Computational Errors Resolved in CAP version 2021

1. CAP previously could interpolate discharge coefficients to values less than 0.88 for type 1, 2, and 3 flows at mitered culverts. CAP was revised to use a minimum discharge coefficient of 0.88 when $(h_1\text{-}z)/d < 0.4$ as indicated in figure 25 of TWRi book 3, chap. A3.
2. CAP incorrectly used r/D (rise) instead of r/b (span) to determine k_r for box culverts. CAP was revised to use r/b to determine k_r for box culverts.
3. CAP incorrectly used w/D instead of w/b to determine k_w for box culverts. CAP was revised to use w/b to determine k_w for box culverts.
4. CAP extrapolated values of k_L to less than 0.90 for $L_p/D > 0.8$. CAP was revised to use $k_L=0.90$ when $L_p/D > 0.8$ as indicated in the table on page 42 of TWRi book 3, chap. A3.
5. Computational errors could occur when certain record types were not input in a specific order for manually constructed input files. The following records (if included in the input file) must be entered in the following order (though not necessarily in series): *C1, *C5, *C3, then *CC. The CAP input produced by iRIC automatically orders these records correctly. (Note this ordering requirement is not documented in the CAP User's Guide, WRIR 98-4166.)
6. CAP did not correctly support input of the effective culvert length (as determined by the user) for non-standard culverts. CAP now accepts the effective culvert length for nonstandard culverts in the CV record when the INLET code = 2 (mitered-end culverts) in the *CC record.
7. CAP did not compute a coefficient adjustment (k_L) for culvert projection (L_p) of non-standard culverts – CAP returned k_L as -Inf and produced FAILED INTERPOLATION errors. CAP now computes the correct coefficient adjustment (k_L) based on input value of L_p for a nonstandard culvert with projecting entrance (consistent with TWRI guidance). CAP code also was modified to compute D (culvert rise) for use in determining L_p/D and k_L as described in TWRi book 3, chap. A3, p. 42.
8. Barrel properties for pipe arches can be computed by CAP based on measured corner, bottom, and/or top rounding radii. CAP uses regression equations to compute radii that were determined based on known pipe-arch designs when all radii are not explicitly input. Previous versions of CAP had errors in some of the regression equations that resulted in computation of incorrect barrel dimensions. The erroneous regression equations were corrected. See additional guidance for analyzing pipe-arch culverts in the document titled CAP_2021_version_notes.pdf.
9. TWRi book 3, chap. A3 (p. 42, 43, and 44) specifies that no projection adjustment (k_L) should be made for beveled-end concrete pipes with projecting entrance. Previous versions of CAP incorrectly facilitated an adjustment by allowing specification of concrete-pipe projection on the *CC record. CAP was modified so that the projection adjustment factor gets set to 1.0 anytime the culvert is identified as a concrete pipe (i.e., a material code of 1). A projection adjustment of 1.0 will be used and reported for concrete pipes even if L_p is specified on the *CC record.

Additions to CAP in version 2021

1. The ability to compute barrel properties based on measured radii was added for non-plate corrugated metal pipe-arch culverts. Non-plate corrugated metal pipe-arch culverts are specified as a material code of 7 on the CG record.
2. A warning message is printed if the radii entered for a pipe-arch culvert result in computed radii that are outside the range of values in the regression-equation calibration data set. While the check will catch some errors, it is still possible that computed barrel dimensions can be inaccurate if the pipe arch has been deformed from industry-standard dimensions. Pipe arches that don't conform to industry-standard dimensions should be analyzed using a shape code I=4 (non-standard shape), which requires that the culvert geometry be measured and entered as x-y point coordinates.
3. A clarification message was added to the CAP output to alert the user that discharge coefficients were increased if the contraction ratio (m) was <0.80 for types 1-3 flow, as described in TWRi book 3, chap. A3, fig. 19, p. 38. CAP does not output computed contraction ratios.