



**REPUBLIC OF THE PHILIPPINES**  
**DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS**  
*Project Management Office – Major Flood Control Projects*

**PASIG-MARIKINA RIVER CHANNEL  
IMPROVEMENT PROJECT (PHASE III)**  
(JICA LOAN No. PH-P252)

**CONTRACT PACKAGE NO. 2  
LOWER MARIKINA RIVER (NAPINDAN CHANNEL TO  
DOWNSTREAM OF MANGGAHAN FLOODWAY)**

# **BID DOCUMENTS(DRAFT)**

## **PART 2 – WORKS REQUIREMENTS**

### **SECTION VI - WORKS REQUIREMENTS**

- VOLUME 1 - SCOPE OF WORKS**
- SPECIFICATIONS**
  - SUPPLEMENTARY INFORMATION**

**FEBURUARY 2013**

**PASIG-MARIKINA RIVER CHANNEL IMPROVEMENT PROJECT (PHASE III)**

**CONTRACT PACKAGE No. 2**

**BID DOCUMENTS**

Part 1 Bidding Procedures

- Section I: Instructions to Bidders
- Section II: Bid Data Sheet
- Section III: Evaluation and Qualification Criteria
- Section IV: Bidding Forms
- Section V: Eligible Countries of Japanese ODA Loans

**Part 2 Works Requirements**

- Section VI: Works Requirements**
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## **SPECIFICATIONS**

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S3	WATER CONTROL
S4	EXCAVATION AND EARTHWORKS
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## **S1. PRELIMINARY AND GENERAL**

### **S1.1. GENERAL SITE DETAILS**

#### **1. Location**

The Project is located in Metro Manila in the southern part of Luzon Island, Republic of the Philippines.

#### **2. Land Available**

The land available to the Contractor free of charge for the duration of the Contract will be the land occupied by the Permanent Works.

Materials or equipment shall not be stored on any roadway except where and as permitted by the Engineer.

#### **3. Access**

The Contractor shall make all arrangements and assume full responsibility for transportation to the Site of all plant, materials and supplies needed for the proper execution of the Works.

Without limiting any of its obligations or responsibilities under the Contract, the Contractor will be deemed to have obtained all necessary information pertaining to, and to have complied with, all regulations and procedures governing the use of facilities such as roads, railroads, waterways, harbours, and airports.

The Contractor shall be responsible for determining the load limits existing at the time and ensuring that its construction plant does not exceed such limits. Before moving any construction traffic onto highways, roads or bridges, the Contractor shall make suitable arrangements with the appropriate authorities and obtain their approval for the passage of such traffic.

The Contractor shall use every reasonable means to prevent any of the roads or bridges connecting, or on the routes to, the Site from being damaged or injured by any traffic of the Contractor or any of its subcontractors and, in particular, shall select routes, choose and use vehicles and restrict and distribute loads so that any such extraordinary traffic shall be limited as far as reasonably possible and so that no unnecessary damage or injury may be caused to such roads and bridges.

### **S1.2. CONTRACTOR'S GENERAL RESPONSIBILITIES**

These Specifications detail the required quality of materials, workmanship, etc., but the actual methods of construction are not generally specified and the Contractor shall be fully responsible for the adequacy of all work methods.

Notwithstanding any information submitted with the Contractor's bid, acceptance of that bid does not signify acceptance of the Contractor's proposed equipment, methods of construction, Temporary Works or materials, nor does it in any way relieve the Contractor of any of its responsibilities under the Contract. Further, it will not be accepted as a basis for claiming additional compensation where the proposed methods of construction are impractical or the proposed materials result in work not complying with the specified requirements.

When requested, the Contractor shall submit to the Engineer such details concerning the methods, equipment and materials proposed for each section of the work as the Engineer may reasonably require.

### **S1.3. CONTRACTOR'S TELEPHONE CONTACT**

The Contractor shall provide a telephone contact point or points that will allow contact to be made with the Contractor's Representative at any and all times for the duration of Contract.

The Contractor shall supply details of the contact telephone number(s) to the Engineer at least seven days prior to commencement of work on the Site.

### **S1.4. STANDARDS**

Wherever reference is made in the Contract to specific standards and codes to be met by the materials, Plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure substantial equivalence to the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the Contract documents.

The Contractor shall have available in its Site office at all times at least one copy of every Standard or Code referred to in these Specifications and any additional Standard or Code which may be referred to therein, and shall make these available for reference by the Engineer upon request.

### **S1.5. EMPLOYER'S DRAWINGS**

#### **1. Intent of Drawings and Specifications**

The intent of the Drawings and Specifications is to prescribe the details for the construction and completion of the Works. Where the Drawings or Specifications describe portions of the work in general terms, but not in complete detail, it is to be understood that only the best general practice is to prevail and that only materials and workmanship of the first quality are to be used.

#### **2. Bid Document and Contract Drawings**

The drawings included in the bid documents, and which will form part of the drawings to be used for the construction of the Works, show the work to be carried out in accordance with the Contract in sufficient detail for the Contractor to fully plan its activities.

An electronic copy, one full size print and one A3 size print of copies of the bid document drawings will be issued to the Contractor. These will be the Contract Drawings.

On receipt of the Contract 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. Although the drawings may be prepared to scale, work shall be based upon dimensions shown on the drawings and not on dimensions scaled from the drawings.

The Contractor may use the Contract Drawings for placing preliminary orders for materials and for preparing drawings of the Temporary Works. However, the Contract Drawings shall not be used as a basis for fabrication of equipment or for construction of the Works.

The Engineer may, from time to time during the construction, issue further drawings if deemed necessary.

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## **S1.6. CONTRACTOR'S DOCUMENTS**

### **1. General**

The Contractor shall prepare, and submit for approval where specified, full details of designs for which it is responsible as well as other documents specified following.

### **2. As-Staked Plans (Working Drawings)**

The Contractor shall use the Contract Drawings, together with survey of existing ground profiles required under Sub-section S1.11.2, as the basis for preparing As-Staked Plans for all parts of the Permanent Works. These As-Staked Plans shall show, where applicable, concrete outlines, bending/cutting schedules and layout of reinforcing steel bars, types of material to be used, exact dimensions and any other details which may be required for construction purposes or the derivation of work item quantities.

All As-Staked Plans shall be submitted to the Engineer for approval prior to the commencement of work associated with each particular drawing.

### **3. Record Drawings**

During the progress of the Works, the Contractor shall keep a detailed and up-to-date record of all changes where the actual construction or installation differs from that shown on the approved As-Staked Plans.

These records shall form the basis for preparation of the As-Built Drawings.

### **4. As-Built Drawings**

Progressively throughout the construction of the Works, the Contractor shall prepare As-Built Drawings for the various features as they are completed. Such drawings shall show any authorized change that may have been made to the As-Staked Plans, to the extent that they correctly portray the true "as-built" condition of each part of the Permanent Works. The As-Built Drawings shall be prepared in the same electronic format as the As-Staked Plans.

As-Built Drawings shall be subject to review by the Engineer and, if not considered satisfactory or up-to-date, shall be corrected by the Contractor within seven days of the Contractor having been advised by the Engineer of the deficiency.

As-Built Drawings, after approval by the Engineer, shall be signed by both the Engineer and the Contractor.

Within 28 days after the issuance of the Taking-Over Certificate, the Contractor shall furnish to the Engineer:

- 2 sets of full sized drawings on transparent tracing film (mylar);
- 3 sets of full sized prints of all approved and signed drawings;
- 10 sets of A3 sized prints of all approved and signed drawings; and
- 1 copy of all approved drawings in electronic format.

### **5. Form and Presentation of Contractor's Drawings**

All drawings produced by the Contractor or its subcontractors for the Contract shall use a common system of sizes, title blocks and numbers.

The title block 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 part of the number.

The 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.

The Contractor may, if it desires, insert its own reference number in the appropriate place on the title block.

## **6. Approval of Contractor's Drawings**

All drawings that require the approval of the Engineer shall be submitted to the Engineer at least 56 days prior to the commencement of fabrication or execution of the work concerned with the particular drawing. Unless otherwise specified, three copies of the drawings shall be submitted.

Within 28 days of receipt of the drawings, the Engineer will return one copy marked with one of the following classifications:

- “approved”;
- “approved except as noted - resubmission not required”;
- “resubmit after correction”; or
- “not approved”.

When returned drawings or documents have been marked for resubmission or not approved, the Contractor shall make necessary corrections and/or revisions to the drawings in a timely manner and shall resubmit three copies of revised drawings to the Engineer for further review. This procedure shall continue until drawings and documents have eventually been approved.

Any work done prior to the Engineer's approval of drawings or documents shall be at the Contractor's risk. Approval by the Engineer of the Contractor's drawings or documents shall not relieve the Contractor of any of its obligations under the Contract.

## **S1.7. CONFORMITY OF MATERIALS WITH SPECIFICATION**

All materials that will become part of the Permanent Works shall be new and shall, unless otherwise provided in these Specifications, conform to the requirements of the Department of Public Works and Highways “*Standard Specifications for Public Works and Highways*” edition that is current at the time of bid submission.

The Contractor shall make diligent efforts to procure the specified materials but where, because of priorities or other causes, specified materials are not available, substitute materials may be used, subject to prior written approval of the Engineer. The Engineer's decision as to whether substitution will be permitted, and as to what substitute materials may be used, will be final and binding.

Unless specifically stated otherwise, any reference in these Specifications or on the Drawings to trade names, catalogue numbers or a particular manufactured product does not imply that the article or product so mentioned is the only one that may be supplied or used. Any reference so made is given as a standard of the quality, class, type and finish of the items required. Articles or products of at least equivalent type and quality produced by other manufacturers may be proposed by the Contractor to the Engineer for consideration for approval for use.



## **S1.8. PRESERVATION OF PROPERTY**

The Contractor shall exercise due care to avoid damage to existing improvements or facilities, utility and service facilities, adjacent property, and trees, shrubs and other plants that are not to be removed.

Trees, shrubs and other plants that are not to be removed, and pole lines, fences, signs, markers and monuments, buildings and structures, conduits, pipelines under or above ground, sewer and water lines, and any other improvements or facilities within or adjacent to the Works shall be protected from injury or damage.

If damaged due to the Contractor's operations, the facilities shall be replaced or restored to a condition as good as when the Contractor entered upon the Site, at the Contractor's expense.

The fact that any underground facility is not shown on the Drawings shall not relieve the Contractor of the responsibility under Sub-section S1.14 of these Specifications. It shall be the Contractor's responsibility to ascertain the location of those underground improvements or facilities that may be subject to damage by reason of the Contractor's operations.

## **S1.9. COMMUNITY RELATIONS**

### **1. Community Involvement**

The Contractor shall be involved in keeping the community informed of progress of the Works and other matters which may be of interest, and shall ensure that:

- the local community is informed of, and wherever possible contributes to, decisions taken on the details of the Works which most affect it;
- users of the road and waterway network affected by the Works are informed of planned traffic arrangements including any temporary traffic diversions; and
- affected and concerned owners and occupants are informed of planned construction operations.

The Contractor must expeditiously address and seek the early resolution of all complaints and claims, directed against the Contractor or others, by members of the community in respect of the Works.

### **2. Community Liaison Officer**

The Contractor shall appoint a suitably experienced community liaison officer acceptable to the Engineer.

The community liaison officer shall be responsible for liaising and co-operating with members of the community for the purpose of:

- keeping the local communities advised about the general progress of the Works;
- giving advance notification to the local community when particular operations will commence and finish, particularly those which might inconvenience the inhabitants of the area;
- receiving and replying to complaints from the community about matters related to the Works;
- ensuring that remedial and corrective action is taken wherever necessary in response to complaints from the community; and
- supporting community awareness programmes.

The community liaison officer shall be on Site not later than 14 days after the Commencement Date and shall remain in position until the Taking-Over Certificate has been issued.

### **3. Public Convenience**

In addition to the requirements of Sub-section S1.15, the Contractor shall conduct its operations so as to cause obstruction and inconvenience to the public.

All public and private roads which are being used by the Contractor's, sub-contractors' or suppliers' vehicles for the construction of the Works shall be kept clean and free of dirt and mud arising from the Works.

#### **S1.10. MOBILIZATION AND DEMOBILIZATION**

Mobilization, as provided in these Specifications, means preparatory work and operations, including, but not limited to, those necessary for the movement of necessary personnel, plant and equipment to the Site.

Demobilization means the removal of such personnel, plant and equipment from the Site.

In accordance with Sub-section S1.17.2, the Contractor shall furnish the Engineer with a resources schedule, showing in detail the sequence of proposed delivery to the Site of plant and equipment necessary to comply with the proposed construction programme.

The Contractor shall keep the Engineer informed of the arrival of plant and equipment on the Site.

In accordance with the Conditions of Contract, the Contractor shall not remove construction plant and equipment from the Site without the approval of the Engineer.

#### **S1.11. SURVEY AND SETTING OUT**

##### **1. Setting Out**

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced qualified surveyors acceptable to the Engineer for this purpose.

The Contractor shall install all level and survey stations required. Such stations shall be of robust construction, protected against damage and the influence of any movement that may arise from the execution of the Works.

The Contractor shall check the survey stations at regular intervals during the progress of the Works.

The Contractor shall provide the Engineer with the location and description of all survey stations, the results of surveys and all calculations and, if required by the Engineer, shall give adequate opportunity for the Engineer to check such stations prior to their utilization.

The degree of accuracy employed in the survey and setting out shall be such as will allow the alignment, levels and dimensions specified for the Works to be achieved.

##### **2. Survey of Ground Profiles**

The Contractor shall inform the Engineer in writing, at least 14 days before commencing such work, of the intention to perform any work that will result in a change to the topography of the existing Site, whether such work is for Permanent Works or Temporary Works. Thereupon, before commencing any work, the Contractor shall survey the original topography to the approval of the Engineer over the entire area to be occupied or disturbed.

The information so obtained shall be recorded by the Contractor in an approved electronic format and on drawings that shall be signed, after agreement, by both the Contractor and the Engineer.

The Contractor shall prepare survey drawings to the scales shown in Table 1-1, or as may otherwise be required by the Engineer.

Table 1-1

Feature	Plan	Profile		Cross section	
		Vertical	Horizontal	Vertical	Horizontal
Dikes	1:500	1:100	1:1000	1:100	1:200
River channels, floodways	1:200	1:100	1:1000	1:100	1:200
Other structures	1:100	-	-	-	-

Contour line intervals shall be as instructed by the Engineer.

The Contractor shall then provide the Engineer with a transparency of the drawings and a copy of the electronic data. The drawings will serve as a permanent record for the purpose of determining both the quantities of excavation and earthworks carried out in the Permanent Works and the extent to which the Temporary Works shall be removed or temporary excavation shall be refilled upon completion of the Works.

The Contractor shall survey all excavated and final surfaces to a standard subject to the approval of the Engineer for the purpose of recording as-built details and for the measurement of quantities:

- on completion of excavation, or each excavation stage, and prior to commencement of placing fill, backfill or concrete or other work; and
- on completion of placing fill, backfill or concrete or other work.

The information shall be agreed and recorded as set out above for original ground profiles.

**3. Assistance to Engineer for Survey**

The Contractor shall cooperate with the Engineer in checking the setting-out and the measurement surveys for record and payment purposes. The Contractor shall provide all necessary assistance to the Engineer and shall supply, as required and for the sole use of the Engineer, sufficient quantities of pegs, poles, straightedges, stagings, moulds, templates, profiles and all other requisite items for checking the Contractor's setting-out and measurement of the Works.

**S1.12. TEMPORARY WORKS**

**1. General**

The Contractor's proposals for the erection of all Temporary Works shall be generally in accordance with any proposals submitted with its bid or with such modifications as are made from time to time.

**2. Submission of Details for Temporary Works**

The Contractor shall submit drawings and full particulars of all Temporary Works, which it intends to construct, to the Engineer at least 28 days before the commencement of construction of such works. The submission to the Engineer of any such proposals by the Contractor shall not relieve the Contractor of its responsibility for the sufficiency of the Temporary Works for their intended purpose. The Contractor shall also obtain any necessary approval from local, statutory or other Government authorities before commencing construction of the Temporary Works.

If any equipment, appliances, types or quality of Temporary Works such as scaffolding, forms and safety provisions are in the opinion of the Engineer either unsafe or unsuitable, the Engineer may instruct the Contractor to replace or modify the item or items concerned. Whether or not the Contractor is in

agreement with such opinion, the Contractor shall forthwith make the required alterations without any additional payment.

### **3. Removal of Temporary Works on Completion of the Works**

On completion of the Works, all Temporary Works constructed by the Contractor, unless otherwise specified or instructed, shall be removed from the Site. The Contractor shall make safe all areas affected by Temporary Works and reinstate natural drainage.

#### **S1.13. FOUNDATION INVESTIGATIONS**

Where instructed, the Contractor shall carry out foundation investigations to determine as accurately as possible details of the foundation materials at various depths.

The foundation investigation shall comprise boring with SPT and unconfined compressive strength tests.

Bore holes shall be 89 mm in diameter and up to 25 m in depth.

SPT tests shall be carried out at 1 m intervals and 2 unconfined compressive strength tests shall be done for each borehole as instructed by the Engineer.

The Contractor shall submit the results of the investigations and testing to the Engineer as soon as practicable in an approved format.

Detailed bore logs shall be recorded by an experienced geotechnical engineer and shall include the surveyed location and existing ground level of each bore hole.

#### **S1.14. UTILITY OR SERVICE FACILITIES**

For the purposes of this Specification, utility or service facility means all private and public utilities and service facilities located within the Site including, but not limited to:

- electricity cables and poles;
- telephone lines and poles;
- water, drainage and sewer pipes;
- underground cables of any nature; and
- fuel and gas pipelines.

Prior to the commencement of the Works, the Contractor shall be deemed to have familiarized itself with the locations of all utility or service facilities passing through, under or over the Site.

Attention is directed to the possible existence of underground facilities not indicated on the Drawings and to the possibility that underground facilities may be in a location different from that indicated on the Drawings. The Contractor shall ascertain the exact location of underground facilities whose presence is indicated on the Drawings, the location of their service laterals or other appurtenances, and of existing service laterals or appurtenances of any other underground facilities which can be inferred from the presence of visible facilities such as buildings, meters and junction boxes prior to doing work that may damage any of the facilities or interfere with their service.

If the Contractor cannot locate an underground facility whose presence is indicated on the Drawings, the Contractor shall notify the Engineer in writing.

If the Contractor discovers an underground facility not indicated on the Drawings, the Contractor shall immediately notify the Engineer and the facility owner of the existence of that facility.

The Contractor shall protect from damage utility and service facilities that are to remain in place, be installed, relocated or otherwise rearranged.

Underground cables may be carefully excavated, laid aside and protected, and be relocated in trenches on completion of the new work.

Unless otherwise advised by the Engineer, utility or service facilities shall be relocated by the owning authority. The Contractor shall make all arrangements and pay all costs and charges made by the authority to perform this work. The Contractor shall attend and assist the authority in carrying out any alterations to services.

In the event of interruption to any service as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with that authority in the restoration of the service.

If an essential service is interrupted, repair work shall be continuous until the service is restored.

Unless otherwise approved, the Contractor shall not disturb any existing drainage pipe in any way that may affect the drainage pattern. Where necessary, the Contractor shall provide temporary outlets to any affected drainage pipes until they have been reconnected to their permanent outlets.

## **S1.15. TRAFFIC MANAGEMENT**

### **1. General**

The Contractor shall implement an approved Traffic Management Plan for both vehicular and water-borne traffic. At least seven days prior to commencing any work on a particular stage of the Works, the Contractor shall submit to the Engineer for approval a detailed plan covering all aspects of traffic management for that particular stage. The submission shall include documentation evidencing approval by all relevant authorities. No work shall commence on any work stage until the Engineer has approved the plan for that stage. Upon the Engineer's approval, the Contractor shall immediately implement the plan and keep it in operation for the full duration of the relevant work stage.

The Contractor shall be responsible at all times for the safety of the public on the Site and, should the Contractor fail to provide the necessary traffic management, the Engineer may arrange for others to carry out such work as he deems to be necessary. The Contractor shall be responsible for the cost of the necessary work and the Employer may recover this by deduction from any money due, or which may become due, to the Contractor under the Contract.

### **2. Traffic Arrangements**

Due to extreme traffic congestion on most roads in the vicinity of the Site, it is expected that the majority of the Works will be constructed using water-borne craft and that minimal interference will be caused to road users. Where the safe movement of vehicular or water-borne traffic may be affected, the Contractor shall ensure that all necessary traffic control is provided to the satisfaction of the Engineer and the respective authorities.

Where required, or where instructed, the Contractor shall furnish and station competent flagmen whose sole duties consist of directing the movement of traffic through or around the work.

All traffic safety and management measures necessary for any part of the Works shall be fully operational before the Contractor commences any work on that part of the Works.

### **3. Compliance with Instructions**

The Contractor shall comply with any instruction given by the Engineer or the relevant authority in respect of any traffic control proposal.

The Engineer or a relevant authority may at any time instruct the Contractor to re-open any traffic route to traffic without delay, whether or not closed by prior agreement.

The Engineer may order suspension, or cessation, of any activity that causes delay to traffic or threatens the safety of the public, notwithstanding that approval had been given to the traffic change.

## **S1.16. QUALITY MANAGEMENT**

### **1. General**

The Contractor shall be responsible for ensuring that the Works comply with the specified requirements and shall maintain an effective and adequately documented system of Quality Management necessary to satisfy the Contract requirements. This requirement shall be met by the establishment and implementation of procedures that ensure that only acceptable work is delivered to the Employer.

No part of the Contractor's procedures shall be used to pre-empt, preclude or otherwise negate the technical requirements of the Contract. The acceptance of any of the Contractor's procedures by the Engineer shall not in any way relieve the Contractor of the responsibility to comply with the requirements of the Contract.

The Contractor shall ensure that all its subcontractors and suppliers observe the provisions of this Sub-section S1.16.

### **2. Staffing**

The Contractor shall employ, for the duration of the Works, a Quality Assurance Engineer and sufficient staff to carry out the inspections, testing, etc., required by the Contract. These staff shall have no involvement in other functions such as programming or managing the Works and shall be employed solely on quality assurance functions.

The Quality Assurance Engineer shall be subject to the approval of the Engineer, which approval may be withdrawn at any time. Should the Engineer withdraw approval, the Contractor shall immediately provide an acceptable replacement.

### **3. System and Procedures**

The Contractor shall:

- implement a quality system which complies with the requirements of ISO 9001 and includes a Quality Manual and procedures as required by ISO 9001;
- provide a Quality Plan which encompasses the planning requirements of ISO 9001 and the requirements set out in the Specifications;
- within 28 days of the Commencement Date, submit three controlled copies of the current edition of the Quality Manual and the first edition of the Quality Plan to the Engineer for approval;
- review the Quality Plan monthly and revise it when necessary to address changes in the construction process and promptly submit the revised Quality Plan to the Engineer for approval; and
- review the Quality Manual if necessary and promptly submit any revision to the Engineer for approval.

#### **4. Hold Points**

The Project Quality Plan shall include a schedule of Hold Points assigning a designated authority for release of each Hold Point.

A “Hold Point” is an identified point in a work-related process, beyond which the subsequent activity cannot proceed without release of the Hold Point. Release of a Hold Point is subject to:

- the production of records by the Contractor which verify conformance with the Specification;
- an independent inspection of critical aspects of the works; and
- acknowledgment that critical aspects of the works may commence.

All instances where review or approval or consent is required from the Engineer shall be considered to be Hold Points where the designated authority for release is the Engineer.

Acceptance and release of other items shall be on the basis of a Certificate of Compliance from the Contractor stating that the product or service complies with the specified requirements, and inspection and test requirements have been successfully completed. Objective evidence shall be available to support the Certificate of Compliance.

A Certificate of Compliance issued by a subcontractor must be endorsed by the Contractor to be considered as a valid release document.

Release documentation shall also include copies of approval records from applicable authorities, and any inspection/release documentation issued by the Engineer.

Release of a Hold Point or failure to detect a non-conformance shall not in any way relieve the Contractor from the responsibility for the satisfactory performance or execution of the work subject to the Hold Point.

#### **5. Control of Non-conformance**

A “Non-conformance Report” is a report that is issued by the Contractor when a non-conformance occurs that cannot be rectified by a continuation or extension of the current process. The report must summarise in what manner the non-conformance does not comply with the Contract and shall have attached any relevant inspection and test records. It must also include the Contractor’s proposed disposition (eg accept as is, rework or replace). The report shall be issued within one ordinary working day of the non-conformance being recognised.

In the event of a non-conformance related to the Contract being observed and the Contractor does not take appropriate action when informed, the Engineer will issue a Corrective Action Request (CAR) to the Contractor. The Contractor shall respond by issuing a Non-conformance Report which indicates the proposed method of disposition.

The identification of a product related non-conformance and the subsequent issue of a Non-conformance Report or Corrective Action Request shall constitute a Hold Point. Acceptance by the Engineer of the Contractor's proposed disposition is required before the Contractor may proceed with further work on that lot.

The Contractor shall review and analyse the cause of all non-conformances and develop a plan of corrective action to minimise the likelihood of recurrence. Details of such corrective action shall be entered in a Non-conformance Report or Corrective Action Request as appropriate.

Following completion of the disposition, the Contractor shall re-submit the Non-conformance Report, together with any necessary supporting evidence, for release of the Hold Point.

## **6. Subcontractors**

The Contractor shall be fully responsible for the integration of each subcontractor's quality systems into its own system, or alternatively for the subcontractor to work within the Contractor's Quality Plan.

The Contractor shall be the single point of responsibility for the production, implementation and auditing of the quality system required under the Contract.

## **7. Approval of System**

The Engineer will approve or reject the current edition of the Quality Manual and the first edition of the Quality Plan submitted by the Contractor within 28 days of its submission.

Any rejected Quality Manual or Quality Plan shall be promptly amended and resubmitted to the Engineer for approval.

Following approval, the Contractor shall without delay commence and continue implementation of the Quality System.

## **8. Amendments**

The Engineer may at any time instruct the Contractor to amend the Quality Manual or Quality Plan. The Contractor shall thereupon promptly amend the Quality Manual or Quality Plan and resubmit it to the Engineer for approval.

## **9. Consultation**

The Contractor shall consult with the Engineer on a regular basis for the purpose of assessing and, where relevant, improving the Contractor's performance in carrying out the Works.

The discussions may include, among others, the following:

- items of non-conformance, the corrective action taken, complaints, training, inspection and tests, quality records and the like;
- where relevant, methods for the improvement of the quality or efficiency of the performance of the Works; and
- issues arising from observations by the Engineer of the Contractor's execution of the Works.

## **10. Testing of Materials**

The Contractor is responsible for ensuring that the testing, inspection and examination necessary to verify conformance with this Contract is undertaken.

Unless otherwise specified, all testing shall be carried out and interpreted in accordance with the methods given in the relevant Standards.

The Contractor shall provide, maintain and operate until the completion of the Works a laboratory complete with furnishings, fixtures and equipment sufficient to carry out all required quality control testing. Alternatively, the Contractor may nominate a commercial testing laboratory accredited by the Bureau of Research and Standards (BRS), the Department of Science and Technology (DOST) or the Department of Trade and Industry (DTI) where the testing can be carried out. Such an alternative laboratory shall only be used with the specific approval of the Engineer.

The laboratory shall be provided within 56 days of the Commencement Date and the Contractor shall utilize the services of the BRS of DPWH for testing until the laboratory is operational.



The Engineer shall have access to the laboratory at all times and the Contractor shall provide, within the laboratory, a separate furnished office for the Engineer's use.

#### **11. Quality of Materials and Samples**

When required by the Engineer, the Contractor shall furnish all information as to quality, constituent substances, dimensions, levels, strength and description of the materials and work, and shall give the Engineer such other particulars as may be required.

Before placing any order for materials for incorporation in the Works, the Contractor shall submit to the Engineer for information the names of the firms supplying materials and details such as the origin, manufacturer's instructions and material specifications. When requested, the Contractor shall provide such samples and test certificates as the Engineer may require.

Unless otherwise specified, all proprietary materials shall be used and placed in strict accordance with the relevant manufacturer's instructions.

#### **12. Quality Records and Reports**

The Contractor shall maintain a system of records that provide objective evidence that the requirements of the Contract have been met. The Contractor shall ensure that subcontractors' records pertinent to the Contract are included in this system.

All applicable records shall be available for audit and review by the Engineer during the period of the Contract and for at least seven years after the date of Taking-Over.

The Contractor shall provide a monthly quality report to the Engineer containing the following:

- identification of all work in progress; and
- details of all action taken on the Quality System since the last monthly report.

#### **13. Surveillance and Audits by the Engineer**

While the primary responsibility for all verification, validation, inspection and testing lies with the Contractor, the Engineer reserves the right to carry out verification, inspection and testing of the Works, and conduct audits to evaluate the Contractor's performance in complying with its obligations under the Contract.

The Contractor shall make all necessary arrangements to ensure that the Engineer has access to all facilities, documentation, records and personnel (including, without limitation, those of subcontractors) that are required by the Engineer for the carrying out of the surveillance and audits.

#### **14. Provision of Laboratory Equipment for Employer**

After completion of the Works, the Contractor shall hand over to the Employer the equipment listed in Table 1-2 in good working order.

Table 1-2

Item	No.
Sample splitter	1
ASTM standard sieve set	1
Plastic limit test set	1
Liquid limit test set	1
Standard/Modified compaction test set	1
Field density test set	1
Specific gravity and absorption test set	1
Los Angeles Abrasion machine	1
Concrete test mould, cylinder 150 mm x 300 mm	18
Concrete test mould, cube 150 mm x 150 mm	12
Slump cone	2
Concrete compressive strength testing machine	1
Cylindrical concrete specimen capping set	1
Entrained air meter with complete accessories	1
Field oven with temperature control	1
Balance with O-Haus 16 kg capacity	1
Triple beam balance, 2610 g cap., 0.1g sensitivity	1
Heavy duty balance, 20 kg capacity, 1g sensitivity	1
Flatform balance 100 kg	1
Speedy moisture tester 0-20 %	1
Laboratory concrete mixer	1

## S1.17. PROGRAMMING AND REPORTING

### 1. General

The Contractor shall employ on its site staff an experienced planner, with adequate support staff and systems, who will be responsible for preparation and updating of programmes and progress reports.

### 2. Construction Programme

For the purpose of this Specification, “construction programme” means the programme to be submitted in accordance with the Conditions of Contract and used to plan and organize the work.

