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USACE / NAVFAC / AFCEC **UFGS-35 31 19.40 (November 2024)**

Preparing Activity: USACE **Superseding**
UFGS-35 31 19 (November 2023)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
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11/24

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SECTION 35 31 19.40

STONE REVETMENTS
11/24

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NOTE: This guide specification covers the requirements for stone protection, including foundation preparation, bedding layers and filters, for the slopes and bottom of channels, ditches, structures, lock approaches, etc.; constructing trenchfill revetment, bank paving, and outlet drains; stone revetment, stonefill dikes, stoneroots, and junctions; constructing stone capouts and revetment reinforcing along the river; revetment repairs; shoreline/coastal protection. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Field adjustments may be made at the direction of the Contracting Officer's Representative (COR/ACO) to the location of stone placement that do not alter the design intent or pay quantities. Such field adjustments should be documented as to the justification, location, and documentation of the adjustments should be included in the permanent Contract Documentation and As-Built drawings. The Contracting Officer and Designer of Record should be notified as soon as practicable.

Comments, suggestions and recommended changes for this guide specification are welcome and should be

submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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NOTE: The EMs and ETLs referenced in this guide specification can be found on the Internet at http://www.usace.army.mil.inet/usace-docs.

To clarify the difference between Stone Protection, Channel Protection, and Shoreline Protection, the following definitions are provided. Stone Protection is defined as a system which includes a layer of bedding material or layers of filter material beneath a layer or layers of riprap. Stone protection is placed around structures in slack water or within a dewatered site. Stone protection may also be used to protect channel banks when it is placed in the dry or in slack water. Riprap is defined as a material having a gradation band similar to those specified in EM 1110-2-1601, Chapter 3. Channel Protection is stone placed in a current as revetment, dikes, or slope paving without the use of a separate layer of bedding or filter material. In this type of environment, bedding sand or geotextiles and materials with gradation bands with a top size of 150 mm 6 inches will not stay where placed. Shoreline Protection is defined as a system of bedding or filter materials and stone used to protect coastlines of lakes and oceans and for harbor protection.

Grouted riprap should only be used when the quantity of larger stone on a project is very small and in a noncritical area. Also, grouted riprap should be considered only when minor settlement is expected in the foundation, potential of undermining is very low, and the density of the fill material is at a minimum of 95 percent Standard Proctor. Additional information provided in ETL 1110-2-334.

EM 1110-2-2302, Construction with Large Stone, presents criteria and gives guidance for selection, evaluation, and use of large-stone materials in construction. This document also references other EM's that have additional related guidance for the protection design. One additional reference not listed is EM 1110-2-1614, Design of Coastal Revetments, Seawalls, and Bulkheads. However, the quality criteria specified in this document was based upon a limited review of criteria being used by Corps. Quality criteria that is specified by a District should be that which has been selected to be used on its projects or criteria specified by a Division to be used by the District to meet the durability requirements for the project being constructed.

"Riprap Quality Criteria in Standard Specification and Engineering and Guidance", Rock for Erosion Control, ASTM STP 1177; and TR-GL-81-8, Evaluation of Quality and Performance of Stone as Riprap or Armor", both support the need to perform freeze-thaw testing by COE CRD-C 144 instead of ASTM procedures. Also, both indicate that soundness tests and L.A. Abrasion tests are of limited use when evaluating Riprap and Armor Stone.

NOTE: The designation of types of materials (sand, filter, stone, riprap, bedding, etc. should be consistent with the nomenclature of the project and entities involved - and defined within PART 1 and/or PART 2 of the Specification. Such designations as "Type 1, Type A, must be well-defined and consistently used in order to avoid confusion and to limit the apparent numbers of different materials required by the Contract. The designations between the definitions in the Technical Specification, the Drawings and the Bid Schedule MUST BE CONSISTENT.

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1.1 UNIT PRICES

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NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

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1.1.1 [Bedding][and][Filter] Layer(s)

1.1.1.1 Payment

Payment for gravel, crushed stone, and sand placed for bedding and/or filter material will be made at the applicable contract unit prices for [Sand "[_____]",][and][Gravel "[_____]",][and][Filter Stone,] [Bedding Stone]. Price(s) and payment(s) include all costs of furnishing, hauling, placing and maintaining the bedding and/or filter material until placement of the riprap cover is completed and accepted. Geotextiles used as filters will be paid for in accordance with provisions of Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Preparation of the base will not be paid for separately and all costs incidental thereto will be included in contract prices for other items for which payment will be made. No payment will be made for excess thickness of bedding and/or filter material, nor for material required to replace subgrade material lost by rainwash, wind erosion, overexcavation or otherwise.

1.1.1.2 Measurement

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NOTE: Alternative 1.

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[[Gravel,][crushed stone,][and sand] placed for bedding and/or filter

layers will be measured for payment by the ton (metric) ton. Quantities will be computed to the nearest whole ton. Gravel, crushed stone, and sand will be measured for payment, in the presence of the Contracting Officer, by weighing on approved, accurately calibrated scales furnished by and at the expense of the Contractor.[The scales must be capable of printing a weight ticket including time, date, truck number, and weight.] Weight certificates furnished by a public weighmaster will be acceptable.] Submit Weigh Scale Certification and Certified Weight Scale Tickets, by a copy of the certification from the regulation agency, attesting to the scale's accuracy and a copy of each certified weight scale ticket after [_____] working day(s) after weighing.

****
NOTE: Alternate 2.
****

[[Gravel,][crushed stone,][and sand] placed for bedding and/or filter layers will be measured for payment as the volume determined by multiplying the area[, as measured in the field,] of the surface on which the gravel, crushed stone, or sand is placed, by the thickness measured perpendicular to the surface of the gravel, crushed stone, or sand as dimensioned on the contract drawings.] Geotextiles used as filters will be measured in accordance with provisions of Section 01 20 00 PRICE AND PAYMENT PROCEDURES. Preparation of the base will not be measured for payment.

1.1.1.3 Unit of Measure

Unit of measure: [ton (metric)][cubic meter][ton][cubic yard].

1.1.2 [Riprap] [[Manufactured] Derrick Stone] [Capstone] [Graded Stone] [Stone] [Bedding/Mattress Stone] [Splash/Fill Stone] [Armor/Cover Stone] [Core/Underlayer/Scour Stone]

[Due to the variable nature of broken concrete or construction debris, it is prohibited for stone channel, shoreline, or coastal protection.][_____]

1.1.2.1 Payment

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NOTE: Select the first optional paragraph for Alternate 1; select the second optional paragraph for Alternate 2a; select the last optional paragraph for Alternate 2b.
****

[Payment for [riprap] [and] [stone] satisfactorily placed will be made at the applicable contract unit price for [M[_____] R[_____] Riprap,] [Grouted M[_____] R[_____] Riprap,] [[Manufactured] Derrick Stone,] [and] [Capstone,] [Stone,] [Bedding/Mattress Stone,] [Splash/Fill Stone,] [Armor/Cover Stone,] [Core/Underlayer/Scour Stone]. Price(s) and payment(s) constitute full compensation for furnishing, hauling, handling, placing, and maintaining the [riprap][stone] until final acceptance by the Government. [No separate payment will be made for the stockpiling of [riprap] [and] [stone], and include all cost in connection with stockpiling in the Contract Unit Price for [riprap] [and] [stone].]]

[Payment for [riprap] [and] [stone] satisfactorily placed will be made at the applicable contract unit price for [M[_____] R[_____] Riprap,] [Grouted

M[_____] R[_____] Riprap,] [[Manufactured] Derrick Stone,] [Capstone,] [Stone,] [Bedding/Mattress Stone,] [Splash/Fill Stone,] [Armor/Cover Stone,] [Core/Underlayer/Scour Stone]. Price(s) and payment(s) constitute full compensation for furnishing all plant, labor, materials and equipment and constructing the stone protection in the work as specified. [No separate payment will be made for the stockpiling of [riprap] [and] [stone], and include all cost in connection with stockpiling in the contract unit price for [riprap] [and] [stone].]]

Payment for stone satisfactorily placed in constructing the [trenchfill revetment,] [stonefill dikes,] [stonefill revetments and junctions,] [excluding trenchfill revetments, wrap-around,] [dike capouts,] [reinforcements,] [bank paving,] and [outlet drains] will be made at the contract unit price for Graded Stone ["A"] ["B"] [and/or] ["C"], [57][_____]-kg [125][_____]-pound stone. Price(s) and payment(s) constitute full compensation for furnishing all plant, labor, stone, and performing all work necessary in placing the stone in constructing the trenchfill revetment, bank paving, and drainage structures as specified herein or shown on the drawings. Full payment for stone will not be permitted until trenchfill bank paving has been completed in a satisfactory manner. Twenty (20) percent of the payment for stone will be retained until bank paving has been completed in a satisfactory manner.

1.1.2.2 Measurement

****
NOTE: Alternative 1.
****

[[Riprap][Stone] will be measured for payment by the ton (metric) ton. Quantities will be computed to the nearest whole ton.] [[Riprap][Stone] will be measured for payment, in the presence of the Contracting Officer, by weighing on approved, accurately calibrated scales furnished by and at the expense of the Contractor.][The scales must be capable of printing a weight ticket including time, date, truck number, and weight.][Weight certificates furnished by a public weighmaster will be acceptable.]

****
NOTE: Alternative 2.
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[[Riprap][and][Stone] will be measured for payment by the ton (metric) ton as determined by [barge][vessel] displacement, [certified railroad weights,] where direct placement into structure(s) is practicable, or by weighing by the truckload on approved scales meeting the requirements of paragraph TRUCKLOAD.]

a. Truckload. Weigh each truck load to the nearest 0.10 ton (metric) 0.1 ton and the final quantity rounded to the nearest whole ton. Weigh [Riprap] [and] [Stone] for payment by weighing on approved scales before being placed in the work. Provide scales of sufficient length to permit simultaneous weighing of all axle loads and with an accuracy within 0.2 percent throughout the range of the scales. Ensure the scale's accuracy conforms to the applicable requirements of NIST HB 44 and is certified [by an acceptable scales company representative] [by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located] prior to weighing any [riprap] [and] [stone].[Locate the scales at the site of work.][Ensure the scales are capable of printing a weight ticket

including time, date, truck number, and weight.][If commercial scales are readily available in close proximity (within [_____][16] km [_____][10] miles) of site of work, they are to be used with the approval of the Contracting Officer and documentation certifying that the scales meet the requirements of the specification are to be provided.][Furnish the scales and weigh the [riprap] [and] [stone] in the presence of the Contracting Officer,[who will read and record the weights thereof][who will certify the correctness thereof]].[The Contracting Officer may elect to accept certified [railroad weights or] weight certificates furnished by a public weighmaster in lieu of scale weights at the jobsite.][Quarry weights will not be accepted.] Scales will be checked and certified before hauling [riprap] [and] [stone] [and after each [50 000][_____] tons (metric) [50,000][_____] tons increment of [riprap][and][stone] weighed under this contract].

b. [Barge][or Vessel] Load

(1) If delivered by [barge][or vessel], [riprap][and][stone] will be measured for payment by the Contracting Officer by weight determined by [barge][vessel] displacement. Furnish the Contracting Officer a [barge][vessel] displacement table not less than 10 work days prior to unloading the [riprap][and][stone] from any [barge][vessel]. Submit each table showing the name and/or number of the [barge][vessel] owner, the name of the fabricator, and the certification and date of certification of the person or firm preparing the table. Furnish with the [barge] [vessel] displacement tables a drawing or sketch of each [barge][vessel], dimensioned in sufficient detail to permit checking of the tables. Show, as a minimum, the length, width, depth of the [barge][vessel], and dimensions of the rake or rakes. A person or firm customarily performing this function other than the Contractor must certify the accuracy of each such table. Submit each table containing, in parallel columns, the freeboard of the [barge][vessel] in meters feet and tenths from zero to the full depth of the [barge][vessel] and the corresponding gross displacement to the nearest ton. Mark each [barge][vessel] suitably with [two][three] displacement gaging locations on each side near each end of the [barge][vessel][and two amidships on opposite sides]. Mark each gaging location by a line perpendicular to the edge of the [barge][vessel], 100 mm 4 inches wide and 300 mm 1 foot long, on both the deck and side of the [barge][vessel][and two amid ship on opposite sides]. Provide [barges][vessels] with rakes that have the displacement gaging lines placed at each corner of the box section between the rakes. If a [barge][vessel] has a box end or ends, place the gaging locations approximately 1200 mm 4 feet from the box end(s). The freeboard will be measured at the [four][six] gaging locations and the displacement determined by the use of "STANDARD [BARGE][VESSEL] TABLES" from the average of these measurements. The displacement will be determined before and after being unloaded and the difference between these values is the quantity delivered. Submit the Gaging Table Data, stone hauling vessel, gaging tables[and a copy of the data and calculations used for the preparation of the tables]. [Load [barges][vessels] so that the readings taken at the gaging locations do not vary more than 450 mm 1.5 feet port to starboard fore and aft and do not vary more than 150 mm 0.5 feet port to starboard. If such is not the case, trim the carrier by shifting the stone until this limit is

reached, before the measurement will be accepted.][Determine the draft from the average of all six readings weighting the readings of the middle gage at double those of the end gages. (G_1 + G_2 + 2xG_3 + 2xG_4 + G_5 + G_6) divided by 8 = average draft.][Ensure all carriers used in transporting stone are free of leaks such as would render accurate gauging difficult. Provide facilities for inspecting the hold of each carrier to determine whether leakage is occurring. Provide each carrier with adequate pumping facilities, and if water is found to be accumulating in the hold, pump the carrier dry before each gaging, both before and after unloading.] [Lightening by pumping or by transfer of crew or supplies will not be permitted while stone is being transferred.] [Leave rejected [riprap][stone] [_____] and unacceptable material aboard the [barge][vessel] until after the final readings are taken.]

(2) [If [barge][vessel] tables are furnished for fresh water and if it is believed that [barge][vessel] displacement measurements made within the contract limits of the work are being taken in water that has salinity, the Contractor has the option of obtaining water samples and determining densities or unit weights of these samples. Take these water samples in accordance with ASTM D3370 (Practice A - Grab Samples) at depths of 1200 and 2400 mm 4 and 8 feet in the area where measurements are made. Perform water sampling when the [barges][vessels] are measured for quantities, both when fully loaded and when empty. Take water samples, as witnessed by the Contracting Officer, with the use of "Polypro" 2000 ml water sampler, or equal. Determine densities as specified in ASTM D1429 (Method D-Hydrometer Method). Perform testing for the Contractor by a [certified] [validated] testing laboratory, and ensure test results are certified by the laboratory. After review and approval of the test results by the Contracting Officer, the average of the densities obtained at 1200 and 2400 mm 4 and 8 feet will be used as the suitable salt water conversion factor. In all calculations, the unit weight of 1000 kN/m^3 62.4 pounds per cubic foot will be used for fresh water.]

c. Stockpiled [Riprap][Stone] [_____]. If the Contractor elects to stockpile [riprap][stone] [_____] [on the worksite] [or] [offsite], weigh the [riprap][stone] [_____] immediately before placement by [either][the] method described above. [[Riprap][Stone] [_____] placed in temporary storage on the worksite as specified in paragraph WORKSITE STOCKPILE will not be required to be re-weighed prior to placement.] [If the [barge][vessel] displacement method is elected, a minimum of [one-third the total maximum displacement of the [barge][vessel]] [_____][500] tons (metric) [_____][500] tons of [Riprap][Stone] [_____] is required on each [barge][vessel].]

(1) Determination of Excess Stone. All stone outside the limits and tolerances of the cross sections of the structure, except variations so minor as not to be measurable, will be deducted from the quantity of new stone for which payment is to be made. Weight of excess stone will be determined from the cross sections obtained by the method provided for in paragraph FINAL SURVEYS, on the basis that the cubic meters feet of volume (including voids) for each type of stone, as listed in the Table in paragraph FACTORS USED FOR CONVERTING IN PLACE VOLUME TO WEIGHT, is equal to one ton (metric) or 1000 kg one ton or 2,000 pounds

for the bulk specific gravity and percentage of voids shown. If the bulk specific gravity of the stone furnished or the percentage of voids is other than as listed below, recompute the cubic meters feet of volume equaling 1000 kg 2,000 pounds as described in paragraph REVISIONS OF BIDDING SCHEDULE QUANTITIES. Should any excess stone be disclosed above the tolerance line as defined in paragraph CONSTRUCTION TOLERANCES, its volume will be computed by the average end area method, based upon the cross section in the following manner. The average end area of excess stone above the tolerance line for two (2) successive cross sections, multiplied by the distance between the cross sections will be accepted as the volume. [The Contractor will not be required to remove such excess stone and deductions for the weights thereof will be made from contract payments for new stone.]In addition to the above, deduct stone, which has been delivered to the site and has been lost or wasted or otherwise not properly incorporated into the final required work, from the quantity for which payment is to be made.

(2) Final Surveys. Perform survey work and measurements required for determination of excess volume computations for stone materials in the presence of the Contracting Officer. Notify the Contracting Officer not less than 3 days in advance of each survey.[In the event of unavailability of the Contracting Officer, perform the survey and certify to the Contracting Officer that it complies with the specifications.] Take cross section surveys perpendicular to the axis of the structures. Take elevations and soundings on lines [8][_____] m [25][_____] feet apart measuring along the structure reference line, with the readings at 1.5-meter 5-foot intervals and at breaks in the grade along the line. Other survey intervals and readings may be used if deemed appropriate or advisable by the Government's on-site representative. Additional cross sections, elevations, and soundings may be taken if determined necessary by the Government's on-site representative. Determination of quantities will be made by the Government's on-site representative and having once been made, will not reopen, except on evidence of collusion, fraud or obvious error. Prior to performing any work under this Section, coordinate all operations with the Government's on-site representative so that excess volume surveys will be made at the appropriate time. The surveys made under paragraph CHECK SURVEYS may be used when deemed appropriate by the Government's on-site representative, as part of the surveys required herein. Base stone quantity computations entirely upon weights of new stone as determined from carrier displacement or certified scale weight tickets. [Existing stone placed in lieu of new stone from off-site sources is excluded from measurement and payment.]

1.1.2.3 Unit of Measure

Unit of measure: [ton (metric)][cubic meter] [ton][cubic yard].

1.1.3 Concrete Grout for Grouted Stone Protection

1.1.3.1 Payment

Payment will be made for cost associated with concrete grout for grouted stone protection, which includes full compensation for furnishing all

plant, labor, material, equipment and other items necessary and incidental to the completion of the work.

1.1.3.2 Measurement

Concrete grout for grouted stone protection will be measured for payment based upon the volume determined from the calculated batch volume and the number of mixed batches delivered to the site and acceptably placed in the work.

1.1.3.3 Unit of Measure

Unit of Measure: cubic meter cubic yard.

1.1.4 Bedding Sand

1.1.4.1 Payment

Payment for bedding sand will be made at the contract unit price for "Bedding Sand" and constitute full compensation for material and placement of bedding sand in constructing drainage structures as specified herein.

1.1.4.2 Measurement

Measure bedding sand for payment by the ton (metric) ton of sand satisfactorily in-place in accordance with the requirements for stone measurement in paragraph STONE.

1.1.4.3 Unit of Measure

Unit of measure: ton (metric) ton.

1.1.5 Revetment Repairs

1.1.5.1 Earthwork, Small Repairs

When less than 8000 cubic meters 10,000 cubic yards of earthwork is specified, consider the earthwork as Earthwork, Small Repairs.

a. Payment will be made for costs associated with grading and excavation, which includes furnishing all equipment, labor and materials, and performing all clearing, except range clearing, drift removal and disposal of debris; grading and excavation; disposal of material from grading, whether or not used for fill; dressing; and all other operations incidental thereto.

b. Earthwork, Small Repairs will be measured for payment based upon on-site surveys, taken under the direction of the Government Representative, of the required grading or excavation areas prior to commencement and on-site surveys taken after completion of the work. All quantities removed will be determined from these surveys computed to the nearest cubic meter yard.

c. Unit of measure: cubic meter yard.

1.1.5.2 Earthwork, Large Repairs

When 8000 cubic meters 10,000 cubic yards or more of earthwork is specified, consider the earthwork as Earthwork, Large Repairs.

a. Payment will be made for costs associated with grading and excavation, which includes furnishing all equipment, labor and materials, and performing all clearing, except range clearing, drift removal and disposal of debris; grading and excavation; disposal of material from grading, whether or not used for fill; dressing; and all other operations incidental thereto.

b. Earthwork, Large Repairs will be measured for payment based upon on-site surveys, taken under the direction of the Government Representative, of the required grading or excavation areas prior to commencement and after completion of the work. All quantities removed will be determined from these surveys computed to the nearest cubic meter yard.

c. Unit of measure: cubic meter yard.

1.1.5.3 Breaking Out Pavement

a. Payment will be made for costs associated with breaking out asphalt and/or concrete pavement, which includes furnishing all material, equipment and labor for breaking out pavement, breaking concrete or asphalt into the required sizes, and using the broken pavement as fill where required, disposing of any excess material, and performing all work incidental thereto. Broken concrete or asphalt is prohibited as part of the designed structure. No payment will be made for breakout in those areas where only restoration or dressing of subgrade is necessary.

b. Breaking Out Pavement will be measured for payment based upon the number of square meters feet broken out, computed to the nearest 1/10 square meter 1/100 square foot.

c. Unit of measure: square meter feet.

