SECTION 35 31 19

STONE PROTECTION
01/08

PART 1 GENERAL

Processing, testing, hauling, and stockpiling stone shall meet the requirements of the contract documents.

All supplied stone shall be from Corps of Engineers approved sources. For the purpose of this specification, a source will refer to a specific bed at a specific quarry location. Gradation and evaluation testing will be at the expense of the quarry. If the quarry proposes an unapproved source, then the quarry will be responsible for the cost of gradation and evaluation testing. Evaluation testing of unlisted stone sources proposed by the quarry must indicate quality is equivalent or better than the approved sources for approval.

1.1 REFERENCES

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.

ASTM INTERNATIONAL (ASTM)

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C535	(2016; R 2024) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
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)

EM 1110-2-1601	(1991; 1994 Change 1) Engineering and Design -- Hydraulic Design of Flood Control Channels

1.2 DEFINITIONS

1.2.1 Stone Protection

Stone Protection is defined as a system which may include a layer of bedding 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 or shoreline when it is placed in the dry or in slack water.

1.2.2 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. The terms riprap and stone are used interchangeably in 35 31 19.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with the "DO" designation require review and approval by the District Office. Submit the following to the Missouri River Project Office, 790 E HWY 224, Napoleon, MO 64074.

SD-01 Preconstruction Submittals

QC Plan, Including Quarry Production Control Plan which includes

dimensions of blast area; G, DO

SD-03 Product Data

Riprap; G, DO

SD-04 Samples

Stone (Demonstration Stockpiles); G, DO

SD-06 Test Reports

Gradation Test; G, DO

Evaluation Testing of Stone; G, DO

SD-07 Certificates

Stone; G, DO

Weigh Scale Certification; G

Certified Weight Scale Tickets; G

1.4 QUALITY ASSURANCE

1.4.1 Stone

For the purpose of this specification, a source will refer to a specific bed at a specific quarry location.

1.4.1.1 General

All stone shall be durable material as approved by the Missouri River Project Office. Stone shall be of a suitable quality to ensure permanence in the structure and in the climate in which it is to be used. It shall be free from cracks, blast fractures, bedding, seams and other defects that would tend to increase its deterioration from natural causes. Inspections for cracks, fractures, seams and defects shall be made by visual examination. If, by visual examination, it is determined that 10 percent or more of the stone produced contains hairline cracks, then all stone produced by the means and measures which caused the fractures shall be rejected. A hairline crack that is defined as being detrimental shall have a minimum width of 4 mil and shall be continuous for one-third the dimension of at least two sides of the stone. The stone shall be clean and adequately free from all foreign matter. Any foreign material adhering to or combined with the stone as a result of stockpiling shall be removed prior to delivery. If an unapproved source is to be used, show that an adequate quantity of material is available and provide quality test data.

1.4.1.2 Sources

Stone shall be furnished from one or a combination of approved sources.

The quarry will pay all costs for gradation and evaluation tests from the approved source to assure the acceptability of the stone. The quarry will be responsible for sending suitable stone samples to a lab for evaluation testing of stone from sources with an adequate supply of material and submitting test results to the Missouri River Project Office.

a. Selection of Source. Designate in writing only one source or one combination of sources from which the quarry proposes to furnish stone. If the quarry proposes to furnish stone from a unapproved source they shall notify the Missouri River Project Office at least 60 workdays before the stone leaves the quarry. It is the quarry'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. Samples for acceptance testing shall be in accordance with paragraph EVALUATION TESTING below.

b. Acceptance of Materials. For approved sources listed in the table at the end of this specification, prepare a demonstration stockpile for government evaluation at the quarry. Organize a visit to the quarry by a representative of the Missouri River Project Office for evaluation of the demonstration stockpile. Submit gradation test results and await approval of the gradation test results and demonstration stockpile by the Missouri River Project Office prior to delivery of any stone material to the worksite. Stone material must undergo a minimum 14-day curing period prior to delivery of any stone material to the worksite, as described in paragraph Quarry Operations. Evaluation test results will be used to evaluate acceptability of any unapproved sources proposed by the quarry. Evaluation test results from an approved or unapproved source must be submitted together.

c.

