

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL POLICY

POLICY NO.: Technical Policy, TECH-006

EFFECTIVE DATE: March 23, 2006

REVISED DATE: 5/18/21

POLICY NAME: Erosion Protection of Fill Pads in Regulatory Floodplains

PURPOSE: To clarify Section 16.26.040.B of the Ordinance regarding the protection of fill pads from erosion in order to establish consistent permitting requirements that provide sufficient erosion protection for fill pads and associated structures.

BACKGROUND:

The Floodplain Management Ordinance (Ordinance) Section 16.26.040.B requires that any fill placed in a regulatory floodplain be adequately protected from erosion by rip-rap, vegetative cover, bulk-heading, or other approved method, but does not establish appropriate levels of erosion protection based on the hazards that may be encountered due to the erosive forces of moving water. In addition, the Ordinance encourages the placement of the least amount of fill necessary to achieve the purpose.

Historically, the need for erosion protection has not been strictly addressed at the time of permitting and therefore, erosion protection may not have been provided. The March 23, 2006 version of the policy addressed this deficiency with reference to the following publications:

- The FEMA publication, *Manufactured Home Installation in Flood Hazard Areas, FEMA85*, published in September 1985.
- The 2005 draft of *FEMA85*.
- The City of Tucson Drainage Standards Manual.

Refer to the March 23, 2006 version of the policy for a discussion regarding these publications.

Since 2006, new requirements have been promulgated and new information has become available, both of which affect this policy. The new requirements and information are as follows:

- 1) In October 2008, the State of Arizona's Office of Manufactured Housing (OMH) informed the District of new federal installation requirements for Manufactured Homes. One of these new requirements was for engineered foundations in all floodplains. These new requirements would become effective on January 1, 2009.
- 2) On January 3, 2009, the Chief Engineer approved Technical Policy *TECH-003* which established construction standards for manufactured home foundations. These were considered by the District to be engineered foundations that were compliant with OMH requirements.
- 3) On February 19, 2009, the Arizona Housing Association requested that the District reevaluate the standards for fill pads in an effort to reduce the fill pad dimension to 10 feet around the exterior

wall of a structure from 25 feet in order to reduce construction costs while offering the same level of protection.

- 4) The District commenced an evaluation of the flooding effects on fill pads using FLO-2D modeling. This reanalysis provided significant insights regarding the flow of water around fill pads, demonstrating that the previous policy may not have offered sufficient protection at the upstream edge and corners of fill pads, and may have been over protective at the downstream edge of fill pads.
- 5) Figure 006-D added in 2019 in order to provide additional flexibility and improve constructability.

POLICY:

This policy may be used to determine erosion protection for fill pads, including toe down depths, rip-rap size, and pad side slope, as long as the following conditions are met:

- 1) The fill pad does not encroach into an erosion hazard setback or erosion hazard area, a study area that establishes a requirement for an engineering analysis or an area that the District has determined that, due to unusual conditions, engineering is required. If a fill pad is proposed in these areas, the engineering analysis requirements supersede this policy.
- 2) For a manufactured home installed on a fill pad, OMH standard details shall be used for flow depths of one foot or less. The use of District standard details or a site-specific engineered design is required when the parameters for the use of OMH details are exceeded.
- 3) The fill pad is constructed according to the appropriate fill pad width tables. Tables have been provided for a 40 foot wide fill pad and an 80 foot wide fill pad. The use of Table 006-A is limited to fill pads that are 40 feet wide or less and the use of Table 006-B is limited to fill pads wider than 40 feet but no wider than 80 feet.
- 4) Fill pad erosion protection shall be constructed at the following locations as prescribed below:
 - a. When the fill pad is surrounded by floodwaters:
 - i. A toe-down depth is prescribed along the entire upstream edge of the fill pad and at least 10 feet along the sides of the fill pad extending from the upstream corners,
 - ii. A second toe-down depth is prescribed along the remaining perimeter of the fill pad,
 - iii. The rip-rap diameter sizing table shall apply to the entire fill pad.
 - b. When the fill pad is not surrounded by floodwaters:
 - i. One toe-down is prescribed along the upstream edge and at least 10 feet along the side of the fill pad that are located within the 100-year floodplain,
 - ii. A second toe-down depth is prescribed along the remaining perimeter of the fill pad that experiences flood flows,
 - iii. The rip-rap diameter sizing table shall apply to all portions of the fill pad that are located within the 100-year floodplain,
 - iv. The portions of the fill pad that are not exposed to floodwaters do not require erosion protection.