1.1.5.4 Bedding Stone

a. Payment will be made for costs associated with Bedding Stone satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. Bedding Stone will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.5 [[57][_____]-kg [125][_____]-Pound Stone] [[_____] Riprap]

a. [Payment will be made for costs associated with [57][_____]-kg [125][_____]-Pound Stone] [[_____] Riprap] satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement

Premium".

b. [[57][_____]-kg [125] [_____]-Pound stone] [[_____] Riprap] will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.6 [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs

a. Payment will be made for costs associated with [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs, satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Small Repairs, will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.7 [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs

a. Payment will be made for costs associated with [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs, satisfactorily placed, which includes furnishing all material, equipment, and labor; placing the stone, including overbank paving and stone fills; dressing of subgrade; and performing other work incidental thereto, except that stone used in overbank paving, overbank stone spur, or stone landward of an obstruction will be paid for under pay item "Stone Placement Premium".

b. [Graded Stone ["A"] ["B"] ["C"]] [[_____] [Stone][Riprap]], Large Repairs, will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.5.8 Stone Placement Premium

a. A premium payment will be made for costs associated with [Crushed Stone][[57][_____]-kg [125][_____]-Pound] [Riprap][Stone][Graded Stone A, Small Repairs][Graded Stone A, Large Repairs] satisfactorily placed in overbank paving, overbank stone spur, or stone landward of an obstruction satisfactorily constructed or repaired, which includes furnishing all material, equipment, and labor; preparing the subgrade; hauling or rehandling stone; shaping spurs to the lines and grades specified; and performing other work incidental thereto.

b. Stone Placement Premium will be measured for payment based upon the quantities of stone satisfactorily placed.

c. Unit of measure: ton (metric) ton.

1.1.6 Reworking and Utilizing Existing Stone Materials

1.1.6.1 Payment

Payment for reworking existing stone materials and utilizing existing stone in lieu of required materials from off-site sources will be paid for separately from construction utilizing materials obtained from off-site sources. [Specifications pertaining to construction with existing onsite materials are included in Section 31 00 00 EARTHWORK for Site Preparation.]

1.1.6.2 Measurement

Reworking and Utilizing Existing Stone Materials will be measured for payment based upon [_____][[cubic][square] meters [cubic yards][square feet]of surface area of existing protection].

1.1.6.3 Unit of Measure

Unit of measure: [ton (metric)][square meter] [ton][square foot].

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 305R	(2020) Guide to Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2024c) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C127	(2024) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C476	(2023) Standard Specification for Grout for Masonry
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C685/C685M	(2024) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1429	(2013) Specific Gravity of Water and Brine
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3370	(2018) Standard Practices for Sampling Water from Flowing Process Streams
ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4992	(2014; E 2015) Evaluation of Rock to be Used for Erosion Control
ASTM D5312/D5312M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM D5313/D5313M	(2012; R 2013) Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions
ASTM D5519	(2015) Particle Size Analysis of Natural and Man-Made Riprap Materials

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing
COE CRD-C 148	(1969) Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
EM 1110-2-1601	(1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels
EM 1110-2-1906	(1970; 1986 Change 2) Engineering and

1.3 DEFINITIONS

1.3.1 Bank Stabilization

This paragraph explains certain terminology which is common to construction of bank stabilization work on the [_____] and which may not be self explanatory in the subsequent applicable provisions of the technical specifications and on the drawings.

1.3.1.1 Revetments

The term "revetment" applies to various types of stabilization structures that are constructed along the river approximately parallel to the current. The revetments are constructed of stone or piling.

1.3.1.2 Dikes

The term "dike" applies to the types of stabilization structures that are constructed along the river at an angle to the current. The dikes are constructed of stone or piling.

1.3.2 Standard Drawings

Details of various types of structures in general use on the [_____] are shown on standard drawings forming a part of these specifications.

1.3.3 Stone Protection

Stone Protection is defined as a system which includes a layer of bedding material or layers of filter material beneath a layer or layers of riprap. Stone protection is placed around structures in slack water or within a dewatered site. Stone protection may also be used to protect channel banks when it is placed in the dry or in slack water.

1.3.4 Riprap

Riprap is defined as a material having a gradation band similar to those specified in EM 1110-2-1601, Chapter 3, uniform graded material. Riprap is normally produced by mechanical methods, with a jaw crusher and grizzly after the stone has been mined by blasting in a quarry. Riprap gradations have a maximum top size of 3.5 tons.

1.3.5 Graded Stone

Graded Stone is defined as material with gradations that are produced by the mining technique and minimal additional processing other than the use of a skeleton bucket or a bar grizzly. The gradation band have more fines than riprap and have gradations with top size up to 3.5 tons and could be classified as being well graded.

1.3.6 Channel Protection

Channel protection is stone placed in a current as revetment, dikes, or slope paving without the use of a separate layer of bedding or filter material. In this type of environment, bedding sand or geotextiles and materials with gradation bands with a top size of 150 mm (6 inches) will not stay where placed.

1.3.7 Shoreline Protection

Shoreline Protection is defined as a system of bedding or filter materials and stone used to protect coastlines of lakes and oceans and for harbor protection.

1.4 SYSTEM DESCRIPTION

1.4.1 Factors Used for Converting In-Place Volume to Weights

****
NOTE: Insert values from the design report in the following table.
****

The following factors were used in converting the in-place volume to the quantities shown in the BIDDING SCHEDULE.

BULK STONE MATERIAL	SPECIFIC GRAVITY (SSD)	PERCENT VOIDS	CUBIC METERSFEET OF VOLUME PER METRIC TON INCLUDING COMPENSATION VOIDS (For Excess Quantity Calculations)
Mattress	[_____]	[_____]	[_____]
Bedding	[_____]	[_____]	[_____]
Core	[_____]	[_____]	[_____]
Underlayer	[_____]	[_____]	[_____]
Cover	[_____]	[_____]	[_____]
Armor	[_____]	[_____]	[_____]
Riprap	[_____]	[_____]	[_____]
Scour	[_____]	[_____]	[_____]
Fill	[_____]	[_____]	[_____]

1.4.1.1 Revision of Bidding Schedule Quantities

The estimated quantities of stone listed in the BIDDING SCHEDULE were computed on the basis of stone having a percentage of voids and a bulk specific gravity (saturated surface dry (SSD) basis) as shown in the above table based on water having a unit weight of 1000 kg per cubic meter 62.4 pounds per cubic foot. When the bulk specific gravity (SSD) of the stone to be used in the work is other than that shown in the above table, the estimated quantities will be revised by multiplying them by the fraction which results when the bulk specific gravity (SSD) of the stone furnished is divided by the value shown in the above table for each respective stone gradation. Revision for the percentage of voids will likewise be made. The Contracting Officer will issue a modification to the contract in accordance with FAR 52.243-4 Changes, to adjust the estimated quantities

in the BIDDING SCHEDULE. The revised quantities will then be the quantities from which the allowable fifteen percent (15 percent) variation in estimated quantity, for payment purposes, will be determined as defined in FAR 52.211-18 Variation in Estimated Quantity.

1.4.1.2 Re-revision of Estimated Quantities

If during the progress of the work it is determined that the delivered stone actually placed has a percentage of voids or a bulk specific gravity range different from that on which the BIDDING SCHEDULE is based, the BIDDING SCHEDULE will be further revised in accordance with paragraph REVISION OF BIDDING SCHEDULE QUANTITIES.

1.4.2 Bulk Specific Gravity of Stone and Redesign

If the Contractor, after award of the contract, requests approval of stone from a source(s) which has a range of bulk specific gravity (SSD), whose limits are lower or higher than the specified design range of [2.5 to 2.9] [_____] as specified in paragraph MATERIAL QUALITY, consideration will be given to revising the project design through modification of the design range under the following conditions:

a. The modification of the specified design range will result in a savings to the Government. Such savings are not subject to FAR 48 Value Engineering.

b. Only one (1) such proposal for modification will be allowed. In addition, do not extend the required completion time more than [thirty (30) [_____] calendar days as a result of redesign for any reason, including acts of the Government.

c. The modified design range of bulk specific gravity (SSD) to be used must not have a lower limit of less than [2.30] [_____] nor higher than [3.50] [_____].

d. The stone sections of the required structure are to be redesigned by the Government. Such redesign will be based upon the Contractor's proposed modifications to the specified design range of bulk specific gravity (SSD) and will include any required revisions to allowable tolerances. Only one such redesign will be made. A charge of [$5,000] [$_____] will be assessed the Contractor whether the redesign is used or not.

(1) The above redesign will be made upon written request from the Contractor. State the proposed modified design range of bulk specific gravity (SSD). With the request, submit records of laboratory tests performed on the proposed stone source(s) indicating the range of bulk specific gravity (SSD) of the stone source(s). Ensure the laboratory tests are performed by a Government validated commercial laboratory.

(2) The Government is allowed a period of [twenty-one (21)] [_____] calendar days after receipt of the request to make the redesign. The redesign will be made based upon the lower limit of the proposed modified design range of bulk specific gravity (SSD) furnished.

(3) Upon completion, redesign will be furnished to the Contractor, including revised estimated quantities for the BIDDING SCHEDULE,

based upon the average bulk specific gravity (SSD) of the proposed modified design.

(4) Upon receipt of the redesign, make a formal proposal to modify the allowable range and to perform the work in accordance with the redesign, within fifteen (15) calendar days after receipt of the Government's redesign; if the Contractor proposes to utilize stone having a specific gravity outside of the specific design range, and as a result thereof, the Government provides the Contractor with a redesign. Include a statement of the direct savings to the Government and a tabulation in the form of a revised BIDDING SCHEDULE showing unchanged unit prices for the revised quantities.

e. Submit any proposal to modify the specified design range within fifteen (15) calendar days after receipt of the Government's redesign and include a statement as to the savings which will result from the modification. If a formal proposal is not submitted within the time limit, perform the work in accordance with the specified design, in which case use of stone having a bulk specific gravity (SSD) less than the specified design range is not allowed.

f. The statement of savings must be in the form of a proposed revised BIDDING SCHEDULE showing unchanged unit prices for the revised quantities.

g. If the Contractor elects to perform the work in accordance with the redesign, the estimated quantities to be shown in the BIDDING SCHEDULE will be the quantities derived from the Government's redesign. See the above paragraph REVISION OF BIDDING SCHEDULE QUANTITIES.

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Riprap; G, [_____]

Filter Material; G, [_____]

Bedding Material; G, [_____]

Ready-Mixed Concrete Grout

Conveying and Placing

Admixtures

Curing Materials

Batching and Mixing Equipment

Gaging Table Data

[Manufactured]Derrick Stone; G, [_____]

Concrete Grout Mixture Proportions; G, [_____]

Bulk Specific Gravity of Stone and Redesign; G, [_____]

SD-04 Samples

Stone; G, [_____]

SD-06 Test Reports

Gradation Test

Evaluation Testing of Stone

Bedding Material

Bulk Specific Gravity

SD-07 Certificates

Stone

Bedding Material

Filter Material

Laboratory; G, [_____]

Weigh Scale Certification

Certified Weight Scale Tickets

1.6 QUALITY ASSURANCE

1.6.1 Stone

****

NOTE: For contracts having a short duration or awarded for emergency repair, there will be insufficient time to allow a Contractor to propose an unlisted source and have it evaluated; therefore, the bracketed sentences in paragraph STONE, subparagraphs SOURCES and EVALUATION TESTING, should be deleted.

****

Submit suitable stone samples prior to delivery of any such material to the worksite if stone is not from one of the stone sources listed at the end of this section.

1.6.1.1 General

All stone must be durable material as approved by the Contracting Officer. [Selected stone from the required excavation may be used if it satisfies all requirements as to quality and dimensions.] In case an unlisted source is to be used, show that an adequate quantity of material is available and provide quality test data.[Unlisted sources necessitate an evaluation by the Contracting Officer to determine their acceptability based upon a combination of laboratory test results, prior use in projects of a similar size and scope, and a site inspection by a Government geologist.] Provide stone of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. Ensure stone is free from cracks, blast fractures, bedding, seams and other defects or discontinuities that would tend to increase its deterioration from natural causes.[Inspect for discontinuities, cracks, fractures, seams and defects by visual examination. If, by visual examination, it is determined that [10][20] percent or more of the stone produced contains significant hairline cracks, then reject all stone produced by the means and measures which caused the fractures.] A hairline crack that is defined as being detrimental must have a minimum width of 0.1 mm 4 mil and continuous for one-third the dimension of at least two sides of the stone. [Provide stone that is clean and reasonably free from soil, quarry fines, and contains no refuse.] [Provide stone that is clean and adequately free from all foreign matter. Remove any foreign material adhering to or combined with the stone as a result of stockpiling prior to placement.]

1.6.1.2 Sources

****

NOTE: A special test that could be used to evaluate

the abrasion resistance of the riprap is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete. Assume that an Abrasion-Erosion Loss, percent by Mass of approximately 4 is equal to an L.A. Abrasion of 20 percent for a chert aggregate, and 8 is equal to an L.A. Abrasion of 20 percent for limestone.

The number of work days specified in this paragraph are based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

On the form attached at the end of this section, the Specifier must insert a listing of POTENTIALLY acceptable sources, giving at the minimum quarry locations, addresses, and telephone numbers applicable for the contract or a more detailed list as presented in EM 1110-2-2302, Figure 4-2.

****

[Stone approval is based on lab testing, in-service performance of stone in this or other projects from this source, quarry inspection and a demonstration stockpile on site at the quarry. Provide Lab testing results obtained not more than 5 years prior to date of Contract Award to ensure the data are representative and that the quarry has not moved into a section of substantially different material. Each source approval request is evaluated on a case by case basis. Evaluation requires submission of up-to-date lab testing results with every source approval. Approval testing will be at the contractor or quarry's expense. Test results will be accepted from a [certified] [validated]independent laboratory in lieu of testing at the government's laboratory at the discretion of the Contracting Officer.]

If approved, furnish stone from any of the sources listed at the end of this section or from any other source designated by the Contractor and accepted by the Contracting Officer, subject to the conditions herein stated.[Non-listed sources are prohibited.][If the Contractor proposes to furnish stone from a source not currently listed at the end of this section, the Government will conduct a quarry investigation and evaluate the quality test data provided by the Contractor to determine whether acceptable quantity and quality stone can be produced from the proposed source.] Satisfactory service records on other similar work may be considered by the Contracting Officer in the investigation. In order for stone to be acceptable on the basis of service records, stone of a similar quantity and size must have been placed in a similar thickness and exposed to weathering under similar conditions as are anticipated for this contract, and must have satisfactorily withstood such weathering for a minimum of [5][20] years. If no such records are available, the Government may choose to have tests conducted [at the Contractor's expense] [at the Government's expense] to assure the acceptability of the stone.[In addition to an acceptable 5 year service record, the Contracting Officer has the option to have representative samples taken and tested.]

[a. List of Sources. On the basis of information and data available to the Contracting Officer, stone meeting the quality requirements of these specifications has been produced from the sources listed at the end of this section.]

[
a. List of Sources]

[(1) Category I Sources: Category I sources have been inspected and evaluated within the last five years by the Government and have produced stone materials of acceptable quality from satisfactory geological formations. The Category I sources have previously demonstrated effective quality control programs at the source and the test results of the materials furnished have been verified that some material are of satisfactory quality. In a like manner, the source would be capable of providing the quality[, quantity,][and] [gradation] of required stone materials. Further evaluation and testing of the source will not be required unless the preparation of the required demonstration stockpile reveals an adverse condition not previously taken into account.]

****

NOTE: Lists may be provided either categorized indicating the level of confidence in a source's ability to meet the criteria of a specification based on how recent the previous usage, testing or inspections have been, by designating Category 1 and Category 2, or the list may simply provide sources with which there is some familiarity and that have a prior record. For emergency or expedited Contracts, or in the interests of common understanding between the agency, suppliers and contractors, or for reasons of cost or material availability, it may be useful to utilize State Highway Department gradations of materials. This should be done with caution as there is potentially great difference in quality requirements for highway department materials and Erosion Protection stone. When using highway department gradations it must be emphasized that the designation is FOR GRADATION ONLY, and that QUALITY/STONE CHARACTERISTICS properties MUST STILL BE MET, REGARDLESS OF STATE HIGHWAY DEPARTMENT CERTIFICATION.

****

[(2) Category II Sources: Category II sources either have not been inspected and evaluated within the past five years or have had a deficiency in the past which may or may not affect its qualifications to provide stone materials for this project. Deficiencies may include, but are not limited to: ineffective quality control program; unsatisfactory production techniques; unacceptable quality of material in the geological formation being quarried; insufficient quantities of required materials; or unsatisfactory durability of stone materials previously furnished. These factors of this kind do not disqualify the source for this project. A current inspection and evaluation of the source by the [Government][Contractor] would be necessary [to determine whether acceptable stone can be produced from the

proposed source][before allowing the source to proceed with preparation of demonstration stockpiles].[Disapproval of a proposed Category II source based on the inspection and evaluation would necessitate having the Contractor name a replacement source from the Category I list.]]

[b. Selection of Source. Designate in writing only one source or one combination of sources from which he proposes to furnish stone. [If the Contractor proposes to furnish stone from a source not listed at the end of this section, he may designate only a single unlisted source for stone and notify the Contracting Officer at least [60] [30] workdays before the stone leaves the quarry.] It is the Contractor's responsibility to determine that the stone source or combination of sources selected is capable of providing the [quality,] quantities and gradation needed and at the rate needed to maintain the scheduled progress of the work.[Provide samples for acceptance testing in accordance with paragraph EVALUATION TESTING below. If a source for stone so designated by the Contractor is not accepted for use by the Contracting Officer, the Contractor may not propose other sources but must furnish the stone from a source listed[in Category I] at the end of this section with no additional payment.]]

[c. Acceptance of Materials.[Acceptance of a source of stone is not to be construed as acceptance of all material from that source. The right is reserved to reject materials from certain localized areas, zones, strata, or channels, when such materials are unsuitable for stone as determined by the Contracting Officer. The Contracting Officer also reserves the right to reject individual units of produced specified materials in stockpiles at the quarry, all transfer points, and at the project construction site when such materials are determined to be unsuitable. During the course of the work, the stone may be tested by the Government, if the Contracting Officer determines that testing is necessary. If such tests are determined necessary, the testing will be done in [the Government's testing laboratory][or][commercial laboratory selected by the Government]. Materials produced from a listed or unlisted source must meet all the requirements herein. The cost of testing will be at the Government's expense.][During the contract period, both prior to and after materials are delivered to the job site, visual inspections and measurements of the stone materials may be performed by the Contracting Officer. If the Contracting Officer, during the inspections, finds that the stone quality, gradation or weights of stone being furnished are not as specified or are questionable, re-sampling and re-testing is required. Sampling of the delivered stone for testing and the manner in which the testing is to be performed must be as directed by the Contracting Officer. Perform this additional sampling and testing at the Contractor's expense when test results indicate that the materials do not meet specified requirements. When test results indicate that materials meet specified requirements, an equitable adjustment in the contract price will be made for the sampling and testing. Remove or dispose of any rejected material as specified and at the Contractor's expense.]]

1.6.1.3 Evaluation Testing of Stone

****

NOTE: Alternate 1 - Use this paragraph if testing is to be performed by the Government at the Material Testing Center at CEWES or at a Government selected

commercial laboratory that has been validated to being able to perform the required tests; delete paragraph EVALUATION TESTING OF STONE (Alternate 2) in PART 2 PRODUCTS.

For contracts having a short duration or are awarded for emergency repair, there will be insufficient time to allow a Contractor to propose and unlisted source and have it evaluated; therefore, delete the bracketed sentences in paragraph STONE above; and subparagraphs SOURCES, above, and this paragraph, EVALUATION TESTING OF STONE, should be deleted.

Table 6-1 of EM 1110-2-2302 gives a broad generalization of desired quality criteria for stone. However, the quality criteria specified in this document was based upon a limited review of criteria being used by Corps. Each District or Division should specify the desired quality of stone necessary to meet performance criteria. It is recommended that at a minimum the stone should be evaluated using petrographic analysis, specific gravity, unit weight, freezing and thawing, and resistance of rock to wetting and drying. The freezing and thawing testing should be performed in accordance with COE CRD-C 144 or ASTM D5312/D5312M on the largest sawn sections of stone, between [_____] mm^2 (144-2304 square inches), so that bedding planes or any potential planes of weakness can be evaluated. These size samples require stone samples that range between 70 kg and 3400 kg 150 pounds and 7400 pounds. If ASTM D5313/D5313M are required, the test specimen must be of the same size range as specified above. LRD has testing and evaluation procedures for shoreline protection that require larger samples for evaluation of material being used on their projects due to the severity of their environment and the larger sizes of stone used for shoreline protection. These procedures should be investigated if the standard procedures specified are not giving you adequate durability for stone placed on past projects.

A special test that could be used to evaluate the abrasion resistance of stone is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete.

The number of work days specified in this paragraph are based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

The size of a sample has been reduced to three

pieces of stone weighing 70 kg 150 pounds minimum each for stone gradations with a nominal top size less than 1400 kg 3000 pounds. The number of pieces has been reduced by the COR being a geologist or materials engineer and present during the sample collection. Also, the pieces need to be washed to make sure they are similar and only three pieces are required by the Laboratory for evaluation of sample. Larger size stones may be required for evaluating stone used for shoreline protection.

Delete this submittal if evaluation testing of stone will be performed by the Government at a Government Laboratory.

****

****

NOTE: The Drop Test should not be used to determine stone durability as it is entirely qualitative, and may produce fine fractures that are not immediately discernible. Further, it may damage stone that may very well be later incorporated into the work, if not discarded following the "test."

****

Submit a copy of the laboratory inspection report along with actions taken to correct deficiencies and a copy of the test reports, prior to delivery of such material to the worksite; since quality test on the stone in accordance with PART 2 paragraph EVALUATION TESTING OF STONE is the responsibility of the Contractor. The tests to which the stone may be subjected will include petrographic analysis, specific gravity, unit weight, absorption, wetting and drying, freezing and thawing and such other tests as may be considered necessary to demonstrate that the stone is of a satisfactory quality which is at least equivalent to stone from the sources listed at the end of this section.

a. [Unit Weight][Bulk Specific Gravity, saturated surface dry (SSD)] and Absorption. Stone must [weigh more than [_____][2500] kN/m^3 [_____][155] pounds per cubic foot][have a bulk specific gravity, saturated surface dry, (SSD), greater than [_____][2.48]]. Provide stone with an absorption less than [2][_____] percent unless other tests and service records show that the stone is satisfactory. The method of test for [unit weight][bulk specific gravity (SSD)] and absorption will be ASTM C127.

b. Samples. Take samples of stone from a source not listed at the end of this section by a representative of the quarry under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Samples consist of at least three pieces of stone, roughly cubical in shape and weighing no less than [70][_____] kg [150][_____] pounds each from each unit that will be used in the production of the required stone. If the source is an undeveloped quarry[, or if the operation has been dormant for more than one year such that fresh samples are not available,] expose fresh rock for 6 m 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation.[The Contracting Officer may also require documentation of subsurface exploration of an

undeveloped quarry in order to determine whether or not sufficient reserves are available.] Ship samples at the Contractor's expense to [Waterways Experimental Station, Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180, Attn: [_____]], and notify [Mr.][Ms.] [_____], [_____] Branch, [_____] District to arrange for testing at least [40][60][_____] workdays before the stone leaves the quarry.

c. Tests. The tests will be conducted in accordance with applicable Corps of Engineers methods of tests given in the Handbook for Concrete and Cement or ASTM methods of tests.[The cost of testing one new source will be borne by the Government.]