For any unapproved source proposed by the quarry prepare suitable stone samples (demonstration stockpile) for government evaluation at the quarry. Organize a visit to the quarry by a representative of the Missouri River Project Office for evaluation of the demonstration stockpile. Submit gradation test and evaluation test results and await approval of the source by the Missouri River Project Office prior to delivery of any stone material to the worksite. Stone material must undergo a 14-day curing period prior to delivery of any stone material to the worksite, as described in paragraph Quarry Operations. Evaluation testing of unapproved stone sources proposed by the quarry must indicate quality is equivalent or better than the approved sources.

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 Missouri River Project Office. The Missouri River Project Office 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 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 Missouri River Project Office. If the Missouri River Project Office, during the inspections, finds that the stone quality, gradation or weights of stone being furnished are not as specified, are questionable, or there has been a facies change, replacement with product meeting the requirements of this specification or re-sampling and re-testing confirming compliance with this specification is required. Sampling of the delivered stone for testing and the manner in which the testing is to be performed shall be as directed by the Missouri River Project Office. This additional sampling and testing shall be performed at the quarry's expense. Any material rejected shall be removed or disposed of as specified and at the quarry's expense.

PART 2 PRODUCTS

2.1 STONE

2.1.1 General

2.1.1.1 Evaluation Testing of Stone

Samples shall consist of at least three pieces of stone, roughly cubical in shape and weighing not less than 150 pounds each and from each proposed unit for 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, a fresh rock face, 20 feet long and the full height of the proposed face shall be available prior to the field evaluation. Evaluation of stone shall comply with ASTM D4992. The tests to which the stone shall be subjected are listed below. Evaluation testing of stone shall be performed for all approved sources and all beds or ledges to be used or proposed. Evaluation testing of stone shall be submitted to the Missouri River Project Office as described in paragraph 1.4.1.

a. Bulk Specific Gravity. The method of test for bulk specific gravity (SSD) shall be ASTM C127.

b. Absorption. The method of test for absorption shall be ASTM C127.

c. Resistance to Freezing and Thawing. Freeze-thaw testing shall be in accordance with ASTM D5312/D5312M.

d. LA Abrasion. LA abrasion testing shall be in accordance with ASTM C535.

e. Resistance to wetting and drying if argillaceous limestone and sandstone are used. Evaluation of durability of rock testing shall be in accordance with ASTM D5313/D5313M.

2.1.1.2 Quarry Operations

Conduct quarry operations in a manner to produce stone conforming to the specified requirements, this may involve selective quarrying, handling,

processing, blending, and loading as necessary. The quarry operator shall plan controlled blasting and handling of rock to produce rock of the size ranges and quality specified and to minimize likelihood of microfractures induced by blasting. 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 for upstream protection of a critical flood control project. All aspects of blasting operations shall be specifically designed 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 and to allow the stone to demonstrate that it will not fracture during the energy release and drying-out phase. Stones of sizes which are individually picked shall be temporarily stockpiled at the quarry site a minimum of 14 calendar days before being shipped to the project site, unless this requirement is waived by the Missouri River Project Office. Such waivers will be granted only if the stone has characteristics that make curing unnecessary.

b. Stone Quarrying Exclusion Period

Stone quarried between the 15th of September, and the 15th of April will not be approved for use in the project. Stone quarried before 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 unless this requirement is waived by the Missouri River Project Office. Such waiver will be granted only if the quarry and stone produced from that quarry has characteristics that make stone quarrying exclusion period unnecessary.

c. Temporary Storage at Quarry

Underwater storage of stone materials is prohibited. Ensure storage area is graded to drain and free of objectionable material prior to storage of material. Any foreign material adhering to or combined with the stone as a result of storage shall be removed prior to delivery.

2.1.1.3 Proportional Dimension Limitations

The maximum aspect ratio (greatest dimension:least dimension) of any piece of stone for size ranges shall be not greater than 3:1 when measured across mutually perpendicular axis. Not more than 25 percent of the stone within a gradation range shall have an aspect ratio greater than 2.5:1. A maximum of 5 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. ASTM D4791 shall be used as a guide to perform the test.

2.1.1.4 Stockpile

The quarry's stockpile shall be a maximum of 12 feet high and formed by truckload dumps, where the rock essentially remains where it is placed.

Driving on top of stockpiled material and stockpiling in layers where further handling of material is required will not be permitted.

a. Worksite Stockpile. Riprap delivered to the work sites shall be placed where indicated by the Missouri River Project Office.