- 5) The fill pad is oriented with the long axis parallel to the direction of flow. This will minimize the flow obstruction and reduce the anticipated scour depths to those shown in the attached Tables.
- 6) The fill pad shall be constructed at or above the BFE and shall extend at such elevation a minimum of 10 feet from the perimeter of the structure.
 - a. The top of the fill pad shall be sloped a minimum of 2% in order to provide positive drainage away from the structure. As a result, the portion of fill pad adjacent to the structure will be a minimum of 0.2 feet (2.4”) above the BFE.
 - b. Once the fill pad extends 10 feet beyond the exterior walls of the structure, it shall be sloped down to natural grade,
 - i. The side slopes shall be no steeper than 3:1 when no erosion protection or dumped rock rip-rap erosion protection is proposed.
 - ii. The side slopes may be as steep as 1:1 when grouted rip-rap or gunite slope erosion protection is proposed.
 - iii. In some circumstances, as described below, the use of a concrete/CMU cut-off wall may be used to provide fill pad erosion protection.
- 7) Erosion protection shall be constructed pursuant to the following description, and shall be considered the minimum necessary unless an alternative is justified by an Arizona registered engineer:
 - a. Toe-down – The toe-down refers to the depth below natural grade of the erosion protection and may be constructed in one of two ways. Either the rip-rap can be continued at the same side slope below natural grade until the upper surface of the rip-rap reaches the required toe-down depth, or the below grade portion may be constructed as a 12-inch thick vertical concrete cut-off wall that extends below natural grade to the toe-down depth. It is not acceptable to place the rip-rap vertically below natural grade. See Figures 006 A, B, C and D for additional requirements.
 - b. Rip-rap sizing - The site plan shall specify the diameter (D_{50}) of the rip-rap from the appropriate Table and shall contain a note that states that the rip-rap is angular, durable, free of organic material, and meets the requirements provided on the construction detail. In addition, the site plan shall specify that the fill be protected by the use of geo-textile filter fabric underlying rock rip-rap, that the minimum rip-rap blanket thickness be twice the diameter of the minimum rip-rap diameter (D_{50}), and extend below natural grade to the required toe-down depth. See Figures for fill pad construction for additional requirements.
 - c. For a specific range of flow depth and ground slope conditions, Tables 006-A and –B specify that erosion protection is required only at the upstream edge and corners of the fill pad. Under these conditions, an additional option of constructing a vertical cut-off wall is available, as illustrated in Figure 006-D. This option eliminates the rip-rap component and uses a vertical wall that extends above grade to the BFE (minimum) and below grade to the required toe-down depth (minimum).

- 8) Fill pad details and specifications shall either be provided in the building plan set, or the appropriate Figure(s) shall be referenced on the site plan.

APPROVED BY:



Suzanne Shields, P.E.
Director and Chief Engineer

5/19/21

Date

Original Policy Approved: 3/23/06

Date(s) Revised: 8/31/09, 11/2/15, 5/18/21

TABLE 006-A

40 Foot Wide Fill Pad

RIP-RAP SIZE & TOE-DOWN DEPTH REQUIREMENTS FOR EROSION PROTECTION OF FILL PADS
PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL POLICY TECH-006

TOE-DOWN DEPTH BELOW NATURAL GRADE FOR UPSTREAM EDGE AND CORNERS OF 40 FOOT WIDE FILL PAD															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

TOE-DOWN DEPTH BELOW NATURAL GRADE FOR SIDES AND DOWNSTREAM EDGE OF 40 FOOT WIDE FILL PAD															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
1.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
1.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
2.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
2.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
3.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White

= DV ² greater than 18	= no toe-down required, see below for rip-rap size for exposed slopes	24 Inches	= 24 inch toe-down required, see below for rip-rap size	36 inches	= 36 inch toe-down required, see below for rip-rap size	48 inches	= 48 inch toe-down required, see below for rip-rap size	= Engineering required
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RIP-RAP SIZE (D50)															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

= DV ² greater than 18	None/6 in.	= No rip-rap on sides, back; 6 inch rip-rap on front and upstream corners	6 inches	= 6 inch rip-rap	9 inches	= 9 inch rip-rap	= Engineering required
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TABLE 006-B

80 Foot Wide Fill Pad

RIP-RAP SIZE & TOE-DOWN DEPTH REQUIREMENTS FOR EROSION PROTECTION OF FILL PADS
PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL POLICY TECH-006

