Manufactured Home Installations in Flood Hazard Areas

State and Local Coordination in Action

Department of Fire, Building and Life Safety Seminar

April 27, 2010

Brian.Jones@rfcd.pima.gov

Pima County Regional FLOOD CONTROL DISTRICT

Overview

- History of this effort - why and how we got where we are today
- Technical overview – how the details were developed and their limitations
- Benefits of using standard designs – why you should use them

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Timeline for Implementation of Standard Designs

- October 2008 – After 35 years of development, HUD requirements are published, which requires site-specific designs for MH in floodplains based on *FEMA85: Manufactured Home Installations in Flood Hazard Areas*
- December 2008 –District proposes use of standard details sealed by Chief Engineer using FEMA85 and County standards to satisfy site-specific design requirement for flow depths up to 3 feet
- January 2009 - HUD requirements become effective, OMH accepts District standard details. District recommends OMH/ADWR adopt standard details for statewide use
- May 2009 - OMH develops standard details for use statewide when depth is ≤ 1 ft. Within unincorporated Pima County, District and OMH agree to:
  - Use OMH standard details for flood depths of 1 foot or less
  - Use District standard details for flood depths greater than 1 foot
- October 2009 - OMH revises standard details for use statewide based on District comments

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Impact to Pima County

- HUD site-specific design requirements extend to both FEMA and local flood hazard areas
- The District is very proactive in mapping flood hazard areas in addition to those mapped by FEMA
- 827 sq. mi. of mapped flood plain
  - 402 sq. mi. of FEMA mapped floodplain
  - 425 sq. mi. of locally mapped floodplain
    - 345 sq. mi. of locally mapped sheet flow floodplain
- HUD requirements would have a huge impact (expense and time) to our customers and the District

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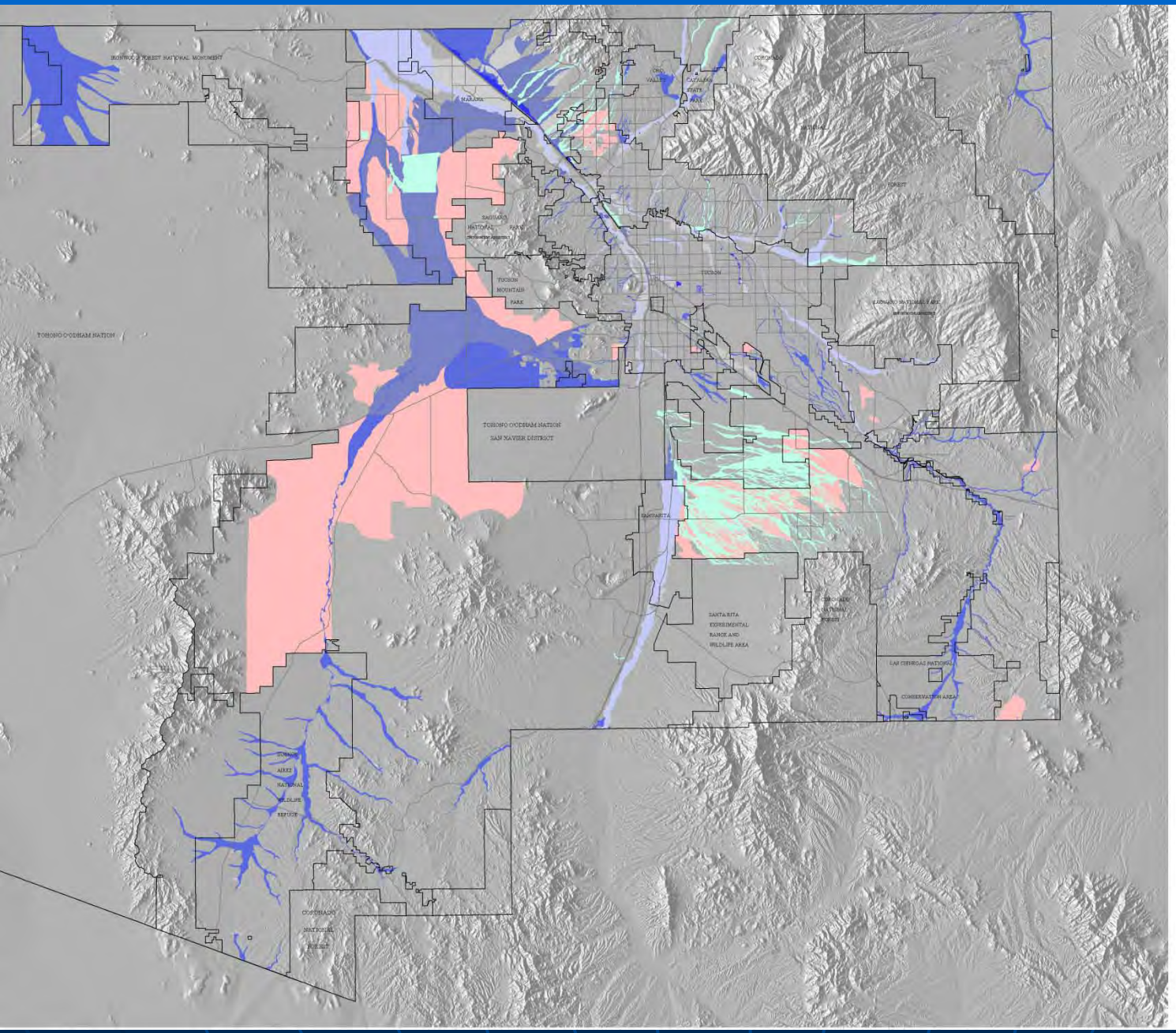


