

SECTION 600

OPEN CHANNELS, DIKES OR DAMS

600.1 GENERAL

600.1.1 This section shall provide the specifications for storm drainage facilities, such as open channels, dikes, and dams. For the purposes of this section these facilities are defined as follows:

600.1.2 Open channel shall mean open rectangular concrete channels and lined or unlined trapezoidal channels.

600.1.3 Dikes are for diversion of storm drainage flows and shall be constructed of compacted earth, riprap, soil-cement stabilization, or concrete surface.

600.1.4 Earth dams for detention of storm run-off may require one of the surface treatments as indicated for dikes.

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SECTION 601

EARTHWORK FOR OPEN CHANNELS, DIKES, OR DAMS

601.1 GENERAL

Earthwork specifications for channels, dikes, and dams shall consist of excavation, grading, side sloping, and compaction. Structural earthwork requirements are contained in Section 500.

601.2 REFERENCES

601.2.1 ASTM

D 1557

601.2.2 This publication:

SECTION 201  
SECTION 204

601.3 CLEARING AND GRUBBING

The area for clearing and grubbing shall be defined on the construction plans and this area shall be cleared and grubbed in compliance with Section 201.

601.4 UNSUITABLE MATERIALS

601.4.1 Unsuitable materials include all material that contains debris, roots, organic matter, stones or boulders too large to be used in the intended construction, or other materials that are determined by the ENGINEER to be suitable. Otherwise suitable materials which are unsuitable due to excess moisture content will not be classified as unsuitable material unless it cannot be dried by manipulation, aeration or blending with other materials satisfactorily as determined by the ENGINEER.

601.4.2 On-site unsuitable materials will not be used for channel, dike, or dam construction. The CONTRACTOR shall remove and dispose of all unsuitable materials.

601.5 ROCK EXCAVATION

601.5.1 Rock excavation shall consist of igneous, metamorphic and sedimentary rock, naturally in place, which cannot be excavated without blasting or the use of rippers, and all boulders or other detached stones having a volume of one (1) cubic yard or more, as determined by physical measurements or visually by the ENGINEER. Where any portion of the excavation contains strata classified as Rock Excavation and the various strata are parted with strips or strata not classified as Rock Excavation which constitute twenty-five (25) percent or less of the total thickness of the rock plus non-rock layers, the entire volume of the combined layers shall be paid as Rock Excavation. Removal of surface boulders in excess

of 1 cubic yard in volume shall be paid for under Clearing and Grubbing, unless specifically identified as Rock Excavation.

601.6 CHANNELS

Open channels for the purpose of this section shall mean lined or unlined trapezoidal channels.

601.6.1 EXCAVATION:

601.6.1.1 Excavation for channels shall be made to provide a uniform unlined channel surface for natural or earth channels or a surface suitable for placement of a specified lining material. Surfaces of the excavation shall be firm and unyielding and shall be such as will stand or can be made to stand without sloughing.

601.6.1.2 Excavation to provide a subgrade for lined channels or subdrainage material shall be to the lines indicated on the drawings; and excavation made below subgrade shall be backfilled and compacted to a density of not less than 90 percent, as determined by ASTM D 1557, or if approved by the ENGINEER with the concrete or other materials being placed. However, no payment will be made for such overexcavation or for the backfill thereof, regardless as to the approved material used for such backfill.

601.6.1.3 Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, the voids remaining after the removal of such boulders or interfering objects shall be backfilled as follows:

601.6.1.4 When the void is below the subgrade for a lined channel, it shall be filled with suitable material, as approved by the ENGINEER, compacted to a density of not less than 90 percent, as determined by ASTM D 1557, or with the approval of the ENGINEER, concrete of the same mix as used in the concrete channel.

601.6.1.5 When the void is in the side of the excavation, suitable material, as approved by the ENGINEER, shall be placed in the manner and to the same relative density as the backfill in the vicinity of the void or, with the approval of the ENGINEER, concrete of the same mix as used in a concrete lined channel. If concrete is placed prior to lining, a lower grade concrete may be used only if approved by the ENGINEER.

601.6.1.6 If during the progress of excavation material is encountered which, in the opinion of the ENGINEER, is unsuitable for subgrade for the structure to be constructed thereon, the ENGINEER may direct the CONTRACTOR

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to excavate beyond the pay lines shown on the drawings. However, suitability of subgrade shall be determined by the ENGINEER on the basis of its ability to withstand the load of the proposed channel and not upon the capacity to withstand the loads which may be placed thereon by the CONTRACTOR's equipment. Should the CONTRACTOR be directed to excavate beyond the pay lines shown on the drawings, said pay lines will be extended to include such ordered excavation and the pay lines for subdrainage material, if used, will be adjusted accordingly.

601.6.1.7 Materials used for work performed by the CONTRACTOR to stabilize subgrade so it will withstand loads which may be placed thereon by his equipment shall be at the CONTRACTOR's expense.

#### 601.6.2 FILL AND COMPACTED BACKFILL:

601.6.2.1 Suitable material obtained from the project excavations will be used as fill or backfill provided all organic material, rubbish, debris, and other objectionable material contained therein are first removed. However, stone and broken Portland cement concrete pavement obtained from the project excavations will be permitted in the backfill or fill with the following limitations:

601.6.2.1.1 The maximum dimension of any piece used shall be 12 inches.

601.6.2.1.2 Pieces larger than 4 inches shall not be placed within 12 inches of any structure.

601.6.2.2 Unless otherwise specified on the plans, the density, placement, and compaction of fills and backfills shall be as specified in Section 204.

601.6.2.3 There shall be no extra payment made for moving and using excavated materials within the limits of the projects.

#### 601.6.3 GRADING

601.6.3.1 Grading of unlined channels and berms shall conform to the following tolerances:

601.6.3.1.1 A vertical tolerance of none above and 3 inches below the specified grade will be allowed on channel bottom, channel side slopes in both cut and fill, and berms and access road side slopes in cut.