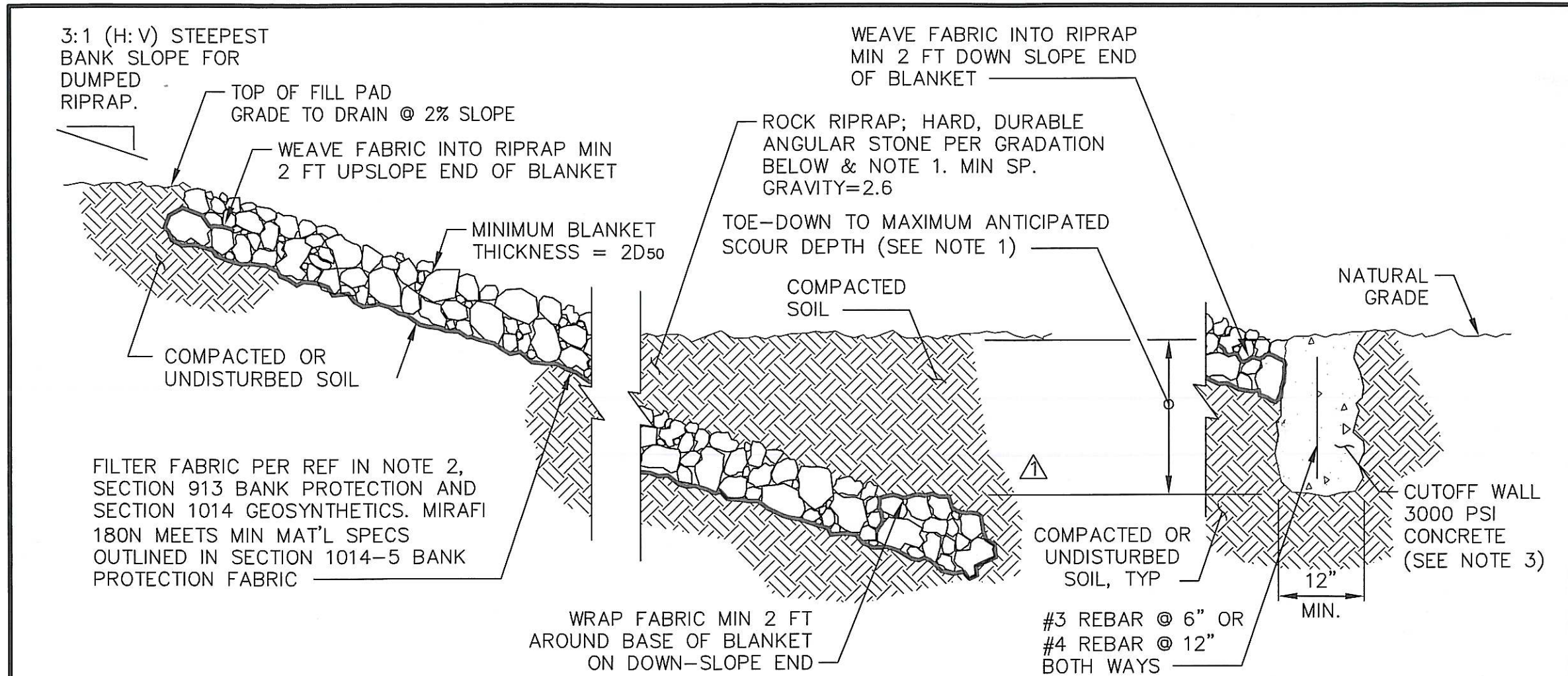
TOE-DOWN DEPTH BELOW NATURAL GRADE FOR UPSTREAM EDGE AND CORNERS OF 80 FOOT WIDE FILL PAD															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

TOE-DOWN DEPTH BELOW NATURAL GRADE FOR SIDES AND DOWNSTREAM EDGE OF 80 FOOT WIDE FILL PAD															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
1.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
1.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
2.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
2.50	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White
3.00	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White

= DV ² greater than 18	White	= no toe-down required, see below for rip-rap size for exposed slopes	Yellow	= 24 inch toe-down required, see below for rip-rap size	Orange	= 36 inch toe-down required, see below for rip-rap size	Red	= 48 inch toe-down required, see below for rip-rap size	Purple	= Engineering required
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RIP-RAP SIZE (D50)															
Flow Depth, ft	slope, ft/ft														
	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030
0.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
1.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.50	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3.00	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

= DV ² greater than 18	White	= No rip-rap on sides, back; 6 inch rip-rap on front and upstream corners	Yellow	None/6 in.	Orange	= 6 inch rip-rap	Red	= 9 inch rip-rap	Purple	= Engineering required
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OPTION A
EXTENSION OF DUMPED RIPRAP BLANKET BELOW GRADE

OPTION B
CONCRETE CUTOFF WALL BELOW GRADE

NOTES

1. D₅₀ AND TOE-DOWN DEPTH FROM TABLE TITLED: "RIPRAP AND TOE-DOWN REQUIREMENTS FOR EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS":
TABLE 006-A 40-FOOT WIDE FILL PAD, AND
TABLE 006-B 80-FOOT WIDE FILL PAD
2. UNLESS NOTED OTHERWISE HEREIN, ALL MATERIAL & INSTALLATION PER "STANDARD SPECIFICATIONS FOR PUBLIC IMPROVEMENTS", CURRENT ED.
3. CONCRETE CUTOFF WALL (OPTION B) MAY BE SUBSTITUTED FOR TOE-DOWN OF DUMPED RIPRAP BLANKET (OPTION A) BELOW GRADE. (OPTIONS A AND B SHOWN ABOVE REFER ONLY TO THE BELOW GRADE PORTION OF THE EROSION PROTECTION. SELECTED OPTION MUST BE USED EXCLUSIVELY. A HYBRID OF THE TWO OPTIONS IS NOT ALLOWED.)