In addition to the requirements detailed in the Conditions of Contract, the construction programme shall be prepared on a computer using approved software and shall include:

- the duration, sequence and logic links between major activities and any other activities or group of activities which comprise the Works, necessary to define the critical path and logic of the programme;
- dates by which Drawings are required;
- dates by which relocation of services are required;
- the planned dates for completion of the Works and each section of the Works;
- the critical path(s) for the Works and each section of the Works;
- information on shutdown periods, vacation days and other non-working time periods; and
- the estimated value of work to be done each month.

The construction programme shall, in the opinion of the Engineer, be reasonable in all respects.

When instructed, the Contractor shall promptly furnish a detailed sub-programme of the construction programme for particular features of the Works.

### **3. Monitoring of Progress**

During the execution of the Contract, the Contractor shall monitor the progress of activities relative to the construction programme and shall submit a report to the Engineer on a monthly basis detailing the results of the monitoring.

### **4. Progress Meetings**

The Contractor shall attend regular Site meetings with the Engineer where the progress of the Works will be reviewed. Such meetings will normally be held monthly and may be attended by representatives of the Employer.

The Contractor shall also attend weekly meetings with the Engineer and provide, prior to each meeting, detailed programmes showing separately the various activities of the Contractor anticipated over the forthcoming two week period as well as the progress achieved over the preceding week relative to the programme applicable to that period.

### **5. Progress and Completion Reports**

In addition to the requirements detailed in the Conditions of Contract, the progress report shall contain the following:

- a general description of the work performed during the reporting period and notable problems which were encountered;
- an inventory of the amount of major construction materials consumed and delivered to the Site during the reporting period;
- an inventory of all equipment and plant, their present status, and time when their repair is expected to be finished (if under repair);
- a general description of weather, and a list of rainfall and maximum and minimum temperatures for each day;
- details of any industrial problems;
- details, including dates and amounts, of Statements submitted and payments received;
- details of any foreseeable problems; and
- a record and status of correspondence exchanged between the Contractor and the Engineer.

Within 28 days of the date of issue of the Taking-Over Certificate, the Contractor shall submit a completion report to the Engineer for approval. The completion report shall contain details of all items listed above for the progress report.

### **6. Provision of Software**

The Contractor shall within 14 days of the Commencement Date provide to the Engineer two original copies of the latest version of the programming software being used by the Contractor.

The Contractor shall also provide upgrades to the software, as the upgrades become available.

The licences of the software shall be held in the name(s) as approved by the Engineer.

## **S1.18. HEALTH AND SAFETY**

### **1. General**

In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect persons or property from injury and shall comply with any safety instruction given by the Engineer.

The Contractor shall comply with all current statutory requirements, and shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of its employees. In particular, the Contractor shall follow the recommendations set out in “*Occupational Safety and Health Standards*” published by the Department of Labor and Employment and “*Safety and Health in Construction*” published by the International Labour Office and shall strictly observe the provisions of the Department of Labor and Employment Order No. 13-1998 “*Guidelines Governing Occupational Safety and Health in the Construction Industry*”.

## **2. Accident Prevention Officer**

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 duties 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.

If work is being carried out in shifts, the Contractor shall appoint at least one deputy with the same duties, and either the Accident Prevention Officer or the deputy shall be available on Site at all times that work is in progress.

The Accident Prevention Officer and the deputy shall be fluent in English and have at least a working knowledge of Filipino.

## **3. Health and Safety Plan**

The Contractor shall implement an approved Health and Safety Plan. Within 28 days from the Commencement Date, the Contractor shall submit to the Engineer for approval a detailed plan covering all aspects of health and safety for each stage of the Works. No work shall commence on any work stage until the Engineer has approved the Health and Safety Plan for that stage. Upon the Engineer's approval, the Contractor shall immediately implement the Plan and keep it in operation for the full duration of the relevant work stage.

The Contractor shall promote the need for safety awareness in all aspects of the work by conducting safety awareness programs and campaigns, displaying posters and signs and using audio-visual methods.

The Contractor shall conduct formal induction sessions for all persons on Site, including issuing each of its employees and employees of its sub-contractors with an induction health and safety booklet, and during the Contract continue with ongoing training on site health and safety matters.

The Engineer will monitor the effectiveness of the implementation of the Contractor's Health and Safety Plan, and the Contractor shall comply with any instructions for improvements that the Engineer may give.

## **4. Safety of the Public**

Where the public could be exposed to danger by any of the Contractor's activities, the Contractor shall as appropriate provide suitable flagmen, barriers or warning signs.

The Contractor shall ensure that all local communities that may be affected by the Works are made aware of the hazards of construction.

## **5. STI, STD and HIV/AIDS Alleviation Programme**

The implementation of the programme shall be through an experienced specialist provider approved by the Employer and the Philippine National AIDS Council.

## **6. First Aid**

The Contractor shall take all reasonable steps to ensure that employees receive prompt first aid treatment in case of an injury or emergency.

First aid boxes, appropriately equipped, shall be placed in positions where they are easily accessible by employees at the workplace.

## **7. Hazardous Substances**

The Contractor shall identify and keep records of all hazardous equipment, materials or other substances on the Site and the Engineer shall be granted access to such records at all times.

The Contractor shall conduct and document, at least weekly, inspections of storage areas for spillage and leaks. The Contractor shall, within 28 days of the Commencement Date, submit to the Engineer, for approval, a method statement demonstrating how spills of toxic or unacceptable contaminants will be prevented from entering natural streams or water courses, and also how areas outside the Site will be cleared to protect the environment and maintain the safety of persons on the Site and of the general public.

The Contractor shall also, within 28 days of the Commencement Date, submit for the consent of the Engineer details of buildings proposed to contain or store hazardous substances. They shall show methods of ventilation and containing spillage, and shall indicate the method of cleaning any spillage that may occur.

## **8. Provision of Personal Protective Equipment**

The Contractor shall, within 28 days of the Commencement Date, prepare for the consent of the Engineer a schedule of Personal Protective Equipment (PPE) for free issue, including replacement, to all persons employed on the Works, including Employer's Personnel. Provision shall also be made for supplying PPE to official site visitors.

The schedule shall include the PPE recommended in "*Safety and Health in Construction*" and shall address the need to provide such clothing and equipment suitable for the climatic conditions on the Site.

The Contractor shall immediately implement the issue of such PPE once it has obtained the Engineer's consent to the schedule and all the Contractor's employees shall be made aware of the need to wear such clothing and to use such equipment, and to maintain the same in good working order.

The Contractor shall make the proper use of PPE a condition in every person's contract of employment on the Works.

## **9. Rescue Boat**

Whenever work is being carried out on or near the river channel, the Contractor shall ensure that a rescue boat and trained crew are available in the immediate vicinity in case of emergency.

## **10. Provision of Sanitary Conditions**

The Contractor shall provide, at or near all work places, adequate toilet facilities, water for washing, etc. The Contractor shall maintain the facilities in a clean and sanitary condition to the satisfaction of the Engineer.

## **11. Lighting**

Without limiting the generality of the Conditions of Contract, the Contractor shall provide sufficient lighting to ensure that safe working conditions are provided in all places where work is in progress.

All equipment or plant used during night operations shall be equipped with sufficient lights and reflectors to ensure safe working conditions.

Not less than 14 days before the start of any night operations, the Contractor shall submit to the Engineer its proposals for lighting in the areas in which it proposes to work at night. The Contractor shall modify the proposal if instructed and shall not begin operations at night until the proposals for lighting, in an amended form if required, have been approved.

Should the Contractor fail to provide sufficient lighting, work in areas affected shall be prohibited until lighting has been provided to the satisfaction of the Engineer.

Approval of the Contractor's proposals for lighting shall not relieve the Contractor of any of its liabilities or obligations under the Contract.

## **12. Electrical Power**

All electrical power circuits shall be fitted with earth leakage systems. Such systems shall be regularly tested and any circuit where the earth leakage system is malfunctioning shall be repaired immediately or removed and replaced with a satisfactory unit.

## **13. Reports**

The Contractor shall promptly report to the Engineer, in an approved format, any occurrence affecting the health or safety of any employee or of any member of the public on the Site.

### **S1.19. CONTRACTOR'S FACILITIES**

The Contractor shall make arrangements as necessary for the provision of all administrative offices, workshops and other necessary facilities.

Full details of the Contractor's facilities shall be submitted to the Engineer within 28 days of the Commencement Date.

The design and layout of the Contractor's facilities shall comply with the appropriate statutory regulations in all respects.

The design, construction and maintenance of the Contractor's facilities shall include all necessary site works and services for water supply, sewerage, drainage, lighting, roads, paths and parking places.

The Contractor shall arrange for a high standard of sanitation to be maintained throughout the Site. The Contractor shall construct and maintain a system of surface drainage and waste disposal that shall be sufficient for the purpose and in accordance with all relevant regulations.

The Contractor shall provide and maintain a distribution system for electric power and a lighting system to provide a reasonable degree of illumination to the temporary works areas.

The Contractor's temporary works areas shall be surrounded by approved security fencing.

The Contractor shall provide and erect Project billboards at conspicuous locations on the Site in accordance with Department Order No. 86, Series of 2002, "Installation of Project Billboards".

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The Contractor shall remove all buildings and facilities erected by it from the Site on completion of the Works. The Contractor shall fill in all excavated areas, remove all refuse, debris and other objectionable materials and leave all areas in a clean and sightly condition.

#### **S1.20. PHOTOGRAPHS**

The Contractor shall maintain a photographic record of the progress of the Works by taking photographs using a digital camera from such locations and at such times as the Contractor may choose or as the Engineer may instruct.

At least 50 photographs shall be taken each month and the Contractor shall submit to the Engineer a copy of a CD-ROM containing the digital photographs taken each month. From these, the Engineer will select photographs for inclusion in the monthly progress report as provided in Sub-section S1.17.5.

The digital image files shall be recorded using a naming system approved by the Engineer.

#### **S1.21. SECURITY**

The Contractor shall operate a security system at all the areas of the Site on a 24 hour per day basis to the satisfaction of the Engineer. Such a system shall include full and effective security control of access to all work areas.

The Contractor shall cooperate with the local Police and comply with the Engineer's requirements on all matters relating to security of the Works and persons entering the Site.

#### **S1.22. OFFICE FOR EMPLOYER'S PERSONNEL**

##### **1. General**

The Contractor shall provide, and maintain until the completion of the Works, a Site office for the Employer's Personnel at a location prepared by the Employer.

The facilities shall be provided within 56 days of the Commencement Date.

The Contractor shall submit the specifications and detailed drawings to the Engineer for approval.

Until completion of the facilities the Contractor shall provide temporary facilities to the satisfaction of the Engineer.

##### **2. Design and Construction**

The office shall comply with any statutory building requirements.

The office shall have a floor area of at least 200 m<sup>2</sup>. The internal arrangement shall be as shown on the Drawings or instructed by the Engineer.

The building shall be constructed with materials and to standards appropriate to the type of building and to the satisfaction of the Engineer.

The minimum clear height between floor and ceiling shall be 2.5 m.

The building shall be fully burglar-proofed.

**3. Furnishings, Equipment and Consumable Items**

The Contractor shall supply furniture, equipment and consumables for the Site office as required by the Engineer.

**4. Parking Areas**

The Contractor shall provide paved parking areas suitable for at least eight vehicles.

**5. Services**

The Contractor shall provide all power, sewerage, water supply and communication facilities to the Engineer's Site office.

**6. Maintenance**

The Contractor shall maintain the building in good order and condition until the completion of the Works. Maintenance shall include the repair and making good of all faults and defects that become apparent in the building, electrical, plumbing, water supply and sewerage services appurtenant to the building and all items in the building provided in accordance with this Section S1.22.

**7. Cleaning**

The Contractor shall provide a daily cleaning service to keep the office and surrounding areas in a neat and tidy condition to the satisfaction of the Engineer.

**8. Removal**

On completion of the Works, the building provided by the Contractor in accordance with this Section shall remain the property of the Contractor and shall be removed from the Site.

**S1.23. TRANSPORTATION FOR EMPLOYER’S PERSONNEL**

The Contractor shall provide, within 28 days of the Commencement Date, and maintain at all times transportation for the exclusive use of the Employer’s Personnel. The transportation items shall comprise the numbers and types shown in Table 1-3.

Table 1-3

Type	Description	Total number to be provided
A	4WD vehicle	5
B	Motor cycle, 200cc capacity	3
C	Inspection boat	1

Transportation item types and specifications shall be as instructed by the Engineer.

All transportation items shall be new when supplied.

All passenger carrying transportation items shall be provided with a competent and experienced driver to the satisfaction of the Engineer.

All motor vehicles shall be fitted with a fire extinguisher, first aid kit, tool kit, wheel wrench, jack and spare wheel, all of which shall be serviceable at all times.

The boat shall be equipped with six life jackets, a life ring buoy, anchor and other necessary accessories.



All motor vehicles and motor cycles shall satisfy requirements for on-road registration in the Republic of the Philippines and shall be so registered.

All transportation items shall be comprehensively insured in the joint names of the Contractor and the Employer including for use whether on or off the Site.

Maintenance shall include registration, insurance, fuel, oil, tyres and all other running costs and mechanical upkeep sufficient to keep the transportation items in good condition for the period of the Contract.

If a transportation items is unavailable or unserviceable for more than 24 hours the Contractor shall supply a suitable replacement.

#### **S1.24. COMMEMORATIVE PANELS**

The Contractor shall provide and install commemorative panels describing the funding provided by the Japanese ODA where instructed by the Engineer. The design and quality of materials shall be to the approval of the Engineer.

The logos and wording shall be as shown on the Drawings or approved.

#### **S1.25. SITE CLEAN UP**

On completion of the Works, the Contractor shall clean up all areas of the Site and restore them to their original condition.

#### **S1.26. DISPUTE BOARD**

As provided in the Conditions of Contract, the Employer and the Contractor shall appoint a Dispute Board and the Employer and the Contractor shall each be responsible for paying one-half of the Dispute Board's remuneration.

In accordance with the provisions of the Conditions of Contract, the Contractor shall first pay the full cost of the Dispute Board member's invoices and the Employer shall reimburse the Contractor for one-half of the amounts of these invoices in the Statements under the Contract.

#### **S1.27. MEASUREMENT AND PAYMENT**

##### **1. Mobilization and Demobilization**

Payment will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.10/1	Mobilization and demobilization	Lump Sum

Payment of 70% of the Lump Sum will be made monthly in the proportion that the progress of mobilization completed in a particular month bears to the total numbers of plant and equipment shown in the approved resources schedule.

The remaining 30% of the Lump Sum will be paid upon certification by the Engineer that the demobilization of plant and equipment has been completed to his satisfaction.

## 2. Survey and Setting Out

Payment will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.11/1	Survey of ground profiles	Lump Sum

Payment of the Lump Sum will be made monthly in the proportion that the progress of the Works completed in a particular month bears to the whole of the Works.

## 3. Foundation Investigation

### (a) Measurement

Measurement, for payment, of foundation investigation will be made of the length actually drilled or investigated as instructed.

### (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.13/1	Foundation investigation	Metre

Separate payment will not be made for sampling, testing, preparation and submission of reports or any other necessary incidental work.

## 4. Relocation of Utility or Service Facilities

Payment for relocation of utility or service facilities will be made under the following Provisional Sum:

BoQ Item No.	Description	Unit of Measurement
P1.14/1	Relocation of utility or service facilities	Provisional Sum

Relocation of existing structures/services identified in other Sections of these Specifications will be paid under the provisions in those Sections.

## 5. Traffic Management

Payment will be made at the applicable rate or Lump Sum bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
1.15/1	Traffic Management Plan	Lump Sum
1.15/2	Implementation and operation of traffic management plan	Month

Payment of the Lump Sum for establishment and provision of the Traffic Management Plan will be made after the detailed system has been approved by the Engineer and the Contractor has commenced operation of the system.

## 6. Quality Management

Payment will be made at the applicable rate or Lump Sum bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
1.16/1	Quality Management Plan	Lump Sum
1.16/2	Implementation and operation of quality management plan	Month
1.16/3	Provision of laboratory equipment for Employer	Lump Sum

Payment of the Lump Sum for establishment and provision of the Quality Management Plan will be made after the detailed system has been approved by the Engineer and the Contractor has commenced operation of the system.

## 7. Programming and Reporting

Payment will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.17/1	Programming and reporting	Lump Sum

Payment of the Lump Sum will be made monthly in the proportion that the progress of the Works completed in a particular month bears to the whole of the Works.

## 8. Health and Safety

Payment will be made at the applicable rate, Lump Sum or Provisional Sum bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
1.18/1	Health and Safety Plan	Lump Sum
1.18/2	Implementation and operation of health and safety plan	Month
P1.18/3	STI, STD and HIV/AIDS Alleviation Programme	Provisional Sum
P1.18/4	PPE for Employer's Personnel	Provisional Sum

Payment of the Lump Sum for establishment and provision of the Health and Safety Plan will be made after the detailed system has been approved by the Engineer and the Contractor has commenced operation of the system.

## 9. Photographs

### (a) Measurement

Measurement, for payment, of providing progress photographs will be made of the number of months for which photographs are provided.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.20/1	Progress photographs	Month

**10. Office for Engineer**

Payment will be made at the applicable rate, Lump Sum or Provisional Sum bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
1.22/1	Provision of office for Employer's Personnel	Lump Sum
1.22/2	Maintenance of office for Employer's Personnel	Month
P1.22/3	Furnishings, equipment and consumables for office of Employer's Personnel	Provisional Sum

Payment of 80% of the Lump Sum for provision of the Employer's Personnel office will be made after the Engineer certifies that the Contractor has fully provided the specified facilities, and the remaining 20% when the facilities have been removed from the Site and the area reinstated to the satisfaction of the Engineer.

**11. Transportation for Employer's Personnel**

## (a) Measurement

Maintenance of the transportation items will be measured on a monthly basis, by the numbers of the respective types of transportation items supplied and which shall be deemed to include for each item: comprehensive insurance, licenses, all running and repair costs and the provision of full time competent drivers for all passenger carrying transportation items.

## (b) Payment

Payment will be made at the applicable rate, or Provisional Sum, bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
P1.23/1	Provide Type A transportation item	Provisional Sum
P1.23/2	Provide Type B transportation item	Provisional Sum
P1.23/3	Provide Type C transportation item	Provisional Sum
1.23/4	Maintain Type A transportation item	Month
1.23/5	Maintain Type B transportation item	Month
1.23/6	Maintain Type C transportation item	Month

**12. Commemorative Panels**

## (a) Measurement

Measurement, for payment, of providing and installing commemorative panels will be made of the number of panels installed.

**(b) Payment**

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.24/1	Commemorative panels	Number

**13. Site Clean Up**

Payment will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
1.25/1	Site clean up	Lump Sum

Payment will be made after the Site clean up has been completed to the satisfaction of the Engineer.

**14. Dispute Board**

Payment will be made at the applicable Provisional Sum in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
P1.26/1	Employer's 50% share of Dispute Board remuneration	Provisional Sum

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## **S2. ENVIRONMENTAL**

### **S2.1. ENVIRONMENTAL MANAGEMENT - GENERAL**

The Contractor shall conduct its activities so as to cause the least possible disturbance to the existing amenities, whether natural or man-made, and so as to comply with all statutory requirements.

In particular, the Contractor shall comply with all relevant requirements of the Environmental Compliance Certificate for the Project issued by the Department of Environment and Natural Resources.

The Contractor shall:

- undertake all work in an environmentally sensitive manner;
- undertake no work outside the defined work site area without prior written approval from the Engineer;
- take all necessary actions to ensure that river water quality is not adversely affected;
- minimize the effects of runoff and erosion;
- minimize disturbance or disruption of the daily lives of local communities to the maximum possible extent; and
- ensure that at all times the Site is maintained in a neat and tidy condition.

The Contractor shall comply with additional environmental restrictions that the Engineer may, at his discretion, instruct in writing.

### **S2.2. CONTRACTOR'S GENERAL RESPONSIBILITIES**

#### **1. Contractor's Environmental Management Plan**

Within 14 days of the Commencement Date, and at least 42 days before commencing work on the Site, the Contractor shall prepare and submit to the Engineer for approval a Construction Contractor's Environmental Program (CCEP).

The CCEP shall detail how the environmental management requirements, as identified in the Project's Environmental Management Plan (EMP) and that are the responsibility of the Contractor, will be implemented and managed on site. The CCEP shall detail how the Contractor will mitigate construction impacts and document the Contractor's response to inspecting, monitoring, verifying, internal auditing and correcting or improving environmental performance.

The CCEP shall address and include:

- reference to the Contract Number;
- a brief project description;
- the Contractor's environmental objectives;
- a description of the role of the CCEP and how it will be utilised during the Contract;
- a description of the Contractor's environmental management system including documented policies, work procedures, document control and corrective action and review procedures;
- the specific requirements of the EMP, Contract specifications and statutory provisions, including legislation, standards and codes of practice;
- strategies to manage environmental issues nominated in the EMP;
- a monitoring schedule of the required environmental management for each identified environmental issue/impact as defined in the Project's environmental monitoring plan (EMoP), with reference to the following:
  - item number as identified in the corresponding EMP schedule
  - action required to implement the EMP measure
  - inspection frequency

- test frequency
- acceptance criteria
- evidence
- Contractor's personnel responsible.

After approval the CCEP shall be strictly adhered to.

## **2. Training for Contractor's Personnel**

The Contractor shall inform all employees and subcontractors of their environmental obligations, and shall ensure that employees are adequately experienced and properly trained to conduct the Works in a manner to minimise environmental impact.

Prior to commencing any work on the Site, the Contractor shall arrange an environmental briefing for all employees and subcontractors.

Whenever necessary, suitably qualified and experienced individuals or organisations shall be assigned for training purposes.

The Contractor shall retain records of all briefing and training sessions, including a list of attendees.

## **3. Reporting**

The Contractor shall provide the Engineer with a regular status/progress report on the implementation of the CCEP for the duration of the Contract. Reports shall include details of all environmental aspects of the Contract including: construction update summary; environmental issues; mitigation measures implemented; effectiveness of control measures; maintenance of controls; results of monitoring against project criteria; audit results and corrective action; environmental induction and training; complaints summary; and other relevant information relative to the implementation of the EMP.

## **4. CCEP Auditing**

The Contractor shall conduct frequent internal audits to ensure the CCEP is implemented effectively and that the environmental objectives are being met.

Audits by the Engineer or Employer will be in accordance with Section S2.13.

### **S2.3. POLLUTION CONTROL - GENERAL**

The Contractor shall design, construct, maintain and operate suitable temporary pollution control facilities necessary to prevent discharge of pollutants or visible suspended waste material into rivers, streams or existing drainage systems.

All diverted and pumped water shall be discharged at locations on the surface from which it cannot re-enter the Works and in a manner which does not cause erosion, pollution or nuisance to land holders, other contractors employed by the Employer or other persons within or adjacent to the Site.

Waste oil from construction equipment and vehicles shall be collected and stored at designated areas of the Site away from any water drainage or existing watercourses. The collected waste oils shall be sent to DENR accredited waste treatment facilities or contractors for proper treatment and disposal.

The burning of waste such as plastics and rubber will not be permitted and all such material shall be disposed of in an approved manner which, wherever possible, shall be by recycling.

Soil contaminated by cement or other chemicals shall be removed and placed in approved disposal areas.



Before any work is carried out in any area of the Site, all specified or instructed or approved pollution control measures shall be in place and operational.

## **S2.4. EROSION AND SEDIMENT CONTROL**

### **1. Soil Erosion and Drainage Management Plan**

The Contractor shall develop, implement and maintain a Soil Erosion and Drainage Management Plan (SEDMP) as part of its CCEP.

The SEDMP shall be updated prior to any changes to construction processes that may cause erosion or sedimentation or disturbance to the natural surface condition of the Site. The Contractor shall provide a copy of the SEDMP to the Engineer at least 5 working days prior to the commencement of any work that may disturb the natural surface.

### **2. Protection of Watercourse and Drainage Systems**

The Contractor shall not obstruct or divert any waterway, stream or channel, unless authorised by the Engineer. The Contractor shall be responsible for assessing and developing effective control measures for the Works. Control measures shall be suitable for any rainfall event that may result in surface runoff and shall be fully operational prior to commencing work.

The Contractor shall be responsible for the design, construction, operation and maintenance of drainage and temporary erosion control measures.

The Contractor shall:

- plan and carry out the work to minimise the effects of runoff and erosion on the Site and downstream areas. The Contractor shall avoid unnecessary ground disturbance and provide for the proper control of stormwater runoff at every stage;
- ensure that all required runoff, erosion and sediment control measures are in place and comply with the SEDMP prior to the commencement of earthworks; and
- establish sediment control structures around all areas prone to erosion including stockpiles, batters and drainage lines.

Water retained in any basin or treatment device shall be treated prior to discharge, including discharge to groundwater. The proposed level of treatment shall be as approved by the Engineer.

Work undertaken within a watercourse shall comply with the following requirements:

- work shall not cause destabilisation of the bed and banks of the watercourse;
- all excavated material shall be removed from the watercourse and securely stored away from the watercourse to ensure that it does not return to the watercourse; and
- any material placed in and around the bed and banks of the watercourse shall be compacted to prevent the movement of loose material and downstream sedimentation.

Immediately after the completion of earthwork areas (including batters, drains, cut and fill areas), or if earthwork areas are to remain essentially the same for 2 days or more, the Contractor shall install temporary measures to prevent erosion and/or sedimentation. All proposed temporary erosion and sediment control measures shall be documented in the SEDMP.

### **3. Inspection and Reporting**

The Contractor shall inspect the sediment and erosion control devices at the following intervals:

- during and immediately after a rain period;
- once per week during dry weather;
- within the first hour of a storm event during daylight periods;
- as soon as practicable following storm events outside working hours and not later than the following day; and
- twice during daylight periods of continuous rain events.

The Contractor shall maintain a register documenting all relevant information, recording inspection dates, names of personnel performing the inspections, corrective actions, and performance of sediment control devices. The register shall include:

- the location and description of all sediment control structures and all in-stream devices on scale diagrams;
- the time and date on which the sediment control structures and in-stream devices are inspected, and observations made as to their operating effectiveness;
- the time and date on which the sediment control structures and in-stream devices are cleaned, repaired, maintained or altered and the action taken; and
- the signature of the person making each entry.

The register shall be made available for viewing when requested by the Engineer or any concerned Agency.

The Contractor shall rectify any defects revealed during an inspection immediately and these erosion control measures and sediment collection structures shall be cleaned, repaired and augmented as required to ensure effective control thereafter.

#### **S2.5. HYDROCARBONS AND HAZARDOUS LIQUIDS**

The Contractor shall ensure that any fuel, oil, lubricants and other chemicals stored on Site:

- are stored within a bund with an impervious floor; and
- are not stored in an area which is subject to flooding or is within 20 metres of a natural or built drainage line.

The Contractor shall ensure that:

- fuel, oil or lubricants do not leak from machinery;
- appropriate methods during refuelling and maintenance are implemented to ensure that any spills/leaks are contained;
- a hydrocarbon spill kit(s) for the purpose of cleaning up oil and fuel spillage is accessible at all times and personnel trained in the efficient deployment of the spill kit are readily available in the event of a spill; and
- a responsible person is always in attendance while refuelling operations are in progress.

In the event of a leak, the Contractor shall immediately clean up the contaminated area, dispose of any affected material in an approved manner and, if necessary, replace the contaminated soil with clean fill.

Maintenance of vehicles and machinery shall be carried out off-site where practicable. If maintenance is to occur on the Site, the location and procedure shall be documented in the CCEP.

**S2.6. WATER QUALITY PROTECTION**

The Contractor shall ensure that any water entering the natural watercourse system or stormwater drainage system from areas disturbed by the Contractor complies with the limits for Class C waters in accordance with DAO No. 34 series of 1990.

The Contractor shall take appropriate measures to prevent solid waste, oils, chemicals, waste and waste water from concrete construction from entering existing waterways.

**S2.7. AIR QUALITY**

The Contractor shall take appropriate measures to minimize the generation of dust and other air pollutants as a result of its operations and activities and so as to comply with the limits set out in DENR Administrative Order No. 81, series of 2000 and with the IRR of RA 8749 (Philippine Clean Air Act of 1999).

**S2.8. NOISE**

**1. General**

The Contractor shall carry out its operations such that the ambient noise levels do not exceed the limits given in PD 984 (Pollution Control Law) and shown in Table 2-1.

Table 2-1

Area	9 a.m. to 6 p.m.	5 a.m. to 9 a.m. 6 p.m. to 10 p.m.	10 p.m. to 5 a.m.
AA	50 dB	45 dB	40 dB
A	55 dB	50 dB	45 dB
B	65 dB	60 dB	55 dB
C	70 dB	65 dB	60 dB
D	75 dB	70 dB	65 dB

- Area AA: areas within 100 m of facilities such as schools, nurseries, hospitals and homes for the aged.
- Area A: residential areas.
- Area B: commercial areas.
- Area C: light industrial areas.
- Area D: heavy industrial areas.

**2. Noise Monitoring Program**

During construction, the Contractor shall implement a weekly noise monitoring program which shall monitor all noise generating equipment at a distance of 7 m from the item of equipment.

Additional noise monitoring shall be carried out in the event that complaints are received about a specific activity or in a particular area; or if there are significant changes in construction equipment or procedures.

**S2.9. VIBRATION**

The Contractor shall ensure that construction activities do not cause vibration induced damage to any structure or building.

**S2.10. SOLID WASTE MANAGEMENT**

The Contractor shall implement efficient solid waste management practices and use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse.

Solid waste shall be managed in accordance with RA 9003 (Ecological Solid Waste Management Act of 2000).

Hazardous waste management shall be carried out by an accredited hazardous waste contractor or treatment facility and shall be in accordance with RA 6969 (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990).

## **S2.11. ENVIRONMENTAL SAFETY AND RISK MANAGEMENT**

The Contractor shall develop and maintain an Emergency Response Plan that includes the following information as appropriate for environmental emergencies:

- emergency contacts;
- key personnel;
- communications plan;
- action to be taken;
- information on hazards;
- training plan and equipment.

In the event of a spill or emergency incident, the Contractor shall:

- keep a record of the incident, the response and the corrective action taken; and
- provide notification to the Engineer within 24 hours.

## **S2.12. REHABILITATION OF WORKS AREAS**

The Contractor shall rehabilitate disturbed areas of the Permanent Works and the areas required for the temporary works, as well as such other areas as may be specified or instructed by the Engineer. Such rehabilitation shall include re-vegetation that will match adjacent undisturbed areas and shall be carried out at the earliest opportunity during the course of the Works.

Rehabilitation measures shall be carried out concurrently with construction of the Works.

Cut and fill slopes shall be shaped in such a manner that the final profile appears as a natural extension of the adjacent undisturbed ground profiles.

Shaped surfaces shall be left slightly rough to facilitate binding with topsoil or the natural establishment of vegetation.

