures demolished and removed in accordance with the specification and to the approval of the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall include the entire cost of completing the work including materials, labour, equipment, transportation and disposal material and all associated costs.

Items to be paid under this clause are as follows:

Pay Item No.	Description	Unit of Measurement
2.1.3 3.1.3	Demolition	m ³

SECTION 3. EARTHWORKS

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SECTION 3. EARTHWORKS

3.1 GENERAL

This section covers the general and specific requirements for earthworks to be carried out under the Contract which include, but are not limited to, excavation works for the improvement of the Tau Hu and Ben Nghe canals, earthworks for [sewers and sewer](#) outlets and other incidental works relating to landscaping.

3.1.1 Character of Strata

The Contractor shall acquaint himself with all available data regarding earthworks and the character of strata and materials to be excavated and used as filling. He shall satisfy himself as to :

- the general circumstances at the Site of the Works
- any obstructions thereon
- the form of canal bed and banks
- his obligations for diversion and care of water
- the flow of water in the canals
- tidal effects
- springs, subsoil and river water
- the surface of the ground
- possible subsidence of soft ground
- poor materials
- possibility of floods
- slipping clay
- running sand
- trees, brushwood, timber and debris
- floating debris
- obstructions of any kind and material of whatever nature.

Rates entered in the Bill of Quantities shall reflect the Contractor's own assessment of risk and influence that these matters may have on his costs and no subsequent adjustments shall be made to rates for any reason.

3.1.2 Earthworks to Dimensions, Lines and Levels

All earthworks shall be carried out to the dimensions, lines and levels as shown on the Drawings, or to such other dimensions, lines and levels as may be ordered by the Engineer. Dimensions and lines, which are based on or related to ground levels, shall be referred to the Engineer before commencing earthworks at any location.

For the purpose of the Specification the term original surface level shall refer to the ground or canal bed surface before the start of earthworks as measured by the Contractor and approved by the Engineer in accordance with [Clause 1.11](#) of the General Specification.

The Contractor shall be completely and solely responsible for setting out the works and establishing an adequate number of bench marks and reference points. Surveys to be performed by the Contractor are described in [Clause 1.11](#) of the General Specification.

3.1.3 Method of Excavation

The Contractor shall carry out excavation in whatever material may be encountered and by any method or combination of methods he considers most suitable subject to any restrictions herein.

The Contractor shall give due consideration to the matters in Clause 3.1.1 (Character of Strata), Clause 2.2 (Care of Water) of Section 2, location and access to soil disposal areas, fill and stock pile areas and all other relevant factors.

3.1.4 Unsuitable Materials

Excavated materials which, in the opinion of the Engineer, do not meet required Specifications for fill, embankment or backfill shall not be used for such purpose and shall be transported to the designated spoil disposal area.

3.1.5 Transportation of Excavated Material

The transportation of excavated material to fill embankment, backfilling or stockpile site or disposal of excess or unsuitable materials shall be carried out in accordance with the approved schedule of earthworks operations. The Contractor shall transport material by the most appropriate route between excavation and placement or disposal areas using, as far as practical, access and haul roads within the site or by the use of waterborne transport (eg barges). Protective measures shall be made and maintained throughout the duration of the Works for the safety of operations both on-site and off-site.

When hauling by road is done off-site loads shall be trimmed to prevent spillage. Wet materials to be hauled shall be dried sufficiently prior to loading to prevent spillage by leaking. Any damage or unsightly appearance on the surface of any road caused by the Contractor's hauling operation shall be reinstated by the Contractor at his own expense.

When hauling by barge is carried out it shall be done in accordance with the safety provisions of Section 1, General Specification.

3.1.6 Disposal of Excavated Materials

Excavated material which, in the opinion of the Engineer, is suitable for use in filling, embankment or backfill may be transported directly to its final position, stock piled, or placed as otherwise approved by the Engineer.

Unsuitable soil or surplus excavated materials shall be disposed of in the designated spoil disposal area. The Contractor shall trim and grade spoil tips to profiles, heights and levels approved by the Engineer. He shall also maintain without interruption the flow of water courses affected by tips and comply with any other arrangement at the site existing between the Engineer and any other parties involved.

3.2 EXCAVATION

3.2.1 Channel Excavation

3.2.1.1 General

The work covered by this Clause relates to the excavation of the improved waterway channels of the Tau Hu and Ben Nghe canals.

For the purposes of this contract Channel Excavation below Water Level shall refer to the excavation carried between the inner extents of the revetment walls to be constructed under this contract in the existing canal channel and will usually be carried out under water (with the exception of at very low tides in some places). Other excavation made in dry conditions for excavation works relating to the re-routing of the canal shall be paid for as common excavation.

The Contractor shall carry out all channel excavation in whatever material may be encountered in accordance with these Specifications, the Drawings and any directions of the Engineer. The Contractor shall provide and operate all necessary excavating, lifting, hauling, transport and other equipment to deal with any type of material encountered. Excavation for the various works shall be carried out to such widths, lengths, depths and profiles as shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing.

3.2.1.2 Trimming Tolerances

Excavated surfaces shall be trimmed to the lines and grades as shown in the Drawings or to other lines and grades as may be directed by the Engineer. The bed level of the canals at any cross section shall be trimmed to a tolerance of 0 mm above the specified elevation and not more than 200 mm below the specified elevation.

3.2.1.3 Excavation Beyond True Line

The waterway channels shall be cut to the lines and level as shown in the Drawings and to the tolerances stated in [Clause 3.2.1.2](#).

For all parts of the waterway channels, for whatever reason and cause, unless as a result of the Engineer's direction, the Contractor shall, at his own expense, make good the excavation to the required line and level with approved material and in such a manner as the Engineer may approve. Where over-excavation is not detrimental to canal flow and not unsightly, the Engineer may, at his sole discretion, waive the requirement for making good such over-excavation. Any under excavation beyond the stated tolerances shall be corrected.

3.2.1.4 Inspection and Survey

The Contractor shall measure work in progress by means of appropriate survey methods and in the presence of the Engineer or his representative.

The Engineer will carry out inspection of work progress and measurement of work completed assisted by the Contractor who shall provide boats, boatmen, labourers, materials and all other items necessary for the Engineer's use.

3.2.2 Common Excavation

3.2.2.1 General

This [Clause 3.2.2](#) refers to all common excavation to be carried out under the Contract and shall be read in conjunction with [Clause 3.1](#).

Common excavation is the open-cut excavation of all materials including, but not limited to soil, sand, gravel, clay, silt, sediments, etc. excluding rock as determined by the Engineer. Any excavation without a classification of the material generally means common excavation.

The Contractor shall carry out all common excavation in whatever material may be encountered in accordance with these Specifications, Drawings and any directions of the Engineer. The Contractor shall provide and operate all necessary excavating, lifting, hauling, transport and other equipment to deal with any type of material encountered. Excavation for the various works shall be carried out to such widths, lengths, depths and profiles as shown on the Drawings, or to such other dimensions as may be ordered by the Engineer in writing.

3.2.2.2 Support of Excavation

Where necessary the sides of all excavations shall be properly shored up and supported with strutting and planking, and the sides shall be close sheeted where necessary to prevent the entry of running sand, mud and the like.

Furthermore, where excavation is being carried out in trenches, pits or other confined spaces the Contractor shall give particular care to the safety of workers and shall follow the appropriate recommendations in BS 6031 – Code of Practice for Earthworks.

No separate payment will be made for the cost of shoring and its cost shall be deemed to be included in the rates for excavation.

3.2.2.3 Inspection of Excavation

When any excavation has been completed and trimmed, the Engineer shall be informed so that he may make a formal inspection. No excavation shall be backfilled or covered with concrete until it has been inspected and the Contractor has been authorised to proceed. Excavation Beyond True Line

Where any over-excavation occurs for whatever reason or cause, unless as a result of the Engineer's direction, the Contractor shall, at his own expense, make good those excavations to the required line and level with :

- 1) approved material and in such manner as the Engineer may direct where the excavation is other than for concrete work; or
- 2) concrete of the same grade as that to be used in the true excavated shape, unless directed otherwise by the Engineer, where the excavation is for concrete work.

3.2.3 Excavation of Trenches

3.2.3.1 General Requirements

Excavation of trenches shall be performed in accordance with the requirements of Clause 3.2.2 and this Clause 3.2.3.

Excavation methods and equipment to be used for trenches shall be suitable for the particular work. Trenching shall be to the lines and grades shown on the Drawings and to the required width and depth. Excavation to the final trench bottom shall be done in such a way as to leave the bottom undisturbed. All excavation of trench shall be done in the dry.

No excavation of trench shall be carried out until the Contractor's method statement has been approved by the Engineer. Approval of the Contractor's method statement shall not relieve the Contractor of his obligations or liabilities under the Contract.

3.2.3.2 Removal of Pavement

Pavement to be removed during excavations shall be cut along straight parallel lines before excavating to provide a uniform edge and minimize the amount of pavement disturbed.

Asphalt pavement shall be cut with vertical sides. Settlement and cracks in bituminous pavement are to be restored to the approval of the Engineer.

Concrete curbs shall be sawn with vertical sides in line with the sides of the trench or, in the case of precast block, sufficient blocks shall be removed and stockpiled for future reinstatement.

3.2.3.3 Trench Widths for Sewer Lines

Trenches shall be excavated to the widths shown on the Drawings which shall include the thickness of sheeting, bracing, sheet piling used as temporary works to support the sides of the trench. Over excavation of the width of trenches for sewer lines shall be corrected by backfilling to the crown level of the sewer pipe to be constructed in the trench and re-excavating to the required width.

3.2.3.4 Protection of Existing Utilities and Trees

Existing facilities, including water pipelines, electrical cables, telephone cables and existing sewers shall be supported as necessary and protected from damage during all phases of construction, and they shall be kept in full operation during the work of this Contract.

Trees and their root structures intended to remain must be protected during excavation to the satisfaction of the Engineer.

3.2.4 Excavation of Pits for Manholes

Excavation of pits for manholes for sewer or stormwater pipeline construction shall be carried out with the same provisions as specified in Clause 3.2.2 and as follows.

The widths of pits shall be constructed to 1m (including the thickness of shoring) beyond the external face of the structure unless otherwise directed or approved by the Engineer.

3.3 FILL

3.3.1 General

The work described in this Clause shall consist of the furnishing of necessary materials and selecting, stockpiling and blending if required, transporting, placing, spreading, adjustment of moisture content, compaction, shaping and doing incidental items of work to construct the finished fill to the lines, grades and profiles as shown on the Drawings or as directed by the Engineer.

The Contractor shall make due allowance for consolidation and settlement whether compaction is specified or not, such that the levels, widths and dimensions of the finished surfaces at the end of the Defects Liability Period shall not be less than the levels and dimension shown on the Drawings.

All filling and embankments shall be constructed to the lines and levels shown on the Drawings or established by the Engineer.

Backfilling of trenches and filling adjacent to structures is also included in this category of work.

Accumulation of material at the base of embankment slopes will not be permitted.

3.3.2 Materials

Materials to be used for the various types of fill, backfill or bedding shall conform to the requirements specified herein or as approved by the Engineer.

(a) Earth Fill (selected from Common Excavation)

Material to be used shall be extracted and selected from excavated material from common excavation, and shall not contain roots, turf or clod exceeding 75 mm in size or organic matter of any kind and shall be approved by the Engineer.

(b) Sandy Soil Fill

Sandy soil fill material shall be clean well graded sand, free of organic or other deleterious matter conforming to the following requirements:

- The percentage, by weight passing the 0.075 mm sieve shall be less than 35%
- The uniformity Coefficient (Uc), defined as D_{60}/D_{10} shall not be less than 4.

(This material is locally know as “black sand”)

(c) Sand

Sand for use in sand bedding or sand backfill shall consist of natural sand, having clean, hard and durable particles, and it shall be free from clay, organic matter, and other deleterious materials. It shall be uniformly graded and shall meet the following grading requirements :

Sieve Size (mm)	Cumulative Passing Percentage by Weight
9.5	100
4.75	95 - 100
2.36	80 - 100
1.18	50 - 85
0.600	25 - 60
0.300	10 - 30
0.150	2 - 10

(This material is locally know as “yellow sand”)

(d) Free Draining Gravel

Gravel for use in Free Draining Gravel shall consist natural gravel or crushed stone which shall be hard and durable and which will not break down or deteriorate in service and shall be clean and free from clay, organic matter or other deleterious materials. The maximum particle size shall be 40mm and the minimum particle size shall be 20 mm.

(e) Gravel

Gravel for use in [gravel bedding or gravel fill](#) shall consist natural gravel or crushed stone which shall be hard and durable and which will not break down or deteriorate in service and shall be clean and free from clay, organic matter or other deleterious materials. The plasticity index shall be not greater than 10 and the grading shall comply with the following requirements.

Sieve Size (mm)	Cumulative Passing Percentage by Weight
50	100
4.5	25 - 90
.075	0 - 10

(f) Clay

Clay to be used in the [sandy soil/clay fill](#) along the banks of the Tau Hu and Ben Nghe canals shall have a cohesion, after compaction of 2.0 ton/m² and may be obtained from excavated material or from sources outside the Site and shall be subject to the approval of the Engineer.

3.3.3 Soil Tests

Tests on materials for use as fill or backfill materials shall be performed by the Contractor and shall enable determination of soil characteristics, suitability, dry density/moisture content relationships and the like. A formal report of all tests shall be prepared by the Contractor and approved by the Engineer. Tests shall be performed by the Contractor prior to commencement of earthworks, and every time soil characteristics change. Tests shall include but not be limited to the following :

- a) Compaction (AASHTO T 99) (Dry Density)
- b) Particle size distribution
- c) Specific gravity
- d) Moisture content
- e) Plastic limit, Liquid limit
- f) Direct shear

Test results shall be submitted to the Engineer for approval.

Field compaction tests of compacted filling shall be made on each layer and at a frequency of one test for every 300 m².

For backfilling of trenches, field compaction tests shall be made for every layer or as otherwise directed by the Engineer.

The Contractor shall prepare a soil test programme in conjunction with his earthworks operation schedule and submit it to the Engineer for approval.

3.3.4 Placing, Compaction and Moisture Content of Fill

This Clause relates to the earth fill and sandy soil fill as shown on the Drawings.

Prior to commencement of filling, the Contractor shall carry out, under direct supervision and to the satisfaction of the Engineer, a series of field tests to determine optimum conditions and minimum number of passes of each type of equipment required to achieve the specified compaction for each type of fill material.

Fill material shall not be placed when, in the opinion of the Engineer, satisfactory results cannot be achieved due to heavy rain or other adverse conditions.

Fill shall be spread and compacted in approximately horizontal layers of uniform moisture content and uniform compacted thickness not exceeding 200 mm (or to lesser thickness as specified elsewhere). Filling operations shall be such as to ensure that materials will be blended sufficiently to achieve the highest practicable dry density, impermeability and stability. Where the surface of any layer of filling is too dry or too smooth to bond properly with the next layer of material, it shall be moistened and/or scarified in an approved manner to provide a satisfactory bonding surface before the next layer is placed.

The moisture content of filling shall be carefully controlled, either by natural drying or wetting with a fine spray, to achieve optimum values. Fill material shall be compacted to a density of not less than 90% maximum standard dry density determined in accordance with AASHTO T 99. For portions of fill upon which road pavements are to be constructed the upper 300 mm of fill material directly below the road pavement shall be compacted at optimum moisture content to a compaction of 95% maximum standard dry density in accordance with AASHTO T 99 for the full width of the roadway or for the full width of the trench as the case may be. Where practical, as determined by the Engineer, moistening of the material shall be performed at the site of stockpiles but such moistening shall be supplemented by fine spraying at the time of compaction, if necessary. Where moisture content is beyond the optimum range, the operation shall not proceed except with the specific approval of the Engineer, until the material has been conditioned by wetting or drying to achieve a moisture content in the required range.

All compaction equipment shall be approved by the Engineer in writing before commencement of any filling operations.

3.3.5 Preparation of Surface under Fill

Filling shall not be placed on any portion of embankment foundation until such foundation has been cleared, stripped of topsoil, suitably prepared and has been approved by the Engineer. Tests pits, trenches and cavities resulting from the removal of unsound foundation materials or for inspection of sub-surface conditions shall be filled with selected materials.

Foundation material which does not have a density in the undisturbed condition as specified for the fill material to be placed upon it shall be moistened and compacted to specified dry density or shall be removed, filled and compacted or shall be treated in a manner as directed by the Engineer.

3.3.6 Filling Adjacent to Structures

Filling adjacent to structures shall be placed and compacted to avoid damage to such structures. Compaction adjacent to structures shall be carried out by hand or with suitable hand-operated equipment in horizontal layers not exceeding 150 mm thickness after compaction.

Unless otherwise specified or permitted by the Engineer, filling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of the concrete.

3.3.7 Backfilling

Backfill comprising approved materials complying with the specification for filling provided in [Clause 3.3.2](#), shall be placed and compacted adjacent structures or in trenches generally in accordance with [Clause 3.3.4](#), as shown on the Drawings or as directed by the Engineer.

Prior to commencement of backfilling adjacent to structures, the area shall be cleared of all formwork and other temporary works. Compaction shall be carried out by hand or with suitable hand operated equipment so as to achieve specified compaction without damage to structures. Backfilling material shall be wetted or allowed to dry in order achieve optimum moisture content for compaction.

Backfilling shall be placed and compacted in continuous horizontal layers of not more than 150 mm compacted thickness. Unless otherwise specified, backfilling shall be compacted to 90% of the maximum dry density as determined in the laboratory compaction test referred to in [Clause 3.3.3](#).

Unless otherwise specified or permitted by the Engineer, backfilling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of concrete.

Compaction of backfilling material placed above buried concrete, however, shall not be permitted to be carried out with vibrating equipment except with the prior approval of the Engineer.

3.3.8 Backfilling of Sewer Trenches

For trenches less than 4 m deep and where timber sheeting is used, backfill shall be placed in layers as described above, while trench support is being concurrently partly withdrawn.

For deeper trenches, where sheet piling support has been used, backfilling shall be completed up to the subgrade level before sheet piling is withdrawn.

This Clause shall be read in conjunction with [Clause 6.5.2](#) which specifies special requirements for backfilling around pipes.

3.3.9 Gravel Placement

This Clause covers the requirements for placing gravel bedding or free draining gravel in the locations as shown on the Drawings or as directed by the Engineer.

Materials shall comply with the requirements of [Clause 3.3.2](#)

Gravel shall be placed and compacted in continuous horizontal layers of not more than 150 mm compacted thickness. Each layer shall be compacted until it is stable and dense and shows no movement under compaction.

Unless otherwise specified or permitted by the Engineer, backfilling shall not be placed and compacted adjacent to concrete until at least fourteen (14) days after the placing of concrete.

Compaction of backfilling material placed above buried concrete, however, shall not be permitted to be carried out with vibrating equipment except with the prior approval of the Engineer.

3.3.10 Fill adjacent to Canals

Fill material to be placed between the existing natural surface and the inner face of the revetments to be constructed under this contract along the banks of the Tau Hu and Ben Nghe canals shall be composed of a mixture of sandy soil and clay materials as specified in Clause 3.3.2 (b) and (f) respectively, in equal proportions, in order to achieve the required soil parameters for stability.

The provisions of Clauses 3.3.4 and 3.3.5 shall apply except as modified herein.

Mixing of the sandy soil and clay shall be achieved by mixing the materials in stockpile prior to placement or by spreading and mixing in-situ, by mechanical means, prior to compaction. The method to be adopted shall have the prior approval of the Engineer.

3.4 RIP RAP

3.4.1 General

This Clause refers to the construction of rip rap for protection of the toes of revetments as shown on the Drawings or directed by the Engineer.

3.4.2 Material

Stone shall be clean, hard, and durable with a specific gravity not less than 2.5.

Samples of stone proposed for use in rip rap construction shall be submitted to the Engineer for his approval.

3.4.3 Preparation

Where applicable, surfaces on which rip rap is to be placed shall be completed to the satisfaction of the Engineer prior to placing rip rap.

3.4.4 Selection and Placement

Stones of size 250 mm to 300 mm in maximum dimension in accordance with Clause 3.4.2 shall be selected for use.

Stones shall be carefully placed such they are stable, closely interlock with adjacent stones and are arranged such that they comply with the lines, levels and profiles of the stone facing as shown on the Drawings to a tolerance of + or – 100 mm. Particular care shall be taken not to damage other parts of the revetments when placing rip rap. Any such damage caused shall be rectified by the Contractor at his expense.

3.5 GEOTEXTILE CLOTH

3.5.1 General

This Clause covers the requirements of geotextile filter cloth for use in revetment construction or as directed by the Engineer.

3.5.2 Materials

Geotextile filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 g/m² and shall comply with AASTHO M 288 'Geotextiles used for Subsurface Drainage Purposes'.