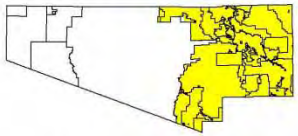
Floodplains in Eastern Pima County

- Jurisdiction Lines
- Major Streets
- Local Floodplains
- Sheet Flooding Areas

FEMA Floodplains

- Zone A
- Zone AE
- Zone AH
- Zone AO
- Zone Shaded X

Pima County Index Map



Index Map Scale 1:5,000,000

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Scale 1:500,000

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Sheet Flow Flooding

- Sheet flow flooding is a common flood hazard affecting large areas in Pima County and statewide
- Sheet flow conditions are more uniform than riverine conditions in terms of flow depth and velocity
- Creates opportunity to develop standard foundation designs without the need for every property owner to hire an engineer for their installation

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Importance of Adequate Standards

Benefits of Statewide Standards

- Money spent by owner can go into protecting the MH instead of going to the cost of hiring an engineer
- These reduced costs to the owner help keep MH installations affordable
- Reduces permit complexity between jurisdictions (Floods know no political boundaries)
- Savings of time and manpower to the District during permit review process
- Faster permit turnaround time

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Implementation Issues

- Had to learn about each other's processes and how best to work together to meet a common goal
- Had to ensure that the District provides inspectors with enough information to perform a thorough inspection
- Established distinct roles for each entity:
  - The District interprets flood information, applies OMH standards, establishes requirements via permit conditions
  - OMH verifies installation meets District's permit conditions
- Establishing a level of trust that:
  - The District will provide complete and accurate installation requirements to OMH
  - OMH will perform inspections to ensure that MHs are installed to the minimum standards required by the permit, while allowing changes that are more protective

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Technical Background: Elevation Methods

- Built-up piers
  - Grouted, reinforced CMU piers with site-specific toe-down
- Stem wall
  - Grouted, reinforced CMU stem wall with site-specific toe-down
- Fill pad
  - Protected with dumped or grouted rip-rap and concrete cut-off wall with site-specific toe-down (OMH details, flow depths 1 foot or less)
  - Protected with dumped or grouted rip-rap and concrete cut-off wall or rip-rap with site-specific toe-down (District details, flow depths greater than 1 foot)
  - Conventional installation of MH is allowed on fill pad

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Technical Background on the Creation of Standard Details

- Details created using FEMA 85 and Draft FEMA 85 guidelines
- Standard engineering practices were followed
- Standard design development considered:
  - Flow depth
  - Flow velocity, determined from:
    - Ground slope
    - Manning's N (surface roughness coefficient)
  - Potential scour, using:
    - Typical soils data
    - Local scour calculations
- FLO-2D, two-dimensional flow modeling was used to guide erosion protection design