## **S2.13. EMPLOYER'S ENVIRONMENTAL MONITORING**

In order to inspect and confirm the effectiveness of the Contractor's environmental protection measures, the Employer may carry out monitoring either directly or through others.

The Contractor shall provide all assistance, including access to relevant records, that may reasonably be required.

## **S2.14. MONITORING OF DREDGING WORKS**

### **1. Testing of Dredged Material**

The Contractor shall, in addition to any other requirements of the Specifications, carry out the testing shown in Table 2-2.

Table 2-2

Item	Parameter	Test	Frequency
Material to be dredged (in situ)	Items in DAO No. 34	Elutriate test	Every 1,000 m <sup>3</sup>
	Items in DAO92-29	TCLP test	
Dredged material after treatment	Items in DAO No. 34	Elutriate test	Every 1,000 m <sup>3</sup>
	Items in DAO92-29	TCLP test	

The Contractor shall maintain detailed records of dredged material movement, so as to be able to trace material from individual test sample locations to its final deposit locations.

**2. Monitoring of Discharge Water**

The Contractor shall plan and manage the treatment and fill operations so that any water emanating from the dredged material is collected and stored in a retention basin prior to discharge off the disposal site.

The Contractor shall monitor the quality of this collected water by regular and frequent testing of the pH values.

Collected water shall not be discharged off the disposal site unless the pH value is within the range of 6.5 to 8.5, and the Contractor shall carry out any treatment necessary to adjust the pH values.

**S2.15. MEASUREMENT AND PAYMENT**

**1. Contractor’s Environmental Management**

Payment for carrying out the Contractor’s obligations for environmental management will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
2.1/1	Contractor’s environmental management	Lump Sum

Payment of the Lump Sum will be made monthly in the proportion that the progress of the Works completed in a particular month bears to the whole of the Works.

**2. Environmental Requirements for Dredging**

Payment for testing of the dredged materials will be made at the Lump Sum bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
2.14/1	Testing of dredged materials	Lump Sum

Payment for adjusting the pH of discharge water will be made under the following Provisional Sum:

BoQ Item No.	Description	Unit of Measurement
P2.14/2	Adjustment of pH of discharge water	Provisional Sum

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### **S3. WATER CONTROL**

#### **S3.1. GENERAL**

The Contractor shall design, construct and maintain all temporary diversion and protective works and dewatering systems that are necessary to protect the various parts of the Works from water originating from any source.

Diversion and protective works shall be located such that there is no encroachment on any area required for construction of the Works.

Control of water shall at all times be subject to the approval of the Engineer with regard to sufficiency of measures taken and environmental protection.

On completion of the Works all diversion and protective works and dewatering systems shall be removed and disposed of so as not to interfere in any way with the operation or usefulness of the Works, and the Site restored in a manner to give a slightly appearance.

#### **S3.2. RESPONSIBILITY FOR WORKS**

The Contractor shall be fully responsible for any damage or delay to the Works caused by failure of the diversion and protective works and/or dewatering installations, and shall indemnify the Employer against claims by landholders or other persons arising out of any such failure.

The Contractor shall be responsible for, and shall repair or reinstate at its expense, any damage to any part of the Works caused by the failure of the diversion and protective works and/or dewatering installations.

#### **S3.3. WATER CONTROL PLAN**

At least 28 days before commencing any construction work, the Contractor shall submit to the Engineer a detailed Water Control Plan describing the proposed methods for control of water.

Diversion of, or interference with, the natural flow of rivers or drainage channels on the Site for any purpose shall be subject to approval.

#### **S3.4. SURFACE EXCAVATIONS**

The Contractor shall take all necessary steps to ensure that any water entering any surface excavation does not endanger the stability of the surface excavation at any time.

The Contractor shall ensure that no concentrations or accumulations of water occur either within or around or above the area of any open excavation that may affect the safety of the excavation.

Where excavations are not self-draining, sufficient pumps and sumps shall be installed to keep the water level in such sumps at least 0.5 m below the lowest excavated surfaces for as long as required for construction of the Works. Standby pumps shall be readily available in case of breakdowns.

#### **S3.5. NOT USED**

#### **S3.6. NOT USED**

#### **S3.7. WATER CONTROL DURING CONCRETING**

All water which could flow into an area to be concreted shall be diverted clear of the area. Water arising within the area to be concreted shall be piped or pumped clear of the area.

Pumping shall be done in such a manner as to prevent any of the concrete materials being carried away. No pumping shall be done during the placing of concrete, or for a period of 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall.

### **S3.8. COFFERDAMS**

Cofferdams shall be constructed where necessary to protect concrete work against damage from a sudden rise of the river water level, to allow construction of parts of the Works that are below water level and to prevent erosion of embankment foundations.

Cofferdams shall be founded well below the bottom of the footings or embankment toes, constructed to a height sufficient to seal off all water, and shall be well braced and as watertight as practicable. Sufficient clearances shall be maintained between the outside line of footings or walls and the interior sides of cofferdams to provide space for formwork and to permit pumping outside the forms. Excavation and backfilling to provide clearances outside the limits specified in Section S4 [*Excavation and Earthworks*] of these Specifications shall be at the Contractor's cost.

No shoring that will induce stress, shock, or vibration in any part of the Permanent Works will be permitted. Cross struts or bracing shall not extend into the substructure without written permission from the Engineer.

Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

After the completion of the substructure or embankment to a level where protection is no longer necessary, the cofferdams shall be removed in such manner as not to disturb or mar the finished work.

After removal of cofferdams, the area shall be cleaned of debris and other objectionable material. All temporary fills shall be excavated and disposed of as approved.

### **S3.9. MEASUREMENT AND PAYMENT**

Separate payment will not be made for water control and the entire cost of this work shall be deemed to be included in the various rates and prices in the priced Bill of Quantities.



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## **S4. EXCAVATION AND EARTHWORKS**

### **S4.1. GENERAL**

The Contractor shall carry out excavation and earthworks to the lines, grades and dimensions shown on the Drawings or instructed.

At least 28 days before commencing work in any area in which removal or relocation of utilities is required, the Contractor shall notify the Engineer in writing, giving details of the affected utilities.

### **S4.2. STANDARDS**

The Standards referenced in this section of the Specification are:

AASHTO T99	Moisture-density relations of soils using a 2.5 kg rammer and 305 mm drop
AASHTO T180	Moisture-density relations of soils using a 4.5 kg rammer and 457 mm drop
ASTM D698	Laboratory compaction characteristics of soil using standard effort (600kN-m/cu. m.)
ASTM D1556	Density and unit weight of soil in place by the sand-cone method
ASTM D6938	In-place density and water content of soil and soil-aggregate by nuclear methods (shallow depth)

### **S4.3. NOT USED**

### **S4.4. CLEARING, GRUBBING AND STRIPPING**

The Contractor shall clear the areas to be occupied by the Works of all trees, stumps, roots, brush, rubbish and other objectionable matter except such objects as are designated by the Engineer to remain.

Where shown on the Drawings, the Contractor shall strip topsoil from areas to be backfilled or excavated. In areas where soils do not have a true topsoil structure, surface soils shall be stripped and shall be considered topsoil for the purposes of this Sub-Section.

Stripping shall be to the depth shown on the Drawings or instructed.

Topsoil removed in stripping shall not be used for backfill or constructing embankments.

### **S4.5. REMOVAL AND/OR RELOCATION OF EXISTING STRUCTURES**

#### **1. General**

The Contractor shall be responsible for removing and/or relocating all structures and other objects identified on the Drawings or in these Specifications, or encountered during excavation work, and also for the removal of any existing culverts that are to be replaced as part of the Works.

When existing structures, or parts thereof, are intended to be used as permanent parts of the new structure, only those portions indicated on the Drawings or instructed by the Engineer to be removed shall be removed, and removal shall be effected in such a manner as to leave the remaining parts of the structure undamaged and in proper condition for the use contemplated.

All exposed portions of the structures to be removed shall be completely removed. Portions within a watercourse shall be removed down to the natural or design streambed level, whichever is the lower. Portions outside of a watercourse shall be removed down to at least 600 mm below the surrounding

ground level. Where portions lie within the limits of a new structure, they shall be removed as necessary to accommodate the new structure.

Cavities caused by the removal shall be backfilled to the adjacent level and, if within the area of an embankment, shall be compacted to meet the requirements for the embankment.

Demolition and/or relocation of privately owned structures shall be done to the satisfaction of the owner of the structure.

No demolition work shall be carried out without the prior approval of the Engineer.

## **2. Ownership of Material**

Materials, which are designated for salvage, shall remain the property of the Employer.

All salvaged material requiring hauling off the Site shall be loaded into carriers provided by the Employer. The Contractor shall provide the loading equipment.

All other material, except that belonging to a public or private utility company, shall become the property of the Contractor and shall be removed from the Site.

### **S4.6. EXCAVATION - GENERAL**

Excavation shall be carried out to the lines, grades and dimensions shown on the Drawings or instructed.

Prior to the commencement of any excavation work, the Contractor shall submit details of the proposed work methods and schedule to the Engineer. Details shall include quantity, type and capacity of the equipment, excavation method envisaged, transportation and distribution of excavated materials, locations of stockpiles and spoil areas.

Survey reference points, boundary markers and the like shall not be removed without the Engineer's approval. Removed survey points or markers shall be restored to the Engineer's satisfaction at the Contractor's expense.

All necessary precautions shall be taken to preserve, in the soundest possible condition, the material below and beyond the lines of all excavation. Any damage, including loosening of the material beyond the required excavation lines, shall be rectified by and at the expense of the Contractor. Any and all over-excavation performed by the Contractor for any purpose or reason, except as may have been instructed, and whether or not due to the fault of the Contractor, shall be at the expense of the Contractor. Where, in the opinion of the Engineer, it is necessary, all such over-excavation shall be filled with approved materials furnished by and placed at the expense of the Contractor.

Operations shall be conducted so that existing structures or facilities that are to remain in place will not be damaged. It shall be the responsibility of the Contractor to furnish, install and maintain protective means or temporary supports for the preservation of such structures or facilities. The Contractor shall have sole responsibility for any claim arising from any damage to person or property occasioned by the excavation work.

All materials from excavation shall, so far as is practicable, be used in the Permanent Works if the materials meet the specified requirements. Suitable materials for use in the Permanent Works shall be excavated separately from the materials to be wasted and the suitable materials shall be segregated during the excavation operations and placed in the approved final locations directly from the excavation, or may be placed in stockpiles and later placed in the approved locations.

Unsuitable material and required excavation in excess of that needed for the Works shall be known as spoil and shall be disposed of in accordance with Section S4.20.

#### **S4.7. NOT USED**

#### **S4.8. EXCAVATION FOR STRUCTURES**

##### **1. General**

Excavation for structures includes all excavation required for foundations of drains, culverts, sluice structures, revetments, retaining walls, headwalls, wingwalls, other minor structures and elsewhere as shown on the Drawings or instructed.

Excavation shall be performed in such a manner as to prevent shattering of the sides and bottom of the excavated area.

Unless otherwise shown on the Drawings or instructed, excavation for structures shall be carried out to the slopes shown below:

- slopes to be permanently exposed            1.0 (H) : 1.0 (V)
- slopes to be backfilled                        0.5 (H) : 1.0 (V).

A berm with a width of at least 1 m shall be provided on the excavated slope at vertical height intervals of 3 m unless otherwise shown on the Drawings or instructed.

For foundations of small structures, the line of the excavated slope shall be drawn from a point 0.5 m outside of the foundations of the structures. For large structures such as sluices and box culverts, the line shall be drawn from a point 1 m outside of the foundations of the structures.

Materials deposited within any watercourse shall be removed, and the watercourse left in its original condition, unless otherwise approved.

##### **2. Condition of Foundation**

All loose and disintegrated material shall be removed. When the footing is to rest on material other than rock, special care shall be taken not to disturb the bottom of the excavated area, and excavation to final grade shall be deferred until just before the footing is to be placed. When, in the opinion of the Engineer, the foundation material is soft or otherwise unsuitable, the Contractor shall remove the unsuitable material and place foundation fill material or concrete as specified or shown on the Drawings or instructed. If foundation fill material is required, it shall be placed and compacted in layers not more than 150 mm thick to not less than 95% of the maximum dry density of the material determined by ASTM D698.

Excavation for driven pile-supported footings shall be completed to the bottom of the footings before the piles are driven, unless otherwise approved. Any excess material remaining in the excavation after pile driving shall be removed to the elevation of the bottom of the footings.

##### **3. Approval of Foundations**

After each excavation is completed, and before the foundation is covered, the Contractor shall notify the Engineer and no material shall be placed until the Engineer has approved the condition of the foundation and its depth, and has given permission to proceed.

**S4.9. NOT USED****S4.10. EMBANKMENTS - GENERAL****1. General**

Embankments shall be constructed to the required grade and the completed embankments shall correspond to the shape of the typical sections shown on the Drawings.

The construction of any section of an embankment shall not commence until the foundation for that section has been approved by the Engineer.

The method and equipment used in compacting the embankment material shall be as approved by the Engineer with due regard to the material involved.

Where any embankment is being placed on soft foundations, placement shall be in uniform layers not greater than necessary to support the equipment while placing subsequent layers. If compaction is difficult immediately after placement due to excess pore pressures, compaction shall be delayed to allow dissipation of the pore pressures.

Where an existing embankment is to be widened or included in a new embankment, the slopes of the existing embankment shall be benched and the new embankment built up in successive layers initially to the level of the existing embankment. If less than 150 mm additional embankment material is to be placed above the existing embankment, the top 150 mm of the existing embankment shall be scarified and recompacted to a minimum of 90% of maximum dry density of the material, as determined in ASTM D698, for the full width of the embankment.

Material for embankments at points inaccessible to normal compacting equipment shall be placed in horizontal layers of loose material not more than 100 mm thick and thoroughly compacted by the use of approved mechanical tampers.

The Engineer may require that embankment construction operations be suspended when he considers that the compacting equipment is not suitable for the material being placed.

The Engineer may allow embankment construction to proceed during light rain provided that at all times the working surface is sufficiently crowned or sloped to prevent any ponding or ingress of water, the moisture content of the material is acceptable and the surface is not being adversely affected by construction traffic. Otherwise, no placing of embankment material shall be permitted during periods of rain.

**2. Materials**

Materials for embankments shall consist of suitable materials from required excavation, from borrow or from commercial sources.

Only suitable materials shall be used in the construction of embankments. Brush, roots, rubbish, sods, weeds, logs, stumps, heavy vegetation or other organic or deleterious material shall not be incorporated or placed in the embankments.

Suitable material may be either common material or rock meeting the following:

- The fraction passing a 75 mm sieve shall be 100%.
- The fraction passing a 0.075 mm sieve shall be less than 15%.
- The plasticity index shall be less than 6.
- The liquid limit shall be less than 30.

### **3. Preparation of Foundation for Embankment**

Where shown on the Drawings or specified or instructed, the natural ground shall, after clearing and grubbing, be compacted to a depth of 150 mm, measured from the original ground, to not less than 90% of the maximum dry density of the material as determined by ASTM D698.

If unsuitable materials occur in some areas under the embankment, such materials shall be removed to levels instructed by the Engineer, the bottom of the excavation shall be compacted, as described above, and the areas backfilled and compacted layer by layer with suitable material.

All compaction shall conform to the requirements of Section S4.10.5.

Where embankments are to be placed on sloping foundations, the slopes shall be benched and the embankment built up in successive layers. Benches shall have a vertical height of approximately 300 mm.

### **4. Embankment Placing**

During construction of the embankment, a smooth surface having an adequate crown or superelevation shall be maintained to provide drainage. Embankments shall be constructed to the required levels, and completed embankments shall correspond to the shape of the typical sections shown on the Drawings and to the specified tolerances.

Hauling equipment shall be distributed over the full width of the embankment being filled and in no case shall deep ruts be allowed to form during the construction of the embankment.

Materials approved for use in the embankment, from whatever source, shall be uniform when run out in loads on the embankment. If, in the opinion of the Engineer, there is unacceptable non-uniformity in the delivered materials either within individual loads or between successive loads, the Contractor shall remove the material from the Works.

Embankments shall be constructed in successive layers, for the full width of the cross section and in such lengths as are suited to the equipment and methods used. Prior to compaction the layers shall not exceed 300 mm in depth.

### **5. Compaction of Embankments**

Each layer of material shall be compacted uniformly by the use of adequate, appropriate and approved compaction equipment. The compaction shall be done in a longitudinal direction along the embankment and shall generally begin at the outer edges and progress toward the centre in such a manner that each section receives equal compactive effort.

The Contractor shall compact the material to a uniform density of not less than 95% of the maximum dry density determined by AASHTO T99 Method C.

### **6. Quality Control and Testing**

The Contractor shall carry out regular compaction testing and daily control testing.

A regular compaction test in accordance with ASTM D1556 shall be carried out for every 5,000 m<sup>3</sup> of material placed. Measurement of natural moisture content and specific gravity of soils, and determination of the optimum moisture content and the maximum dry density, shall be made.

Testing of in-situ dry density and moisture content shall be carried out in accordance with ASTM D6938. The frequency of testing shall be one group of three in-situ density tests for every 150 m<sup>2</sup> of completed layer.

All test data shall be recorded and filed together with the direct output from the nuclear densometer. The details recorded shall include:

- date and time of test;
- weather condition;
- location of test;
- approximate volume of embankment placed since last test;
- type of embankment material;
- moisture content at excavation site, borrow pit or stockpile;
- moisture content at embankment site;
- maximum dry density of embankment material; and
- degree of compaction.

The Contractor shall plot the data in a form of a daily control graph and shall statistically monitor variations.

For compaction to be considered acceptable, four of the last five densities measured shall be equal to or greater than the specified level of compaction, and all five shall be greater than the required density minus 5%, and the average of all five shall be not less than the required value.

The Contractor shall submit copies of all test results to the Engineer once every week.

## **7. Compaction and Trimming of Slopes**

General compaction requirements shall at any level apply to the full width of the embankment. Slopes to be covered with topsoil and grassing shall have a firm surface before topsoil is placed.

Where embankments are not constructed to the full width required, these shall be benched and reconstructed.

Under no circumstances shall additional embankment material be tipped over the slopes and spread to make up a shortfall in width of embankment.

If, in the opinion of the Engineer, the embankment slopes do not appear to be suitably compacted, additional compaction shall be carried out on the slopes as instructed by the Engineer.

### **S4.11. DIKE EMBANKMENTS**

#### **1. General**

Dike embankments shall be constructed in accordance with the general requirements of Section S4.10 and the particular requirements of this Section S4.11.

#### **2. Compaction**

Each layer of the embankment shall be compacted to a dry density equal to at least 90% of the maximum dry density of the material as determined by AASHTO T180.

**S4.12. NOT USED****S4.13. NOT USED****S4.14. NOT USED****S4.15. NOT USED****S4.16. RANDOM BACKFILL**

The Contractor shall supply, place and compact random backfill to the lines, grades and dimensions and in the locations shown on the Drawings or instructed.

Random backfill shall be obtained from approved sources and shall be free from stumps, roots, rubbish, topsoil and other objectionable matter. Random backfill placed within 1 m of structures shall be selected material containing rocks not larger than 75 mm in maximum dimension and shall be placed carefully so as not to damage the structure.

Random backfill shall be deposited in horizontal layers not more than 150 mm thick after being compacted, and shall be brought to the moisture content required for the purpose of compaction, and the moisture content shall be uniform throughout each layer. The density of compacted random backfill shall not be less than 90% of the maximum dry density obtained by compaction in accordance with AASHTO T180.

**S4.17. BACKFILLING OF PIPE TRENCH****1. General**

Pipes shall be backfilled as shown on the Drawings, in accordance with the following requirements or as instructed.

Backfilling shall be done in uniform layers of 150 mm maximum thickness. Special care shall be taken to ensure that the backfill is placed evenly on both sides of the pipe for the full length. Heavy earthmoving and compacting equipment shall not operate closer to the culvert than 1.5 m until the culvert has been covered to a depth equal to at least  $\frac{1}{4}$  of the diameter of the culvert, but in no case less than 600 mm, unless otherwise approved by the Engineer. Lightweight equipment may be operated within the above limitation after the embankment has been placed and compacted to give a minimum cover of 300 mm over the top of the culvert.

**2. Backfill (Zone B)**

Zone B backfill material shall consist of fine cohesionless granular material which has not less than 95% passing a 12.5 mm sieve, not less than 95% retained on a 4.75 mm sieve and not more than 5% passing a 0.075 mm sieve.

Backfill in Zone B shall be placed and compacted in layers around the pipe until 300 mm above the crown of the pipe, particularly ensuring compaction of the material at the pipe haunches, to ensure that there are no voids.

The backfill material shall be compacted to at least the density of the adjacent undisturbed material to minimise settlement.



### **3. Backfill (Zone C)**

Zone C is the backfill above Zone B to the surface level. This backfill shall be excavated material free from stones larger than 150 mm and shall be compacted to at least 90% of the maximum dry density obtained by compaction in accordance with by AASHTO T180.

## **S4.18. DREDGING**

### **1. General**

The Contractor shall carry out excavation of the river bed by dredging to the lines and limits shown on the Drawings or instructed.

The Contractor shall use dredging equipment and methods which ensure that dredging operations do not result in total suspended solids in the immediate vicinity of the dredging operations increasing by more 30 mg/L.

Within 28 days of the Commencement Date, the Contractor shall provide a detailed method statement of the dredging operations and details of proposed equipment to the Engineer for approval.

### **2. Access for Vessels**

Dredging work shall be carried out in a manner and sequence so as to avoid interference and disturbance to traffic using the waterways.

The Contractor's Health and Safety Plan shall make specific reference to the steps to be taken to ensure that other vessels are able to safely pass the dredging plant, and shall be responsible for any damage caused to other waterway users as a result of any failure by the Contractor to comply with all applicable regulations for safe navigation.

### **3. Watching and Lighting**

The Contractors dredging plant shall carry and display navigation lights and signals as required by the relevant Authority.

All lights shall be placed or screened so as not to interfere with any existing navigation lights or with any traffic or signal of any Authority, and so as not to be mistaken for navigation lights.

When night work is in progress, the Contractor shall maintain lighting from sunset to sunrise to allow the observation of dredging operations. Lighting shall conform to visibility and colour requirements of the appropriate Authority.

All pipelines placed in water shall be clearly marked with high visibility floating buoys. Any existing aids to navigation/ markers / buoys etc. located within the area shall not be moved without the approval of the Engineer. Any aid, if moved, shall be reinstated by the Contractor as soon as possible to its original location.

### **4. Artificial Obstructions**

The Contractor should be aware of the possibility of encountering underwater obstructions during the dredging operations. Prior to dredging, the Contractor shall "sweep" the dredge areas and shall remove obstructions encountered in accordance with the requirements of Section S4.5.

## 5. Survey and Measurement

The following requirements supplement those included in Section S1 [*Preliminary and General*] of these Specifications.

The Drawings are believed to accurately represent conditions existing at the time of their preparation but the depth shown thereon shall be updated by pre-dredge surveys carried out as described following.

Prior to commencing dredging in any particular area, the Contractor shall take soundings and plot a survey of that area by means of transverse lines not more than 20 m apart, and at such intervals as the Engineer may require.

Soundings may be carried out with an approved ultrasonic sounder, or by lead line /sounding pole, or a combination of methods as approved by the Engineer. A copy of all sounding records shall be provided to the Engineer.

As soon as practicable after completion of dredging in a particular area, a further survey shall be made along the same transverse lines as the pre-dredging survey.

The Contractor shall assist the Engineer in checking the work, including providing boats, boatmen, labour and material as may reasonably be necessary.

## 6. Dredging Tolerances (Overdepth)

Dredging shall be carried out as closely as practicable to the lines shown on the Drawings or instructed, and shall be within the following absolute limits:

- Bottom depth: -200 mm to +00 mm.
- Side slopes: -500 mm to +00 mm (longitudinal).

Should any shoals, lumps, or other lack of depth or width be disclosed by the after-dredging survey, the Contractor shall correct the deficiency by redredging, however if the bottom is soft and the shoal areas are small and have no material effect on the flood flow capacity, the requirement to remove such shoal areas may be waived at the discretion of the Engineer.

Notwithstanding the permissible overdepth limits, the Contractor shall limit the depth and profile of dredging operations near wharves/ jetties, bridge supports, revetment structures and the like so that the structural integrity of such structures is not compromised. The Contractor shall be responsible for obtaining all information from the Engineer relating to such depths and profile limitations in advance of starting operations. The Contractor shall be liable for any damage cause to any structure due to over-dredging near the structure.

## 7. Use of Dredged Material

Dredged material shall be transported to the Laguna backfill area shown on the Drawings, or any other area as may be approved by the Engineer, and utilised for filling the whole area to a uniform level.

The Employer has identified a potential alternative disposal site located at approximately Sta. 3+500 however at the time of preparation of these documents has not been able to confirm the availability. At an early stage of the Contract, the Contractor shall, in conjunction with the Employer and the Engineer, investigate the possibility of utilising this alternative site. In the event that the Contractor considers that use of the alternative site would be feasible, he shall prepare and submit a value engineering proposal in accordance with Clause 13.2 of the Conditions of Contract for consideration by the Engineer.

## **8. Shoaling**

The Contractor shall not be required to maintain those Sections of the dredged Works for which a Taking-Over Certificate has been issued, except that the Contractor shall remove accumulations of silt above the design levels arising from the Contractor's operations, notwithstanding the previous acceptance of those Sections of the Works.

### **S4.19. DISPOSAL OF DREDGED MATERIAL**

#### **1. General**

If necessary, at the Laguna backfill site, the Contractor shall treat the dredged material by dewatering and stabilising by the addition of cement.

All proper precautions shall be taken by the Contractor to prevent discharge of polluting matter or water containing visible suspended materials. The Contractor shall, where necessary, construct, maintain and operate suitable dikes, settling ponds, drainage systems or other effective works to prevent or control such discharge, all as described in Section S2 [*Environmental*] and Section S3 [*Water Control*] of these Specifications.

Prior to commencing any treatment work, the Contractor shall submit to the Engineer a work plan which shall include details of the proposed work procedures and equipment.

#### **2. Preparation of Laguna Backfill Area**

Prior to transporting of any of the dredged material, the Contractor shall prepare the backfill area by clearing and grubbing the whole area and constructing a ditch around the perimeter to collect and channel surface runoff water from outside the backfill area to approved discharge locations.

A berm on the inner side of the ring ditch shall be constructed where necessary to prevent water from within the backfill area entering the ditch.

#### **3. Removal of Debris from Dredged Material**

The Contractor shall note that the dredged material will likely contain substantial quantities of accumulated debris.

Any debris which, in the opinion of the Engineer, may affect the stabilisation or consolidation of the stabilised material shall be removed prior to stabilisation.

Debris so removed shall be dealt with in accordance with the requirements for solid waste management specified in Section S2 [*Environmental*] of these Specifications.

#### **4. Stabilisation**

The dredged material shall be stabilised by the incorporation of cement so that, following treatment, the material has a minimum standard cone index ( $q_c$ ) of 200 kN/m<sup>2</sup> otherwise specified by the Engineer.

Based on previous sampling and testing, it has been determined that there are 3 distinct material types.

Sampling has indicated that the different material types are located approximately as shown in Table 4-1.

Table 4-1

Station	Material Type
LM 0+00 to 0+975	A
LM 0+975 to 1+025	B
LM 1+025 to 1+275	A
LM 1+275 to 1+675	B
LM 1+675 to 1+775	A
LM 1+775 to 2+225	C
LM 2+225 to 2+425	A
LM 2+425 to 2+775	B
LM 2+775 to 2+925	C
LM 2+925 to 3+375	B
LM 3+375 to 3+575	A
LM 3+575 to 3+825	B
LM 3+825 to 4+225	C
LM 4+225 to 4+475	B
LM 4+475 to 5+400	C

It is anticipated that the required minimum strength will be achieved by the incorporation of cement in accordance with Table 4-2.

Table 4-2

Material Type	Moisture Content (%)	Fine Particle Content (%)	Amount of cement (kg/m <sup>3</sup> )
A	60 –	50 –	75
B	40 – 60	20 – 50	50
C	0 – 40	0 – 20	0

The Contractor shall carry out moisture content and fine particle content tests on the dredged material on a daily basis prior to the incorporation of any cement in order to verify the material type and the amount of cement to be added.

Following placing and compaction of the stabilised material, the Contractor shall carry out tests at a frequency of every 1,000 m<sup>3</sup> of treated material to determine cone resistance, moisture content and fine particle content. Based on the results of this testing, the Engineer may instruct the adjustment of cement quantities to be used for stabilisation.

**5. Weather Conditions**

Treatment or spreading of material shall not be carried out during periods of heavy rainfall that may result in the addition of excess water to the material.

**6. Compaction of Treated Material**

Following treatment, the dredged material shall be spread in layers of up to 200 mm thickness and compacted by the controlled passage of haulage equipment over the surface of each layer. Material shall be placed in such a way that a uniform fill is obtained, avoiding pockets or layers of very fine material, and the surface sloped uniformly towards the culverts to be installed in accordance with Section S4.19.8.

**7. Dike Maintenance Road**

The Contractor shall reconstruct the existing dike maintenance road in accordance with the details shown on the Drawings.

The embankment shall be constructed in accordance with Section S4.11 and shall have a base course pavement in accordance with the requirements of Section S9 [Roadworks] of these Specifications.

## **8. Drainage**

The Contractor shall supply and install reinforced concrete pipe culverts in the dike maintenance road as shown on the Drawings to discharge water from the disposal site.

The culverts and associated wingwalls/headwalls shall be constructed in accordance with Section S8 [*Drainage*] and Section S5 [*Concrete*] of these Specifications as applicable.

## **9. Monitoring of Discharge Water**

The Contractor shall monitor the quality of water emanating from the dredged material in accordance with the requirements of Section S2 [*Environmental*] of these Specifications.

## **10. Groundwater Observation Wells**

Following completion of the backfill, the Contractor shall install groundwater observation wells in the locations shown on the Drawings to a depth of 10 m below the finished surface level.

The wells will be used for long-term monitoring of the groundwater condition by others.

## **S4.20. DISPOSAL AND STOCKPILING OF EXCAVATED SURFACE MATERIALS**

### **1. General**

The Contractor shall dispose of excavated surface materials which are unsuitable, or which are not required, for construction in approved disposal areas.

Except for those areas shown on the Drawings, the Contractor shall be responsible for locating disposal and spoil areas.

The disposal areas shall generally be levelled and trimmed to reasonably regular lines to the approval of the Engineer.

Unless otherwise approved, the finished outer slopes of the disposal areas shall not be steeper than 1 vertical to 3 horizontal, and not be more than 1.5 m high.

Excavated materials suitable for use in construction that cannot be used immediately shall be stockpiled in approved areas.