DUMPED/HAND-PLACED RIPRAP GRADATION	
% PASSING	SIZE
100 - 90	2.00 D ₅₀
85 - 70	1.50 D ₅₀
50 - 30	1.00 D ₅₀
15 - 5	0.67 D ₅₀
5 - 0	0.33 D ₅₀

6/15/10 FIX TOE-DOWN

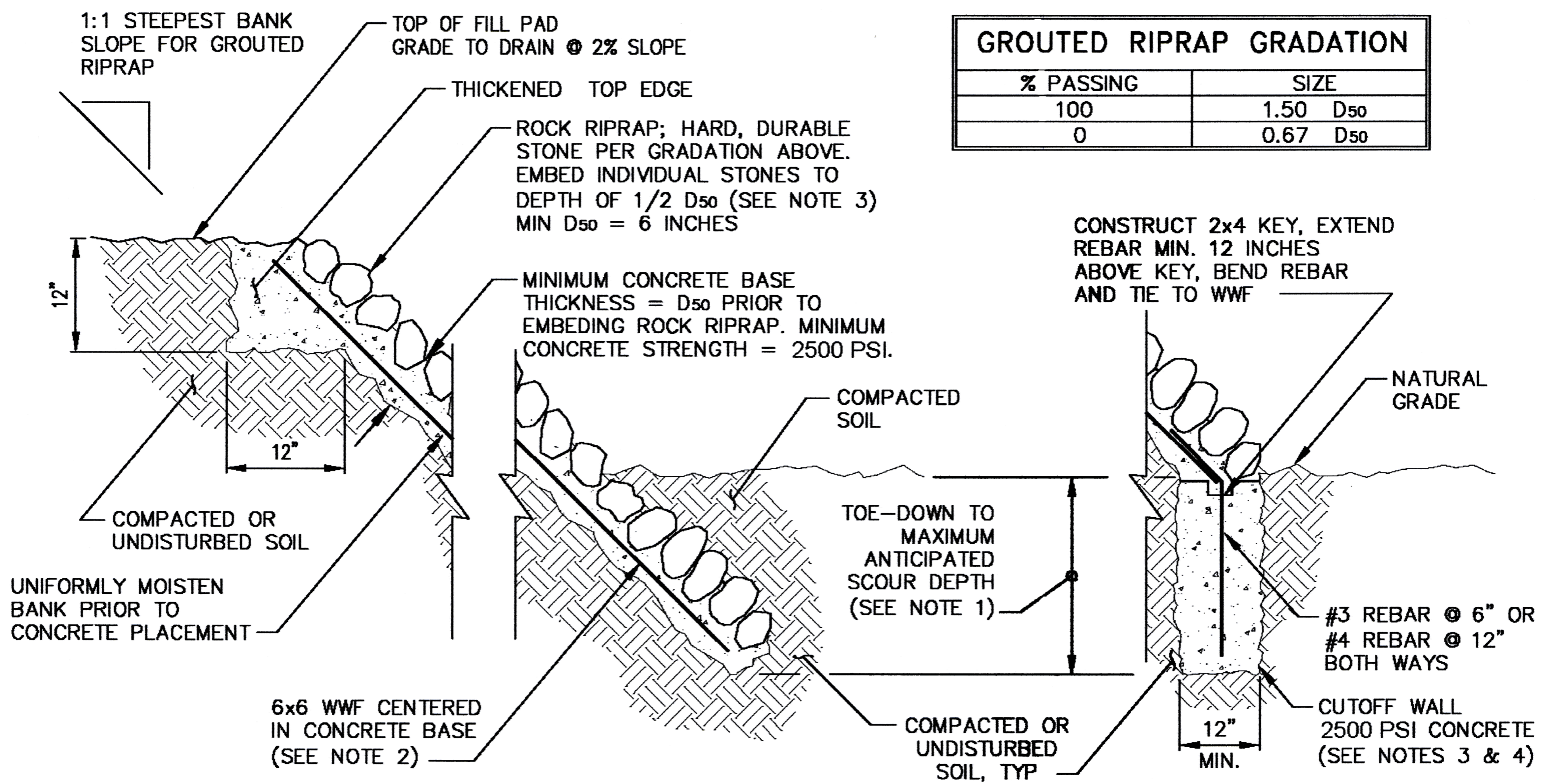
Professional Engineer
Suzanne J. Shields
15610
Suzanne J. Shields
6/15/10

THE SEAL OF PIMA COUNTY ARIZONA



FIGURE 006-A
DUMPED RIPRAP EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS
SCALE: NONE DRAWN BY: sak DATE: AUG 2009