601.6.3.1.2 A vertical tolerance of none below and 3 inches above the specified grade will be allowed on top surfaces of berms and access road in both cut and fill, and berm and access road side slopes in fill.

601.6.3.1.3 Regardless of the construction tolerances specified, excavation and grading shall be performed so that finished surfaces are in uniform planes with no abrupt breaks in the surface.

601.6.3.1.4 Construction tolerances specified hereinabove for grading are solely for purposes of field control.

601.6.3.2 Grading tolerances for channels which will be lined with concrete, riprap, or flexible matting shall be specified on the construction plans.

#### 601.7 DIKES AND DAMS

601.7.1 The construction plans shall specify the zones for key or core excavation, type of earth materials in each zone, maximum compaction required in each zone, and surface grading tolerances.

601.7.2 The CONTRACTOR will submit samples of the proposed fill materials for compliance with the specifications.

#### 601.8 MEASUREMENT AND PAYMENT

601.8.1 Earthwork for open channels shall be measured by the cubic yard in place at the time of excavation. Payment will be made at unit price per cubic yard for the particular operation, as specified in the Bid Proposal.

601.8.2 Clearing and grubbing may be included in the unit price of the excavation, or may be at a lump sum price, or may be at a unit price per cubic yard. Bid Proposal shall specify the unit of payment.

601.8.3 Compacted fill will be measured by the cubic yard of the material compacted in place. Payment will be made at the unit price per cubic yard per specified material as defined in the Bid Proposal.

601.8.4 Rock excavation will be paid by the cubic yard in place, prior to start of construction and measured to the limits of excavation specified on plans. No compensation will be made to the CONTRACTOR for excess rock excavation due to overshooting, nor for the cost of backfilling voids or depressions resulting from overshooting.

## SECTION 602

### PORTLAND CEMENT CONCRETE FOR CHANNEL LINING AND DIKE OR DAM SURFACING

#### 602.1 GENERAL

This section governs the construction of Portland Cement Concrete for channel lining, or surfaces of dikes or dams on a prepared subgrade in substantial compliance with the lines, grades, thickness, and typical cross-sections shown on the plans or established by the ENGINEER.

#### 602.2 REFERENCES

602.2.1 American Society for Testing and Materials (Latest Editions)(ASTM)

C-33 Specification for Concrete Aggregates

602.2.2 This Publication:

Section 101 Portland Cement Concrete  
Section 102 Steel Reinforcement  
Section 105 Concrete Curing Compound  
Section 107 Joint Filler and Sealant Material  
Section 349 Concrete Curing

#### 602.3 MATERIALS

602.3.1 The cement, water, fly ash, and admixtures used in the concrete work constructed under this section shall conform to the requirements of Section 101 or as modified by the plans and/or the Supplemental Technical Specifications and the approved concrete mix design(s).

602.3.2 Aggregates shall meet the requirements of ASTM C-33 and shall conform to the grading for Size Number 467, as per Table 2 of ASTM C-33.

602.3.3 Steel reinforcement used in the concrete constructed under this section shall conform to the requirements of Section 102 or as modified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings of the steel reinforcement.

602.3.4 Expansion joint material, fillers and sealants used in the concrete constructed under this section shall conform to the requirements of Section 107 or as modified by the plans and/or the Supplemental Technical Specifications and the approved shop drawings, if required.

602.3.5 Liquid membrane-forming compounds for curing concrete if used on the concrete constructed under this section shall conform to the requirements of Section 105 or as modified by the plans and/or Supplemental Technical Specifications.

#### 602.4 STEEL REINFORCEMENT

The steel reinforcement size and spacing shall be as shown on the construction plans. Concrete blocks or steel chairs shall be used to provide the requirement minimum clearance of 3" between the subgrade and the steel.

#### 602.5 CONCRETE JOINTS

602.5.1 Expansion, contraction, and/or construction joint spacing and details shall be as shown on the construction plans.

602.5.2 Where joints are formed, preformed polyethylene zip-strip forms shall be used. The joint shall be completed while concrete is plastic where the construction joints are allowed with preformed metal forms to remain in place, no bonding agent will be used, and the edging tool shall a 1/4 inch radius. This type of joint will be allowed above nuisance flow elevations only.

602.5.3 Where saw cutting is allowed or required, it shall be done with a wheel mounted saw, except where hand held saw is required to complete the saw cuts at plane intersections.

602.5.4 Where saw cutting is required re-size or straighten sealant nosing, it shall be done with a wheel mounted do bladed saw so that the nosing faces are uniformly spaced, vertical and true, or, with a track mounted adjustable arbor saw so that the two nosing cuts will achieve the same results as a double bladed saw. Hand held saws will be allowed for joining the cuts at plane intersections where the mounted saws cannot reach.

602.5.5 All joints to be sawed shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, joints shall be sawed in sequence. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set concrete. Contraction joints shall be formed or sawed to one-fourth the depth the concrete lining.

602.5.6 At end of concrete placement construction joints shall have a 12 inch thickened edge or as shown on plans. Said joints shall be formed with continuous steel through

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the forms, and the forms shall be removed before the concrete placement continued. When the forms are removed, previously placed concrete shall be sandblasted to remove oil and wax and a fresh concrete epoxy bond applied immediately before fresh concrete is placed against it. This joints shall be edged with a 1/8 inch maximum radius tool.

#### 602.6 PLACEMENT, CONSOLIDATION, AND FINISHING OF CONCRETE

602.6.1 The thickness of the concrete lining shall be as specified on the construction plans.

602.6.2 The ENGINEER shall approve the CONTRACTOR'S proposed method of placing and consolidating the fresh concrete. The use of a canal or slope paving machine is encouraged. Such machine must meet the following conditions:

602.6.2.1 It shall be of the type having rollers and augers and shall also have vibrating pans, or spud-type vibrators capable of vibrating at 3500 impulses per minute.

602.6.2.2 The machine shall be in good repair and properly maintained. Fuel tanks must be full before placing concrete, and should be of sufficient capacity to preclude refueling during concrete placement.