Disposal of dredged material shall be in accordance with the requirements of Section S4.19.

### **2. Compaction of Disposed Material**

Material placed in disposal areas shall be dumped, spread in layers and compacted by the controlled passage of haulage equipment over the surface of each layer.

### **3. Treatment of Disposal Areas and Stockpiles**

Disposal and stockpile areas shall be treated in accordance with Section S2 [*Environmental*] of these Specifications.

#### 4. Transport and Disposal of Hazardous Material

Contaminated excavated material shall be transported to an approved hazardous waste treatment, storage, or disposal facility by an accredited hazardous waste subcontractor.

At least 28 days before the commencement of transport of any contaminated excavated material, the Contractor shall submit details of the proposed hazardous waste subcontractor and of the proposed disposal facility.

#### S4.21. MEASUREMENT AND PAYMENT

##### 1. Removal and/or Relocation of Structures

Payment will be made at the applicable rate or Lump Sum bid therefore in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
4.5/1-B	Demolition and removal of existing concrete wall and structure between Sta. 0+921 and 1+338L	Lump Sum
4.5/2-B	Demolition and removal of existing net fence between Sta. 0+921 and 1+338L	Lump Sum
4.5/3-B	Demolition and removal of existing concrete road between Sta. 0+921 and 1+338L	Lump Sum
4.5/4-B	Demolition and removal of existing guard rail between Sta. 0+921 and 1+338L	Lump Sum
4.5/5-B	Temporary relocation and re-installation of lighting post between Sta. 0+921 and 1+338L	Lump Sum
4.5/6-B	Demolition and removal of existing concrete wall and structure between Sta. 3+033 and 3+621R	Lump Sum
4.5/7-B	Demolition and removal of existing net fence between Sta. 3+033 and 3+621R	Lump Sum
4.5/8-B	Demolition & removal of existing concrete road between Sta. 3+033 and 3+621R	Lump Sum
4.5/9-B	Temporary relocation and re-installation of lighting post between Sta. 3+033 and 3+621R	Lump Sum
4.5/10-B	Demolition and removal of existing steel structure, gate, plate and speaker post between Sta. 3+033 and 3+621R	Lump Sum
4.5/11-B	Demolition and removal of existing concrete wall and structure between Sta. 3+898 and 4+670L	Lump Sum
4.5/12-B	Demolition and removal of existing net fence between Sta. 3+898 and 4+670L	Lump Sum
4.5/13-B	Demolition & removal of existing concrete road between Sta. 3+898 and 4+670L	Lump Sum
4.5/14-B	Temporary relocation and re-installation of lighting post between Sta. 3+898 and 4+670L	Lump Sum
4.5/15-B	Demolition and removal of existing sluice structure and steel post between Sta. 3+898 and 4+670L	Lump Sum

Payment for the removal and/or relocation of objects and structures necessary for the construction of new drainage structures will be made in accordance with the provisions of Section S8 [*Drainage*] of these Specifications.

Payment for removal and/or relocation of objects and structures encountered during construction of the Works other than those listed above will be made under the following Provisional Sum:

BoQ Item No.	Description	Unit of Measurement
P4.5/1	Removal and/or relocation of previously unidentified objects and structures	Provisional Sum

**2. Excavation for Structures**

(a) Measurement

Measurement, for payment, of excavation for structures will be made of the volume of material excavated to the lines, grades and dimensions shown on the Drawings or specified or instructed.

The volume of excavation will be calculated by the average end area method and based on the survey of ground profiles carried out in accordance with Section S1 [*Preliminary and General*] of these Specifications.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
4.8/1	Excavation for manholes and junction manholes	Cubic metre
4.8/2	Excavation for pipe culverts	Cubic metre
4.8/3	Excavation for other structures	Cubic metre

**3. Dike Embankment**

(a) Measurement

Measurement, for payment, of dike embankment whether obtained from borrow, required excavation or other sources, will be made by the volume of embankment materials compacted in place to the lines, grades and dimensions shown on the Drawings or instructed.

Measurement will include the material placed above the design levels as shown on the Drawings or instructed.

The volume of embankment will be calculated by the average end area method and based on the survey of ground profiles carried out in accordance with Section S1 [*Preliminary and General*] of these Specifications.

Volumes of topsoil on side slopes will not be included in the measurement of dike embankment.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
4.11/1	Dike embankment	Cubic metre

**4. Random Backfill**

## (a) Measurement

Measurement, for payment, of random backfill will be made of the volume of backfill placed as shown on the Drawings or specified or instructed.

Measurement will be from the approved foundation level to the level of the original ground surface.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
4.16/1	Random backfill	Cubic metre

**5. Backfilling of Pipe Trench**

## (a) Measurement

Measurement, for payment, of backfilling of pipe trenches will be made of the volume and type of backfill placed as shown on the Drawings or instructed.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
4.17/1	Zone B pipe backfill	Cubic metre
4.17/2	Zone C pipe backfill	Cubic metre

**6. Dredging**

## (a) Measurement

Measurement, for payment, of dredged material will be made of the volume of material dredged to the lines, grades and dimensions shown on the Drawings or instructed and transported to the Laguna backfill area.

The volume of excavation will be calculated by the average end area method and based on the initial and final surveys carried out in accordance with Section S4.18.5.

Material dredged outside the lines, grades and dimensions shown on the Drawings or instructed, including any material from within the permitted overdepth limits shown in Section S4.18.6, will not be included in the measurement for payment.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
4.18/1	Dredging	Cubic metre



**7. Disposal of Dredged Material**

(a) Measurement

Measurement, for payment, of disposal of dredged material will be based on the volume of each type of treated material sourced from within the dredging lines, grades and dimensions shown on the Drawings.

Material from outside the dredging lines, grades and dimensions shown on the Drawings, including the material from within the permitted overdepth limits shown in Section S4.18.6, will not be included in the measurement for payment.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
4.19/1	Disposal of dredged material Type A	Cubic metre
4.19/2	Disposal of dredged material Type B	Cubic metre
4.19/3	Disposal of dredged material Type C	Cubic metre

Unless otherwise provided, separate payment will not be made for other disposal and/or stockpiling activities and the entire cost of the other activities shall be deemed to be included in the various rates and prices in the priced Bill of Quantities.

**8. Disposal and Stockpiling of Excavated Materials**

Payment will be made under the following Provisional Sum:

BoQ Item No.	Description	Unit of Measurement
P4.20/1	Transport and disposal of hazardous material	Cubic metre

Unless otherwise provided, separate payment will not be made for other disposal and/or stockpiling activities and the entire cost of the other activities shall be deemed to be included in the various rates and prices in the priced Bill of Quantities.

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## S5. CONCRETE

### S5.1. GENERAL

The Contractor shall furnish, place and finish concrete in structures in accordance with this Specification and conforming to the lines, grades and dimensions shown on the Drawings or instructed.

For manufacture of concrete at the Site, the Contractor shall, not less than 28 days before installing its plant and equipment, submit to the Engineer flow charts, drawings, and written descriptions of its proposals for the production of aggregates and the production and placing of concrete in the Works.

For ready-mixed concrete, the Contractor shall, not less than 28 days before placing any concrete, nominate the plant from which it proposes to obtain concrete and submit details of the equipment it proposes to use for transporting and placing concrete. Ready-mixed concrete shall be produced in accordance with ASTM C94 and the requirements of this Specification. Ready-mixed concrete shall only be procured from approved companies. The Contractor shall satisfy the Engineer that the materials used in ready-mixed concrete comply with this Specification in all respects. The specified requirements as to the sampling, preliminary and trial mixes, batching, testing and quality of concrete of various classes shall apply equally to ready mixed concrete. Records, charts or tapes as prescribed in Section S5.8.4 shall become the property of the Employer.

### S5.2. STANDARDS

The Standards referenced in this section of the Specification are:

ACI 315	ACI Detailing Manual: Section details and detailing of concrete reinforcement
ACI 318	Building codes – structural concrete
ASTM A184M	Fabricated deformed steel bar mats for concrete reinforcement
ASTM A185M	Steel welded wire fabric, plain, for concrete reinforcement
ASTM C29M	Unit weight and voids in aggregate
ASTM C31M	Making and curing concrete test specimens in the field
ASTM C33	Concrete aggregates
ASTM C39	Compressive strength of cylindrical concrete specimens
ASTM C42	Obtaining and testing drilled cores and sawed beams of concrete
ASTM C88	Soundness of aggregates by use of sodium sulfate or magnesium sulfate
ASTM C94	Ready-mixed concrete
ASTM C127	Specific gravity and absorption of coarse aggregate
ASTM C128	Specific gravity and absorption of fine aggregate
ASTM C131	Resistance to degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles machine
ASTM C136	Sieve analysis of fine and coarse aggregates
ASTM C138	Unit weight, yield, and air content (gravimetric) of concrete
ASTM C143	Slump of hydraulic cement concrete
ASTM C171	Sheet materials for curing concrete
ASTM C172	Sampling freshly mixed concrete
ASTM C173	Air content of freshly mixed concrete by the volumetric method
ASTM C227	Test method for potential alkali-silica reactivity of cement-aggregate combinations (mortar bar method)
ASTM C233	Air-entraining admixtures for concrete
ASTM C289	Test method for potential alkali-silica reactivity of aggregates (chemical method)
ASTM C309	Liquid membrane-forming compounds for curing concrete
ASTM C596	Test method for drying shrinkage of mortar containing Portland cement
ASTM D75	Sampling aggregates

ASTM D1140	Amount of material in soils finer than the No. 200 (75-micrometer) sieve
ASTM D1751	Prefomed expansion joint filler for concrete paving and structural composition (non-extruding and resilient bituminous types)
ASTM E11	Wire-cloth sieves for testing purposes
AWS D1.4-98	Structural welding code - reinforcing steel
PNS 7	Portland cement - specification
PNS 49	Steel bars for concrete reinforcement
PNS 211	Rerolled steel bars for concrete reinforcement

### S5.3. CONCRETE CLASSES

The classes of concrete applicable to the concrete in various structures shall be as specified in Table 5-1.

Table 5-1

Class of Concrete	Maximum size of aggregate (mm)	Minimum cement content (kg/m <sup>3</sup> )	Characteristic Strength (MPa)
A	40	345	21
B	50		17
C	12.5	345	21
E	25		30
F	-		12

The various concrete classes shall be placed in the location specified in Table 5-2 and elsewhere as instructed.

Table 5-2

Concrete Class	Location
A	General reinforced structures; concrete pavement
B	Unreinforced concrete; bedding and backfilling; filler concrete; concrete blocks
C	Thin section precast concrete; second stage concrete for mechanical plant
E	Precast piles and pipes
F	Levelling concrete

### S5.4. MATERIALS

#### 1. Cement

Cement shall be ordinary Portland cement conforming to PNS 7, obtained from approved manufacturer(s).

The Contractor may, if it chooses, use high-early-strength Portland cement in some parts of the Works, but only with prior approval of the Engineer and without additional cost to the Employer.

Cement, which for any reason, has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

#### 2. Fine Aggregate

Fine aggregates shall conform to ASTM C33 and to the requirements of this Specification.

Fine aggregates shall consist of natural sand, stone screenings or other inert materials with similar characteristics and shall come from approved sources. Fine aggregate that, in the opinion of the Engineer, has become contaminated shall be removed from the Site.

Crushed sand may be added to natural sand in order to achieve the required grading. Crushed sand alone may be used only with the approval of the Engineer. Beach sand shall not be used.

Fine aggregate shall not contain more than 3% of material passing the 0.075 mm sieve by washing nor more than 1% each of clay lumps or shale.

If the fine aggregate is subjected to five cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10%.

The fine aggregate shall be free from injurious amounts of organic impurities. If subjected to the colorimetric test for organic impurities and a colour darker than the standard is produced, it shall be rejected. However, when tested for the effect of organic impurities of strength of mortar by AASHTO T71, the fine aggregate may be used if the relative strength at 7 and 28 days is not less than 95%.

The fine aggregate shall be well graded conforming to the limits shown in Table 5-3.

Table 5-3  
Grading of Fine Aggregate

Sieve size (mm)	Percentage of total mass passing sieve
10	100
4.75	95-100
2.36	-
1.18	45-80
0.6	-
0.3	5-30
0.15	0-10

### 3. Coarse Aggregate

Coarse aggregates shall conform to ASTM C33 and to the requirements of this Specification.

Coarse aggregate shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.

It shall contain not more than 1% of material passing the 0.075 mm sieve, not more than 0.25% of clay lumps, nor more than 3.5% of soft fragments.

If the coarse aggregate is subjected to five cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12%.

Coarse aggregate shall have a wear not exceeding 40% when tested by AASHTO T 96.

The aggregate shall consist substantially of particles having a maximum dimension not greater than three times the minimum dimension.

Should an analysis of the grading of the material show a deficiency in any particular size so as to affect the density of the concrete, the Engineer may require the Contractor to add such quantity of aggregate of any particular size that he may deem advisable. In every case the material shall, when mixed with fine aggregate, produce a well graded mixture from the largest to the smallest size specified to ensure that concrete of high density is produced.

#### **4. Water**

The water used in concrete, for washing aggregate and for curing concrete, shall be subject to approval and shall be free from objectionable quantities of suspended material, organic matter, acid, alkali, salts and other impurities.

Water shall contain not more than 1,000 mg/l of sulfates (SO<sub>4</sub>), not more than 100 mg/l of chlorides (Cl) and shall have a turbidity limit of not more than 1,000 ppm.

Saline or brackish water shall not be used.

#### **5. Steel Reinforcement**

Unless otherwise shown on the Drawings, reinforcement 10 mm or greater in diameter shall be deformed high yield bars, Grade 275, complying with PNS 49. Reinforcement less than 10 mm in diameter shall comply with PNS 211.

Reinforcing fabric shall comply with ASTM A185M.

Bar mat reinforcement for concrete shall conform to the requirements of ASTM A184M.

All reinforcing bars shall have deformed surfaces except that 6 mm diameter bars may be plain.

High tensile steel strand shall conform to ASTM A416.

Tie wire shall be plain, cold drawn annealed steel wire 1.6 mm in diameter.

Reinforcement shall be clearly labelled and stored on the Site either in racks or on a hard impermeable base so that it remains straight and free from contamination.

Any reinforcement that is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement that has become corroded or pitted to an extent that, in the opinion of the Engineer, will affect its properties shall be removed from Site without delay.

#### **6. Admixtures**

Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batcher and added to the mixing water separately before discharge into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification. All admixtures shall be prevented from segregating before batching.

If necessary to achieve the specified air content, the Contractor shall use a neutralized, vinsol-resin air-entraining agent. Where the Contractor wishes to use an alternative air-entraining agent, it shall demonstrate, to the satisfaction of the Engineer, the admixture's compliance with ASTM C233 when tested with the cement, aggregates and other admixtures used in the Works.

#### **7. Joint Filler**

Joint filler shall conform to ASTM D1751 non-extruding, resilient bituminous type. The filler shall be furnished for each joint in a single piece, unless otherwise approved. When the use of more than one piece for a joint is approved, abutting ends shall be fastened and held securely to shape by stapling or other means of positive fastening.

**8. Rubber Waterstops**

Rubber waterstops may be moulded or extruded and shall have a uniform cross-section, free from porosity or other defects, conforming to the nominal dimensions shown on the Drawings.

The waterstop may be compounded from natural rubber, synthetic rubber, or a blend of the two together with other compatible materials that will produce a finished waterstop meeting the requirements given in Table 5-4.

Table 5-4

Property	Requirement
Hardness (by shore durometer)	60 to 70
Compression set	Max. 30%
Tensile strength	Min. 17.2 MPa
Elongation at Break	Min. 450%
Tensile stress at 300% elongation	Min. 6.2 MPa
Water absorption by mass	Min. 5%
Tensile strength after aging	Min. 80%

**9. PVC Waterstops**

PVC waterstops shall be the nominal width shown on the Drawings.

The waterstops shall be fabricated from a compound, the basic resin of which shall be virgin PVC. No reclaimed PVC or manufacturer's scrap shall be used. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, the finished product has the physical properties specified in Table 5-5.

All waterstops shall be moulded or extruded in such a manner that any cross section will be dense, homogeneous, and free from porosity and other imperfections.

Table 5-5

Properties of PVC Waterstops

Specific gravity	1.33 +/- 0.03 at 25°C
Tensile strength	Minimum 9.7 MPa
Ultimate elongation	Minimum 260%

PVC waterstops shall be of sufficient stiffness so that they remain in their correct position during concreting. The type shall suit the particular location in which the waterstop is to be placed and the pattern shall be such that concrete can be placed all around it with complete consolidation and no voids or crevices. PVC waterstops used in each location shall include at least one nailing strip located so that the efficiency of the waterstop is not impaired.

The number of joints in PVC waterstops shall be the minimum practicable.

"Tee" and "Flat X" joints shall be factory produced.

All joints shall be made with a temperature-controlled apparatus and in such a manner as to ensure that:

- the PVC is not damaged by heat, searing or by the application of cementing materials;
- the splice has a tensile strength not less than 80% of that specified for the PVC;
- the splice is watertight and free of air bubbles; and
- the ribs and central bulb, where applicable, match up exactly and are continuous.

**10. Curing Membranes**

Impervious sheet materials shall conform to ASTM C171 or equivalent except that polyethylene film, if used, shall be white opaque.

Membrane forming curing compound shall conform to ASTM C309 or equivalent.

**11. Storage of Cement and Aggregates**

All cement shall be stored, immediately upon delivery at the Site, in weatherproof buildings which will protect the cement from dampness. The floor shall be raised from the ground. The buildings shall be placed in locations approved by the Engineer. Provisions for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner as to allow the earliest deliveries to be used first and to provide easy access for identification and inspection of each shipment. Storage buildings shall have capacity for storage of a sufficient quantity of cement to allow sampling at least 12 days before the cement is to be used. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. Stored cement shall meet the test requirements at any time after storage when retest is ordered by the Engineer. At the time of use, all cement shall be free-flowing and free of lumps.

The handling and storing of concrete aggregates shall be such as to prevent segregation or the inclusion of foreign materials. The Engineer may require that aggregates be stored on separate platforms at satisfactory locations.

In order to secure greater uniformity of concrete mixes, the Engineer may require that the coarse aggregate be separated into two or more sizes. Different sizes of aggregate shall be stored in separate bins or in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed.

**S5.5. REQUIRED PROPERTIES OF CONCRETE**

Plastic concrete shall have an air content within the ranges shown in Table 5-6.

Table 5-6  
Required Air Content

Coarse Aggregate (maximum size, mm)	Total Air (percentage of volume of concrete)
10, 20	6 ±1
40	5 ±1

After the concrete has been discharged at the placing point and before it has been consolidated, the slump shall be within the ranges shown in Table 5-7.

Table 5-7

Element	Slump (mm)	
	Min.	Max.
Pavement concrete	10	40
Precast concrete	50	70
Formed elements, thickness 200 mm or less	75	100
Formed elements, over 200 mm thickness	50	100
Concrete placed under water	125	220
Filling for wet stone masonry	75	200
Levelling concrete	100	200
Pumped concrete	80	120
Other concrete	50	90



Hardened concrete shall have a characteristic strength for the particular class complying with Section S5.6.

#### **S5.6. ACCEPTANCE OF CONCRETE**

The strength of concrete shall be deemed acceptable if the average of 3 consecutive strength test results is equal to or exceeds the specified strength and no individual test result falls below the specified strength by more than 15 %.

#### **S5.7. TESTING PRIOR TO PRODUCTION**

The Contractor shall be responsible for the design of concrete mixes and for ensuring that all concrete placed in the Works meets the specified requirements.

At least 91 days before placing any concrete in the Permanent Works, the Contractor shall submit to the Engineer test results of the following, based on the materials proposed for use in the Works:

- cement properties;
- fine and coarse aggregate properties;
- mix water properties;
- admixture properties.

Following approval by the Engineer of the proposed materials, and at least 56 days before placing any concrete in the Permanent Works, the Contractor shall prepare trial mixes, using the approved materials, of all the required classes of concrete to verify their compliance with the specified requirements.

The trial mix program shall be continued until the concrete mixes show appropriate strength, workability and density without the use of excessive cement.

Until the results of trial mixes for a particular class have been approved by the Engineer, no concrete of the relevant class shall be placed in the Permanent Works.

#### **S5.8. BATCHING AND MIXING**

##### **1. Plant**

If the Contractor installs a plant for batching concrete at the Site, it shall be constructed and operated in accordance with ASTM C94 and this Specification.

Separate bins or compartments shall be provided for each size or classification of aggregate and for cement. The compartments shall be of ample size and constructed so that the materials will be maintained separately so that the flow of each material into the batcher is stopped automatically when the designated weight has been reached.

Aggregates may be weighed in separate weigh hoppers with individual scales or cumulatively on one weigh hopper with one scale. Bulk cement shall be weighed in a separate weigh hopper. Water may be measured by weight or by volume. If measured by weight, it shall not be weighed cumulatively with any other ingredient. Batching control shall be interlocked so that the charging mechanism cannot be opened until the scales have returned to zero.

A semi-automatic batcher control shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached and interlocked in such a manner that the discharge device cannot be actuated until the indicated material is within the applicable tolerance.

The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each of the bins or compartments for testing purposes.

## **2. Calibration**

The construction and accuracy of the weighing and measuring equipment shall be such that the equipment will maintain an accuracy within 0.4% of the scale capacity. The equipment shall be capable of ready adjustment for compensating for the varying weight of any moisture contained in the aggregates and for effecting changes in concrete mix proportions. Batching equipment shall be maintained and operated so that the combined inaccuracies in feeding and measuring the materials do not exceed 1% for water or admixtures and 3% for cement and each size of aggregate.

The Contractor shall provide standard certified test weights and any other auxiliary equipment required for checking the accuracy of each measuring device.

The Contractor shall calibrate each measuring device at least once every month in the case of equipment for measuring aggregates and at least once every two weeks in the case of equipment for measuring cement, water and admixtures.

The Contractor shall furnish copies of the complete results of all calibrations to the Engineer and shall adjust, repair or replace any measuring device that does not meet the requirements for accuracy.

## **3. Moisture Control**

The plant shall be capable of ready adjustment to compensate for the varying moisture contents of the aggregate, and to change the weights of the materials being batched. An electronic moisture meter shall be provided for measurement of moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the charging gate for the fine aggregate.

## **4. Recorders**

An accurate recorder or recorders shall produce a graphical or digital record of the scale reading after each of the aggregates and cementitious materials have been weighed prior to delivery to the mixer and after the batch has been discharged (returned to zero reference). The weights or volumes of water and admixtures shall also be recorded.

Each recorder shall be housed in a cabinet that is capable of being locked.

The charts or tapes shall clearly indicate the different types of mixes used by stamped letters, numerals, coloured ink or by other suitable means.

The charts or tapes shall show the time of day (stamped or pre-printed) at intervals of not more than 15 minutes.

The recorders shall be placed in a position convenient for observation by the plant operator.

All weighing, indicating, recording, and control equipment shall be sufficiently protected against exposure to dust, moisture and vibration so that there is no interference with proper operation of the equipment.

## **5. Mixers**

### **(a) General**

Concrete mixers shall be stationary mixers or transit mixers of approved specifications.

The mixers shall have a rated capacity of at least 0.76 m<sup>3</sup> of mixed concrete, and shall not be charged in excess of the capacity recommended by the manufacturer. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. Stationary mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time had elapsed.

The mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The specified mixing periods are based on proper control of the speed of rotation of the mixer drum or blades, and on proper introduction of the materials into the mixer.

The mixing time for stationary mixers shall be increased when such increase is necessary to produce the required uniformity and consistency of the concrete. Excessive overmixing requiring the addition of water will not be permitted.

The mixers and mixer drums shall be maintained in satisfactory operating condition and mixers shall be kept free of hardened concrete. Mixer blades shall be replaced when worn down more than 10% of their depth. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

### **(b) Stationary mixers**

The mixing time for each batch after all solid materials are in the mixer, provided that all of the mixing water is introduced before one-quarter of the mixing time has elapsed, shall be one minute for mixers having a capacity of 0.76 m<sup>3</sup>, and for mixers of larger capacities the mixing time shall be increased by 15 seconds for each additional 0.76 m<sup>3</sup> or fraction thereof.

### **(c) Transit Mixers**

Transit mixers shall conform to the requirements of ASTM C94, including requirements for uniformity of concrete.

In the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum at the rate of rotation designed by the manufacturer of the equipment at mixing speed and at the capacity designated in ASTM C94.

If the batch is at least 0.38 m<sup>3</sup> less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to not less than 50. Any additional mixing shall be done at the speed designated by the manufacturer of the equipment at agitating speed. Each mixer shall be equipped with two counters from which it is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

## **S5.9. SAMPLING AND TESTING DURING PRODUCTION**

### **1. General**

The Contractor shall carry out tests on materials and samples of concrete during production and placing of concrete to verify compliance with the specified requirements.

The Contractor shall keep records of test results, and shall provide copies to the Engineer on a regular basis.

**2. Testing Facilities**

The Contractor shall provide facilities and staff for testing concrete and materials for concrete in accordance with the provisions of Section S1 [*Preliminary and General*] of these Specifications.

**3. Testing Methods**

Unless otherwise specified, sampling and testing of concrete materials and concrete shall be in accordance with the testing methods and recommended practices of the American Society of Testing and Materials (ASTM).

Tests shall include, but not necessarily be restricted to, those listed in Table 5-8 and Table 5-9.

All sieve sizes refer to the aperture dimensions in millimetres of sieves conforming to ASTM E11.

Table 5-8  
Standards for Testing Concrete

Test	Standard
Sampling	ASTM C172
Compressive strength	ASTM C39, C31M
Slump	ASTM C143
Air Content	ASTM C173
Unit weight	ASTM C138
Drying shrinkage	ASTM C596

Table 5-9  
Standards for Testing Aggregate

Test	Standard	Sampling/testing frequency (m <sup>3</sup> )
Sampling	ASTM D75	500
Material finer than 20 μm	ASTM D1140	500
Soundness	ASTM C88	2,500
Grading	ASTM C136	500
Abrasion	ASTM C131	500
Unit mass	ASTM C29M	2,500
Alkali reactivity	ASTM C227, C289	2,500
Specific gravity and absorption	ASTM C128, C127	500

**4. Testing Cement**

All cement shall be certified by the manufacturer as complying with the requirements of this Specification. Before orders are placed, the Contractor shall submit details of the proposed supplier(s) together with all necessary information on the proposed methods of transport, storage and certification so that the Engineer may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction.

Having obtained the Engineer's approval of the supplier(s), transport, storage and certification of the cement, the Contractor shall not modify or change the agreed arrangement without first having obtained the Engineer's permission.

In addition to routine test certificates which shall be supplied by the manufacturer(s) to show the results of sample tests made on batches of cement produced at the plant, each consignment dispatched to the Site shall be sampled and tested by the Contractor and the results of the standard three-day and seven-day tests

shall be submitted promptly to the Engineer. The date of manufacture of the consignment shall be stated on the test certificates.

The Engineer may also make further tests when he considers it necessary or advisable to satisfy himself that the cement on Site complies with this Specification and has not suffered deterioration in any manner during transit or storage.

**5. Testing Aggregate**

At least 56 days before placing any concrete, the Contractor shall submit to the Engineer results of tests on representative samples of the proposed aggregates.

**6. Sampling and Testing Plastic Concrete**

The Contractor shall sample concrete, for testing, from the batching and mixing plant, delivery trucks, at the forms or elsewhere where concrete is being handled or placed. Samples shall be obtained at uniform intervals, as approved by the Engineer, throughout the production or delivery of concrete for a given lot. In general, the frequency of sampling of a class of concrete in any one lot shall be in accordance with Table 5-10, provided that at least one sample shall be taken per day for each class of concrete placed.

Table 5-10  
Frequency of Sampling Concrete

Up to 10 m <sup>3</sup>	1 sample
10 to 20 m <sup>3</sup>	2 samples
20 to 40 m <sup>3</sup>	3 samples
Each additional 20 m <sup>3</sup>	1 additional sample

A sample shall comprise at least three specimen cylinders, one for testing at 7 days and two for testing at 28 days, shall be prepared.

Where the concrete is deposited into the forms directly from an agitator truck chute, sampling shall be from the discharge and the sampling procedure shall be as in ASTM C172.

The Contractor shall test the plastic concrete to determine its compliance with the provisions of this Specification.

The Engineer has the right to be present at any sampling or testing conducted by the Contractor.

**7. Testing Hardened Concrete in Structures**

If approved by the Engineer on each specific occasion, hardened concrete liable to rejection may be tested for compressive strength in accordance with ASTM C42. Unless otherwise approved, core specimens shall be 150 mm in diameter. At least three specimens shall be tested and the points from which the specimens are obtained shall be as decided by the Engineer.

If the average compressive strength of the core specimens so obtained is equal to or greater than the specified characteristic strength for that section of the Works, then the concrete represented by the core specimens shall be considered to be structurally satisfactory.

If the concrete is considered to be structurally satisfactory, then the holes left by the removal of the test cores shall be repaired in an approved manner.

Unless otherwise approved, concrete which fails to meet the requirements of this Section shall be removed and replaced in an approved manner.

## **8. Testing Reinforcement**

The Contractor shall furnish the Engineer with two copies of the mill test certificates for the steel reinforcement to be used in the Works. The Engineer may, however, order independent tests to be made and any steel that does not comply in all respects with the appropriate Standards shall be rejected. The Contractor shall be responsible for the cost of such independent tests.

## **9. Testing Jointing Materials**

At least 28 days prior to the use of any jointing material, the Contractor shall submit to the Engineer, for approval, test results of the proposed product.

## **S5.10. FALSEWORK AND FORMWORK**

### **1. General**

The Contractor shall construct falsework and formwork in accordance with approved working drawings and maintain tolerances of finished concrete work as specified in Section S5.19.

Forms shall be installed so that they can be removed without inducing shock or vibration to the concrete. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50 mm to the finished surface and a cavity shall be formed so as to permit satisfactory filling.

All joints shall be closed tightly to prevent leakage of cement grout. At construction joints, the Contractor shall secure the formwork tightly against previously cast or hardened concrete to prevent ridges on exposed surfaces.

The Contractor shall make due allowance in setting the forms for any deflection which will occur during the placing of concrete within the forms. The Contractor shall make panels with true edges to permit accurate alignment and provide a neat line with adjacent panels and at all construction joints.

All exposed corners, both horizontal and vertical, shall be chamfered 20 mm x 20 mm. The chamfer fillet shall be accurately cut to size to provide a smooth and continuous chamfer.

### **2. Working Drawings**

The Contractor shall submit working drawings, including design calculations, for falsework and formwork to the Engineer at least 35 days prior to commencing any concrete work.

Each working drawing and erection drawing shall bear the signature of the Contractor's qualified engineer.