[1.6.1.4 Random Sampling

The stone produced by each source will be sampled by the Government for Quality Assurance testing on the basis of a minimum once each year[or once during the production of each [_____][25 000][50 000] tons (metric) tons of stone produced each year for the Government]. The samples will be evaluated based upon petrographic analysis, specific gravity, [unit weight,][bulk specific gravity (SSD),] [_____], and absorption.

]1.6.2 Concrete Grout for Stone Protection

****
NOTE: If the Designer elects to specify grouting requirements for the project under another section, special care should be taken to delete all grouting requirements specified in this section and appropriate references added identifying the section specifying the grouting requirements.
****

1.6.2.1 General

The Government reserves the right to sample and test the aggregates and grout to determine compliance with the specifications. Provide facilities and labor as may be necessary to assist the government in procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Grout will be sampled in accordance with ASTM C172/C172M. The slump and air content will be determined when cylinders are molded in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively. Compression test specimens will be made, cured and transported in accordance with ASTM C31/C31M. Compression test specimens will be tested in accordance with ASTM C39/C39M. Samples for strength tests will be taken not less than once each shift in which grout is produced. A minimum of three specimens will be made from each sample, two will be tested at 28 days (90 days if pozzolan is used) for acceptance and one will be tested at 7 days for information.

1.6.2.2 Concrete Grout Mixture Proportions

Concrete grout mixture proportions is the responsibility of the Contractor.[Submit the mixture proportions that will produce grout of the qualities required, ten days prior to placement.][Submit grout mixture proportions for grouting manufactured derrick stone.] Submit mixture proportions for review [_____] [10] days prior to being used under this contract. Include mixture proportions of the dry weights of

cementitious material(s); the specific gravities, absorptions, and saturated surface-dry weights of the fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic meters cubic yards of grout. Also, submit applicable test reports, such as air content, compressive strength, and unit weight of the grout, to verify the proportions selected will produce grout of the quality specified. Do not change the approved grout mixture proportions without approval by the Contracting Officer. The air content must be between 4.5 and 7.5 percent. The specified compressive strength f'c is [1.4][1.8][_____] kg/mm^2 [2000][2500][_____] pounds per square inch at 28 days (90 days if pozzolan is used). The maximum water cement ratio is [_____][0.70]. The slump of the grout mix is 150 mm 6 inches plus or minus 25 mm 1 inch. For maximum coarse aggregate size see paragraph AGGREGATES FOR CONCRETE GROUT.

1.6.2.3 Evaluation and Acceptance of Grout

The acceptance test results will be the average of the strengths of the two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete grout will be considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength f'c and no individual acceptance test result falls below the specified strength f'c by more than [350] g/mm^2 500 pounds per square inch.

1.7 REGULATORY REQUIREMENTS

****
NOTE: Insert the appropriate State Highway Department specifications as applicable.
****

The regulatory requirements listed below form a part of this specification to the extent referenced. The regulatory requirements are referred to in the text by basic designation only.

[_____] STATE HIGHWAY AND TRANSPORTATION DEPARTMENT ([_____])

[_____] [(____)] Standard Specifications for Highway Construction

1.8 CONSTRUCTION TOLERANCES

****
NOTE: For tolerances in general, 1/2 of the D-50 stone dimension of gradation range is allowed above the neatline and 1/4 of the same dimension is allowed below the neatline for stone gradation with a maximum size of 300 kg 650 pounds. For large stone the tolerance may be reversed. It is critical to make sure that layer thicknesses are physically possible for the stone materials specified - you cannot require two layers of stone in space too small for even one individual stone. Check both the Specifications and the Drawings to verify that the slopes and grades are constructable with the sizes of materials specified.
****

The finished surface and stone layer thickness is not allowed to deviate from the lines and grades shown by more than the tolerances listed below. Tolerances are measured perpendicular to the indicated neatlines. Ensure extreme limits of the tolerances given are not continuous in any direction for more than [_____] [five] times the nominal stone dimension nor for an area greater than [9.3][18.6][93] m^2 [100][200][1000] square feet of the structure surface.

NEATLINE TOLERANCES		
MATERIAL	ABOVE NEATLINE (mm)(inches)	BELOW NEATLINE (mm)(inches)
Foundation	[_____]	[_____]
Mattress	[_____]	[_____]
Bedding	[_____]	[_____]
Core	[_____]	[_____]
Underlayer	[_____]	[_____]
Cover	[_____]	[_____]
Armor	[_____]	[_____]
Riprap	[_____]	[_____]
Scour	[_____]	[_____]
Fill	[_____]	[_____]

The intention is that the work is built generally to the required elevations, slope and grade and that the outer surfaces are even and present a neat appearance. Remove or rearrange placed material not meeting these limits as directed by the Contracting Officer. Payment will not be made for excess material which the Contracting Officer allows to remain in place.

PART 2 PRODUCTS

2.1 BEDDING MATERIAL

****
NOTE: This paragraph presents gradation bands of materials that were developed based upon seepage criteria presented in EM 1110-2-1913. Each bedding material system should be designed to be used with a specific range of riprap gradations, foundation conditions, and channel conditions.
****

2.1.1 General

Submit the source for materials used in riprap[,] [and] [filter][,] [and] [bedding]. Provide bedding material consisting of [a washed] [gravel or] crushed stone. Submit test reports attesting that the [bedding material] [,] [and] [filter material] meet specified requirements.

2.1.2 Material

****
NOTE: Delete gradation limits that are not required.
****

Ensure bedding material is composed of tough, durable particles, adequately free from thin, flat and elongated pieces, and contains no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Provide aggregates meeting the quality requirements of ASTM C33/C33M[or paragraph REGULATORY REQUIREMENTS]. Use gradation conforming to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
BEDDING STONE NO. 1 - GRAVEL OR CRUSHED STONE	
100 mm4 in.	[_____]
75 mm3 in.	[_____]
50 mm2 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]
4.75 mmNo. 4	[_____]

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
BEDDING STONE NO. 2 - CRUSHED STONE	
150 mm6 in.	[_____]
100 mm4 in.	[_____]
75 mm3 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]
2.36 mmNo. 8	[_____]

Provide bedding material well-graded between the limits shown. Perform at

least one test on each [_____] 1000 tons [to be delivered to the project site][placed] for each specified gradation in accordance with ASTM C136/C136M.[Remove a representative sample weighting no less than 45 kg 100 pounds from the bedding layer placed at locations directed by the Contracting Officer.] Ensure all points on individual grading curves obtained from representative samples of bedding material lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG FORM 2087 or similar form. The individual gradation curves within these limits are not allowed to exhibit abrupt changes in slope denoting either gap grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the bedding layers.

2.2 FILTER MATERIAL

****

NOTE: This paragraph presents gradation bands of materials that were developed based upon seepage criteria presented in EM 1110-2-1913. Each filter material system should be designed to be used with a specific range of riprap gradations, foundation conditions, and channel conditions.

The Specifier should use Alternative 1 if there is a concrete section in the specifications and if the gradations therein are satisfactory for filter materials. If there is no concrete section, or if the gradations therein are unsatisfactory for filter materials, the Specifier should use Alternative 2.

NOTE: Alternative 1.

****

Submit certificates of compliance attesting that the materials meet specification requirements.[Provide filter material consisting of [washed][sand and gravel][and crushed stone] [filter stone and geotextile]. Provide [sand and gravel][and crushed stone] for filter materials which meets the applicable requirements of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE, paragraph MATERIALS, subparagraph AGGREGATES.][Provide geotextiles as specified in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.]

****

NOTE: Alternative 2.

****

[Provide filter material consisting of [Sand "[_____]",] [Gravel "[_____]",] [Filter Stone] [Filter Stone and Geotextile]. Ensure the [filter material] [filter stone] is composed of tough, durable particles, adequately free from thin, flat and elongated pieces, and contains no organic matter nor soft, friable particles in quantities considered objectionable by the Contracting Officer. Provide aggregate meeting the quality requirements of ASTM C33/C33M[or paragraph REGULATORY REQUIREMENTS]. Ensure grading conforms to the following requirements:

U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
SAND "[_____]"	
9.50 mm3/8 in.	[_____]
4.75 mmNo. 4	[_____]
2.36 mmNo. 8	[_____]
1.18 mmNo. 16	[_____]
600 µmNo. 30	[_____]
300 µmNo. 50	[_____]
150 µmNo. 100	[_____]
U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
GRAVEL "[_____]"	
37.5 mm1-1/2 in.	[_____]
19.0 mm3/4 in.	[_____]
9.5 mm3/8 in.	[_____]
4.75 mmNo. 4	[_____]
2.36 mmNo. 8	[_____]
1.18 mmNo. 16	[_____]
U.S. STANDARD SIEVE	PERMISSIBLE LIMITS PERCENT BY WEIGHT, PASSING
FILTER STONE	
150 mm6 in.	[_____]
100 mm4 in.	[_____]
75 mm3 in.	[_____]
37.5 mm1-1/2 in.	[_____]
25 mm1 in.	[_____]
12.5 mm1/2 in.	[_____]

Provide [filter materials] [filter stone] that are well-graded between the limits shown.[Naturally-produced gravel is not considered crushed stone.] Perform at least one test on each 1000 tons [to be delivered to the project site][placed for each specified gradation in accordance with

ASTM C136/C136M].[Remove a representative sample weighing no less than 45 kg 100 pounds from the filter layer placed at locations directed by the Contracting Officer.] All points on individual grading curves obtained from representative samples of [filter material] [filter stone] must lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG FORM 2087 or similar form. The individual gradation curves within these limits are not allowed to exhibit abrupt changes in slope denoting either gap grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the filter. Provide geotextile in accordance with Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.]

2.3 [BEDDING]SAND[FILL][CUSHION LAYER]

****

NOTE: Sand fill is used to bring areas which are below grade in paragraph BASE PREPARATION to within allowable minus tolerance instead of using filter or bedding materials.

****

[Provide a clean, free draining sand in accordance with classification SP in ASTM D2487, except that no more than 5 percent by weight of the material smaller than a No. 4 sieve, must pass a No. 200 sieve. If sand meeting this criteria is available on site it may be used.][Sand must meet [paragraph REGULATORY REQUIREMENTS][ASTM C33/C33M] gradation requirements for fine aggregate.]

2.4 STONE

2.4.1 General

2.4.1.1 Evaluation Testing of Stone

****

NOTE: Alternate 2 - Use this paragraph if testing is to be performed by the Contractor at a Commercial Laboratory; delete paragraph EVALUATION TESTING OF STONE (Alternate 1) in PART 1 GENERAL.

For contracts having a short duration or are awarded for emergency repair, there will be insufficient time to allow a Contractor to propose an unlisted source and have it evaluated; therefore, delete the bracketed sentences in paragraph STONE above, and subparagraphs SOURCES, above, and this paragraph EVALUATION TESTING OF STONE, should be deleted.

Table 6-1 of EM 1110-2-2302 gives a broad generalization of desired quality criteria for stone. However, the quality specified in this document was based on a limited review of criteria being used by the Corps. Each District or Division should specify the desired quality of stone necessary to meet performance criteria. It is recommended that at a minimum the stone should be evaluated using petrographic analysis, specific gravity, unit weight, absorption, freezing and thawing, and resistance of rock to wetting and

drying. The freezing and thawing testing should be performed in accordance with COE CRD-C 144 or ASTM D5312/D5312M on the largest sawn sections of stone, between 0.09-1.49 m^2 144-2304 square inches so that bedding planes or any potential planes of weakness can be evaluated. These size samples require stone samples that range between 70 kg and 3400 kg 150 pounds and 7400 pounds. If ASTM D5313/D5313M is required, the test specimen must be of the same size range as specified above. Some organizations have testing and evaluation procedures for shoreline protection that require larger samples for evaluation of material being used on their projects due to the severity of their environment and the larger sizes of stone used for shoreline protection. These procedures should be investigated if the standard procedures specified are not giving adequate durability information for stone placed on past projects.

A special test that could be used to evaluate the abrasion resistance of the stone is COE CRD-C 63, Abrasion-Erosion Resistance of Concrete.

The number of work days specified in this paragraph is based on the assumption that to tentatively approve the use of a source under a single contract requires data for unit weight, absorption, and petrographic analysis of the stone. A minimum of 80 work days would be required to have available data from the freeze and thawing test. Arrangements need to be made with the testing laboratory when notice is given to evaluate source not after samples are collected.

The size of a sample has been reduced to three pieces of stone weighing 70 kg 150 pounds minimum each for stone gradations with a nominal size less than 1400 kg 3000 pounds. The number of pieces has been reduced by the COR being a geologist or materials engineer and present during the sample collection. Also, the pieces need to be washed to make sure they are similar and only three pieces are required by the laboratory for evaluation of sample. Larger size stones may be required for evaluating stone used for shoreline protection.

****

For stone from an unlisted source, have evaluation tests performed on stone samples collected from the proposed source. Perform quarry investigation by a registered geologist or registered engineer. The tests include petrographic examination (ASTM C295/C295M), [bulk specific gravity (SSD),][unit weight,] absorption (ASTM C127), resistance of stone to freezing and thawing ([COE CRD-C 144][ASTM D5312/D5312M]), resistance to wetting and drying (ASTM D5313/D5313M). The laboratory to perform the required testing must be validated based on relevant paragraphs of ASTM D3740, and no work requiring testing is permitted until the laboratory has been inspected and validated unless approved prior to testing by the Contracting Officer. A copy of the documents, provided by

the Materials Testing Center (MTC) at CEWES[or other governmental agency], that validates that the laboratory can perform the required tests. List the individual tests for which the validation covers along with the date of the inspection. The first inspection of the facilities is at the expense of the Government and any subsequent inspections required because of failure or deficiencies identified by the first inspection are at the expense of the Contractor.

a. Bulk Specific Gravity Range. All stone must have a minimum bulk specific gravity, saturated surface dry (SSD), of [_____][2.50][and a maximum bulk specific gravity of not more than [_____] [2.90]] based upon water having a unit weight of 9.8 kN/m^3 62.4 pounds per cubic foot. The method of test for bulk specific gravity (SSD) is ASTM C127.[Reference is made to paragraph FACTORS USED FOR CONVERTING IN-PLACE VOLUME TO WEIGHT for instructions for converting in-place volume to bid quantities and for instructions on adjusting bid schedule quantities for variations in bulk specific gravity and percentage of voids.]

b. Unit Weight and Absorption. Stone must [weigh more than [24][_____] kN/m^3 [155][_____] pounds per cubic foot][have a bulk specific gravity, saturated surface dry, greater than [2.48][_____][2.60]]. Provide stone with an absorption less than [1][2][_____] percent unless other tests and service records show that the stone is satisfactory. The method of test for unit weight and absorption is ASTM C127.

c. Petrographic Examination. Evaluate stone in accordance with ASTM C295/C295M which includes information required by ASTM D4992, paragraph 10. Use COE CRD-C 148 to perform Ethylene glycol tests required on rocks potentially containing smectite as specified in ASTM D4992 and on samples identified to contain swelling clays.

d. Resistance to Freezing and Thawing. Use stone with a maximum loss of [_____][5][10] percent after the number of cycles specified in ASTM D5312/D5312M, Figure 1, when determining the durability of stone when subjected to freezing and thawing in accordance with [COE CRD-C 144][ASTM D5312/D5312M], except the surface area of one side of the sample must be between [0.09][_____] and [1.49][_____] m^2 [144][_____] and [2304][_____] square inches.

[

e. Resistance of Rock to Wetting and Drying. Use stone with a maximum loss of [1][_____] percent when determining the durability of stone when subject to wetting and drying in accordance with ASTM D5313/D5313M, except the surface area of one side of the sample must be between [0.09][_____] and [1.49][_____] mm^2 [144][_____] and [2304][_____] square inches.]

f. Samples. Take samples of stone from a source not listed at the end of this section by a representative of the quarry or source under the supervision of the Contracting Officer for testing and acceptance prior to delivery of any stone from this source to the site of the work. Include in the information provided with the samples the location within the quarry or source from which the sample was taken along with a field examination of the quarry or source. Include the information outline in ASTM D4992, paragraph 7, in the field examination. Samples consist of at least three pieces of stone, roughly cubical in shape and weighing no less than [70][_____] kg

[150][_____] pounds each from each unit that is used in the production of the required stone. If the source is an undeveloped quarry, or if the operation has been dormant for more than one year such that fresh samples are not available, expose fresh rock for 6 m 20 feet horizontally and for the full height of the face proposed for production, prior to the field evaluation.[The Contracting Officer may also require documentation of subsurface exploration of an undeveloped quarry in order to determine whether or not sufficient reserves are available.] Ship samples at the Contractor's expense to a laboratory validated by the government to perform the required tests.

g. Tests. Conduct the tests in accordance with applicable ASTM and Corps of Engineers methods of tests, given in the Handbook for Concrete and Cement, in a laboratory validated by the government. The cost of testing are borne by the Contractor.

2.4.1.2 Quarry Operations

Conduct quarry operations in a manner to produce stone conforming to the requirements specified. This may involve selective quarrying, handling, processing, blending, and loading as necessary, [as specified in Section 01 45 00 QUALITY CONTROL]. Controlled blasting and handling of rock to produce rock of the size ranges and quality specified. Techniques such as the use of proper hole diameter, hole depth, hole angle, burden and spacing distances, types and distribution of explosives. delay intervals and sequence, removal of muck piles between each shot, and special handling techniques are required as necessary to produce the specified materials. Specifically design all aspects of blasting operations so that the end product is not damaged from the blasting technique and that the stone is suitable for the intended purpose.

a. Curing Stone

Conduct curing operations on freshly quarried stone to allow it to release stored energy and moisture. This will allow the stone to exhibit initial and subsequent post blasting stress relief and reveal any significant fractures during the energy release and drying-out phase. Stockpile stones of sizes which are individually picked temporarily at the quarry site a minimum of [_____] calendar days before being shipped to the project site, unless this requirement is waived by the Contracting Officer. Such waiver will be granted only if the stone has characteristics that make curing unnecessary.

b. Stone Quarrying Exclusion Period

****
NOTE: Exclude the possibility of waiving the quarrying period restrictions unless the District Geologist authorizes inclusion of the language in the specification for the project.
****

Stone quarried between the [_____][15th of September and the 15th of April] will not be approved for use in the project.[If the stone is not affected by freeze-thaw cycles, and the durability history of the stone demonstrates that quarrying during the exclusion period has not adverse effect on the durability of the stone and the Contracting Officer approves the use of stone quarried during the exclusion period, the stone quarrying period exclusion may be waived by the

Contracting Officer.] Stone quarried before the the exclusion period at a time which will not permit sufficient curing time before being subjected to freezing conditions, and which is subject to fracturing as a result of freeze-thaw cycles, will not be approved for use.

c. Temporary Storage at Quarry

Prolonged storage of stone materials prior to shipment from the quarry and prior to permanent placement in the required work are subject to approval of the Contracting Officer.[Underwater storage of stone materials is prohibited.]

2.4.1.3 Gradation Test

****

NOTE: As a rule of thumb the sample size should be between 20 to 100 times the weight of the maximum size stone within a specified gradation (see ASTM D5519, Note 2). Recommend using either the calculated minimum sample size or the following size samples for the ranges specified.

15 metric ton sample required for riprap with a top size up to 225 kg 500 pounds. 25 metric ton sample required for riprap or stone with top size between 225 kg 500 pounds and 1000 kg 2200 pounds and 50 metric ton sample required for riprap or stone with top size larger than 1000 kg 2200 pounds up to 3400 kg 7500 pounds.

For sources which have riprap or stone as a standard production item: One gradation test minimum, at the quarry, required for each 50 000 metric tons of riprap or stone with a top size of 460 kg 1,000 pounds or larger, or one test required for each 25,000 metric tons of smaller riprap or stone.

To allow the Contractor to perform a gradation test without the Contracting Officer present, the quantity of riprap or stone required for the project must be less than 10,000 metric tons.

Use consistent terminology - if the CLIN in the Bid Schedule refers to Jetty Stone or Armor Stone, use terms exclusively in the text of the Specifications that apply to each - and cross check that the terms are used correctly in the Drawings.