602.6.2.3 Rails must be strong enough and sufficiently anchored to prevent flexing or bending when the machine is operated. Rails must be kept clean during paving operations.

602.6.3 Slope paving machine operation shall include the following procedures:

602.6.3.1 Follow manufacturer's guidance regarding set-up and operation.

602.6.3.2 A dry run shall be made before concrete is placed to check grades and lines and proper operation.

602.6.3.3 Only authorized operator(s) will be allowed on the machine while in operation.

602.6.3.4 Augers shall be adjusted up or down to maintain a roll of concrete one inch high on the front or leading end of the finishing rollers.

602.6.3.5 The rear of the machine should be raised slightly (about 1/8 inch) to allow grout on the side of the

finishing rollers to feather itself out and leave a smooth finish.

602.6.3.6 The machine shall be advanced such that all concrete receives at least three passes of the rollers.

602.6.4 Concrete placement shall include the following techniques:

602.6.4.1 A concrete pump or other ENGINEER approved method shall be used to place the concrete. Provision shall be made for a backup unit. Concrete samples for slump tests shall be taken at the pump outlet.

602.6.4.2 Concrete shall be placed close to the final position, and to its full thickness.

602.6.4.3 Do not place concrete more than 12 feet in front of the machine.

602.6.4.4 The height of the concrete roll in front of the augers shall be at least one-half the diameter of the auger.

602.6.5 Finishing of the concrete shall be accomplished with a magnesium or aluminum float followed by a medium broom. The surface shall be finished to a plane having no variation in excess of 1/4 of an inch when measured with a 10 foot straightedge, including joints to existing, adjacent concrete surfaces, unless a curved surface is specified.

#### 602.7 CURING

602.7.1 Immediately after the finishing operations have been completed the CONTRACTOR shall initiate the curing of the concrete as specified in Section 349 and/or as approved by the ENGINEER.

#### 602.8 PROTECTION FROM DRAINAGE FLOWS

602.8.1 The CONTRACTOR shall take all necessary precautions to assure that no damage to new work or the existing channels in work areas is caused either by flood waters, well wash water or other drainage. Suggested precautions include scheduling work in conjunction with favorable weather forecasts and by coordinating work with the Albuquerque Bernalillo County Water Utility Authority.

602.8.2 Adequate control of water channeling and pumping shall be done to prevent damage to existing or new channel lining. Concrete lining damaged by water action shall be removed and replaced by the

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CONTRACTOR at the CONTRACTOR'S expense. The CONTRACTOR will hold the OWNER harmless for any damage to materials, equipment or manpower caused by flooding.

#### 602.9 REPAIR AND REPLACEMENT OF CONCRETE LINING

602.9.1 Work that is found to be defective or damaged prior to acceptance, or existing lining damaged by the CONTRACTOR'S operations shall be replaced by the CONTRACTOR at no expense to the OWNER.

602.9.2 The Portland cement concrete to be used for repair shall conform to Section 101.

#### 602.10 TOLERANCE IN PAVEMENT THICKNESS

602.10.1 Acceptance of the finished channel lining with respect to thickness shall be on the basis of random core sampling, as designated by the ENGINEER. A minimum of two core samples will be taken from longitudinal lengths of channel not to exceed 500 linear feet, or from a one day's placement of concrete not to exceed 500 linear feet. If deficiencies are noted, the ENGINEER may require additional core samples to be taken. All coring required by the ENGINEER shall be at the OWNER'S expense.

602.10.2 Should the CONTRACTOR desire to have additional core samples taken these samples would be taken at the CONTRACTOR'S expense.

602.10.3 Deduction for a deficiency in thickness shall be made according to Table 602.10.3. Thickness deficiency shall be based on the average thickness of the number of samples taken within the specified length of channel.

602.10.4 It shall be the responsibility of the person requesting the core sampling to have the core holes immediately filled with fresh concrete. This concrete shall be of the same concrete mix and of equal compressive strength as the original concrete.

602.10.5 Any concrete lining that is noted to be deficient in thickness at or more than the reject level on Table 602.10.3 shall be removed and replaced at the CONTRACTOR'S expense.

602.10.6 For information purposes only, the ENGINEER may have the core samples tested for compressive strength.

#### 602.11 STRENGTH TEST REQUIREMENTS

602.11.1 Concrete for channel lining shall be designed for a minimum compressive strength as specified in Section 101 or as modified in the Supplemental Technical Specifications and the approved concrete mix design(s).

602.11.2 The CONTRACTOR shall furnish the concrete for casting cylinders. Unless otherwise specified, four (4) cylinders shall be made for each 100 cubic yards of concrete placed. The ENGINEER or an independent testing laboratory designated by the ENGINEER shall fabricate and test specimens. Sampling and testing of smaller quantities of concrete used in minor channel work will be done as required by the ENGINEER. Results of all tests shall be reported to the ENGINEER, CONTRACTOR, SUPPLIER, and OWNER.

602.11.3 Casting, curing, and testing of concrete cylinders shall comply with the requirements in Section 101.

#### 602.12 MEASUREMENT AND PAYMENT

602.12.1 MEASUREMENT: Concrete lining or surfacing shall be measured by the square foot, as measured along the finished surface for the type and thickness stated on the construction plans.

602.12.2 PAYMENT: The payment for concrete lining or surfacing shall be at the contract unit price per square foot per type and thickness complete in place, which price shall include all material, equipment and labor required in the subgrade finishing, placement of the reinforcement steel, forming, placement of the concrete, finishing, curing, form removal, backfilling, and cleanup.

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TABLE 602.10.3

DEDUCTIONS FOR DEFICIENCY IN THICKNESS  
(Average thickness per core measured in accordance with ASTM C 174)

Thickness Deficiency	Percentage of Contract Price Allowed		
	6"*	7"*	8"*
O to 1/4"	100	100	100
Greater than 1/4" to 1/2"	90	92	94
Greater than 1/2" to 3/4"	Reject	84	88
Greater than 3/4" to 1"		Reject	82
Greater than 1"			Reject

\*Design Thickness

## SECTION 603

### RIPRAP SURFACE TREATMENT

#### 603.1 GENERAL

The construction of riprap surface treatment shall consist of furnishing and placing stone, with or without grout, with or without wire mesh, or sacked concrete riprap. The depth and type of riprap shall be as shown on the construction plans.

