

**Part 1        General**

**1.1        SCOPE**

- .1        This Section covers the production of stone materials for the project, including submittals for the Departmental Representative's approval, and Quality Control/Quality Assurance (QC/QA) tasks as they relate to the production of stone. The Contractor is responsible for Quality Control. The Departmental Representative is responsible for Quality Assurance.

**1.2        RELATED SECTIONS**

- .1        Section 01 45 00 – Quality Control.

**1.3        REFERENCES**

- .1        The latest editions of the standards and publications listed below form a part of this specification to the extent referenced.
  - .1        American Society for Testing and Materials (ASTM)
    - .1        ASTM C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
    - .2        ASTM C127 Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
    - .3        ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
    - .4        ASTM C295 Petrographic Examination of Aggregates for Concrete
    - .5        ASTM C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
    - .6        ASTM D6928 : Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.
    - .7        ASTM D7012 : Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures

#### 1.4 MEASUREMENT AND PAYMENT

- .1 Stone provide by PWGSC .

Categories	Quantity of stone provided by PWGSC	Quantity required for works
8 to 12 t.m.	8 150 mt.	9 150 mt
1 to 3 mt.	3 300 mt.	3 600 mt.
1 to 1,5 mt.	5 018 mt.	3 600 mt.
100 to 300 kg	3 322 mt.	3 322 mt.
300 to 450 mm	3 418 mt.	350 mt.
Quarry run	500 mt.	3 500 mt.

#### 1.5 SUBMITTALS

- .1 The following information shall be submitted to the Departmental Representative by the Contractor.
- .1 Stone source information: Within fifteen (15) working days of Contract award, the Contractor shall submit the following information for all proposed stone sources for each stone size classification:
- .1 Name and location of quarry;
  - .2 Areas and lifts of the quarry to be worked;
  - .3 Specific geological stratum or strata to be utilized;
  - .4 Laboratory test records and results (refer to requirements in Table 1) representative of areas and lifts to be worked for this project.
  - .5 List of completed marine projects constructed using the same stone to be furnished for this Project.
- .2 Stone Materials and staff control: Within ten (10) working days of notice of acceptance of offer, the Contractor shall submit a written Stone materials and staff control plan. The Plan shall describe the means and methods to be used for the production, handling, transport, placement and effective inspection of stone materials in a manner which shall result in satisfactory quality of in-place stone construction. Written procedures shall be included for the following:
- .3 Pre-Production Reference Stones: Within twenty (20) working days of notice of acceptance of offer, the Contractor shall provide a set of Pre-Production Reference Stones for evaluation by the Departmental Representative at the source. At least 25 Pre-Production Reference Stones shall be provided. Specific requirements for the Pre-Production Reference Stones are described in Clause 1.9 of this section.

- .4 Revision of Stone Materials and staff Control Plan: If the Contractor elects to initiate a proposal to revise the Stone materials control and staff control plan, the Contractor shall submit the proposed revision not later than five (5) working days prior to the date it proposes to implement the revision and shall not implement the revision prior to the review of the Departmental Representative. Proposed changes staffing shall likewise be submitted for review. Departmental Representative required revisions to the Plan or staffing shall follow the procedures prescribed elsewhere in this Section.
- .5 Stone Control Plan Reports : The Contractor shall maintain daily reports of all work performed under the approved Plan. The daily reports shall be available for review by the Departmental Representative upon request. In addition, the daily reports shall be assembled at the end of each week and submitted to the Departmental Representative on a weekly basis. Daily reports shall be prepared by each inspector, and shall include the following information:
  - .1 SMC inspector's name.
  - .2 Identification of the stone handling equipment during all phases of the work, and the name(s) of equipment operator(s) used to accommodate the stone inspection.
  - .3 Date of stone inspection.
  - .4 Weather conditions, including temperature.
  - .5 Temperature and date stone was removed from quarry face, and date and details of blasting, if applicable.
  - .6 Location and strata within quarry where stone removal took place (horizontally and vertically).
  - .7 Colour(s) and character(s) used by inspector for spray paint marks and the applicable code for stones which are individually sorted (versus mechanically sorted) and for any rejected stone.
  - .8 Breakdown of the approximate quantity, by classification, of accepted and rejected stone processed for the project during the day.
  - .9 A summary of the cause or causes for most of the rejections of stone occurring during the day.
  - .10 Running total of the quantity of stone shipped from the source to date.
- .6 Gradation Tests: Submit all gradation tests for review, complete with gradation test data sheets, calculations and graphical presentation of results.
- .7 Installation and certification of weigh scale:

The Contractor shall make arrangements for the installation and certification of an electronic weigh scale at the work site before shipping the stones as indicated in 1.4.1.1. Weigh scale installation and certification are provided at Contractor's expense.

At least five (5) working days before loading, submit the details concerning the location and the type of weigh scale installed for the purpose of the project as well as a document certifying the accuracy of the scale(s) under Industry Canada.
- .8 Weigh scale operators:

The Contractor shall provide weigh scale operators and pay all costs involved.

- .9 Other weighing devices:  
Submit the details of the equipment incorporating load cells or other devices to weigh stones individually. These devices are provided at Contractor's expense.
- .10 Certified weight scale tickets:  
A copy of each weight scale tickets, including certification of exact weight, time of weighing and of delivery shall be submitted to the Departmental representative the day following the weigh-in.

## **1.6 TERMINOLOGY**

- .1 The following definitions shall pertain to these terms:
  - .1 Dimensional ratio (l/d) – report between the length (l) and the thickness (d) measured on three axes mutually perpendicular. The length of the stone (l) is the most long distance between two points on the stone (between two opposite corners). The thickness of the stone (d) is the minimal dimension of two opposite faces of the stone.
  - .2 The word “ton” (t) refers to the metric ton (1 t = 1 000 kg).

## **1.7 QUALITY CONTROL**

- .1 The SMC Plan shall be incorporated into the Contractor's overall Quality Control Program (QCP) in accordance with Section 01 45 00.

## **1.8 QUALITY CONTROL STAFFING**

- .1 General:  
  
The Contractor shall provide a qualified full-time Stone Materials Control (SMC) Field Supervisor, and appropriate stone source and loading facility inspector(s). In addition, the Contractor shall retain the services of a Licensed Professional Geologist to assist the SMC Field Supervisor on an “as required” basis throughout the duration of the Work. The SMC staff shall verify that all stone produced, delivered to the Project site, and placed in the Works conforms to the requirements of the Contract Drawings and Specifications.
- .2 Supervisor's qualifications and duties :  
  
The supervisor is responsible for implementing all the elements in the control plan for stones. He has at least two years of specialised experience in the inspection and assessment of armour stone for marine projects. The experience must have been acquired in the quality assessment of the type and size of stone involved in the project at hand. Where the Contractor obtains the stones for this project from a subcontractor, the supervisor shall not be an employee of the latter.  
  
The supervisor shall be responsible for the implementation and fulfilment of the control plan for stones, including the management, control and assessment of the work performed

by all the inspectors. He shall provide qualified inspection personnel at all times and replace any person whose performance is unsatisfactory. The supervisor is responsible for the quality of all stone produced.

.3 Qualifications and Duties of Geologist:

The Geologist shall be a Licensed Professional Geologist, with at least one year of practical experience in armour stone inspection and assessment. The Geologist shall provide assistance to the SMC Field Supervisor during stone source selection, including the completion of visual and petrographic examinations (refer to Table 1), identification of specific areas and lifts of acceptable and unacceptable stone at the source(s) and the selection of Pre-Production Reference Stones. In addition, the Geologist shall be retained during stone production if ongoing Quality Control (QC) or Quality Assurance (QA) activities indicate that the quality of stone being furnished is not as specified or is questionable, as directed by the Departmental Representative.