3.5.3 Construction

The surface on which the geotextile filter cloth is to be laid shall be completed to the satisfaction of the Engineer and then the cloth shall be laid out uniformly taking care not to puncture the cloth. Laps shall be a minimum of 300 mm.

Placement of material above the geotextile cloth shall be made carefully so as not to cause puncturing or dislodgement.

3.6 MEASUREMENT AND PAYMENT

3.6.1 Excavation

3.6.1.1 Channel Excavation below Water Level

Measurement of the volume of Channel Excavation below Water Level will be made using the average end area method of calculation for that portion of the volume of channel as defined in Clause 3.2.1.1. Measurement for payment shall not be made of over-excavation beyond the lines, levels and profiles shown on the Drawings.

Payment shall be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the excavation from the approved original surface levels down to the lines, levels and profiles shown on the Drawings including materials, labour, equipment, transportation and any other associated costs.

No payment shall be made for over-excavation

Payment shall be deemed to include allowance for the cost of:

- 1) excavation through any material and to any depth
- 2) trimming to the correct profiles, lines and levels as shown in the Drawings
- 3) transporting excavated materials to the designated spoil disposal area.
- 4) preparation, clearing and operation of spoil disposal areas as described in this Specification.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.2.1 3.2.1	Channel Excavation below Water Level	m ³

3.6.1.2 Common Excavation

Measurement of the volume of common excavation will be made using the average end area method.

Measurement for payment shall not be made of over-excavation beyond the lines, levels and profiles shown on the Drawings except as provided for herein.

For common excavation of trenches, measurement shall include allowance for working space around the structure to be constructed in the trench plus the volume occupied by the shoring approved by the Engineer.

Where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer.

The working space around structures shall be 600 mm unless otherwise approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the excavation from the approved original surface levels down to the lines, levels and profiles shown on the Drawings including materials, labour, equipment, transportation and any other associated costs.

No payment shall be made for over-excavation

Payment shall be deemed to include allowance for the cost of:

- 1) excavation through any material and to any depth
- 2) trimming to the correct profiles, lines and levels as shown in the Drawings
- 3) separating and setting aside those excavated materials suitable for re-use for other purposes and transporting to spoil those materials unsuitable for re-use or surplus to requirements
- 4) transporting excavated materials to the designated spoil disposal areas, stockpiles or to areas to be filled with approved material..
- 5) preparation, clearing and operation of spoil disposal areas as described in this Specification.
- 6) [Shoring of excavations as required.](#)

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.1 2.4.1 2.5.1 3.3.1 3.4.1 3.5.1 3.6.1 3.8.1 3.9.1	Common Excavation: including hauling shoring and disposal in designate area	m ³
2.2.2 2.3.2 2.4.2 3.2.2 3.3.2 3.4.2 3.5.2	Common Excavation: including shoring and hauling to stockpile in vicinity of the Site	m ³

3.6.2 Fill

3.6.2.1 Earth Fill

Measurement of the volumes of earth fill shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

For backfilling of trenches, measurement shall include allowance for working space around the structure to be constructed in the trench plus the volume occupied by the shoring approved by the Engineer as for excavation.

For filling, where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer as for excavation.

Payment shall include the cost, hauling from stockpile, placing, watering, levelling, compacting and testing of the materials of in-place fill. Payment shall also include cost of preparation of surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.6 2.4.6 3.3.6 3.4.6 3.5.6	Earth Fill from stockpile: including hauling and placement	m ³

3.6.2.2 Sandy Soil Fill and Backfill

Measurement of the volumes of sandy soil fill shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

For backfilling of trenches, measurement shall include allowance for working space around the structure to be constructed in the trench plus the volume occupied by the shoring approved by the Engineer as for excavation.

For filling, where the Engineer has permitted open cut excavation without shoring, the volume shall include working space around the structure to be constructed plus battering of the cut slope to an angle approved by the Engineer as for excavation.

Payment shall include the cost of procurement, hauling, placing, watering, levelling, compacting and testing of the materials of in-place fill. Payment shall also include cost of preparation of surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.4 2.5.2 3.3.4 3.5.5 3.6.2 3.9.3	Sandy Soil Fill: including supply and placement	m ³
	Sandy Soil Backfill: including supply and placement	m ³

3.6.2.3 Sand Bedding or Sand Backfill

Measurement shall be made of the volume of sand bedding with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.4 2.5.3 3.5.4 3.6.3 3.8.10 3.9.7	Sand Bedding	m ³
3.9.2	Sand Backfill	m ³

3.6.2.4 Free Draining Gravel

Measurement shall be made of the volume of free draining gravel with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.5 3.3.5 3.4.5	Free Draining Gravel: including supply and placement	m ³

3.6.2.5 Gravel Bedding

Measurement shall be made of the volume of gravel bedding with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.15 2.5.5 3.3.15 3.4.15 3.6.5	Gravel Bedding: including supply and placement	m ³

3.6.2.6 Geotextile Cloth

Measurement shall be made of the area of geotextile cloth with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings. Measurement shall not be made of the area of laps or waste.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.7 3.3.7 3.4.7	Geotextile Cloth: including supply and placement	m ²

3.6.2.7 Rip Rap

Measurement shall be made of the volume of rip rap with materials as described in Clause 3.3.2. to the lines and levels as shown on the Drawings.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including material, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.14 3.3.14 3.4.14	Rip Rap 250 – 300 dia : including supply and placement	m ³

3.6.2.8 Sandy Soil/Clay Fill

Measurement of the volumes of sandy soil/clay fill shall be made of the actual volume in cubic meters as determined by the measurement taken before and after filling operation. No measurement and payment shall be made for unauthorised filling outside the lines shown on the Drawings.

Payment shall include the cost of procurement, hauling, placing, mixing watering, levelling, compacting and testing of the materials of in-place fill. Payment shall also include cost of preparation of surface and trimming of slopes and all labour, materials and equipment necessary to complete the work.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.5 3.4.4	Sandy Soil/Clay Fill: including supply, mixing and placement	m ³

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SECTION 4. CONCRETE WORKS

4.1 GENERAL

This section covers the general and specific requirements for the mixing, placing and use of concrete of the various classes to be used in the structures, precast concrete units and non-structural applications in the Works for Package A which includes the use of concrete in revetments, sewers, landscaping works and all works in which concrete is specified, shown on the Drawings or directed to be used by the Engineer.

All concrete works shall be constructed in accordance with these specifications, to the lines, grades and dimensions shown on the Drawings, and as directed by the Engineer.

References to concrete classes A, B or C or to bridge work shall be disregarded as they are not applicable to the Works in Package A.

4.2 CONCRETE

4.2.1 Description

4.2.1.1 Scope

Portland cement concrete shall consist of a mixture of cement, water and coarse and fine aggregates.

4.2.1.2 Concrete Classes and their Use

The use of each class of concrete shall be as follows unless otherwise specified, shown on the Drawings, or directed by the Engineer :

Table 4.2.1.2

CLASS	USE OF EACH CLASS OF CONCRETE	STRENGTH* MPa
A	Jacking pipes	50
B	Prestressed concrete for bridge girders	42
C	Diaphragm wall	30
D	Precast concrete	25
E	General use reinforced concrete	21
F	Plain (unreinforced) concrete	18
G	Levelling concrete	10

*Note: Minimum 28-day compressive strength by cylinder test (300 mm x 150 mm diameter).

Note that only concrete classes E, F and G are applicable to this contract package.

4.2.1.3 Mix Design

No structural concrete shall be placed in the Works until the relevant mix has been approved by the Engineer.

The Contractor shall submit to the Engineer for his consent details of the concrete mix design, including the water-cement ratio proposed to be used for each class of concrete. These details shall be supplied six (6) weeks in advance of placing that particular class of concrete in the work so as to permit strength tests to be made from trial mixes.

The maximum aggregate size shall be 25 mm for reinforced concrete and 15 mm for secondary concrete unless otherwise directed by the Engineer.

(a) Trial Mixes

The trial mixes shall be carried out using samples of the materials submitted, and in the proportions proposed, by the Contractor. Alternatively the Engineer may request the Contractor to prepare, at the Contractor's expense, a trial mix of each class of concrete proposed to be used incorporating only such materials as have been tested and their use consented to by the Engineer. The trial mixes shall be made in the presence of the Engineer or his representative using the plant and the degree of quality control proposed for the work. Each mix shall be tested for slump, workability and strength.

If the coarse aggregate or fine aggregate is composed of more than one material or size of material the mix proportions of each shall be specified separately. Samples of each type of material and/or each size of material shall also be supplied by the Contractor as specified in Clause 4.2.2

The Proportions of the concrete mixes shall be designed by the Contractor to satisfy the specified requirements of strength, grading and consistency.

Unless otherwise specified or consented to by the Engineer, slump, water cement ratio and cement content shall conform to the values in Table 4.2.1.3.

Table 4.2.1.3

Class /1	Strength MPa /2	Minimum Cement Content (kg/m³) /3	Maximum Water/Cement Ratio by mass	Slump (mm) /4
A /5	50			
B	42	470	0.375	80 ± 20
C /6	30	370	0.45	180 ± 25
D	25	330	0.60	80 ± 20
E	21	268	0.60	80 ± 20
F	18	280	0.60	80 ± 20
G	10	200	0.60	80 ± 20

Notes:

1. Class of concrete shall be applied as shown in Clause 4.2.1.2.
2. Minimum 28-day compressive strength by cylinder test (300 mm x 150 mm diameter) determined in accordance with the requirements of AASHTO T22 and 23.
3. Concrete to be placed under water shall have a minimum cement content of 400 kg/m³.
4. Slump will be determined in accordance with AASHTO T119 or JIS A 1101.
5. Concrete Class A shall not be batched by the Contractor but shall be supplied by a specialist manufacturer of jacking pipes
6. Concrete Class C, which is to be used exclusively for diaphragm wall construction, shall contain admixtures subject to the provisions of Clause 4.2.2.3.

(b) Trial Mix Results

Prior to consent being given to a mix by the Contractor its compressive strength and shrinkage at 28 days will be checked from trial mixes.

A minimum of 20 specimens shall be cast for the purpose of ascertaining the compressive strength of the trial mix.

Laboratory test results on samples from trial mixes shall show an adequate working strength margin, in accordance with normal good practice, so that the probability of site working strength test values falling below the minimum specified strength shown in Table 4.2.1.2 is reduced to a value not exceeding 5%.

In the case of urgency or for mixes which contain special admixtures, or are stream cured the Engineer may give a provisional consent based on tests at an earlier age than 28 days but tests at age 28 days shall be the basis of final consent.

No change in the source or character of the materials shall be made without due notice to the Engineer and no new materials shall be used until the Engineer has accepted such materials and has designated new proportions based on tests or trial mixes as provided herein. Should the changes due to the new materials require an increase in the amount of cement, no additional payment shall be made to the Contractor for the cost of such additional cement.

4.2.1.4 Sampling of Concrete

In order to assess compliance of concrete during construction, the Contractor shall prepare and cure test specimens which shall be tested at 7 days and 28 days as determined by the Engineer, or at any other interval that may be deemed necessary to determine the strength of concrete. (Site Working Strength).

(a) Specimens shall be made in pairs as follows:

(i) For batches for Individual Pours

- < 1 m³:

Not more than one sample shall be taken from which not less than 2 specimens shall be tested.

- For batches > 1 m³ < 20 m³:

Not more than two samples shall be taken from which not less than 4 specimens shall be tested.

(ii) Continuous Pours

For any given section of the work that does not qualify as bulk concrete i.e. $> 20 \text{ m}^3 < 100 \text{ m}^3$ a minimum of three random samples shall be taken from which not less than 6 specimens shall be tested.

For any given section of the work that is considered as bulk concrete i.e. $> 100 \text{ m}^3$ a minimum of four random samples shall be taken for every 100 m^3 of concrete or fraction thereof greater than 100 m^3 placed during one day's work or as deemed necessary by the Engineer from which not less than eight specimens shall be tested.

- (b) Irrespective of the quantity, every day's production of concrete shall be tested both for strength and for slump and every structure and every component of every structure shall likewise be so tested for strength and for slump. The checking and testing of the concrete shall be the prerogative of the Engineer, and he may increase the specified strength and condition as required for the project.

The concrete test specimens will be tested by the Contractor at a conveniently located and properly equipped laboratory.

The Contractor shall take, on his own responsibility, every precaution to prevent injury to the test specimens during handling, transporting and storing.

4.2.1.5 Strength Requirements

(a) Specimen Preparation

The ultimate compressive strength of the concrete shall be determined on specimens obtained and prepared in accordance with AASHTO T141 (ASTM C 172) and AASHTO T23 (ASTM C 31). Test cylinders shall conform to AASHTO T126 (ASTM C 192).

The compression test performed on cylinders shall be according to specifications AASHTO T22 (ASTM C 39).

(b) Compressive and Flexural Strength

The average site working strength value of any 4 consecutive results of the 28 day tests shall not be less than the minimum strength specified in [Table 4.2.1.2](#) for the respective class of concrete. In the event of failure to comply with this requirement all of the concrete in all the batches represented by such samples and specimens, including any batches within the sequence which were not sampled shall be deemed not to comply with the strength requirement of this Clause.

If at any time the average of any 4 consecutive results of 7 day tests falls below 70% of the prescribed minimum value at 28 days for compressive strength or below 80% of the prescribed minimum value at 28 days for flexural strength the cement content of the concrete will be increased by at least 20 kg per cubic metre of compacted concrete, without extra payment, until any necessary mix modifications have been agreed following examination of 28 day tests.

(c) Characteristic Strength

The characteristic strength of the various classes of concrete shall be determined as soon as the first 30 test results of each class become available.

The characteristic strength shall be calculated by the equation:

$$\bar{X}_0 = X - kS$$

Where :

\bar{X}_0 : characteristic strength

X : mean or average of the series of results

k : a factor depending upon the percentage of results that fall below the characteristic strength

S : standard deviation given by the equation :

$$S = \left[\frac{\sum (X - \bar{X})^2}{(N - 1)} \right]^{\frac{1}{2}}$$

Where :

X : the individual result

N : the total number of results

The values for the factor k are :

Percentage of results falling below the minimum	Value of k
0.1	3.09
0.6	2.50
1.0	2.33
2.5	1.96
5.0	1.64

If the characteristic strength so determined falls below the minimum site working strength the Contractor shall increase the cement content in the same manner as described in Item (b) above until such time as adjustments shall be made in the mix proportions or improvements made in the quality control measures to raise the average strength or reduce variation to the satisfaction of the Engineer.

(d) Failure to Comply with Compressive Strength Requirements

In the event of compressive strength results not complying with the strength requirements of this Clause or in the event of doubtful results, the Engineer will proceed to check the sample compressive strength by means of crushing tests performed on test specimens taken with a rotary core borer at suitable points indicated by the Engineer on the structure already constructed.

Such tests shall be carried out by an agreed authority having suitable test facilities. If such tests show strength in compliance with the requirements herein specified, the concrete will be considered satisfactory. If such tests do not comply with the requirements, the Engineer may direct the Contractor to cut out and make good the defective work at the Contractor's expense.

(e) Care of Specimens

The cost of taking specimens and performing the tests including the cost of providing stout, substantial packing cases and the cost of shipping or transporting the test specimens from the site to the laboratory shall be included as part of the price bid for Portland cement concrete. The Contractor shall take, on his own responsibility, every precaution to prevent injury to the test specimens during handling and transporting.

(f) Records

The original records of all tests shall be kept by the Engineer and a copy retained by the Contractor. The records of all tests shall be kept by the Engineer but results shall be available at all times to the Contractor. The Contractor shall be responsible for making such adjustments as may be necessary to produce specification concrete and the test results shall include whether or not the concrete is satisfactory.

4.2.2 Materials

4.2.2.1 General

All materials to be furnished and used that are not covered in this Clause shall conform to the requirements stipulated in other applicable sections.

4.2.2.2 Cement

Unless specified to the contrary or otherwise permitted by the Engineer the Contractor shall use only one brand of any one type of cement having uniform quality for the Works. All cement used in the Works shall be Ordinary Portland Cement (ASTM Type-I) conforming to the minimum requirements of JIS R 5210, AASHTO-M 85, BS 12: 1978 or TCVN 2682 - 1992 for PC-40 Cement.

4.2.2.3 Admixtures

Admixtures may only be used if consented to by the Engineer and then only in such quantities and manner as he may consent to in writing.

Such admixtures shall conform with the requirements of:

- AASHTO M 194 (ASTM C 494) "Specification for Chemical Admixtures for Concrete":
 - Type A - Water-reducing
 - Type B - Retarding
 - Type C - Accelerating
 - Type D - Water-reducing and retarding
 - Type E - Water-reducing and accelerating
 - Type F - Water-reducing (high range) and
 - Type G - Water-reducing(high range) and retarding
- AASHTO M 154 (ASTM C 260) "Specification for Air-entraining Admixtures for Concrete".

Admixtures shall not reduce the strength of concrete below that specified. Shrinkage and dosage sensitivity characteristics will be taken into account, if relevant.

Admixtures shall not contain chlorides, chlorine, sulphides or sulphites, or any other substance which may be detrimental to concrete or steel.

Use calcium chloride or admixtures containing calcium chloride will not be permitted.

4.2.2.4 Water

All water used in concrete shall be subject to the Engineer's approval. Water used in mixing, curing, or other designated applications shall as a general rule be potable, otherwise reasonably clean and free from oil, salt, acid, alkali, sugar, vegetable, or any other substance injurious to the finished

product. If required by the Engineer, water shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement test for soundness, time of setting and mortar strength. Indication of unsoundness, change in time of setting of plus or minus 30 minutes or more, or decrease of mortar strength more than 10 percent compared with distilled water shall be sufficient cause for rejection of the water that is being tested.

Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

4.2.2.5 Fine Aggregate

- (a) The fine aggregate for concrete shall consist of natural sand or, subject to approval of the Engineer, other inert materials with similar characteristics, having clean, hard and durable particles, and it shall be free from objectionable quantities of dust, silt, clay, organic matter, and other impurities.
- (b) The fine aggregate shall be uniformly graded and shall meet the following grading requirements :

Grading of Fine Aggregate:

Sieve Size (mm)	Cumulative Passing Percentage by Weight
9.5	100
4.75	95 – 100
2.36	80 – 100
1.18	50 – 85
0.600	25 – 60
0.300	10 – 30
0.150	2 – 10

Sieve analysis of fine aggregate shall be made in accordance with JIS A 1102 (Method of Test for Sieve Analysis of Aggregate) or AASHTO - T 27.

The gradation requirements given above are the extreme limits to be used in determining the suitability of material from all possible sources of supply. The gradation of materials from any one source shall not vary in composition beyond the range of values that govern the selection of a source of supply. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples, submitted by the Contractor, from such sources as he proposes to use. If fineness modulus of fine aggregate varies more than 0.2 from the value used in selecting concrete proportions, the fine aggregate shall be rejected unless suitable adjustment of the mix proportions are made with the approval of the Engineer.

- (c) The amount of deleterious substances in fine aggregate shall not exceed the limits specified in [Table 4.2.2.5](#). Treatment of other deleterious substances which are not shown in the above table shall be determined by the direction of the Engineer.

Tests for material finer than 0.075 mm sieve shall be made in accordance with JIS A 1103 (Method of Test for Amount of Material Passing Standard Sieve 0.074 mm in Aggregates), or AASHTO - T 11.

Table 4.2.2.5
Limits for Deleterious Substances in Fine Aggregates

Item	Maximum % by Weight
* Clay lumps	1.0
* Material finer than 0.075 mm sieve:	
Concrete subject to abrasion	3.0 <u>1/</u>
All other concrete	5.0 <u>1/</u>
* Material coarser than 0.300 mm sieve floating on a liquid having a specific gravity of 1.95	0.5 <u>2/</u>

Note :

- 1/ In the case of crushed aggregate, if the material finer than 0.075 mm sieve consists of the dust of fracture essentially free from clay or shale, these percentages may be increased to 5 and 7 percent respectively.
- 2/ This requirement does not apply to manufactured sand produced from blast furnace slag.

- (d) All fine aggregate shall be free from injurious amounts of organic impurities. Approximate determination of the presence of injurious organic impurities in natural sand shall be in accordance with JIS A 1105 (Method of Test for Organic Impurities in Sands) or AASHTO T 21. Aggregate subjected to the colourimetric test for organic impurities, and producing a colour darker than the standard, shall be rejected.

However, any sand that fails to meet the above requirement may be used provided that the compressive strength of mortar specimens using such sand is more than 95% of that of mortar specimens using the same sand which is washed by 3% solution of sodium hydroxide and then by water, and approved by the Engineer. Testing age of mortar specimens shall be 7 and 28 days for normal Portland cement.