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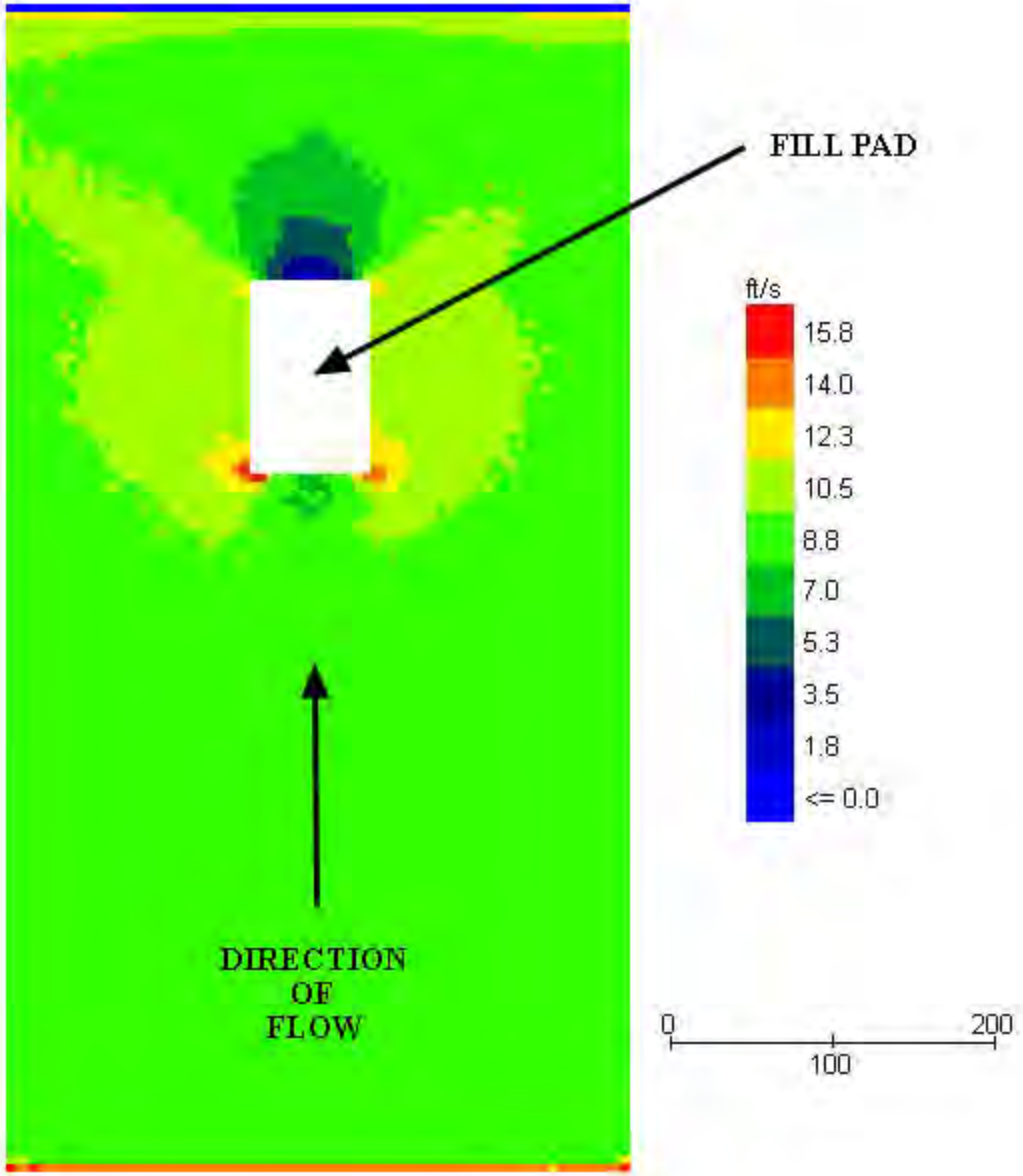
FLO-2D Modeling

VELOCITY OF 100-YEAR FLOOD APPROACHING A FILL PAD WHICH IS ALIGNED PARALLEL TO FLOW

100-YEAR FLOW DEPTH = 2.5 FT
LAND SLOPE = 0.030
MANNING'S ROUGHNESS = .065
PERPENDICULAR WIDTH = 80 FT

RESULTS FROM 2-DIMENSIONAL FLOW SIMULATION USING FLO-2D AND A 5-FT GRID SPACING



Results of FLO-2D Analysis

- Justifies reduced protection on the downstream portion of fill pads and stem walls, reducing owner costs
- Supports requirement that MH be oriented parallel to flow, which also reduces foundation costs
- Demonstrates that the placement of MHs in sheet flow floodplains does not significantly impact water surface elevations