GROUTED RIPRAP GRADATION	
% PASSING	SIZE
100	1.50 D ₅₀
0	0.67 D ₅₀



OPTION A
EXTENSION OF GROUTED RIPRAP
BLANKET BELOW GRADE

OPTION B
CUTOFF WALL BELOW GRADE

NOTES

- TOE-DOWN DEPTH FROM TABLE TITLED: "RIPRAP AND TOE-DOWN REQUIREMENTS FOR EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS":
 TABLE 006-A 40-FOOT WIDE FILL PAD, AND
 TABLE 006-B 80-FOOT WIDE FILL PAD
- FOR D₅₀=6 INCHES, USE W3.5xW3.5. FOR D₅₀=9 INCHES, USE W5.5 x W5.5.
- UNLESS NOTED OTHERWISE HEREIN, ALL MATERIAL & INSTALLATION PER STANDARD SPECIFICATIONS FOR PUBLIC IMPROVEMENTS", CURRENT ED.
- CONCRETE CUTOFF WALL (OPTION B) MAY BE SUBSTITUTED FOR TOE-DOWN OF GROUTED RIPRAP BLANKET (OPTION A) BELOW GRADE. (OPTIONS A AND B SHOWN ABOVE REFER ONLY TO THE BELOW GRADE PORTION OF THE EROSION PROTECTION. SELECTED OPTION MUST BE USED EXCLUSIVELY. A HYBRID OF THE TWO OPTIONS IS NOT ALLOWED.)