Compressive strength of mortar specimens shall be determined by AASHTO T 71, "Effect of Organic Impurities in Fine Aggregate on Strength of Mortar".

4.2.2.6 Coarse Aggregate

- (a) The coarse aggregate shall consist of one or more of the following: crushed stone, gravel, blast-furnace slag, or other approved inert materials of similar characteristics having clean, hard, durable pieces. It shall be free from objectionable quantities of flat or elongated particles, organic matter or other deleterious matter.
- (b) Sieve analysis of coarse aggregate shall be made in accordance with JIS A 1102 (Method of Test for Sieve Analysis of Aggregate) or AASHTO T 27 and material shall meet the following grading requirements:

Grading of Coarse Aggregate

SIZE	PERCENTAGE BY WEIGHT (JIS A 1102)										
	AMOUNTS FINER THAN EACH STANDARD SIEVE (mm)										
mm	100	80	60	50	40	25	20	15	10	5	2.5
50 - 5	-	-	100	95-100	-	37-70	-	10-35	-	0-5	-
40 - 5	-	-	-	100	95-100	-	35-70	-	10-30	0-5	-
25 - 5	-	-	-	-	100	95-100	-	30-70	-	0-10	0-5
20 - 5	-	-	-	-	-	100	90-100	-	20-55	0-10	0-5
15 - 5	-	-	-	-	-	-	100	90-100	40-70	0-15	0-5
80 - 40	100	90-100	45-75	-	0-15	-	0-5	-	-	-	-
60 - 40	-	100	90-100	35-70	0-15	-	0-5	-	-	-	-
50 - 25	-	-	100	90-100	35-70	0-15	-	0-5	-	-	-
40 - 20	-	-	-	100	90-100	20-55	0-15	-	0-5	-	-

The amount of deleterious substance in coarse aggregate shall not exceed the limits prescribed in [Table 4.2.2.6](#)

- (c) Treatment of the other deleterious substances which are not shown in the table shall be determined by the direction of the Engineer.

Table 4.2.2.6

Limits of Deleterious Substance (Percent by Weight) in Coarse Aggregate

Item	Maximum
Clay lumps	0.25
Soft particles	5.0
Material finer than 0.075 mm sieve	1.0 <u>1/</u>
Material floating on a liquid having a specific gravity of 1.95	1.0 <u>2/</u>

Note :

- 1/ In the case of crushed aggregate, if the material finer than 0.075 mm sieve consists of the dust of fracture essentially free from clay or shale, this percentage may be increased to 1.5.
 - 2/ This requirement does not apply to manufactured sand produced from blast furnace slag.
- (d) Test for material finer than 0.075 mm sieve shall be made in accordance with JIS A 1103 (Method of Test for Amount of Material Passing Standard Sieve 0.075 mm in Aggregates), or AASHTO T11. Test for soft particles shall be made in accordance with JIS A 1126 (Method of Test for Soft Particles in Coarse Aggregate by Use of Scratch Tester), or AASHTO T 112.

4.2.2.7 Test of Aggregate

Before use, results of the foregoing tests of aggregate from each source shall be submitted to and approved by the Engineer. Coarse aggregate shall meet the requirements ASTM C39 for Compressive Strength and the percentage of wear of the Aggregate shall not be greater than 50 as determined by AASHTO T96 . Tests for aggregate in use shall be made when required by the Engineer.

4.2.2.8 Expansion Joint Materials

Jointing materials, joint filler, sealants etc. shall comply with ASTM D 2125, Class 1, Grade15, or BS 8007: 1987 and BS 6213, AASHTO M 33 or other equivalent standards

Expansion joint filler shall consist of formed polythene elastic material sheet material 20 mm thick and with asphaltic sealant on the external surfaces as shown on the Drawings.

Cut-off plate for water stops used for the expansion joints, where required, shall be flexible PVC to JIS K 6773

All expansion joint materials shall be subject to approval by the Engineer following submission of samples and technical specifications by the Contractor of proposed materials.

4.2.2.9 Storage of Materials

- (a) Storage of cement - Cement may be shipped from pre-tested and approved bins at the mill. Cement shall be stored in a damp-proof warehouse with a floor raised at least 300 mm from the ground so as to permit easy access for inspection and for use in the delivered order. Bagged cement shall not be piled more than 13 sacks high. Cement which has become damp, lumpy or otherwise not in proper condition shall not be used. Cement stored by the Contractor for a period longer than 60 (sixty) days shall require the Engineer's approval before being used on the work.
- (b) Storage of aggregate - Fine and coarse aggregates shall be stored separately to prevent contamination by foreign material. Aggregate shall be stored in such a manner as to keep the moisture content as uniform as possible, and shall be handled in such a manner as to prevent segregation. Aggregate shall be stored so as to protect it from the direct rays of the sun. Aggregate from different sources of supply shall not be stored in the same place without permission from the Engineer.

4.2.3 Equipment and Tools

Equipment and tools necessary for handling materials and performing the work, and satisfactory to the Engineer as to design, capacity, and mechanical condition, shall be at the site of the work before work is started.

If any equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or other satisfactory equipment substituted or added at the direction of the Engineer.

4.2.3.1 Batching Plant and Equipment

- (a) General - All material in the mix shall be proportioned wholly by weight. The batching plant shall include bins, weighing hoppers and scales for the fine aggregate and for each separated size of coarse aggregate. If cement is used in bulk, a bin, hopper and scales for the cement shall be included. The container shall be watertight. Provision satisfactory to the Engineer shall be made for batching other components of the mix at the batching plant, which may be either stationary or mobile type. It shall be always properly levelled within the accuracy required for the proper operation of weighing mechanisms.
- (b) Bins and hoppers - Bins with adequate separate compartments for fine aggregate and for each required size of coarse aggregate shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening for removing any overload of the several materials from the hopper shall be provided. Weighing hopper shall be constructed so as to discharge completely.
- (c) Scales - The scales for weighing aggregates and cement shall be of either the beam type or the spring-less dial type. They shall be accurate within one-half of 1% under operating conditions throughout the range of use. Ten weights of 25 kilograms each shall be available for checking accuracy. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean. When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate at least the last 100 kilograms of load and up to 25 kilograms overload.

All weighing and indicating devices shall be in full view of the operator while charging the hopper and he shall have convenient access to all controls.

Cement may be measured by weight, or in standard sacks considered to weigh 50 kilograms net. When measured by weight a separate, satisfactory scale and hopper shall be provided together with a boot or other approved device to transfer the cement from the weighing hopper. Satisfactory methods of handling shall be employed.

Batching shall be so conducted as to result in the weights of material required, within tolerances of 1% for cement and 2% for aggregates.

4.2.3.2 Mixers

- (a) General - All concrete shall be mixed in batch mixers. It may be mixed at the site of construction, at a central plant, or in transit.
- (b) Each mixer shall have attached to it in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of mixing drum.
- (c) Mixers at site of construction - Mixers at the site shall be approved drum-type capable of combining the aggregate, cement and water into a thoroughly mixed and uniform mass within the specified mixing period

and of discharging the mixture without segregation. The mixer shall be equipped with a suitable charging hopper, water storage, and a water measuring device, accurate within 1%. Controls shall be so arranged that the water can be applied only while the mixer is being charged. The discharge level shall lock automatically until the batch has been mixed the required time after all materials are in the mixer.

- (d) Suitable equipment for discharging the concrete on the roadbed shall be provided. The mixer shall be cleaned at suitable intervals. The pick-up and throw-over blades in the drum shall be replaced when they have lost 10% of their depth.
- (e) Central plant mixers - These mixers shall be of approved drum type capable of combining the aggregate, cement and water into the thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Central plant mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. The water system for a central mixer shall be either a calibrated measuring tank or a metre and shall not necessarily be an integral part of the mixer.

The mixers shall be cleaned at suitable intervals. They shall be examined daily for changes in interior condition. The pick-up and throw-over blades in the drum shall be replaced when they have lost 10% of their depth.

- (f) Truck or transit mixers - These shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may readily be verified and the counters shall be actuated at the commencement of mixing operations at designated mixing speeds. The mixer when loaded shall not be filled to more than 60% of the drum gross volume. The mixer shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Except when intended for use exclusively as agitators, truck mixers shall be provided with a water measuring device to measure accurately the quantity of water for each batch. The delivered amount of water shall be within plus or minus 1% of the indicated amount.

4.2.3.3 Vibrators

Unless otherwise directed, the concrete shall be consolidated with approved mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

The vibrators shall be of a type approved by the Engineer, with a minimum frequency of 3500 impulses per minute and shall be capable of visibly affecting a properly designed concrete with a 20 mm slump over a circular area of 450 mm radius. The number of vibrators used shall be sufficient to consolidate the concrete properly within 10 minutes after it is deposited in the forms and in addition at least 3 spare vibrators shall be available on standby at the site of the pour to maintain immediate continuity in case of breakdown.

4.2.3.4 Forms

- (a) Forms shall be made of metal, timber or other approved material and shall conform to the shape, lines and dimensions of the members shown on the Drawings, and shall be so constructed as to prevent deformation due to load, vibration, and other causes.
- (b) Forms shall be properly equipped with braces, ties and other devices, so as to maintain them in the positions and the shape as shown on the Drawings.
- (c) Forms shall be so constructed that they can be removed easily and safely. Joints in linings or panels shall be either horizontal or vertical as far as possible, and shall be sufficiently tight to prevent any leakage of mortar.
- (d) Curved forms shall be of the radius called for on the Drawings and acceptable flexible forms shall be installed with that radius.
- (e) After forms have been set in the correct location, they shall be inspected and approved by the Engineer before concrete is placed.
- (f) Care shall be exercised to keep forms free from dust, grease or other foreign matter. No material or treatment that will adhere to concrete or discolour concrete shall be used. All forms shall be treated with an approved form-release-oil prior to placing reinforcement.
- (g) For narrow walls, columns, etc., where the bottom of the form is inaccessible, lower form boards or parts thereof shall be left loose so that they may be removed for cleaning out extraneous material immediately before placing concrete.
- (h) Forms for exposed surfaces shall be constructed with triangular fillets not less than 25 mm x 25 mm attached so as to prevent mortar runs and to produce smooth straight chamfers at all sharp external edges of the concrete.

4.2.3.5 Batching and Transporting Materials

For mixing at site of construction, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers adequate in design and construction to properly carry the batch required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or while being dumped.

Cement in original shipping containers may be transported on top of the aggregates. The number of sacks of cement required for each batch shall be placed on the aggregates for that batch. Sacked cement shall be emptied into the aggregates prior to dumping into mixer.

Batches shall be delivered to the mixer separately and intact. Each batch container shall be dumped cleanly into the mixer without loss of cement or mixing or spilling of material from one batch compartment into another.

4.2.3.6 Mixing Concrete

- (a) General - Concrete shall be mixed at the construction site, at a central mixing plant, in a truck mixer, or by a combination of central plant and truck mixing. Hand-mixing may be used only when approved by the Engineer. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

- (b) Mixing at site of concrete construction - Concrete shall be mixed in a batch mixer of the type and capacity approved by the Engineer. Mixing time shall be determined by the Engineer in accordance with JIS A 1119 (Method of Test for Variation in Unit Weight of Air Free Mortar in Freshly Mixed Concrete). When results of the above tests are not available, the mixing time shall be longer than 1 1/2 minutes after all the materials have been introduced into the mixer, but in no case shall the mixing time exceed three times the mixing time prescribed above. Charging of water into the mixer shall begin before the cement and aggregates enter the drum. During mixing, the drum shall be operated at speeds specified by manufacturers. Pick-up blades in the drum of the mixer which are worn down 20 mm or more at any part must be replaced.

The volume of a batch shall not exceed the manufacturer's rated capacity of the mixer without written permission of the Engineer. No mixer whose rated capacity is less than a one-bag batch shall be used.

Concrete shall be mixed only in such quantities as are required for immediate use, and concrete which is not of the required consistency at the time of placement shall not be used.

Re-tempering of concrete will not be permitted. Entire content of the mixer shall be removed from the drum before materials for the next batch are placed therein. Upon cessation of mixing for a considerable length of time, the mixer shall be cleaned thoroughly. Upon resumption of mixing, the first batch of concrete material placed in the mixer shall contain sufficient sand, cement, and water to coat the inside surface of the drum without diminishing the required mortar content of the mix.

- (c) Central plant mixing - When mixed at a central plant, the mixer and methods used shall be in accordance with the requirements of [Sub-Clause 4.2.3.6 \(b\)](#). Mixed concrete shall be transported from the central mixing plant to the site of work in agitator or non-agitator trucks approved by the Engineer.

Agitator trucks shall be equipped with a water-tight revolving drum, and shall be capable of transporting and discharging concrete without segregation. The agitation speed of the drum shall be between 2 and 6 revolutions per minute. The volume of mixed concrete permitted in the drum shall not exceed the manufacturer's rating nor exceed 70% of the gross volume of the drum. Upon approval of the Engineer, truck mixers may be used in lieu of agitator trucks for transportation of central plant mixed concrete. Gross volume of agitator bodies, expressed in cubic metres, shall be as determined by the mixer manufacturer. The interval between introduction of water into mixer drum and final discharge time shall be a maximum of 45 minutes unless the use of additives have been approved. Depending on the type and usage of the approved additives this interval may be extended up to a maximum of 2 hours. During this interval the mixture shall be agitated continuously.

Bodies of non-agitator trucks shall be smooth and water-tight. Covers shall be provided when needed for protection against rainfall. The non-agitator trucks shall deliver concrete to the work site in a thoroughly mixed and uniform mass. Uniformity shall be deemed satisfactory if samples from the one-quarter and three-quarter points of the load do not differ more than 25 mm in slump. Placing of concrete shall be completed within 30 minutes after introduction of mixing water into the cement and aggregates or if admixture is used at a time to be determined by the Engineer.

- (d) Truck mixing - Concrete may be mixed in truck mixers of approved design. Truck mixing shall be in accordance with the following provisions. The truck mixer shall be either a closed, water-tight, revolving drum or an open-top revolving-blade or paddle type. It shall combine all ingredients into a thoroughly mixed and uniform mass, and shall discharge the concrete with satisfactory uniformity. A maximum difference of 25 mm between slumps of samples from the one-quarter and three-quarter points of the discharge load shall be deemed satisfactory.

Mixing speed for revolving drum type mixers shall not be less than 4 revolutions per minute of the drum nor greater than a speed resulting in a peripheral velocity of the drum of 1 metre per second. For the open-top type mixer, mixing speed shall be between 4 and 16 revolutions per minute of the mixing blades or paddles. Agitation speed for both the revolving-drum and revolving blade type mixers shall be between 2 and 6 revolutions per minute of the drum or mixing blades or paddles.

The capacities of truck mixer shall be in accordance with the manufacturer's ratings except that they shall not exceed the limitation herein. Standard for normal rated capacity, expressed as percentage of the gross volume of the drum, shall not be more than 50% for truck mixing and 70% for agitating.

The concrete shall be delivered to the site of the work and discharge shall be completed within 45 minutes after the introduction of the mixing water into cement and aggregates unless the use of additives have been approved by the Engineer. Depending on the type and usage of the approved additives this interval may be extended up to a maximum of 2 hours. During this interval the mixture shall be agitated continuously.

When the concrete is mixed in a truck mixer, the mixing operation shall begin within 30 minutes after the cement has been mixed with the aggregates. Except when intended for use exclusively as agitators, truck mixers shall be provided with a water measuring device which will measure accurately the quantity of water for each batch. The delivered amount of water shall be within plus or minus 1% of the indicated amount when the tank, if mounted on the truck mixer, is satisfactorily and practically level.

- (e) Hand mixing - Hand mixing will not be permitted, except in case of emergency, without written permission from the Engineer. When permitted, it shall be performed only on water-tight mixing platforms made of metal, etc. Concrete shall be turned and returned on the platform at least six times and until all particles of the coarse aggregate are covered thoroughly with mortar and the mixture is uniform.

4.2.3.7 Retempering Concrete

Retempering concrete by adding water will not be permitted under any circumstances. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be permitted only with the written approval of the Engineer.

4.2.3.8 Consistency

Slump will be measured in accordance with AASHTO T 119 or JIS A 1101 and shall be in accordance with [Table 4.2.1.3](#).

4.2.4 Construction

4.2.4.1 General

The Contractor shall maintain an adequate number of trained and experienced supervisors and foremen at the site to supervise and control the work. All construction, other than the concrete, shall conform to the requirements prescribed in other sections or Clauses for the several items of work entering into the complete structure.

4.2.4.2 Foundation

Preparation of foundations shall conform to the details as shown on the Drawings in accordance with the requirements of [Section 3, Earthworks](#). The Engineer may order further excavation as necessary to obtain satisfactory foundations in the event that unsuitable foundations are encountered at the depths shown on the Drawings.

Pile foundations shall be constructed in accordance with the provisions set out in the other relevant Clauses and as shown on the Drawings.

4.2.4.3 Falsework

Falsework shall be built on foundations of sufficient strength to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings must be supported by ample falsework piling provided at the Contractor's expense.

Before constructing forms or falsework the Contractor, if required, shall submit detailed drawings of proposed forms or falsework for approval by the Engineer, but such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

4.2.4.4 Formwork

Before concrete is placed the Engineer shall inspect all formwork and falsework and no concrete shall be placed until the Engineer has inspected and approved such formwork and falsework. Such approval shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

Internal formwork for hollow slab construction shall be made of plywood, thin metal plate or other materials. These materials shall have sufficient strength to resist the pressure and the buoyancy effects of fresh concrete.

Type and structure of joint and cover for the cylindrical form shall be tight to prevent any leakage of concrete, and shall be approved by the Engineer. Nominal diameter of cylindrical forms shall be the outer diameter, or the outer diameter of projecting portion in case of thin metal plate having projection. The height of the projection shall be less than 10 mm.

Internal forms shall be fixed in the correct position such that they will not displace or deform during placing concrete. Ushape bolts shall be used to fix the internal forms and the method of supporting and fixing the internal forms shall be approved by the Engineer. Care shall be taken to ensure that U-shape bolts and other items can resist the buoyancy forces on the formwork.

In falsework, bridge camber shall be considered in accordance with the Working Drawings prepared by the Contractor and approved by the Engineer.

4.2.4.5 Reinforcement

The Engineer shall inspect and approve all reinforcement in place in accordance with the requirements of [Clause 4.3](#), before concrete is placed. An experienced steel fixer shall be present while all concrete is placed to ensure that no reinforcement becomes displaced during placing and if it does to reposition reinforcement before placing continues.

4.2.4.6 Placing Concrete

- (a) General - All concrete shall be placed within the time specified in [Sub-Clause 4.2.3.6](#). Concrete shall be placed in such a manner as to avoid segregation and the displacement of reinforcing bars and shall be spread in horizontal layers where practicable. Concrete shall be placed where necessary inside forms by hand shovels and in no instance shall vibrators be so manipulated to transport concrete inside formwork. Care shall be taken to prevent mortar from spattering forms and reinforcing steel and from drying ahead of the final covering with concrete. When spattering has occurred the forms and steel shall be cleaned with wire brushes or scrapers before concrete is placed around steel or in forms which have been spattered.

Troughs, pipes, or short chutes used as aids in placing concrete shall be positioned in such a manner that segregation of the concrete will not occur. All chutes, troughs, and pipes shall be kept clean and free from coating of hardened concrete or mortar. Concrete shall not be dropped freely over a vertical distance of more than 1.5 metres.

[Concrete shall generally be placed continuously throughout each section of the structure or between indicated joints if shown on the Drawings or as directed by the Engineer.](#)

If in an emergency it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the Engineer may direct and the resulting joint shall be deemed a construction joint, and treated as specified herein below.

- (b) [Concrete columns - Concrete in columns, bents or walls shall be placed in one continuous operation subject to a maximum height of 4m unless shown on the Drawings or otherwise permitted by the Engineer.](#)
- (c) Concrete slab and girder spans - Slabs and girders having spans of 10 metres or less shall be placed in one continuous operation unless otherwise stated on the Drawings. Concrete preferably shall be deposited by beginning at the centre of the span working from the centre toward the ends.

Concrete in slab spans shall be placed in one continuous operation and in one layer for each span, unless otherwise stated on the Drawings.

Concrete in girders spanning more than 10 metres may be placed in two operations, the first operation being the placing of concrete in the girder stems to the bottom of the slab haunches or the bottom of the slab whichever is applicable. A period of at least 24 hours shall elapse between the completion of placing concrete in the girder and the commencement of placing concrete in slab.

The construction procedure for the concrete deck slab on steel box girders shall be so arranged as to eliminate excessive stress in new or recently placed concrete.