2.1.2 Riprap

Only quarried stone shall be used. Riprap quality shall be as specified in paragraph QUALITY ASSURANCE, subparagraph STONE. Stone shall be well graded and shall conform to the table(s) below. Submit weigh scale certification and certified weight scale tickets

RIPRAP GRADATION - 24 inches	
PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, LB.
100	500-691
50	130-205
15	41-102

PART 3 EXECUTION

3.1 PLACEMENT OF RIPRAP

The desired distribution of the various sizes of stones throughout the mass shall be obtained by selective loading of the material at the quarry or other source. No stone shall be dropped from a height greater than 8 feet. Each truckload shall be representative of the gradation requirements.

3.2 TESTS AND INSPECTIONS

3.2.1 Pre-Production

3.2.1.1 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.

3.2.1.2 Demonstration Stockpile at Source

Following submission of proposed stone source information and certifications, a representative sample of the stone proposed for use as riprap in construction shall be made available in a demonstration stockpile for a Government visual field review of quality and rock size at the quarry well prior to the start of full-scale quarry production. This sample shall consist of not less than 60 tons. The sample shall be handled in a manner to duplicate the type and conditions of actual handling, loading, hauling and unloading leading to placement at the work site. The stones placed in the demonstration stockpiles shall not be selectively picked but shall be a representative sample of the general quality of materials produced from the source. Results of the 60-ton sample visual field review shall be furnished

to the Missouri River Project Office for approval prior to the mass production or delivery of any stone to the project site. From the approved 60-ton sample, deliver a representative one-fifth (roughly 12 tons) pre-production sample to each of the four project sites for stockpiles in a suitable area where it shall remain undisturbed for use as a quality control reference for future deliveries. The remaining roughly 12 tons of the approved sample shall remain undisturbed at the quarry where it shall serve as a quality control reference for quarry operations. The approved samples may be placed in the work after the last load of quarry production is delivered to site. The quarry shall furnish all labor, equipment, and materials needed for the sample review. The Government may reject stone deliveries, or require modification of quarry operations, based on comparisons between current production and the approved samples.

3.2.1.3 Evaluation of Demonstration Stockpile at Source

The quarry shall notify the Missouri River Project Office when stockpiles are ready for evaluation. Government inspectors will evaluate the demonstration stockpiles.

3.2.1.4 Approval of Demonstration Stockpile at Source

At the time the Missouri River Project Office finds the contents of a demonstration stockpile to be acceptable, through visual examination the quarry will be notified in writing within one week that the source is approved, whereupon the quarry may proceed with production of materials for the project provided they are consistent with demonstration stockpiles.

3.2.1.5 Duration of Demonstration Stockpile at Source

Other than being shipped as the final quantities of materials to be placed in the work, each demonstration stockpile shall remain unchanged at the source until all other required material of the size range represented by the stockpile has been shipped from the source. The stockpiles shall be used as a visual calibration standard of acceptable materials by the production staff.

3.2.2 Gradation Test

3.2.2.1 Riprap

Gradation tests shall be performed in accordance with ASTM D5519, Test Method A. The quarry shall perform gradation tests at the quarry. The sample shall be taken by the quarry in the presence of a representative of the Missouri River Project Office. The quarry shall notify the Missouri River Project Office not less than 3 days in advance of each test. In the event of the unavailability of the Missouri River Project Office, the quarry shall perform the tests and certify to the Missouri River Project Office that the material shipped complies with the specifications. At least one gradation test shall be performed per 15,000 tons of riprap placed and shall be collected in a random manner which will provide a sample of at least 25 tons that accurately reflects the gradation arriving at the jobsite. The gradation tests shall be reported using the attached forms, GRADATION TEST DATA SHEET and ENG FORM 4055. The initial gradation test shall have a sample size of 60 tons to form the demonstration stockpile. The quarry shall designate on the test form that portion, in tons, of the lot tested which is applicable to the contract. Any deviation from the reported tonnage shall be corrected and recorded on a revised GRADATION TEST DATA SHEET. 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 all riprap represented by the failed tests shall be set aside and not incorporated 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 shall be representative of the gradation requirements. Certification and test results shall represent materials shipped from the quarry. Certification and test results must be received by the Missouri River Project Office at the jobsite before the riprap is used in the work.

