PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NUMBER: Technical Policy, TECH-012 **EFFECTIVE DATE :** April 29, 2015
REVISED: N/A

POLICY NAME: Methods to Estimate Maximum Anticipated Scour Depth Including Optional Adjustment for Flood Duration

PURPOSE:
To clarify Section 16.20.020.C.5 of the Ordinance regarding the use of an engineering study to evaluate the potential impact of erosion on a development, by establishing methods to estimate maximum anticipated scour depth (MASD). This policy also establishes an alternate method to estimate MASD which considers the effect of flood duration. This policy does not apply to watercourses with base flood peak discharges ≥10,000 cubic feet per second (cfs), nor does it address long term aggradation/degradation, or scour at in-channel hydraulic structures such as culverts, channel drops, grade-controls or improved at-grade crossings.

BACKGROUND:
The *Standards Manual for Drainage Design and Floodplain Management* (SMDDFM, 7/98) outlines a method to estimate MASD as the sum of 5 scour components, multiplied by a factor of safety. Local scour is one of these components; it is caused by abrupt changes in direction as flow passes a development, and includes pier and abutment scour. In addition to the equations for pier and abutment scour provided in the SMDDFM, Federal guidelines for estimating these scour components are presented in the publication titled: *Evaluating Scour at Bridges, Fourth Edition, Publication No. FHWA NHI 01-001*, (HEC18, 5/01). The District accepts the HEC18 equations for pier and abutment scour, and these may be substituted into the SMDDFM method for estimating MASD.

In an effort to facilitate application of the requirements of the Ordinance, the District has prepared a number of typical foundation designs which use the SMDDFM scour equations to establish minimum foundation toe-downs for different overbank flow scenarios. These can be found in *Technical Policies TECH-003, TECH-006, and TECH-014*. An applicant may use one of the Technical Policies if the proposed development meets certain criteria, such as location outside the erosion hazard setback, meeting specific obstructive width requirements, and falling below specific flow depth and velocity thresholds. Default erosion hazard setback distances are specified in Chapter 16.28 of the Ordinance. Methods for evaluating an alternative safe erosion hazard setback are described in *Technical Policy TECH-020*.

When these applicability criteria cannot be met, or if the applicant desires a more detailed analysis, an engineering study is required which evaluates the SMDDFM scour components using information derived specifically for the development site. The SMDDFM method for determining MASD is incorporated into this Technical Policy.

When development is located in a sheetflow area, or in an overbank area outside of the erosion hazard setback, the duration of the flood event may be considerably shorter than the duration of the in-channel flood. The MASD equations from both HEC18 & the SMDDFM do not account for flood duration and will generally predict large scour depths in these areas. These scour depths may be conservative for use in Pima County. The District requested an outside study to propose a method for adjusting these equations for flood duration. This method is presented in the document titled: *Procedure for Determining Local Scour Depths in Overbank/Sheetflow Areas* (Tetra Tech, 1/2012). This method is referred to as the "Short Duration MASD method". It requires evaluation of

hydrograph time-to-rise (T_R) and foundation material median diameter (D_{50}). The method incorporates equations for the pier and abutment scour components from HEC18, with the resulting MASD consisting of only an abutment scour component, or of the sum of pier and contraction scour components, depending on the type of obstruction. The other scour components of MASD specified in the SMDDFM method are not used in the Short Duration MASD method. In addition, the scour components are not multiplied by a factor of safety; instead, the unit discharge is adjusted for non-uniform flow distribution prior to use in the equations for the scour components. The Short Duration MASD method is also incorporated into this Technical Policy.

POLICY:

A. When development is proposed within a regulatory floodplain, the effect the flood has on the stability of the development due to scour and erosion must be considered and the calculation of the maximum anticipated scour depth (MASD) is required. The *Standards Manual for Drainage Design and Floodplain Management* (SMDDFM, 7/98) shall be used to estimate MASD and the development shall be designed and constructed to remain stable after considering the loss of soil to the MASD. The applicant has three options available to make this determination:

   1. Use of existing Technical Policies: The District has prepared a number of typical foundation designs which use the SMDDFM scour equations to establish MASD and minimum foundation toe-downs for different overbank flow scenarios. These can be found in *Technical Policies TECH-003, TECH-006, and TECH-014*. An applicant may use one of the Technical Policies if the proposed development meets certain criteria, such as location outside the erosion hazard setback, meeting specific obstructive width requirements, and falling below specific flow depth and velocity thresholds.