Immediately before placing concrete, the top surface of the previously placed concrete shall be hammered with a sharp hand tool (scrabbled) until the aggregate is exposed and cleaned. The Contractor shall check all falsework for shrinkage and settlement, and shall tighten all wedges to ensure minimum deflection of all formwork.

- (d) Walls, piers, etc. - Where walls, piers, columns, struts, posts and other such structural members allow horizontal construction joints, concrete shall not be placed on top of other concrete which has not been allowed to set for 12 hours or more.

Work shall not be discontinued within 450 mm of the top of any face, unless provision has been made for a coping less than 450 mm thick, in which case, if permitted by the Engineer, the construction joint may be made at the underside of the coping.

- (e) Culverts - The slabs of box culverts shall be placed for their full depth in one mass or layer and allowed to set not less than 12 hours before any additional work is done on them.

Before concrete is placed in sidewalls, bottom slabs shall be cleaned of all shavings, sticks, sawdust and other extraneous material.

The Contractor shall submit to the Engineer for approval his proposals for pouring culvert walls before commencing culvert construction. Concrete shall not be placed in layers more than one metre high relative to the concrete already placed. Deposition shall proceed in a systematic manner.

- (f) Depositing concrete underwater - Concrete shall not be deposited in water except with the approval of the Engineer and with his immediate supervision, and by the method described in this paragraph.

To prevent segregation, the concrete shall be carefully placed in a compact mass in its final position by means of a tremie tube or pipe, or a closed bottom-dump bucket, or by other means, and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Concrete seals shall be placed in one continuous operation. When a tremie tube or pipe is used, it shall consist of a tube or pipe not less than 250 mm in diameter, constructed in sections having flanged couplings fitted with gaskets.

The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the concrete and permit its being lowered rapidly when necessary to choke off or retard the flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie shall contain sufficient concrete to prevent any water entry.

When concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than 1.20 cubic metres and shall be equipped with loose-fitting top covers. The bottom door shall open freely downward and outward when tripped. The bucket shall be completely filled and be lowered gradually and carefully until it rests on the surface upon which the concrete is to be deposited. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Dewatering shall proceed only when the concrete seal is considered strong enough to withstand any pressures to be exerted upon it. This time will be decided by the Engineer. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, jetting, chipping or other means which will not unduly injure the seal.

- (g) Construction joints - Construction joints shall be located where shown on the Drawings or permitted or instructed by the Engineer. Construction joints shall be perpendicular to the principal lines of stress and in general shall be located at points of minimum shear.

At horizontal construction joints, details shall be as approved by the Engineer. Before placing fresh concrete, the surfaces of construction joints shall be scabbled, sandblasted or washed and scrubbed with a wire brush to expose clean aggregate, drenched with water until saturated, and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place and the old surface shall be coated thoroughly with a 1.5 mm thick coating of neat cement mortar. Concrete in substructures shall be placed in such a manner that all exposed horizontal construction joints will be truly horizontal.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through panelled wing walls or other large surfaces which are to have an architectural finish. Necessary dowel, load-transfer devices, and bonding devices shall be placed as shown on the Drawings or directed by the Engineer.

- (h) Expansion joints – Expansion joints shall comprise formed polythene elastic material with asphaltic sealant, 20mm thick, and shall be located and formed as required on the Drawings. Cut-off plate for water stops used for the expansion joints shall be placed in accordance with the Drawings. The water stops shall be held firmly in place to prevent displacement during concreting. If after placing concrete water stops are materially out of position or shape, the surrounding concrete shall be removed, the water stop reset, and the concrete replaced, all at the Contractor's expense.

Water stop shall be furnished full length for each straight portion of the joint, without field splices. Water stop shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion. All field splices shall be performed by heat sealing, hot-air welding or vulcanising the adjacent surfaces in accordance with the manufacturer's recommendations to form continuous watertight joints.

Dowel bars, where required, shall be complete with uPVC sleeves and shall be accurately installed in expansion joints in accordance with the Drawings or as directed by the Engineer. Particular care shall be taken to ensure that concrete cannot enter the uPVC sleeves during casting.

- (i) Open joints - Open joints shall be constructed where shown on the Drawings by insertion and subsequent removal of a wooden strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the Drawings.
- (j) Anchor bolts - All necessary anchor bolts shall be accurately set in holes formed while the concrete is being placed. Holes may be formed

by inserting in the fresh concrete oiled wooden plugs, metal pipe sleeves, or other approved devices, and withdrawing them after the concrete has partially set. Holes so formed shall be at least 100 mm in diameter. Bolts shall be set accurately and fixed with grout completely filling the holes. The grout shall be non-shrink mortar of a type approved by the Engineer.

- (k) Shoes and bearing plates – [Not applicable to the Works in Package A](#)
- (l) Drainage holes and weep holes - Drainage holes and weep holes shall be constructed in the manner and at the locations indicated on the Drawings or required by the Engineer. Ports or vents for equalizing hydrostatic pressure shall be placed below low water.
- (m) Forms for weep holes through concrete shall be PVC pipe. Exposed surfaces of weep drain pipe shall be flush with the concrete.
- (n) Pipe, conduits, and ducts - Pipes, conduits, and ducts that are to be encased in concrete shall be installed by the Contractor before the concrete is placed. Unless otherwise indicated, pipe embedded in concrete shall be standard, light-weight, non-corrosive pipes. Pipes shall be held or braced rigidly during concrete placement in order to prevent their displacement.
- (o) Piers and abutments – [Not applicable to the Works in Package A](#)

4.2.4.7 Curing Concrete

Immediately after forms have been removed and finishing work completed, all concrete shall be cured by one of the following methods. The Engineer will specify the concrete surface which may be cured by either method.

- (a) Water method - The entire exposed surfaces other than slabs shall be protected from the sun and the whole structure shall be covered with wet burlap, cotton mats, or other suitable fabric for a period of at least seven days. These materials shall be kept thoroughly wet for the entire curing period. Curbs, walls, and other surfaces requiring a rubbed finish may have the covering temporarily removed for finishing, but the covering must be restored as soon as possible. All concrete slabs shall be covered as soon as possible with sand, earth or other suitable material and kept thoroughly wet for at least seven days. This covering material shall not be cleared from the surface of the concrete slabs for a period of twenty one days.

If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent them from shrinking.

- (b) Membrane forming curing compound - All surfaces shall be given the required surface finish prior to application of the curing compound. During the finishing period, the concrete shall be protected by the water method of curing.

Membrane curing compound shall be applied after the removal of forms, or after the disappearance of surface water. It can be sprayed or applied to the concrete surface by means of an applicator in one or more coats at the rate instructed by the manufacturer.

Should the membrane seal be broken or damaged before the expiration of the curing period, the damaged area shall be immediately repaired by the application of additional membrane material.

The Contractor's proposals for the use of liquid membrane curing compound and the locations shall be subject to the approval of the Engineer.

4.2.4.8 Removal of Formwork and Falsework

- (a) Time of removal - formwork and falsework shall not be removed without the approval of the Engineer. The Engineer's approval shall not relieve the Contractor of responsibility for the safety of the work. Blocks and bracing shall be removed at the same time as the forms and in no case shall any portion of wooden forms be left in the concrete.

Falsework removal for continuous or cantilevered structures shall be as approved and directed by the Engineer and shall be such that the structure is gradually subjected to its working stress.

When the time for removal of forms and supports is determined based on concrete strength tests, such removal shall not begin until the concrete has attained the percentage of the specified design strength shown in the table below.

If field operations are not controlled by compressive strength tests, the time shown below for removal of forms and supports shall be used as a minimum:

In continuous structures, falsework shall not be released in any span until the first and second adjoining spans on each side have reached the strength specified herein or in the special provisions. When cast-in-place post-tensioned bridges are constructed, falsework shall remain in place until all post-tensioning has been accomplished

Removal of Formwork and Falsework

Structure	Standard Concrete	Early Strength Concrete	Percentage of Design Strength
Centering under girders, beams, frames or arches	14 days	7 days	80%
Floor slabs	14 days	7 days	70%
Walls	1 day	12 hours	-
Columns	2 days	1 day	-
Sides of beams and all other vertical surfaces	1 day	12 hours	-

Falsework under all spans of continuous structures shall be completely released before concrete is placed in railings and bridge parapets [or other upper elements depending on the type of structure.](#)

Forms and falsework shall not be released from under concrete without first determining if the concrete has gained adequate strength without regard to the time element. In the absence of strength determinations, the forms and falsework are to remain in place until removal is permitted by the Engineer.

The forms for footings constructed within cofferdams or cribs may be left in place when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the finished structure. All other forms shall be removed whether above or below the ground line or water level.

All formwork shall be removed from the cells of concrete box girders within which utilities are required, and all formwork except that necessary to support the deck slab shall be removed from the remaining cells of the box girder.

To facilitate finishing, forms used on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed at least 12 but not more than 48 hours later depending upon weather conditions.

In order to determine the condition of concrete in columns, forms to columns shall always be removed before releasing supports from beneath beams and girders.

Falsework supporting the deck of rigid frame structures shall not be removed until fill has been placed behind the vertical legs.

- (b) Patching - Immediately following removal of the forms all projecting wires or metal devices that have been used for holding the forms in place shall be removed or cut back at least 25 mm beneath the surface of the concrete. Fins or runs of mortar and all irregularities caused by form joints shall be removed. Small holes, depressions, and voids that show on the concrete shall be filled with cement mortar mixed in the same proportions as that used in the body of the work, except without coarse aggregate.

The surface of this mortar shall be floated with a wooden float before initial set takes place. It shall be uniform in colour with the surrounding concrete and neat and workmanlike in appearance.

- (c) Cause for rejection - Excessive honeycombing shall be sufficient cause for rejection of portions of the structure containing this honeycombing. The Contractor, on receipt of written orders from the Engineer, shall remove and rebuild such portions of the structure at his own expense.

4.2.4.9 Finishing Concrete

All concrete surfaces exposed in the completed work shall comply with the requirements of [Item \(c\)](#) Ordinary finish herein except where otherwise shown or specified.

- (a) Concrete [bridge](#) decks - Immediately after placing concrete, concrete decks shall be struck off with templates to provide proper transverse sections and shall be hand finished smooth to the concrete levels. Finish shall be slightly but uniformly roughened by brooming. The finished surface shall not vary more than 10 millimetres from a 4 metre straightedge placed parallel to the centreline of the roadway and 10 millimetres from a transverse template cut to the true cross section of the roadway. (This Item is not applicable to this Package)
- (b) Curb, footpath and concrete paved surfaces - Exposed faces of curbs and footpath shall be finished true to lines and grades. The curb surface shall be wood floated to a smooth but non-slippery finish. Footpath surfaces shall be slightly but uniformly roughened by brooming across the direction of travel. [Concrete paved surfaces shall be wood float finished.](#)
- (c) Ordinary finish - An ordinary finish is defined as the finish left on a surface after the removal of the forms when all holes left by form ties have been filled, and any minor surface defects have been repaired. The surface shall be true and even, free from depressions or projections and of reasonably uniform colour.

Repaired surfaces, the appearance of which is not satisfactory, shall be "rubbed" as specified in [Item \(d\)](#) Rubbed finish.

The concrete in bridge seats, caps, and tops of walls shall be struck off with a straightedge and floated to true grade. Unless shown on the Drawings the use of mortar topping for concrete surfaces will not be permitted.

- (d) Rubbed finish - After the removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in patching to set thoroughly. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as those used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform colour.

After the final rubbing has been completed and the surface has dried, it shall be rubbed with burlap to remove loose particles and laitance. The final surface shall be free from all unsound patches, paste, powder and objectionable marks.

- (e) Backfill and road fills - All spaces which have been excavated and the volumes of which are not occupied by the concrete structure shall be backfilled and compacted with acceptable material in accordance with the provisions of [Section 3](#) of these Specifications.

If there is likelihood of water accumulating behind any wall, the backfill shall not be placed until after the retaining, diaphragm, or spandrel walls are 28 days old. No fill shall be placed over arches and slabs until the concrete is 28 days old or until test specimens indicate the concrete has attained the required 28-day strength.

- (f) Loading - Traffic or heavy construction equipment shall not be allowed on reinforced concrete structures until 28 days have elapsed from the last placing of concrete except as noted below. If it is proposed to use the structure at an earlier date, extra test specimens shall be cast. The structure may be used when tests of these specimens show that the concrete has attained its specified 28-day strength.

4.2.4.10 Cleaning Up

Upon completion of structure and before final acceptance, the Contractor shall remove all falsework, falsework piling, etc., down to 1.0 metre below the finished ground line. Excavated, or useless materials, rubbish, etc. shall be removed from the site and the site shall be left in a neat and presentable condition satisfactory to the Engineer.

4.3 REINFORCING STEEL BARS

4.3.1 Description

This work shall consist of furnishing, fabricating, and placing reinforcing steel bars of the type and size provided in accordance with these Specifications and in reasonably close conformity with the Drawings or as directed by the Engineer.

4.3.2 Materials

Reinforcing steel shall conform to the requirements of the following specifications except that the weights of the standard bar sizes will be taken as per [Table 4.4.2.a](#) and [Table 4.4.2.b](#), irrespective of the specification used in manufacture.

Round Bar :

A-I (CT-3) 22TCN 18-79; or
JIS G 3112 (Grade SR 235); or
ASTM A615

Deformed Bars :

A-II (CT-5) 22TCN 18-79; or
JIS G 3112 (Grade SD 295A); or
JIS G 3112 (Grade SD 345); or
ASTM A615

Reinforcing bars shall be kept off the ground and stored within a building or provided with suitable cover.

4.3.3 Construction

4.3.3.1 Fabrication

- (a) Reinforcing bars shall be accurately formed to the shapes and dimensions indicated in the design, and shall be fabricated in a manner that will not injure the material.
- (b) Unless otherwise permitted, all reinforcing bars requiring bending shall be bent cold. When reinforcing bars are bent by heating, the entire operation shall be approved by the Engineer. Should the Engineer approve the application of heat for field bending reinforcing bars, precautions shall be taken to ensure that the physical properties of the steel will not be materially altered.
- (c) Reinforcing bars that cannot be straightened by means of fabrication shall not be used. Bars partially embedded in concrete shall not be bent except as shown on the Drawings or otherwise permitted.
- (d) Qualified workers shall be employed for cutting and bending, and proper appliances shall be provided for such work.
- (e) If it is necessary for the Engineer to ascertain the quality of reinforcing bars, the Contractor shall test reinforcing bars, at his own expense, by means as directed by the Engineer.

4.3.3.2 Placing

- (a) Reinforcing bars before being positioned shall be cleaned and free from rust, dirt, mud and loose scale and from paint, oil, or any other foreign substance that destroys or reduces the bond.
- (b) Reinforcing bars shall be accurately placed in proper position so that they will be firmly held during placing concrete. Reinforcing bars for erecting shall be used when needed.
- (c) Bars shall be tied at all intersections by using annealed iron wire 0.9 mm or larger diameter or suitable clips. Welding will not be permitted for this requirement.

- (d) Distances from the forms shall be maintained correctly by means of metal hangers, mortar blocks, metal supports, or other supports approved by the Engineer.
- (e) Reinforcing bars shall be inspected by the Engineer after placing. When a long time has elapsed after placing reinforcing bars, they shall be cleaned and inspected again by the Engineer before placing concrete.

4.3.3.3 Splicing

- (a) When it is necessary to splice reinforcing bar at points other than shown on the designs, positions and methods of splicing shall be determined based on strength calculations approved by the Engineer.
- (b) In lapped splices, the bars shall be lapped the required length and wired together at several points by using annealed iron wire larger than 0.9 mm.
- (c) Exposed reinforcing bars intended for bonding with future extensions shall be effectively protected from injury and corrosion.
- (d) Welding of reinforcing steel shall be done only if detailed on the Drawings or if authorized by the Engineer in writing.
- (e) Substitution of different size bars shall be permitted only upon the specific authorization of the Engineer. If steel is substituted, it shall be of a size equivalent to the design size or larger.

4.4 MEASUREMENT AND PAYMENT

4.4.1 Concrete

(a) Measurement

Measurement shall be made of the volume of concrete of the various classes in place and approved by the Engineer.

In computing quantities the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer but the measurement shall not include any concrete used for the construction of temporary works. No deduction from the measured quantity shall be made for the volume occupied by pipes less than 200 mm in diameter nor for reinforcing steel, anchors, conduits, weep holes or piling.

No pay allowance shall be made for any increased cement content, for any admixtures nor for any finishing of any description of concrete or concrete floor.

Unless described otherwise, Concrete used for the works on other Pay Items in these Specifications (e.g. precast concrete culverts) will not be measured for payment under this Clause.

(b) Payment

Payment for the various classes of concrete shall be paid for at the respective unit rate per cubic metre entered in the Bill of Quantities. The payment shall be full compensation for furnishing and placing all materials, including all labour, tools, equipment, formwork, falsework (scaffolding and supporting; for mixing, placing, finishing and curing the concrete, etc., and all incidental work thereto.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.9 2.3.10 2.4.19 2.4.20 2.5.6 2.5.7 3.3.9 3.3.10 3.4.9 3.4.10 3.5.17 3.5.18 3.6.6 3.6.7 3.9.8 3.9.9 3.9.10	Concrete (various classes): including supply, placement and formwork	m ³

4.4.2 Reinforcing Steel Bar

(a) Measurement

The quantity of reinforcing steel bar to be paid for shall be the mass (kg) of reinforcing bar erected as shown on the Drawings or ordered by the Engineer in writing. The mass calculated will be based upon the following tables :

Table 4.4.2.
Unit Mass of Reinforcing Steel Bars

Nom. Bar Size (diameter mm)	9	10	12	14	16	18	20
Mass per linear metre in kg	0.499	0.617	0.888	1.210	1.580	2.000	2.470

Nom. Bar Size (diameter mm)	22	28	30	32	36	40	-
Mass per linear metre in kg	2.98	4.83	5.55	6.31	7.99	9.89	-

The lengths to be taken in calculating the mass for the purpose of payment shall be shown on the Drawings or ordered in writing by the Engineer.

No measurement or payment will be made for splices added by the Contractor for his convenience or for splices which are not shown on the Drawings and are not approved by the Engineer.

Clips, ties or other material used for positioning and fastening the reinforcing bars in place shall not be measured for payment. Reinforcing steel bars used for precast concrete elements shall not be measured for payment under this Clause.

(b) Payment

Payment for reinforcing steel bar shall be made at the unit rate entered in the Bill of Quantities. This payment shall be full compensation for furnishing all labour, equipment, and materials, necessary for fabricating, bending, assembling and erecting reinforcing bar, for unloading at the specific location, storing and handling of reinforcing steel bar and any other associated costs.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.21 2.5.8 3.5.19 3.6.8 3.9.12	Deformed Reinforcing Bar	kg

SECTION 5. REVETMENTS

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SECTION 5. REVETMENTS

5.1 GENERAL

This section specifies the requirements for the construction of revetments along the banks of the improved portions of the Tau Hu and Ben Nghe canals.

Revetments shall be completed in sections of a minimum of 200 m and any temporary works (eg. Cofferdams) removed prior to carrying out channel excavation in the adjacent canal bed.

5.2 SCOPE OF WORK

The Contractor shall construct the revetments Type A and Type B to the lines and level as shown on the Drawings, in accordance with this specification and the directions of the Engineer.

For the purposes of this specification, revetments shall include timber piling, free draining gravel, geotextile cloth, precast, reinforced concrete toe block, levelling concrete and plain concrete, wet stone masonry facing, weep holes, stone masonry stairs, expansion joints, rip rap toe and any other incidentals necessary to complete the work.

5.3 PREPARATORY WORKS

The Contractor shall complete all necessary preparatory works in accordance with the requirements of Section 2, Preparatory Works.

Coffer dams shall be in place and an effective dewatering system in place and operating before construction of revetments commences.

Payment for preparatory works in connection with the construction of revetments will be paid under Section 2, Preparatory Works.

5.4 EARTHWORKS

The contractor shall carry out all earthworks required for the construction of revetments in accordance with the requirements of Section 3, Earthworks. This work shall include, but not be limited to, excavating and trimming the bank to the required slope, compacting subgrade and placing and compacting sandy soil fill.

Payment for earthworks in connection with the construction of revetments will be paid under Section 3, Earthworks.

5.5 CONSTRUCTION OF REVETMENTS

5.5.1 General

The Contractor shall submit his proposal for construction of revetments, in accordance with the Drawings, for approval by the Engineer. The proposal shall clearly indicate the sequence of work, the method of dewatering, the materials and equipment to be deployed. Construction shall be made in the dry using coffering and dewatering. The work sequence shall be from timber piling, concrete toe footing construction then proceeding upwards.

5.5.2 Timber Piling

5.5.2.1 General

Timber piles shall be driven to the depths and at the spacing (or density) as shown on the Drawings or as directed by the Engineer.