****

Perform a gradation test or tests on the riprap, stone, or [_____] at the quarry in accordance with paragraph STANDARD TEST METHOD FOR GRADATION OF RIPRAP, GRADED STONE, AND [_____]. Take the sample in the presence of the Contracting Officer. Notify the Contracting Officer not less than 3 days in advance of each test. Submit the gradation tests using the GRADATION TEST DATA SHEET enclosed at end of this section for riprap or stone. [In the event of unavailability of the Contracting Office, perform the tests and certify to the Contracting Officer that the riprap, stone, or [_____] shipped complies with the specifications.] Perform at least [one] [_____] gradation test(s) per [50,000] [_____] tons(metric)tons of each size of

riprap, stone, or [_____] placed, but do not perform less than one test. Report gradation tests using the forms, GRADATION TEST DATA SHEET and ENG FORM 4794-RM 4794-R, attached at end of this section or approved alternative.[Designate on the test form that portion in tons (metric) tons of the lot tested which is applicable to this contract. Correct any deviation from the reported tonnage and record on a revised GRADATION TEST DATA SHEET.][Provide sample consisting of no less than [15] [25] [50] [_____] tons(metric) tons of [_____] riprap, stone, or [_____], and collect in a random manner which will provide a sample which accurately reflects the actual gradation arriving at the jobsite.][Provide sample consisting of between 30 to 35 pieces of armor stone and jetty stone. A minimum of two tests are required for acceptance of armor stone and jetty stone. Mark the weight of the individual pieces of armor stone and jetty stone, representing the minimum, maximum and 50 percent greater than sizes for the specified armor stone and jetty stone gradation, on each stone [and place at the quarry to provide visual comparison during production at the quarry]and place in a location adjacent to the work site in order to provide a basis for visual comparison during placement of the armor stone and jetty units. Use these stones in the last placement if needed.] Failure of the test on the initial sample and on an additional sample will be considered cause for rejection of the quarry and/or quarry process, and set aside all riprap, stone , or [_____] represented by the failed tests and do not incorporate into the work. Any additional tests required because of the failure of an initial test sample will not be considered as one of the other required tests. If collected by the truckload, each truckload must be representative of the gradation requirements. [The Contracting Officer may direct additional testing of the riprap, stone or [_____] at the project site if the riprap, stone, or [_____] appears, by visual inspection, to be out of gradation.] [Perform additional tests on in-place materials at the locations directed, or on random loads selected by the Contracting Officer.][In-place test areas must be no less than 3.6 by 3.6 m 12 by 12 feet [_____] and include the full thickness of the placed riprap, stone, or [_____] layer, without disturbing or including the underlying material and meet the minimum sample size specified above]. Refill and rework each pit or void excavated for an in-place test sample to provide a surface void of signs of disturbance.[Perform [one][additional] in-place gradation on each [3800 cubic meters][7500 tons (metric) [5,000 cubic yards][7,500 tons] or portion thereof placed.][If the gradation test fails, additional gradation tests will be required at the Contractor's expense to delineate the limits of unacceptable stone. Do not count additional gradation tests as part of the minimum number of gradation tests required. Rework and replace the unacceptable stone as necessary to correct the deficiency within the specified gradation or remove the stone from the project site as determined by the Contracting Officer.] The Contracting Officer may direct this testing under FAR 52.246-12 Inspection of Construction. Provide all necessary screens, scales and other equipment, and operating personnel, to grade the sample. Certification and test results represent riprap, stone, or [_____] shipped from the quarry. Certification and tests results must be received by the Contracting Officer at the jobsite before the riprap, stone. or [_____] is used in the work.

2.4.1.4 Proportional Dimension Limitations

[The maximum aspect ratio (greatest dimension:least dimension) of any piece of stone for size ranges [which are not graded with a screen or grizzly,] must be not greater than 3:1 when measured across mutually perpendicular axis. Allow no more than 25 percent of the stones within a gradation range to have an aspect ratio greater than 2.5:1.][A maximum

of [5][10][15] percent flat and elongated pieces by weight will be acceptable. A flat and elongated piece of riprap is defined as having a ratio of width to thickness or length to width greater than 3:1. Use ASTM D4791 as a guide to perform the test.]

2.4.1.5 [Riprap][Stone][_____] Stockpile

Storage of [riprap][stone][_____] at the worksite is not to be confused with off-site stockpiling of riprap, stone, or [_____]. If the Contractor elects to provide off-site stockpiling areas, notify the Contracting Officer of all such areas.[The Contractor's stockpile must be a maximum of 3.6 m 12 feet high and formed by a series of layers of truckload dumps, where the rock essentially remains where it is placed. Start subsequent layers 3 m 10 feet from the edge of the previous layer so that the rock will not roll down the edges of the previous layers.] The first layer must be a maximum of 1.8 m 6 feet high. After being stockpiled, do not put any riprap, stone, or [_____] which has become contaminated with soil or refuse into the work unless the contaminating material has been removed from the riprap, stone, or [_____] prior to placement.

a. Worksite Stockpile. [Place riprap, stone, or [_____] delivered to the work sites, which requires temporary storage[landward of top of slope,] in a container suitable for storing the riprap, stone, or [_____] without waste[, or a sand-clay-gravel or crushed stone pad may be constructed for the storage area and removed upon completion of the work. If the sand-clay-gravel or crushed stone pad method is used, use pad with a minimum thickness of at least 150 mm 6 inches.] The container[or sand-clay-gravel or crushed stone pad method] is subject to approval by the Contracting Officer prior to delivery of the riprap, stone, or [_____]. Upon completion of the work, clean the storage areas of all storage residues and return to their original condition.][Temporary storage of riprap, stone, or [_____] at the worksite will be allowed, provided the stockpile toe of the riprap, stone, or [_____] be no closer than [18][30] m [60][100] linear feet from the closest edge of the [excavation's][stream's] top slope, and the amount must not exceed 200 t 200 T[unless otherwise approved].]

b. Off-site Stockpile. In areas where riprap, stone, or [_____] is stockpiled for placement, remove excess or residual rock prior to completion of work. Remove all rock and spalls greater than 75 mm 3 inches in diameter. Where rocks may have become buried due to soft ground or operation of the equipment, [dispose of rock as directed] [put rock in a disposal area][buried in acceptable soil]. After the excess or residual rock has been removed, grade, dress, and fill the storage area to return the ground surface as near as practical to the condition that existed prior to construction unless otherwise approved by the Contracting officer.

2.4.2 Riprap

****

NOTE: At the end of this section, the Specifier must attach copies (Plates) of ENG FORM 4794-RM RIPRAP GRADATION CURVES for M40, M65, M90, M180, or M300 (ENG FORM 4794-R RIPRAP GRADATION CURVES FOR R90, R140, R200, R400, or R650), etc., as applicable for this contract.

The riprap gradations presented were developed in

Lower Mississippi Valley Division in 1981 and were standardized to limit the number of gradation bands that a producer would have to produce. These gradation bands were developed from gradation bands presented in EM 1110-2-1601, Chapter 3. All bands were modified slightly after meetings with producers in AR, MO, and IL to reduce production costs. These five of thirteen gradation bands are provided as examples.

Riprap gradations may be designated by state highway department standard specifications in areas where quarries are more familiar with producing these products, provided the gradations meet the project needs. Care must be taken in accepting sources of state highway department gradations of riprap to verify the STONE QUALITY CRITERIA other than merely gradation also meet the project needs, as state highway departments may not design to the same long-term performance durations.

Riprap is typically specified by the weight of the maximum D100 size of the riprap gradation.

****

Use only quarried stone. Provide well graded stone conforming to [the table(s) below and to Plate(s) [_____], [_____], [_____] and [_____] attached at the end of this section][the gradation requirements for [_____], [_____], and [_____] as specified in [paragraph REGULATORY REQUIREMENTS][_____]].

TABLE [_____] - FOR RIPRAP "M40""R90"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	40 - 2090 - 40
50	20 - 1040 - 20
15	10 - 320 - 5

TABLE [_____] - FOR RIPRAP "M90""R200"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	90 - 35200 - 80
50	40 - 2080 - 40
15	20 - 540 - 10

TABLE [_____] - FOR RIPRAP "M300""R650"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	300 - 120650 - 260
50	130 - 60280 - 130
15	60 - 20130 - 40

TABLE [_____] - FOR RIPRAP "M450""R1000"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KGLB.
100	450 - 1801000 - 400
50	200 - 90430 - 200
15	95 - 30210 - 60

TABLE [_____] - FOR RIPRAP "M3400"	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, KG
100	3400 - 1350
50	1400 - 680
15	680 - 225

2.4.3 [Riprap][Stone] Paving

Use stone for [riprap][stone] paving in pieces approximately rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension and with one dimension not varying more than 50 mm 2 inches from the thickness of the paving as shown.

2.4.4 [Manufactured]Derrick Stone

****
NOTE: Specifier should insert weight limits, a weight tabulation to define the desired range of sizes (similar to a riprap gradation), or a range of sizes.
****

[Manufactured derrick][Derrick] stone must be unreinforced concrete shapes weighing not less than 2300 kN/m^3 145 pounds per cubic foot. Provide concrete as specified in Section [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [03 70 00 MASS CONCRETE].[Submit the design of the shapes of the manufactured derrick stone prior to commencing their manufacture. Form [either handling][handling] holes in the shapes[or embed handling hardware in the shapes] at the time they are manufactured.] Derrick stone must consist of [pieces weighing [_____] kg plus or minus [_____] kg pounds plus or minus [_____] pounds] [pieces as tabulated below:]

[rectangular pieces [_____] m feet long by [_____] m feet wide by [_____] m feet thick.] [pieces with dimensions as tabulated below:]

[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

[Ensure stone is [roughly] graded as to size between the several limits.][Provide stone in pieces generally rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension.]

2.4.4.1 Grout for Manufactured Derrick Stone

Use materials required to make the grout as specified in Section [03 70 00 MASS CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. Mix grout in the proportions of one part cement to [_____] parts sand, [and] sufficient water to produce a workable mixture[, and that amount of admixture which will entrain sufficient air to produce durable grout. Submit grout mixture proportions in accordance with paragraph SUBMITTALS.]

2.4.4.2 Epoxy Materials

Epoxy material must meet the requirements of ASTM C881/C881M, [Type IV, when mixed with packaged sand to form a mortar] [Type VII, for a sealer.]

2.4.5 [Capstone][and][Derrick Stone]

[Capstone][and][Derrick stone] must consist of [pieces weighing [_____] kg plus or minus [_____] kg pounds plus or minus [_____] pounds] [pieces as tabulated below:] [rectangular pieces [_____] m feet long by [_____] m feet wide by [_____] m feet thick.] [pieces with dimensions as tabulated below:]

[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

[Provide stone that is [roughly] graded as to size between the several limits.][Provide stone in pieces generally rectangular in cross section, each piece having its greatest dimension no more than three times its least dimension.]

2.4.6 Graded Stone "A"

Graded Stone "A" must conform to the following table:

GRADED STONE "A"	
STONE WEIGHT (kg)(Pounds)	CUMULATIVE PERCENT (Finer by Weight)
23005000	100
11502500	70-100
230500	40-65
45100	20-45
25	0-15
0.51	0-5

A plot of the gradation curve is attached at the end of this section.

2.4.7 Graded Stone "B"

[_____].

2.4.8 Graded Stone "C"

[_____].

2.4.9 57-kg 125-Pound Stone

Except as indicated by the following tolerances, 57-kg 125-pound riprap stone must be in pieces weighing no less than 2.7 kg 6 pounds each nor more than 57 kg 125 pounds each,and no dimension must be over 500 mm 20 inches. Grade each shipment as follows:

WEIGHT OF PIECES (KG)(LBS)	PERCENT OF TOTAL WEIGHT
34 to 5775 to 125	10 Maximum
11 to 3425 to 75	40 to 60
3 to 116 to 25	20 to 40
0 to 30 to 6	0 to 15
Note: Not more than 5 percent passing a 25 mm1-inch sieve.	

****

NOTE: For any of the following four paragraphs, when the size of the largest stone within a gradation is 115 kg 250 pounds or less, specify gradation by dimension (mm (inches) instead of by weight.

****

2.4.10 [Bedding/Mattress] Stone

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines and well graded within the following limits:

STONE WEIGHT IN KG LBS	PERCENT LIGHTER BY WEIGHT OF TOTAL MIXTURE
[_____]	[_____]
[_____]	[_____]

2.4.11 [Core/Underlayer/Scour] Stone

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines and well graded within the following limits:

STONE WEIGHT IN KG LBS	PERCENT LIGHTER BY WEIGHT OF TOTAL MIXTURE
[_____]	[_____]
[_____]	[_____]

2.4.12 [Armor/Cover] Stone

****

NOTE: The design of armor/cover stone should be based upon criteria presented in EM 1110-2-2904. Quality Control and gradations for especially large armor stone may be more stringent than riprap. Armor stone quarries are less common because the geology, strata or rock mass necessary to produce large intact and durable pieces free from weak discontinuities is less common.

****

Furnish stones that weigh between [_____] kg pounds and [_____] kg pounds each, free of fines. Ensure seventy-five percent (75 percent) of the stones weigh greater than [_____] kg pounds each.

2.4.13 Splash/Fill Stone

Furnish stones for splash/fill stone behind the steel sheet pile wall that are well graded from [_____]mm inch to [_____] mm inches, free of fines and contain no more than five percent (5 percent) stones larger than [_____] mm inches in any dimension.

2.5 CONCRETE GROUT

****

NOTE: If concrete grouting is not required for the project, delete this paragraph and its subparagraphs in their entirety.

Requirements are written to match an abridged version of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE or applicable Grout specs. Do not use grouted riprap in areas where frost heave or ice in the sub-base can be expected to cause uplift failure and on the river-side slopes of levees. A system designed for pressure relief and drainage should be provided beneath the area to be grouted along with edge and toe design to prevent undercutting and lateral movement of water beneath the grouted riprap.

****

2.5.1 Cementitious Materials

Submit manufacturer's certificate of compliance, or mill test reports, stating that the materials meet the requirements of the furnished specification.

2.5.1.1 Portland Cement

ASTM C150/C150M, Type [I,] [IA,] [II,] [IIA], low alkali.

2.5.1.2 Pozzolan

ASTM C618, Class C or F, including requirements of Tables 1A and 2A. Pozzolan in amount not to exceed 25 percent, based on absolute volume, may be substituted for an equivalent amount of portland cement in the grout mixture proportions.

2.5.2 Aggregates for Concrete Grout

****

NOTE: Insert the appropriate State Highway Department gradation requirements if applicable.

****

Use fine aggregates for grout meeting the quality and gradation requirements of either ASTM C33/C33M or paragraph REGULATORY REQUIREMENTS. Use coarse aggregates meeting the quality and gradation requirements of ASTM C33/C33M, Class designation 4M, Size No. 67, 7 or 8[or paragraph REGULATORY REQUIREMENTS], Class designation [_____], Size No. [_____].

2.5.3 Admixtures

Submit manufacturers' literature for the concrete admixtures and curing materials. Use admixtures, when required or approved, that comply with the following:

a. Air-Entraining Admixture: ASTM C260/C260M.

b. Water-Reducing or Retarding Admixture: ASTM C494/C494M, Type A, B, or D.

2.5.4 Curing Materials

Provide curing materials as follows:

a. Impervious Sheet Materials: ASTM C171, type optional, except polyethylene film, if used, must be opaque white.

b. Membrane-Forming Curing Compound: ASTM C309, Type 1-D or 2, Class [A] [B].

2.5.5 Water

Use fresh, clean, potable water for mixing and curing. Ensure water is free from injurious amounts of oil, acid, salt, alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.5.6 [Equipment]

Batching and mixing equipment will be accepted on the basis of manufacturer's data which demonstrates compliance with the applicable specifications.

PART 3 EXECUTION

3.1 DEMONSTRATION SECTION

Prior to placement of stone, construct a section of [stone][channel] protection consisting of [toe stone][riprap][grouted stone][_____] to demonstrate his proposed operations for production placement. Demonstrate procedures and capability of grading, placing [toe] stone and bank protection[, and placing grout, and curing of the grouted stone] within the tolerances specified. The demonstration section must be[30][_____] m [100][_____] feet in length and must conform to all applicable specifications.

3.1.1 Methods and Equipment

Demonstrate means, methods and equipment employed for placement of [toe stone][riprap][grouted stone][_____] conform to the requirements specified. Accurately tabulate quantities of all materials placed within the section and provide immediately to the Contracting Officer for comparison with computed quantities.

3.1.2 Demonstration Section Evaluation

Do not proceed with placing [stone][channel] protection prior to the approval of the demonstration section. Within a period of 7 days after completion of the section, the Contracting Officer will determine the adequacy of the section to function as part of the permanent construction. The Contractor will be notified as to the acceptability of the section and may be directed to modify methods of construction[, mix design,] and remove the section if necessary.

3.1.3 Removal of Demonstration Section

If removal of the demonstration section is required, conduct it in such a manner as to maintain the integrity of the underlying subgrade. Dispose of unused demonstration section materials at an offsite location.

3.2 BASE PREPARATION

****

NOTE: Sand fill is specified for the filling of low areas below the waterline around structures in slack water and giving the Contractor the option of using bedding or filter materials. However, if fill material is required where the designer assumes there will be flowing water, the designer will have to determine the minimum size of materials that will stay in place until the stone protection can be completed. This may require the fill material to be specified as bedding/filter material or riprap.

Tolerances plus 50 to 75 mm 2 to 3 inches (Above water placement).

Tolerances plus 300 mm 1 foot and minus 600 mm 2 feet (Below water placement).

****

Grade and/or dress areas on which [geotextile and riprap are] [filter layers and riprap are] [bedding material and riprap are] to be placed to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 50 mm 2 inches and minus 100 mm 4 inches from the theoretical [slope] lines and grades. The prepared base must be approved by the Contracting Officer. Where such areas are below the allowable minus tolerance limit, restore to grade by fill [with earth similar to the adjacent material] [with sand fill] and then compact to a density equal to the adjacent in place material. [Subaqueous areas on which [bedding material and riprap] [filter materials and riprap] are to be placed must be geotechnically stable as determined by a qualified geotechnical engineer. Grade and/or restore subaqueous material to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 300 mm 1 foot and minus 600 mm 2 feet from the specified [slope] line and grades. Where such areas are below the allowable minus tolerance limit, fill with sand or other suitable fill as determined by the existing bottom conditions. As an alternative, these areas may be filled with [bedding material] [filter material] if approved by the Contracting Officer. No payment will be made for any material thus required.] Immediately prior to placing the [geotextile] [bedding layers] [filter layers], the prepared base will be inspected by the Contracting Officer and do not place material thereon until that area has been approved.

3.3 PLACEMENT OF BEDDING LAYERS

3.3.1 General

****

NOTE: The following construction tolerances will be used for bedding layer placement. Tolerances will vary based upon District experience and project conditions.

Plus or minus 50 mm 2 inches

Plus 100 mm 4 inches or minus 50 mm 2 inches

Plus 150 mm 6 inches or minus 50 mm 2 inches (below water) should be possible if water depths are less than 3 m 9 feet. Placement tolerances at greater

depths should be deleted and replaced with tons/square as specified for under water placement of stone.

****

Place a bedding layer, consisting of a [_____] -mm -inch layer of [gravel or] crushed stone, on the prepared base as described below, in accordance with the details shown on the contract drawings, and within the limits shown on the contract drawings or staked in the field. A tolerance of plus 50 mm 2 inches and minus 25 mm 1 inch from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the bedding, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

3.3.2 Placement of Bedding Material on Prepared Base

Spread bedding material uniformly on the prepared base to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Placing of [gravel or] crushed stone by methods which tend to segregate the particle sizes within the bedding layer [or cause mixing of the separate layers] is prohibited. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Replace or repair any damage to the surface of the prepared base that occurs during placement. Compaction of material placed on the prepared base will not be required, but finish [the material surface] [each layer] to present an adequately even surface, free from mounds or windrows.

3.4 PLACEMENT OF FILTER LAYERS

3.4.1 General

****

NOTE: The following construction tolerances will be used for filter layer placement. Tolerances will vary based upon District experience and project conditions.

Plus or minus 50 mm 2 inches

Plus 100 mm 4 inches or minus 50 mm 2 inches

Plus 150 mm 6 inches or minus 50 mm 2 inches (below water) should be possible if water depths are less than 3 m 10 feet. Placement tolerances at greater depths should be deleted and replaced with tons/square as specified for under water placement of stone.

****

****

NOTE: Alternative 1.

****

Place [filter layers, composed of geotextile [and a [_____] -mm -inch layer of filter stone][and a [_____] -mm -inch layer of sand (cushion layer)] on the prepared base as described below, in accordance with the details shown on the contract drawings, and within the limits either shown

on the contract drawings or stake in the field.] [A tolerance of plus 50 mm 2 inches and minus [25][50] mm [1 inch][2 inches] from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the filter layers, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.]

****
NOTE: Alternative 2.
****

Place [filter layers composed of a [_____] -mm -inch lower layer of [Sand "[_____]"], [a [_____] -mm -inch middle layer of Gravel "[_____]"], and a [_____] -mm -inch upper layer of [Gravel "[_____]"] [Filter Stone] on the prepared base as described below, in accordance with the details on the contract drawings, and within the limits shown on the contract drawings or stake in the field.] [A tolerance of plus [_____] mm inch(es) and minus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the filter layers, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet].

[3.4.2 Geotextile

****
NOTE: Delete this paragraph if Alternate 2 is used.
****

Install geotextile as specified in Section 31 05 19.13 GEOTEXTILES FOR EARTHWORK.

][3.4.3 Placement of [Filter Material] [Sand Cushion Layer] on Geotextile

****
NOTE: Delete this paragraph if Alternate 2 is used.
****

Uniformly spread [crushed stone][filter material] on the geotextile to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the geotextile. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Placing of [crushed stone][filter stone][sand cushion layer] by methods which tend to segregate the particle sizes within the filter layer is prohibited. Repair or replace any damage to the surface of the geotextile during placement of [crushed stone][filter stone][sand cushion layer] before proceeding with the work. Compaction of material placed on the geotextile will not be required, but finish to present an adequately even surface, free from mounds or windrows.

]3.4.4 Placement of Filter Material on Prepared Base

Uniformly spread filter material on the prepared base to the [slope] lines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Placing of [sand,] [gravel,] and [crushed

stone] by methods which tend to segregate the particle sizes within the filter layers or cause mixing of the separate layers is prohibited. Repair or replace any damage to the surface of the prepared base during placement of the material before proceeding with the work. Compaction of material placed on the prepared base will not be required, but finish each layer to present an adequately even surface, free from mounds or windrows.

3.5 PLACEMENT OF RIPRAP

****
NOTE: At the end of this section, the Specifier must attach copies (Plates) of ENG FORM 4794-RM RIPRAP GRADATION CURVES for M40, M_____ (ENG FORM 4794-R RIPRAP GRADATION CURVES for R90, R_____), etc.
****

3.5.1 General

****
NOTE: The Specifier will not specify riprap by layer thickness. Specify riprap by the weight of the maximum D100 size of the riprap gradation.
****

Place riprap on the [filter] [and] [bedding] layers specified in paragraph(s) [BEDDING MATERIAL] [and] [FILTER MATERIAL] within the limits shown on the contract drawings.