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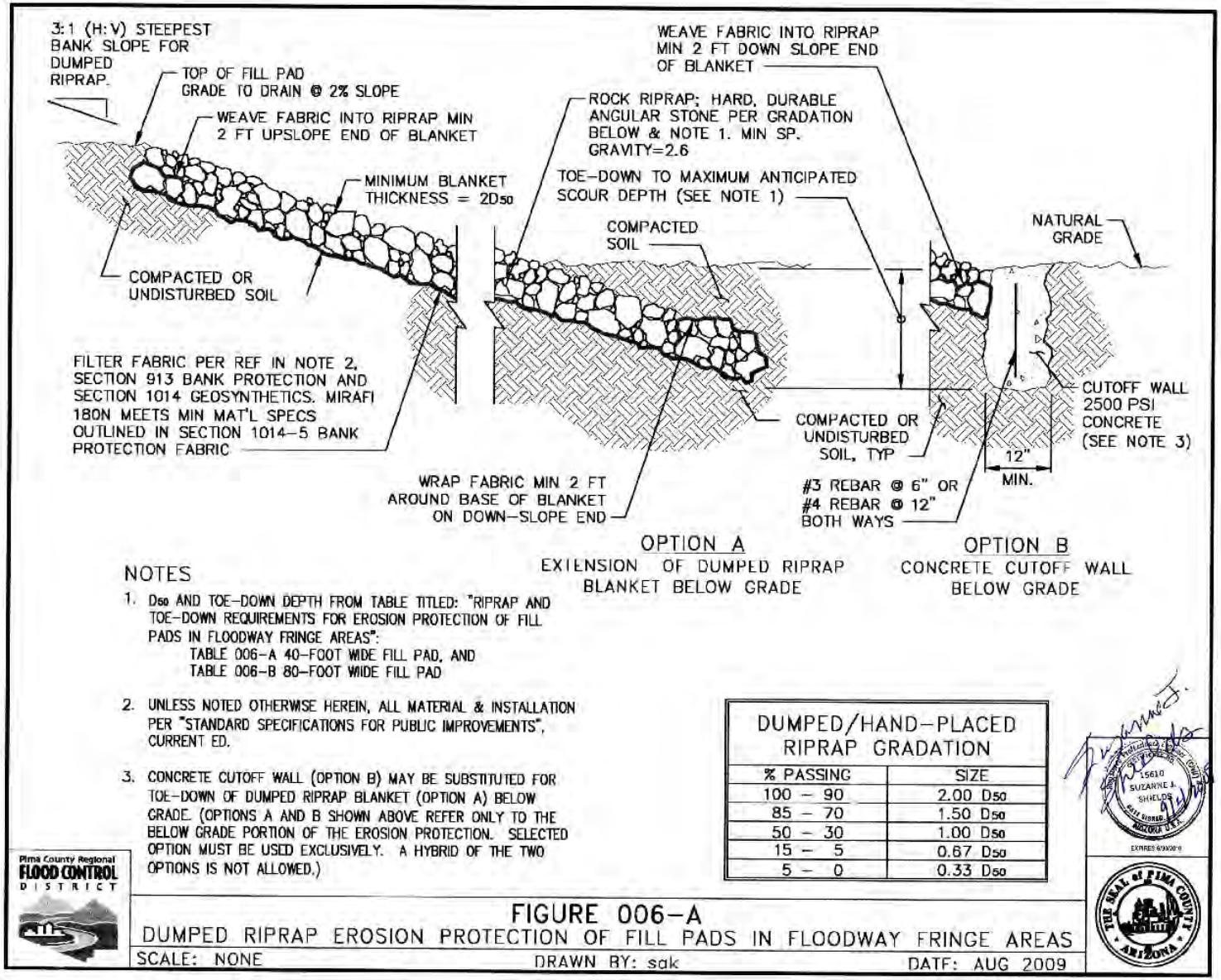
District Fill Pad Detail



NOTES

1. D_{50} 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}

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FIGURE 006-A
DUMPED RIPRAP EROSION PROTECTION OF FILL PADS IN FLOODWAY FRINGE AREAS