5.5.2.2 Materials

Timber Piles (Wooden Piles) shall be cut from Paper Bark or other locally available timber which, subject to the Engineer's approval, is suitable for the intended application. Piles shall be of single length, not shorter than 4500 mm and with diameter not less than 80 mm at any point in the length and not greater than 150 mm and shall be straight to a tolerance of 50 mm over their full length, stripped of any branches and of sound condition. Splicing shall not be permitted. Piles not meeting the foregoing requirements shall be removed from the Site.

5.5.2.3 Construction

Timber piles shall be driven at the density (piles per square metre) shown on the drawing to depths such the pile heads correspond to the lines and levels of the subsequent structure or layer, or to the natural surface level as the case may be.

Piles shall be driven true and plumb and spacings shall be regular. Any pile which split, broken, or is more than 300 mm out of position shall be replaced at the Contractor's expense.

5.5.3 Gravel

Gravel bedding and free draining gravel shall comply with Clause 3.3.2 and shall be placed in accordance with Clause 3.3.8 of Section 3, Earthworks.

5.5.4 Levelling Concrete

Levelling concrete shall be placed on the bed of prepared gravel as shown on the Drawings. Concrete shall be in accordance with the requirements of Section 4.

5.5.5 Precast Reinforced Concrete Toe Blocks

5.5.5.1 General

Precast, reinforced concrete, toe block for revetments shall be furnished and laid to the lines and levels shown on the Drawings or as instructed by the Engineer.

5.5.5.2 Materials

Concrete shall be concrete class D as specified in Section 4.

Reinforcement shall be deformed bars as specified in Section 4.

5.5.5.3 Construction

Toe blocks shall be precast at least 14 days prior to installation. The concrete strength of blocks shall be verified by reference to the 7-day test results prior to use. Any block whose 7 day strength is below target strength shall not be used. The subsequent use shall be dependent on the 28 day strength results and the Engineer's approval.

Toe blocks shall be laid on the bed of levelling concrete accurately in position to a tolerance of + or - 25 mm.

Any block which is damaged in handling and deemed unsuitable for use by the Engineer shall not be used and shall be removed from the site.

5.5.6 Weep Holes

5.5.6.1 General

Weep holes shall be constructed at the locations shown on the Drawings.

5.5.6.2 Materials

Pipe:

Material for weep holes shall be 100 mm nominal diameter, black, Unplasticised Poly-Vinyl-Chloride (uPVC) conforming to the requirements of JIS K 6741. Pipe for weep holes shall be approved in writing by the Engineer before any purchase orders are placed.

Filter Cloth

Filter cloth shall be a polyester, staple fibre, needle punched felt with a minimum mass of 250 g/m² and shall comply with ASTM M 288 'Geotextiles used for Subsurface Drainage Purposes'.

5.5.6.3 Construction

Pipes for weep holes shall be cut to the required lengths as shown on the Drawings. Filter cloth shall be tied firmly to the pipe with nylon twine so as to ensure that all water which will enter the pipes must pass through the filter cloth.

Assembled units shall be placed in the work at the levels, positions shown on the Drawings taking care to ensure that filter constructed as described above remains intact and that the exposed ends on the face of the work are flush with the face of the structure through which the weep hole passes. Gravel backfill shall be carefully hand placed around inner ends of the filters ensuring that that the filter remains intact.

5.5.7 Geotextile Cloth

Geotextile cloth shall be placed on the prepared, trimmed, batter surface of the bank prior to placing the free draining gravel layer. Materials and workmanship shall be in accordance with Section 3, Clause 3.5. Laps shall not be less than 250 mm.

5.5.8 Concrete Works

5.5.8.1 General

Concrete works for revetment construction shall consist of levelling concrete, 100 mm plain concrete screed and plain concrete bedding for the wet stone masonry, reinforced concrete for toe blocks and plain concrete stringers for stairs.

5.5.8.2 Materials

All materials shall comply with the requirements of Section 4, Concrete.

Reinforced Concrete shall be Class E

Plain Concrete shall be Class F

Levelling Concrete shall be Class G

Reinforcement shall be deformed bars in accordance with Sub-Clause 4.3.2, Section 4.

5.5.8.3 Construction

All concrete construction relating to revetment construction shall be in accordance with Section 4, Concrete.

When placing concrete care shall be taken to ensure that weep holes are not blocked or dislodged from position.

The 100 mm thick concrete screed for the wet stone masonry shall not be placed until the underlying free-draining gravel bed has been placed and approved by the Engineer.

5.5.9 Stone Masonry

5.5.9.1 General

Stone masonry to be constructed as part of revetments comprise wet stone masonry revetment facing and stone masonry stairways.

5.5.9.2 Materials

(a) Stone

Stone for all classes of masonry shall be clean, hard, and durable.

Samples of stone proposed for use in masonry construction shall be submitted to the Engineer for his approval.

Stones shall be of the sizes shown on the Drawings or appropriate for the particular application. Unless otherwise shown on the Drawings, stones shall have thickness of not less than 150 mm, widths of not less than one and a half times their respective thicknesses, and lengths of not less than one and a half times their respective widths. Each stone shall be free of depressions and projections that would prevent it from being properly bedded.

Stone to be used in wet stone masonry revetments shall be regular in size and their thickness shall be approximately 280 mm.

Stone shall be dressed to remove any thin or weak portions. Face stone shall be dressed to provide bed and joints lines that do not vary more than 20 mm from true lines and to ensure the meeting of bed and joints lines without the rounding of the corners of the stones in excess of 30 mm in radius. Bed surfaces of face stones shall be normal to the faces of the stones for 80 mm and from this point may depart from a normal plane by an angle which is not to exceed 50 mm in 300 mm.

Face stones shall be pitched to line along all beds and joints. The maximum projections of rock faces beyond the pitch lines shall not be more than 10 mm.

(b) Concrete Bedding

Concrete into which stones are bedded shall be concrete Class F

5.5.9.3 Construction of Wet Stone Masonry Revetment Facing

(a) Preparation

The gravel bed, the 100 mm concrete screed, the concrete toe block and edge forms shall be completed to the approval of the Engineer prior to placing wet stone masonry.

(b) Selection and Placing

All stones shall be cleaned thoroughly and wetted immediately before being set, and the concrete bed which is to receive them shall be cleaned and moistened before the bedding concrete is spread. Stones shall be laid with their longest faces horizontal in full beds of concrete, and the joint shall be flushed with concrete.

The exposed faces of individual stones shall be parallel to the revetment face in which the stones are set and the pattern shall be regular.

The stones shall be so handled as not to jar or displace the stones already set.

(c) Beds and Joints

Beds for stones may vary from 20 mm and to 50 mm in thickness. At no place shall corners of four stones be adjacent to each other.

(d) Pointing

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into gaps between stones with a pointing tool. Stones shall be proud of the pointed mortar by approximately 20 mm. The wall shall be kept wet while pointing is being done.

(e) Weep Holes

Weep holes shall be constructed at the locations as shown on the Drawings or as directed by the Engineer in accordance with the requirements of Sub-Clause 5.5.6, Weep Holes.

(f) Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all faces stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

(g) Curing

The masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

5.5.9.4 Construction of Wet Stone Masonry Stairs

(a) Preparation

The gravel bed, the 100 mm concrete screed, the concrete toe block and concrete stringers shall be completed to the approval of the Engineer prior to placing wet stone masonry.

(b) Materials

Stones for stairs shall comply with the requirements of Clause 5.5.9.2. In addition, stones for outer faces of stair treads shall be carefully prepared and selected so as to be able to form flat treads with vertical faces on the risers.

(c) Selection and Placing

All stones shall be cleaned thoroughly and wetted immediately before being set, and the concrete bed which is to receive them shall be cleaned and moistened before the bedding concrete is spread. Stones shall be laid with their longest faces horizontal in full beds of concrete, and the joint shall be flushed with concrete.

The stones shall be so handled as not to jar or displace the stones already set.

(d) Beds and Joints

Beds for stones may vary from 20 mm and to 50 mm in thickness. At no place shall corners of four stones be adjacent to each other. Steps so formed shall be uniform in rise and tread. Treads shall horizontal and flat to a tolerance such that deviation under a 1000 mm straight edge is + 0, -10 mm.

(e) Pointing

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into gaps between stones with a pointing tool. Pointing on the face of stairs shall be flush with the face of the stones. The stairs shall be kept wet while pointing is being done.

(f) Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all faces stones shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

(g) Curing

The masonry shall be satisfactorily protected from the sun and shall be kept wet for a period of at least three days after completion.

5.5.10 Expansion Joints

5.5.10.1 General

Expansion Joints shall be constructed in the revetment as shown in the Drawings or as directed by the Engineer.

5.5.10.2 Materials

The Contractor shall submit samples and technical data of his proposal for joint filler not less than 3 months before its intended use.

Joint filler shall be pre-formed, highly resilient-type sponge or cellular rubber conforming to ASTM D 1056, of 10 mm thickness and of density not less than 30 kg/m³.

Joint filler shall have, but not be limited to, the following minimum properties:

- It shall exhibit sustained adhesion to concrete under wet conditions and not become brittle after prolonged hot dry conditions
- It shall not rupture as a result of a shear movement of 30 mm
- It shall be non-toxic and non-injurious to concrete.

All joint surfaces to be filled shall be clean, dry and fully cured.

5.5.10.3 Construction

The openings for expansion joints shall be constructed during the placing of wet stone masonry. Faces of joints shall be vertical and perpendicular to the centreline of the canal.

Joint filler shall be held in place against the completed side of an expansion joint by a waterproof cement or other approved means in accordance with the supplier's recommendations.

The outer edge of the joint shall be sealed with an asphaltic joint filler.

5.5.11 Rip Rap

General

The Contractor shall construct rip rap at the toes of the revetments to the lines and levels as shown in the Drawings or as directed by the Engineer

Materials

Rip rap shall conform to the requirements of Clause 3.4 in Section 3.

Construction

The bed of the canal shall be excavated to the lines and levels and grades as shown in the Drawings to accept the rip rap.

The rip rap shall be placed in accordance with the requirements of Clause 3.4.4 of Section 3.

5.6 MEASUREMENT AND PAYMENT

5.6.1 Earthworks

Common excavation, sandy soil fill, free draining gravel, geotextile cloth shall be measured and paid in accordance with the respective Clauses in Section 3, Earthworks.

5.6.2 Concrete

Concrete, excluding precast reinforced concrete toe blocks, shall be measured and paid in accordance with the applicable Clause in Section 4, Concrete.

5.6.3 Timber Piling

Measurement shall be made of the length of timber piling driven and approved by the Engineer. The length determined shall be calculated by the multiplying the number of piles by the nominal length of 4500 mm. Piles shorter than 4500 mm shall not be counted for payment.

Payment shall be made at the rate per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of the timber piling.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.3 2.4.3 3.3.3 3.4.3 3.5.3	Timber Piling 80 – 100 dia x 4500	m

5.6.4 Wet Stone Masonry

Measurement will be made of the volume of wet stone masonry complete in place and accepted. Projections extending beyond the faces of the walls will not be included. In computing the quantity for payment, the dimensions used shall be those shown on the Drawings or ordered in writing by the Engineer. No deductions shall be made for weep holes, drain pipe, pipe, or other openings of less than 0.01 square metres in area.

Payment will be made at the unit rate entered in the priced Bill of Quantities which shall include full payment for providing all labour, materials including the concrete bedding and mortar, tools, equipment and any other works incidental to the completion of stone masonry.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.11 3.3.11 3.4.11	Wet Stone Masonry (250 dia, t=300)	m ³

5.6.5 Weep Holes

Measurement will be made of the number of weep holes of the various lengths completed in accordance with the Drawings, the Specification and to the approval of the Engineer.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.12 3.3.12 3.4.12	Weep Holes, PVC 100 dia x 1000 with filter cloth	No

5.6.6 Joint Filler

Measurement will be made of the area in square metres of joint filler completed in accordance with the Drawings, the Specification and to the approval of the Engineer.

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other associated costs.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.13 3.3.13 3.4.13	Joint Filler, 10 mm thick	m ²

5.6.7 Precast Reinforced Concrete Toe Block

Measurement will be made of the number of precast reinforce concrete toe blocks completed and laid in accordance with the Drawings, the Specification and to the approval of the Engineer

Payment will be made at the rate entered in the Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation and any other costs associated with precasting, testing, handling and laying.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.3.8 3.3.8 3.4.8	Precast Concrete Toe Block	No.

SECTION 6. SEWERS AND DRAINAGE WORKS

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SECTION 6. SEWERS AND DRAINAGE WORKS

6.1 GENERAL

This section covers the general and specific requirement for the construction of sewers and related works.

6.2 SCOPE OF WORK

The sewer work to be completed by the Contractor shall consist of the following:

This work shall consist of reinforced concrete drainage pipe and precast reinforced concrete box culverts furnished and installed at such locations as shown on the Drawings or directed by the Engineer in accordance with the Drawings, classes of pipe, lines, levels, grades and dimensions. The work shall include the furnishing and construction of such joints and connections to other pipes, inlets, manholes and other structures as shown on the Drawings or directed by the Engineer. In further clarification of the foregoing, the work comprises the following:

(a) Sewer Outlets:

Existing sewers leading to the Tau Hu and Ben Nghe canals are required to be extended and new outlet structures built.

The work consists of demolishing existing outlet structures, extending the sewer lines and constructing new outlet structures within the revetment-lined banks of the canal banks.

(b) New Sewer Line:

Drainage works are required for a new portion of road is to be constructed between [Sections 77 and 84](#) on South side of the Tau Hu Canal. The work consists of the construction of new sewer lines, manhole structures, curb inlet structures, outlet structures and joining existing sewers into the new sewage line at manholes.

6.3 WORKS SPECIFIED ELSEWHERE

Care of Water shall be in accordance with Section 1

Demolition shall be in accordance with Section 1

Earthworks shall be in accordance with Section 3

Concrete work shall be in accordance with Section 4

Timber Piling shall be in accordance with Clause 5.5.2 of Section 5

Metalwork shall be in accordance with Section 9

6.4 MATERIALS

6.4.1 Timber Piles

Timber piles shall be in accordance with Clause 5.5.2 of Section 5

6.4.2 Concrete

Cast in situ reinforced concrete shall be concrete class E as specified in Section 4.

Plain concrete base and all other plain concrete shall be concrete class D as specified in Section 4.

6.4.3 Reinforcement

Reinforcement shall be deformed bars of the sizes shown on the Drawings.

6.4.4 Earthworks Materials

Earth fill, sandy soil fill and sand shall be in accordance with Clause 3.3.2 of Section 3, Earthworks.

6.4.5 Reinforced Concrete Pipes

The requirements for reinforced concrete pipes listed hereunder shall apply to all such pipes to be used for sewers.

Reinforced concrete pipes shall be of spigot and socket type Class 1 or Class 2 as shown on the Drawings complying with the requirements of JIS A 5372.

Concrete and reinforcement shall comply with the requirements of Section 4.

Dimensional tolerances shall be in accordance with Annex 2, Table 6 of JIS A 5372.

Permeability shall be in accordance with Clause 5.1 of JIS A 5372.

Strength (cracking and crushing loads) shall meet the requirements of Annex 2, Table 3 of JIS A 5372.

Testing for compliance with the requirements for dimensional tolerance, permeability and strength shall be in accordance with the methods and limits stated in Annex 2 of JIS A 5372. Prior to the procurement of pipes the Contractor shall submit for the Engineer's approval, a quality assurance programme for pipe quality which will include testing of pipes (including destructive testing). The cost of the quality assurance programme including the cost of testing shall be borne by the Contractor. Pipes which have not been manufactured under a quality assurance programme approved by the Engineer shall be subject to rejection.

Pipes in a batch shall be considered as meeting the strength test requirements when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirement the Contractor shall be allowed a retest on two additional specimens for each specimen that failed and the pipes shall be acceptable only when all of the retest specimens meet the strength requirements.

The following information shall be clearly marked on each section of pipe.

- Pipe class and standard of manufacture
- Date of manufacture
- Name or trade mark of the manufacture
- Where tests have been successfully carried out on representative samples from the batch in which the unit was made

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by an inspector of the Engineer. Pipes shall be subject to rejection on account of failure to conform to any of the specification requirements. Pipes may be rejected because of any of the following:

- Fractures or cracks passing through the wall, except for a single end crack that do not exceed the depth of the joint.
- Defects that indicate imperfect proportioning mixture and moulding.
- Surface defects indicating honeycombed or open texture.
- Damaged ends where such damage would prevent the making of a satisfactory joint.

Pipes may be repaired, if necessary, because of occasional imperfections in manufacture or accidental damage during handling and will be acceptable if, in the opinion of the Engineer, the repairs are sound and properly finished and cured and the repaired pipes conform to the requirements of the specification.

Joint rings for spigot and socket pipes shall be manufactured from ethylene propylene rubber (EPM or EPDM) or styrene butadiene rubber (SBR) or natural rubber (NR) and shall comply with the requirements of BS 2494. They shall be suitable for use in sewerage pipelines at an ambient temperature of 30° C and shall be of size, shape that, when joined, it will provide a watertight seal.

6.4.6 Precast Reinforced Culverts

Precast reinforced culvert units shall be manufactured in accordance with the requirements of section 4.

Prior to the procurement of precast reinforced culvert units the Contractor shall submit for the Engineer’s approval, a quality assurance programme the cost of which shall be borne by the Contractor. Any unit which has not been manufactured under the quality assurance programme approved by the Engineer shall be subject to rejection.

Concrete shall be Class D.

Reinforcement shall be deformed bars.

All precast units of the same cross section shall be regular in shape and shall have accurately formed rebated joints which permit adjacent pipes to lap together as shown on the Drawings.

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by the Engineer. Precast units shall be subject to rejection on account of failure to conform to any of the specified requirements and/or evidence of any of the following defects.

- Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
- Defects that indicate imperfect proportioning mixture and moulding.
- Surface defects indicating honeycombed or open texture.
- Damaged ends where such damage would prevent the making of a satisfactory joint.

Any precast unit rejected by the Engineer shall be so marked and removed from the Site.

6.4.7 Manhole Covers

Manhole covers shall be of the following types:

TYPE	DESCRIPTION	DIMENSIONS Lid Dimensions (Opening Dimensions)	APPLICATION
Type A	1 cast iron, 30-ton design load cover comprising a cast iron inner frame and circular removable lid and an outer frame consisting of precast concrete and fabricated, galvanized steel	900 x 900 (800 x 800)	Manholes in roadway

Type C	1 30-ton design load fabricated, galvanized steel grid cover and an outer frame consisting of precast concrete and fabricated, galvanized steel	900 x 900 (800 x 800)	Manholes in roadway at designated locations
Type E	1 6-ton design load cover comprising a cast iron square lid and an outer frame consisting of precast concrete and fabricated, galvanized steel	900 x 900 (800 x 800)	Inlet Pits in sidewalk

All manhole covers and their respective frames shall be made in accordance with the Drawings, the directions of the Engineer and the Specification.

Cast iron components shall comply with the requirement of the Ho Chi Minh City Urban Drainage Company.

Fabricated steel components shall comply with the requirements of Section 9, [Metal Work](#)

All fabricated steel components shall be galvanized in accordance with the requirements of [Section 9, Metal Work](#).

6.5 CONSTRUCTION OF SEWERS

6.5.1 General

Preparatory works, excavation, timber piling, bed preparation and backfilling shall be carried out in accordance with the referenced specifications in [Clause 6.3](#).

Any trench for sewer pipes which has been excavated wider than the trench width shown on the Drawings plus 250 mm shall be backfilled and re-excavated to the correct width.

All reinforced concrete sewer pipes and precast box culvert section sewer units shall be laid to the lines and levels as shown on the Drawings or as directed by the Engineer. Laying of pipes shall start from the downstream end unless otherwise agreed to by the Engineer. Pipes shall be laid to a tolerance of + or - 15 mm from the given grade line of the invert and without low points.

All work shall be carried out in the dry and the Contractor shall keep excavations dewatered in accordance with his obligations for care of water under Section 2.

6.5.2 Pipes with Sand Bedding and Surround

Where sand bed and sand surround is to be provided, after completion of timber piling, sand bedding material shall be carefully placed and compacted in layers not exceeding 100 mm thickness to the required thickness for the full width of the trench. The material shall preferably be compacted by vibrating plate type plant using a minimum of one pass per layer. Should hand tamping be allowed by the Engineer the Contractor shall demonstrate by means of in-situ test to the approval of the Engineer that his proposed method of compaction will achieve a minimum of 90% of the maximum dry density as determined by the AASHTO T 99 test or equivalent.

The bedding shall be constructed so as to ensure even and continuous support throughout the length of the barrel of each pipe. Recesses shall be formed in the bedding to accommodate pipe sockets.