3.5.2 Placement

****
NOTE: Select appropriate Alternative.
****

[Use under water placement rates when the top of the layer to be placed is covered by more than 900 mm 3 feet of water.]

[3.5.2.1 Above Water

****
NOTE: Alternative 1.

For placement of riprap above water on a bedding layer or filter layer(s).

For tolerances in general, 1/2 of the average stone dimension of gradation range is allowed above the neatline and 1/4 of the same dimension is allowed below the neatline.

Use bottom hinged tailgates on dump trucks used in placing the riprap if larger than M180 R400 riprap is specified.
****

Place riprap in a manner which will produce a well-graded mass of rock with the minimum practicable percentage of voids, and construct, within the specified tolerances, to the lines and grades shown on the contract drawings or stake in the field. A tolerance of plus [_____] mm inch(es)

and minus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the riprap, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average tolerance above or below the neat lines for the entire job must have no more than 50 percent of the tolerances specified above. [Place riprap by means of truck, crane operated skip-pan (box), dragline bucket, clamshell, rock-bucket, hydraulic excavator, trackhoe, or other approved equipment. [The use of tractor loaders or other equipment commonly referred to as front end loaders is prohibited. [Pneumatic tired front end loaders may be used provided that in the opinion of the Contracting Officer no degradation of the rock occurs.]]] Place riprap to its full course thickness in one operation and in such manner as to avoid displacing the [bedding] [filter] material. Distribute large stones well and grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Provide finished riprap that is free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, is prohibited. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Produce the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or by other methods of placement which will produce the specified results. Each truckload must be representative of the gradation requirements. [Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck.] Rearrange individual stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above.[However, manipulating stone by means of dozers or other blade equipment is prohibited.][Unless otherwise authorized by the Contracting Officer, place riprap in conjunction with the construction of the embankment and with only sufficient lag in construction of the stone protection as may be necessary to prevent mixing of embankment and stone protection materials.][Maintain the stone protection until accepted by the Contracting Officer; replace any material displaced prior to acceptance due to the Contractor's negligence with no additional payment and to the lines and grades shown on the contract drawings.]

****

NOTE: Alternative 2.

For placement of riprap on geotextile or geotextile and filter stone.

Tolerance +100 mm and -50 mm +4 inches and -2 inches for riprap with a top size up to 230 kg 500 pounds riprap and a tolerance of +150 mm and -150 mm +6 inches and -6 inches for large riprap.

Add bottom hinged tailgates to dump trucks used in placing the riprap if larger than M180 R400 riprap is specified.

Drop heights of 900 mm 3 feet specified in this paragraph are based on the geotextile having a minimum puncture strength of 0.51 kN 115 pounds and a minimum tensile strength of 1.07 kN (240 pounds) and the riprap has a top size larger than 90 kg 200 pounds. For riprap with a top size larger than 90 kg 200 pounds and less than 225 kg 500 pounds, the drop height is reduced to 600 mm 2 feet without a layer of filter stone or a sand cushion layer is required.

****

[Place riprap to produce a well graded mass of rock with the minimum practicable percentage of voids, and construct within the specified tolerances to the lines and grades indicated. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material to ensure a relatively homogenous mass. A tolerance of plus [_____] mm inch(es) or minus [_____] mm inch(es) from the slope lines and grades indicted will be allowed in the finished surface of the riprap, except ensure that either extreme of such tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from the neat line of the entire job must not be more than 50 percent of the tolerance specified above. Do not drop stone through air from a height greater than 900 mm 3 feet and do not drop stones heavier than 230 kg 500 pounds from a height greater than 600 mm 2 feet. [The drop height greater than 300 mm 1 foot for riprap with a top size of 225 kg 500 pounds is prohibited, except, if approved by the Contracting Officer, it may be, increased by placing a cushioning layer of sand [or [_____]] on top of the geotextile before placing the riprap, or other methods deemed necessary if demonstrated in the field to not damage the geotextile.] Distribute the larger stones and roughly grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP, subparagraph GENERAL. Provide finished riprap that is free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source, by controlled dumping of successive loads during final placing, or by other methods of placement which will produce the specified results. Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck. Rearrange stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above. Maintain the stone protection until accepted by the Contracting Officer; replace any material displaced by any cause, with no additional payment, to the lines and grades indicated.]

][3.5.2.2 Under Water

****

NOTE: The equation presented in this paragraph (Alternative 3) was developed to simplify the relationship between required riprap layer thickness and underwater placement rate in slack water. This

equation assumes that riprap weighs approximately 1.8 tons metric per cubic meter 1.5 tons per cubic yard and that the underwater placement rate is based upon a required layer thickness 1.5 times the layer thickness required to be constructed in the dry. The quantities are based on a placement to be performed in two passes with the second pass being perpendicular to the first. This equation is provided as an example and should be modified to meet project design criteria.

$$T_{mm} = \frac{(1.36t)(1.5)}{(25M^2)(304\ mm)} = R_M$$

T_{mm} = Required theoretical thickness if placed in the dry. (Layer thickness given in mm.)

R_M = Required placement rate in Tons/sq m/pass

180 kg placement rate is 10 T/sq m/pass (assume required thickness in the dry is 750 mm for high turbulent flow criteria).

90 kg placement rate is 5 T/sq m/pass (assume required thickness in the dry is 400 mm for low turbulent flow criteria).

$$T(0.347) = \frac{(1.5\ T/yd^3)(100\ ft^2)(1.5)}{(27\ ft^3/yd^3)(12\ in./ft)(2)} = R$$

T = Required theoretical thickness if placed in the dry. (Layer thickness given in inches.)

R = Required placement rate in Tons/sq/pass. Where a square is referring to 100 square feet.

400 pound placement rate is 10 T/sq/pass (assume required thickness in the dry is 30 inches for high turbulent flow criteria).

200 pound placement rate is 5 T/sq/pass (assume required thickness in the dry is 16 inches for low turbulent flow criteria).

Alternative 3:

The depth of water over the geotextile is based on the puncture strength of the geotextile being a minimum of 0.61 kN 140 pounds and the impact energy of 1.74 kN 400 pounds top size riprap being placed without a layer of filter stone or sand cushion layer.

****

When riprap [, with a maximum size of 180 kg 400 pounds,] is placed under water onto geotextile it may be dropped from the water surface if the water depth over the geotextile is greater than 1.5 m 5 feet. Place

riprap in the wet evenly at a rate of [_____] tons per square (9.3 m^2) tons per square (100 square feet) per pass for M[_____] R[_____] riprap and [_____] tons per square (9.3 m^2) tons per square (100 square feet) per pass for M[_____] R[_____] riprap. Prior to starting work, submit the proposed method of placing riprap under water. Riprap to be placed in the wet must be done during periods of low water levels during the months of June through November. Place riprap in two passes, with the second pass perpendicular to the first pass. The total quantity of M[_____] R[_____] riprap placed in two passes must be [_____] tons per square and the total quantity of M[_____] R[_____] riprap placed in two passes must be [_____] tons per square.

][3.6 PLACEMENT OF GROUTED RIPRAP

3.6.1 General

Place riprap on the [filter] [and] [bedding] material specified in paragraph(s) [FILTER MATERIAL] [and] [BEDDING MATERIAL] within the limits shown. [Install pressure relief holes every 3 m 10 feet and formed by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with grout. Use perforated or slotted cap end(s) of the pipe buried in the [bedding][filter] layer. Exercise necessary care to prevent grout from entering the weep holes.]

3.6.2 Placement

****

NOTE: Placement of grouted riprap must be placed in the dry on filter layers or bedding layer.

Tolerances of +150 mm +6 inches for riprap up to 300 kg 650 pounds and a tolerance of +300 mm +12 inches for large riprap.

Add bottom hinged tailgates to dump trucks used in placing the riprap if larger than 180-kg 400-pound riprap is specified.

****

[Place riprap in a manner which will produce a well-graded mass of rock with the minimum practicable percentage of voids, and construct, within the specified tolerance, to the lines and grades either shown on the contract drawings or staked in the field. A tolerance of not less than plus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the riprap except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from the lines on the drawing for the entire job must have no more than 50 percent of the tolerances specified above. Place riprap to its full course thickness in one operation and in such manner as to avoid displacing the [filter] [bedding] material. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Distribute large stones well and grade the entire mass of stones in their final position to conform to the gradation specified in paragraph RIPRAP. Ensure the finished riprap is free from objectionable pockets of small stones and clusters of larger stones.

Placing riprap in layers is prohibited. Placing riprap by dumping it into chutes, or by similar methods likely to cause segregation of the various sizes, is prohibited. Placing riprap by dumping it at the top of the slope and pushing it down the slope is prohibited. Do not operate equipment directly on the completed stone protection system. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing; or by other methods of placement which will produce the specified results. Each truckload is representative of the gradation requirements. [Equip all dump trucks used in placing the riprap with bottom hinged tailgates. Arrange the gate releasing mechanism so that it may be operated only from, at, or near the front of the truck.] Rearrange individual stones to the extent necessary to obtain a well-graded distribution of stone sizes as specified above. [Unless otherwise authorized by the Contracting Officer, place riprap in conjunction with the construction of the embankment and with only sufficient lag in construction of the stone protection as may be necessary to prevent mixing of embankment and stone protection materials.] Maintain the stone protection until accepted by the Government; replace any material displaced prior to acceptance due to the Contractor's negligence at no additional cost, and to the lines and grades shown on the contract drawings.]

3.6.3 Grouting of Riprap

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.7 PLACEMENT OF RIPRAP PAVING STONE

3.7.1 General

Place riprap paving on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown.

3.7.2 Placement

Place riprap paving stone carefully, by hand or machine, resulting in a compact paving to the lines and grades either shown on the drawings or staked in the field. Place the stone in a single layer with the dimensions of the stones corresponding to the thickness of the paving laid normal to the plane of the slope. Select adjacent stones for size and shape and lay in such close contact as to produce a reasonable minimum of voids. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Place the stones in roughly coursed array with courses running horizontally and breaking joints with the preceding course as far as practicable. Double-decking of the flat stones to obtain the required depth of paving is prohibited. Fill spaces between the stones in the face of the paving with tightly driven spalls and tamp the paving if necessary to produce a compact mass and an adequately even surface. A tolerance of plus or minus [_____] mm inch(es) from the slope lines and grades shown will be allowed in the finished surface of the riprap paving, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

][3.8 PLACEMENT OF HAND-PLACED RIPRAP

3.8.1 General

Place hand-placed riprap on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of [paragraph RIPRAP][Part 2 of this Setion]. Except for spalls for wedging, stone must be roughly rectangular in shape of which the least dimension must be no less than one-third the length.

3.8.2 Placement

Carefully place riprap by hand in such a manner that adjacent stones are in close contact and, in general, have their greatest dimensions across the slope. Place "through stones" well-distributed throughout the mass and the sum of their cross sections, parallel to the slope being protected, and covering not less than than two-thirds of such area. As used in this specification a "through stone" is defined as a stone with dimension normal to the surface being riprapped is not less than the full depth of the riprap. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Begin placement at the bottom of the area to be covered and continue up slope. Place subsequent loads of material on the slope immediately adjacent to previously placed material in such a manner to ensure a relatively homogenous mass. The riprap along the lower edge of an area must consist of the largest stones set in a trench so as to form a band. Except for spalls used to fill voids between larger stone, do not use stone in the exposed face of the riprap which will extend less than one-half the thickness of the riprap. Fill spaces between the larger stones with spalls and smaller stones of the largest feasible size to form a compact mass. Do not place spalls and small stone in nests in lieu of larger size stone. A tolerance of plus or minus [_____] mm inch(es) from the slope lines and grades shown will be allowed in the finished surface of the riprap paving, except ensure that the extreme of this tolerance is not continuous over an area greater than 18 m^2 200 square feet.

][3.9 PLACEMENT OF GROUTED HAND-PLACED RIPRAP

3.9.1 General

Place hand-placed riprap on the [filter][and][bedding] material specified in paragraph(s) [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of paragraph RIPRAP. Except for spalls for wedging, stone must be roughly rectangular in shape of which the least dimension must be no less than one-third the length.

3.9.2 Placement

Carefully place the riprap paving to form a layer [_____] mm inch(es) in thickness. Place the riprap in conformance with the general requirements of paragraph PLACEMENT OF HAND-PLACED RIPRAP, except lay the stone with open joints to facilitate grouting and do not fill the smaller spaces between stones in the face of the paving with spalls but leave open to receive grout readily. [Install pressure relief holes every 3 m 10 feet and form by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with

grout. Use slotted or perforated caps on the end(s) of the pipe, which is buried in the [bedding][filter] layer.. Exercise necessary care to prevent grout from entering the weep holes.]

3.9.3 Grouting of Hand-Placed Riprap

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.10 PLACEMENT OF GROUTED RIPRAP PAVING

3.10.1 General

Place riprap paving on the [filter][and][bedding] material specified in paragraph [FILTER MATERIAL][and][BEDDING MATERIAL] within the limits shown. Stone must conform to the requirements of paragraph PLACEMENT OF RIPRAP PAVING STONE.

3.10.2 Placement

Carefully place riprap paving to form a layer [_____] mm inch(es) in thickness. Place riprap in conformance with the general requirements of paragraph PLACEMENT OF RIPRAP PAVING STONE except place the stone with open joints to facilitate grouting.Do not fill the smaller spaces between stones. Filling joints with spalls is prohibited in this case. Leave open space to receive grout readily. [Install pressure relief holes every 3 m 10 feet and form by 75-mm 3-inch diameter pipe. Install the end(s) of the pipe into the [bedding][filter] layer so that it will not become clogged with grout. Cap the end(s) of the pipe which is buried in the [bedding][filter] layer and perforate with holes or slots. Take care to prevent grout from entering the weep holes.]

3.10.3 Grouting of Riprap Paving

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

][3.11 PLACEMENT OF [DERRICK STONE] [AND] [CAPSTONE]

****
NOTE: The tolerance for the riprap layer may have to be tightened in paragraph PLACEMENT OF RIPRAP to meet tolerance required for this layer.
****

3.11.1 General

Place [derrick stone] [and] [capstone] carefully with equipment suitable for handling the stone of the size(s) specified on a [_____] mm inch(es) thick layer of [M40] [M____] [R90] [R____] riprap specified in paragraph PLACEMENT OF RIPRAP.

[3.11.2 Placement

Place the various sizes of [derrick stone] [and] [capstone] in such a manner as to produce a compact, uniform, well-graded mass [within the limits shown on the contract drawings.] [to the lines and grades indicated on the contract drawings and staked in the field.] Begin placement at the bottom of the area to be covered and continue up slope.

Place subsequent loads of material against previously placed material in such a manner as to ensure a relatively homogenous mass. Select adjacent stone with reasonable care as to size and shape and place in close contact, the smaller stones filling the spaces between the larger ones so as to leave a reasonable minimum of voids. Distribute "through stones" well throughout the mass, and ensure the sum of their cross sections parallel to the surface being protected is no less than 70 percent of such area. As used herein, a "through stone" is defined as a stone whose dimension normal to the surface being protected is not less than the full depth of the protection. A tolerance of no less than plus [_____] mm inch(es) from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the stone except ensure the extreme of deviation from lines and grades is not continuous over an area greater than 18 m^2 200 square feet. The average deviation from lines and grades of the entire job must have no more than 50 percent of the tolerances specified above. Maintain the stone until accepted by the Government; replace to the lines and grades shown on the contract drawings any material displaced prior to acceptance at no additional cost to the Government.

]]3.12 GROUTING OF STONE PROTECTION

Place grout as specified in paragraph PRODUCING, CONVEYING AND PLACING OF GROUT.

3.12.1 Producing, Conveying and Placing of Grout

3.12.1.1 Producing Grout

Use batching and mixing equipment with provide sufficient capacity to prevent cold joints. Stockpile materials and utilize batching methods that prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mixture. Follow applicable portions of ASTM C476 requiring clean a potable water. Mixing in additional water in excess of the amount required by the job mix to the grout mixture during mixing, hauling, or after arrival at the delivery point[, except as required and approved] is prohibited.

a. Ready-Mixed Concrete Grout must conform to ASTM C94/C94M except as otherwise specified.

b. Volumetric Batching and Continuous Mixing must conform to ASTM C685/C685M.

c. Onsite Batching and Mixing. The Contractor has the option of using an onsite batching and mixing facility. The facility must provide sufficient capacity to prevent cold joints and be able to batch the cement and aggregate by weight, and the water and admixtures by weight or volume. The method of measuring materials, the batching operation, and the mixer must be approved in accordance with paragraph SUBMITTALS. On-site plant must conform to the requirements of either ASTM C94/C94M or ASTM C685/C685M.

3.12.1.2 Preparation for Placing

[Take adequate precautions to prevent grout from penetrating the upper filter layer.]Flush the rock with water to remove the fines from the rock prior to placing the grout. Keep tstone moist just ahead of the actual placing, but keep free of flowing or standing water during the

grout operation. Remove any snow and ice. Ensure all equipment needed to place, protect, and cure the grout is at the placement site and in good operating condition. The entire preparation must be accepted by the Contracting Office prior to placing the grout.

3.12.1.3 Conveying and Placing

Grout placement will not be permitted when weather conditions prevent proper placement, except upon approval. Submit the methods and equipment for transporting, handling, depositing, and consolidating the grout prior to first grout placement. Do not place the grout mixture until the stone protection has been inspected and approved. Ensure grout is in place within 15 minutes after discharge from the mixer. Do not drop grout more than 1.5 m 5 feet vertically unless suitable equipment is used to prevent segregation.

a. Conveying

When the grout is mixed [and] [or] transported by a truck mixer, deliver the grout to the site of the work and complete discharge within 1-1/2 hours after introduction of the cement to the aggregate and water. When the air temperature is 29 degrees C 85 degrees F or greater) or under conditions contributing to quick stiffening of the grout, the time between the introduction of the cement and discharge of the grout must not exceed 45 minutes. The Contracting Officer may allow a longer time, provided the setting time of the grout is increased a corresponding amount by the addition of an approved set-retarding admixture. Deposit grout as close as possible to its final position by methods that will prevent segregation of the aggregates or loss of mortar.

b. Placing

Keep the riprap moist just ahead of the actual grout placement, but free of standing or flowing water when placing grout. Grout placed on inverts or other nearly level areas may be placed in one course. On slopes, place the grout in two (2) courses in successive lateral strips approximately 3 m 10 feet in width starting at the toe of the slope and progressing to the top. Deliver the grout to the place of final deposit and discharge directly on the surface of the riprap, using a splash plate of metal or wood to prevent displacement of the rock directly under the discharge. Direct the flow of grout with brooms, spades or baffles to prevent it from flowing excessively along the same path and to assure that all intermittent spaces are filled. Perform sufficient barring to loosen tight pockets of riprap and otherwise aid the penetration of grout so that all voids are filled and the grout fully penetrates the riprap [as specified][from the base of the riprap layer to at least two-thirds of the thickness of the stone layer]. Ensure all brooming on slopes is uphill and after the grout has stiffened, rebroom the entire surface to eliminate runs, to fill voids caused by sloughing, and to remove grout from the top surface and pockets or depressions of the upper stones.

3.12.1.4 Cold-Weather Requirements

Do not place grout when the ambient temperature is below 2 degrees C 35 degrees F, nor if the ambient temperature is below 5 degrees C 40 degrees F and falling. Provide suitable covering and other means, as approved, for maintaining the grout at a temperature of at least 10 degrees C 50 degrees

F for no less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. When freezing conditions prevail, riprap to be grouted must be covered and heated to a range of 5 to 16 degrees C 40 to 60 degrees F for at least 24 hours prior to placing the grout. Mixing salt, chemicals, or other foreign materials with the grout to prevent freezing is prohibited. Remove and replace any grout damaged by freezing at the expense of the Contractor.

3.12.1.5 Hot Weather Requirements

When the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, is expected to exceed 100 g/m^2 0.2 pounds per square foot per hour, provide windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement, and deploy protective measures as quickly as finishing operations will allow.

3.12.2 Curing and Protection of Grouted Stone Protection

Beginning immediately after placement and continuing for at least 7 days, cure all grout and protect from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. Make all materials and equipment needed for adequate curing and protection available and at the site of the placement prior to the start of grout placement. After completion of any strip or panel, no workman or other load is permitted on the grouted surface for a period of twenty-four (24) hours. Keep exposed surfaces continuously moist for the entire curing period, or until curing compound is applied. Preserve moisture for grout surfaces by one of the following methods:

a. Continuous sprinkling and ponding.

b. Application of absorptive mats or fabrics kept continuously wet.

c. Application of sand kept continuously wet.

d. Application of impervious sheet material conforming to ASTM C171.

e. Application of membrane-forming curing compound conforming to ASTM C309. Spray the compound on the moist surface as soon as free water has disappeared, but do not apply to any surface until finishing of that surface is completed. Apply at a uniform rate of not less than 300 ml/m2 (1 gallon per 150 square feet) of surface and form a continuous adherent membrane over entire surface to be cured. Curing compound on surfaces requiring bond to subsequently placed grout is prohibited. If the membrane is damaged during the curing period, reapply compound to damaged area at the rate of application specified above.

3.13 TRENCHFILL REVETMENT, BANK PAVING, AND OUTLET DRAINS

3.13.1 Trenchfill Revetment

Stone for the trenchfill must be Graded Stone ["A"] ["B"] ["C"] [[_____]-kg] [[_____]-Pound] Stone and must be back-dumped from the dump trucks, placed by skip, clamshell, or other approved method directly in the trench excavated at the toe of the graded revetment slope. Do not place stone more than 300 m 1,000 feet in advance of the completed trenchfill section, including upper bank paving, unless otherwise permitted by the Contracting Officer. Construct the trenchfill to the

elevations and cross sections shown on the drawings. A tolerance of [150][_____] mm [6][_____] inches above or below the lines and grades of final excavation will be permitted provided the area of the finished section is not less than the area of the theoretical section. Complete placement of the trenchfill prior to placement of the bank paving. Bulldozing of stone from the upper bank into the excavated trench is prohibited.