.4 Qualifications and Duties of Inspectors:

The SMC inspectors shall be persons with sufficient training and a minimum of one year of relevant experience to competently and independently perform the tasks itemized below while under the general supervision of the SMC Field Supervisor.

- .1 Participate in the selection of stone for the Pre-Production Reference Stones and in the evaluation of stone placed in the stockpiles.
- .2 Maintain a clear, legible daily log of activities and observations in a format to be approved by the Engineer. Prepare daily inspection reports and submit in a timely manner.
- .3 Visually inspect every Armour stone to verify that the stone meets the quality requirements of this Section. The examination shall focus on stone quality, fractures, stone geology and other detrimental features that may cause the stone to deteriorate into smaller pieces after it is in place in the Work.
- .4 Clearly mark every acceptable Armour stone with spray paint using a colour and/or symbol system approved by the Departmental Representative. Unless otherwise directed, each stone shall be suitably marked on three mutually perpendicular sides. Inspection duties also include identifying and marking stones that do not meet the criteria for acceptability, including size, quality and shape. Unacceptable stones shall be marked with a spray painted red "X" on three mutually perpendicular sides.
- .5 Measure every Armour stone along three mutually perpendicular axes and estimate its weight, based on the unit weight of that stone type, and its aspect ratio.
- .6 Unless each stone is weighed individually using appropriate equipment, estimate the weight of each unit based on the weight of this type of stone and its dimensions.
- .7 Proceed to regular checks of estimated weights against the scaled weights using a weight measurement method approved by the Departmental Representative.
- .8 Build and maintain separate stockpiles for each category of stone.

- .9 Ensure that rejected stones are stockpiled in the “reject” pile or that they are removed without delay from the site after being marked. Rejected stones shall always be segregated from accepted stones.
- .10 Perform periodic checks that load cells or other equipment-mounted weight scale devices are accurately weighing stone for quality control.

## **1.9 PRE-PRODUCTION REFERENCE STONES**

### **.1 Preparation:**

Within twenty (20) working days of notice of acceptance of offer, the Contractor shall provide a set of Pre-Production Reference Stones. The SMC Field Supervisor or an SMC inspector shall select the Pre-Production Reference Stones for evaluation by the Departmental Representative. The Pre-Production Reference Stones shall be located at the source and be laid out in windrow fashion. At least 25 Pre-Production Reference Stones shall be provided for each Armour stone size classification. The Pre-Production Reference Stones shall be representative of the areas, geologic units, faces, and lifts within the quarry from which the stone will be furnished; the quality of stone to be furnished

### **.2 Inspection of Pre-Production Reference Stones:**

The Contractor's SMC Field Supervisor and all SMC inspectors shall accompany the Departmental Representative during the inspection of the stones. The Contractor shall arrange to have individual stones free from any dust or mud covering the faces, and to have stones turned as necessary to accommodate the Departmental Representative's inspection. The Departmental Representative will mark any unacceptable stones with a red “X” on three mutually perpendicular sides. If twenty per cent (20%) or more of the stones with Contractor shall replace the unacceptable stones for re-inspection. If, after a total of two attempts, the Contractor is unable to present an acceptable set of Pre-Production Reference Stones, the source shall be disapproved for this Contract. The Contractor shall then be required to identify a new source for approval. The Contractor may, of its own accord, choose a new source at the time the first or second set of Pre-Production Reference Stones are found to be unacceptable. The Contractor is responsible for all costs associated with the replacement of stones for sets of Pre-Production Reference Stones, or for changing stone sources. In addition, no extension in the required completion date for this Contract will be allowed because of changing stone sources.

### **.3 Maintenance of Pre-Production Reference Stones as Examples:**

The acceptable Pre-Production Reference Stones, and typical unacceptable stones, as determined by the Departmental Representative, shall remain on display at the quarry as examples (of quality, size and shape requirements) throughout the duration of shipping stone for this Contract. The weight of each acceptable Pre-Production Reference Stone shall be clearly marked on them.