SCALE: NONE DRAWN BY: sak DATE: AUG 2009

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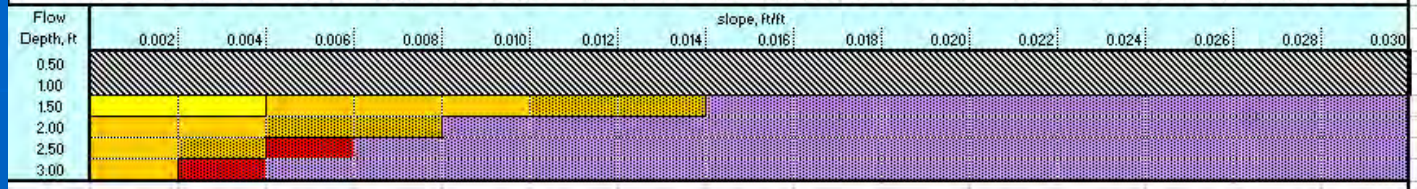
TABLE 006-A

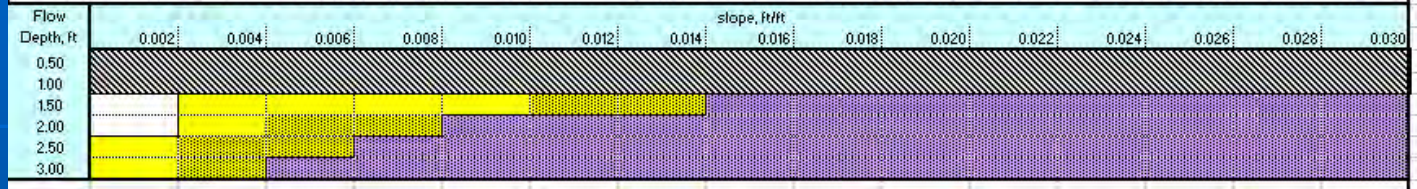
40 Foot Wide Fill Pad

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

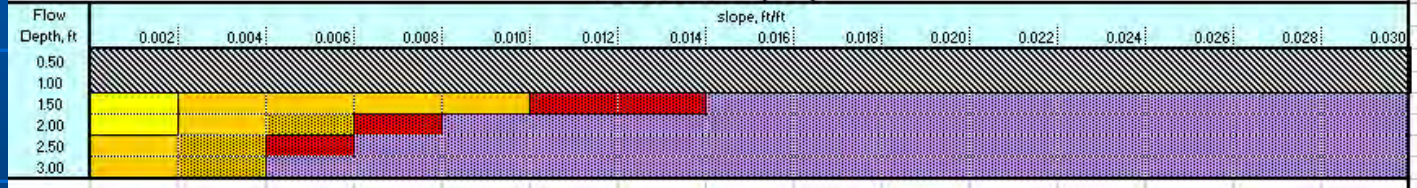


TOE-DOWN DEPTH BELOW NATURAL GRADE FOR SIDES AND DOWNSTREAM EDGE OF 40 FOOT WIDE FILL PAD



= DV^2 greater than 15		= 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

RIP-RAP SIZE (D50)



= DV^2 greater than 15	= Use AZ Office of Manufactured Housing Stds Below	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

OMH Fill Pad Table for 0.5 Foot Depth (Table "H" from Sheet 4)

Upstream Edge and 10 Feet from Upstream Corners	Slope	Less than 0.012	0.012-0.026
	Pad Thickness	12"	12"
	Toe-Down Depth	24"	24"
	Rip-Rap Sizing	D50 = 6"	D50 = 6"
Remainder of Fill Pad	Pad Thickness	12"	12"
	Toe-Down Depth	None	24"
	Rip-Rap Sizing	None	D50 = 6"

OMH Fill Pad Table for 1.0 Foot Depth (Table "I" from Sheet 4)

Upstream Edge and 10 Feet from Upstream Corners	Slope	Less than 0.004	0.004-0.012	0.012-0.016	0.016-0.022
	Pad Thickness	18"	18"	18"	18"
	Toe-Down Depth	24"	24"	36"	36"
	Rip-Rap Sizing	D50 = 6"	D50 = 6"	D50 = 6"	D50 = 9"
Remainder of Fill Pad	Pad Thickness	18"	18"		18"
	Toe-Down Depth	None	24"		24"
	Rip-Rap Sizing	None	D50 = 6"		D50 = 9"

SLOPE CALCULATION. Slope measurement should extend upstream and downstream from the structure far enough to adequately represent the slope.