3.13.2 Bank Paving

Stone bank paving must be Graded Stone "C" [[57][_____]-kg [125][_____]-pound stone] [_____] -kg -Pound riprap. Excess stone placed directly in the trench at the toe of the graded revetment slope may be dragged up the slope a maximum of 3 m 10 feet vertically above the [Average Lower Water Plane (ALWP)] [Lowe Water Datum (LWD)]. The remainder of the upper bank paving stone may be placed in continuous stockpiles at 3 m 10 feet intervals above the [ALWP][LWD] by means of back-dumping from dump trucks or by skip, clamshell, or other approved method, and dragged up the slope a maximum of 3 m 10 feet vertically. The remainder of the upper bank paving stone may also be back-dumped from dump trucks; placed by skip, clamshell, or other approved method; and spread by bulldozing except that pushing stone down the slope will not be permitted and maximum allowed drop heights are not to be exceeded. Place the stone in such a manner to achieve a minimum of segregation of sizes in the in-place upper bank paving stone, with uniform gradation from the bottom of the slope to the top elevation of the stone as indicated on the drawings. Prior to placing the stone, bring graded slopes to final grade and dress to conform to the limits specified in Section 31 00 00 EARTHWORK and to the lines and grades in the contract drawings. A tolerance of 75 mm 3 inches above and below the specified bank paving thickness will be allowed provided the area of the finished section is not less than the area of the theoretical section. To prevent overtopping of the paved portion of the slope by rising river stages, place bank paving in strips parallel to the water's edge when directed by the Contracting Officer. Repair any damage to the graded bank or paving occasioned by such overtopping of the paving because of failure to keep paving operations above the water surface.

3.13.3 Outlet Drains

Where required, construct standard outlet drains or special drainage ditches. A tolerance of 150 mm 6 inches above or below the lines and grades will be permitted provided the area of the finished section is not less than the area of the theoretical section. Place Graded Stone "C" [[_____] -kg -Pound stone] [[_____] -kg -pound riprap] for all outlet drain paving to provide a minimum of segregation of sizes in the in-place materials. Place a layer of 150-mm 6-inch thick bedding stone under the Graded Stone "C" [[_____] -kg -pound stone] [[_____] -kg -pound riprap] in the manner and at the locations shown on the drawings. A thickness tolerance of plus 25 mm 1 inch for the 150-mm 6-inch thick bedding material will be allowed. Where the outlet drains must be constructed in silts or silty sands, place a 150-mm 6-inch layer of bedding sand beneath the bedding stone. The bedding sand must meet the quality and gradation requirements as specified in paragraph BEDDING MATERIALS.

3.13.4 Toe Trench Revetment

Construct toe trench revetment, when so ordered on the construction schedule, at locations where the existing bank or riverbed at the

structure azimuth line is 3 m 10 feet or less below [Average Low Water Plane (ALWP)] [_____]. The Toe Trench Revetment must consist of stone placed along the toe of the bank excavated as specified in [Section 31 00 00 EARTHWORK] [_____] and on the graded slope of the upper bank as applicable. Provide two types of Toe Trench Revetment as shown on the contract drawings for the following conditions:

a. Type "A" - For conditions where the top of the graded slope is 2700 mm 9 feet or more above [Average Low Water Plane (ALWP)] [LWD] [_____].

b. Type "B" - For conditions where the top of the graded slope is less than 2700 mm 9 feet above [Average Low Water Plane (ALWP)][LWD] [_____].

3.13.4.1 Trench Fill

Place a fill consisting of stone along the excavated toe of the bank to the elevation and cross section designated on the contract drawings for both types of toe trench revetment. Ensure fill consists of no less than 27 tons 9 tons nor more than 41 tons 14 tons of stone per meter linear foot of fill, unless otherwise specified on the construction schedule. A dozer to move stone from the upper bank into the trench is prohibited.

3.13.4.2 Upper Slope Fill

For Type "A" revetment, place a fill consisting of stone on the graded slope to a minimum depth normal to the slope of 250 mm 10 inches at the top of the slope and increasing uniformly to a minimum depth of 375 mm 15 inches where it abuts the trench fill. Arrange the upper slope fill uniformly with the larger stone at the bottom of the slope and the small stone at the top and do not exceed 0.7 t/m^2 7 T per 100 square foot of upper slope fill. Rearrange the upper slope fill stone as necessary to conform to these specifications. The use of a dozer in placing the upper slope fill is prohibited.

3.13.4.3 Crown Fill

For Type "B" revetment, place a fill consisting of stone, abutting the trench fill, to the elevation and crown width specified on the construction schedule and drawings. The crown fill must have a riverward side slope of 1V on 3H, a landward side slope of 1V on 2H, and a minimum thickness of 375 mm 15 inches as shown on the contract drawings.

3.13.4.4 Juncture With Other Types of Revetment

Where toe trench revetment joins an existing structure and the alignment and riverward slopes of the stone fills in the structures are not the same, construct a transition by gradually adjusting the alignment and slope of the toe trench revetment over a distance of approximately 30 m 100 feet so that it conforms to the alignment and slope of the existing stone fill at the junction of the structures. Construct the transition in a workmanlike manner and as directed by the Contracting Officer.

3.13.4.5 Intermittent Repair of the Trench Fill and Upper Slope Area of Revetment

Intermittent repair consists of stone placed along the trench fill and/or upper slope area of the revetment to the elevation and cross section designated on the drawings for trench fill or upper slope, and is ordered

on the construction schedule. When specified by the Contracting Officer, adjustment in the line and grade may be authorized to accomplish necessary repairs to conform to alignment and grade of undamaged sections. Do not perform trench fill repair when the river stage exceeds [Average Low Water Plane (ALWP)] [LWD] [_____] and do not perform upper slope repair when the river stage exceeds 1.5 m 5 feet above [ALWP] [LWD][_____], unless otherwise directed by the Contracting Officer.

3.13.5 Stone Fill Revetment

Construct stone fill revetment, when so ordered on the construction schedule, that consists of a stone fill placed as specified in [Section 31 00 00 EARTHWORK] [_____]. If required to obtain proper placement of material, the Contractor has the option of using either mooring piles, anchors, spud barges, or other suitable methods approved by the Contracting Office to obtain the proper configuration and alignment while placing stone.

3.13.5.1 Stone Fill

Place a fill consisting of stone along the structure azimuth line to a cross-section as shown on the contract drawings and to such elevation and crown width as specified on the construction schedule. The [riverward][lakeward][inboard] slope must be [1V on 1.5H][ ] and must intersect the structure azimuth line 900 mm 3 feet below [ALWP][LWD] [_____] unless otherwise specified; minor irregularities must be approved by the Contracting Officer. Place the stone in lifts of such height and length as the Contracting Officer considers necessary to prevent or reduce scour ahead of the fill.

3.13.5.2 Juncture With Other Types of Revetment

Where stone fill revetment joins and existing structure and the alignment and riverward slope of the stone fills in the structures are not the same, construct a transition by gradually adjusting alignment and slope of the stone fill revetment over a slope of the existing stone fill at the junction of the structures. Construct the transition in a workmanlike manner and as directed by the Contracting Officer.

3.14 STONE REVETMENT, STONEFILL DIKES, STONEROOTS, AND JUNCTIONS

3.14.1 Excavation and Grading

Where required for bank protection, excavate and grade the existing ground at the proposed structures to provide a foundation for the complete placement of stone. Perform excavation and grading in accordance with Section 31 00 00 EARTHWORK.

3.14.2 Construction Method

Construct the stonefill revetment and dikes of [Graded Stone ["A"] ["B"] ["C"]] to the lines, grades, and sections shown or as noted on the drawings. Commence construction of the stonefill revetments and stonefill dikes at the upstream end and continue progressively to the downstream end. The initial work consists of a stone blanket approximately 600 mm 2 feet thick and extending over the full width and length of the revetment or dike. If stone is placed by land based equipment, this stone blanket is not unless directed by the Contracting Officer. Place the remaining stone required to complete the underwater portion of the revetment or dike

from the shoreward to the [riverward] [lakeward] end of the revetment or dike in approximately uniform layers not exceeding 1.5 m 5 feet in thickness and extending over the full width and length of the revetment or dike. The portion of the revetment or dike above the water may be placed in one lift.

3.14.3 Placement

Place stone in the revetment and dikes by skip or clamshell, cast off barges by hand or machine, or by other methods approved by the Contracting Officer. Distribute the larger stone well throughout the mass, and ensure the finished revetment or dike is free from pockets of small stone and clusters of larger stone. A tolerance of plus or minus 300 mm 1 foot will be allowed on the prescribed crown elevation and width. Determine the side slopes by the natural angle of repose of the stone, varying from 1V on 1.25H to 1V on 2H.

3.14.4 Stoneroots

Place stoneroots consisting of [Graded Stone ["A"] ["B"] ["C"] [_____] -kg -pound stone][[_____] -kg -pound riprap] in the excavated trench as specified in paragraph PLACEMENT and as shown on the drawings.

3.14.5 Junctions

Construct junctions consisting of [Graded Stone ["A"] ["B"] ["C"] [_____] -kg -pound stone][[_____] -kg -pound riprap]. The 60 m 200 feet trenchfill revetment wraparound portion of the junction must consist of Graded Stone "B".

3.15 CAPOUT AND REINFORCEMENT

The work covered by this section consists of furnishing all plant, labor and stone, and performing all work necessary in placing the stone for the revetments and dikes capouts, and reinforcement, complete, all as specified herein and shown on the drawings. Ensure stone is Graded Stone "B".

3.15.1 Debris Removal

Remove debris from the structures to allow for the placement of the stone in the capout and reinforcement to the extent directed by the Contracting Officer. There will be no measurement nor payment for the debris removal and all costs will be considered incidental to the contract. Dispose of debris [landward of the existing structures] [_____] so as not to interfere with placement of capouts and reinforcement.

3.15.2 Construction Method

Construct capouts and reinforcement of Graded Stone "B" at the lines, grades and sections shown or as noted on the drawings. Commence construction at the upstream end of each structure or portion thereof and continue progressively to the downstream end. Place stone required to complete the underwater portion of the capouts and reinforcement from the upstream to the downstream end of the revetments and landward end to the riverward end of the dikes in approximately uniform layers not exceeding [1.5][_____] m [5]feet[_____] in thickness and extending over the full width and length of the revetment. The portion of the revetments or dikes above the water may be placed in one lift. Where reinforcement is required

to be placed below water , place the stone from barges or by other approved methods to provide a close compact paving with a required thickness of [600][_____] mm [2][_____] feet. Ensure that the stone placement methods for placement of stone between Structural Azimuth Line (SAL) stations [_____] to [_____] will not result in damages to the "sensitive historic site." Prior to the start of work submit,for approval, the proposed method or methods for placing stone underwater.

3.15.3 Placement

Place stone in the capouts and reinforcement by skip, clamshell, cast off barges by hand or machine, or by other methods approved by the Contracting Officer. Distribute the larger stone well throughout the mass and ensure the finish revetment is free from pockets of small stone and clusters of larger stone. A tolerance of plus or minus [150][_____] mm [6][_____] inches will be allowed for reinforcement and a tolerance of plus or minus [300][_____] mm [1][_____] foot will be allowed for capouts on the prescribed crown elevation and width provided the area of the finished section is not less than the area of the theoretical section. Ensure the allowable tolerances from the prescribed theoretical cross section are not continuous for more than [60][_____] m [200][_____] linear foot of revetment and/or dike. When completed, abrupt changes in the revetment and/or dike crown widths and elevations are not permitted.[The side slopes may be determined by the natural angle of repose of the stone, varying from 1V on 1.25H to 1V on 2H.]

3.16 STONE DIKE

3.16.1 Dike Stone Placement

Construct diked to the elevations, cross sections, and minimum thicknesses and within the limits shown on the contract drawings. Determine side slopes by the angle of repose of the stone, approximately 1V on 1.25H. Construct dikes of Graded Stone "A" as specified in paragraph GRADED STONE "A". Place stone in the dikes in such a manner as to produce a well-graded mass of stone with the minimum practicable percentage of voids. A tolerance of 300 mm 1 foot will be allowed in the specified elevation, and 300 mm 1 foot under and 600 mm 2 feet over in the specified crown width provided these variations are gradual over a minimum distance of 30 m 100 feet measured along the dikes centerlines. The stone may be placed by either backhoe or dragline equipped with rock bucket; by [either bulldozer or]front-end loader or bulldozer, except when placing the base blanket subaqueously; and by trucks and other methods, if approved by the Contracting Officer. Add additional stone if either soundings or sections indicate such to be necessary to attain required lines and grades. Arrange large stones throughout the mass distributed and finished sodikes are free from pockets of small stones and clusters of large stones. Bulldozing stone into excavated trenches is prohibited. Subaqueous placement of stone is prohibited at river stage limitations specified in [Section [_____]] [_____], paragraph [RIVER STAGE LIMITATIONS], without prior approval, in writing, by the Contracting Officer or at any river stage when site and current conditions prevail which, in the opinion of the Contracting Officer, make construction operations either impractical or uneconomical.

3.16.2 Placement Control

Furnish, operate, maintain necessary equipment, and furnish all necessary material and supplies while maintaining control of the placement of stone

in the dikes. At all times when stone placement from floating plant is underway, the means by which the Contractor positions the plant, equipment, and stone supply barges must function accurately and consistently. The plant and equipment must have a dragline or backhoe capable of being mobile on the spud barge and the flexibility to perform stone placement by the drag-off method. Do not use the kick-off method for stone placement unless approved by the Contracting Officer. Whatever the method employed, it must readily permit the Contractor and the Government inspector to determine the exact position of the stone-placing operation. Do not not place anchors for the purpose of holding floating plant in place over existing or partially completed dikes.

3.16.2.1 Alignment Control

The method of alignment control must be either a manned transit or laser or colored or polarized light beams, or any other method demonstrated to be practicable and sufficiently precise and reliable as approved by the Contracting Officer.

3.16.2.2 Distance Control

The method of distance control for floating plant engaged in the subaqueous placement of stone must be either wire distance wheel or another equally accurate measuring device as approved by the Contracting Officer.

3.16.2.3 Depth Finder

Provide an electronic recording depth finder, approved by the Contracting Officer, in writing, during the construction of the dikes. Provide depth finder with a recording scroll no less than 150 mm 6 inches wide with a scale of not more than 3 m of depth to 25 mm 10 feet of depth to the inch. Ensure the depth finder is capable of obtaining accurate profiles and cross-sections during construction of the dikes and use it to monitor anticipated and actual scour and as an aid in the control of stone placement. Furnish and maintain an adequate stock of recording paper for the depth finder.

3.16.2.4 Nonpermitted Devices

The use of buoys and piles of stone placed above the water surface as placement control devices will not be permitted. The use of bank targets for alignment control will not be permitted for work distances of more than 120 m 400 feet without prior approval, in writing, by the Contracting Officer.

3.16.2.5 Skiff or Boat

Furnish an aluminum skiff or boat with a minimum length of 5.5 m 18 feet and equipped with a 38 kW 50 hp outboard motor.

3.16.3 Longitudinal Stone Dike Placement

****
NOTE: For use with stone under 180 kg 400 pounds top size.
****

Place stone in the longitudinal peaked stone dikes, stone tiebacks and

transverse stone dikes by skip, grapple, hand, or other approved method, in such a manner as to produce a well graded mass or stone with the minimum practicable percentage of voids. Do not drop stone from a height greater than 900 mm 3 feet. A variation of 300 mm 1 foot above or 150 mm 6 inches below the specified deviation and 150 mm 6 inches under or 300 mm 1 foot over the specified crown width will be allowed provided these variations are gradual over a minimum distance of 3 m 10 feet measured along the dike's centerline. Bulldozing stone into excavated trenches will not be permitted. Store stone delivered on-site as specified in paragraph STONE.

3.17 CORRECTIVE EARTHWORK

3.17.1 Grading

Grading consists of the sloping of bluff banks damaged by failures in the bank paving and the preparation of the subgrade for placement of new paving; reshaping of damaged drains and constructing new drains; reshaping of overbank areas; and any incidental work as may be required in the prosecution of the work. Most of the grading will be in areas where mechanical equipment can be used, but some hand grading will be required. Use material resulting from grading operations, including broken pavement, if any, for making fills where required, including the restoration of deficient slopes. Perform all grading and filling to the lines and grades as staked in the field or as specified. Roots, trees, brush, roots, trash and organic materials are prohibited for use in fills. Restored subgrade must be free from roots, brush or other debris; and placed in layers not to exceed 300 mm (1 foot) in thickness. Thoroughly compact each layer to a density at least equal to that of the adjacent undisturbed earth. If environmentally approved, [spread excess clean fill material on the slope adjacent to the area of repair] [excess clean fill may be disposed of].

3.17.2 Excavation in Failure Areas

Perform excavation in failures where protrusion of stone above adjacent surface is objectionable. Where specified, excavate subgrades 250 to 300 mm 10 to 12 inches below the surface of the adjacent paving. Large areas may not require excavating throughout, but excavation to the depths specified above will be required only for a distance of 1.5 m 5 feet inside the perimeter of the failure. Most of the excavation can be accomplished by mechanical means, but some hand work around the edges will be required. Perform all excavation to the lines and grades as staked in the field or as specified. Use material resulting from the operation for making fills where required as specified in paragraph GRADING. Excess material may be wasted or spread on the adjacent slopes.

3.18 BREAKING OUT PAVEMENT

The work consists of the breaking out of concrete or asphalt pavement in damaged or undermined areas of pavement. The concrete pavement is approximately [100][_____] mm [4][_____] inches in thickness, and the asphalt pavement is approximately [125][_____] mm [5][_____] inches in thickness. The area of pavement to be broken out will be marked by the Contracting Officer prior to the start of work. Any additional areas to be broken out adjacent thereto will be marked as required as the work progresses. Repair or replace any pavement outside the limits marked to be broken out that is damaged by the Contractor's operations at no additional cost to the Government. The breaking out may be done by any approved method which will accomplish the results desired and will not

damage paving outside the limits marked.[Blasting is prohibited.]

3.18.1 Concrete Breakout

Break up damaged or undetermined monolithic, articulated or slab concrete into pieces not exceeding 450 mm 18 inches in any dimension. Leave the pieces on the subgrade where broken. In areas where grading may be required, break out the concrete to the extent necessary to permit grading the bank to slopes suitable for paving and the broken concrete used in making fills adjacent to the breakout. Using broken concrete for riprap or armor stone is prohibited.

3.18.2 Asphalt Breakout

Generally, asphalt breakout will be limited to areas requiring grading of the bank to slopes suitable for paving. Use the broken asphalt to the extent possible in making fills adjacent to the breakout. When broken asphalt is used in making fills, the pieces must not exceed 450 mm 18 inches in any dimension. Spread out the broken asphalt that is not used for fill sufficiently to avoid abrupt humps on the adjacent paving. In areas where asphalt is damaged and grading of bank is not required, stone may be placed on top of the broken or damaged asphalt to the extent necessary to cover the damaged area.

3.18.3 Removal of Drift and Clearing

Remove accumulations of drift from the areas to be repaired. Clearing will not generally be necessary; however, cut off any trees, stumps or brush in the areas where repair work is prescribed flush with the ground or to an elevation 300 mm 1 foot below the top of the fill, and remove from the area. Dispose of debris as specified in [Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL][and][Section 31 11 00 CLEARING AND GRUBBING].

3.18.4 Preparation of Subgrade

In areas where grading or excavation is required, dress the subgrade to a uniform surface suitable for paving. In other areas where crushed stone or [riprap][stone] is specified, dress the subgrade as necessary to provide an even surface for paving or to provide for a suitable tie to the existing paving.

3.19 STONE WORK

Use bedding stone, [_____] -kg -pound [Riprap][Stone][, and/or] [Graded Stone ["A"]["B"] ["C"]] to repair failure areas in existing paving or to protect the upstream, downstream, and landward areas adjacent to an existing paved bank; for constructing or repairing drains; for making stone fills, both above and below the water surface; and for constructing overbank spurs. Place stone on the bank or overbank area by crane or dragline equipped with skip, grapple, clamshell, or rock bucket; by front-end loader[or bulldozer]; or by trucks or other methods approved by the Contracting Officer. Unless otherwise approved by the Contracting Officer, the maximum capacity of dragline buckets used to place [Riprap][Stone] paving on the bank will be limited to 2.3 cubic meters 3 cubic yards.

3.19.1 Placement

It is contemplated that the quantities required will be in increments of a barge load of approximately [_____] [1000] tons (metric) [_____] [1,000] tons for placement at a single revetment. When less than [_____] [10 000] tons (metric) [_____] [10,000] tons of [Graded Stone ["A"]["B"]["C"]] [_____] is specified at a single revetment, consider the stone "Graded Stone "A", Small Repairs" for payment purposes. When [_____][10 000] tons (metric) [_____] [10,000] tons or more of Graded Stone "A" is specified at a single revetment, consider the stone "Graded Stone ["A"]["B"]["C"] [_____], Large Repairs" for payment purposes.

3.19.1.1 Bedding Material

Bedding stone may be required for use under [Riprap][Stone] paving or to fill scoured areas or depressions in the subgrade, or as a blanket in the construction or repair of drains. Bedding stone is normally placed [100][_____] mm [4][_____] inches in thickness above the water surface, [150][_____] mm [6][_____] inches in drains and in the amount of 1.8 t per square (9.3 m^2) [two][_____] T per square (100 square feet) when placed below the water surface. Place materials above the water must be to the lines and grade specified or as staked in the field; below the water surface, in the amount specified or as directed at the time of placing.

3.19.1.2 [Riprap][Stone] Paving

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NOTE: For determining the placement rate for under water placement, see notes at paragraph PLACEMENT OF RIPRAP, subparagraph [UNDER WATER].