#### 603.2 REFERENCES

##### 603.2.1 ASTM

C 143

##### 603.2.2 This publication:

SECTION 101  
SECTION 109

#### 603.3 MATERIAL

603.3.1 Riprap stone shall be as specified in Section 109 of these specifications.

603.3.2 Other materials necessary for completion of various types of Riprap Surface Treatments shall be as specified in the following subsections.

#### 603.4 PREPARATION OF GROUND SURFACES

603.4.1 The bed for the riprap shall be shaped and trimmed to provide even surfaces. A footing trench shall be excavated along the toe of the slope as shown on the plans.

603.4.2 Specified filter cloth shall be placed on earth bed prior to placement of stone.

603.4.3 Earth surface shall be shaped and trimmed to conform to the construction plans prior to the placement and compaction of the gravel type of filter material.

#### 603.5 PLACING RIPRAP STONE

603.5.1 When the required riprap is less than 20 inches in depth, stone shall be placed by hand unless otherwise authorized by the ENGINEER. Stone shall be placed to provide a minimum of voids. The larger stone shall be placed in the toe return, foundation course, and on the outer surface of the riprap. Stones shall be placed with their longitudinal axis normal to the face of the embankment and so arranged that each rock above the foundation course has at least a 3 point bearing on the underlying stones. Bearing on smaller stones used to chink voids will not be acceptable. Interstices between

stones shall be chinked with small stones and spalls. The finished surface shall be even and tight and shall not vary from the planned surface by more than 3 inches per foot of depth. When the required riprap is 20 inches or more in depth, the stone may be placed by dumping and spread in layers by bull-dozers or other suitable equipment.

603.5.2 Riprap shall be placed to its full design thickness (depth) in one operation.

#### 603.6 GROUTED RIPRAP

603.6.1 Riprap shall be placed as specified and grouted with Portland cement mortar. The grout shall consist of one part cement and 3 parts by volume of aggregate. The Portland cement shall be Type I or Type II as specified in Section 101 and the aggregate shall be 2 parts sand and 1 part gravel passing a 3/8 inch square mesh screen. The amount of water shall be such as to permit gravity flow into the interstices with limited spading and brooming. The consistency of the grout shall be as approved by the ENGINEER.

603.6.2 Except when hand mixing is permitted by the ENGINEER, grout shall be mixed in an approved machine mixer for not less than 1 1/2 minutes. Should hand mixing be permitted, the cement and aggregate shall be thoroughly mixed in a clean, tight mortar box until the mixture is of uniform color after which clean water shall be added in such quantity as to provide a grout of the specified consistency.

#### 603.7 SACKED CONCRETE RIPRAP

603.7.1 The Portland cement, aggregates, and mixing shall be as specified in Section 101 and as herein specified. The aggregate may be pit-run material, at least 80 percent of which shall pass a 1 1/2 inch square mesh screen. Separating aggregates by primary sizes will not be required. Los Angeles abrasion tests and soundness tests will not be required.

603.7.2 The mixed concrete shall contain 376 pounds (4 sacks) of Portland cement per cubic yard.

603.7.3 The amount of water shall be such as to produce a mixture with a slump of 3 to 5 inches when tested in accordance with ASTM C 143.

603.7.4 Sacks shall be made of at least 10 ounce burlap and shall be approximately 19 1/2 inches by 36 inches measured inside the seams when the sack is laid flat.

603.7.5 Slopes on which the sacked concrete riprap is to



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be placed shall be finished within 0.2 foot of the designated grades. The first course shall be a double row of stretchers laid in a neatly trimmed trench. The second course shall be a single row of headers. The third and remaining courses shall be stretchers or headers as shown on the plans and shall be placed so that joints between courses are staggered. Dirt and debris shall be removed from the tops of sacks before the next course is laid thereon. Headers shall be placed with the folds upward. Not more than 4 vertical courses shall be placed in any tier until the initial set has taken place in the first course of any such tier.

603.7.6 When, in the opinion of the ENGINEER, there will not be proper bearing or bond due to delays in placing succeeding layers or the hampering of work by storm, mud, or for any cause, a small trench shall be excavated back of the row of sacks already in place and this trench filled with fresh concrete before more sacks are placed. Payment for the concrete in the trenches shall be at the price per cubic yard for sacked concrete riprap. Payment for excavating the trenches shall be considered as included in the payment for the concrete in the trench.

603.7.7 Sacked concrete riprap shall be cured by sprinkling with a fine spray of water every 2 hours during daylight for not less than 3 days.

#### 603.8 WIRE ENCLOSED RIPRAP

603.8.1 Wire enclosed riprap shall consist of a layer of rock of the required thickness enclosed on all sides in wire fabric in conformity with the details shown on the plans. The wire fabric shall be drawn tightly against the rock on all sides and tied with galvanized wire of the required gauge. The ties shall be spaced approximately 2 feet on centers and shall be anchored to the bottom layer of wire fabric, extended through the rock layer, and tied securely to the top layer of wire fabric. When indicated on the plans, wire enclosed riprap shall be anchored to the slopes by steel stakes driven through the riprap into the embankment. Stakes shall be spaced as shown on the plans. Wire fabric used for riprap shall conform to the mesh, gauge, and weight shown on the plans. Tie wire shall be galvanized and of the gauge shown on the plans. Wire fabric shall be furnished in such lengths and widths as to reduce the number of splices to a minimum.

603.8.2 Steel stakes shall be cut to the required length from steel railroad rails, galvanized steel pipe, or steel angles of the dimension and weight shown on the construction plans.