The Missouri River Project Office may direct additional testing of materials at the project site if the material appears, by visual inspection, to be out of gradation. The additional tests shall be performed on in-place riprap materials at the locations directed, or on random loads selected by the Missouri River Project Office. In-place test areas shall not be less than 12 feet by 12 feet and shall include the full thickness of the placed riprap, without disturbing or including the underlying material, and shall meet the minimum sample size specified above. The additional gradation tests shall not count as part of the minimum number of gradation tests required. All costs associated with the additional testing of materials shall be paid for by the quarry. The unacceptable stone shall either be reworked to bring the stone within the specified gradation, or the stone shall be removed from the project site as determined by the Missouri River Project Office. The quarry shall provide all necessary screens, scales, and other equipment and operating personnel necessary to grade the sample. Weighing and measuring devices must comply with NIST HB 44.

3.3 DELIVERY AND DELIVERY LOCATION

3.3.1 Delivery of Stone

The stone shall be delivered in quantities to the sites indicated in the paragraph below at a rate of at least 1,500 tons per day. Delivery to only one site at a time will be permitted. All deliveries shall be between the hours of 7 A.M and 5 P.M. Monday through Friday except for federal holidays.

Rock or scale tickets shall be given to onsite personnel at the time of stone delivery.

All rejected material shall be removed by the quarry prior to completion of rock installation at each site. All costs, including trucking and loading, associated with the removal of the rejected material shall be the responsibility of the quarry.

3.3.2 Delivery Methods

All stone shall be delivered by a standard end dumping truck. A standard end dumping truck has a single chassis or base frame with a mounted bed. The front of the bed is raised by a hydraulic cylinder(s) and is hinged at the rear. Trailers, belly dumps or side dumps will not be permitted.

3.3.3 Measurements

Materials shall be measured at such times and places as approved by the Missouri River Project Office.

Stone delivered at the site of the work shall be weighed on public scales or

privately owned scales generally used by the public which have been certified by the State in which the scales are located, and which have been approved by the Missouri River Project Office. If public scales are not available, the Contractor can furnish approved scales, subject to certification acceptable to the Missouri River Project Office, with the weighing service to be supplied by an independent professional organization approved by the Missouri River Project Office. The quarry shall furnish the Government a legible copy of each weigh bill, when self-printing scales are used, or a legible copy of the weigh bill signed by the weighmaster as each load is delivered to the jobsite. All cost for weighing the stone on a public or quasi-public scale shall be borne by the quarry.

3.3.4 Delivery Locations and Quantities

The quantity of stone shall be delivered to the sites listed in this section. Each site is designated by name with corresponding coordinates, latitude and longitude, and stone quantity.

Site Name	Coordinates		Latitude	Longitude	Quantity (Tons)
Site A Prairie Ridge	40.87166	-92.90357	40°52'17.02"N	92°54'13.07"W	11,321
Site B1 Prairie Ridge	40.86421	-92.90694	40°51'51.99"N	92°54'23.42"W	2,780
Site D South Fork	40.84753	-93.01689	40°50'51.03"N	93° 1'10.98"W	26,930
Site E Camp Appanoose	40.85684	-93.02297	40°51'24.51"N	93° 1'22.73"W	26,420
				Total	67,451

EXAMPLE WORKSHEET				
STONE SIZE LBS	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT	CUMULATIVE RETAINED	PERCENT PASSING
400	0	0	0	100
160	9600	30	30	70
80	11,200	35	65	35
30	8000	25	90	10
<30	3200	10	100	-
TOTAL	32,000 pounds			
NOTE: Largest stone 251 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	

Stone Size (lbs)	Weight Retained	Individual % Retained	Percent Retained	Percent Passing	Specification % Finer by Wt
Total					
Max Size Stone					

Remarks:

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

Contractor (Quarry) Representative _____

Government Representative _____

QUARRY LOCATION, ADDRESS, & TELEPHONE	APPROVED LEDGE
Cantera Aggregates LLC, "Walnut City" Appanoose County 14592 Hwy. J5T Mystic, IA 52574 (641)649-2730	Bed 6
Cantera Aggregates LLC, Quarry 203 Appanoose County 11278 112th Ave Plano, IA 52581 (641)649-2730	Exline/Cooper Creek LS, Beds 1 and 3 *Note-Lower half of bed 1 only. Quarry added to approved sources list for Rathbun Shoreline Protection and Walker Branch projects only.

-- End of Section --