****

Place [riprap][stone] of the specified maximum size on the dry slope or overbank areas and rearrange by hand as necessary to provide complete coverage of the specified area with an average thickness of [250][_____] mm for [57][_____]-kg [10][_____] inches for [125][_____]-pound [riprap][stone]. A tolerance of 50 mm 2 inches above or below the average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope will not be allowed. Spalls and quarry chips may be used as a base but not as a filler. Place stone for underwater portions of the work uniformly distributed at the rate of [_____][7.3] tons per square [_____][8] tons per square unless another rate is shown or specified. [Riprap][Stone] may be required for use in constructing stone fills and making other repairs to revetments. [It is contemplated that the quantities of [_____] -kg -pound [riprap][stone] required will be in increments of a barge load of approximately 1000 tons for placement at one or more nearby locations.]

3.19.1.3 Overbank Paving

[Riprap][Stone] paving may be required to repair scour damage behind top bank. Overbank paving will generally consist of a blanket of stone 250 mm 10 inches thick and up to 15 m 50 feet wide placed behind the top bank or landward of the existing paving. Place overbank paving in accordance with paragraph [Riprap][Stone] PAVING above or as specified.

3.19.1.4 Stone Fills

Stone fills may be required to be constructed of [_____] -kg -pound

[riprap][stone] or Graded Stone ["A"] ["B"] ["C"] as specified. Place stone fills specified above the water surface to the lines and grades specified or as staked in the field. Where specified below the water surface, the material may be placed by any method elected by the Contractor, subject to approval by the Contracting Officer.

3.19.1.5 Overbank Stone Spurs

In the repair or prevention of overbank scour, [riprap][stone] is required to construct or repair spurs landward of the top of bank at some locations. Provide spurs consisting of stone fill with variable crown widths and side slopes, usually tying into the revetment paving and extending landward at varying angles with the top of bank. Extensions of existing overbank spurs may also be required. The height of stone spurs will usually be from 900 to 1800 mm 3 to 6 feet, with maximum heights depending upon the depth of overbank scour. Generally, work will not extend beyond 90 m 300 feet landward of the top of the bank, but conditions at some locations may require construction beyond this limit. The location, alignment, and dimensions of the overbank spurs are as shown or as directed. [Riprap][Stone] that can be placed entirely by the floating plant will not be considered Overbank Stone Spur.

3.19.1.6 Stone Landward of an Obstruction

Occasionally in the repair of a revetment, stone must be placed on the revetment slope behind or landward of a structure which prevents placement of stone by a barge-mounted dragline or at a revetment location which, in the opinion of the Contracting Officer, is inaccessible by floating plant for other reasons. These repairs may be accomplished by hauling or other means approved by the Contracting Officer.

3.20 SLOPE DRESSING AND [Riprap][Stone] PAVING

3.20.1 Slope Dressing

The work consist of furnishing all plant, labor and materials and performing all work in strict accordance with these specifications, schedules and drawings for construction of [Riprap][Stone] paving on the [river banks] [banks of the [_____] River between [_____] and [_____]]. Perform work at several localities which will be selected after the award of the contract and will be designated in the jobsite specifications and "Before Construction" drawings to be issued pursuant to paragraph [_____],[Section 01 35 13 SPECIAL PROJECT PROCEDURES][,_____]. Perform the work regardless of the number of localities involved. Work may not be required under these specifications at all localities at which mattress sinking operations will be performed; however, work may be required at locations where articulated concrete mattress is not required. The work to be performed normally includes the final preparation of the slopes and procuring and placing the [Riprap][Stone] on the graded bank. At some locations, underwater and/or overbank paving may be required. Such locations will be specified in the jobsite specifications or indicated on the "Before Construction" drawings. The Government reserves the right to accomplish all or any portion of the work at any location by other means.

3.20.1.1 General

The bank will be graded, including finish grading, by others. However, preparatory to placing the paving, dress the slope to eliminate any irregularities, including irregularities in the bedding material placed by

others, due to rain or wave wash or operations of the Contractor's equipment. Fill irregularities in the ungraveled slope with layers of earth no greater than 300 mm 1 foot in uncompacted thickness and firmly compact into place. If directed by the Contracting Officer, fill irregularities in graveled areas with stone, and payment will be made at the applicable contract unit price for "[Riprap][Stone] Paving" for stone so placed. Acquire earth fill material from adjacent areas within the limits of the right-of-way. Redress and/or clean out any landside drainage ditch damaged by the operations.

[3.20.1.2 Regrading

Any regrading necessitated by slides in the bank occurring before or during construction of the bank paving will be done by others and will in no way be the responsibility of the Contractor except that evidence of such slides should be reported promptly to the Contracting Officer. Do not place paving on such a disturbed area until the slide has been graded out or otherwise corrected.

]3.20.1.3 Repairs

Repair, with no additional payment, any damage to the graded bank or strip paving caused by failure to place paving at the rate required by paragraph [_____] of [Section 01 35 13 SPECIAL PROJECT PRODCEDURES][_____]. If strip paving is ordered by the Contracting Officer due to reasons beyond the control of the Contractor and the graded bank or strip paving is damaged by rain wash or overtopping, make the repairs as ordered by the Contracting Officer and an adjustment in the contract price and time of performance as appropriate for that portion of the work will be made in accordance with the Contract Clause, CHANGES.

3.20.2 [Riprap][Stone] Paving

3.20.2.1 General

[Riprap][Stone] upper bank paving consists of a course of stone with an average thickness of 250 mm 10 inches, measured normal to the slope, except where other thickness is specified or indicated on the drawings. Cover the surface of the bank between the limits of work as shown on the site plans or surface of the bank between the limits of work as shown on the site plans or as determined by the Quality Assurance Representative in the field. The landward limit of [riprap][stone] paving may include an overbank strip not exceeding a distance of 15 m 50 feet landward of the top of the bank. The bank to be paved will have been graded by others to a slope that will vary from approximately 1V on 3H to 1V on 5H and any overbank area to be paved will have been dressed by others to a surface suitable for paving. In general, the width of the paving will vary between approximately 15 m 50 feet and 60 m 200 feet slope measurement.

3.20.2.2 Strip Paving

When directed by the Contracting Officer, pave the bank in strips parallel to the water's edge. It is anticipated that strip paving will be required whenever there is more than 600 m 2,000 linear feet of unpaved bank available to the Contractor for paving or whenever rising river stages threaten overtopping of the inshore limit of mattress within that area. In areas where an articulated concrete mattress has been placed, provide strip paving consisting of placing [riprap][stone] paving in a strip along and parallel to the inshore edge of mattress. Unless otherwise authorized

or directed, the strip paving must be 9 m 30 feet wide except it must include complete paving of drains within the area. At locations requiring only stone paving, place the underwater paving along with a strip 9 m 30 feet wide above and parallel to the water's edge and include paving of drains. Once strip paving operations are directed, continue this method of paving as long as required by the Contracting Officer, and conduct at such locations and in such order of precedence as required in order to protect the interest of the Government. If strip paving operations and moving, as required by the Contracting Officer to be performed the most essential work, prevent the Contractor from maintaining the required production rate, an equitable adjustment in contract time will be allowed upon written request and justification. Additional towing required to move between jobs as prioritized by the Contracting Officer and to return to unfinished jobs to complete them will be paid for as provided in [Section 01 35 13 SPECIAL PROJECT PROCEDURES][_____], paragraph [PAYMENT FOR EXCESS TOWING][_____].

3.20.2.3 Underwater Paving

Where specified in the Plans and Specificationsor indicated on the "Before Construction" drawings, place underwater [riprap][stone] paving on subaqueous areas not covered by articulated concrete mattress. Distribute the underwater [riprap][stone] paving uniformly over the area to be paved in the amount of 7.3 tons per square (9.3 m^2) 8 tons per square (100 square feet) or such other amount as indicated in the Specifications.

3.20.2.4 Placement

Place the stone on the graded slopes by crane or dragline equipped with skip, grapple,clamshell, or rock bucket or by other method approved by the Contracting Officer and rearranged by use of a trackhoe or by hand as necessary to provide complete coverage of the banks to the specified average thickness. If the entire upper bank cannot be paved from floating plant and stone is windrowed on the upper slope, spread the windrowed stone to the prescribed thickness by pulling the stone up the slope with a trackhoe or by other approved methods. Pulling stone downslope is prohibited. A tolerance of 50 mm 2 inches above and below the specified average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope or gravel blanket will not be permitted. In underwater placement, distribute the stone uniformly in the amount specified. Control placement of [riprap][stone] underwater to the extent necessary to provide coverage as indicated on the "Before Construction" drawings and/or to assure a connection between articulated concrete mattress and [riprap][stone] paving placed above water.

3.20.2.5 Connections

Construct connections between [riprap][stone] upper bank paving and concrete mattress or paving as detailed on the drawings. Remove any stone placed or spilled onto the concrete mattress and place by hand into the paving and mattress connection area. Ensure the thickness of stone in the connection is no less than 450 mm 18 inches at a point 1200 mm 4 feet from the concrete mattress or paving, and taper to an average thickness of 250 mm 10 inches at the edge of the mattress and at a point 1800 mm 6 feet from the mattress or paving, unless other thickness is specified. At the connection between [riprap][stone] paving and existing asphalt paving, increase the thickness of the [riprap][stone] paving to 250 mm 18 inches in a strip approximately 1200 mm 4 feet in width along the connection of the [riprap][stone] and existing asphalt paving.

3.20.2.6 Bedding Material

Bedding material approximately [100] [_____] mm [4] [_____] inches thick will have been placed by others at most locations from approximately the [_____] contour to the [_____] contour. Exercise reasonable care in placing [riprap][stone] so that the bedding material will not be damaged.

3.20.2.7 Exposed Flanks

When the bank paving ends with a flank or flanks not connected with existing work, the Contracting Officer may direct that the last 18 m 60 linear feet be paved with [riprap][stone] averaging 500 mm 20 inches in thickness from a point 1200 mm 4 feet landward of the articulated concrete mattress to the landward limit of the paving.

3.20.2.8 Ditch Outlets

Pave the bottom and side slopes of drainage ditches for a distance of 3 to 8 m 10 to 25 feet landward of the top bank as specified in [the Supplementary Specifications] [_____][or in the jobsite specifications].

3.21 DIKE REPAIRS

The work requires grading and paving areas of damaged dike bankheads, placing stone fill in areas of dikes where damage has occurred, and performing other stone repairs necessary to maintain integrity of the dike field. Except as provided below, work will be required only on portions of dike fields which are accessible by floating plant. Jobsite work orders will be issued for each dike field where work is required, setting forth the details and limits of work. It is anticipated that at some locations where dike field repairs are specified, the site may be inaccessible to floating plant, and hauling of stone may be necessary to restore the integrity of the dike field or to extend a dike landward. In such cases, [except for work at [_____],]the Contractor will be given the option of performing work at the applicable contract unit prices or omitting the work. However, should the Contractor agree to do the work, the entire work specified at that location must be satisfactorily completed. The Contractor will be furnished a jobsite work order with details as necessary to perform the work. After a review of the jobsite work order and an inspection of the site, notify the Contracting Officer, in writing, whether the work will be performed at the contract unit price or omitted from the job. It is anticipated that the length of a landward dike extension will not exceed [150][_____] m [500][_____] feet. Grading and dressing of the bank and excavation may be required. The type of stone required may be [57][_____] kg [125][_____] pounds [Riprap][Stone], or Graded Stone ["A"]["B"]["C"]. The placing of any of the above types of stone may include placing fill in a dike, bank paving and the filling of key trench. Where the Contractor agrees to perform stone dike repair work, which is inaccessible by floating plant and must be hauled, additional compensation for the tonnage hauled will be made at the applicable contract unit price for "Stone Placement Premium".

3.21.1 Tolerances

The following tolerances will be allowed in the specified repairs, provided the extremes do not occur adjacent to each other.

a. Surface Elevations

(1) [Upstream [_____] m feet of dike crown - zero to minus 300 mm 1 foot][_____].

[(2) [Downstream 2700 mm 9 feet of crown and apron -plus or minus 150 mm 6 inches][_____].]

b. Crown line (each side) -150 mm 6 inches inside to 300 mm 1 foot outside.

c. Slopes - plus or minus 300 mm 1 foot.

3.21.2 Earthwork

3.21.2.1 Grading

Grade or fill the bank with material available from grading to the slopes indicated in the Plans and Specifications and as staked in the field. Slopes must be no steeper than 1V on 3H except that steeper slopes may be authorized in making connection with existing paving. The grade of the slope must conform to the prescribed grade within the limits of plus or minus 300 mm 1 foot. When less than 7600 m^3 10,000 cubic yards is specified in the for a single dike field, consider the grading "Earthwork, Small Repairs" for payment purposes. When 7600 m^3 10,000 cubic yards or more of grading is specified in the Plans and Specifications for a single dike field, consider the grading "Earthwork, Large Repairs" for payment purposes.

3.21.2.2 Key Trench

A key trench may be required along the downstream limit of the [Riprap][Stone] paving or at other locations on the bankhead. Unless otherwise specified or directed, the key trench must extend from top of bank to waters edge, have a bottom width of 3 m 10 feet and side slopes of 1V on 1H. The bottom grade must be 1.5 m 5 feet below the prescribed grade of [riprap][stone] paving.

3.21.2.3 Disposal of Material

Dispose of material from grading in excess of that used as fill by depositing riverward of the top of bank upstream or downstream from the limits of the repair work.

3.21.2.4 Stone Work

a. Provide stone quality and size as specified.

b. Where [riprap][stone] is required in dike repairs, the size is [57][_____]-kg [125][_____]-pound [riprap][stone].

(1) [Riprap][Stone] Paving - Unless otherwise specified, provide [riprap][stone] paving consisting of a course of graded stone with an average thickness of 300 mm 12 inches measured normal to the slope. Where paving is placed under water, the amounts required are 7.3 tons 8 tons per square unless otherwise shown in the Contract Drawings or as directed by the Contract Office. Placing of stone must follow grading and excavation as soon as practicable. Preparatory to placing the [riprap][stone] paving, dress the slope to eliminate any irregularities due to wave or

rain wash, or operation of the Contractor's equipment. Place the stone by crane or dragline equipped with skip, clamshell, or rock bucket; by frontend loader or bulldozer; or by trucks or other methods approved by the Contracting Officer and rearrange by hand as necessary to provide complete coverage of the bank to the specified average thickness. A tolerance of 20 percent above or below the specified average thickness will be allowed. Openings between stones exposing more than 2600 mm^2 4 square inches of the graded slope will not be permitted. In underwater areas, place the stone uniformlydistribute in the amount specified.

(2) Stone-Filled Key Trench - Fill the excavated key trench to the elevation of adjacent [riprap][stone] with stone of the specified size to provide a thickness of 1.5 m 5 feet with a tolerance of 300 mm 1 foot. Bulldozing stone into the excavated trenches is prohibited.

(3) [Riprap][Stone] Fill - Restore eroded areas of stone dikes and fill minor gaps with [riprap][stone] of the specified size. Place the stone fill to the elevations and sections of adjacent portions of the dike or in accordance with theContract Drawings or as directed by the Contracting Officer. Construct underwater portion of the repairs in uniform horizontal layers of about 1.5 m 5 feet thickness. Construct each lift across the entire length of the dike repairs. Generally a 1800 mm 6 feet crown width with slopes of angle of repose (approximately 1V on $1^{1/4}$ H) will be required. A tolerance of plus or minus 300 mm 1 foot will be allowed in the specified elevation and crown width. Place the stone by a crane or dragline equipped with a skip, grapple, clamshell, or rock bucket; by frontend loader or bulldozer; or by trucks or other equipment approved by the Contracting Officer. Placing of stone along the dike when river stages are above the top of dike without prior approval of the Contracting Officer or at any river stages when site and current conditions prevail which, in the opinion of the Contracting Officer, make operations impracticable or uneconomical is prohibited.

3.21.2.5 Placement Control

Control placement of stone in the dikes, and furnish, operate, and maintain the necessary equipment, and all necessary material and supplies. At all times, when stone placement from floating plant is underway, the means by which the plant, equipment, and stone supply barges are positioned must function accurately and consistently. Whatever the method employed, it must permit the Contractor and the Government Quality Assurance Representative to readily determine the exact position of the stone-placing operation. Prior approval of the contracting Officer will be required in each instance before placing any stone subaqueously without the aid of any equipment listed below.

a. The method of alignment control may consist of piles or pile clumps. Other acceptable methods of alignment control include the use of a manned transit, laser, colored or polarized light beams, or other method demonstrable to be practicable and sufficiently precise and reliable.

b. Acceptable methods of distance control for floating plant engaged in subaqueous placement of stone may consist of piles or pile clumps at intervals of 90 to 120 m 300 to 400 feet. Supplement piles or pile

clumps, if used, by a wire distance wheel or other equally accurate measuring device for use in conjunction with the piles. Other acceptable methods include the use of electronic distance surveying instruments or other method demonstrable to be practicable and sufficiently precise and reliable.

c. Provide suitable recording electronic depth finder at each location of work under this contract. Provide a depth finder with a recording scroll no less than 100 mm 4 inches wide with a scale of no more than 3 m of depth to 25 mm 10 feet of depth to the inch. Ensure the depth finder is capable of obtaining accurate soundings and use as an aid in the control of subaqueous stone placement. Ensure that the depth finder is in proper working order at all times and furnish and maintain an adequate stock of recording paper for the depth finder. Submit to the Contracting Officer, for approval, the manufacturer's name, model number, and/or model name of the electronic depth finder proposed for use prior to the unit being place in service.

d. The use of buoys as placement control devices will not be permitted. The use of bank targets for alignment control will not be permitted for working distance of more than 1200 mm 400 feet without prior approval of the Contracting Officer.

3.22 PLACEMENT OF SHORELINE PROTECTION

3.22.1 Debris

Remove any timbers, unsatisfactory material and debris within the reaches for construction except as otherwise directed by the Contracting Officer, and upon removal is the property of the Contractor. Properly dispose of all materials in accordance with the requirements of Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS, including any applicable local requirements.

3.22.2 Limitations of Placement Procedures

Stone construction in advance of completed permanent protection except as specified herein is performed at the Contractor's risk. Keep the Contracting Officer informed as to any and all situations that may result in a possible interruption of work.

3.22.2.1 Interruptions

If the Government can anticipate that the stone construction will be interrupted for more than [_____] [four (4)] continuous days, including weekends and holidays, the Contractor may be required to complete the placement of [_____] and [_____] stone on both sides of the breakwater and provide protection of the exposed ends prior to the start of the interruption. The above-required protection for the exposed ends of the breakwater must consist of the same type of stone protection required on the lake side of the breakwater. Remove all material used for protecting the exposed ends of the breakwater after the need therefore has ended and incorporate appropriately into the required permanent construction. All materials which are removed and placed in the permanent construction, in accordance with the provisions of this section, will be measured and paid for only once. When temporary protection of exposed ends of construction in progress is ordered or directed by the Contracting Officer, an equitable adjustment will be made for the work of temporarily placing and removing the stone materials. The Government has no obligation to order

that exposed ends be protected. If the Government takes no action to have exposed ends protected, then the provisions of the paragraph MATERIAL PLACEMENT IN ADVANCE apply.

3.22.2.2 Material Placement in Advance

Do not construct the breakwater more than [_____] m feet in advance of completed placement of the [_____] and [_____] stone. If at the completion of a day's placement operations the unprotected portion (maximum [_____] m feet) is surveyed to determine the shape and grade of the materials placed, the Government will assume the responsibility for the cost to replace it (maximum [_____] m feet) if it is displaced or lost due to a storm during the nonwork period but not exceeding a continuous [_____] [four] day nonwork period. In the event an unprotected section of any length unsurveyed is left during a nonwork period or is left unprotected for a period longer than four continuous days and is damaged or causes damage to a completed section, replace or reshape the damaged portion(s) as approved by the Contracting Officer with no additional payment.

[3.22.3 Core/Mattress/Bedding Stone

Place stone to the lines, grades and thickness shown on the Contract Drawings. Use placement method such that any soft and organic materials on the lake floor will be displaced outward towards the extreme outside toes of the required sections of the structure and in the direction of the construction. Start stone placement at the centerline of the stone structure and extend outward to the toes of the structure in a fashion whereby the line of stone advancement takes an inverted "U" shape.[Placement by self-unloading lake carriers [will be allowed] is prohibited.] Place with reasonably systematic care that segregation of particle sizes will not occur.[If the materials are placed by clam shell, dragline, or other similar equipment, do not drop the stone from a height exceeding [_____][600] mm [_____][two] feet above the existing lake bottom or previously placed material.][Placement with bottom dump scows [is prohibited][will be allowed].] Ensure the finished surface of the stone is adequately smooth and free of mounds or windrows.[Ensure the finished work is free of clusters or small stones and cluster of larger stones.]

][3.22.4 Armor/Cover/Riprap Stone

Place stone in the locations and at the thickness shown without deviating from the lines and grade shown, including allowance for tolerances. Perform final shaping of the slope concurrently with the initial placement of the stone. Randomly select stones and set in contact with each other so that the interstices between adjacent stones are as small as the character of the stone will permit. Place the face of stone having the largest area against the surface of the underlying material. Begin placement at the bottom of the slope. Place the heaviest stones as toe stones. Place stones in a manner to avoid displacing underlying materials or placing undue impact force on underlying material that would cause the breaking of stones. Unless otherwise specified, do not drop stone from a height greater than [_____][600] mm [_____][two] feet. Use equipment in placing the stone suitable for handling materials of the sizes required including the ability to place the stone over its final position before release and if necessary pick up and reposition the stone. Do not use dragline buckets and skips in placement. Moving stone by drifting or manipulating down the slope is prohibited. The finished work must be a

well distributed mass, free of pockets of either smaller or larger stone, having a minimum of voids and with the maximum of interlocking of stones. It should be anticipated that rehandling of individual stones after initial placement will be required to achieve the above requirements. Do not drop stones required to be placed over or adjacent to drains and subsurface pipes, but gently lower and place in their final position by material handling equipment.

][3.22.5 Underlayer Stone

Place stone, to a full zone thickness, in one operation in a manner to avoid displacing the underlying material or placing undue impact force on underlying materials and supporting subsoils. Place underlayer stone in a manner to produce a resultant graded mass of stone with minimum voids. Rearranging of individual stones may be required to achieve this result. Placement by any method which is likely to cause segregation of the various sizes is prohibited. Lower unsegregated stone in a bucket or container and place in a systematic manner directly on the underlying material. Begin placement at the bottom of the slope and proceed upward. Casting or dropping of stone over [_____][600] mm [_____] [2] feet or moving by drifting and manipulating down the slope is prohibited. Construct final finish of the slope as the material is placed.