#### 603.9 FILTER CLOTH

603.9.1 MATERIAL: The filter cloth shall be a non-woven polyester geotextile, such as: Mirafi No. 140N drainage Fabric, Mirafi Inc., Charlotte, North Carolina, or approved equal.

603.9.2 INSTALLATION: The surface to receive the cloth shall be prepared to a relatively smooth condition free of obstructions, depressions, and debris. The cloth shall not be laid in a stretched condition but shall be laid loosely with a long dimension perpendicular to the channel centerline. The cloth shall be placed so the upstream edge overlaps the downstream edge a minimum of 12 inches, with securing pins inserted through both layers at no greater than two-foot intervals. Cloth damaged or displaced before or during installation or placement of the overlaying riprap shall be replaced or repaired to the satisfaction of the ENGINEER at the CONTRACTOR'S expense.

#### 603.10 GRAVEL TYPE OF FILTER MATERIAL

603.10.1 MATERIAL: Filter material shall be comprised of sand, gravel, and cobble in mixes as specified on the plans. Alternate materials such as milled Portland cement concrete, concrete wash, or reclaimed material may be substituted with the ENGINEER'S approval.

603.10.2 INSTALLATION: Filter material shall be used as a subbase for riprap as shown on the plans. The minimum depth of filter material shall be one foot unless the plans provide an alternate detail for filter blanket construction.

#### 603.11 MEASUREMENT AND PAYMENT

603.11.1 Riprap, such as: plain stone, grouted, wire enclosed, or sacked concrete shall be measured by the cubic yards placed to the lines and grades shown on the construction plans. Payment for riprap will be made at the unit price per cubic yard for the type of riprap as specified in the Bid Proposal and shall include materials, labor, and equipment necessary to complete the work.

603.11.2 Filter cloth shall be measured by the square foot and overlaps shall be measured as a single layer of cloth. Payment shall be made at the unit price per square foot as per Bid Proposal, and shall include shipping, handling, storage, seams, special fabrication, securing pins, and/or installation.

603.11.3 Gravel type filter material shall be measured by the cubic yard of material in place, in accordance with the construction plans. Payment will be made at the unit

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price per cubic yard as per Bid Proposal and shall include all materials, labor, and equipment necessary for the installation of the material.

## SECTION 604

### FLEXIBLE SOIL MATTINGS

#### 604.1 GENERAL

Flexible soil mattings provide reinforcement to the soil slopes and/or bottoms of low velocity channels, dikes, and small dams. In addition to the soil reinforcement, certain of these materials will permit growth of native vegetation or park type of grass cover. Because of the various applications which may be encountered the construction plans will indicate the types of materials to be installed, the location of the material in relation to the soil surface, seeding if required, and securing material.

#### 604.2 REFERENCES

#### 604.3 MATERIALS

604.3.1 Prior to placement of materials other than those approved in this section, the CONTRACTOR shall furnish samples and manufacturer's literature of other similar products, which he intends to use, to the ENGINEER for review and approval.

604.3.2 The following products are approved:

604.3.2.1 Filter fabric--"Stabilenka", Types T-80, T-100, or T-140N, manufactured by American Enka Company, Enka, North Carolina.

604.3.2.2 Germination blanket--"Curlex", either standard or high velocity, manufactured by American Excelsior Company, Arlington, Texas.

604.3.2.3 Interwoven flexible monofilament matting, "Enkamat," Types 7010 or 7020, manufactured by American Enka Company, Enka, North Carolina.

604.3.2.4 Erosion control and revegetation mat, "Miramat, ECRM," manufactured by Mirafi, Charlotte, North Carolina.

604.3.2.5 Staples for securing the matting to the soil surface will conform to the material, shape, and dimensions, as shown on the construction plans.

#### 604.4 INSTALLATION

604.4.1 The placement of one or more of the matting materials shall conform to the details on the construction plans.

604.4.2 Unless otherwise specified on the plans, filter material will have a minimum overlap of 1 inch and the interwoven flexible monofilament material will have a 3 inch overlap. The germination blanket will only require

butting of the edges.

604.4.3 Stapling or pinning spacing shall be as shown on the plans.

604.4 The location of the various matting materials in relation to the soil surface will be shown as a placement section on the construction plans.

604.4.1 When required, select soils, suitable for seeding, may be specified on the construction plans.

#### 604.5 MEASUREMENT AND PAYMENT

604.5.1 Matting material shall be measured by the square foot, as measured along the finished surface for the type of material installed. Payment shall be made at the unit price per square foot for the specific material, as defined in the Bid Proposal, and shall include material, placement, and staples. If over-lapping is required, the matting material shall be considered as a single layer; no extra payment for overlapped material.

604.5.2 Seeding shall be a separate item, as measured and paid for per the Bid Proposal.

604.5.3 Select backfill or cover soil materials will be measured by the square yard per specified thickness. Payment will be made at the unit price per square yard per specified thickness and material, as defined in the Bid Proposal.

## SECTION 610

### GABIONS

#### 610.1 GENERAL

This work shall consist of furnishing, transporting, and constructing wire mesh gabions in compliance with the construction plans and these specifications. Installation of the gabions shall be at the locations shown on the plans.

#### 610.2 REFERENCES

##### 610.2.1 ASTM

A 116 C 88  
A 239 C 131  
B 117 D 1557

##### 610.2.2 This publication

SECTION 109

610.2.2.1 This specification covers the use of galvanized steel wire mesh baskets filled with stone used as retaining walls, slope paving, river bank protection, outfall structures, weirs and drop structures, etc.

#### 610.3 DEFINITIONS

610.3.1 Gabions are defined as galvanized steel wire mesh box-shaped baskets, of various sizes. The baskets are filled on site with clean-hard stones.

610.3.2 The selvages of the gabions are the thicker perimeter and edge wires to which the wire mesh is securely tied to withstand sudden or gradual stress from any direction.