After laying and jointing pipes, the bedding shall be placed and hand compacted in layers not exceeding 100 mm thick. Care should be taken that the bedding material is well rammed into the cavities under the two lower quadrants of the pipe and that the bedding is brought up simultaneously and evenly on both sides of the pipe. Sand bedding shall be placed and compacted up to a minimum of 200 mm above the crown of the pipe.

Backfilling of the trench above this level shall be performed in accordance with the requirements of Section 3.

6.5.3 Precast Box Culvert

After completion of timber piling, sand bedding material shall be carefully placed and compacted in layers not exceeding 100 mm thickness to the required thickness for the full width of the trench as specified in [Clause 6.5.1](#). Trench sheeting shall be withdrawn for the depth of the bedding layer prior to compacting bedding material.

The bedding shall be constructed so as to ensure even and continuous support throughout the length of each unit. Recesses of the required dimensions shall be formed in the bedding at each joint and the jointing concrete (class F) shall be placed just prior to laying precast units.

Units shall be carefully placed on the sand bed ensuring that adjacent units are properly jointed and that the concrete under the joint is in contact with the joint.

Concrete haunching (class F) shall be formed around each joint as shown on the Drawings.

Haunching concrete shall be allowed to cure for a minimum of 7 days before backfilling. Backfilling with sandy soil at the sides of the precast units shall be placed in layers not exceeding 100 mm and hand compacted up to a level 250 mm above the top of the sewer. Above this level backfilling may proceed in accordance with the requirements of Section 3.

6.5.4 Manholes and Inlet Pits

Manholes and inlet pits shall be constructed in the locations and to the lines and levels shown on the Drawings or as directed by the Engineer.

The connecting pipe between inlet pit and manhole shall be constructed in the manner described in [Clause 6.5.1](#).

All manholes and catch pits shall be constructed such that they are watertight.

Benching consisting of plain concrete (Concrete Class F) shall be placed in the bottom of manholes as shown on the Drawings. A 20 mm thick granolithic topping shall be provided to the surface of the concrete benching. Granolithic coating shall consist of cement : granite mix approximately 1: 2 by weight. The granite chips shall be hard, non-weathered granite, free of clay or other deleterious matter of maximum size 6 mm. Prior to application the benching surface shall be wire brushed to remove all laitance and loose material and the surface thoroughly wetted. The granolithic topping shall be steel trowel finished to produce a smooth surface and shall provide a uniformly graded channel through the manhole from inlet to outlet.

Manhole frames shall be solidly bedded in 1:3 sand cement mortar so that the covers when in position are fair and even with the adjacent finished surfaces.

6.5.5 Outlet Structures

Outlet structures shall be constructed in the locations and to the lines and levels shown on the Drawings or as directed by the Engineer. Headwalls and wing walls shall be positioned such that they conform to the alignment of the adjacent revetment structure.

6.6 INSPECTION, TESTING AND CLEANING OF SEWERS

6.6.1 General

All sewers, including manholes shall be tested, inspected and cleaned in accordance with this Clause 6.6.

Should the visual inspection or tests fail, the Contractor shall, at his own cost, replace defective pipes, make good any leaking joint, or otherwise re-execute defective work, after which cleaning, inspection and testing shall be repeated.

Only sewers which have undergone inspection and testing and have received the Engineer's approval shall be approved for payment.

The Contractor shall provide all equipment and personnel for carrying out tests and assisting the Engineer or his Representative in performing inspections.

All costs incurred by the Contractor in complying with the requirements of this Clause 6.6 shall be deemed to be included in the unit rates for the respective sewer elements.

6.6.2 Scope of Inspection and Testing

Testing and inspection shall be performed in accordance with the following schedule:

Sewer Type Or Element	Size	Test(s) and Inspections to be carried out
RC Pipe	All	Visual Inspection Leakage Test
RC Box Culvert Section	All	Visual Inspection Leakage Test
Manholes	All	Visual Inspection Leakage Test

6.6.3 Visual Inspection

All joints, including joints between pipes and manholes, shall be subject to inspection by the Engineer or his Representative.

6.6.4 Leakage Test

After completion of backfilling and restoration of normal sub-soil conditions, all sewers and manholes shall be inspected for infiltration. Acceptance criterion for this test is infiltration not exceeding 0.5 litre per linear metre per metre of nominal bore (for circular sections) or 0.5 litre per linear metre per metre width (for rectangular sections including manholes).

6.6.5 Cleaning and Inspection of Sewers

The Contractor shall at all times take reasonable measures to prevent the ingress of solid matter into sewers. Such steps shall include, but not be limited to the provision of temporary plugs where appropriate.

Following completion of sewers and manholes, the interior of pipelines and box culvert sections shall be cleaned of all silt and debris and inspected by the Engineer.

Pipelines of 600 mm diameter or smaller shall be demonstrated to be clear of all obstructions by drawing a sphere 25 mm smaller than the internal diameter of the pipe throughout the length of the section under inspection.

Should the Contractor fail to keep an inspected sewer satisfactorily isolated after it has been inspected and shown to be free of obstruction, he shall repeat cleaning and demonstrate to the Engineer's satisfaction that it is clear of obstruction, all at his expense, shortly before taking over.

6.7 MEASUREMENT AND PAYMENT

6.7.1 Preparatory Works

The cost of all preparatory works is included in payment items in Section 2.

6.7.2 Earthworks

Common excavation, sandy soil fill, shall be measured and paid in accordance with the respective Clauses in Section 3, Earthworks.

6.7.3 Concrete

Concrete shall be measured and paid in accordance with the applicable Clause in Section 4, Concrete.

6.7.4 Timber Piling

Timber piling shall be measured and paid in accordance with Clause 5.6.3 of Section 5.

6.7.5 Precast Reinforced Concrete Drainage Pipes

Measurement shall be made of the length of the various diameters of precast reinforced drainage pipes completed, in place and approved by the Engineer.

Payment shall be made at the respective rates per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of precast reinforced concrete drainage pipes.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
2.4.7 3.5.7 3.9.4	Precast, Reinforced Concrete Drainage Pipes 400 dia.	m
2.4.8 3.5.8	Precast, Reinforced Concrete Drainage Pipes 600 dia.	m
2.4.9 3.5.9 3.9.5	Precast, Reinforced Concrete Drainage Pipes 800 dia.	m
2.4.10 3.5.10	Precast, Reinforced Concrete Drainage Pipes 1000 dia.	m
2.4.11 3.9.6	Precast, Reinforced Concrete Drainage Pipes 1200 dia.	m
2.4.12 3.5.11	Precast, Reinforced Concrete Drainage Pipes 1500 dia.	m

6.7.6 Precast Reinforced Concrete Box Culverts

Measurement shall be made of the length of the various sizes of precast reinforced concrete box culverts completed, in place and approved by the Engineer.

Payment shall be made at the respective rates per metre entered in the Bill of Quantities which shall include full payment for providing all labour, materials, tools, equipment and any other works incidental to the completion of precast reinforced concrete box culverts.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.5.12	Precast, Reinforced Concrete Box Culvert 1000 W x 1000 H	m
3.5.13	Precast, Reinforced Concrete Box Culvert 1200 W x 1200 H	m
2.4.13 3.5.14	Precast, Reinforced Concrete Box Culvert 1500 W x 1500 H	m
2.4.14	Precast, Reinforced Concrete Box Culvert 1600 W x 2000 H	m
2.4.15	Precast, Reinforced Concrete Box Culvert 1800 W x 2000 H	m
2.4.16 3.5.16	Precast, Reinforced Concrete Box Culvert 2000 W x 2000 H	m
2.4.17	Precast, Reinforced Double Cell Concrete Box Culvert 2000 W x 2000 H	m
2.4.18	Precast, Reinforced Concrete Box Culvert 3000 W x 1500 H	m
3.5.15	Precast, Reinforced Concrete Box Culvert 2800 W x 2400H	m

6.7.7 Granolithic Topping

Measurement shall be made of the plan area of granolithic topping in manholes or diversion chambers completed and approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs, for completing the granolithic topping in accordance with the Drawings and the Specification.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.9.11	Granolithic Topping: including supply and placement	m ³

6.7.8 Manhole Covers

Measurement shall be made of the number manhole covers of the various types described in Clause 6.4.7 completed, installed and approved by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs (including the cost of the frame and its bedding), for completing the manhole covers in accordance with the Drawings and the Specification.

The following pay items shall be measured and paid under this Clause:

Pay Item No.	Description	Unit of Measurement
3.9.14	Cast Iron Manhole Cover (Type A): including supply and installation	set
3.9.15	Cast Iron Manhole Cover (Type C): including supply and installation	set
3.9.16	Cast Iron Manhole Cover (Type E): including supply and installation	set

SECTION 7. ROADS AND PAVEMENTS

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SECTION 7. ROADS AND PAVEMENTS

7.1 GENERAL

This section covers the requirements for the construction of roadworks which includes new sections of roads to be constructed in the vicinity of the Tau Hu Canal and the paving of backfilled trenches in which sewers drainage pipes or other buried facilities have been constructed.

All roadworks shall be constructed to the lines, grades and levels shown in the Drawings. Those roadworks which consist of paving of backfilled trenches shall be constructed such that the finished surface conforms to the adjacent existing pavement.

7.2 PREPARATION OF SUBGRADE

7.2.1 General

This Clause specifies the requirements for the preparation of the surface on which the sub-base is to be constructed.

7.2.2 Testing and Preparation

Before placing any sub-base or base course the sub-grade shall be prepared as follows.

- (a) All surfaces below carriageway, footways and hard shoulders shall, after reinstatement of any soft areas, be well cleaned and free from mud and slurry.
- (b) The surface if dry shall be watered and compacted by 4 passes of a smooth wheeled roller having load of 45 kN/m (45 kg/cm) width or 8/10 tonne tire roller.
- (c) The formation shall be regulated and trimmed to the road width as shown on the Drawings by using a motor grader.
- (d) The trimmed formation shall be rolled by 1 pass of a smooth wheeled roller having and load of 22kN/m (22 kg/cm) width or a vibratory roller having a static load of 8kN/m (8 kg per cm) width or vibratory plate compactor having a static pressure under base plate of not less than 14 kPa)

The sub-grade shall be in such a condition that it will carry 8 to 10 ton smooth wheel roller without any deformation and/or visible springing effect.

Any portion of the subgrade which shown deformation under the above loading shall be replaced with sub-base course material and re-rolled until no deformation occurs under rolling.

In confined areas, such as in trenches where road pavement is to be constructed, the Contractor may propose alternative, smaller, compaction or trimming equipment for the Engineer's approval provided that such equipment shall achieve the same degree of preparation.

7.3 SUB-BASE COURSE

This item comprises the supply and placement of granular sub-base material in accordance with the following:

7.3.1 Materials

Aggregates for sub-base shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matters. The composite material shall be free from organic matters and lumps or balls of clay, and shall be of such nature that can be compacted readily to form a firm, stable sub-base.

Materials for sub-base shall conform to the requirements for sub-base as specified below or directed by the Engineer.

Grading Requirements of Sub-Base Course

AASHTO Designation No.	Percentage Passing by Weight
2 inch	100
1 1/2 inch	70 - 100
1 inch	55 - 85
3/4 inch	50 - 80
3/8 inch	40 - 70
No. 4 (5 mm)	30 - 60
No. 10 (2 mm)	20 - 50
No. 40 (0.4 mm)	10 - 30
No. 200 (0.074 mm)	5 - 15

The percentages passing the various sieves are subject to appropriate correction by the Engineer when aggregates of varying specific gravities are used.

Other Requirements of Sub-Base Course

Liquid Limit (AASHTO T89)	25 max
Plasticity Index (AASHTO T91)	6 max.
Sand Equivalent (AASHTO T176) :	25 min.
Loss by Abrasion of particles retained on ASTM No. 12 sieve (AASHTO T96) :	40% max.
Soaked CBR at the required density (100% of the maximum dry density according to AASHTO T180) :	60% max.

7.3.2 Placing and Spreading

- (a) Sub-base material shall be placed as a uniform mixture on the prepared subgrade in a quantity which will provide the required compacted thickness. When more than one layer of sub-base material is required, each layer shall be shaped and compacted before the succeeding layer is placed. When uniformly mixed, the sub-base material shall be spread to the required thickness as shown on the Drawings or as directed by the Engineer.
- (b) Sub-base material shall be distributed in a continuous uniform layer or windrow of such size that, when spread and compacted, the finished layer shall be equal to or slightly greater than the nominal thickness of sub-base shown on the Drawings.
- (c) When hauling is done over previously placed sub-base material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.
- (d) Where the required thickness is 150 mm or less, the material may be spread and compacted in one layer. Where the required thickness is more than 150 mm, sub-base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 150 mm. All subsequent layers shall be spread and compacted in a similar manner.
- (e) The moisture content of sub-base material shall be adjusted before compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the required compaction.

7.3.3 Compacting the Sub-base

- (a) Immediately after each layer of the sub-base has been spread, the full width shall be compacted by approved compaction equipment. Compaction shall progress gradually from the sides to the centre, parallel to the centreline of the road, and shall continue until the whole surface has been compacted. All irregularities or depressions that develop shall be corrected by loosening material at these places and adding or removing material until the surface is smooth and uniform. At all places not accessible to the compaction equipment, the sub-base material shall be compacted thoroughly with approved tampers or compactors.
- (b) Each layer of the sub-base shall be compacted to a density of at least one hundred percent (100%) of the maximum dry density determined in accordance with AASHTO T180, Method D. In-situ density of the compacted sub-base shall be measured in accordance with AASHTO T191 at the location directed by the Engineer.

7.3.4 Tolerances

Tolerances for the sub-base course shall be as specified in the following table:

Tolerances for Sub-Base Course:

Feature	Tolerance
Permitted variation from thickness of layer	± 20 mm
Permitted variation from design level of surface	+ 10 mm - 20 mm
Permitted surface irregularity measured by 3-m straightedge	20 mm
Permitted variation from design crossfall or camber	± 0.3%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%

7.4 BASE COURSE

This item comprises the supply and placement of granular base course material in accordance with the following:

7.4.1 Materials

Aggregate for base course shall consist of hard, durable particles or fragments of stone or gravel crushed to the size and of the quality requirements of this Clause. It shall be clean and free from organic matters, lumps or balls of clay and other deleterious substances. The material shall be of such nature that it can be compacted readily to form a firm, stable base.

All base course aggregate shall conform to the following physical requirements:

Physical Requirements of Base Course Material

(i) Toughness (ASTM D3)	6 min.
(ii) Loss by Sodium Sulphate Soundness Test (AASHTO T104)	10% max.
(iii) Loss by Magnesium Sulphate Soundness Test (AASHTO T104)	12% max.
(iv) Loss by Abrasion after 100 revolutions (AASHTO T96)	10% max.
(v) Loss by Abrasion after 500 revolutions (AASHTO T96)	40% max.
(vi) Thin and elongated pieces, by weight (pieces larger 1 inch., with thickness less than 1/5 of length)	5% max.
(vii) Soft fragments (AASHTO T189)	5% max.
(viii) Clay lumps (AASHTO T112)	0.25% max.

Aggregate for base course shall conform to the requirements as specified herein. Crushed gravel or rock fragments for base course shall consist of the product obtained by crushing gravel or rock, which, if directed by the Engineer, has first been screened in such a manner that when the aggregate is produced from gravel, not less than eighty percent (80%) by

weight of the coarse aggregate shall be of particles having at least one fractured face.

Base course material shall be crushed rock or crushed gravel conforming to the following grading requirements:

Grading Requirements for Base Course

AASHTO Designation No.	Percentage Passing by Weight
2 1/2 inch	100
2 inch	90 - 100
1 1/2 inch	35 - 70
1 inch	0 - 15
1/2 inch	0 - 5

Blending material shall be quarry screenings or natural sand of suitable binding quality as approved by the Engineer. Blending material shall be free from foreign or organic matter, dirt, shale and clay lumps or other deleterious matter and shall conform to the following requirements:

Grading Requirements of Blending Materials for Base Course

	Percentage Passing by Weight
3/8 inch	100
No. 4 (5 mm)	85 - 100
No. 100 (0.15 mm)	10 - 30
Plasticity Index (AASHTO T90)	6 max.
Sand Equivalent (AASHTO T176)	30 min.

The percentage of crushed aggregate composed of elements having at least one fractured face shall be at least eighty percent (80%) by weight of the material retained on sieve No. 4.

7.4.2 Spreading and Compacting

The coarse and fine components of the base course material shall be mixed in proportions as directed by the Engineer

Base course material shall be spread and compacted in the same manner as specified above for Sub-base Course.

7.4.3 Tolerances

Tolerance for the base course shall be as specified in the following table.

Tolerances for Base Course

Feature	Tolerance
Permitted variation from thickness of layer	± 10 mm
Permitted variation from design level of surface	+ 5 mm -10 mm
Permitted surface irregularity measured by 3-m straightedge	5 mm
Permitted variation from design crossfall or camber	± 0.2%
Permitted variation from design longitudinal grade over 25 m in length	± 0.1%

7.5 BITUMINOUS PRIME COAT

7.5.1 General

This work shall consist of furnishing and applying bituminous material to the completed and approved base course or to other areas shown on the Drawings, in accordance with this Clause and/or as directed by the Engineer.

7.5.2 Material

Asphalt for the prime coat shall be either AC-20 grade asphalt cement (which is approximately equivalent to 60/70 Pen.) diluted with kerosene or cutback asphalt MC-70 conforming to the requirements of AASHTO M82 or equivalent.

7.5.3 Surface Preparation before Prime Coating

Immediately before applying the asphalt material all loose dirt and other objectionable material shall be removed from the surface with a power broom and blower as required. Such cleaning shall continue until the entire surface shows a pattern of exposed large particles well wedged together and free from dust. When so ordered by the Engineer a light application of water shall be made just before the application of asphaltic material. No application shall be made during wet weather.

7.5.4 Application of Prime Coat

- (a) Asphaltic materials shall be applied by means of a pressure distributor or other equipment approved by the Engineer, at a temperature between 40.5°C and 85°C. in accordance with the following table:

Spraying Temperatures of Prime Coat

Type of Material	Temperature Range
Cutback, 50 pph kerosene (MC-70 grade cutback)	70 ± 10 deg. C
Cutback, 75 pph kerosene (MC-30 grade cutback)	45 ± 10 deg. C
Cutback, 100 pph kerosene	30 ± 10 deg. C
Cutback, more than 100 pph kerosene	Not Heated

- (b) The rate of application of the liquid asphalt shall be from 0.8 to 2.5 litre per square meter, but the exact rate shall be as directed by the Engineer.
- (c) The prime coat shall be left undisturbed for at least 24 hours and shall not be opened to traffic until the prime coat has penetrated and cured sufficiently so that it will not be picked up by the wheels of passing vehicles. The primed area shall be maintained until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amount; any excess shall be blotted with sand or removed as directed.

- (d) All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying from the distributor.
- (e) Structures and trees adjacent to the area being treated shall be protected to prevent their being spattered or marred.

7.6 TACK COAT

7.6.1 General

This work shall consist of furnishing and applying asphaltic material to an existing pavement, in accordance with the specification and to the width and area required by the Engineer prior to construction of so surfacing, so as to provide a bond between the binder course and the surface course or other layers as directed by the Engineer.

7.6.2 Materials

Material for tack coat shall be either AC-20 grade asphalt cement (which is approximately equivalent to 60/70 Pen.) diluted with between 25 and 30 parts per hundred of kerosene per hundred parts of asphalt cement by volume, or slow setting emulsified asphalt conforming to the requirements of AASHTO M 140 or M 208. The Engineer may permit or require dilution of the emulsion with 1 part clean water per 1 part of emulsion.

7.6.3 Construction Method

7.6.3.1 Equipment

The equipment shall be as for bituminous prime coat.

7.6.3.2 Surface Preparation

When, in the opinion of the Engineer, it is necessary, the full width of surface to be treated shall be cleaned with a power broom or power blower to remove loose dirt and other objectionable material. The surface to be treated shall be dry.

7.6.3.3 Application of Tack Coat

Immediately after cleaning the surface, asphaltic material shall be applied by means of a distributor at the rates directed by the Engineer, but not to exceed 0.45 litre per square meter and at the temperature within the range specified in the following table:

Spraying Temperatures of Tack Coat

Type of Material	Temperature Range
Cutback, 50 pph kerosene	110 ± 10 deg. C
Emulsified Asphalt or Diluted Emulsified Asphalt	20 to 70 deg. C

The tack coat shall be applied only when the surface is dry except with the permission of the Engineer.

The surfaces of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred. No asphaltic material shall be discharged into a borrow pit or gutter. The Engineer may direct that emulsions shall be diluted with clean water in order to control the rate of spread. This shall be done at the Contractor's expense.

The surface course shall not be placed over the tack coat until it is in a proper condition of tackiness to receive it. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. Until the surface course is placed, the Contractor shall protect the tack coat from damage.