Slope _____ **Flow Depth:** 0 **TOE-DOWN DEPTH REQUIREMENTS:**

_____ **Upstream edge and corners:**

_____ **Sides/downstream:**

_____ **Rip-Rap size (D50)**

Light Green Fields: Calculation fields, write protected

Yellow Fields: Results, Data Entry Required

OMH Design Tables

TABLE "A" STEM WALL FOOTING DEPTH FOR INSTALLATION IN FLOODPLAIN UP TO BFE OF 0.5 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.014	0.014-0.04	0.04-0.06	0.06-0.07	OVER 0.07
FOOTING DEPTH WITHIN 10 FT. EACH DIRECTION OF EACH U/S CORNER.	24"	30"	36"	36"	ENGINEER DESIGN
FOOTING DEPTH- REMAINDER OF STEM WALL	18"	18"	18"	24"	ENGINEER DESIGN

TABLE "B" I-BEAM PIER FOOTING THICKNESS FOR INSTALLATION IN FLOODPLAIN UP TO BFE OF 0.5 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.011	0.011-0.022	0.022-0.047	0.047-0.07	OVER 0.07
FOOTING THICKNESS-	6"	8"	10"	12"	ENGINEER DESIGN

TABLE "C" STEM WALL FOOTING DEPTH FOR INSTALLATION IN FLOODPLAIN BFE 0.5 FT TO 1.0 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.004	0.004-0.008	0.008-0.022	0.022-0.026	OVER 0.026
FOOTING DEPTH-WITHIN 10 FT. EACH DIRECTION OF EACH U/S CORNER.	42"	48"	54"	54"	ENGINEER DESIGN
FOOTING DEPTH- REMAINDER OF STEM WALL	18"	18"	18"	24"	ENGINEER DESIGN

TABLE "D" I-BEAM PIER FOOTING THICKNESS FOR INSTALLATION IN FLOODPLAIN BFE 0.5 FT TO 1.0 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.01	0.011-0.02	0.021-0.026	OVER 0.026
FOOTING THICKNESS-	8"	8"	10"	ENGINEER DESIGN

TABLE "E" PIER FOOTING DEPTH FOR INSTALLATION IN FLOODPLAIN UP TO BFE 0.5 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.008	0.008-0.038	0.038-0.07	OVER 0.07
FOOTING DEPTH-	18"	24"	30"	ENGINEER DESIGN

TABLE "F" PIER FOOTING DEPTH FOR INSTALLATION IN FLOODPLAIN BFE 0.5 FT TO 1.0 FT.

GROUND SLOPE ft./ft.	LESS THAN-0.01	0.01-0.025	0.025-0.047	0.047-0.07	OVER 0.07
FOOTING DEPTH-	30"	36"	42"	48"	ENGINEER DESIGN

STATE OF ARIZONA
REFER TO SHEET #1
NOV 14 2009
Review of this document does not authorize or approve any commission or deviation from the applicable standards.
F-LD 00 SUP

NOTE:
FOOTING AND CUTOFF WALL DEPTHS ARE MEASURED FROM NATURAL (UNDISTURBED) GRADE DOWN TO THE BOTTOM OF THE FOOTER OR CUTOFF WALL.

MH FOUNDATIONS, OR FILL PAD EROSION PROTECTION, FOR INSTALLATIONS WITHIN FLOODPLAINS WITH A BASE FLOOD ELEVATION DEPTH GREATER THAN 1.0 FOOT SHALL BE DESIGNED BY AN ARIZONA REGISTERED CIVIL ENGINEER, AND APPROVED BY ALL APPROPRIATE LOCAL GOVERNMENTAL AGENCIES AND BY THE OMH.

revised 9/22/09

TABLE "G" MARRIAGE LINE FOOTING DIMENSIONS FO INSTALLATION IN FLOODPLAIN UP TO BFE 1.0 FT.