610.3.3 Reinforcing wires are the thicker wires incorporated into the netting during fabrication.

610.3.4 The diaphragms are internal wire mesh partitions which divide the gabion into equal-sized cells.

610.3.5 Lacing or binding wire is the wire used to assemble and join the gabion units.

610.3.6 Connecting wires are the internal wires used to prevent the gabions from bulging.

#### 610.4 MATERIALS FOR WIRE MESH BASKETS

##### 610.4.1 FABRICATION:

610.4.1.1 Gabions shall be fabricated so that the sides, ends, lid, and partitions can be assembled at the construction site into rectangular baskets of the specified sizes. Gabions shall be of single unit construction. The base, ends, and sides shall be woven into a single unit, or one edge of these members shall be connected to the base section of the gabion so that strength and flexibility at the point of connection is at least equal to that of the mesh.

610.4.1.2 Where the length of the gabion exceeds one and one-half its horizontal width, the gabion shall be equally divided by partitions, of the same mesh and wire diameter as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary partitions secured in proper position on the base section so that no additional tying at this juncture will be necessary.

610.4.1.3 Perimeter edges shall be securely selvaged or bound so that the joints formed by tying the selvages have approximately the same strength as the body of the mesh. Ties used for this purpose shall be spaced at not more than 6-inch centers.

610.4.2 DIMENSIONS: Gabions shall be supplied as specified in various lengths and heights shown on the plans. See Table 610 for standard sizes.

610.4.3. TOLERANCES: Gabion dimensions are subject to a tolerance limit of  $\pm 3$  percent of manufacturer's published sizes.

##### 610.4.4 WIRE:

610.4.4.1 Wire used in the body of the mesh shall be approximately 0.12 inch in diameter, (after galvanization). Wire used in the mesh shall equal or exceed ASTM A 116, finish 5, medium hardness, Class 3 coating. Samples for testing shall include at least one sample of each component of the mesh. Uniformity of coating shall equal or exceed 10 one-minute dips by the Preece Test, ASTM A 239. A certification of resistance to corrosion may be substituted in lieu of requirements for Class 3 coating as follows: A section of mesh, including twists or fastenings forming the mesh, shall be exposed to a salt spray fog test, ASTM B 117, for at least 200 hours before failure to any part of the mesh

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TABLE 610

## STANDARD GABIONS

Size Code	Dimensions L x W x H	No. of Cells	Capacity Cu. Yds.	Filler Rock
A	6'x3'x3'	2	2	Type L
B	9'x3'x3'	3	3	Type L
C	12'x3'x3'	4	4	Type L
D	6'x3'x1'x6"	2	1	Type L
E	9'x3'x1'x6"	3	1.5	Type L
F	12'x3'x1'x6"	4	2	Type L
G	6'x3'x1'	2	0.666	Type VL
H	9'x3'x1'	3	1	Type VL
I	12'x3'x1'	4	1.33	Type VL

610.4.4.2 Tie and connection wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion and diaphragms and to provide for four cross-connecting wires in each cell 1/2 unit high and 8 connecting wires in each cell 1 unit high. Selvedge or perimeter basket frame wire shall be of a heavier gauge than the mesh wire with a minimum diameter of 0.150 inches (US gauge 9) after galvanization. Lacing and connecting wire shall meet the same specifications as the wire used in the gabion body except that its diameter shall be of 0.0866 inches (US gauge 13 1/2) after galvanization.

610.4.4.3 All of the above wire diameters are subject to tolerance limit of  $\pm 2 \frac{1}{2}\%$ .

610.4.5 MESH OPENINGS: Opening of the mesh shall not exceed 4 inches in the longest dimension.

610.4.6 NON-RAVELING CONSTRUCTION: The wire mesh shall be fabricated so as to be non-raveling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire strand in a section of mesh is cut and the section of mesh is then subjected to the load test described in Load Test Number 1.

610.4.7 MESH ELASTICITY: The wire mesh shall have elasticity sufficient to permit elongation of the mesh equivalent to a minimum of 10 percent of the length of the section of mesh under test without reducing the diameter or tensile strength of individual wire strands to values less than those for similar wire 0.01 inch smaller in diameter.

610.4.8 METHOD OF SAMPLING, INSPECTION,

AND TEST:

610.4.8.1 Mesh: A section of mesh 6 feet in length and not less than 3 feet in width, after first being subjected to the elongation test described in Subsection 610.3.7, shall withstand a load test of 6,000 pounds applied to a 1-square foot area approximately in the center of the section. This test is more specifically described in Load Test Number 1.

610.4.8.2 Load Test No. 1: A uncut section of mesh, 6 feet in length, not less than 3 feet in width, and including all selvedge bindings, shall be the ends securely clamped for 3 feet along the width of the sample. When the width of the section under test exceeds 3 feet the clamps shall be placed at the center of the width, and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to tension sufficient to cause 10 percent elongation of the sample section between the clamps. After elongation and while clamped, as described above (and otherwise unsupported), the section shall be subjected to a load applied to a 1-square foot area in the approximate center of the sample section between the clamps and in a direction perpendicular to the direction of the tension force. The sample shall withstand, without rupture of any strand or opening of any mesh fastening, an actual load, so applied, equaling or exceeding, 6,000 pounds.

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610.4.8.3 The fan head used in the test shall be circular and have its edges beveled or rounded to prevent cutting of the wire strands.

610.4.8.4 Inspection and Certification: The CONTRACTOR shall furnish a certified report of tests made by an approved testing laboratory showing that the product to be supplied equals or exceeds these specifications.

610.4.9 MARKING: Each gabion shall be clearly marked by color code or some other readily identifiable means to indicate size.

#### 610.5 ROCK FILLER MATERIAL

610.5.1 Rock used in filling gabions shall be as shown in Table 610. Rock shall meet the requirements of Section 109 Riprap Stone.

#### 610.6 CONSTRUCTION REQUIREMENTS

610.6.1 Gabions shall be constructed and erected in accordance with the manufacturer's published procedures or, as a minimum, as specified herein.

610.6.2 The foundation under the gabions shall be prepared as shown on the drawings, but as a minimum, the top six inches of the gabion soil foundation shall be compacted to no less than 95 percent of maximum density, as determined by ASTM D 1557.