7.7 ASPHALT BINDER AND WEARING COURSES

7.7.1 General

The work shall consist of providing dense durable binder course and wearing course hot asphaltic mixtures composed of aggregate and bituminous materials mixed in a central plant, and of spreading and compacting the mixtures in accordance with this Specification and in conformity with the lines, grades and cross sections shown on the Drawings or as required by the Engineer.

7.7.2 Materials for Asphaltic Mixtures

7.7.2.1 Composition of mixtures

The bituminous material shall be composed of a mixture of aggregate, filler and hydrated lime-if required, and asphalt cement. The several aggregate fractions shall be size, uniformly graded and combined in such proportions that the resulting composite blend meets the job-mix formula and the following index of retained strength as determined in accordance with AASHTO T 245

Requirements for Binder and Wearing Courses

Stability (kg)	900
Flow (mm)	2.5 – 4.0
Void in total mix (%)	3 - 5
Void Filled with Asphalt (%)	75 - 85

In calculating the void characteristics of the mixture the Contractor shall allow for the asphalt absorbed by the aggregate and use the effective specific gravity of aggregate and the maximum specific gravity of the loose paving mixture (AASHTO T 209)

The several aggregate and filler fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend meets one of the grading requirements in the following table

Aggregate Grading Requirements

<i>Sieve Designation (mm)</i>	<i>Percentage Passing by Weight</i>	
	For Asphalt Binder Course	For Asphalt Wearing Course
50	-	-
37.5	-	-
25	100	-
19	95-100	100
12.5	68-86	95-100
9.5	56-78	74-92
4.75	38-60	48-70
2.36	27-47	33-53
1.16	18-37	22-40
0.600	11-28	15-30
0.300	6-20	10-20
0.075	0-8	4-9

The Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix to be used with the proposed materials. The formula submitted shall propose definite single values for:

- The percentage of aggregate passing each specified sieve.
- The percentage of bituminous material to be added, on the total aggregate basis.
- The temperature of the mixture leaving the mixer.
- The temperature of the mixture delivered on the road.
- The grade of bituminous material.

Values shall be proposed within the limits specified for the particular type of bituminous concrete called for. The Engineer will determine a job-mix formula with single values for the above- mentioned and so notify the Contractor in writing.

The mixture furnished by the Contractor shall conform to this job- mix formula, within the following range of tolerances and within the grading ranges shown in the following table:

Tolerances for Mixture

Aggregate passing the 4.75 mm and large sieve	± 7 percent
Aggregate passing the 2.36 mm through the 0.150 mm sieve	± 4 percent
Aggregate passing the 0.075 mm sieve	± 2 percent
Bituminous material	± 0.4 percent
Temperature leaving the mixer	± 6 deg. C
Temperature delivered on the road	± 6 deg. C

When unsatisfactory results make it necessary, the Engineer may establish a new job-mix formula and notify the Contractor in writing. Should a change in sources of material be proposed, a new job-mix formula will be established before the new material is used.

The plant mixed material will be tested after blending or mixing at the plant or prior to final incorporation in the work.

7.7.2.2 Coarse aggregate

The coarse aggregate (retained on the 2.36 mm sieve) shall consist of clean tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable material. The percentage of wear when tested according to AASHTO T 96 , shall be as follows:

For use in asphalt binder and wearing course – not more than 40

The sodium sulphate soundness loss shall not exceed 9 percent and the magnesium sulphate soundness loss shall not exceed 12 percent. When crushed gravel is used, not less than 50 percent of the particles by weight retained on the 4.75 mm sieve shall have at least one fractured face.

7.7.2.3 Fine aggregate

The fine aggregate (passing a 2.36 mm sieve), shall have General Characteristics and Soundness in accordance with AASHTO M 29.

7.7.2.4 Filler

Mineral filler, when required, shall consist of limestone dust, Portland cement or other non plastic mineral matter from sources approved by the Engineer. Mineral filler shall be dry, free flowing, free from lumps and other objectionable material and when tested by means of laboratory sieve, shall meet the following gradation requirement:

<i>Sieve Designation (mm)</i>	<i>Percentage Passing by Weight</i>
0.600	100
0.180	95 – 100
0.075	65 – 100

7.7.2.5 Asphalt cement

Asphalt cement shall be of penetration grade 60 – 80, and shall conform with the requirements of AASHTO M 20.

7.7.3 Preparation of Sub-base

The prime coat shall be applied in accordance with the Clause 7.5.

Twenty-four (24) to forty-eight (48) hours after application of the prime coat, when it has sufficiently dried, it shall be broomed. A limited amount of sand, as directed by the Engineer, may be sprinkled on the prime coat to make further work possible if it is necessary to perform further work without waiting for the prime coat to dry sufficiently. Excess sand shall be removed by brooming before spreading the binder course

7.7.4 Preparation of the Bituminous Mixture

- (a) Aggregates shall be dried and heated at the paving plant so that, when introduced into the mixer, the moisture content does not exceed 0.5%.
- (b) Water in aggregates shall be removed by heating to the extent that there is no subsequent foaming in the mixture before placing and spreading. Aggregates shall be heated to the temperature designated by the job formula with the specified job tolerance, with a maximum temperature and a rate of heating that will not cause permanent damage to the mixture.
- (c) Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The quantity of bituminous material for each batch or the calibrated amount for continuous mixer, as determined by the Engineer, shall be measured by weight and introduced into the mixer, at the specified temperature, using the lowest rate possible for adequate mixing and spreading.
- (d) For batch mixers, all mineral aggregates shall be placed in the mixer before the bituminous material is added. The exact temperature within the specified range shall be as directed by the Engineer.
- (e) Mixing shall continue for the time necessary to coat all particles uniformly, as directed by the Engineer. This time is dependent upon the mix design and type of mixing equipment used.

7.7.5 Transportation and Delivery of the Mixture

- (a) Trucks used for hauling bituminous mixtures shall have tight, clean and smooth metal beds. To prevent mixtures from adhering, beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather and an insulated bed to maintain the mixture at the specified temperature.
- (b) The mixture shall generally be placed at a temperature of between 120°C to 150°C when asphalt cement is used. When the mixture is placed during warm weather and the Engineer has determined that satisfactory results can be obtained at a lower temperature, he may direct that the mixture be mixed and delivered at the lower temperature.
- (c) Loads shall not be dispatched from the mixer if it is expected that spreading and compaction of the mixture cannot be completed under conditions of adequate lighting.
- (d) Mixtures shall be delivered to the point of placement at a temperature within the tolerances required by the Job Mix Formula.

7.7.6 Spreading

- (a) Immediately before placing the bituminous mixture, the prime coat shall be cleaned using a power sweeper equipped with a blower, supplemented with hand brooms if necessary, or by other approved means.

- (b) The mixture shall be laid upon an approved surface which is thoroughly dry and in suitable condition, and only when weather conditions are fair unless otherwise directed by the Engineer.
- (c) Placing shall commence at points farthest from the mixing plant and progress continuously toward the plant, unless otherwise directed by the Engineer. Traffic shall not pass over the base course until it has been thoroughly compacted as specified, and allowed to cool to atmospheric temperature.
- (d) Upon arrival the mixture shall be dumped into an approved bituminous paver, immediately spread to the full width required, and struck off in a uniform layer at such thickness that, when work is completed, the layer will have the required thickness conforming to the specified grade and surface profile.
- (e) The bituminous paver shall be a self-contained, power propelled unit with an activated screed or strike-off assembly heated as necessary. The paver shall be capable of spreading and finishing courses of bituminous plant mix material of the specified thickness, smoothness and grade, and shall also be equipped with an automatic line and grade controlling device.
 - (i) The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation, and the hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.
 - (ii) The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging.
 - (iii) The paver shall be capable of operating at forward speeds consistent with the satisfactory laying of the mixture and the paver speed shall be regulated to eliminate pulling and tearing of bituminous material.
- (f) The mixture shall be placed in strips not less than 3 meters wide. To ensure proper drainage, spreading shall begin along the pavement centreline on a crowned section, or on the high side of a pavement with a one-way slope.
 - (i) After the first strips has been compacted, the second strip shall be placed, finished, and compacted in the same manner as the first strip. After the second strip has been placed and rolled, a 5-meter straightedge shall be placed across the longitudinal joint to determine if the surface conforms to the grade and contour requirement.
- (g) In areas where use of mechanical spreading and finishing equipment is impractical because of irregularities or unavoidable obstacles, the mixture may be hand-spread.

7.7.7 Compaction of the Mixture

- (a) After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Sufficient rollers shall be furnished and operated to handle plant output.

- (b) Rolling shall begin as soon as the mixture can bear the roller without undue displacement or hair cracking, and shall start from the centre of the first strip and continue toward either edge. On subsequent strips, rolling shall start from the edge adjacent to the previously laid material and continue toward the opposite edge.
- (c) The speed of roller shall, at all times, be slow enough so as to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and by applying fresh mixture where needed.
- (d) Rolling shall continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section, and the in-situ density is not less than ninety-eight per cent (98%) of the specified laboratory density as obtained from laboratory compacted specimens of the same materials and same proportions used in the asphalt mixture as determined by AASHTO T166. The method of sampling the mixture and the compaction of specimens shall be in accordance with AASHTO T168 and AASTHO T245, respectively. Field density tests shall be made at least twice daily.
- (e) In areas not accessible to the roller the mixture shall be thoroughly compacted with hot mechanical tampers.
- (f) Any mixture which becomes loose and broken, contaminated with dirt, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding areas, all at Contractor's expense. Skin patching will not be permitted.

7.7.8 Trimming and Clean-up

- (a) Placing of the bituminous mixture shall be as continuous as possible. Rollers shall not pass over the unprotected and freshly laid mixture unless authorized by the Engineer.
- (b) Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. When so directed by the Engineer, a brush coat of bituminous material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.
- (c) The exposed edges of the completed pavement shall be cut true to the required lines. Material trimmed from the edges and any other discarded or rejected bituminous mixture shall be removed from the roadway and disposed of in an approved manner.

7.7.9 Application of Asphalt Wearing Course

Prior to placing the asphalt wearing course a tack coat shall be applied in accordance with Clause 7.6.

- (a) The mixture shall be spread at a temperature of not less than 107°C and all initial rolling shall be done immediately after spreading. The mixture shall not be placed on any wet surface or when weather conditions will otherwise prevent its proper handling and finishing.
- (b) Asphalt pavers shall be self-propelled, mechanical, spreading and finishing equipment, provided with a screed or strike-off assembly capable of distributing the material to not less than the full width of a traffic lane.

- (c) Screed action shall include any cutting, crowning or other practical action which is effective on the mixture without tearing, shoving or gouging, and which produces a surface texture of uniform appearance. The screed shall be adjustable to the required section and thickness. The paver shall be provided with either a full width roller or tamper or other suitable compacting device. Pavers that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation shall not be used.
- (d) Where a course previously laid is joined to a course to be laid later, the first course shall be cut back and painted with asphalt as directed.
- (e) The mix shall be compacted immediately after placing. Initial rolling with a tandem steel roller or a three-wheeled steel roller shall follow the paver as closely as possible. Immediately following the sealing of the longitudinal joints, rolling shall commence at the outside edges and progress towards the centerline. Rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. In areas too small for the roller, a vibrating plate compactor or hand tamper shall be used to achieve thorough compaction.
- (f) Rolling shall continue as long as required to attain a minimum compaction of ninety-seven percent (97%) of the Marshall density of the approved Job Mix.

7.7.10 Completion Test

- (a) Surface Test : Tests for conformity with the specified crown, grade and width shall be made by the Contractor immediately after initial compaction. Any deviation shall be corrected by removal or addition of materials and continuous rolling.
- (b) After completion of final rolling, the smoothness of the course shall again be tested along the whole distance. Humps or depressions that exceed the specified tolerances or that retain water on the surface shall be immediately corrected by removing defective work and replacing it with new material at the Contractor's expense.
- (c) Finished surfaces shall not vary from the design elevations by more than 5 mm when tested with a crown template and a 3m straightedge furnished by the Contractor. Tests shall be performed at 10 m intervals along the road centreline.
- (d) The width shall not be less than 25 mm of the design section measured at 20 m intervals.
- (e) Thickness Tests : The total thickness of each completed course of asphalt treated base shall be determined by cores taken by the Contractor for each completed layer at places designated by the Engineer. One core test shall be performed for every 200 m² of paved area. The thickness shall not be 5 mm less than the design depth for any one test, and not less than 2.5 mm for an average of 10 tests.
- (f) When deficiencies in either elevation or thickness exceed the specified tolerance, the Contractor shall remove and replace the asphalt treated base with new material.

7.8 CONCRETE CURBS

7.8.1 Excavation

Trenches for curbs shall be excavated to the depths and dimensions shown on the Drawings in accordance with the requirements of Section 3. The bottom width of trenches shall not exceed the widths shown on the Drawings.

7.8.2 Gravel Bedding

The bottom of the trench shall be tamped with hand operated equipment following which gravel bedding for curbs shall be placed and spread over the full width of the prepared trench and compacted in accordance with Section 3.

7.8.3 Levelling Concrete

Levelling concrete (Concrete Type G) shall be placed to the lines and dimension shown on the Drawings in accordance with the requirements of Section 4, Concrete.

7.8.4 Concrete Curbs

Concrete Curbs of Concrete Type E shall be cast in situ to the lines and dimensions shown on the Drawings. The concrete, workmanship and finish shall all be in accordance with the requirements of Section 4, Concrete.

7.9 MEASUREMENT AND PAYMENT

7.9.1 Subgrade Preparation

Measurement shall be made of the area in m² of subgrade preparation made on original ground on which the sub base was constructed. No measurement for payment shall be made of areas of subgrade comprising fill.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for the cost of all labour, materials and incidental items necessary to complete the subgrade preparation in accordance with the Specification and the instructions of the Engineer.

The cost of subgrade preparation for sub base constructed on fill is deemed to be included in the cost of fill, specified elsewhere.

7.9.2 Sub-Base Course

Measurement shall be made of the volume of sub base course material placed and compacted to the lines grades and dimensions shown on the drawing or as directed by the Engineer and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

7.9.3 Base Course

Measurement shall be made of the volume of Base Course material placed and compacted to the lines grades and dimensions shown on the drawing or as directed by the Engineer and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the Works in accordance with the Specifications and instructions by the Engineer.

7.9.4 Asphalt Binder Course

Measurement will be made of the mass in tonne (1 tonne = 1000 kg mass) of asphalt binder course, based on certified delivery notes from the supplier, placed to the lines, grades and dimensions as shown on the Drawings or directed by the Engineer and approved by the Engineer. Materials placed outside the limits shown on the Drawings shall not be measured for payment.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the asphalt binder course in accordance with the Specifications and instructions by the Engineer.

7.9.5 Asphalt Wearing Course

Measurement will be made of the mass in tonne (1 tonne = 1000 kg mass) of asphalt wearing course, based on certified delivery notes from the supplier, placed to the lines, grades and dimensions as shown on the Drawings or directed by the Engineer and approved by the Engineer. Materials placed outside the limits shown on the Drawings shall not be measured for payment.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of materials labour, tools, equipment and incidental items necessary to complete the asphalt wearing course in accordance with the Specifications and instructions by the Engineer.

7.9.6 Bituminous Prime Coat

Measurement shall be made of the actual volume in litres of bituminous prime coat material placed on the prepared subgrade at the rate of application directed by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for all labour, materials, equipment and all incidentals necessary for the completion of bituminous prime coat in accordance with the Specification and the instructions of the Engineer.

7.9.7 Tack Coat

Measurement shall be made of the actual volume in litres of bituminous tack material placed on the surface of the binder course (or other surface as directed by the Engineer) at the rate of application directed by the Engineer.

Payment shall be made at the rate entered in the Bill of Quantities which shall be full compensation for all labour, materials, equipment and all incidentals necessary for the completion of bituminous tack coat in accordance with the Specification and the instructions of the Engineer.

Items to be paid under this Clause are as follows:

Pay Item No.	Description	Unit of Measurement
3.8.3	Subgrade Preparation	m ²
3.8.4	Sub Base	m ³
3.8.5	Base Course	m ³
3.8.6	Asphalt Concrete Binder Course	tonne
3.8.7	Asphalt Concrete Wearing Course	tonne
3.8.8	Prime Coat	litre
3.8.9	Tack Coat	litre

7.9.8 Concrete Curbs

Measurement shall be made of the completed length of concrete curb approved by the Engineer.

Payment shall include full compensation for providing all materials, equipment and labour for completing the concrete curbs and shall include the cost of excavation, bedding, levelling concrete and all incidental items for completing the work in accordance with the Drawings, the specification and the directions of the Engineer.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
3.8.2	Concrete Curb and Ditch with Mortar Finishing: including supply and placement	m

SECTION 8. LANDSCAPING

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SECTION 8. LANDSCAPING

8.1 GENERAL

This section covers the general and specific requirements for landscaping.

The landscaping work to be completed by the Contractor comprises the construction of curbs, laying of paving, and the planting of grass, trees and shrubs along the banks of the Tau Hu and Ben Nghe canals in areas described on the Drawings as operation and maintenance areas.

8.2 PREPARATORY WORKS

Prior to the commencement of landscaping works the earthworks, specified elsewhere shall be completed to the lines and grades shown on the Drawings. Particular attention shall be given to the earth fill which shall form the subgrade of the paving which shall be compacted to the relative density specified in section 3, Earthworks.

Electrical Cable and any other buried services shall be installed prior to the commencement of landscaping works.

No separate payment shall be made for preparatory works and all costs shall be considered to be included in other rates included in the Bill of Quantities.

8.3 CONCRETE CURBS

8.3.1 Excavation

Trenches for curbs shall be excavated to the depths and dimensions shown on the Drawings in accordance with the requirements of Section 3. The bottom width of trenches shall not exceed the widths shown on the Drawings.

8.3.2 Gravel Bedding

The bottom of the trench shall be tamped with hand operated equipment following which gravel bedding for curbs shall be placed and spread over the full width of the prepared trench and compacted in accordance with Section 3.

8.3.3 Levelling Concrete

Levelling concrete (Concrete Type G) shall be placed to the lines and dimension shown on the Drawings in accordance with the requirements of Section 4, Concrete.

8.3.4 Concrete Curbs

Concrete Curbs of Concrete Type E shall be cast in situ to the lines and dimensions shown on the Drawings. The concrete, workmanship and finish shall all be in accordance with the requirements of Section 4, Concrete.

8.4 PRECAST CONCRETE PAVING BLOCKS

8.4.1 General

Precast concrete paving blocks shall be laid in the areas shown on the drawing in accordance with this specification and the directions of the Engineer.

8.4.2 Materials

(a) Sand Bedding

Sand bedding shall comply with the requirements specified in Section 3.

(b) Concrete Paving Blocks

Paving block made of concrete shall have compressive strength not less than 20 MPa , shall be plain or coloured and shall have dimensions 198 x 98 x 65 thickness and shall be subject to the approval of the Engineer.

(c) Filler Material

Filler material shall consist of natural sand, having clean, hard and durable particles, and it shall be free from clay, organic matter, and other deleterious materials. It shall be uniformly graded and shall meet the following grading requirements :

Sieve Size	Percentage Passing by Weight
9.52 mm	-
4.75 mm	-
2.36 mm	100
1.18 mm	90 – 100
0.600 mm	60 – 90
0.300 mm	30 – 60
0.150 mm	15 – 30
0.075 mm	5 – 10

8.4.3 Construction

8.4.3.1 Sand Bedding

Sand bedding shall be placed to the lines and grades shown on the Drawings. The sand shall be placed in accordance with the requirements specified in Section 3. Particular care shall be taken to ensure that the sand is properly compacted against curbs and all surrounding concrete edging of the area to be paved.

8.4.3.2 Paving Blocks

Paving blocks shall be laid manually on the prepared sand bed which shall be screeded to the required profile just prior to laying paving blocks.

Paving blocks shall be cut at edges using a mechanical saw so that the completed paving precisely matches the area to be paved.

After laying, the paved area shall be compacted with not less than 3 passes of a vibrating plate compactor to ensure uniformity the upper surface.

Dry fine sand filler material shall be spread over the pavement and brushed so as to fill the joints between paving blocks. All excess sand shall then be removed.

8.5 TREES AND SHRUBS

8.5.1 General

The work to be performed by the Contractor consist of the supply, planting and maintenance of trees, shrubs, ground cover in the areas shown on the Drawings.

The supply, planting and maintenance of trees and shrubs shall be by a specialist subcontract with extensive experience in similar work and shall be subject to the approval of the Engineer.

8.5.2 Materials

(a) Plants

Trees, shrubs, ground cover and grass shall be of the types shown in the planting list in the Drawings. Each plant or shrub shall meet the acceptable size range indicated in the planting list for height, diameter of trunk and diameter of root ball.