Details of all proposed formwork shall be submitted to the Engineer for approval before any materials are ordered. If the Engineer so requires, samples of proposed formwork shall be constructed and concrete placed at the Contractor's expense so that the proposed methods and finishes can be demonstrated.

### **3. Falsework**

The Contractor shall be responsible for designing and constructing falsework that will provide the necessary rigidity and the strength to support the imposed loads, so as to result in the structure being constructed within the specified dimensions and tolerances.

The falsework shall be constructed in accordance with the approved falsework drawings. Falsework shall be founded on solid footings safe against undermining. When satisfactory footings cannot be obtained, falsework shall be supported on piling that shall be spaced, driven and arranged in a manner satisfactory to the Engineer.

Suitable jacks or wedges shall be used in connection with falsework, to set the forms to the required level and to take up any excessive settlement in the falsework either before or during the placing of the concrete.

Should events occur that, in the opinion of the Engineer, would prevent obtaining a structure conforming to the specified requirements, the placing of the concrete shall be discontinued until corrective measures satisfactory to the Engineer have been carried out. In the event satisfactory measures are not carried out prior to the initial set of the concrete in the affected area, the placing of concrete shall be discontinued at a location to be determined by the Engineer. All unacceptable concrete shall be removed without cost to the Employer.

#### **4. Formwork**

Concrete forms shall be mortar-tight, true to the dimensions, lines and grades of the structure and with sufficient strength, rigidity, shape and surface smoothness as to leave the finished works true to the dimensions shown on the Drawings or required by the Engineer and with the surface finish as specified.

The inside surfaces of forms shall be cleaned of all dirt, mortar and foreign material. Forms which will later be removed shall be thoroughly coated with form oil prior to use. The form oil shall be a commercial quality form oil or other approved coating which will permit the ready release of the forms and will not discolour the concrete.

Concrete shall not be deposited in the forms until all work in connection with constructing the forms has been completed, all materials required for the unit to be poured, and the Engineer has inspected and approved the forms and materials. Such work shall include the removal of all dirt, chips, sawdust and other foreign material from the forms.

The rate of depositing concrete in forms shall be such to prevent bulging of the forms or form panels in excess of permissible deflections.

Forms for all concrete surfaces which will not be completely enclosed or hidden below the permanent ground surface shall conform to the requirements for forms for exposed surfaces. Interior surfaces of underground drainage structures shall be completely enclosed surfaces.

Formwork for concrete placed under water shall be watertight. When lumber is used, it shall be planed, tongued and grooved.

Forms for exposed concrete surface shall be designed and constructed so that the formed surface of the concrete does not undulate excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Undulations exceeding either 2 mm or 1/270 of the center to center distance between studs, joists, form stiffeners, form fasteners, or wales will be considered to be excessive. Should any form or forming system, even though previously approved for use, produce a concrete surface with excessive undulations, its use shall be discontinued until modifications satisfactory to the Engineer have been made. Portions of concrete structures with surface undulations in excess of the specified limits may be rejected by the Engineer.

All exposed surfaces of similar portions of a concrete structure shall be formed with the same forming material or with materials which produce similar concrete surface textures, color and appearance.

Forms for exposed surfaces shall be made of form materials of even thickness and width and with uniform texture. The materials shall have sharp edges and be mortar-tight.

Forms for exposed surfaces shall be constructed with triangular fillets at least 20 mm wide attached so as to prevent mortar runs and to produce smooth straight chamfers at all sharp edges of the concrete.

Form fasteners consisting of form bolts, clamps or other devices shall be used as necessary to prevent spreading of the forms during concrete placement. The use of ties consisting of twisted wire loops to hold forms in position will not be permitted.

Anchor devices may be cast into the concrete for later use in supporting forms or for lifting precast members. The use of driven types of anchorage for fastening forms or form supports to concrete will not be permitted.

**5. Removal of Formwork and Falsework**

Forms shall be removed in such a manner as will not damage the concrete. No forms shall be removed until the concrete has gained sufficient strength to support itself. Falsework may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety.

Minimum stripping and striking times shall be as shown in Table 5-11 unless otherwise shown on the Drawings or approved by the Engineer.

Table 5-11

	Minimum time	Minimum % of design strength
Vertical sides of beams, wall, piles, pile caps and columns, lift not exceeding 1.2 m	24 hours	70
Vertical sides of beams and walls, lift exceeding 1.2 m	36 hours	70
Soffits of main slabs and beams	14 days	80
Removal of props from beams and main slabs and other work	14 days	80

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

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

To facilitate finishing, forms used on ornamental work, railings, parapets and exposed vertical surfaces shall be removed in not less than 12 hours, nor more than 48 hours, depending upon weather conditions.

**S5.11. REINFORCEMENT**

**1. Dimensions and Unit Weights**

The nominal dimensions and unit weights of bars shall be in accordance with Table 5-12.



Table 5-12

Nominal diameter (mm)	Nominal perimeter (mm)	Nominal sectional area (mm <sup>2</sup> )	Unit weight (kg/m)
6	18.8	28.27	0.222
7	22.0	38.48	0.302
8	25.1	50.36	0.394
10	31.4	78.54	0.616
12	37.7	113.10	0.888
16	50.3	201.06	1.578
20	62.8	314.16	2.466
25	78.6	490.88	3.853
28	88.0	615.75	4.834
32	100.5	804.25	6.313
36	113.1	1,017.88	7.990

## 2. Drawings and Bar Lists

The Contractor shall submit working drawings showing reinforcing bar placing and bar lists for the Engineer's approval.

Such working drawings shall clearly indicate bar sizes, placing location and quantities of reinforcement, mesh, chairs, spacers and other details in accordance with the ACI 315.

## 3. Bending and Splicing

Reinforcement shall be fabricated to the shapes and dimensions shown and shall be placed where indicated on the Drawings.

The use of heat to bend or straighten reinforcement will not be permitted. Bars that develop cracks or splits shall not be used in the Works.

Splices or overlapping in reinforcement shall conform to ACI 318. Lap lengths shall not be less than 36 and 24 times the reinforcing bar diameter for tension and compression, respectively, but not less than 300 mm or as shown on the Drawings. All laps shall be staggered or be made at points where the steel stress is less than 50% of the allowable stress. Where laps cannot be staggered or be made at points of reduced stress, lap lengths shall be increased by 30%.

## 4. Placing

The Contractor shall maintain the number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement in exact accordance with the Drawings and keep them in the correct position and with the required cover without displacement during the process of placing and compacting the concrete.

All necessary spacer bars shall be provided to maintain the reinforcement in the correct position. The type of spacers shall be subject to the approval of the Engineer. Timber blocks for wedging the steel off the formwork will not be allowed.

Any ties, links or stirrups connecting the bars shall be adequately tied so that the bars are properly braced and the inside of hooks and bends shall be in actual contact with the bars around which they are intended to fit.

**5. Welding of Reinforcing Bars**

Welding of reinforcing bars will only be permitted where shown on the Drawings. All welding shall be performed in accordance with AWS D1.4-98 or equivalent.

**6. Tying and Cleaning**

Reinforcement shall be tied as shown on the Drawings, approved by the Engineer, or at the location where spacing in each direction is:

- less than 300 mm: tied at alternate intersections
- 300 mm or more: tied at each intersection.

Reinforcing bars shall be cleaned before placing concrete so that they are free from loose or flaky rust and mill scale, or any other substance that would reduce or destroy the bond.

**7. Exposed Reinforcing Bars, Dowels, etc.**

Exposed reinforcing bars, dowels and plates intended for bonding with future extensions shall be protected from corrosion by means approved by the Engineer.

**8. Cover for Reinforcement**

Unless otherwise shown on the Drawings, the minimum concrete cover of reinforcement in concrete cast-in-situ shall be as specified in Table 5-13.

Table 5-13

Condition		Minimum Cover (mm)
Concrete cast against and permanently exposed to earth		75
Concrete exposed to earth or weather	Primary reinforcement	50
	Stirrups, ties, and spirals	40
Concrete deck slabs in mild climates	Top reinforcement	50
	Bottom reinforcement	25
Concrete not exposed to weather or in contact with ground	Primary reinforcement	40
	Stirrups, ties, and spirals	25
Concrete piles cast against and/or permanently exposed to earth		50

**9. Inspection before Placing Concrete**

No concrete shall be placed until the Engineer has inspected and approved reinforcement work in place. The Contractor shall allow a minimum of two days for the Engineer's inspection, correction of deficiencies and reinspection before placing concrete.

**10. Wire-Mesh, Dowels, Tie-Bars and Supports**

Wire-mesh reinforcement shall be continuous between crack control joints in slabs on grade and shall be continuous between expansion joints in other slabs. Laps shall be at least one full mesh plus 50 mm, staggered to avoid continuous lap in either direction and securely wired or clipped with standard clips.

Dowels in slabs on grade shall be installed at right angles to construction joints and expansion joints as shown on the Drawings or instructed. Dowels shall be accurately aligned parallel to the finished surface, and shall be rigidly held in place and supported during placing of the concrete. One end of dowels shall be oiled or greased, and be provided with a PVC cap as shown on the Drawings.

Tie bars on grade shall be placed at right angles to construction joints. Tie bars shall be accurately aligned parallel to the finished surface, and shall be rigidly held in place and supported during placing of the concrete.

Supports shall be provided in conformity with ACI 315 and ACI 318 unless otherwise specified.

#### **11. For Slabs on Grade**

Reinforcement shall be supported on pre-cast concrete spacers at intervals required by the size of reinforcement used, to keep reinforcement to the specified cover.

#### **12. For Slabs other than on Grade**

Supports for which any portion will be less than 25 mm from a concrete surface that will be exposed to view or painted shall be plastic-coated steel, stainless steel, precast concrete or plastic.

Precast concrete spacers shall be wedge-shaped, not larger than 90 mm by 90 mm, and of thickness equal to the specified cover. The spacers shall have cast-in galvanized tie wires for tying to the reinforcement and shall blend with concrete surfaces after finishing is completed. The concrete in the spacers shall be of the same quality as for the concrete in which they are placed, but with the coarse aggregate reduced.

Plastic supports shall be of adequate strength and spacing so as not to be deformed by the weight of concrete.

### **S5.12. HANDLING AND PLACING CONCRETE**

#### **1. General**

To allow the Engineer to be present, the Contractor shall give the Engineer at least 48 hours notice of when concrete is to be placed. Unless otherwise approved, concrete shall only be placed in the presence of the Engineer.

No concrete shall be placed when the climatic conditions are such that, in the opinion of the Engineer, proper placing and hardening of the concrete may be adversely affected.

#### **2. Preparation for Placing**

Hardened concrete, debris and foreign materials shall be removed from the interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position and shall be inspected and approved by the Engineer before placing concrete. Runways shall be provided for wheeled concrete-handling equipment. Such equipment shall not be wheeled over reinforcement, and runways shall not be resting on reinforcement.

The Contractor shall have sufficient protective coverings available to prevent damage to fresh concrete from adverse weather.

The surfaces of absorptive foundations, against which concrete is to be placed, shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. An approved water barrier shall be used to cover absorbent foundations.

The surfaces of construction joints shall be clean and damp when covered with fresh concrete. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coatings, sand, curing compound if used, and other foreign material to the satisfaction of the Engineer.

The surfaces of all construction joints, including surfaces of blockouts, shall be washed thoroughly with air-water jets immediately before placing adjoining concrete. All pools of water shall be removed from the surfaces of construction joints before the new concrete is placed.

### **3. Handling**

Concrete shall be mixed and transported to the place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients, until the scheduled concrete placing is completed. Placing will not be permitted when insufficient numbers or types of equipment prevent proper finishing and curing of the concrete.

### **4. Time Interval Between Mixing and Placing**

Concrete shall be placed in the forms within 45 minutes from the time ingredients are charged into the mixing drum.

### **5. Concrete Temperature and Hot Weather Concreting**

The temperature of concrete during mixing, transporting and placing shall not be permitted to rise above 32°C. Any batch of concrete with a temperature higher than 32°C shall not be used in any part of the Permanent Works.

The Contractor's attention is drawn to the recommendations contained in the "*Manual of Concrete Practice Part 2-1989, Hot Weather Concreting - American Concrete Institute 305R-77*". The Contractor shall adopt any or all of these recommendations as necessary to manufacture and place concrete in accordance with this Specification.

When these procedures are not sufficient to control the temperature to within the specified limit, concreting work shall be restricted to evenings or nights.

### **6. Placing Concrete**

Concrete shall be placed in the positions and sequences described in the construction methodology approved by the Engineer. Except where otherwise approved, concrete shall not be placed unless the Engineer is present and has previously examined and approved the positioning, fixing and condition of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability of the containing surfaces or formwork.

Whenever practicable, concrete shall be deposited directly in its final position and shall not be dropped, chuted or caused to flow in a manner that causes segregation. Methods and equipment used in depositing concrete shall be such that clusters or groups of coarse aggregate being separated from the mass does not occur. The Contractor shall provide chutes and baffles to confine and control the falling concrete. The movement of concrete within the forms by use of vibrators will not be permitted.

Concrete shall be placed in the forms, as close as possible to final position, in uniform approximately horizontal layers not deeper than 300 mm.

If pumping is approved by the Engineer, the Contractor shall:

- arrange equipment so that no vibrations resulting therefrom will cause damage to freshly placed concrete;
- operate pumps so that a continuous stream of concrete is produced without developing air pockets;
- when pumping is discontinued and concrete remaining in the pipe line is to be used, empty the pipe line in a manner that prevents contamination of concrete or separation of ingredients; and

- unless otherwise specified, consolidate the concrete with high speed internal vibrators.

## **7. Placing Concrete in Water**

Concrete shall not be placed in water except with approval of the Engineer and under his immediate supervision.

Concrete deposited in water shall be Class A concrete with a minimum cement content of 400 kg/m<sup>3</sup> of concrete. The slump of the concrete shall be maintained between 100 mm and 200 mm. To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom-dump bucket, or other approved means, and shall not be disturbed after being placed.

A tremie shall consist of a tube having a diameter of not less than 250 mm constructed in sections having flanged couplings fitted with gaskets with a hopper at the top. The tremie shall be supported so as to permit free movement of the discharge and over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be completely submerged in concrete at all times; the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by lightly raising the discharge end, but always keeping it in the placed concrete. The flow shall be continuous until the work is completed.

When the concrete is placed with a bottom-dump bucket, the top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

## **8. Concreting in Adverse Climatic Conditions**

No concreting shall take place in the open during storms or heavy rain. In places where such conditions are likely to occur, arrangements for adequate protection of the materials, plant and formwork shall be made by the Contractor so that the work may proceed under proper cover. Where strong wind and rain are likely to be experienced, additional precautions shall be taken to ensure protection from driving rain and dust.

## **9. Concreting at Night or in the Dark**

Where approval has been given to carry out concreting operations at night or in places where daylight is excluded, adequate lighting shall be provided at all locations where mixing, transportation and placing of concrete are in progress.

## **10. Compaction**

Concrete shall be thoroughly compacted during and immediately after placing. The concrete in walls, beams, columns and the like shall be placed in horizontal layers not more than 300 mm thick unless otherwise specified or approved. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set to prevent injury to the green concrete and to avoid surfaces of separation between the layers. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer.

The compaction shall be done by mechanical vibration. The concrete shall be vibrated internally unless otherwise approved. Vibrators shall be of an approved type, design, and frequency. The intensity of vibration shall be such as to visibly affect a mass of concrete with a 30 mm slump over a radius of at least 500 mm. A sufficient number of vibrators shall be provided to properly compact each batch immediately after it is placed in the forms. Vibrators shall be manipulated so as to thoroughly work the concrete

around the reinforcement and embedded fixtures and into the corners and angles of the forms and shall be applied at the point of placing and in the area of freshly placed concrete. The vibrators shall be inserted into and withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to compact the concrete thoroughly but shall not be continued so as to cause segregation and at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced, and not farther apart than twice the radius over which the vibration is visibly effective. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. Vibration shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms, troughs or chutes.

### **S5.13. JOINTS**

#### **1. General**

The concrete in each form shall be placed continuously. Placing of concrete in any such form shall not be allowed to commence unless sufficiently inspected and approved materials for the concrete is at hand, and labour and equipment are sufficient to complete the pour without interruption.

Joints in the concrete due to stopping work shall be avoided as much as possible. Such joints, when necessary, shall be constructed to meet the approval of the Engineer.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its shape, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. Where a "faster edge" might be produced at a construction joint, as in the sloped top surface of a wingwall, an inset formwork shall be used to produce an edge thickness of not less than 150 mm in the succeeding layer. Work shall not be discontinued within 500 mm of the top of any face, unless provision has been made for a coping less than 500 mm thick, in which case if permitted by the Engineer, the construction joint may be made at the underside of coping.

Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcing steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. Care shall be exercised, during the cleaning of the reinforcing steel, not to injure or break the concrete-steel bond at and near the surface of the concrete.

#### **2. Construction Joints**

Construction joints shall be made only where shown on the Drawings or called for in the pouring schedule, unless otherwise approved by the Engineer. Shear keys or reinforcement shall be used, unless otherwise specified, to transmit shear or to bond the two sections together.

Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened in a manner that will not leave loose particles of aggregate or damage concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance. When instructed by the Engineer, the surface of the hardened concrete which will be in contact with new concrete shall be washed with water to his satisfaction, and to ensure an excess of mortar at the juncture of the hardened and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces shall first be thoroughly covered with a coating of mortar of the same proportion of sand and cement as the class of concrete used against which the new concrete shall be placed before the grout or mortar has attained its initial set.

The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished true to line and elevation.

### **3. Contraction Joints**

Contraction joints shall be located where shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at contraction joints shall be coated with an approved bond breaking material before the concrete on the other side of the joint is placed.

### **4. Expansion Joints**

The Contractor shall make expansion joints in the same way as construction joints but, in addition, an approved compressible sheet or filler shall be supplied and placed in the joint to provide freedom for the two adjacent concrete slabs or blocks to expand. In certain situations, a highly compressible joint of expanded polyethylene or other approved material shall be used. The exposed edges of the compressible sheet or filler shall be sealed with an approved resilient sealing compound or similar product. No reinforcement, nor other fixed metal items, shall be run continuous through joints containing expansion joint filler, through crack-control joints in slabs on grade or on vertical surfaces.

### **5. Joints with Existing Structures**

Vertical joints with existing structures shall include a high swell hydrophilic waterstop.

The waterstop shall be from an approved manufacturer and shall be installed in accordance with the manufacturer's recommendations.

Horizontal joints shall be constructed in the same manner as is specified for construction joints.

### **6. Placing of Waterstops**

Waterstops shall be furnished full length for each straight portion of the joint, without field splices. Splices, as may be necessary to avoid buckling or distortion of the web or flange, shall be installed at changes in direction. Waterstops shall be securely held in position by the use of spacers, supporting wires, or other approved devices that will not injure or puncture the waterstop.

Field splices for waterstops shall be made in accordance with the manufacturer's recommendations so as to provide a watertight connection.

Extra care shall be taken in concreting operations around waterstops to preserve their shape and position in the joint.

## **S5.14. CONCRETE SURFACE FINISHING**

### **1. General**

Surface finishing shall be classified as follows:

- Class 1 - Ordinary Finish;
- Class 2 - Rubbed Finish; and
- Class 3 - Floated Finish.

All concrete shall be given Class 1 - Ordinary Finish and additionally any further finish as specified.

Unless otherwise specified, the following surfaces shall be given a Class 2 - Rubbed Finish:

- exposed faces of floodgate structures, wingwalls and retaining walls; and

- outside faces of girders, T-beams, slabs, columns, brackets, curbs, headwalls, railings and parapets,

except for the tops and bottoms of floor slabs and sidewalks, bottoms of beams and girders, sides of interior beams and girders, or the underside of copings. Wingwalls shall be finished from the top to 500 mm below the finished slope lines on the outside face and shall be finished on top and for a depth of 200 mm below the top on the back sides.

## **2. Class 1 - Ordinary Finish**

Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except for those that are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned and, after having been kept saturated with water for a period of not less than three hours, shall be carefully pointed and made true with a mortar of the same mix as the concrete being finished. Mortar used in pointing shall not be more than one hour old. The mortar patches shall be cured as specified in Section S5.15. All construction and expansion joints in the completed work shall be carefully tooled and free of all mortar and concrete. The joint filler shall be exposed for its full length with a clean and true edge.

The resulting surface shall be true and uniform. All repaired surfaces, the appearance of which is not satisfactory to the Engineer, shall be "rubbed" as specified below.

## **3. Class 2 - Rubbed Finish**

After patching with mortar, the affected areas shall be screeded to leave the patches slightly higher than the surrounding surface. The mortar patches shall be allowed to attain initial set and shrinkage, after which a rubbed finish shall be applied. In preparation for rubbing, the concrete surface shall be liberally moistened with water for three hours. 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 proportions used in the concrete being finished. Rubbing shall be continued until all form marks and irregularities have been removed, all voids filled, and a uniform surface texture obtained. The paste produced in the rubbing process shall be left in place.

In multiple lifts, the procedure outlined above shall be repeated for every lift until the whole surface has been finished in the specified manner. After the initial finishing, the final finish shall be started by rubbing with a fine carborundum stone and water. The final rubbing shall be continued until the entire surface attains a smooth texture and uniform colour. After the surface has dried, it shall be wiped clean of all loose powder and other particles, with burlap or other suitable material. Curing shall then be carried out.

## **4. Class 3 - Floated Finish**

A floated finish shall be applied to pavements for vehicular traffic.

After the concrete is compacted as specified, the surface shall be carefully struck off with a strike board to conform to the cross-section and grade shown on the Drawings. Proper allowance shall be made for camber if required. The strike board may be operated longitudinally or transversely and shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither is raised from the side forms during the process. A slight excess of concrete shall be kept in front of the cutting edge at all times.

After striking off and consolidating as specified above, the surface shall be made uniform by longitudinal or transverse floating or both. Longitudinal floating will be required except in places where this method is not feasible.



The longitudinal float, operated from foot bridges, shall be worked with a sawing motion while held in a floating position parallel to the road centerline and passing gradually from one side of the pavement to the other. The float shall then be moved forward one-half of each length and the above operation repeated. Machine floating which produces an equivalent result may be substituted for the above manual method.

The transverse float shall be operated across the pavement by starting at the edge and slowly moving to the center and back again to the edge. The float shall then be moved forward one-half of each length and the above operation repeated. Care shall be taken to preserve the crown and cross-section of the pavement.

After the longitudinal floating has been completed and the excess water removed, but while the concrete is still plastic, the slab surface shall be tested for trueness with a straight-edge. For this purpose, the Contractor shall furnish and use an accurate 3 m straight-edge swing.

Testing with the straightedge shall be in successive stages of not more than one-half the length of the straightedge. Any depression found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. The straight-edge testing and refloating shall continue until the entire surface is found to be free from observable departure from the straight-edge and the slabs has the required grade and contour, until there are no deviations of more than 3 mm under the 3 m straight-edge.

When the concrete has hardened sufficiently, the surface shall be given a broom finish. The broom shall be an approved type. The strokes shall be square across the slabs from edge to edge, with adjacent strokes slightly overlapped, and shall be made by drawing the broom without tearing the concrete, but so as to produce regular corrugations not over 3 mm in depth. The surface as thus finished shall be free from porous spots, irregularities, depressions and small pockets or rough spots such as may be caused by accidental disturbing, during the final brooming of particles of coarse aggregate embedded near the surface.

Surfaces of pedestrian walkways shall be given a broom finish. After the concrete has been deposited in place, it shall be compacted and the surface shall be struck off by means of strike board and floated with a wooden or cork float. An edging tool shall be used on all edges and at all expansion joints. The surface shall not vary more than 3 mm under a 3 m straight-edge. The surface shall have a granular or matted texture which will not slick when wet.

## **S5.15. CURING**

### **1. Water Method**

The concrete shall be kept continuously wet by the application of water for a minimum period of 7 days after the concrete has been placed.

The entire surface of the concrete shall be kept damp by applying water with an atomizing nozzle. Cotton mats, rugs, carpets, or earth or sand blankets may be used to retain the moisture. At the expiration of the curing period the concrete surface shall be cleared of the curing medium.

### **2. Curing Compound Method**

Surfaces of pavements and structures, except parts of structures with rubbed and other special finishes exposed to view, may be cured by the application of an impervious film. This film shall be formed by the uniform spraying of pigmented curing compound that dries out to form a practically colourless membrane. The rate of application shall be as recommended by the approved manufacturer and sprayed under sufficient pressure to seal the concrete surface thoroughly. The film shall remain undamaged for 7 days and any portion damaged within the curing period shall be repaired immediately with additional compound. The curing compound shall be applied to the concrete following the surface finishing

operation when the moisture sheen has just disappeared from the surface, but before any drying shrinkage or craze cracks begin to appear.

### **3. Waterproof Membrane Method**

The exposed finished surfaces of concrete shall be moistened with a fine spray of water, and the curing membrane shall be placed. The curing membrane shall conform to ASTM C171, shall remain in place for 7 days and shall be formed into such widths as to completely cover the entire concrete surface. All joints in the sheets shall be securely lapped and cemented together to prevent the escape of moisture by placing a bank of earth on the edges of the sheets, or by other means satisfactory to the Engineer. Damaged sheeting shall be immediately covered with new sheeting properly fastened into place.

### **4. Forms-in-Place Method**

Formed surfaces of concrete may be cured by retaining the form in place. The forms shall remain in place for a minimum period of 7 days after the concrete has been placed, except that, for members over 500 mm in least dimensions, the forms shall remain in place for a minimum period of five days. Wooden forms shall be kept wet by watering during the curing period.

### **5. Steam or Radiant Heat Curing Method**

Steam or radiant heat curing will only be permitted for precast concrete members manufactured in an established plant.

Steam or radiant heat curing shall be carried out under suitable enclosures that contain the live steam or the heat.

Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where the temperature of the enclosure will be the same as that of the concrete.

Sufficient temperature recording devices shall be installed to verify that the temperatures are uniform throughout the enclosure and within the specified limits.

Steam shall be low pressure and saturated. Steam jets shall not impinge directly on the concrete, test cylinders or forms. Enclosures for steam curing shall allow free circulation of steam about the member and shall contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good condition and secured in such a manner as to prevent the loss of steam and moisture.

To allow the initial set of the concrete to take place, the initial application of steam or heat shall be from two to four hours after the concrete placement has been completed. If retarding admixtures have been used, the waiting period shall be increased to between four and six hours after placement.

During the waiting period, the temperature in the curing enclosure shall not be permitted to fall below 10°C and steam or radiant heat may be used to maintain this minimum temperature. During this period the concrete shall be kept wet.

During the initial application of the live steam or radiant heat, the ambient temperature within the enclosure shall increase at a rate not exceeding 20°C per hour until the curing temperature is reached. The maximum curing temperature throughout the enclosure shall not exceed 65°C and shall be maintained at a constant level for a time sufficient to develop the required compressive strength. In discontinuing the steam application, the ambient air temperature shall not decrease at a rate exceeding 20°C per hour until a temperature 10°C above the temperature of the air to which the concrete will be exposed has been reached.

Radiant heat may be applied by means of pipes circulating a hot medium or by electric heating elements. Moisture loss shall be minimised by covering all exposed concrete surfaces with plastic sheeting or by applying an approved liquid membrane curing compound to all exposed concrete surfaces.

#### **S5.16. PRECAST CONCRETE**

Concrete members so specified shall be fabricated as precast units with concrete of the specified class. The Contractor will be permitted to obtain precast concrete units from outside suppliers provided that they comply with the specified requirements and that the Contractor obtains the Engineer's approval for each supplier.

The Contractor shall submit to the Engineer for approval full details of proposed methods of manufacture, handling and erecting precast concrete units.

Permanently exposed surfaces shall be cast against a closely-jointed steel form. The surface shall be improved by carefully removing all fins and other projections. After inspection by the Engineer, any concrete surfaces that have been accepted but contain blemishes, air holes, etc., shall be thoroughly washed down and the surface blemishes filled with a cement and fine aggregate paste matching the colour of the concrete.

Surfaces which will subsequently receive grout or concrete to complete a structural connection, or other composite structural component of which the precast unit forms a part, shall be prepared for surface treatment as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not yet hardened, by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without being disturbed. Where this treatment is impractical, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking shall be avoided.

#### **S5.17. NOT USED**

#### **S5.18. MORTAR**

Cement mortar shall be mixed in the proportions (by volume) of one part cement to four parts sand.

Cement mortar shall be thoroughly mixed in the specified proportions to a uniform colour and satisfactory workability.

#### **S5.19. TOLERANCES FOR CONCRETE CONSTRUCTION**

##### **1. General**

Where tolerances are not specified for any individual structure or feature, permissible deviations will be interpreted in conformity with the provisions of this Section S5.19. Notations on the Drawings, or included in these Specifications, of specific tolerances in connection with any dimensions shall be considered as supplementary to the tolerances specified in this Section S5.19.

The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits and shall ensure that the work is completed within the specified tolerances.

##### **2. Concrete**

Tolerances for reinforced concrete structures shall be in accordance with the requirements set out following.

Variation from plumb:

In the lines and surfaces of columns, piers, walls, railing posts	5 mm in any 3 m 8 mm in any 6 m 10 mm in any length 12 m or more.
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Variations from level or grade:

Concrete railings	6 mm
Slab and beam soffits	5 mm in any 3 m 8 mm in any 6 m 16 mm in any length 12 m or more
Top of driven piles	10 mm
Top of pile caps, footings, pier columns, beams and deck slabs	10 mm
Top of bearing pedestals	5 mm.

Variation from indicated position

12 mm.

Variation in cross-sectional dimensions of columns, beams and in the thickness of slabs (other than bridge decks) and walls

+12 mm, -5 mm.

Footings:

Variations in dimensions in plan	+50 mm, -12 mm
Misplacement or eccentricity	2% of the footing width in the direction of misplacement but not more than 50 mm.

**3. Reinforcement**

Tolerances for reinforcing steel:

Variation of protective cover

±5 mm

Variation in indicated position of reinforcement:

starter bars	one bar diameter
slabs and walls	0.25 the indicated spacing
beams and columns	±5 mm.

**4. Embedded Metalwork**

Tolerances for placing embedded metalwork ±5 mm.

**S5.20. NOT USED****S5.21. ANCHOR BARS FOR CONCRETE STRUCTURES**

Where shown on the Drawings or instructed, the Contractor shall drill holes in existing concrete for anchor bars and grout the bars in place.

The dimensions and the locations of the anchor bars shall be as shown on the Drawings or instructed.

Grouting mortar shall consist of cement, water, and sand mixed in the proportion of one part of Portland cement to two and one half parts of sand, by weight, and to the consistency prescribed by the Engineer.