MARRIAGE LINE LOADING LBS.	SOIL LOADING PSI			
	1000	2000	3000	4000
2000	1.5'X1.5'X4"	1.33'X1.33'X4"	1.33'X1.33'X4"	1.33'X1.33'X4"
3000	1.75'X1.75'x6"	1.33'X1.33'X4"	1.33'X1.33'X4"	1.33'X1.33'X4"
4000	2'X2'x6"	1.5'X1.5'X4"	1.33'X1.33'X4"	1.33'X1.33'X4"
5000	2.25'X2.25'x8"	1.75'X1.75'x6"	1.33'X1.33'X4"	1.33'X1.33'X4"
6000	2.5'X2.5'x8"	1.75'X1.75'x6"	1.5'X1.5'X4"	1.33'X1.33'x4"
7000	2.75'X2.75'x8"	2'X2'x6"	1.75'X1.75'x6"	1.33'X1.33'x4"
8000	3'X3'x10"	2'X2'x6"	1.75'X1.75'x6"	1.5'X1.5'x4"
9000	3'X3'x10"	2.25'X2.25'x8"	1.75'X1.75'x6"	1.5'X1.5'x4"

FOOTNOTE 1- IF THE THICKNESS IN THIS TABLE IS SMALLER THAN IN TABLE B OR D THEN USE THE LARGER.
FOOTNOTE 2- FOOTINGS SHALL HAVE 3-#4 REBAR BOTH DIRECTIONS

TABLES "H"&"I" ARE FOR PADS WHERE THE LONG DIMENSION OF THE HOME IS PARALLEL TO FLOOD FLO AND UP TO A 32 FOOT DOUBLE WIDE HOME.

TABLE "H" FILL PAD THICKNESS AND EROSION PROTECTION IN FLOODPLAIN UP TO BFE 0.5 FT

	GROUND SLOPE ft./ft.	LESS THAN-0.012	0.012-0.026	OVER 0.026
U/S END & 10 FOOT FROM U/S CORNERS	PAD THICKNESS TOE DOWN DEPTH RIP-RAP SIZING	12" 2.0' D50=6"	12" 2.0' D50=6"	ENGINEER DESI
REMAINDER OF PAD	PAD THICKNESS TOE DOWN DEPTH RIP-RAP SIZING	12" NONE REQUIRED NONE REQUIRED	12" 2.0' D50=6"	ENGINEER DESI

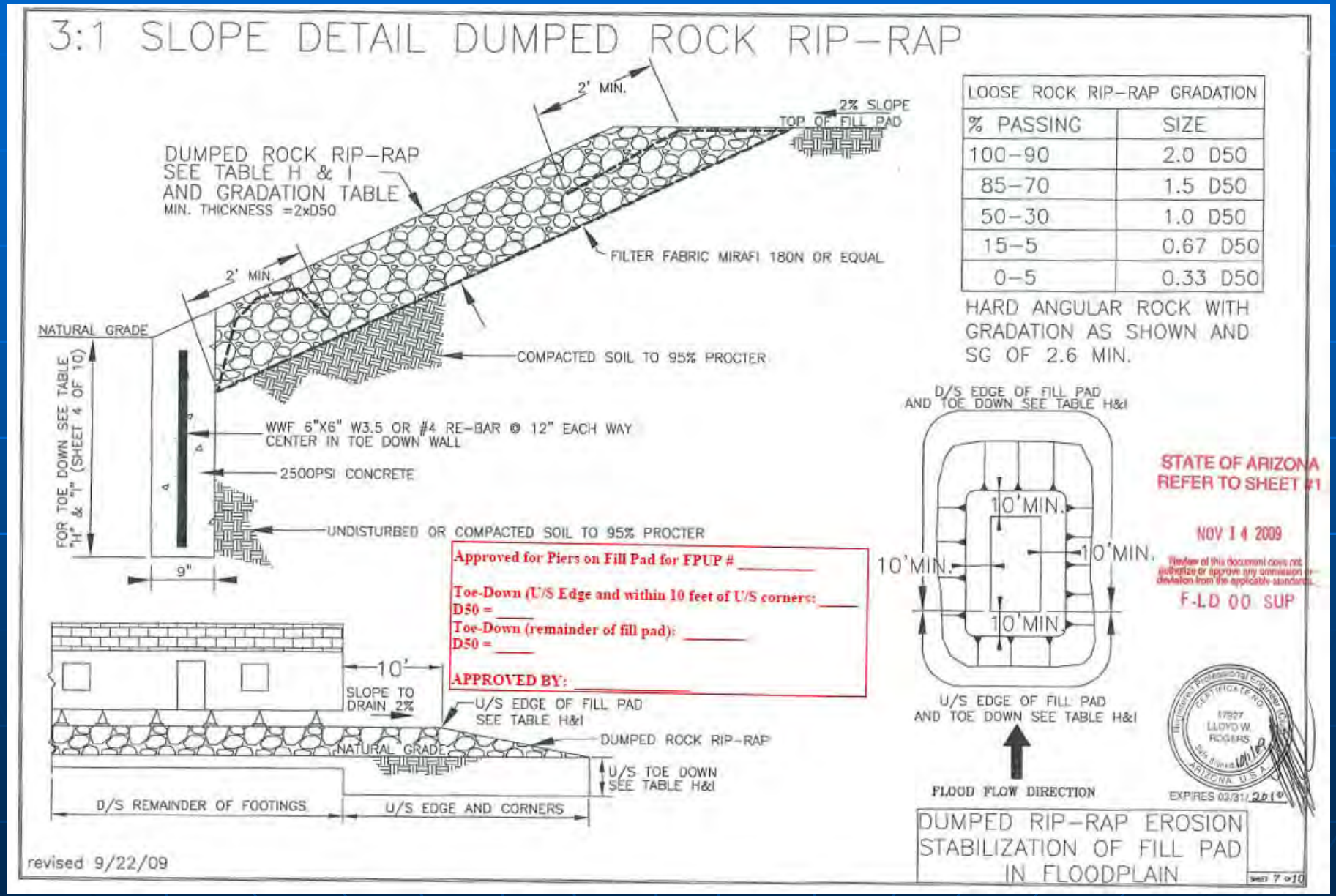
TABLE "I" FILL PAD THICKNESS AND EROSION PROTECTION IN FLOODPLAIN BFE 0.5 FT. TO 1.0 FT.