All plants shall be healthy living plants, free from disease, insects and fungi and shall not be broken or torn.

(b) Fertilizers

Well rotted animal manure, shall be free of grass and weeds shall be used for improving the soil in which plants are to grown.

Chemical fertiliser containing N, P and K elements such as shall be used to develop the growth of root.

Chemical fertilisers containing Urea shall be used for grass.

(c) Planting Medium

A planting medium (shown as "agricultural soil" on the Drawings) consisting a 1:1 mixture of clean soil, free of stones, building rubble or other deleterious matter and animal manure as noted in (b) shall be used.

8.5.2.1 Planting of Trees, Shrubs and Ground Cover

All planting shall be done in late afternoon or at night to prevent plants drying out.

Holes shall be excavated to the sizes and depths shown on the Drawings and backfilled with the planting medium (Agricultural Soil) specified above.

Subsequently, holes shall be dug of sufficient size and depth to accept the root balls of trees or plants to be planted. Trees or shrubs shall be removed from their containers and carefully placed in their respective holes and planting medium carefully placed around the roots ensuring all air voids are filled. Water shall be applied and tamping applied.

Hardwood staking, as shown on the Drawings shall be applied to all trees.

8.5.3 Maintenance

The Contractor shall regularly water and maintain all trees, shrubs and ground cover plants in satisfactory condition for the duration of the Contract and until final acceptance of the Works. Any unhealthy or dead plant shall be promptly replaced.

8.6 SODDING

8.6.1 General

This work shall consist of furnishing, placing and compacting topsoil and laying grass sods in accordance with the Specification where shown on the Drawings or ordered by the Engineer.

8.6.2 Material Requirements

(a) Topsoil

Topsoil shall be clean friable soil free of stones larger than 20 mm and free of weed or other deleterious matter.

(b) Grass Sod

The sod shall consist of a healthy, dense and well rooted growth of living grass with roots surrounded by topsoil and shall not contain weeds or other undesirable plants.

The grass sod shall be cut into uniform squares approximately 300 mm and shall have a minimum thickness of 50 mm (excluding grass blades). The type of grass to be used shall be subject to the approval of the Engineer.

8.6.3 Method of Construction

8.6.3.1 Sodding

The surface of the area to be sodded shall be trimmed to the profile as shown on the Drawings to the approval of the Engineer.

Units of grass sod shall be placed in uniform rows with the sides of adjacent sods in close contact to each other.

The areas to be sodded shall be as shown on the Drawings or as specified by the Engineer. The surface of the areas to be sodded shall be loosened and brought to a reasonably fine texture to a depth of approximately 20 mm. The bed upon which the sod is to be placed shall be moistened to the loosened depth, if not naturally sufficiently moist, and the sod shall be placed thereon within 24 hours after having been cut.

After the placement has been completed, the surface shall be cleared of loose sod, excess soil, or other foreign material, whereupon a thin layer of topsoil shall be scattered over the sod as a top dressing and the areas shall then be thoroughly moistened by sprinkling with water.

The Contractor shall regularly water and maintain sodded areas in satisfactory condition for the duration of the Contract and until final acceptance of the Works.

8.7 MEASUREMENT AND PAYMENT

8.7.1 Excavation

Excavation shall be measured and paid under Section 3

8.7.2 Sand Bedding

Sand Bedding shall be measured and paid under Section 3

8.7.3 Concrete

Concrete [Type E](#) and Concrete [Type G](#) shall be measured and paid under Section 4

8.7.4 Sodding

Measurement shall be made of the area of solid sodding completed in accordance with Clause 8.6.

Payment will be made at the rate entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation, maintenance and any other associated costs:

Payment will be made as follows:

- On completion of planting 60% of the rate in the Bill of Quantities.
- After satisfactory establishment of the sodding a further 20 % of the rate in the Bill of Quantities
- The remaining 20% shall be paid on satisfactory maintenance of the sodding on Completion of the whole of the Works.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.5.9 3.6.9	Sodding	m ²

8.7.5 Flowering Shrubs and Ground Cover Plants

Measurement shall be made of the area of flowering shrubs and ground cover plants completed in accordance with Clause 8.5.

Payment will be made at the rate entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation, maintenance and any other associated costs including planting medium and fertilizers.

Payment will be made as follows:

- On completion of planting, 60% of the rate in the Bill of Quantities.
- After satisfactory establishment of the flowering shrubs and ground cover plants a further 20 % of the rate in the Bill of Quantities

The remaining 20% shall be paid on satisfactory maintenance of the flowering shrubs and ground cover plants on Completion of the whole of the works.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.5.10 3.6.10	Flowering Shrubs and Ground Cover Plants	m ²

8.7.6 Precast Concrete Paving Blocks

Measurement shall be made of the area of precast concrete paving blocks completed in accordance with Clause 8.4.

Payment will be made at the rate entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation, maintenance and any other associated costs including the cost of supply and application of filler medium.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.5.4 3.6.4 3.8.11	Precast Concrete Paving Blocks	m ²

8.7.7 Trees

Measurement shall be made of number of trees of the specified type completed in accordance with Clause 8.5.

Payment will be made at the rate entered in the priced Bill of Quantities and shall include the entire cost of completing the work including materials, labour, equipment, transportation, maintenance and any other associated costs including planting medium and fertilizers.

Payment will be made as follows:

- On completion of planting, 60% of the rate in the Bill of Quantities.
- After satisfactory establishment of the trees a further 20 % of the rate in the Bill of Quantities

The remaining 20% shall be paid following satisfactory maintenance of the flowering shrubs and ground cover plants on Completion of the whole of the works.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.5.11 3.6.11	Tree 3,000 – 4,000m high	No

SECTION 9. METALWORK

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SECTION 9. METALWORK

9.1 GENERAL

9.1.1 Scope

This Section covers the general requirements for designing, manufacturing, transporting, installing, coating and other common requirements incidental to all metal work to be furnished under the Contract.

The metal works herein specified shall mean steel works such as ladder rungs and other metalwork components or items furnished under the Contract as shown on the Drawings or as directed by the Engineer.

The provisions of Causes 9.1 and 9.2 shall apply to all metalwork furnished under the Contract.

9.1.2 Submittals

The Contractor shall prepare Shop Drawings showing complete details, sections and plans of all parts, assemblies, materials lists, components, connections and supports, and relations to the structures based on the Drawings. The shop drawings are subject to approval by the Engineer in accordance with Clause 1.3.5 of Section 1.

9.1.3 Standards

Unless otherwise specifically provided in this Specification, the metal works shall be manufactured, fabricated and installed in accordance with the latest provisions of JIS, or other equivalent standards approved by the Engineer.

All materials to be furnished by the Contractor shall be new and shall have the best quality of their respective kinds.

Unless otherwise specified in this Specification, all materials and methods of fabrication shall conform to the standards listed in the following table.

Standards for Metalwork

Item	Standard
Structural Steel	ASTM A36, JIS G3101 or JIS G3106
Structural Steel Pipe	ASTM 120 or JIS G3444
Steel Pipe	JIS G3452
Bolts and Nuts	ASTM A307 Grade A or JIS B1180
Arc Welding Electrodes	AWS, JIS Z3211
Hollow Steel Sections	JIS 3466

9.2 FABRICATION AND CONSTRUCTION

9.2.1 General

The Contractor shall be responsible for the correctness and completeness of the shop drawings and for shop fit and field connections. The work shall be shop-fitted and shop-assembled as practicable as possible, conforming to the details on the approved shop drawings.

Where necessary, metals shall be insulated to prevent electrolysis due to contact between dissimilar metals and to prevent corrosion due to contact between metals and masonry or concrete. Insulation shall be by means of bituminous paint or other approved means.

All fastening, anchors and accessories required for fabrication and erection shall be provided by the Contractor. Exposed fastenings shall be kept to an absolute minimum, evenly spaced and neatly set out. Wood plugs will not be permitted.

Workmanship in fabrication shall conform to the best modern shop and field practice. All joints and intersecting members shall be accurately fitted and all works shall be fabricated on true planes with adequate fastenings.

9.2.2 Welding

9.2.2.1 General

All welding shall be done either manually by the shielded metallic arc process or automatically by the shielded arc or submerged arc method.

The Contractor shall submit a welding procedure for the approval of the Engineer in the same manner as the Drawings. After the welding procedure has been approved, the Contractor shall record it in the operation and maintenance instructions. Welding sizes and types shall be shown on all Contractor's drawings where welding is required.

Plates to be joined by welding shall be accurately cut to size and rolled by pressure to the proper curvature, which shall be continuous from the edge. Plattering in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration and the edges of plates shall be properly formed to accommodate the various welding conditions. The surfaces of the plates for a distance of 25 mm from the edge to be welded shall be thoroughly cleaned of all rust, grease and scale, to bright metal.

Field welding shall not normally be permitted. However, when expressly authorised by the Engineer it shall not be performed under adverse weather conditions of rain, temperature, moisture and wind unless the welding work is protected in a manner approved by the Engineer.

9.2.2.2 Qualification of Welding Procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the American Welding Society (AWS) standard or other approved equivalent standard.

9.2.2.3 Qualification of Welders and Welding operators

All welders and welding operators assigned to the works shall have passed a qualification test, within the preceding six months, for welders and welding operators, in accordance with JIS Z 3801 or equivalent. The Contractor shall furnish the Engineer with three (3) certified copied of report of the results of physical tests to the Engineer. If the work of any welder at any time appears questionable, he shall be required to pass the appropriate re-qualification test. All costs of qualification tests shall be borne by the Contractor.

9.2.2.4 Welding Electrodes

The welding electrodes shall conform to JIS Z 3211 or 3212, low hydrogen type covering or equivalent.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be of chromium nickel steel. The type, chemical composition and JIS or approved standard number of welding rods used for this purpose shall be subject to the approval of the Engineer.

9.2.2.5 Inspection of Welds

All welds shall be visually inspected by the Engineer and shall be subject to his approval.

When so directed by the Engineer, welds shall be tested by radiographic tests specified in JIS 3104 or other testing method approved by the Engineer.

9.2.2.6 Repair Welding

Welds disapproved by the Engineer shall be chipped out to sound metal, tested and repair to the Engineer's approval using a procedure approved by the Engineer prior to carrying out the repair.

9.2.3 Protective Treatment of Metalwork

All minor metalwork shall be galvanised in accordance with the requirements of this Clause.

- (a) Galvanizing of structural steel, where required, shall be at a rate of 0.6 kilograms per square meter and shall be performed in accordance with ASTM A123, JIS H8641, or equivalent.
- (b) In metal work which is to be galvanized:
 - (i) after fabrication, all joints which are not already welded shall be seal-welded; and
 - (ii) tapped holes shall be tapped slightly oversize and tapped again to the correct size after galvanizing.
- (c) For galvanized metal for handrails, ladders and fence, red lead prime painting will not be required except for weld joints, and one coat of approved paint shall be applied.
- (d) Where painting is called for, galvanized metal surfaces shall be acid-etched prior to the application of the finishing surface coats.
- (e) If painting is required, the Contractor shall submit a proposal of a painting system for the Engineer's approval.

9.2.4 Check Sheets

At least seven (7) days before placing concrete in any structure or installing any metal work, the Contractor shall submit, for approval, three (3) copies of an approved checkout sheet detailing all items of metalwork to be installed including unit masses and dimensions for materials to be furnished and installed and receipted invoices or other approved documentary evidence detailing the mass of any item which has been furnished and installed.

9.2.5 Installation

Metal works to be embedded in concrete shall be embedded when the concrete is being placed or, if shown on the Drawings or directed by the Engineer, recesses or block-outs shall be made in the concrete and the metalwork shall be grouted in place using cement or embedded in second-stage concrete.

The surfaces of all metal works to be in contact with concrete shall be thoroughly cleaned immediately before the grout or concrete is placed.

Metal works shall be accurately positioned and aligned in the locations as shown on the Drawings, and shall be held securely in the correct position during placing and setting of the concrete.

Where it is impracticable to place anchors or anchor bolts required for the installation of metal work when the concrete is placed, holes shall be drilled into the concrete after the concrete has set for 28 days and expansion bolts, adhesive anchor bolts, or other approved anchors shall be installed.

Field welding, cutting or drilling of prefabricated galvanised metalwork items shall not be permitted without the written approval of the Engineer.

9.3 LADDER RUNGS

Ladder rungs shall be fabricated to the size and dimensions as shown on the Drawings and galvanized.

Ladder rungs shall be installed accurately to the lines and spacings shown on the Drawings in the walls of manholes or other structures as shown on the Drawings.

All materials, workmanship, coating and installation shall be in accordance with the requirements specified in [Clauses 9.1 and 9.2](#).

9.4 MEASUREMENT AND PAYMENT

9.4.1 Ladder Rungs

Measurement shall be made of the number of ladder rungs completed and installed and approved by the Engineer.

Payment shall be made at the rate entered in the priced Bill of Quantities which shall be full compensation for the cost of all materials, labour, equipment and incidental costs for completing ladder rungs in accordance with the Drawings and the Specification.

The following pay item shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
3.9.13	Ladder Rungs: including supply and installation in wall of manholes	No.

SECTION 10. ELECTRICAL WORKS

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SECTION 10. ELECTRICAL WORKS

10.1 GENERAL

This section covers the requirement for the electrical works to be carried out by the Contractor.

10.2 SCOPE OF WORK

The Contractor shall furnish, install, test and commission street lighting along the roads bordering each side of the Tau Hu and Ben Nghe canal as shown on the Drawings.

For the purpose of this specification street lighting shall mean the all of the equipment required for lighting the roadway comprising lamps, luminaries, poles, cabling and electrical and other auxiliaries.

The main elements of the street lighting are as follows:

- Over head cables from power company poles to power receiving poles
- Power receiving poles
- Step-down transformers mounted on the receiving poles
- Lighting poles complete with luminaries
- Buried electric cables

Street lighting system will be controlled by panel which located at receiving pole of the power company.

The lighting shall provide an illumination level at ground level of 5 lux.

10.3 POWER SUPPLY

The supplying power for the lighting system will be AC 380V/220V 50Hz.

The receiving pole will be designated by Local Power Company.

Detail of the transformer auxiliaries and requirements for connection to the power company supply are to be advised at a later date following discussions with the local power company.

10.4 RECEIVING POLES

10.4.1 General

Receiving poles shall be provided to at the locations shown on the Drawings. Each receiving pole shall consist of a pole, pole foundation, mounting brackets and accessories for mounting the transformer and other electrical equipment required.

10.4.2 Materials

Poles shall be concrete of the dimensions shown on the Drawings.

10.4.3 Construction

Poles shall be mounted true and plumb in the locations shown on the Drawings.

10.5 LIGHTING POLES

10.5.1 General

Each lighting pole shall consist of a pole, arm, lamp-bulb, luminaire, ballast, electric connection box and pole-foundation.

10.5.2 Materials

(a) Pole:

Height of pole: 6 meters, made by casting aluminium, electrostatic paint, thickness 3mm

(b) Arm:

2 meters, made by GI steel D60

(c) Lamp-bulb

high pressure sodium type

(d) Luminaire:

The reflector made of pressed aluminium sheet, the face of reflector is anodised.

10.5.3 Construction

Poles shall be set true and plumb at the locations and in accordance with the details shown on the Drawings.

10.6 ELECTRIC CABLE

10.6.1 General

The cables shall be sized based on the thermal limits in normal service conditions, and the maximum allowable voltage drops in the circuit.

The carrying capacity (thermal limit) of cables in normal service condition shall take account of the de-rating due to the laying conditions or grouping.

10.6.2 Material:

The cables shall be XLPE/SWG/PCV type.

The size of cables will be 5.5sqmm-4C

10.6.3 Construction

The cables shall be installed buried underground in trenches as shown on the Drawings.

10.7 INSTALLATION, TESTING AND COMMISSIONING

The Contractor shall install and test all electrical equipment in accordance with the relevant Vietnamese codes of practice and local regulations.

Upon completion of all testing and approval by the Engineer, the Contractor shall arrange for the connection of supply from the local power company to each of the lighting systems.

10.8 PAYMENT

10.8.1 Supply of Electrical Equipment

Measurement shall be made of the number of items of respective categories delivered to the Site. For the case of cable, the amount measured shall be the final installed length.

Payment for the supply of electrical equipment will be made on the basis of equipment delivered, installed, tested, commissioned and approved by the Engineer.

Payment shall include the cost of supply, storage, fees and any other incidental costs related to the supply of electrical equipment.

All equipment shall be delivered to the Site complete with its respective documentation including manufacturer's certificates where relevant. Upon certification by the Engineer that the equipment complies with specified requirements seventy-five percent (75%) of the respective prices per unit, lot, set or lump sum, as the case may be, entered in the Bill of Quantities, shall be authorised for payment.

The remaining twenty-five percent (25%) shall be authorized for payment following the completion, testing and commissioning of each run of street lighting.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.6.1.1	Power Receiving Pole complete with fittings	No.
2.6.1.2	Transformer and Auxiliary Equipment	No.
2.6.1.3	Lighting Poles complete with lighting fixture:	No.
2.6.1.4	Electrical Cable	m

10.8.2 Installation, Testing and Commissioning

Payment will be made at the lump sum prices entered in the Bill of Quantities for the installation, testing and commissioning of each lighting system which shall be full compensation for completing the work in accordance with the Drawings, the specification and to the approval of the Engineer and shall include the cost of all labour, tools, equipment and all other related costs.

The price shall specifically include the costs of dealing with the power company, arranging for connection of power, complying with power company requirements and all fees and charges imposed by the local power company.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
2.6.2.1	Installation , Testing and Commissioning of lighting system	L.S.

SECTION 11. MISCELLANEOUS WORKS
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SECTION 11. MISCELLANEOUS WORKS

11.1 GENERAL

This section covers the requirement for miscellaneous works in Package A to be carried out by the Contractor.

11.2 RELOCATION OF EXISTING SERVICES

The Works for Package A include the shifting of the horizontal alignment of the Tau Hu Canal and Ben Van Don Street over a length of approximately 360 m between Sections 77 and 85. This section of roadway is to be completely reconstructed.

This Clause 11.2 describes the scope of the Contractor's obligations and the scope of work for the replacement of services disrupted by the realignment of the canal and the road.

11.3 SCOPE OF WORK

The following is the work to be carried out by the Contractor:

The Contractor shall enter into contracts with the water supply, electric power and telephone services companies for the removal of existing underground services affected by the works and for their complete relocation/ replacement, as required, in locations compatible with the new road alignment.

The Contractor shall liaise with each utility company so as to ensure that the relocation works are completed in a manner and with timing to suite the Contractor's construction schedule for the Works.

11.4 SCOPE OF RELOCATION WORKS

The following is an outline of the works to be carried out by the utility authorities under contracts with the Contractor.

11.4.1 Water Supply Pipe

Replacement of approximately 370 m of 150 dia water supply pipe complete with stop valves, air valves and other fittings.

House connections including the installation of water meters.

The work shall include all materials, labour equipment necessary to complete the work.

11.4.2 Electric Work

Replacement of 25 No., 15m long, concrete, electric power poles along the new southern sidewalk.

Wiring of low voltage and 15 kV cable lines over a length of approximately 370 m.

House connections including the provision of cables and fittings.

The work shall include all materials, labour equipment necessary to complete the work.

11.4.3 Telephone Line

Wiring of telephone line over a length of approximately 370 m.

House connections including the provision of cable and fittings.

The work shall include all materials, labour equipment necessary to complete the work.

11.5 PAYMENT

(a) Management Fee

The Contractor shall be paid a management fee for the relocation of existing utilities at the lump sum entered the Bill of Quantities which shall be full compensation for the cost of liaising with the utility authorities, co-ordinating their activities to ensure compatibility with the Works, paying the invoiced amounts from the utility companies (following approval of such amounts by the Engineer) and the cost of financing the payments to the utility companies between the time of payment to the utility companies and receipt of reimbursement via normal interim payments under the Contract.

No change will be made to the management fee in the event of the costs charged by the utility companies changing from the provisional sums entered in the Bill of Quantities.

(b) Reimbursement of Utility Relocation Charges

The Contractor shall be reimbursed the actual amounts paid to the respective utility companies for the relocation of the utility services. All such claims shall be substantiated by receipts.

The following pay items shall be measured and paid for under this Clause:

Pay Item No.	Description	Unit of Measurement
3.10.1	Management Fee for Relocation of Utility Services	LS
4.1	Relocation of Water Supply Pipe with House Connection: including supply, installation and testing	Provisional Sum
4.2	Relocation of Electric Cable with House Connection: including supply, installation, wiring and testing	Provisional Sum
4.3	Relocation of Telecommunication Line with House Connection: including supply, installation wiring and testing	Provisional Sum