610.6.3 The aggregate shall be placed within the baskets in such a manner as to eliminate as many open pockets as possible. Gabions may be filled by hand or by mechanical means. Every effort shall be made to keep voids and bulges in the gabions to a minimum in order to ensure proper alignment and a neat, compact, square appearance. Exposed surfaces shall be hand placed to provide an aesthetic appearance.

#### 610.6.4 ASSEMBLING AND PLACING

610.6.4.1 Each gabion shall be assembled by tying all untied edges with binding wire. The binding wire shall be tightly looped around every other mesh opening along the seams in such a manner that single and double loops are alternated.

610.6.4.2 A line of empty gabions shall be placed into position according to the contract drawings and binding wire shall be used to securely tie each unit to the adjoining one along the vertical reinforced edges and the

top selvages. The base of the empty gabions placed on top of a filled line of gabions shall be tightly wired to the latter at front and back.

610.6.4.3 To achieve better alignment and finish in retaining walls, gabion stretching is recommended.

610.6.4.4 Connecting wires shall be inserted during the filling operation in the following manner:

##### 610.6.4.4.1 36" Gabions

I. Gabions shall be filled to a depth of twelve (12) inches.

II. One connecting wire in each direction shall be tightly tied to opposite faces of each gabion cell at a height of twelve (12) inches above the base.

III. Gabions shall be filled with a further depth of twelve (12) inches, and two connecting wires shall similarly be tied at this level.

IV. Gabions shall be filled to the top.

##### 610.6.4.4.2 18" and 12" Gabions

610.6.4.4.3 Connecting wires are not necessary unless the 18" size is used to build vertical structures; in this case, two wires, one in each direction, at 9" from the base, must be placed as above.

610.6.4.5 The gabions in any row shall be filled in stages so that local deformations may be avoided. That is, at no time shall any gabion be filled to a depth exceeding one foot more than the adjoining gabion.

610.6.4.6 When a gabion has been filled the lid shall be bent over by hand until it meets the front and ends. Then the lid shall be tightly bound to the rest of the basket with the lacing wire along all edges and internal cell diaphragms in the same manner described above for assembly.

#### 610.7 MEASUREMENT AND PAYMENT

610.7.1 Gabions shall be measured by the cubic yard in place, based on basket dimensions shown on the plans, and shall include excavation, baskets, rock filler, and removal of waste materials. Payment will be made at the unit price per cubic yard as specified in the Bid Proposal.

610.7.2 No direct payment will be made for excavation and disposal of material required for placement of gabions

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or for backfill and compaction behind the gabion walls, and the cost thereof will be considered incidental to the completion of the work.

SECTION 625

SHOTCRETE CHANNEL LINING

625.1 GENERAL

This section governs work for construction of shotcrete channel linings and shall consist of construction of the shotcrete channel lining utilizing the shotcrete process, including mixing, placing, finishing, testing and curing as shown in the contract in compliance with these specifications.

No. 4	95-100	70 - 85
No. 8	80 - 98	50 - 70
No. 16	50 - 85	35 - 55
No. 30	25 - 60	20 - 35
No. 50	10 - 30	8 - 20
No. 100	2 - 10	2 - 10

625.1.2 The requirements of City of Albuquerque Standards and Specifications for Public Works Construction Section 101 - Portland Cement Concrete and Section 510 – Concrete Structures shall apply where appropriate and not expressly modified by these specifications. Fly Ash shall be used in all concrete and shotcrete per section 101.

625.1.3 The design mixes must be submitted by the Contractor for approval by the ENGINEER prior to placement. Submit aggregate source, producers’ names, gradations, specific gravities, compliance with applicable ASTM C33/C33M, and evidence that this data is not more than 1 year old.

625.2 MATERIALS

625.2.1 All requirements of City of Albuquerque Standards and Specifications for Public Works Construction Section 101 - Portland Cement Concrete shall apply except as modified herein. Shotcrete shall have a minimum compressive strength of 4,000 PSI at 28 days, 5.5% plus or minus 1.5% air content at the truck and a slump of 1-1/2” to 4” at the truck. Shotcrete shall be tinted in accordance with Subsection 625.2.1 of these specifications.

625.2.2 Tinted concrete will be made by the addition of:  
DAVIS COLOR OR APPROVED EQUAL  
San Diego Buff (Color number 5237)  
1 lb/sack

Color must be included in the mix design.

625.2.3 Grading limits for combined aggregates.

<u>Sieve</u>  <u>Size</u>	<u>Percent Passing</u>	
	<u>Gradation</u> <u>I</u>	<u>Gradation</u> <u>II</u>
1/2 inch	-	100
3/8 inch	100	90 - 100

625.2.4 Proportioning. Shotcrete shall be mixed and pneumatically applied by the wet-mix process. The concrete shall meet the minimum requirements set forth in Section 510 including the addition of air entrainment, fly ash, and tint.

625.2.5 Preconstruction Testing:  
Test panels simulating actual field conditions shall be fabricated prior to start of construction. Test panels shall be colored shotcrete for color approval prior to construction and shall be a minimum of 8’x20’.

Coordination with the General contractor, shotcrete subcontractor, This preconstruction test panel can be incorporated into the planned work area or waived at the discretion of The ENGINEER and the OWNER.

Prior to gunning the mixture, Specimens shall be tested in accordance with ASTM standards for slump, air content and unit weight. Core three (3) specimens from the test panel in accordance with ASTM C1140 for each 7, 14, and 28-day for compressive strength tests.

625.2.6 Quality Acceptance Tests:  
Test Panel Frame Construction: All test panels shall be 36”x36” square at the base, 8” deep, and constructed of wood and sealed plywood with 45° sloped sides to permit escape of rebound. Panels shall remain in the field and cured using the same method implemented on the structure panels.