## **1.10 ACCEPTANCE DETERMINATION FOR STONE SOURCE(S) AND SMC PLAN**

- .1 The Departmental Representative reserves the right to undertake independent investigations and evaluations as necessary to verify whether or not materials meeting the

requirements of these Specifications can be produced from the proposed source(s), including the stone quality tests listed in Table 1. Any additional testing shall be undertaken on stone samples selected by the Departmental Representative. All costs associated with independent investigations and evaluations of the originally proposed stone source(s) shall be the responsibility of the Departmental Representative.

- .2 The Departmental Representative will make an acceptance determination for the Contractor's proposed stone source(s) and SMC Plan, including SMC staff, based on the following information:
  - .1 Review of the Contractor's Stone Source Information and SMC Plan submittals (see paragraphs 1.5.1 and 1.5.2);
  - .2 Visual inspection of the Pre-Production Reference (see paragraph 1.9);
  - .3 Assessment of this information relative to the specified requirements for stone (see paragraph 2.3 and table 1) quality and stone gradation and shape (see paragraph 2.4).
  - .4 Review of results of additional laboratory testing, if required (see paragraph 1.10.1);
- .3 The Departmental Representative will provide a determination of acceptance or rejection of the stone source(s), SMC Plan and SMC staff proposed by the Contractor within ten (10) work days of the date of Departmental Representative inspection of the Pre-Production Reference Stones or receipt of additional laboratory test results, whichever is later.
  - .1 If the stone source, SMC Plan and SMC staff are determined to be acceptable, the Contractor may then proceed with the production of materials for this Contract, provided the materials are consistent with the accepted Pre-Production Reference Stones.
  - .2 If the SMC Plan is rejected, the Contractor is responsible for preparing a new SMC Plan, possibly including new staff, to the satisfaction of the Departmental Representative prior to proceeding with stone production for the project. No additional payment for Work will be made until a suitable SMC plan has been submitted and reviewed by the Departmental Representative. The Contractor is responsible for all costs associated with preparing a new SMC Plan. In addition, no extension in the required completion date for this Contract will be allowed if a new SMC plan is required.
  - .3 If the stone source(s) is rejected, the Contractor is responsible for finding a new source(s), and undertaking additional sampling and testing as required for source approval by the Departmental Representative. The Contractor is responsible for all costs associated with changing stone sources. In addition, no extension in the required completion date for this Contract will be allowed because of changing stone sources.
- .4 No additional time will be added to Contract milestones or delivery dates for the time required for the Departmental Representative to make a determination of acceptance or rejection of the proposed source(s).

## **1.11 QUALITY ASSURANCE**

### **.1 General**

- .1 Quality Assurance (QA) activities shall be performed by the Departmental Representative. These activities are intended to provide independent observations of conformance to the requirements of this Section prior to shipment of the stone to the site, and in no way relieve the Contractor of his responsibilities for Quality Control and in-place requirements.
- .2 The Contractor shall provide equipment and operations to turn and handle disputable stones that should be revaluated by the Departmental Representative.
- .3 In the event that the Departmental Representative's QA activities indicate non-conformance to the requirements of this Section, the Departmental Representative will reject the non-conforming stones. Materials rejected at the source shall be immediately marked (with a red "X" on three mutually perpendicular sides), segregated and removed from the stockpile area .
- .4 If the Departmental Representative, during his QA activities, finds that the quality of stone being furnished is not as specified or is questionable, additional sampling and laboratory testing may be required. The selection of samples (from stockpiles at the site, source or intermediate location, such as a loading dock), and the required testing of stones, shall be as directed by the Departmental Representative. The Contractor shall pay all costs associated with the additional sampling and laboratory testing of stone.
- .5 Continued non-conformance will be considered justification for rejection of the SMC Plan, like describe in section 1.10.3.2, and/or the rejection of the stone source(s), like describe in section 1.10.3.3.