Anchor bars shall be cleaned thoroughly before being placed. The holes shall be cleaned thoroughly and shall be completely and compactly filled with grout. The anchor bars shall be forced into place before the

grout takes its initial set and, where practicable, shall be vibrated or rapped until the entire surface of the embedded portions of the bars is in intimate contact with the grout. Special care shall be taken to ensure against any movement of the bars that have been placed.

## **S5.22. CONCRETE IN STRUCTURES**

The Contractor shall place Type A, B, C or E concrete in the locations shown on the Drawings or instructed.

## **S5.23. LEVELLING CONCRETE**

The Contractor shall place levelling concrete where and to the depth shown on the Drawings or instructed.

Levelling concrete shall be Class F.

## **S5.24. MEASUREMENT AND PAYMENT**

### **1. Concrete - General**

Unless otherwise provided, concrete will be measured by the volume complete in place and accepted. In computing quantities, the dimensions used will be those shown on the Drawings.

Measurement will not include any concrete used for the construction of Temporary Works or which is included in other billed items.

Measurement will also not include concrete placed outside specified or approved excavation lines, or wasted concrete.

The volume of concrete measured will not be reduced on account of the volume occupied by:

- reinforcement;
- prestressing components;
- pockets, holes, pipes or other cast-in components each not exceeding 0.1 m<sup>3</sup> in volume;
- rebates, throats, fillets, chamfers or internal splays each not exceeding 0.01 m<sup>2</sup> in cross-sectional area; or
- joints or joint components between adjacent volumes of in-situ concrete.

The volume of concrete measured will not be increased on account of the volume occupied by nibs or external splays each not exceeding 0.01 m<sup>2</sup> in cross-sectional area.

Concrete and reinforcement for precast concrete piles will not be separately measured for payment.

Concrete for curbs and gutters (including any reinforcement) will be measured for payment in accordance with Section S15 [*Miscellaneous Works*] of these Specifications.

Concrete for wet masonry will be measured for payment in accordance with Section S7 [*Protection Works*] of these Specifications.

### **2. Reinforcement**

#### **(a) Measurement**

Measurement for payment of furnishing and installing reinforcing bars will be made of the calculated mass of the bars placed in the Works in accordance with the Drawings and bending schedules or as instructed. The calculated mass for reinforcing bars will be determined as follows:

- reinforcing bars - the calculated quantity shall be based on the weights given in Table 5-12;
- only joints and splices shown on the Drawings or instructed will be measured for payment as laps.

Measurement for payment of furnishing and installing reinforcing fabric will be made of the area and type of fabric placed in the Works in accordance with the Drawings or as instructed. Only the net area computed from the Drawings will be used to determine the quantity for payment.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
5.11/1	Reinforcement Grade 275	Ton

### 3. Precast Concrete

(a) Measurement

Measurement, for payment, of precast concrete will be made of the volume of concrete complete in place in accordance with Drawings or as instructed.

Separate measurement will not be made of reinforcement in precast concrete.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
5.16/1	Precast concrete manhole and junction box covers	Cubic metre
5.16/2	Precast concrete U-ditch covers	Cubic metre

### 4. Concrete in Structures

(a) Measurement

Measurement, for payment, of concrete in structures will be made of the volume of concrete complete in place in accordance with Sub-Section S5.24.1.

(b) Payment

Payment for concrete in the various structures in the Permanent Works will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items. These rates shall include the cost of furnishing and placing all materials, trial mixes, materials testing, labour, tools, equipment, falsework and formwork, casting, finishing and all incidentals except that payment for furnishing and placing reinforcement (unless otherwise specified) will be made separately.

BoQ Item No.	Description	Unit of Measurement
5.22/1	Concrete in manholes, junction boxes and outlets	Cubic metre
5.22/2	Concrete for pipe bedding	Cubic metre
5.22/3	Concrete in box culverts	Cubic metre
5.22/4	Concrete in sheet pile copings	Cubic metre
5.22/6	Concrete in parapet walls PW Type 1	Cubic metre

BoQ Item No.	Description	Unit of Measurement
5.22/15	Filler concrete (Class B)	Cubic metre
5.22/16	Concrete in U-ditches	Cubic metre
5.22/18	Concrete in gravity wall	Cubic metre
5.22/19	Concrete revetment	Cubic metre
5.22/20	Concrete in base type A for concrete block retaining wall	Cubic metre
5.22/21	Concrete in base type B for concrete block retaining wall	Cubic metre
5.22/22	Concrete in partition for concrete block retaining wall	Cubic metre
5.22/23	Backfill concrete for concrete block retaining wall	Cubic metre
5.22/24	Top concrete for concrete block retaining wall	Cubic metre
5.22/25	Concrete in stair block	Cubic metre
5.22/26	Concrete in boundary wall	Cubic metre
5.22/27	Concrete in sluice structures	Cubic metre
5.22/28	Concrete in drainage outlet structure at Laguna backfill area	Cubic metre

**5. Levelling Concrete**

(a) Measurement

Measurement, for payment, of levelling concrete will be made of the volume of levelling concrete in place in accordance with Drawings or as instructed.

(b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
5.23/1	Levelling concrete	Cubic metre

**6. Ancillary Items**

Ancillary items such as waterstops and jointing materials will not be separately measured for payment and the cost of these items will be considered to have been included in the items of concrete into which they are incorporated.

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## S6. PILING

### S6.1. GENERAL

The Contractor shall supply and install piling in accordance with these Specifications and as shown on the Drawings or instructed.

Piles shall be of such length as is required to attain the design bearing value and/or to obtain the required minimum length, and to extend into the pipe cap, all as shown on the Drawings.

Pile lengths shown on the Drawings are estimates only, and actual lengths shall be as instructed by the Engineer.

Piles shall only be driven in the presence or with the authorization of the Engineer, and the Contractor shall give the Engineer at least 48 hours notice of any intention to commence driving.

The surfaces of steel piles shall be painted in accordance with the requirements of Section S13 [*Corrosion Protection and Painting*] of these Specifications. This protection shall be to the levels as shown on the Drawings or as instructed by the Engineer.

At least 28 days prior to commencing any piling operations, the Contractor shall submit to the Engineer details and drawings of the proposed piling methods. In determining the piling methods, the Contractor shall take into account the specified noise and vibration limits, and the restrictions on land-based access.

### S6.2. STANDARDS

The Standards referenced in this section of the Specification are:

JIS A5523	Weldable hot rolled steel sheet piles
JIS A5530	Steel pipe sheet piles
JIS G3106	Rolled steels for welded structure
AWS D1.1	Structural welding code - steel

### S6.3. TOLERANCES

Unless otherwise specified or approved, piles shall be installed with a variation of not more than 1 in 100 from the vertical, or from the specified rake, within a maximum tolerance of  $\pm 75$  mm at the pile head.

### S6.4. STEEL SHEET PILING

#### 1. Steel Sheet Piles

All steel sheet piles to be furnished by the Contractor shall be of the type shown on the Drawings and shall comply with JIS A5523 (SYW295 or SYW390), with minimum yield strengths of 295 MPa and 390 MPa respectively.

Unless otherwise shown on the Drawings or approved, steel sheet piles for use in the Permanent Works shall have the properties show in Table 6-1.

Table 6-1

Type	Width (mm)	Height (mm)	Sheet thickness (mm)	Area (cm <sup>2</sup> /m)	Weight (kg/m)	Section Modulus (cm <sup>3</sup> /m)
U-shape						
III <sub>w</sub>	600	180	13.4	173.2	136	1,800
IV <sub>w</sub>	600	210	18.0	225.5	177	2,700
V <sub>L</sub>	500	200	24.3	267.6	210	3,150
VI <sub>L</sub>	500	225	27.6	306.0	240	3,820
Hat-shape						
10H	900	230	10.8	122.2	96	902
25H	900	300	13.2	160.4	126	1,610

Hat-shaped corrugated steel sheet piles shall be strengthened by the attachment by welding of H-beams where and as shown on the Drawings. H-beams shall be SM490A conforming to JIS G3106. Welding shall be in accordance with the relevant codes of the American Welding Society.

## 2. Installation

Steel sheet piling shall be installed in accordance with approved methods. In order to comply with specified noise and vibration limits, and land-based access restrictions, it is anticipated that the majority of the steel sheet piling will be installed using a combined water jetting / vibro hammer method.

Steel sheet piles shall be installed with a variation of not more than 10 mm per metre from the vertical or from the rake shown on the Drawings. When in place, the piles shall be practically watertight at the joints.

Where necessary, existing revetments shall be demolished sufficiently to allow installation of the sheet piles and jointing carried out in accordance with Section S6.4.5.

Where practical, all steel sheet piles shall be installed to the elevation shown on the Drawings, or as instructed by the Engineer. Where, due to subsurface conditions, it is impractical to install the piles to design depth, the piles may be stopped at a higher elevation with the written permission of the Engineer. Where, due to subsurface conditions, it is necessary to install the piles to below the design depth, the piles may be spliced in accordance with Section S6.4.3. Where obstacles to installation exist and the Engineer decides that the obstacles may be removed, the Contractor shall extract the piles, remove the obstacles in an approved manner and reinstall the piles.

The top of the sheet piles shall be trimmed and cut-off to a straight line at the elevation shown on the Drawings or instructed.

## 3. Splicing

Splices may be used if approved by the Engineer. Unless specifically permitted by the Engineer, there shall be no more than two splices per full length of pile and splices shall be staggered such that no splice is located adjacent to another. Splices shall be able to transmit any vertical and lateral forces adequately and, in addition, shall develop not less than 50% of the flexural capacity of the ordinary pile cross section. Splices that are made in the field shall be complete joint penetration groove welds.

## 4. Not Used

## 5. Not Used

## 6. Installation of Piling Beneath Bridges and HV Cables

The Contractor shall be aware of the necessity of installing steel sheet piles beneath existing bridges and HV cables and that work procedures may need to differ from normal methods.

The Contractor shall submit for the Engineer's consideration a description of the proposed method of installation, which shall include details of any changes to these Specifications that may be necessary.

## 7. Inspection of Driven Piling

The Contractor shall inspect the interlocked joints of sheet piling extending above the ground or water level. Piling found to be out of interlock shall be removed and replaced.

**S6.5. NOT USED**

**S6.6. NOT USED**

**S6.7. NOT USED**

**S6.8. NOT USED**

## S6.9. PILE INSTALLATION RECORDS

The Contractor shall provide to the Engineer, at the end of each day on which piling is carried out, a complete record of all piles installed during that day. The record shall include such details as the Engineer may reasonably require.

**S6.10. NOT USED**

## S6.11. MEASUREMENT AND PAYMENT

### 1. Steel Sheet Piles

#### (a) Measurement

Measurement, for payment, of furnishing and installing steel sheet piles will be made of the vertical length of each type of pile installed in the completed work.

#### (b) Payment

Payment will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
6.4/1	Type III <sub>w</sub>	Metre
6.4/5	Type 10H	Metre
6.4/6	Type 10H with flexible joint	Metre
6.4/19	Type 25H	Metre
6.4/20	Type 25H with flexible joint	Metre
6.4/25	Extra-over cost of installing sheet piles beneath bridges and HV cables	Metre

Payment for the installation of sheet piles beneath bridges and HV cables will comprise the basic rate applicable to the type of pile, plus the extra-over rate under BoQ Item No. 6.4/25.

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## **S7. PROTECTION WORKS**

### **S7.1. GENERAL**

The Contractor shall construct the various works for the protection of river banks, dikes, river beds, drainage channel slopes, bridge foundations and other locations as shown on the Drawings or instructed.

Where used in this section of the Specification, "water line" means the level shown on the Drawings or instructed by the Engineer.

Before commencing any protection works, the Contractor shall submit the proposed methods of construction for the different types of protection works for the Engineer's approval.

### **S7.2. STANDARDS**

The Standards referenced in this section of the Specification are:

ASTM A370	Standard test methods and definitions for mechanical testing of steel products
ASTM A641	Zinc-coated (galvanized) carbon steel wire
ASTM A764	Metallic coated carbon steel wire, coated at size and drawn to size for mechanical springs
ASTM A809	Aluminum-coated (aluminized) carbon steel wire
ASTM A856	Zinc-5% aluminum-mischmetal alloy-coated carbon steel wire
ASTM C33	Concrete aggregates
ASTM D1682	Test methods for breaking load and elongation of textile fabrics
ASTM D4355	Deterioration of geotextiles from exposure to light, moisture and heat in a xenon-arc type apparatus
JIS A5371	Precast unreinforced concrete products

### **S7.3. ROCK FILL**

The Contractor shall supply and place rock fill at the locations and to the lines, grades, dimensions, and arrangements shown on the Drawings or instructed.

Rock fill shall consist of hard, durable stone pieces that will not deteriorate when submerged in water or exposed to severe weather conditions.

Rock fill shall consist of the following types:

- Type A: stone pieces shall be generally uniformly graded in sizes ranging from 50 mm to 150 mm.
- Type B: stone pieces shall be generally uniformly graded in sizes ranging from 100 mm to 200 mm.
- Type C: stone pieces shall be generally uniformly graded in sizes ranging from 250 mm to 350 mm.

Rock fill shall be placed on the surface to be protected to the lines, grades and elevations shown on the Drawings or instructed. The rock fill shall be thoroughly rammed into place and the finished surface shall present an even, tight surface. Interstices between stones shall be filled with small broken fragments firmly rammed into place.

**S7.4. NOT USED**

**S7.5. GRAVEL BEDDING AND BACKFILL**

**1. General**

The Contractor shall supply and place gravel bedding and backfill at the locations and to the lines, grades, dimensions, and arrangements shown on the Drawings or instructed.

**2. Materials**

Gravel bedding and backfill shall be well-graded gravel with the grading shown in Table 7-1.

Table 7-1

Sieve size (mm)	Weight Passing (%)
60	100
50	70 – 100
25	60 – 90
5	35 – 75
2	20 – 50
0.4	5 – 25
0.075	1 – 7

**3. Construction**

The gravel shall be placed by hand or equipment and compacted by plate compactor, flat faced tamper or other approved equipment.

The material shall be deposited in layers not more than 150 mm thick after being compacted and during compaction the material shall be wetted thoroughly throughout the entire layer being compacted.

**S7.6. NOT USED**

**S7.7. NOT USED**

**S7.8. GABIONS AND MATTRESSES**

**1. General**

The Contractor shall supply and install gabions and mattresses at the locations and to the lines, grades, dimensions, and arrangements shown on the Drawings or instructed. Unless otherwise shown on the Drawings, gabions and mattresses shall be double-twisted wire mesh Style 1.

**2. Materials**

**(a) General**

Gabions shall be constructed of wire mesh and shall be supplied in various sizes as shown on the Drawings or instructed.

Gabion mattresses shall be divided by diaphragms, spaced at not more than one metre intervals and of the same mesh as the body of the gabions, into cells the length of which does not exceed the horizontal width.

Gabion dimensions shall be within  $\pm 5\%$  of the specified sizes.

Gabions and mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the mattresses' lids which are produced separately from the base. All gabions and mattresses shall be supplied in a collapsed form, either folded and bundled or rolled for shipping.

(b) Wire

The wire shall be double-twisted conforming to the specification for the particular style as shown following:

- Style 1: zinc-coated steel wire conforming to ASTM A641, Class 3 coating, soft temper.
- Style 2: Zn-5Al-MM coated wire conforming to ASTM A856M, Class 3 coating, soft temper.
- Style 3: zinc-coated steel wire conforming to ASTM A641, Class 3 coating, soft temper with an additional PVC coating extruded into the metallic-coated steel wire.
- Style 4: aluminium coated wire conforming to ASTM A809, soft temper.

(c) Lacing Wire and Stiffener

Lacing wire and stiffeners shall be made from wire having the same coating as the particular style of gabion being used.

Fasteners made from zinc-coated steel wire, zinc-5% aluminium-mischmetal alloy coated steel wire and aluminium coated steel shall conform to ASTM A764, Type A, B or C, Table 2 or Table 3.

(d) Dimensions

The minimum size wire to be used in the fabrication of the gabions and mattresses shall be as shown in Table 7-2:

Table 7-2

	Gabion		Mattress	
	Metal coated (mm)	PVC coated (mm)	Metal coated (mm)	PVC coated (mm)
Body wire	3.05	2.70	6.0	6.0
Selvedge or perimeter wire	3.80	3.40	2.70	2.70
Tying or connecting wire	2.20	2.20	2.70	2.20

Diameter tolerance for galvanised wire to be used in the fabrication of gabions and mattresses is  $\pm 0.10$  mm.

The nominal and minimum thicknesses of the PVC coating shall be 0.50 mm and 0.38 mm for gabions and mattresses respectively.

(e) Mechanical Properties

The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with the test methods of ASTM A370 shall be in accordance with the requirements of ASTM A641M (Style 1), ASTM A809 (Style 4), and ASTM A856M (Style 2), for soft temper wire.

(f) Weight of Coating

The minimum weight of zinc per unit area of uncoated wire surface shall be in accordance with ASTM A975 or as shown in Table 7-3.

Table 7-3

Wire Diameter (mm)	Class 3 or A Coating (g/m <sup>2</sup> )
Over 1.90 to 2.30	220
Over 2.30 to 2.70	230
Over 2.70 to 3.10	240
Over 3.10 to 3.50	260
Over 3.50 to 3.90	270

(g) Rock Fill

Rock used in the gabions and mattresses shall consist of hard, durable rock pieces that will not deteriorate when submerged in water or exposed to severe weather conditions. Rock pieces shall be generally uniformly graded in sizes ranging from 100 mm to 200 mm. Filled gabions shall have a minimum density of 1,400 kg/m<sup>3</sup>. Voids shall be evenly distributed.

No rock piece shall exceed two-thirds the mattress depth and at least 85% by weight of the rock fill shall have a size greater than 80 mm. No stones shall be able to pass through the mesh.

The rock shall meet the requirements of ASTM C33, except that the sodium sulphate soundness loss shall not exceed 9% after 5 cycles.

**3. Fabrication**

The wire mesh shall be twisted to form hexagonal openings of uniform sizes. The maximum linear dimension of the mesh opening shall not exceed 100 mm and the area of mesh opening shall not exceed 60 cm<sup>2</sup>. The mesh shall be fabricated in such a manner that it is resistant to pulling apart at any of the twists or connections forming the mesh when a single wire strand in a section is cut.

All connecting edges of the mesh forming the gabion shall be securely selvaged so that the joints, by tying the selvages, have at least the same strength as the body of the mesh.

Selvage wire shall not be less than 3.76 mm in diameter and shall meet the same specifications as for the wire mesh.

Tie and connection wires shall be supplied in sufficient quantity to securely fasten all edges of the gabion. The wire shall meet the same specifications as the wire used in the mesh except that it may be not more than two gauges smaller.

**4. Foundation Preparation**

After excavation or stripping, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above.

Filter fabric consisting of 70% polypropylene and 30% polyethylene and in accordance with Section S7.12 shall be placed on the prepared foundation.



## **5. Assembly and Filling**

Gabions shall be installed in a workmanlike manner. The gabions shall be placed on a smooth foundation. Final line and grade shall be subject to approval by the Engineer.

Each gabion unit shall be assembled by binding together all vertical edges with wire ties at approximately 150 mm spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil every 100 mm. Empty gabion units shall be set to line and grade as shown on the Drawings or instructed. Wire ties or connecting wires shall be used to join the units together. Internal tie wires shall be uniformly spaced and securely fastened in each cell of the structure.

The gabions shall be filled with stone carefully placed by hand or machine in an approved manner to assure alignment and avoid bulges, with a minimum of voids. Stone and connection wires shall be placed alternately until the gabions are filled. After a gabion has been filled, the lid shall be bent until it meets the sides and edges. The lid shall then be secured to the sides and ends with the wire ties or connecting wire.

The vertical joints of gabions and mattresses shall be staggered in a running bond pattern.

### **S7.9. NOT USED**

### **S7.10. PRECAST CONCRETE BLOCK RETAINING WALL**

The Contractor shall manufacture and place precast blocks for retaining walls where shown on the Drawings or instructed.

The blocks shall be manufactured in accordance with JIS A5371.

Half-blocks at ends and joints shall be cast. Cut blocks shall not be used.

The precast blocks shall be laid in a running bond pattern as shown on the Drawings and thoroughly bedded in the filling concrete to provide a uniform surface and solid bedding under each block.

Joints, comprising vertical partition walls and 10 mm thick rubber joint strips, shall be placed at intervals of approximately 15 m.

Rubber joint strips shall be fabricated from a high-grade, tread-type compound. The basic polymer shall be natural rubber or a synthetic rubber.

The rubber joint strips shall be furnished in lengths of not less than 4 m. All rubber joint strips shall be stored in as cool a place as practical, and in no case shall the rubber joint strips be stored in the open or exposed to the direct rays of the sun.

All joints in the rubber joint strips shall be close fitting butt joints, and the location of all such joints shall be subject to the approval of the Engineer.

The variation of the face of the blocks from the slope shown on the Drawings shall not exceed 10 mm in any 3 m.

### **S7.11. GRASS SODDING**

#### **1. General**

The Contractor shall carry out grass sodding where shown on the Drawings or instructed.

The Engineer may instruct the Contractor to carry out topsoiling and grassing measures in successive stages at any time during the execution of the Works when weather conditions are suitable for the establishment of grasses.

## **2. Materials**

Topsoil shall consist of a natural friable surface soil without any undesirable subsoil, refuse or foreign materials. It shall be reasonably free from roots, hard clay, coarse gravel, stones larger than 50 mm in diameter, noxious wood, tall grass, brush, sticks, stubble or other litter and shall be subject to the approval of the Engineer.

Topsoil shall be obtained from approved sources.

Grass sod shall consist of a healthy, dense and well rooted growth of living grass. The grass sod shall be cut into uniform squares approximately 300 mm x 300 mm and shall have a minimum thickness of 50 mm (excluding grass blades). The type of grass shall be subject to the approval of the Engineer.

## **3. Preparation of Areas for Grassing**

The surface shall be roughened to ensure a proper bond between the topsoil and the underlying material. Hardened surfaces shall be broken by ripping or scarifying.

Topsoil shall be placed on the prepared surfaces and be trimmed to the uniform thickness required by means of hand raking or mechanical blading.

The topsoil shall be evenly spread to a depth of at least 100 mm and compacted with a light roller. Spreading shall not be carried out when the surface or the topsoil is excessively wet, or otherwise in an unsatisfactory condition.

After spreading has been completed, large clods, stones, roots, stumps and other loose material shall be raked up and removed. Any erosion, irregularities of grade or other incidental damage to the surface of topsoil prior to the laying of grass sods shall be repaired to the satisfaction of the Engineer.

The areas to be sodded shall be thoroughly watered beforehand so that they are moist to a depth of at least 150 mm when sods are placed. The surface shall be loosened to a depth of approximately 20 mm to allow a good penetration of roots into the topsoil.

## **4. Grassing**

Sods shall be placed within 24 hours of having been harvested and shall be kept moist from the time of harvesting until placed.

The first row of sods shall, where possible, be laid in a straight line and, if on a slope, starting at the bottom of the slope. The sods shall be butted tightly against each other, care being taken not to stretch or overlap sods. Where a good fit cannot be obtained, the intervening space shall be filled with topsoil. Adjacent rows shall be placed with the joints staggered. Each sod shall be lightly rolled or tamped into place.

At points where it is anticipated that water may flow over a sodded area, the highest edge of each sod shall be turned into the soil to be below the adjacent area, and a layer of earth shall be placed over this juncture, and be thoroughly compacted. At the limits of the sodded area, the end strips shall be turned in and treated similarly.

After the sodding has been completed, the surface shall be cleared of loose sod, excess soil, or other foreign material, 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.

All sodded areas shall be adequately watered at intervals sufficient to ensure proper growth until the grass has established an acceptable cover, and thereafter as required to sustain growth.

The Contractor shall mow the grass on all areas that have been grassed wherever necessary such that the maximum height of the grass is 75 mm.

Weeds shall be controlled.

Any bare patches where the grass has not grown, or where it has been damaged, shall be re-sodded to achieve the specified result.

The Contractor shall maintain the grassed areas for a period of 12 months or until the issue of the Taking-Over Certificate, whichever is the later.

### **S7.12. FILTER FABRIC**

The Contractor shall furnish and place filter fabric of an approved type and from an approved manufacturer, beneath rip-rap, gabions, revetment structures and elsewhere as shown on the Drawings or instructed.

The filter fabric shall:

- be a welded non-woven material;
- be resistant to chemical and biological degradation from all naturally occurring minerals and bacteria;
- be permeable and capable of passing 40 litres/m<sup>2</sup>/s at 100 mm head of water with a uniform pore size distribution from 0.02 to 0.15 mm;
- have a minimum tensile strength of 1.7 kN/200 mm and a minimum grab tensile strength of 0.85 kN when tested in accordance with ASTM Standard D1682 with a 200 mm sample width;
- be treated with ultraviolet ray (UV) protection. The UV treated fabric shall provide a minimum of 70% breaking strength retention after 500 hours exposure when tested in conformance with the requirements in ASTM D4355.

Materials placed on top of the fabric shall be placed in such a way that no damage to, or movement of, the fabric sufficient to leave the foundation unprotected takes place.

The filter fabric shall be laid on a prepared foundation or in a prepared trench and shall be overlapped at joints by not less than 0.5 m and shall be laid strictly in accordance with the recommendations of the manufacturer.

### **S7.13. NOT USED**

### **S7.14. NOT USED**

### **S7.15. PROTECTION OF EXISTING BRIDGE FOUNDATIONS**

#### **1. General**

Where shown on the Drawings or instructed, the Contractor shall carry out work to protect existing bridge foundations in sections of the river where dredging has been carried out.

The protection work shall consist of the placing of rock-filled, double-layered Raschel nets fabricated from recycled polyester material ("bottle units").

The protection work shall be carried out immediately after the dredging in the vicinity of each affected structure has been completed.

## **2. Materials**

The bottle units shall be approximately 1,600 mm in diameter, 480 mm in height, and 320 mm in circumferential height.

Rock used for filling the bottle units shall be Type A rockfill in accordance with Section S7.3.

## **3. Trial Section**

At the first structure to be protected, the Contractor shall construct a trial section to demonstrate the adequacy of proposed working methods.

The demonstration section shall be one complete bridge pier.

Within 7 days after completion of the trial section, the Engineer shall determine the adequacy of the section to function as part of the Permanent Works. The Contractor shall be notified as to the acceptability of the section and may be instructed to modify methods of construction and remove the section if necessary.

## **4. Placement Control**

The Contractor shall be responsible for the accuracy of placement of the protection work, and the means by which the Contractor positions the plant, equipment, and supply barges must function accurately and consistently.

## **5. Survey**

Prior to commencing placing of the protection works, the Contractor shall survey the area to establish the post-dredging profile of the riverbed. The Contractor shall take cross sections on lines at 3 m intervals, measured along the outer perimeter of the area to be protected.

The Contractor shall also carry out check surveys as the work progresses to determine the lines, grades and thicknesses of the completed work. The check surveys shall be done along the same lines as the initial survey.

The surveys shall be conducted in the presence of the Engineer.

## **S7.16. MEASUREMENT AND PAYMENT**

### **1. Gravel Bedding and Backfill**

#### **(a) Measurement**

Measurement, for payment, of gravel bedding and backfill will be made of the compacted volume of gravel bedding placed in accordance with the Drawings or as instructed.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
7.5/1	Gravel bedding and backfill	Cubic metre

**2. Gabions**

## (a) Measurement

Measurement, for payment, of gabions will be made of the volume of gabions placed in accordance with the Drawings or as instructed.

Rock fill placed in the gabions will not be measured separately.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
7.8/1	Gabion mattresses	Cubic metre

**3. Precast Concrete Block Retaining Wall**

## (a) Measurement

Measurement, for payment, of the precast concrete retaining wall will be made of the area constructed in accordance with the Drawings or instructed.

Filling concrete is considered a part of the retaining wall and will not be measured separately for payment.

Backfill gravel, backfill concrete, base concrete and partition wall concrete will be measured separately.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
7.10/1	Precast concrete block retaining wall	Square metre

**4. Grass Sodding**

## (a) Measurement

Measurement, for payment, of grass sodding will be made of the area covered with grass sod, as instructed.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
7.11/1	Grass sodding	Square metre

**5. Protection of Existing Bridge Foundations**

## (a) Measurement

Measurement, for payment, of protection of existing bridge foundations will be made of the volume of protection material placed in accordance with the Drawings or as instructed.

## (b) Payment

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
7.15/1	Protection of existing bridge foundations	Cubic metre

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## **S8. DRAINAGE**

### **S8.1. GENERAL**

The Contractor shall construct surface drains, sub-surface drains, culverts and other drainage structures as shown on the Drawings or instructed.

Prior to commencing any drainage work, the Contractor shall submit a proposed program of works and methodology of construction to the Engineer for approval. The Contractor shall take into account the preservation of existing property and the inconvenience the work may cause to the general public. No work shall be started until the approval of the Engineer has been given.

### **S8.2. STANDARDS**

The Standards referenced in this section of the Specification are:

AASHTO M6	Fine aggregate for Portland cement concrete
AASHTO M86	Concrete sewer, storm drain, and culvert pipe
AASHTO M170	Reinforced concrete sewer, storm drain and culvert pipe
JIS A5083	Aluminium and aluminium alloy sheets and plates, strips and coiled sheets

### **S8.3. DRAINAGE DITCH (U-DITCH)**

#### **1. General**

The Contractor shall construct concrete surface drainage ditches (U-ditches) as shown on the Drawings or instructed.

As part of the As-Staked Drawings required under Section S1 [*Preliminary and General*] of these Specifications, the Contractor shall prepare, and submit to the Engineer for approval, detailed longitudinal profiles of the drainage ditches.

A minimum U-ditch size is 300mm x 300mm.

The ditches shall be connected to outlet structures such as manholes or junction boxes. Regarding the U-ditch which is 300mm x 300mm in size, minimum slope should be 0.5%.

#### **2. Construction**

The drainage ditches shall be constructed true to line, grade and cross-section.

Care shall be exercised to avoid excavation below the required grade lines and any over-excavation shall be backfilled with approved suitable material.

Concrete shall be Class C in accordance with Section S5 [*Concrete*] of these Specifications.

The exposed surfaces shall have a Class 1 surface finish.

### **S8.4. PRECAST CONCRETE PIPE CULVERTS**

#### **1. General**

The Contractor shall supply and install concrete pipe culverts in the locations and to the lines, grades and dimensions shown on the Drawings or instructed.



Unless otherwise shown on the Drawings or instructed, the pipes shall be Class II, Wall B.

Reinforced concrete pipes shall be precast and manufactured in accordance with the requirements of AASHTO M170.