][3.22.6 Scour/Riprap Stone

Place stone, to a full zone thickness, in one operation in a manner to avoid displacing the underlying material or placing undue impact force on underlying materials and supporting subsoils. Place the stone in a manner to produce a resultant graded mass of stone with minimum voids. Rearranging of individual stones may be required to achieve this result. Placement by any method which is likely to cause segregation of the various sizes will not be permitted. Lower unsegregated stone in a bucket or container and place in a systematic manner directly on the underlying material. Begin placement at the bottom of the slope and proceed upward. Casting or dropping of stone over [_____][300] mm [_____][one] foot or moving by drifting or manipulating down the slope is prohibited. Construct final finish of slope as the material is placed.

][3.22.7 Fill Stone

Do not place fill stone within steel sheet pile walls until tie-rods, wales, and connections are installed, tightened, and inspected; and the structure is aligned within the required tolerances. Uniformly place the fill materials in maximum [_____][900]-mm [_____][3]-foot lifts and in such a manner that there will be no undue later settlement of the materials and that the structure will not be subjected to undue strains, deformations, or other damage. Responsibility for damage to the structure due to filling operations rests with the Contractor. Distribute and consolidate the stone by use of a vibratory hammer or similar vibrating hammer or similar vibrating equipment affixed to a steel beam inserted into the fill at intervals no greater than [_____][1.5] m [_____][5] feet. Continue vibratory operations until there is no visual continuation of settlement. Other distribution or consolidation methods may be used when approved by the Contracting Officer. Compact stone above water to [_____][90 percent] of maximum density obtained at optimum moisture content as determined by the Contractor in accordance with [EM 1110-2-1906][_____]. Perform at least [_____][one] compaction test for each [_____] metric ton ton of material placed.

][3.22.8 Splash Stone

Place stone to the lines and grades shown and in a manner that will avoid tearing the underlying geotextile.

]3.22.9 Fitted Cap Stone

Place fitted cap stone upon the geotextile covering the fill stone within the limits of the steel sheet pile structure to the lines and grades shown. Use stones of assorted sizes and place to tightly fit against each other in the space bounded by the perimeter [_____][concrete sidewalk]. Use individual stones of the maximum size which will fill a given space between larger stones to minimize the need for chinking. Ensure the flattest face of each stone is the top surface of the placed stone. Following placement of the cap stones, fill the remaining spaces between individual stones with pieces of the next smaller stone obtained from the required[underlayer] stone gradation materials being supplied for this contract. Fill the spaces between cap stones with selected stones of the maximum size which will fit in each remaining space. At the elevation of the upper horizontal surface of the cap stones, place the stones used for chinking with their elongated dimension in a vertical direction and force into place in the spaces between cap stone spaces such that they become firmly wedged in place.

3.22.10 Slides

In the event of the sliding or failure of any part of the structure during its construction, or after its completion, but prior to its acceptance, [upon written order of the Contracting Officer,] cut out and remove the slide from the structure and then rebuild that portion of the structure with new materials or reuse the displaced materials for rebuilding if deemed appropriate. The Contracting Officer will determine the nature and cause of the slide. In case the slide is caused through fault of the Contractor, perform the foregoing operations without cost to the Government.

3.23 TESTS AND INSPECTIONS

3.23.1 Concrete Grout

3.23.1.1 General

****
NOTE: Select the first bracketed option if ACI International references are cited in the project specification; select and verify the correctness of the second bracketed option if ACI International references are not cited in the project specifications.
****

Ensure individuals who sample and test grout as required by this section have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to ACI minimum guidelines for certification of Concrete Transportation Construction Inspector or ACI Concrete Construction Inspector Level II, obtainable from [the address and telephone number for ACI INTERNATIONAL in Section 01 42 00 SOURCES FOR REFERENCE PUBLICATIONS] [ACI INTERNATIONAL, P.O. Box 9094, Farmington Hills, MI 48333-9094, Ph: 248-848-3700, Fax: 248-848-3701, Internet:

http://www.aci-int.inter.net].

3.23.1.2 Preparations for Placing

Inspect riprap in sufficient time, prior to each grout placement, in order to certify that it is ready to receive the grout.

3.23.1.3 Air Content

Check air content at least [once][twice] during each shift during which grout is placed. Obtain samples in accordance with ASTM C172/C172M and test in accordance with ASTM C231/C231M. Whenever a test result is outside the specification limits, do not deliver the grout to the area to be grouted and adjust future air-entrainment admixture proportions.

3.23.1.4 Slump

Check slump [once][twice] during each shift during which concrete grout is produced. Obtain samples in accordance with ASTM C172/C172M and test in accordance with ASTM C143/C143M.

3.23.1.5 Placing

The placing foreman must verify that adequate equipment, supplies and workmen are available before permitting placement to begin on a shift.

3.23.2 Pre-Production

3.23.2.1 Bulk Specific Gravity

Submit, at least [120] [_____] calendar days in advance of shipment of stone to the work site, a copy of bulk specific gravity test results for each gradation range of stone proposed to be furnished. Furnish the information prior to preparation of pre-production demonstration stockpiles. Quantity determinations are contingent upon the range of bulk specific gravity (saturated surface dry (SSD) basis) of stone to be supplied. Therefore, during the process of selecting a source or sources of stone for the project, make an investigation to determine the lowest and highest bulk specific gravity (SSD) of stone available at the source or sources proposed to be utilized for each gradation range of stone. Perform tests at a Government [approved][validated] testing laboratory in accordance with [_____]. Submit testing results in accordance with paragraph SUBMITTALS. Test results which display an extraordinarily wide range of values may necessitate additional testing to determine whether the source contains strata or units with stones of an acceptable range of bulk specific gravity. For Category I sources which have been acceptably tested not more than two years earlier, and the material is of an acceptable quality and bulk specific gravity, the Contracting Officer may waive the requirement for bulk specific gravity testing.

3.23.2.2 Material Quality

Before selecting a source for preparation of a demonstration stockpile, be reasonably certain that the source is capable of meeting the quality and source requirements specified in paragraphs SOURCES and EVALUATION TESTING OF STONE, including their respective subparagraphs.

3.23.2.3 Borderline Material Quality

If the COR's evaluation of a demonstration stockpile results in not being able to determine by visual examination whether the material is acceptable or unacceptable, the COR will select at least one but not more than three representative stones from the demonstration stockpile to be prepared for shipment to the Government's laboratory for testing in accordance with paragraph EVALUATION TESTING OF STONE. Where specified sizes are in excess of 900 kg 2,000 pounds, cut or break a representative piece, weighing approximately 900 kg 2,000 pounds each, off of the selected stones. For specified stone sizes of less than 900 kg 2,000 pounds but more than 230 kg 500 pounds, individual samples must be the size of the largest stone specified for the size range. Samples of stone groupings with a maximum size less than 230 kg 500 pounds must contain at least two (2) stones representative of the higher limit of the stone weights specified. In addition, the sample is representative of the gradation specified and the minimum weight of the total sample must be greater than 230 kg 500 pounds. Repeat sampling and testing procedures for each strata or distinct rock type being quarried. Ship the samples to the laboratory as specified in paragraph EVALUATION TESTING OF STONE. If the laboratory testing reveals the materials are unacceptable, submit a replacement source for approval and proceed with the demonstration stockpile procedures anew.

3.23.2.4 Demonstration Stockpile at Source

Following submittal of the Contractor's Quality Control (CQC) Plan and selection of a source, but prior to the Government's approval of a source and the CQC Plan, make arrangements to provide a pre-production demonstration stockpile for each of the stone size ranges for the project. Assemble the stockpiles at the source of the stone and shape in windrow fashion. Place stones with a size range greater than [_____] [2.7] tons [_____] [3] tons in a single layer with [_____] [300] mm [_____] [1] foot or more of clear space around each stone. Do not stack stones in smaller sizes under [_____] [2.7] tons [_____] [3] tons in weight higher than [_____] [1200] mm [_____] [4] feet. The stones placed in the demonstration stockpiles are representative of the overall quality of materials in the source and must not consist of the best specimens unless it is reasonable to determine that the source will provide the required amount of stone of the applicable size range with a degree of quality no less than that existent in the demonstration stockpile. Prepare separate examples of unacceptable stones so labeled demonstrating characteristics that are outside of acceptability for the project, to be used as guidance by personnel. The quantity of stone required in each demonstration stockpile is dependent upon the gradation size range to be produced for the project. The following parameters apply:

SIZE OF INDIVIDUAL STONES WITHIN A RANGE	DEMONSTRATION STOCKPILE QUANTITY BASED ON PROJECT QUANTITY FOR SIZE RANGE
[_____]	[_____]
[_____]	[_____]
[_____]	[_____]

SIZE OF INDIVIDUAL STONES WITHIN A RANGE	DEMONSTRATION STOCKPILE QUANTITY BASED ON PROJECT QUANTITY FOR SIZE RANGE
[_____]	[_____]

Ensure stones placed in the stockpile have been preselected by the Contractor's Quality Control Plan (QCP) inspector or supervisor and acceptable stones over 230 kg 500 pounds in size have been marked with spray paint on three mutually perpendicular sides with a coded mark to denote acceptability for a certain size range. Assemble a stockpile of representative reject stones marked with a red "X" at the [site][source] as examples of unacceptable materials or shapes.

3.23.2.5 Evaluation of Demonstration Stockpile at Source

Notify the Contracting Officer when stockpiles are ready for evaluation. The Contractor's approved Quality Control Plan (QCP) supervisor and all QCP inspectors must accompany the Contracting Officer's Representative (COR) during the Government's evaluation of the demonstration stockpiles and source. Arrange to have individual stones turned as necessary to accommodate the COR's evaluation. The COR will mark rejected stones with a red "X" and remove such stones to the reject stockpile or to a crusher if one is available. If more than [_____][3 percent] unacceptable stones are found within a stockpile, the entire stockpile will be rejected by the Government and a replacement stockpile will be created for re-evaluation. If the replacement stockpile is rejected, revise and resubmit the Quality Control Plan (QCP) and create another replacement demonstration stockpile for evaluation. If the third demonstration stockpile for a particular size range at a single source is found unacceptable, the source will be disapproved for such size rang and submit a new source for approval. In addition, submit the name and qualifications for a person to replace the QCP supervisor. The Contractor may choose a replacement source at the time a first or second demonstration stockpile is found unacceptable. The replacement of demonstration stockpiles or stone sources is at no additional cost to the Government and with no change in the time of completion.

3.23.2.6 Approval of Demonstration Stockpile at Source

At the time the COR finds the contents of a demonstration stockpile to be acceptable, either through visual examination or through laboratory testing, the Contractor will be notified in writing that the source, the QCP plan and QCP staff are approved, whereupon the Contractor may proceed with production of materials for the project provided they are consistent with demonstration stockpiles.

3.23.2.7 Duration of Demonstration Stockpile at Source

Other than for being shipped as the final quantities of materials to be placed in the work, each demonstration stockpile must remain unchanged at the source until all other required material of the size range represented by the stockpile has been shipped from the source.

3.23.3 Placement Control

3.23.3.1 Quality Control Measures

Establish and maintain quality control for all work performed at the job site under this section to assure compliance with contract requirements. Maintain records of the quality control tests, inspections and corrective actions. Cover all construction operations including, but not limited to, the placement of all materials to the slope and grade lines shown and in accordance with this section.

3.23.3.2 Check Surveys

****
NOTE: EM 1110-2-1003 should be referred to for spacing requirements for a Hydrographic Survey.
****

Surveys made by the Contractor are required on each material placed for determining that the materials are acceptably placed in the work. Make checks as the work progresses to verify lines, grades and thicknesses established for completed work. Perform at least one check survey as specified below for each [_____][25] foot section as shown as practicable after completion. Following placement of each type of material, the cross section of each step of the work must be approved by the Contracting Officer before proceeding with the next step of the work. Approval of cross sections based upon check surveys does not constitute final acceptance of the work. Perform cross sections on lines [_____][8] m [_____][25] feet apart, measure along the structure reference line, with readings at [_____][1.5] m [_____][5] foot intervals and at beaks along the lines. However, other cross section spacing and reading intervals may be used if determined appropriate by the Contracting Officer. Take additional elevations and soundings as the Contracting Officer may deem necessary. Conduct surveys in the presence of an authorized representative of the Contracting Officer, unless this requirement is waived by the Contracting Officer.

a. Above Water: Determine the elevation of stone above the water surface by the use of a leveling instrument and a rod having a base 300 mm 12 inches in diameter. If approved by the Contracting Officer other means may also be used.

b. Below Water: For portions of the work that are under water, perform sounding surveys either by means of a sounding pole or a sounding basket weighing about 4 kg 8 1/2 pounds, each of which has a base measuring 300 mm 12 inches in diameter.

c. Gage Board: Check the gage prior to any survey. Install a gage board at the project site.

d. Electronic Depth Recorder Method: When using an electronic depth recorder, use the following procedures.

(1) Calibrate and adjust the depth recorder for the gage, with check bar, at least [_____][six] times within a normal eight hour work day.

(2) Normal calibration times is at the beginning of the work day, mid-morning, close of morning's work, start of afternoon's work,

mid-afternoon, and the end of the day.

(3) Perform further calibrations whenever there is any malfunction within the depth recorder or transducer which might affect the soundings, a major gage change, or change in water temperature due to industrial discharge or other causes.

(4) Set the check bar at approximately the deepest sounding in the area to be sounded.

(5) Calibrate the depth recorder to read at low water datum.

(6) When checking the calibration at mid-morning, end of morning, mid-afternoon and end of work, use the same setting used for the previous calibration.

(7) If the calibration check does not agree with the previous calibration, calibrate the depth recorder to the proper setting.

(8) Do not change the setting of the depth recorder between calibrations.

e. Electronic Depth Recorder: The survey depth recorder used must be a standard model acceptable to the Contracting Officer using a sounding chart that can be read directly to the nearest 300 mm foot and estimated to the nearest 30 mm tenth (0.1) of a foot. Ensure accuracy is better than 1/2 of 1 percent.

f. Tagline Method of Horizontal Location Along Station: If a tagline is used with a depth recorder, mark the soundings with a fix every [_____][1.5] m [_____][5] feet.

g. Predetermined Transit Angle Method or Ranges Method: The interval between predetermined angles or ranges along a sounding line must not exceed [_____][60] m [_____][200] feet along the entire length of the sounding line. Do not allow predetermined angle to form an intersection with the sounding line of less than 45 degrees.

h. Speed of the Sounding Boat: When sounding, ensure the speed of the sounding boat is as constant as possible, preferably between 55 and 67 m per minute 180 and 220 feet per minute.

i. Checking Gage: Check the gage prior to each calibration and record on the sounding chart or in the field notes.

3.23.4 Bedding Layers, Filter Layers, and Sand Fill

3.23.4.1 General

Perform gradation tests to assure compliance with contract requirements and maintain detailed records. Sample bedding material, filter materials and/or sand fill in accordance with ASTM D75/D75M and test in accordance with ASTM C136/C136M. Perform the tests before and after surveys of each layer of stone protection material placed.

3.23.4.2 Reporting

Reporting must be in accordance with paragraph GRADATION TEST.

[3.23.5 Trenchfill Revetment, Bank Paving, and Outlet Drains

Establish and maintain quality control for stone placement operations to assure compliance with contract specifications and maintain records of his quality control for all construction operations including, but not limited to, the following:

a. Check grades of trenchfill and bank paving for compliance with design sections.

b. Record tonnage of stone placed in each station of trenchfill revetment and check quantity for compliance with design sections.

c. Check for uniform thickness of paving stone and specified elevation of top paving on graded slopes.

d. Check for even distribution of spalls used in paving.

[
e. Insure that outlet drains conform with design sections.]

][3.23.6 Stonefill Revetment and Stonefill Dikes

Check grade, slope, and placement of stone for compliance with design sections and specifications.

][3.23.7 Stone Dike

Establish and maintain quality control for all stone dike operations to assure compliance with contract requirements and maintain detailed records of this quality control for all construction operations, including, but not limited to, the following:

a. Placement and alignment of stone in the dike.

[
b. Periodic fathometer surveys as directed by the Contracting Officer.]

[
c. Record of the tonnage of stone placed in each station.]

][3.23.8 Revetment Repairs

Inspect the revetment repairs for compliance with the contract requirements and record the inspection of all operations including, but not limited to, the following:

a. Bank grading, excavating or reshaping damaged drains through the paving, placing graded material into areas, and disposing of waste material.

b. Breaking out pavement within specified limits.

c. Disposition of cleared material, drift, and other debris.

d. Preparation of subgrade for paving.

]3.23.9 [Stone][Riprap] Paving

Establish and maintain quality control for slope dressing and riprap paving to assure compliance with contract requirements, and maintain records of his quality control for all construction operations, including

but not limited to the following:

a. Dressing the slope to eliminate any irregularities, including irregularities in the gravel blanket placed by others, due to rain or wave wash or operations of the Contractor's equipment.

b. Grading and dressing necessary to secure a suitable connection with the riprap paving in place.

c. Underwater paving to assure proper connection with concrete mattress and complete coverage.

d. Above-water connection between riprap paving and concrete mattress.

e. Connection between riprap paving and asphalt paving.

f. Placement of riprap on gravel blanket, upper bank slope, and if applicable, overbank areas for thickness and proper coverage.

g. Placement of riprap in ditch outlets.

3.23.10 Dike Repairs

Inspect all dike stone repair operations for compliance with contract requirements and record the inspection of all operations including, but not limited to the following:

a. Grading of slopes to design grade within tolerance.

b. Disposition of material from grading and excavation.

c. Dressing of slope before placement of paving.

d. Placement of slope and underwater paving.

e. Grade and section of stone fill.

Furnish to the Contracting officer a copy of these records an tests, as well as records of corrective action taken.

[3.23.11 Gradation Tests for Stone

[3.23.11.1 Gradation Test Method for Riprap

Perform gradation tests in accordance with ASTM D5519, Test Method A [_____].

][3.23.11.2 Standard Test Method for Gradation of Quarry Run Stone or Stone Paving

****

NOTES: Alternative 2. The gradation test method was developed to provide guidance to field personnel and Contractors so that the procedures would be uniform. This test procedure is provided as an example.

This test method should not be used in contract specifications that cover stone, upper bank and

stone, overbank, and quarry run stone.

****

a. Select a representative sample (Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter than).

NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

NOTE NO. 2: Selection of Size for Separation: For these types of stone gradations the separation points need to be selected as the smallest size stone at each break in the gradation specified.

EXAMPLE GRADATION SPECIFICATIONS	
INDIVIDUAL PERCENT RETAINED	STONE WEIGHT IN KGLBS
10 Max.	34 - 5775 - 125
40-60	11 - 3425 - 75
20-40	3 - 116 - 25
15 Max.	0 - 30 - 6

EXAMPLE WORKSHEET			
STONE SIZE KGLBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	SPECIFICATIONS
Greater than 57125	0	0	0
34 - 5775 - 125	1180 2600	8	10 Max.
11 - 3475 - 125	735016,200	50	40-60
3 - 116 - 25	45410,000	32	20-40
0 - 30 - 6	1450 3200	10	15 Max.
TOTAL	14,520 kg32,000 pounds		
NOTE: Largest stone 68 kg150 pounds			

]3.23.11.3 Standard Test Method for Gradation of Riprap, Graded Stone, and [_____]

****

NOTE: Alternative 2. The STANDARD TEST METHOD FOR GRADATION OF RIPRAP AND GRADED STONE gradation test method was developed to provide guidance to field personnel and Contractors so that the procedures would be uniform. This test procedure is provided as an example.

This test method should be presented in contract specifications that require riprap or graded stone. This test method should not be used in contract specifications that only cover stone, upper bank and stone, overbank.

****

a. Select a representative sample (Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter

than). Plot percent passing, along with the specification curve on ENG Form 4794-RM 4794-R.

(1) NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

(2) NOTE NO. 2: Selection of Size for Separation: It is quite possible and accurate to run a gradation using any convenient sizes for the separation, without reference to the specifications. After the test is plotted on a curve, then the gradation limits may be plotted. Overlapping gradations with this method are no problem. However, it is usually more convenient to select points from the gradation limits, such as the minimum 50 percent size, the minimum 15 percent size, and one or two others, as separation points.For these types of stone gradations the separation points need to be selected as the smallest size stone at each break in the gradation specified.

F O R

E X A M P L E

O N L Y

EXAMPLE GRADATION SPECIFICATIONS	
PERCENT LIGHTER BY WEIGHT	STONE WEIGHT IN KGLBS
100	180 - 75400 - 160
50	75 - 35160 - 80
15	35 - 1580-30

EXAMPLE WORKSHEET				
STONE SIZE KG LBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
180400	0	0	0	100
75160	43549600	30	30	70
3580	508011,200	35	65	35

EXAMPLE WORKSHEET				
STONE SIZE KG LBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
1530	36298000	25	90	10
<15<30	14513200	10	100	-
TOTAL	14,514 kg32,000 pounds			
NOTE: Largest stone 114 kg251 pounds				

G R A D A T I O N T E S T D A T A S H E E T

Quarry _____ Type of Stone Tested _____

Date of Test _____ Testing Rate _____

T E S T R E P R E S E N T S		
Contract No.	District	Tons
	TOTAL	

G R A D A T I O N					
			Cumulative		
Stone Size (kg)(lbs)	Weight Retained	Individual % Retained	Percent Retained	Percent Passing	Specification % Finer by Wt
Total Weight					
Max Size Stone					

Remarks:

I certify that the above stone sample is representative of the total tonnage covered by this test report.

Contractor Representative _____

Government Representative _____

STONE SOURCES		
LATITUDE/LONGITUDE	QUARRY LOCATION, ADDRESS, & TELEPHONE	MAIN OFFICE ADDRESS & TELEPHONE NUMBER
[STATE]		
[STATE]		

] -- End of Section --