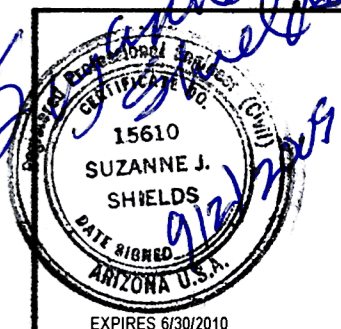
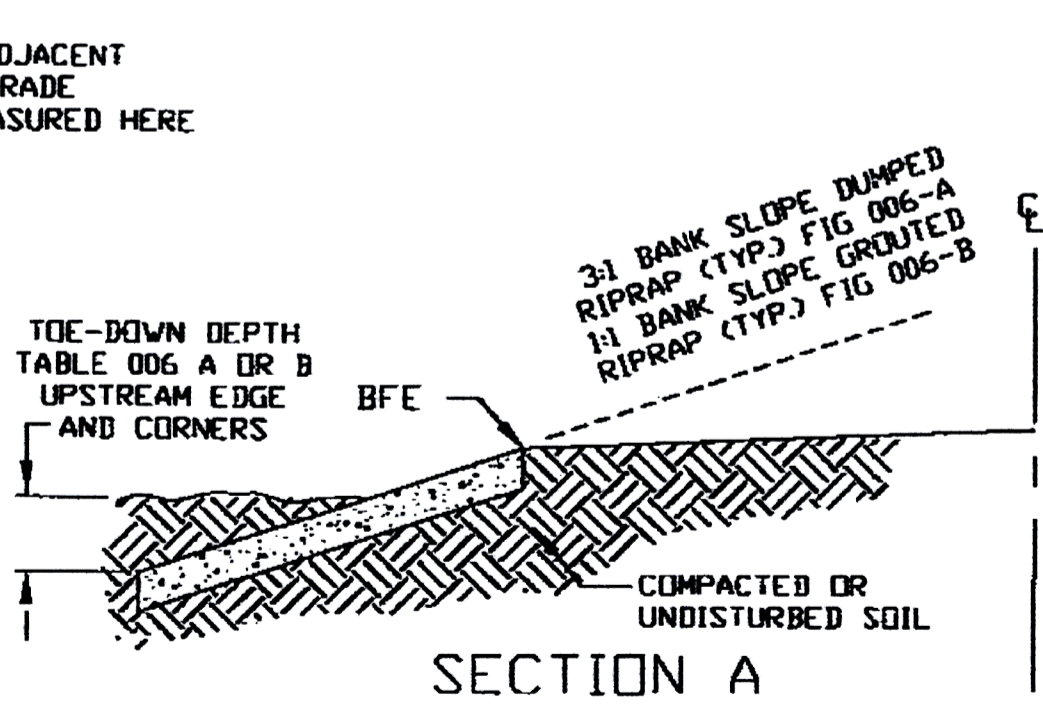
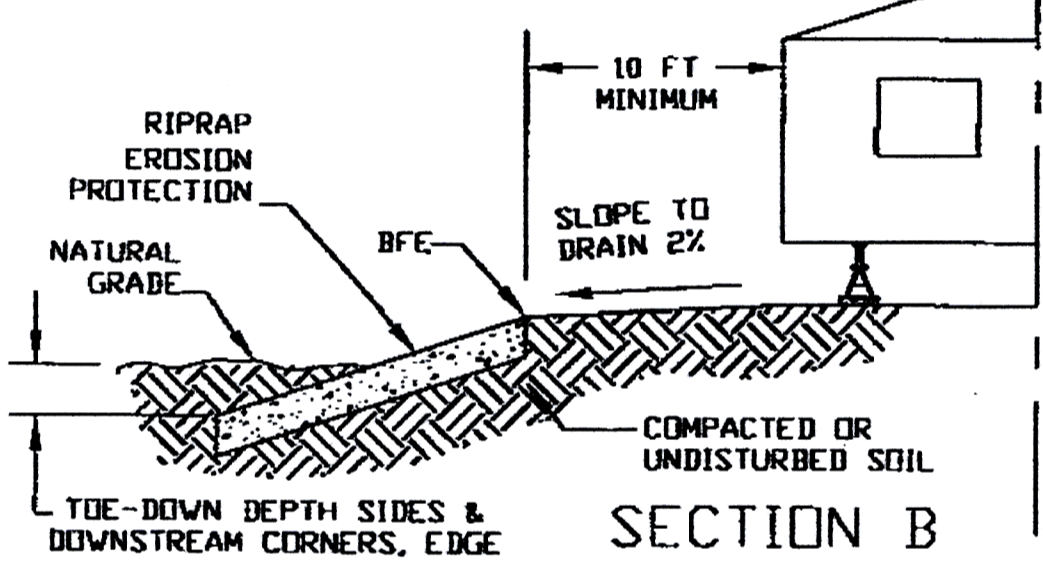