## **Part 2 PRODUCTS**

### **2.1 GENERAL**

- .1 All stone materials to be furnished under this Contract shall meet all requirements specified in this Section of the specifications. The Departmental Representative, at any time during the Contract, may reject materials at the source or at the deposit site for failure to meet the specified requirements. Materials that have been delivered to the deposit site and are rejected, whether in stockpile or in place in the structure, shall be removed from the project at the Contractor's expenses.
- .2 The SMC Plan and QC/QA activities shall be systematically applied throughout the duration of quarry and construction operations for this Project.

### **2.2 STONE SOURCES**

- .1 The Contractor shall be solely responsible that the selected source(s) can meet the delivery schedule and produce the quality and quantity of stone required for the project.
- .2 If the Contractor is unable to obtain a sufficient quantity of acceptable stone materials from the original source(s) during the Contract, the Contractor may request approval to



use an alternative source(s). The Contractor will be responsible for all costs associated with changing stone sources, including additional sampling and testing as required for source approval. In addition, no extension in the required completion date for this Contract will be allowed.

## 2.3 STONE QUALITY REQUIREMENTS

### .1 General (All Stone)

.1 All stone shall be highly resistant to weathering, deterioration or disintegration under freeze-thaw and wetting-drying conditions and shall be of a quality to ensure permanence of the structure in the climate in which it is to be used. The stone shall be durable, sound and free from detrimental cracks, seams and other defects, which tend to increase deterioration from natural causes or cause breakage during handling and/or placing. Argillaceous stone or stone with high shale content is more susceptible to weathering, abrasion, thin bedding, close fracturing and other undesirable rock properties and shall not be accepted. Inclusions of dirt, sand, clay, shale, chert, micaceous minerals, pegmatite, oil and oil-stained stones and rock fines or any organic or other deleterious material will not be permitted.

### .2 Armour Stone A-class

- .1 Sandstone and conglomerate materials will NOT be acceptable as Armour stone for this Project, whatever the conformity of other specifications.
- .2 Is there an uncertainty for sandstone or not, the stone shall have a petrography exam (ASTM C295-03). The laboratory fees will be Contractor's expenses.
- .3 Categories for stone A class are:
  - a) 8 to 12 metric tons
  - b) 1 to 3 metric tons

### .3 Armour Stone B class

- .1 The conglomerate will NOT be accepted as B class stone.
- .2 The stone shall have a minimum weight density of 2600 kg per cubic meter, the absorption degree shall be less than 1% (ASTM-C127) and offer less than 5% of durability loss with the MgSO<sub>4</sub> Soundness after 5 cycles (ASTM-C88).
- .3 The size of stone B class:
  - 1) 0-120 mm : 10% maximum
  - 2) 120-250 mm : 85% minimum
  - 3) 250-300 mm : 5% maximum
- .4 The categories that shall be produced with B class stone is :
  - a) Quarry run

### .4 Stone Sampling and Testing Methods

- .1 Test method references are listed in Section 1.3 - References.

- .2 Stone samples used for laboratory testing shall be representative of the lithologic unit(s) for each stone classification proposed for use under this Contract.

## **2.4 STONE GRADATIONS AND SHAPES**

- .1 At least 90% of stone weight, of same class, 8 to 12 mt and 1 to 3 mt, placed in work shall weight a mass included within this class weight limits.
- .2 At most 5% of stone weight, of same class, 8 to 12 mt and 1 to 3 mt, could weight between 0.75 time and one time minimum required weight for this class.
- .3 Any stone whose weight will be inferior to 0.75 time minimum weight of superior to 1.25 times maximum weight of class in which it is classified will be refused, removed from quantities and shall be removed from worksite.
- .4 In case of contestation about Departmental Representative's decision, Contractor shall demonstrate that involved stones totally meet preceding criteria.
- .5 Every broken stones during handling or shipping shall be revaluated based on previus items.
- .6 The stone shall be angular or oblong shape with a ratio short-dimensional ( $l / d$ ) up to 3 / 1. It should not be more than 10% of stone having a dimensional ratio greater than 2.5 / 1.