   2. Preparation of an engineering study using the SMDDFM method: When an engineering study is prepared without consideration of flow duration the following criteria will apply:
      a. MASD for development in the primary channel or erosion hazard setback (EHSB) shall be calculated using channel hydraulics and MASD shall be measured below the bottom of the channel.
      b. MASD for development outside the channel or EHSB shall be calculated using overbank/sheetflow hydraulics and MASD shall be measured below natural grade at the development.
      c. The SMDDFM method is incorporated into a Microsoft Excel spreadsheet titled: PC-SCOURXX, available for download from the District's website (XX=Version).

   3. Preparation of an engineering study that accounts for short duration flood events: When development is proposed in overbank/sheetflow areas but outside the EHSB, MASD may be evaluated using the Short Duration MASD method. The Short Duration MASD method is incorporated into a Microsoft Excel spreadsheet titled: PC-ScourTRXX, available for download at the District's website (XX=Version). The following criteria apply:
      a. MASD for development in overbank/sheetflow areas is calculated using overbank/sheetflow hydraulics and MASD is measured below natural grade at the development. MASD shall consist of only abutment scour for stem wall foundations or fill pads, or of the sum of pier scour and contraction scour for piers. Contraction scour shall be 20% of the approach flow depth.
      b. Hydraulics (flow depth, velocity, and unit discharge) shall be adjusted for non-uniform flow distribution per the Short Duration MASD method.

c. Pier or abutment scour components shall be evaluated per the HEC18 equations, as modified in by the Short Duration MASD method to eliminate use of the Froude Number in preference for the unit discharge.
d. Adjustment of the MASD for flood duration may be applied if the watershed area ≤ 10 square miles and if the time-of-concentration is ≤ 180 minutes. Temporal adjustment shall be per the Short Duration MASD method using the base flood hydrograph time-to-rise (T_R) and bed sediment median diameter (D_{50}). T_R shall be evaluated per Section 4.5 of the SMDDFM.

B. The following construction standards shall apply in all cases:

1. Erosion protection of a foundation shall be provided by extending the bottom of the footer (for a stem wall), the bottom of the cutoff wall or the top of a riprap blanket (for a fill pad), or the bottom of a pier footing down to MASD.

2. Stem walls or vertical concrete cutoff walls with a potential unsupported height greater than 4 feet shall be sealed by an Arizona-registered civil engineer (structural).

3. For a utility line, determination of MASD using the method found in Section A.2 or A.3 is required when within the EHSB of a watercourse with a base flood peak discharge $\geq 2{,}000$ cfs unless a study demonstrates stability of the utility without erosion protection. For a utility in any overbank/sheetflow area , or within the EHSB of watercourse with a base flood peak discharge < 2000 cfs, the MASD may be determined using the standards of the appropriate utility authority. The utility line shall be buried so that the top of the line is below the MASD.

4. The plan extent of erosion protection shall be shown on the site plan, and shall include the portion of the building, portion of fill, or length of utility which extends into the hazard area. The site plan shall also present sufficient construction details to ensure the erosion protection is properly constructed. The site plan shall be sealed by an Arizona-registered civil engineer, along with the statement: “The building/utility/fill (choose appropriate) as designed shall be safe from erosion hazards during passage of the 1% chance flood.”

REFERENCES

City of Tucson Department of Transportation, 1989; revised 1998. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona*.

Pima County Regional Flood Control District, 2009; revised 2010. *Minimum Construction Requirements for Manufactured Home Foundations in Floodway Fringe Areas*, Technical Policy 003, Tucson AZ.

Pima County Regional Flood Control District, 2009; first revision. *Erosion Protection of Fill Pads in Floodway Fringe Areas, Technical Policy 006*, Tucson AZ

Pima County Regional Flood Control District, 2009; revised 2015. *Erosion Protection of Stem Wall Foundations in Floodway Fringe Areas*, Technical Policy 014, Tucson AZ.

Pima County Regional Flood Control District, 2011. *Engineering Analysis Requirements for Determining an Alternative Safe Eroision Hazard Setback Limit*, Technical Policy 020, Tucson AZ.

Tetra Tech, Inc., 2012. *Procedure for Determining Local Scour Depths in Overbank/Sheetflow Areas*. Pima County Regional Flood Control District.

US Department of Transportation, Federal Highway Administration. May 2001. *Evaluating Scour at Bridges, Fourth Edition*, Publication No. FHWA NHI 01-001, Hydraulic Engineering Circular No. 18.

APPROVED BY:

Suzanne Shields

Suzanne Shields, P.E.
Director and Chief Engineer

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