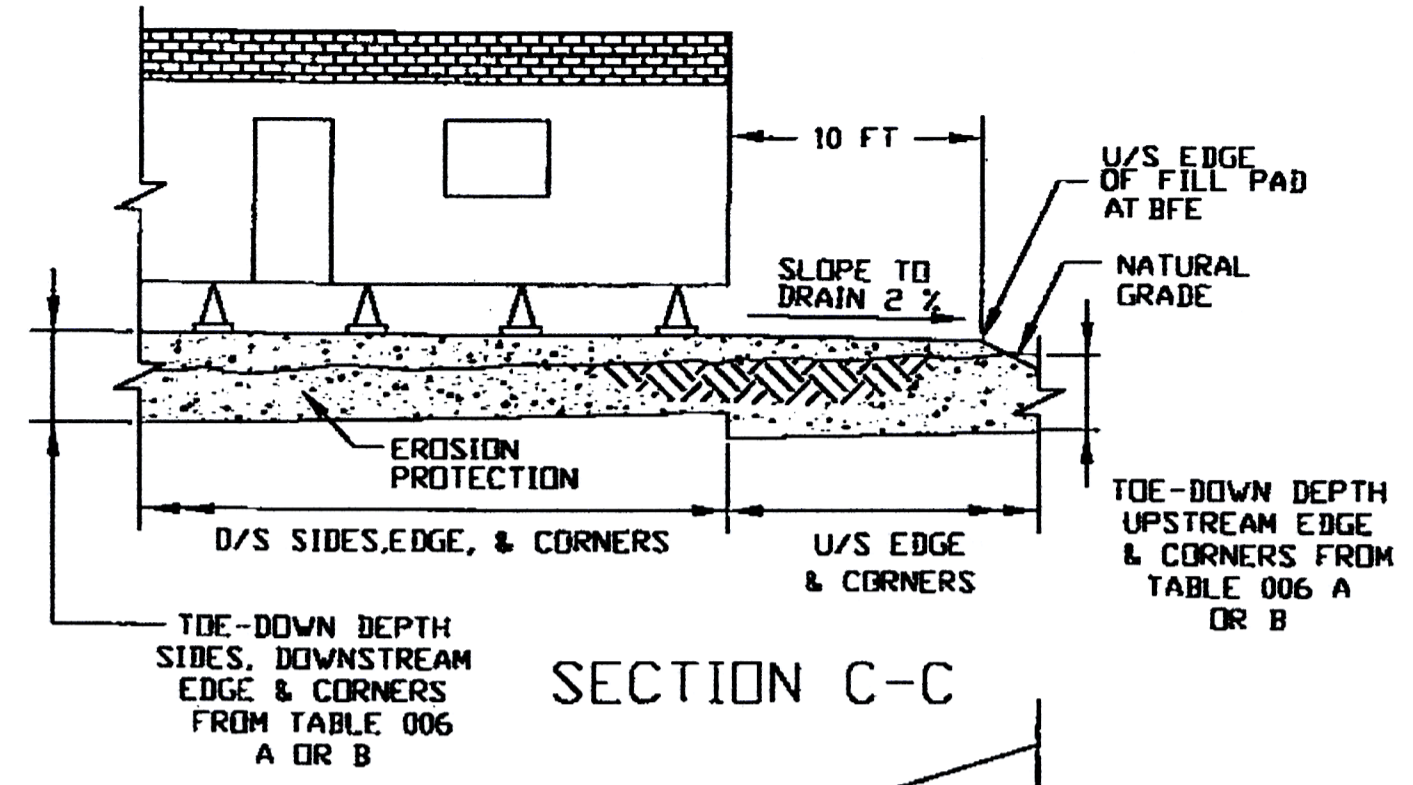
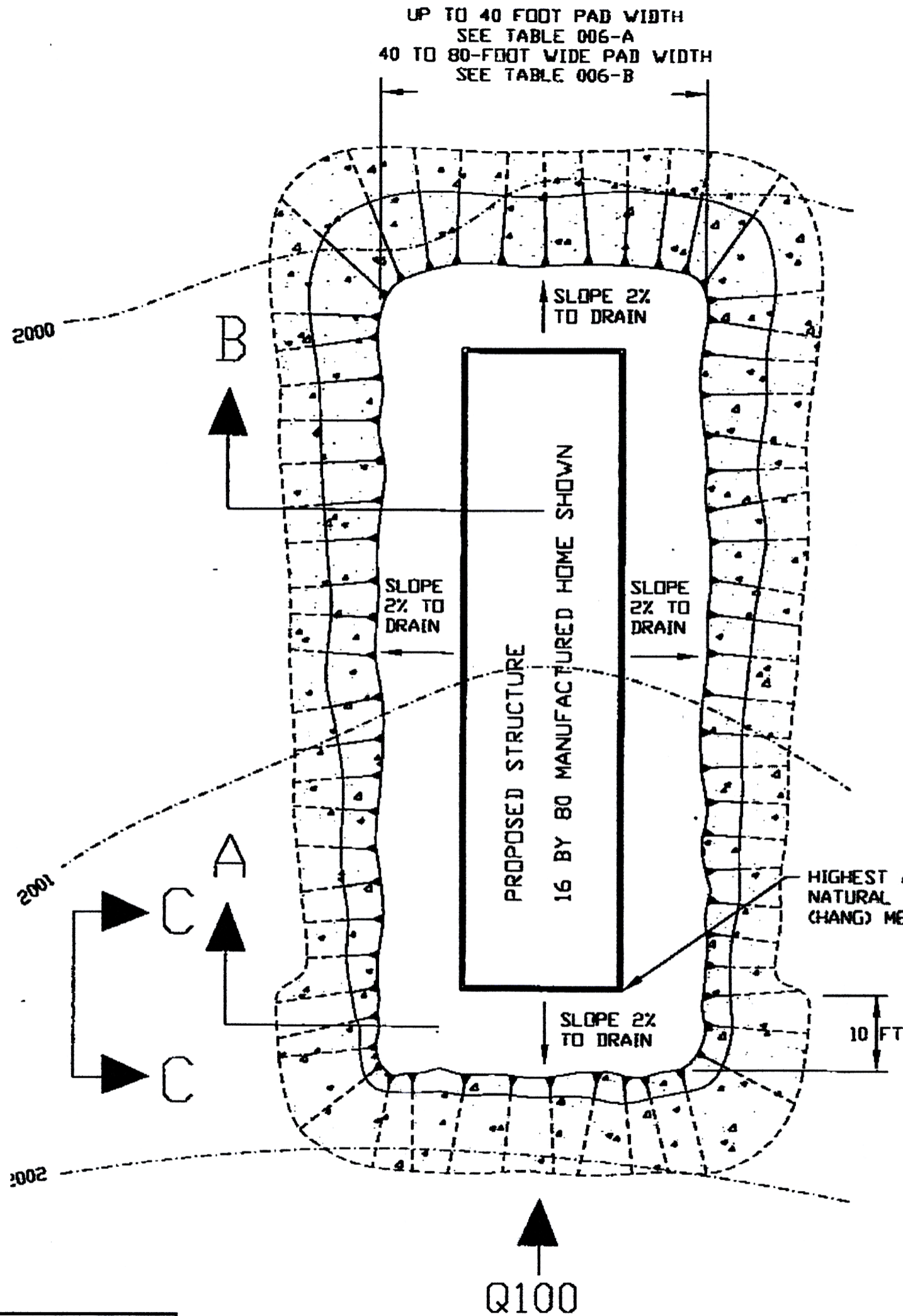