Unreinforced concrete pipes shall be precast and manufactured in accordance with the requirements of AASHTO M86.

Concrete materials including reinforcing steel shall be in accordance with Section S5 [*Concrete*] of these Specifications.

Where necessary, the Contractor shall remove and/or relocate existing objects and structures necessary for the construction of new culverts.

The Engineer reserves the right to inspect and test any pipe proposed for the Works. Defects that are discovered after acceptance of delivery of the pipe but before installation shall be a cause for rejection without additional cost to the Employer.

## **2. Installation**

All pipes shall be laid in trenches in solid ground or, where approved, in drainage depressions. Compressible and other unsatisfactory material on the bottom of the trenches shall be removed as instructed before laying the pipes.

Unless otherwise shown on the Drawings, concrete pipes shall be bedded on a concrete cradle accurately shaped and rounded to conform to the outside portion of the pipe for the entire length of the pipe.

Pipe laying shall generally commence at the downstream end. The pipes shall be carefully laid, with the spigot ends pointing downstream, true to the lines and grades required.

Joints shall be as shown on the Drawings. Mortar for the joints shall comprise two parts of clean fine sand to one part of cement.

After the pipes have been bedded, laid and jointed, backfill shall be placed about the pipes and compacted in accordance with Section S4 [*Excavation and Earthworks*] of these Specifications.

### **S8.5. REINFORCED CONCRETE BOX CULVERTS**

The Contractor shall construct reinforced concrete box culverts in the locations and to the lines, grades and dimensions shown on the Drawings or instructed.

Concrete materials including reinforcing steel shall be in accordance with Section S5 [*Concrete*] of these Specifications. Concrete shall be Class A.

Where necessary, the Contractor shall remove and/or relocate existing objects and structures necessary for the construction of new box culverts.

As an alternative to the construction of in-situ concrete box culverts, the Contractor may propose to use precast concrete box culverts. The use of precast box culverts shall be subject to the approval of the Engineer and the Contractor shall submit design details, drawings and specifications for consideration. Precast box culverts shall be designed and manufactured in accordance with the requirements of AASHTO M259.

Excavation and preparation of foundations shall be carried out in accordance with the provisions of Section S4 [*Excavation and Earthworks*] of these Specifications.

## **S8.6. FLAP GATES**

### **1. General**

The Contractor shall design, supply and install rectangular aluminium-magnesium alloy flap gates complete with seals and all necessary associated embedded components where and as shown on the Drawings or instructed.

The flap gates shall be obtained from an approved manufacturer, and the Contractor shall submit full drawings and details of the proposed flap gate to the Engineer for approval at least 28 days before commencing installation of any flap gate.

The flap gates shall have the following features:

- dual hinge arms, each with dual pivot points;
- stops to prevent the flap overturning;
- distance between hinge arms approximately equal to clear opening width;
- chloroprene seals of durometer hardness 50-70;
- SUS304 stainless steel hinge pins in double shear;
- JIS A5083 grade aluminium frame and cover.

The design closing head shall be 3.5 m.

### **2. Installation**

The gate shall be anchored to the sluice structure wall with stainless steel anchor bolts.

The Contractor shall ensure that the anchor holes are accurately located and shall check the hole spacing by “dry fitting” the gate frame before attempting to mount the gate body on the wall.

Once the flap gate body is mounted on the bolts, it shall be adjusted to a flat level plane, nuts tightened and backfill grout placed in the blockouts.

### **3. Tests after Installation**

After installation, the Contractor shall carry out the following tests on all flap gates:

- inspection by feeler gauge measurement of all sealing faces;
- inspection of satisfactory installation of all clamping elements;
- measurement of the clamping torque;
- check of satisfactory operation under dry condition;
- check of satisfactory release of water under the attainable land-side and river water level; and
- check of water leakage from the closed valve under an acceptable river water level.

Following rectification of any defects or following identification of improper operation, the complete set of tests shall be repeated to the satisfaction of the Engineer.

## **S8.7. CAST IN-SITU MANHOLES, JUNCTION BOXES AND OUTLETS**

Cast in-situ manholes, junction boxes and outlets shall be constructed as and where shown on the Drawings or instructed.

Concrete shall be Class A in accordance with Section S5 [*Concrete*] of these Specifications.

Where necessary, the Contractor shall remove and/or relocate existing objects and structures necessary for the construction of new drainage structures.

The inlet and outlet pipes shall be cast into the structure walls but shall not protrude into the structure by more than 150 mm. Where necessary the pipes shall be bevelled to suit the entrance and exit angles.

Where structures are deeper than 1 m, corrosion-resistant steel step irons shall be cast into the walls at 300 mm vertical intervals.

The structures shall be fitted with precast concrete manhole covers as shown on the Drawings. Precast concrete shall be Class C in accordance with Section S5 [*Concrete*] of these Specifications. The covers shall be furnished complete with any special tools required for removal.

### **S8.8. DRAINS IN WALLS**

Drain holes and weep holes shall be constructed in abutment walls, wingwalls, retaining walls and elsewhere as shown on the Drawings or instructed.

Unless otherwise specified or shown on the Drawings or instructed, the drains shall be placed at the lowest points where free outlet of water can be obtained and shall be spaced not more than 3 m center to center.

Unless otherwise shown on the Drawings, the weepholes shall be formed with a 50 mm diameter PVC pipe.

Retaining wall and abutment wall drains shall be covered at the back face of the wall with hardware cloth. The hardware cloth shall be a commercial quality, approximately 6 mm mesh wire cloth of aluminium or of galvanized steel wire. The aluminium wire, and steel wire before galvanizing, shall have a minimum diameter of 600  $\mu\text{m}$ . Hardware cloth shall be mounted in the forms prior to placing concrete in such a manner that the wire is firmly bonded to the concrete or may be fastened to the exterior of the concrete surface by masonry nails or other methods approved by the Engineer.

A minimum of 0.05 m<sup>3</sup> of filter material, uniformly graded from 75 mm to 3 mm and encapsulated with geotextile filter fabric shall be placed at each drain hole.

Filter material shall be permeable and shall meet the requirements of AASHTO M6, except that the soundness test will not be required and minor variation in grading may be approved by the Engineer.

### **S8.9. NOT USED**

### **S8.10. NOT USED**

### **S8.11. MEASUREMENT AND PAYMENT**

#### **1. Drainage Ditches (U-Ditches)**

Measurement, for payment, of concrete and reinforcement in drainage ditches will be made in accordance with Section S5 [*Concrete*] of these Specifications.

Excavation, bedding and backfill will be measured separately in accordance with Section S4 [*Excavation and Earthworks*] of these Specifications.

## 2. Concrete Pipe Culverts

### (a) Measurement

Measurement, for payment, of concrete pipes will be made of the length of pipes of each particular diameter and class complete in place in accordance with Drawings or as instructed.

Pipes shall be measured from end to end along the centerline. Where two or more pipes are placed on a mutual bedding, each pipe shall be separately measured.

Excavation, bedding, backfill and concrete in wingwalls/headwalls will be measured separately in accordance with Section S4 [*Excavation and Earthworks*] or Section S5 [*Concrete*] of these Specifications, as applicable.

### (b) Payment

Payment will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
8.4/6	Reinforced concrete pipe – 910 mm dia.	Lineal metre
8.4/7	Reinforced concrete pipe – 1070 mm dia.	Lineal metre

Separate payment will not be made for the removal and/or relocation of objects and structures necessary for the construction of new culverts.

## 3. Reinforced Concrete Box Culverts

Measurement, for payment, of concrete and reinforcement in reinforced concrete box culverts will be made in accordance with Section S5 [*Concrete*] of these Specifications.

Excavation, bedding and backfill will be measured separately in accordance with Section S4 [*Excavation and Earthworks*] of these Specifications.

Separate payment will not be made for the removal and/or relocation of objects and structures necessary for the construction of new box culverts.

## 4. Flap Gates

### (a) Measurement

Measurement, for payment, of flap gates will be made of the number of each particular size complete in place in accordance with Drawings or as instructed.

### (b) Payment

Payment will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
8.6/3	Rectangular aluminium flap gate 1000 x 1000	Number
8.6/4	Rectangular aluminium flap gate 1200 x 1200	Number
8.6/5	Rectangular aluminium flap gate 1400 x 1400	Number
8.6/6	Rectangular aluminium flap gate 1500 x 1500	Number

8.6/7	Rectangular aluminium flap gate 1600 x 1600	Number
8.6/8	Rectangular aluminium flap gate 2000 x 1600	Number

## **5. Cast In-situ Manholes, Junction Boxes and Outlets**

Measurement, for payment, of excavation for manholes, junction boxes and outlets will be made in accordance with Section S4 [*Excavation and Earthworks*] of these Specifications.

Measurement, for payment, of concrete and reinforcement in manholes, junction boxes and outlets will be made in accordance with Section S5 [*Concrete*] of these Specifications.

Separate payment will not be made for the removal and/or relocation of objects and structures necessary for the construction of new drainage structures.

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## **S9. ROADWORKS**

### **S9.1. GENERAL**

The Contractor shall construct roadworks including embankment, subgrade, base course and bituminous concrete surfacing to the lines and grades shown on the Drawings or instructed.

### **S9.2. REFERENCES**

The Standards referenced in this section of the Specification are:

AASHTO T27	Sieve analysis of fine and coarse aggregates
AASHTO T90	Determining the plastic limit and plasticity of soils
AASHTO T96	Resistance to abrasion of small size coarse aggregate by use of the Los Angeles machine
AASHTO T99	Moisture density relations of soils using a 2.5 kg rammer and 305 mm drop
AASHTO T104	Test for soundness of aggregate by use of sodium sulfate or magnesium sulfate
AASHTO T180	Moisture-density relations of soils using a 4.5 kg rammer and an 457 mm drop
AASHTO T191	Density of soil in place by the sand-cone method
AASHTO T193	The California Bearing Ratio

### **S9.3. SUBGRADE**

#### **1. General**

Unless otherwise specified, all materials to a depth of 150 mm below subgrade level shall have such gradation that all particles will pass a 75 mm sieve and not more than 15% will pass a 0.075 mm sieve. The material shall have a plasticity index of not more than 6 and a liquid limit of not more than 30.

#### **2. Preceding Works**

Prior to commencing preparation of the subgrade, all culverts, cross drains (including their fully compacted backfill), ditches, drains and drainage outlets shall be completed before commencing the preparation of subgrade.

#### **3. Subgrade in Cut**

Unless otherwise specified, all materials below subgrade level in earth cuttings to a depth of 150 mm, or other depth shown on the Drawings, or as instructed by the Engineer shall be excavated. The materials, if suitable, shall be stockpiled for future use. Unsuitable subgrade materials shall be excavated and replaced with suitable materials.

Where material has been removed from below subgrade level, the base of the resulting cutting shall be compacted to a depth of 150 mm to attain a uniform density of not less than 95% of the maximum density as determined by AASHTO T99. Field density tests shall be carried out in accordance with AASHTO T191 or other approved method, for every 500 m<sup>2</sup> of subgrade preparation completed.

#### **4. Subgrade on Embankment**

After the embankment has been completed, the full width shall be conditioned by removing any soft or other unsuitable material that cannot be compacted properly. The resulting areas and all other low sections, holes, or depressions shall be brought to grade with suitable materials. The entire roadbed shall

then be shaped and compacted in accordance with Section S9.3.3. Scarifying, blading, dragging, rolling, or other approved methods shall be performed as necessary to provide a thoroughly compacted roadbed to the cross section shown on the Drawings.

#### **5. Subgrade on Existing Pavement**

Where the new pavement is to be constructed immediately after removal of an existing portland cement concrete pavement and if so shown on the Drawings or instructed, the slab shall be broken into pieces not larger than 500 mm and the existing pavement material recompacted as specified in S9.3.3 or disposed of as instructed by the Engineer. The resulting subgrade level shall, as part of pavement construction, be shaped to conform to the specified tolerances by placing and compacting where necessary a levelling course comprising of materials of the pavement course to be placed immediately above.

Where the new pavement is to be constructed immediately over an existing asphalt concrete pavement or gravel surfaced pavement and if so shown on the Drawings or instructed, the pavement shall be broken-up, scarified, thoroughly loosened, reshaped and recompacted in accordance with Section S9.3.3. The resulting subgrade level shall conform to the specified tolerances.

#### **6. Protection of Completed Works**

Any part of the subgrade that has been completed shall be protected and damage resulting from negligence on the part of the Contractor shall be repaired as instructed by the Engineer without additional payment.

The Contractor shall be responsible for all the consequences of traffic being permitted to use the subgrade and shall repair any ruts or ridges caused by traffic.

The amount of subgrade preparation shall be limited to an area that can be maintained with the equipment available, and work shall be programmed so that subgrade preparation and sub-base or base placing follow each other closely.

#### **7. Tolerances**

The finished compacted surface of the subgrade shall conform to the following tolerances:

- variation from design level of surface +20 mm, -30 mm;
- surface irregularity measured by 3 m straightedge 30 mm;
- variation from design crossfall or camber +0.5%;
- variation from design longitudinal grade over 25 m length +0.1%.

#### **S9.4. NOT USED**

#### **S9.5. NOT USED**

#### **S9.6. BASE COURSE**

##### **1. General**

The Contractor shall furnish, place and compact an aggregate base course on the prepared subgrade to the lines, grades, thickness and typical cross-sections shown on the Drawings, or as instructed by the Engineer



**2. Materials**

Base course aggregate shall consist of hard durable crushed rock particles that satisfy the grading limits in Table 9-1. The portion that passes the 0.075 mm sieve shall not be more than two-thirds of that portion passing the 0.425 mm sieve.

Table 9-1

Sieve size (mm)	% passing	
	A	B
37.5	100	
25		100
19	60 – 85	
12.5		60 – 90
4.75	30 – 55	35 – 65
0.425	8 – 25	10 – 30
0.075	2 - 14	5 –15

The coarse aggregate, defined as the material retained on the 4.75 mm sieve, shall have a percentage of wear not greater than 45%, when tested according to AASHTO T96 for 500 revolutions, and at least 50% of the particles shall have at least one fractured face.

The portion of the total mixture passing the 0.425 mm sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6.

The CBR of the material passing a 19 mm sieve shall be no less than 80 after 4 days soaking, on samples compacted to 95% of the maximum dry density as determined by AASHTO T180 and over a moisture range of 4%.

When subjected to 5 cycles of the sodium sulphate soundness test, the weighted loss shall not exceed 12%.

If filler, in addition to that naturally present, is necessary for meeting the grading requirements or for satisfactory bonding, it shall be uniformly blended with the crushed base course material in a pugmill unless otherwise approved. Filler shall be obtained from approved sources and shall be free from hard lumps and shall not contain more than 15% of material retained on a 4.75 mm sieve.

**3. Spreading**

Base material shall be spread on the prepared subgrade or sub-base, as applicable, and compacted to the thickness shown on the Drawings or instructed.

When hauling is done over previously placed material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimize rutting or uneven compaction.

Base layers up to 150 mm compacted thickness may be placed in one layer. Specified compacted thicknesses greater than 150 mm shall be constructed in two (or more, as required) layers of approximately equal thickness.

**4. Compacting and Finishing**

Immediately after each layer has been spread and shaped satisfactorily, each layer shall be thoroughly compacted with suitable compaction equipment.

Compaction shall commence along the edges and overlap the shoulder at least 750 mm, or as close to the outer edge of the shoulder as practicable where a full width roadbed base course is shown on the Drawings, and progress toward the centre, gradually in a longitudinal direction. On super-elevated curves,

compaction shall commence at the low side and progress toward the high side. The compaction operation shall continue until all roller marks are eliminated, and the whole layer is thoroughly compacted.

Each layer shall be compacted to at least 98% of the maximum dry density as determined by AASHTO T180. During compaction the moisture content shall be controlled so that moisture content uniformly throughout the finished layer is within the limits of  $\pm 2\%$  of the optimum moisture content, or such other moisture content as shall be agreed with the Engineer as a result of compaction trials.

Base course material containing excess moisture shall be dried using approved methods prior to or during compaction.

Any irregularities that develop in the surface during or after construction shall be corrected by removing or loosening the surface, adding further material as required and re-compacting.

The final shaping and rolling of the shoulders to the full width shall be carried out after the base course is completed.

At the end of each day's work, a construction joint shall be made in thoroughly compacted material. This joint shall be constructed normal to the centreline of the road alignment and with a vertical face. Additional material shall not be placed until the construction joint has been approved by the Engineer.

**5. Tolerances**

Base course shall be placed and compacted to the following tolerances:

- variation from thickness of layer ±10 mm;
- variation from design level of surface +5 mm, -10 mm;
- surface irregularity measured by 3 m straightedge 5 mm;
- variation from design crossfall or camber +0.2%;
- variation from design longitudinal grade over 25 m length +0.1%.

**6. Testing**

The Contractor shall carry out testing as shown in Table 9-2.

Table 9-2

Testing Requirements for Base Course		
Test	Designation	Sampling and Testing Frequency
Gradation	AASHTO T27	3 per source plus 1 per 1,000 m <sup>3</sup>
Plasticity Index	AASHTO T90	3 per source plus as required based on visual observation
CBR	AASHTO T180 and T193	3 per source plus as required based on variation in gradation
Abrasion	AASHTO T96	3 per source plus 1 per 500 m <sup>3</sup>
Sodium Sulfate Soundness	AASHTO T104	3 per source plus 1 per 500 m <sup>3</sup>
Fractured faces	Visual	3 per source plus as required based on visual observation
Moisture Density	AASHTO T180	1 per 1,000 m
Field Density	AASHTO T191	5 per layer per 2,000 m <sup>2</sup> laid. Min. 3 per layer if less than 2,000 m <sup>2</sup> laid

For compaction to be considered acceptable, 4 of the last 5 densities measured shall be equal to or greater than the specified level of compaction, and all 5 shall be greater than the required density minus 3%, and the average of all 5 shall be not less than the required value.

**S9.7. NOT USED****S9.8. BITUMINOUS CONCRETE SURFACE COURSE**

The Contractor shall supply and lay a bituminous concrete surface course, with a thickness of 50 mm.

The bituminous concrete shall be produced and placed in accordance with the latest edition of the DPWH Standard Specifications.

**S9.9. MEASUREMENT AND PAYMENT****1. Base Course****(a) Measurement**

Measurement, for payment, of base course will be made of the volume in place compacted to the lines, grades and dimensions shown on the Drawings and accepted by the Engineer.

Measurements will be based on the cross section of the base course shown on the Drawings and actual length measured horizontally along the centreline of the surface of the road.

Materials placed outside the specified tolerances will not be measured.

**(b) Payment**

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
9.6/1	Base course	Cubic metre

**2. Bituminous Concrete Surface Course****(a) Measurement**

Measurement, for payment, of bituminous concrete surface course will be made of the area in place compacted to the lines, grades and dimensions shown on the Drawings and accepted by the Engineer.

**(b) Payment**

Payment will be made at the rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
9.8/1	Bituminous concrete surface course	Square metre

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## S11. STRUCTURAL AND MISCELLANEOUS METALWORK

### S11.1. GENERAL

The Contractor shall supply and install structural and miscellaneous metalwork where shown on the Drawings or instructed.

Connections for which details are not shown on the Drawings shall be designed by the Contractor and shall be welded or bolted, unless otherwise specified.

The Contractor shall provide all materials and parts necessary to complete each item, even though such work may not be shown on the Drawings or included in these Specifications.

Except as otherwise provided in these Specifications, the design, fabrication, welding and erection of structural steel shall be carried out in accordance with the provisions of the Architectural Institute of Japan (AIJ) publications "*Standard for Design of Steel Structures*" and "*Technical Recommendations for Steel Construction for Buildings*", Parts 1 and 2.

Welding shall be in accordance with the relevant provisions of the American Welding Society (AWS) Specifications.

### S11.2. STANDARDS

The Standards referenced in this section of the Specification are:

JIS A5526	Steel H piles
JIS B1180	Hexagonal bolts
JIS B1186	High strength hexagon steel bolts, hexagon nuts and washers for friction grip joints
JIS G3101	Rolled steels for general structures
JIS G3106	Rolled steels for welded structures
ASTM A501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
AWS D1.1	Structural welding code - steel

### S11.3. MATERIALS

#### 1. General

Materials shall comply with the Standards listed in Table 11-1.

Table 11-1

Item	Standard
Structural steel	JIS G3101, G3106
Steel H piles	JIS A5526
Carbon steel bolts and nuts	JIS B1180
High strength bolts	JIS B1186

#### 2. Threaded Fasteners

All threaded fasteners shall comply with the ISO metric system, normal series, coarse pitch.

#### 3. Embedded Metalwork

Metalwork to be embedded in concrete shall be embedded when the concrete is being placed or, if shown on the Drawings or instructed, recesses or blockouts shall be made in the concrete and the metalwork

shall be grouted in place or embedded in second-stage concrete. The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned immediately before the grout or concrete is placed. Metalwork shall be accurately positioned and aligned in accordance with the specified tolerances 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 comparatively light metalwork, when the concrete is placed, holes shall be drilled in the concrete after it has set thoroughly and approved expansion or chemical anchors shall be installed.

#### **4. Protective Coating**

All metalwork shall be cleaned and coated in accordance with Section S13 [*Corrosion Protection and Painting*] of these Specifications.

#### **5. Checkout Sheet**

At least seven days prior to the placement of concrete in any structure or the installation of any metalwork, the Contractor shall furnish to the Engineer three copies of a checkout sheet detailing all items of metalwork to be installed including unit weights for materials to be furnished and installed under this Section. When instructed, the Contractor shall furnish receipted invoices detailing the mass of any item that has been furnished and installed.

### **S11.4. WELDING**

#### **1. General**

The Contractor shall develop and submit a welding procedure for the approval of the Engineer.

Weld sizes and types shall be shown on all Contractor's drawings where welding is employed.

Unless otherwise specifically stated, welded parts requiring machine finishing shall be completely welded before being finished.

All welds shall be made continuous and watertight. The minimum throat dimension of fillet welds shall be 4.5 mm.

#### **2. Standards**

All welding shall be carried out by an electric arc method and, wherever possible, automatic or manually guided machine welding shall be used for both shop fabrication and field erection.

All welding shall comply with AWS D1.1.

#### **3. Qualification of Welders and Welding Procedures**

Welders and welding procedures shall be qualified in accordance with AWS D1.1.

Weld procedure and welder qualification tests shall be carried out under conditions identical to the production conditions, including preheat, electrode treatment, interpass temperature, degree of restraint and stress relief.

Procedures shall be developed for welding all metals included in the Works. The Contractor shall not commence any welding until procedures and welders have been qualified and approved by the Engineer.

#### **4. Welding Material**

The Contractor shall only use welding electrodes, welding wire and fluxes capable of producing satisfactory welds when used by a qualified welder.

Stainless type weld metal, where used in the water passages for protection against pitting, shall be of chromium nickel steel. The type and chemical composition of welding rods for this purpose shall be subject to the approval of the Engineer.

#### **5. Inspection and Testing**

Radiographic, ultrasonic, magnetic particle or liquid penetrant tests shall be conducted on components as specified below. Where ultrasonic or magnetic particle tests indicate the possibility of flaws, the suspect part shall be tested by radiography. All radiographs shall become the property of the Engineer.

The acceptability of parts inspected by magnetic particle and liquid penetrant tests and the acceptability of use of these methods will be as determined by the Engineer.

Radiographic examination shall be made of butt welds in plates forming stressed members.

Ultrasonic examination shall be made of all other stressed groove welds.

Welds that shall be tested by magnetic particle method include the following:

- butt welds in pipes 20% of length of each weld;
- fillet welds (where not otherwise tested) 20% of length.

#### **6. Correction of Defective Welds**

In lieu of the rejection of an entire piece or member containing welding which is unsatisfactory or which indicates inferior workmanship, corrective measures may be approved by the Engineer.

The Contractor shall seek the specific approval of the Engineer for making each correction.

If the workmanship is not satisfactory to the Engineer, the welding shall be chipped out to sound metal, tested and repair welded.

After correction of the defects, the weld shall be re-examined by the original method.

#### **S11.5. FABRICATION**

The Contractor shall fabricate structural metalwork in the shop to the greatest extent possible.

Bolted or welded connections shall be provided, whether fabricated in the shop or the field, as shown on the Drawings or as approved. High strength threaded fasteners for all bolted connections shall be used unless otherwise shown on the Drawings or approved by the Engineer.

Bolt holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning.

Allowance shall be made for all draw-in tension bracing.

All sharp edges and corners shall be ground to a minimum radius of 1 mm and all sharp irregularities, burrs, slag and spatters on welds shall be removed.

Bearing plates shall be provided under beams resting on concrete walls. Contact surfaces between bases of bearing plates and columns or other elements bearing directly upon such plates shall be ground or milled as necessary for full effective bearing. Edges for welding shall likewise be properly prepared.

An inspection shall be made to determine that the fabrication and the matching of the component parts are correct.

Jigs shall be used for the assembly of units as much as possible to maintain the appropriate position of the various components.

Approval of the Engineer shall be required when drilling temporary bolt holes or welding temporary supports to the assembled structure. Tolerances shall not exceed those specified and each unit assembled shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part.

In order to maintain accurate finished dimensions and shape, appropriate reverse strain or restraint shall be provided as required.

Assembly and disassembly shall be performed in the presence of the Engineer, unless waived in writing by the Engineer. The Contractor shall immediately remedy any errors or defects found.

Before disassembly for shipment, each piece of the structure shall be match-marked to facilitate erection in the field.

## **S11.6. ERECTION**

### **1. General**

The Contractor shall furnish all necessary equipment and shall erect the structural metalwork in a workmanlike manner.

Not less than 28 days before starting the work of erection, the Contractor shall submit drawings showing the method of erection proposed and the amount and type of equipment to be used. Steel that has been galvanised shall not be welded. When the galvanising has been damaged, the area affected shall be cleaned and coated with zinc rich paint. Proper allowance shall be made to compensate for shrinkage of field welds so that the structure will not be unduly stressed or correct alignment affected.

### **2. Storage of Materials**

Structural metalwork members to be stored shall be placed on blocks so that no part of the members will touch the ground or be over-stressed and shall be kept clean and properly drained. Columns and chords shall be supported on blocks spaced so as to prevent damage from deflection.

### **3. Anchor Bolts**

Embedded anchor bolts shall be positioned with a template before the concrete is placed and the Contractor shall ensure that the anchor bolts are maintained in the correct position during the placing of concrete.

### **4. Erection**

Temporary bracing or stiffening devices shall be used as necessary to accommodate handling stresses in individual members or assemblies during transport, erection operations or other work. Temporary bracing or stiffening devices shall be maintained in place until permanent connections are completed.



Each structural element shall be accurately assembled as shown on the erection drawings and any match-marks shall be followed.

Hammering that will injure or distort the members will not be permitted. The members shall not be over-stressed during the process of erection. Any error in the work that prevents proper assembling and fitting of parts shall be reported immediately to the Engineer, and his approval of the proposed method of correction obtained.

Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins before tightening the balance of high strength bolts. Fitting-up bolts may be the same high strength bolts used in the installation. If other fitting-up bolts are used, they shall be of the same nominal diameter as the high strength bolts, and cylindrical erection pins shall be 0.7 mm larger.

Bolts shall be installed accurately into the holes without damaging the thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where self-locking nuts are not furnished, bolt threads shall be burred and spot-welded so that the nuts cannot become loosened.

Pilot and driving nuts shall be used in driving pins.

No permanent bolting or welding shall be carried out until the alignment of all parts is within the specified tolerances.

Any shop paint on surfaces adjacent to joints where field welding is to be executed shall be wire brushed to remove paint/primer. Field welding shall be carried out in accordance with Sub-Section S11.4.

## **5. Correction of Errors**

Correction of minor misfits by the use of drift pins, and reaming, chipping or cutting will be permitted.

Any errors to be corrected or adjusted, preventing proper assembly, shall be immediately reported to the Engineer, and such corrections or adjustment shall be made as approved.

Cutting or alterations other than as approved will not be permitted.

## **S11.7. ANCHORAGES TO CONCRETE, BRICKWORK AND BLOCKWORK**

### **1. General**

The Contractor shall furnish and install anchor bolts where shown on the Drawings or instructed.

Anchor bolts shall be furnished complete with nuts, standard washers and turnbuckles if required.

Mild steel and high strength anchor bolts shall be galvanised.

Anchor bolts to be embedded in concrete shall be positioned with a template before the concrete is placed and the Contractor shall ensure that the anchor bolts are maintained in the correct position to the specified tolerances during the placing of concrete.

### **2. Anchor Bolts and Ferrules**

Wherever practicable, cast-in anchor bolts shall be used for the fixing of structural steelwork, major steel fabrications, plant and equipment. Cast-in ferrules are an acceptable alternative.

Anchor bolts and ferrules shall be stainless steel, ordinary carbon steel or high strength steel as shown on the Drawings. All ferrous products shall be hot-dip galvanised unless the manufacturer certifies that this will result in any loss of desirable properties and otherwise shall be electroplated with zinc. All anchor bolts and ferrules for exterior use shall be stainless steel.

Galvanised or electroplated anchor bolts shall be wrapped with 1 mm thickness of corrosion resistant tape extending 20 mm above and below the concrete surface.

Ferrules shall be of the cross-bar type lapped to or extending below the concrete reinforcement.

Anchor bolts and ferrules shall be supplied with all nuts, bolts, screws, washers and turnbuckles.

### **3. Chemical and Expansion Anchors**

Where it is impracticable to embed anchor bolts or anchors before concrete is placed, and when it is necessary to anchor parts where inserts or anchor bolts have not been provided, holes shall be drilled in the concrete and chemical or expansion anchors shall be installed as approved. All holes for chemical or expansion anchors shall be straight and true to the diameter recommended by the manufacturer of the anchors. The Contractor shall use diamond bits to achieve true holes such that anchors fit securely.

Studs for chemical anchors shall be stainless steel.

Where the length of bolt is not indicated, the bolt length shall provide a 90 mm minimum embedment.

Expansion anchors holding components of structural or safety importance shall be cast or forged into the cone-and-shell or wedge-and-shell configuration.

### **4. Light Duty Anchors**

Light duty anchors will be permitted only for the installation of minor equipment, building furniture, saddle clips for small diameter pipes and other like applications where fastener failure would have no serious consequences.

Light duty anchors shall be installed in drilled holes. The use of explosive implanting will not be permitted.

Light duty anchors shall be based on proprietary metal or plastics inserts. Timber or fibre plugs shall not be used.

Metal parts of light duty anchors shall be adequately protected against corrosion.

## **S11.8. THREADED FASTENERS FOR METALWORK AND TIMBER**

### **1. Fasteners for Metalwork**

Threaded fasteners for metalwork comprise all bolts, nuts, studs, anchor bolts, ferrules and threaded inserts, screws and washers. Unless otherwise provided, all threaded fasteners shall be to the ISO metric system, normal series, coarse pitch.