Compressive Strength: Shoot two construction test panels that contain no reinforcement or embedment’s for each nozzle orientation and for each nozzle operator each day of the shotcrete production in the presence of the ENGINEER. Shoot one set of panels for each nozzle operator in the morning and one set of panels for each nozzle operator in the afternoon for a full day’s production or for every 50 cubic yards placed, whichever results in the most panels. Obtain test specimens from the test panels using procedures outlined in ASTM C1140.



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Extract three (3) cores each for the 7, 14, and 28-day compressive strength tests (9 cores total). Each core shall be four (4) inch x eight (8) inch deep (length/diameter ratio of 2:1).

Minimum Compressive Strengths:

7 day	14 day	28 day
2,400 PSI	3,000 PSI	4,000 PSI

The mean compressive strength is acceptable if the average of three cores tested at the specified age is equal to or greater than 85% of the specified strength, with no individual strength test being less than 75% of the specified strength.

Correct unacceptable shotcrete sections at no additional cost to the Owner.

625.3 CONSTRUCTION

625.3.1 Equipment and Workmen.

Shotcreting shall be done only by experienced personnel. The Contractor shall furnish evidence that each foreman, nozzle operator and delivery equipment operator has done satisfactory work in a similar capacity elsewhere and is fully qualified to perform the work.

The Contractor shall furnish the ENGINEER with copies of the manufacturer's specifications and operating instructions for the equipment used. No shotcrete shall be placed until the type of equipment and method of operation has been approved by the ENGINEER.

625.3.2 Premixed Shotcrete.

The mixing equipment shall be capable of thoroughly mixing the specified materials in sufficient quantity to maintain continuous placing.

625.3.3 Surface Preparation.

The foundation for areas to receive shotcrete shall be evenly graded to the required elevation before the shotcrete is applied. The areas shall be thoroughly compacted with sufficient mixture to provide a firm foundation and to prevent absorption of water from the shotcrete. No high subgrade will be permitted.

Surfaces shall not contain free surface water, loose material or frozen material at the time of shotcrete application.

625.33 Forms and Reinforcement.

Forms, headers, and shooting strips shall be provided and rigidly braced as required for backing. Ground or gaging wires and depth gages shall be used where necessary to establish and insure thickness, surface and finish lines.

Steel reinforcement shall be rigidly supported in the position shown in the contract. Metal chairs shall be used to properly anchor and place the reinforcement. All reinforcement shall be clean and free from loose mill scale, loose rust, overspray from previous shotcrete application, soil and other undesirable materials that interfere with bonding.

625.3.4 Placing.

Each layer of shotcrete shall be built up by making several passes of the nozzle over the working area. When enclosing steel reinforcement, the nozzle shall be held so as to direct the material around the bars. The shotcrete shall emerge from the nozzle in a steady, uninterrupted flow. The nozzle shall be directed so as to result in minimum rebound. The velocity of the material as it leaves the nozzle shall be maintained uniform and at a rate determined for the given job conditions.

Contractor shall use appropriate form work to separate areas of different tinting, and shall prevent adjacent areas from being discolored by overspray and rebound.

Rebound shall not be worked back into the construction or salvaged. Rebound that does not fall clear of the work shall be removed.

Shotcrete shall not be placed or cured when the air temperature is below forty five degrees (45°) F unless cold weather construction specifications in Section 101-Shotcrete are followed.

The mixing, transporting, and placement time for shotcrete materials, shall not exceed two hours or 250 revolutions of the mixer drum whichever comes first. Additional water may be added at job site only if requested by the ENGINEER. When additional water is added the drum shall be rotated a minimum of 30 additional revolutions. The ready-mix plant shall certify the material for weight, water, admixtures and mixing time.

625.3.5 Finishing.

After the shotcrete has been placed as nearly as practical to the required thickness, the ground wires may be removed, the surfaces shall be checked with a straight edge, and low spots or depressions shall be corrected by placing additional shotcrete in such a manner that the finished surface is natural

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as left by the nozzle and will be reasonably smooth and uniform.

Loose areas of shotcrete shall be removed and replaced by the Contractor at no additional cost.

625.3.6 Curing.

In all cases, the period of protection shall be not less than 7 days, and not less than 14 days during cold weather construction.

625.3.7 Tolerance in Shotcrete Thickness.

Acceptance of the finished channel lining with respect to thickness shall be on the basis of random core sampling, as designated by the ENGINEER or OWNER. At the discretion of the OWNER or ENGINEER, core sample may be required to confirm shotcrete thickness. If deficiencies are noted, the ENGINEER or OWNER may require additional core samples. All coring required by the OWNER or ENGINEER shall be at the OWNER's expense.

Should the Contractor desire to have additional core samples taken these samples would be taken at the Contractor's expense.

Deduction for a deficiency in thickness shall be made according to the following: Thickness deficiency shall be based on the average thickness of the number of samples taken within each 500 or less linear feet of channel.

<u>Thickness Deficiency</u>	<u>Percent of Contract Price allowed</u>
0-1/2"	100%
Greater than 1/2"	Reject

Any 500 linear foot span of channel lining that is noted to be deficient in thickness by more than the reject level shall be removed and replaced at the Contractor's expense.

It shall be the responsibility of the Contractor to have the core holes immediately filled with fresh shotcrete. This shotcrete shall be of the same mix and of equal compressive strength as the original.

For quality acceptance, the ENGINEER may have the core samples tested for compressive strength.

All cores will be measured in accordance with ASTM C-174.

625.3.8 Method of Measurement.

Shotcrete will be measured by the square yard parallel to the surface.

625.4 Basis for Payment.

625.4.1 The accepted quantities of shotcrete will be paid for at the contract unit price per square yard. Such payment shall constitute full reimbursement for all materials, labor and equipment, subgrade Prep used in the placement of all shotcrete, steel reinforcement, support chairs, forms, joints, tinting, finishing, curing, and all other necessary operations to complete the shotcrete in place. No extra payment will be made for additional shotcrete placed in excess of that shown on the plans unless directed by the OWNER.

625.4.2 Pay Item

Channel Lining, Thickness per contract documents, Tinted Reinforced Shotcrete, 4000 PSI.