FIGURE 006-B
GROUTED RIPRAP EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS
 SCALE: NONE DRAWN BY: sak DATE: AUG 2009

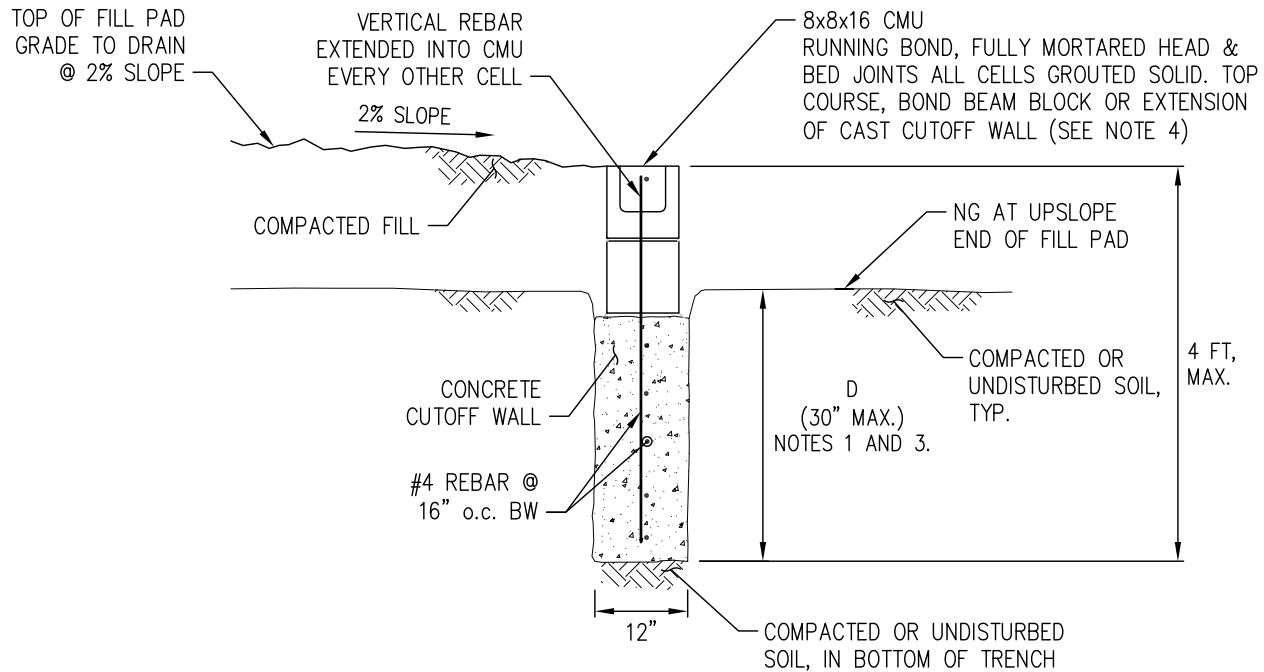


- NOTES:
- EXAMPLE SHOWN: 100-YR FLOW DEPTH = 1 FT, HANG = 2001.5 FT EL. LAND SLOPE = 0.022, 16 FT BY 80 FT MH, FILL PAD WIDTH = 36 FT, FROM TABLE 006-A (FOR 40-WIDE FILL PAD): D50 = 9-IN., TOE-DOWN U/S EDGE, CORNERS = 3 FT, TOE-DOWN SIDES, D/S EDGE CORNERS = 2 FT.

Suzanne J. Shields
 PROFESSIONAL PROFESSIONAL ENGINEER
 CERTIFICATE NO. 15610
 SUZANNE J. SHIELDS
 DATE SIGNED 9/24/2009
 ARIZONA U.S.A.
 EXPIRES 6/30/2010



FIGURE 006-C
 GROUTED OR DUMPED RIPRAP EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS
 SCALE: NONE DRAWN BY: sak DATE: AUG 2009



ABBREVIATIONS

BW = BOTH WAYS
 BFE = BASE FLOOD ELEVATION
 CMU = CONCRETE MASONRY UNIT
 D = TOE-DOWN DEPTH
 d = DEPTH OF EXISTING FOOTER
 FFE = FINISH FLOOR ELEVATION
 HANG = HIGHEST ADJACENT NATURAL GRADE

ksi = KILOPOUND PER SQUARE INCH
 NG = NATURAL GROUND
 N.T.S. = NOT TO SCALE
 o.c = ON CENTER
 SSPI = PC/DOT STANDARD SPECIFICATIONS
 for PUBLIC IMPROVEMENT
 WWF = WELDED WIRE FABRIC

NOTES

1. TOE-DOWN DEPTH FROM TABLE 006-A OR 006-B.
2. MATERIALS: CONCRETE 3000 PSI; REBAR 60 ksi, CMU ASTM C-90 TYPE I OR II, MORTAR TYPE M, N, OR S PER ASTM C-270, GROUT PER ASTM VC-476.
3. THIS OPTION IS APPLICABLE TO FILL PADS REQUIRING ONLY UPSTREAM EROSION PROTECTION. APPLICATION TO OTHER CONFIGURATIONS REQUIRES PRE-APPROVAL BY THE DISTRICT.
4. FORMED CONCRETE OF DIMENSIONAL & MATERIAL CHARACTERISTICS IDENTICAL TO THE CUTOFF WALL MAY BE SUBSTITUTED FOR CMU.

Suzanne Shields

5/19/21

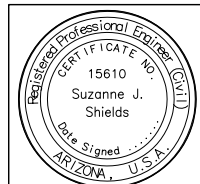


FIGURE 006-D
 VERTICAL WALL EROSION PROTECTION OF FILL PADS
 IN FLOODWAY FRINGE AREAS

SCALE: None

DRAWN BY: sak

DATE: July 2019