Steel bolts shall be forged unless otherwise approved.

Steel fasteners greater than 8 mm diameter and with coarse threads shall be hot-dip galvanised.

Steel fasteners with fine threads and those with coarse threads less than 8 mm in diameter shall be of stainless steel or electroplated with zinc.

Fasteners in contact with water shall be of stainless steel.

## **2. Special Requirements for High Strength Fasteners**

High strength steel fasteners shall be hot dip galvanised if the manufacturer certifies that this will not result in any loss of desirable properties and otherwise shall be electroplated with zinc.

## **3. Fastening Practices for Metalwork**

All parts shall be spot-faced or machined for nuts or bolts excepting the case of clearance bolts in structural steelwork.

Tapped holes shall not be used in sheet metal less than 6 mm thick.

Fasteners of less than 6 mm diameter shall not be used except where specifically approved by the Engineer.

Fasteners of more than 8 mm diameter shall have hexagon or socket hexagon heads.

All threaded fasteners shall be locked in an approved manner. Direct welding of bolts or nuts will not be accepted, except as otherwise specified.

Ordinary carbon nuts and bolts for permanent assembly of structural steelwork shall be drawn tight and the exposed threads burred or spot-welded to prevent loosening.

Bolts and studs greater than 50 mm in diameter shall be tightened by hydraulic tensioning devices.

High strength fasteners shall be tightened to the recommended preloads.

## **4. Fasteners for Timber**

Woodscrews for interior use shall be dull nickel plated brass unless otherwise specified.

Woodscrews for exterior use shall be stainless steel.

Coach bolts and coach screws shall be hot dip galvanised.

### **S11.9. STEP IRONS**

The Contractor shall furnish and install step irons as and where shown on the Drawings or instructed.

The step irons shall be fabricated from corrosion-resistant steel SUS304.

The step irons shall be embedded in the concrete as shown on the Drawings or instructed.

### **S11.10. TRASH SCREENS**

The Contractor shall furnish and install steel trash screens in the sluice gate structures as shown on the Drawings or instructed.

The trash screens shall be fabricated to the details shown on the Drawings.

**S11.11. MEASUREMENT AND PAYMENT****1. Measurement**

Measurement, for payment, of furnishing and installing structural and miscellaneous metalwork will be made of the weight or number of the items listed following and which are installed as specified.

Measurement will be made on the basis of weight computed using the nominal finished dimensions shown on approved shop drawings. The unit weight of steel will be taken as 7,850 kg/m<sup>3</sup>. No deduction will be made for bolt holes and no addition will be made for welds. Bolts, nuts, washers and anchor bars will not be measured.

**2. Payment**

Payment for furnishing and installing structural and miscellaneous metalwork will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
11.10/1	Trash screen 1400 x 1400	Number
11.10/2	Trash screen 1600 x 1600	Number
11.10/3	Trash screen 1800 x 1800	Number
11.10/4	Trash screen 1900 x 1900	Number
11.10/5	Trash screen 2000 x 2000	Number
11.10/6	Trash screen 2400 x 2000	Number
11.10/7	Trash screen 3100 x 1600	Number

Separate payment will not be made for other items of structural and miscellaneous metalwork and the entire cost of that work shall be deemed to be included in the various rates and prices in the priced Bill of Quantities with which the metalwork is associated.

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## **S13. CORROSION PROTECTION AND PAINTING**

### **S13.1. GENERAL**

#### **1. Requirement**

The Contractor shall furnish, prepare and apply all material for cleaning, corrosion protection and painting of all surfaces as specified.

Surfaces of non-ferrous components, active iron, insulation and other parts for which the Contractor has special finishing requirements shall be protected by methods proposed by the Contractor and approved by the Engineer.

#### **2. Surfaces Not Requiring Painting**

The following surfaces and materials shall not be painted:

- concrete surfaces except where required to be painted for architectural reasons or for protection from chemicals as specified or shown on the Drawings;
- hot-dip galvanised steel components except where required as part of the total protection system or for decorative reasons as specified;
- stainless steel, copper, bronze , PVC, glass, vinyl and aluminium surfaces;
- steel surfaces to be covered by insulation and lagging;
- machined surfaces, except side walls of gear rims;
- rolling or sliding surfaces;
- prefinished panels for ceilings, walls and fixtures; and
- steel surfaces subject to temperatures above 100°C.

#### **3. Welding Margins**

Where the protective coating is applied prior to field assembly involving welding, the surface coating shall end not closer than 150 mm to, nor further than 200 mm from, the proposed weld. Field weld preparations and the adjacent blast cleaned surfaces shall be protected with one coat of paint as a corrosion inhibitor. This paint shall be of a type that is readily removable for the restoration of the specified coatings after the assembly is complete.

#### **4. Metal to Metal and Metal to Concrete Contact**

Except as otherwise specified, surfaces of metalwork that will be in contact with other metalwork or concrete shall receive three coats of priming paint. The type of priming paint and the method of surface preparation shall be consistent with the requirement for other surfaces of the same metalwork.

#### **5. Temporary Corrosion Inhibitor**

Items of metalwork to be shipped from overseas, welding margins and all machined surfaces shall be painted with one coat of a temporary corrosion inhibitor on all internal and external surfaces prior to being transported from the place of manufacture.

#### **6. Care of Coated Metalwork**

Metalwork that has been coated shall be handled with care so as to preserve the coating in the best practicable condition and shall be protected from the harmful effects of heat and weather conditions. Where coated items are stored on the Site, the protective coatings shall be periodically inspected. Any damaged coatings shall be immediately repaired.

## 7. Colour Schedule

The final colour schedule will be as advised by the Engineer.

### S13.2. STANDARDS

The Standards referenced in this section of the Specification are:

ASTM A123	Standard specification for zinc (hot-dip galvanized) coatings on iron and steel products
ASTM D522	Mandrel Bend Test of Attached Organic Coatings
ASTM D562	Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
ASTM D870	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
ASTM D1308	Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1475	Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
ASTM D1640	Drying, Curing, or Film Formation of Organic Coatings at Room Temperature
ASTM D2369	Volatile Content of Coatings
ASTM D2697	Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D3359	Measuring Adhesion by Tape Test
ASTM D3363	Film Hardness by Pencil Test
SIS 05 59 00	Pictorial surface preparation standards for painting steel surfaces

### S13.3. SUPPLY OF MATERIALS

#### 1. Qualification of Materials for Painting

The Contractor shall submit, not less than 91 days prior to the proposed date of commencement of painting, the following for each paint type to be used:

- a certificate from the manufacturer giving details for each different product;
- the manufacturer's recommendation as to storage, handling and application;
- the types of equipment with which it is recommended to be used;
- the Contractor's detailed proposals as to equipment, work place, and procedures for application of the paint, consistent with the above instructions.

If requested, the Contractor shall also supply samples of any paint or surface protection coatings proposed for use in the Works.

#### 2. Supply of Materials

All paint materials shall be delivered to the Site in unopened containers bearing the manufacturer's label and instructions. Each container of coating material shall be identified with the name of the paint system, component of the paint system and batch number of that component.

#### 3. Paint Manufacturer

All paints constituting one paint system including primer, intermediate coat and finishing coat shall be supplied by one manufacturer.

#### **4. Tropicalisation**

All decorative internal and external paints shall be of tropical quality. The addition of fungicides that may lose effectiveness in time shall not constitute a suitable tropical quality paint.

#### **S13.4. SURFACE PREPARATION**

##### **1. Metalwork**

All cleaning and surface preparation of metalwork shall be performed by skilled personnel under the supervision of staff experienced in the surface preparation of metalwork.

Weld spatter, burrs and any other objectionable surface irregularities on metalwork shall be carefully removed or repaired before cleaning. Edges of steel plate that are to be painted shall be rounded off to a radius of 3 mm with a smooth transition to the plate surface.

Steel surfaces to be coated shall be cleaned of all detrimental foreign matter such as oil, grease, soil, welding slag or other contaminants.

The Contractor shall use clean, sharp cast iron grit that is free from dust to obtain the surface preparation and the surface profile specified for the particular coating.

Blast-cleaned surfaces showing plate surface defects such as scabs or sharp gouges shall be repaired before applying the coating systems.

For blast-cleaned surfaces, the surface profile shall not be less than preparation grade Sa 2½ of SIS 05 59 00.

Before being coated, the blast-cleaned surface shall be fibre-brushed and vacuum-cleaned to remove all blast products and abrasives from the entire surface including pockets and corners. Final blast-cleaning operations shall not be conducted on surfaces that will become wet after blast-cleaning and before painting, or on surfaces the temperature of which is less than 3°C above the dew point of the surrounding air, or when the relative humidity of the surrounding air is greater than 85% unless otherwise recommended by the coating manufacturer.

Wet-blasting methods shall not be used.

Cleaned surfaces shall be kept free from any contamination and shall not be touched by bare hands. The operators shall wear fabric gloves whilst carrying out cleaning and coating duties, and any areas inadvertently touched by hands or bare parts of the body shall be solvent-cleaned immediately.

##### **2. Concrete and Concrete Blockwork Surfaces**

Concrete and concrete blockwork surfaces to be painted shall be rubbed with a carborundum block and shall be free from dirt, rust stains, encrustations or other contaminants and shall have a smooth uniform surface. Any grinding or buffing to achieve such a surface shall be carried out using flexible cloth backed carborundum discs. Grinding stones and wheels shall not be used for general clean-off of concrete surfaces. Surfaces containing blowholes shall be stopped-up either individually or generally using a cement plaster compatible with the paint. Any excess mortar shall be scraped or sanded from the wall to present a smooth surface for painting.

Concrete surfaces shall be acid-etched with a 10% solution of hydrochloric acid after surface preparation and prior to painting.

Concrete surfaces to be painted shall be water cured.



Concrete surfaces shall not be painted within 21 days after pouring.

### **3. Timber**

Sap or gum exudations shall be scraped off and the areas solvent-cleaned. Dirt and mortar shall be removed using scrapers, abrasive paper or steel wool as necessary. All excessive roughness, loose edges, splinters and splinters shall be removed with abrasive paper. Surface defects, cracks and nail holes shall be stopped up, after application of a primer, with an approved filler.

## **S13.5. APPLICATION OF COATING MATERIALS - GENERAL**

### **1. Personnel**

The application of all coating materials shall be carried out in a neat, workmanlike manner by skilled personnel under the supervision of staff experienced in the application of the particular system and in accordance with the manufacturer's written application instruction.

### **2. Equipment**

All equipment used in the application of coating materials shall be as recommended by the manufacturer. The equipment shall be in first class order and, where power driven equipment is used, shall deliver the coating materials at the rate specified in the manufacturer's application instruction.

### **3. Temperature and Humidity**

Coatings shall only be applied within the temperature and humidity ranges recommended by the coating manufacturer, but in no case shall coatings be applied to surfaces upon which there is any moisture, or during rain or misty weather without suitable protection. Application shall not be carried out when the temperature at the time of application or the temperature anticipated during the subsequent 4 hours is less than 5°C above the dew point of the surrounding air, or when the ambient temperature falls below 7°C or when the relative humidity of the surrounding air is greater than 85% unless otherwise recommended by the coating manufacturer. Each coat shall be protected during the initial curing period against the possibility of moisture condensation or contamination with foreign matter.

### **4. Priming**

Cleaned surfaces shall be primed or treated as specified for the appropriate coating system as soon as practicable and in any case within 4 hours after cleaning or as specified by the coating manufacturer. Blast cleaned surfaces shall not be allowed to stand overnight without having received the first coat of paint. Should rust form, or the surface become otherwise contaminated in the interval between cleaning and coating, reblasting shall be carried out.

The primer coating shall be tinted an approved distinctive colour so as to be readily visually distinguishable from the prepared surfaces.

All surfaces within 75 mm of field welds shall be masked to prevent coating with primer.

The application of a prime coat in the shop followed by the application of the finishing coats in the field will not be accepted.

### **5. Spraying**

When the coating material is applied by spraying, suitable means shall be provided to prevent segregation during the coating operation. Free oil and moisture shall be removed from the air supply lines of all

spraying equipment. Each coat shall be uniform and free from runs, sags and other imperfections. The time between successive coats shall not be less than the minimum, or more than the maximum, re-coating time specified by the manufacturer.

## **6. Finishing Coat**

Not more than 8 hours prior to application of the finish coat, the primer-coated surface shall be washed with fresh clean water to remove any contaminant from the surface and allowed to dry thoroughly. If necessary, suitable solvents shall be used to remove contaminants that are not water-soluble and the areas concerned rewashed with water.

The heads of all bolts, nuts and washers and other metallic coated surfaces, which subsequently will be painted, shall be carefully de-greased using an approved solvent and then given a coat of an approved wash primer of a type compatible with zinc or cadmium, depending on the metal plating used.

The finishing coat shall be applied to the prepared surface by spray so as to produce a smooth even coating and shall be sprayed or hand brushed into all corners and crevices.

## **7. Film Thickness**

The paint shall be applied so that the thickness at any point is that required for the particular coating material within the specified range of thickness, both for the individual coat and the complete system as required. Unless otherwise approved, the dry film thickness shall not be less than the specified thickness and shall not exceed this value by more than:

- 50% for coats up to 100 micron in required thickness; and
- 50 micron for coats exceeding 100 micron in required thickness.

## **8. Tinting**

To facilitate application and inspection, successive coats shall, where required, be tinted distinctively.

## **9. Inaccessible Surfaces**

Surfaces that will be inaccessible after installation shall be completely coated as required prior to installation.

## **10. Protection of Surfaces**

Surfaces not required to be coated, but adjacent to metalwork which is to be cleaned and coated, shall be adequately protected during cleaning and coating.

Metalwork that has been coated shall be handled with care to preserve the coating in the best practical condition and shall be protected from mechanical damage and the harmful effects of heat and weather conditions. Supports and slings used for lifting and holding the coated metalwork shall be padded with rubber blocks or similar material to prevent damage to the external coating.

## **11. Defects**

All coated areas that are defective or damaged shall be cleaned and repaired in accordance with the coating manufacturer's field application instruction. Coatings that are loose, weakly bonded, blistered, abraded or otherwise defective shall be removed and the surface re-cleaned in accordance with the method prescribed for the specified coating. The surface shall then be recoated.

## 12. Elapsed Time

The maximum allowable elapsed time between blast cleaning and application of paint shall be fixed by the Engineer having regard to climatic conditions existing at the time. If a period of more than the maximum allowable time has elapsed, the surface shall be re-blasted to produce a fresh surface. The elapsed time between applications of successive coats shall not be less than the specified minimum recoat time, or more than the specified maximum recoat time. If the elapsed time since the previous coat exceeds the specified maximum recoat time, the Engineer at his discretion may instruct either that the system be removed and reapplied or that the procedure for repair of old paint be followed.

### S13.6. COATING SYSTEMS

The coatings required for various features are specified in Table 13-4.

Each coating system comprises the following four components:

- type of surface preparation;
- type of primer;
- type of body coat; and
- type of finish coat.

### S13.7. GALVANISING

#### 1. General

Galvanising shall be applied by the hot-dip process in accordance with ASTM A123.

The material used for galvanising shall be zinc metal specially made for this purpose and shall be at least 99.5% pure.

The erection marks shall be legible after galvanising.

Where possible, welding, drilling and other working required for fabrication of the material shall be completed and all burrs and other defects removed before the galvanising process commences. All joints shall be seal welded before galvanising.

#### 2. Film Thickness

The surface after galvanising shall carry an unbroken covering, uniform in appearance and thickness. The coating weight and thickness shall be in accordance with Table 13-1.

Table 13-1  
Coating Mass for General Ferrous Articles

Product	Minimum average coating on any individual test area	
	Coating mass (g/m <sup>2</sup> )	Equivalent thickness (micron)
Steel 5 mm thick and over	600	84
Steel under 5 mm thick but not less than 2 mm	450	63
Steel less than 2 mm thick	350	49

**3. Repairs to Galvanising**

Where the galvanised coat has been broken during fabrication, or damaged in handling, the exposed surface shall be painted as soon as possible in accordance with the following procedure:

- clean back to bright steel;
- feather the edges of the surrounding galvanised coating;
- degrease; and
- apply 2 coats of zinc rich primer giving a total dry film thickness of not less than 75 microns. Zinc rich primer shall consist of fine zinc powder, epoxy resin base and polyamide accelerator which, when mixed in the correct proportions, produce a paint suitable for brush or spray application with or without thinning as recommended by the manufacturer. The dry paint film shall contain at least 92% fine zinc powder. The finished repair coating shall be overcoated with a finish coat to approximately colour match adjacent galvanising.

**S13.8. PAINTING CONCRETE, BLOCKWORK AND PLASTERBOARD SURFACES**

**1. General**

Where shown on the Drawings or elsewhere as instructed by the Engineer, concrete, blockwork and plasterboard surfaces shall be painted. The colour of all paints and the time at which painting is carried out shall be as instructed by the Engineer.

Colour samples, in 2 sets each 100 mm x 100 mm following the colour scheme to be furnished by the Contractor, shall be submitted for approval. Upon approval by the Engineer, one set of the samples will be returned to the Contractor and the other retained by the Engineer to compare with the completed painted surfaces.

All paint materials shall be subject to the approval of the Engineer.

**2. Cleaning and Preparation of Surfaces**

Surface preparation shall be in accordance with the provisions of S13.4.2.

**3. Surfaces to be Painted**

The surfaces shall be painted with the number of coats, type of finish and colour shown in Table 13-2.

Table 13-2

Feature	No. of coats	Finish	Colour
Revetment walls	1 coat of primer and 2 final coats of acrylic paint	Semi-gloss	As approved

**4. Paint Application**

All coats shall be applied so as to produce films of uniform thickness and special attention shall be given to edges, corners, and crevices, which shall receive film thickness equivalent to that of flat surfaces. Adjacent areas and installations shall be protected from drips and smears by the use of drip cloths or other approved means.

At the time of application, paint shall show no signs of deterioration. The paint shall be thoroughly stirred, strained and kept to a uniform consistency during application. Paints from different manufacturers shall not be mixed together. Where thinning is necessary, this may be done immediately prior to application in accordance with the manufacturer's instructions.

The time between surface preparation and painting of surfaces shall be as short as practicable. Surfaces that have been cleaned, pre-treated, and prepared for painting shall be given a coat of the specified first-coat materials as soon as practicable after such preparation has been completed.

### **S13.9. NOT USED**

### **S13.10. INSPECTION AND TESTING**

#### **1. General**

Full and uninterrupted access to the Contractor's and any of its subcontractor's workshops shall be provided to the Engineer. The workshops shall possess illumination that, in the opinion of the Engineer, is adequate for the application and inspection of protective coatings.

The Contractor shall provide all necessary inspection and testing equipment to monitor the quality of surface preparations and application of coatings and shall make these available for use by the Engineer when requested.

The Contractor shall perform all measurements and complete all the tests specified and submit records of all testing undertaken to the Engineer in accordance with the Contractor's approved inspection and test procedures.

#### **2. Profile**

The profile shall be measured by direct means such as by surface roughness testers, optical focussing systems, or needle gauges. Routine control may be achieved by the use of standard reference plates.

#### **3. Coating Thickness**

The coating thickness shall be measured by electromagnetic or magnetic gauges at sufficient locations to define the minimum, maximum and average thickness. The gauges shall be calibrated by placing a brass shim on the surface of a flat plate abrasive blasted to the specified profile and the calibration shall be relative to the thickness of the brass shim when so calibrated.

#### **4. Testing of Epoxy Paints**

The Contractor shall carry out tests on the epoxy paints to be used in the coating systems as shown in Table 13-3.

Table 13-3

Test	Standard
Adhesion	ASTM D3359
Chemical resistance	ASTM D1308
Density	ASTM D1475
Dry / cure time	ASTM D1640
Flexibility	ASTM D522
Hardness	ASTM D3363
Total solids (% volume)	ASTM D2697
Total solids (% weight)	ASTM D2369
Viscosity	ASTM D562
Water resistance	ASTM D870

## **5. Other Tests**

In case of a dispute, or to verify the compliance of the coating with the specified requirements, the Engineer may instruct the use of other tests including, but not limited to, adhesion tests and paint film sections.

### **S13.11. REJECTION**

#### **1. Coating Materials**

Coating materials that, in the opinion of the Engineer, have deteriorated due to improper storage, or that have been otherwise damaged or impaired, or that do not comply with the manufacturer's specification shall be liable to rejection and shall not be used for the Works.

#### **2. Surface Preparation**

The Engineer may instruct that surfaces that have become damaged by any means, or that do not meet the specified profile or conditions of cleanliness, be repaired before work continues.

#### **3. Weather**

The Engineer may instruct that surface preparation or coating stop if the environmental conditions are such that there is reasonable doubt as to the ability of the Contractor to perform the work to the specified standard. For this purpose wet and dry bulb thermometers shall be used in conjunction with standard dew point tables.

Coatings that have been applied under weather conditions that prevent proper curing, or that have been marked by rain or condensation, shall be liable to rejection.

#### **4. Properties of Coating**

Surface coatings that do not comply with the requirements for thickness may be liable to rejection or repair. Where the Engineer considers that there is reasonable doubt as to the quality or adhesion of the paint film, he may instruct the use of other tests to determine compliance or otherwise with the specified requirements. Failure to comply with the manufacturer's recommendations may render such coatings liable to rejection. Discontinuities revealed by Holiday detectors shall be repaired and the Engineer may reject such coatings if the incidence of defects revealed by such testing appears excessive. Coatings showing excessive sags or runs shall be liable to rejection.

### **S13.12. MEASUREMENT AND PAYMENT**

Unless otherwise provided, separate payment will not be made for corrosion protection or painting and the cost of corrosion protection and painting shall be included in the rates in the priced Bill of Quantities for furnishing and installing the various items of work to which the corrosion protection or painting has been applied.

Table 13-4  
Coating Systems

Feature	Surface Preparation	Primer	Body Coats	Finish Coats	Total Dry Film Thickness (micron except as noted)	Generic Coating System
Surfaces of steel piles extending from the top to 1 meter below top of riprap or riverbed, whichever is lower	Abrasive blast clean to Sa 2½ of SIS 05 59 00	Zinc rich primer, one coat, 20 µm	Epoxy resin paint, one coat, 60 µm Followed by epoxy MIO, one coat 60 µm	Epoxy resin paint, one coat, 40 µm Followed by epoxy resin paint, one coat 30 µm	210	Epoxy resin
Galvanised steel work	Clean, descale, pickle			Coating mass in accordance with Table 13-1	Thickness in accordance with Table 13-1	Hot-dipped galvanising
Galvanised steel - repair work	Power tool cleaning	Two pack zinc-rich epoxy primer, 40 to 50 µm			Thickness equivalent to Table 13-1	Epoxy
Ladders, handrails, walkways, miscellaneous metalwork	Solvent degrease, clean rust or stain with wire brush to bright metal	Repair damage Two-pack zinc-rich epoxy primer one coat 40-50 µm	Acrylic, solvent borne one coat 40-60 µm	Acrylic, solvent borne one coat 40-60 µm	80-120 (paint only)	Hot-dipped galvanising plus epoxy and acrylic

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## **S15. MISCELLANEOUS CONSTRUCTION**

### **S15.1. NOT USED**

### **S15.2. NOT USED**

### **S15.3. CONCRETE RAILING**

The Contractor shall construct concrete railing along the revetments of the types and to the lines, grades and dimensions shown on the Drawings.

Concrete shall be in accordance with Section S5 [*Concrete*] of these Specifications. Concrete shall be Class A, except that for sections less than 100 mm in thickness Class C shall be used.

The pattern of the railing shall be as shown on the Drawings and the finish shall be Class 2 Rubbed Finish.

### **S15.4. NOT USED**

### **S15.5. NOT USED**

### **S15.6. NOT USED**

### **S15.7. NOT USED**

### **S15.8. BOUNDARY MARKERS**

The Contractor shall supply and install boundary markers where shown on the Drawings or instructed.

The boundary markers shall be cast in-situ concrete of the dimensions shown on the Drawings. Concrete shall be Class C.

Each marker shall be set accurately at the required location and elevation and in such manner as to ensure its being held firmly in place.

The exposed surface of the finished markers shall be uniform, of even texture, and shall be free from holes, cracks and chipped edges.

### **S15.9. MEASUREMENT AND PAYMENT**

#### **1. Concrete Railing**

##### **(a) Measurement**

Measurement, for payment, of concrete railing will be made of the length complete in place in accordance with the Drawings or as instructed.

##### **(b) Payment**

Payment will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following items:

BoQ Item No.	Description	Unit of Measurement
15.3/4	Concrete railing – Type 4	Lineal metre

**2. Boundary Markers**

## (a) Measurement

Measurement, for payment, of supply and installation of boundary markers will be made of the number of markers installed as instructed.

## (b) Payment

Payment will be made at the applicable rate bid therefor in the priced Bill of Quantities under the following item:

BoQ Item No.	Description	Unit of Measurement
15.8/1	Boundary markers	Number

**SECTION VI**  
**WORKS REQUIREMENTS**

## **SCOPE OF WORKS**

**Objective of the Project**

The objective of the Pasig-Marikina River Channel Improvement Project is to mitigate flood damage in Metro Manila caused by channel overflow of the Pasig-Marikina River by carrying out river channel improvement works, together with non-structural measures for flood risk management, and thereby contributing to the sustainable urban economic development of the region.

**Prior Construction Work**

Project construction work commenced during Project Phase II in July 2009 and these works are expected to be completed in May 2013. The work involved improvements to sections along the Pasig River, but many sections were not completed due to financing constraints.

**Project Phase III**

The scope of works involved in Contract Package No. 2 is to improve the lower Marikina River channel from the Napindan Channel to downstream of the Manggahan Floodway.

The main civil works as shown on the Drawings and described in the Specifications include dredging the river channel, construction of dikes and sluiceways, and improvement to revetments and drainage works.

Phase III is being funded by the Japan International Cooperation Agency (JICA) as a Yen Loan Project.

**SUPPLEMENTARY INFORMATION**

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## SITE AND OTHER DATA

### Project Location

The Project is located in Metro Manila in the southern part of Luzon Island, Republic of the Philippines.

Metro Manila, which encompasses 16 cities and 1 municipality having an estimated total population of around 11 million in 2010, is the economic, political and cultural center of the Philippines. The Pasig-Marikina River system, which is the main natural drainage system of the National Capital Region (NCR), runs through the center of Metro Manila and flows into Manila Bay. The 3 largest waterways (Pasig, Marikina and San Juan rivers) with a total catchment area of 621 km<sup>2</sup> (about 20% of which is situated in Metro Manila) contribute largely to the flooding in the metropolis by riverbank overflow of floodwaters during heavy rains and/or high tides.

The Pasig-Marikina River basin encompasses 14 Local Government Units - Manila, Mandaluyong, Makati, Taguig, Pateros, Pasig, Quezon, Marikina and San Juan in the NCR, and Rodriguez, San Mateo, Antipolo, Cainta and Taytay in Rizal Province, Region IV.

The Project Site is located in a densely populated urban environment, and the available work areas will be very restricted. Due to limited amounts of working space and potential traffic problems, it is expected that it will be necessary that the major parts of the work be carried out from river-based equipment.

The working area of the temporary jetty beside the backfill site is expected within 40m from the edges of the existing revetments under the approval of the Engineer based on the Contactor's request.

### Climate

Historically the climate in the Manila area has been that of a typical Southeast Asian monsoon, with a long dry season from November to May and intense rainy periods from June to September.

Typhoons are common from June to November and have a great influence on the climate and weather conditions of the Philippines.

In recent years the weather patterns have been changing, with monsoon rains arriving later and lingering into December and changes in precipitation, temperature, intensity of tropical cyclones and frequency of extreme weather events.

Further details on climatic conditions in the Philippines are available from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) website [www.pagasa.dost.gov.ph](http://www.pagasa.dost.gov.ph).

### Stages of the Project

The Project is being implemented in various stages, the components of which currently are:

- Phase I: Detailed Design for the Overall Project from Delpan Bridge to Marikina Bridge;
- Phase II (Construction Stage I): Channel Improvement Works for Pasig River (Delpan Bridge to Napindan River);
- Phase III (Construction Stage II): Channel Improvement Works for Lower Marikina River (Napindan Channel to downstream of the Marikina Control Gate Structure) and sections of the Pasig River not completed in Phase II;
- Phase IV (Construction Stage III): Channel Improvement Works for Upper Marikina River (Mangahan Floodway to Marikina Bridge) and construction of the Marikina Control Gate Structure.

## DOCUMENTS AVAILABLE FOR BIDDERS' INFORMATION

The Employer, or its consultants, has produced various reports and other information on the Project and copies of these reports will be made available for inspection by bidders in accordance with Sub-Clause 4.10 of the General Conditions of Contract.

The Employer does not guarantee or warrant the accuracy of any data or any conclusions or opinions that may be included in the reports. Any such information does not form part of the Contract.

Following is a listing of all reports or studies that in part or in full provide information on the Project relevant to the Contract:

### **Phase I Documents**

Pasig-Marikina River Channel Improvement Project – Design Report:

Volume I	Executive Summary
Volume II	Main Report
Volume III	Design Criteria
Volume IV	Airphoto Mapping and River Survey
Volume V	Soil Investigation
Volume VI	Hydrology
Volume VII	Hydraulic Design of MCGS
Volume VIII	River Improvement Plan
Volume IX	River Structures
Volume X	Drainage Works
Volume XI	Bridge Works
Volume XII	MCGS Structure and Operation System
Volume XIII	Construction Plan
Volume XIV	Cost Estimate
Volume XV	Project Evaluation
Volume XVI	Quantity Calculation.

(Volumes XIII to XVI will not be made available).

Soil Investigation Works (24 Volumes).

River Survey Works (12 Volumes).

Hydraulic Model Test on MCGS.

### **Phase II Documents**

Design Review Report

Appendix-A:	Design Criteria
Appendix-B:	Design Note (design calculation)
Appendix-C:	Cost Estimates
Appendix-D:	Quantity Estimates
Appendix-E:	Non-uniform Calculation Results for Study on Marikina River Channel Improvement Plan

(Appendices C and D will not be made available).

### **Phase III Documents**

Basic Design Report I (June 2012)

Basic Design Report II (September 2012)



**Detailed Design Report**

Volume I	Design Note of Pasig River
Volume II	Design Note of Marikina River
Volume III	Geology and Soil Mechanics
Volume IV	Structural Calculation of Pasig River
Volume V	Structural Calculation of Marikina River
Volume VI	Quantity Calculation of Pasig River
Volume VII	Quantity Calculation of Marikina River
Volume VIII	Drawing of Pasig River
Volume VIII	Drawing of Marikina River

(Volumes VI and VII will not be made available).