	GROUND SLOPE ft./ft.	LESS THAN-0.004	0.004-0.012	0.012-0.016	0.016-0.022
U/S EDGE & CORNERS	PAD THICKNESS TOE DOWN DEPTH RIP-RAP SIZING	18" 2.0' D50=6"	18" 2.0' D50=6"	18" 3.0' D50=6"	18" 3.0' D50=9"
	GROUND SLOPE ft./ft.	LESS THAN-0.004	0.004-0.016	0.016-0.022	OVER 0.02
SIDES, D/S EDGE & CORNERS.	PAD THICKNESS TOE DOWN DEPTH RIP-RAP SIZING	18" NONE REQUIRED NONE REQUIRED	18" 2.0' D50=6"	18" 2.0' D50=9"	ENGINEER D

FOOTINGS AND CUTOFF WALL DEPTHS AND DIMENSIONS IN FLOODPLAIN

EXP
SHEET

OMH Fill Pad Detail with County Approval



Limitations & Cautions for Use of Details

- Use limited primarily to sheet flow type flooding, when uniform flood conditions are anticipated
- Use should be limited to relatively low flood hazard conditions (e.g. shallow depths and low velocities)
- It is necessary to consider the assumptions, including:
  - Placement of MH away from low flow channels
  - Placement of MH parallel to flow
  - Soil type
  - Vegetation type and density
- Does not consider certain unusual conditions that may affect flood hazards, such as farm dikes, upstream stock ponds (dam breach potential), etc. that may need to be addressed to ensure adequate flood safety

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Benefits of Using OMH Standard Details

- Provides option to customer, who may use the details in lieu of hiring an engineer as required by HUD
- Offsets the cost and delay of engineering
- Helps keep MH affordable while making installations safer
- Allows owners to get more accurate estimate of installation costs up front
- Reduces jurisdiction review time and costs
- Standardizes permits and inspections, leading to less error-prone process
- Reduces liability to jurisdictions
- Satisfies FHA/VA loan requirements

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Additional Benefits of Creating Standard Details for Flood Depths Greater than 1 Foot

- Use of standard details is still voluntary
- Offsets the cost and delay of engineering for more severe floodplains, money that would be spent on engineering can go into a safer foundation
- Further reduces the cost and effort of permit reviews
- Generates public good will

- Most of the work has been done! (You just have to ask us for it.)

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Questions?

http://www.rfcd.pima.gov/

Brian.Jones@rfcd.pima.gov