**Table 1 – Required Stone Quality Tests - Test Methods and Acceptance Criteria**

Test Name	Test Method	Acceptance Criteria
		A-class Stone
Field/Visual Observation/Assessment		
Field Examination <sup>1</sup>	ASTM D4992-07	No sandstone or conglomerate No deleterious materials; good to excellent quality for the intended use
Petrographic Examination <sup>2</sup>	ASTM C295-03	No deleterious materials; good to excellent quality for the intended use
Weathering Grade	Visual	IA - fresh, unweathered rock IB - faintly weathered rock (staining on major discontinuity surfaces)
Laboratory Tests		
Bulk Specific Gravity, SSD	ASTM C127	2.65 to 2.85
Water Absorption <sup>3</sup>	ASTM C127	< 0.5%
Micro-Deval <sup>4</sup>	ASTM D6928-06	< 15
Compressive strength <sup>5</sup>	ASTM D7012-07	> 80 MPa
MgSO4 Soundness	ASTM C88-05	< 1.5% loss after 5 cycles
Petrographic Examination <sup>2</sup>	ASTM C295-03	No deleterious materials; good to excellent quality for the intended use

**Table 1 Notes:**

1. Field examination shall include the preparation of a written report that includes a summary of the quarry and proposed quarry development plan as per ASTM D4992, including: general lithology; geologic unit and age; source homogeneity; stratigraphic faces; metamorphic and weathering phases; dip, strike and thickness of the bedding; proposed blasting procedures and expected curing time.
2. Petrographic examination shall be repeated before AND after MGSO4 soundness tests. Petrographic examination shall be summarized in a written report that includes the rock's geological name, weathering state, main constituents, texture, anisotropy and porosity. In addition, the report shall identify/discuss the presence of any constituents, presence of micro-fractures and/or signs of induced stress (and therefore possible stress release – see Clause 3.2) that may be of concern for the proposed use.
3. Water absorption test to be repeated on ten (10) separate pieces of stone. All ten (10) tests must meet the specified acceptance criteria.
4. Shall be done with two (2) separates stones.
5. Shall be done with three (3) separates stones.

## **Part 3        EXECUTION**

### **3.1        PRODUCTION QUALITY CONTROL**

- .1        The Contractor shall perform Quality Control activities throughout the duration of stone production and placement operations in accordance with the requirements of this Section and Section 01 45 00.
- .2        Weighing of stones or re-measuring them shall be performed to verify computed weights when the Departmental Representative brings the size of specific stones into question, or when the SMC inspector observes the need to do so.
- .3        Drop tests shall be performed when the Departmental Representative questions the quality or integrity of specific armour stones, or when the SMC inspector observes the need to do so. Drop tests shall be undertaken as follows:
  - .1        Visually inspect all sides of the stone, and mark/record existing cracks;
  - .2        Lift and drop stone from a height of 3 m onto a rigid surface (bedrock, or similarly sized stone);
  - .3        Visually inspect all sides of the stone for cracks for the opening of existing cracks and/or the development of new cracks;
  - .4        Repeat at least three times, as directed by Departmental Representative;
  - .5        Stone is acceptable for use if there is no opening of existing cracks and no development of new cracks.

### **3.2        TRANSPORTATION AND TEMPORARY STOCKAGE**

- .1        The Contractor must arrange transport and store the stones to ensure that the piles are not contaminated by dirt and other materials and to reduce the segregation of materials by size.
- .2        Storage of stones following the dispatch of the quarry shall be subject to the approval of the Departmental Representative.

**END OF SECTION**