

Attachment 1 Detailed Documentation on Updating CalSim Inputs to SIT DSMs (v2019 – i.e., Peterson and Duarte 2020) from CalSim II to CalSim 3

We summarize the conversions from CalSim II to CalSim 3 for all updated flow inputs to the v2019 Science Integration Team (SIT) Decision Support Models (DSMs) (i.e., Peterson and Duarte 2020) in the sections below, in which each section is a different data object, typically contained within the repositories *cvpiaData* (<https://github.com/FlowWest/cvpiaData>) or *cvpiaFlow* (<https://github.com/FlowWest/cvpiaFlow>). The conversions were made in close consultation with the Bureau of Reclamation Bay-Delta Office’s Modeling Division, which is responsible for developing and applying CalSim 3 (C. Koizumi, personal comm.). For additional details, refer to the R script ‘DSS workflow_cvpiaFlow_clean_CalSim3.R’, which generates modified data inputs to the SIT DSM from raw CalSim 3 outputs, or the supplemental Excel file ‘CalSim Mapping Document_2.28.23.xlsx’, which presents expected relationships between individual CalSim II and CalSim 3 variables. If inputs are not listed or described here, no change was required going from CalSim II to 3.

1.1 Flow Inputs

1.1.1 *dlt_divers_tot*: Total diverted of delta inflow in cms from 1980-2000.

The following is a comparison of CalSim II and CalSim 3 variables and calculations for total diversions in the North and South Sacramento–San Joaquin Delta (Delta).

- CalSim II:
 - North Delta: D403A + D403B + D403C + D403D + D404
 - South Delta: D418 + D419 + D412 + D410 + D413 + D409B + D416 + D408_OR + D408_VC
- CalSim 3:
 - North Delta: C_CSL004B + DD_SAC017_SACS
 - South Delta: D_OMR028_DMC000 + D_OMR027_CAA000 + DD_SJR026_SJRE + DD_SJR013_SJRW + DD_MOK004_MOK +

DD_OMR027_OMR + D_RSL004_CCC004 + D_OMR021_ORP000 +
D_VCT002_ORP000

- Important caveats or concerns:
 - There is a meaningful difference in how North Delta diversions are handled between CalSim II and 3. Replacing D404 with DD_SAC017_SACS adds ~200 TAF annually due to differences in assumptions regarding consumptive use.

1.1.2 ***dlt_inflow*: Delta inflow in cms from 1980-2000.**

The following is a comparison of CalSim II and CalSim 3 variables and calculations for inflow to the North and South Delta.

- CalSim II:
 - North Delta: C400 + C157
 - South Delta: C401B + C504 + C508 + C644
- CalSim 3:
 - North Delta: C_SAC041 + C_CSL005
 - South Delta: C_SAC029B + D_SAC030_MOK014 + C_MOK022 + C_CLV004 + C_SJR056
- Important caveats or concerns:
 - None

The *dlt_inflow* and *dlt_divers_tot* objects are used in conjunction to calculate the *dlt_divers* object, which represents the proportion of Delta diversions relative to inflow.

1.1.3 ***flows_cfs*: Average monthly flows in all 31 modeled watersheds from 1980-2000**

- CalSim II:
 - Upper Sacramento River: C104
 - Antelope Creek: C11307
 - Battle Creek: C10803
 - Bear Creek: C11001
 - Big Chico Creek: C11501
 - Butte Creek: C217A
 - Clear Creek: C3
 - Cottonwood Creek: C10802

- Cow Creek: C10801
- Deer Creek: C11309
- Elder Creek: C11303
- Mill Creek: C11308
- Paynes Creek: C11001
- Stony Creek: C142A
- Thomes Creek: C11304
- Upper-mid Sacramento River: C115
- Bear River: C285
- Feather River: C203
- Yuba River: C230
- Lower-mid Sacramento River: $C134*35.6/58 + C160*22.4/58$
- American River: C9
- Lower Sacramento River: C166
- Calaveras River: C92
- Cosumnes River: C501
- Mokelumne River: *NA*
- Merced River: C561
- Stanislaus River: C520
- Tuolumne River: C540
- San Joaquin River: C630
- CalSim 3:
 - Upper Sacramento River: C_SAC273
 - Antelope Creek: C_ANT010
 - Battle Creek: C_BTL006
 - Bear Creek: C_BCN005
 - Big Chico Creek: C_BCC004
 - Butte Creek: C_BTC012

- Clear Creek: C_CLR009
- Cottonwood Creek: C_CWD003
- Cow Creek: C_COW003
- Deer Creek: C_DRC005
- Elder Creek: C_ELD005
- Mill Creek: C_MLC004
- Paynes Creek: C_PYN001
- Stony Creek: C_STN004
- Thomes Creek: C_THM005
- Upper-mid Sacramento River: C_SAC193
- Bear River: C_CMPFW
- Feather River: C_FTR059
- Yuba River: C_YUB002
- Lower-mid Sacramento River: $C_SAC093*35.6/58 + C_SAC048*22.4/58$
- American River: C_NTOMA
- Lower Sacramento River: C_SAC063
- Calaveras River: C_NHGAN
- Cosumnes River: C_CSM005
- Mokelumne River: C_CMCHE
- Merced River: C_MCD050
- Stanislaus River: C_STS059
- Tuolumne River: C_TUO054
- San Joaquin River: C_SJR081
- Important caveats or concerns:
 - In CalSim II, the same variable (C11001) previously included both Bear Creek and Paynes Creek. In Calsim 3, the two watersheds have unique flow values.
 - CalSim 3 includes flow values for the Mokelumne River.
 - For several tributaries near the Upper Sacramento River (e.g., Deer Creek, Thomes Creek, Antelope Creek, Mill Creek, Big Chico Creek, Cow Creek,

Cottonwood Creek, Battle Creek), there are new Surface Runoff terms included in CalSim 3 that are not present in CalSim II and could influence flow values.

The *flows_cfs* object is used to calculate both the expected intra-annual variability in flow, or *prop.pulse* (i.e., as a proxy for pulse flow effects), and the flow signal for returning adults as a determinant of straying rates, or *returnQ*.

1.1.4 *upsac_flow*: Flow at Bend Bridge in cms from 1980-2000.

- CalSim II:
 - C109
- CalSim 3:
 - C_SAC257
- Important caveats or concerns:
 - None

1.1.5 *freeportQcms*: Inflow at Freeport in cms from 1980-2000.

- CalSim II:
 - C400
- CalSim 3:
 - C_SAC041
- Important caveats or concerns:
 - None

1.1.6 *Q_vern*: Flow in cms at Vernalis from 1980-1999.

- CalSim II:
 - C639
- CalSim 3:
 - C_SJR070
- Important caveats or concerns:
 - None

1.1.7 *Q_stck*: Flow in cms at Stockton from 1980-1999.

- CalSim II:
 - C417A
- CalSim 3:

- C_SJR053A
- Important caveats or concerns:
 - None

1.1.8 CVP_exp: Total exports for the Central Valley Project (CVP) in cms.

- CalSim II:
 - DEL_CVP_TOTAL
- CalSim 3:
 - DEL_CVP_TOTAL_N + DEL_CVP_TOTAL_s
- Important caveats or concerns:
 - Recommend replacing previous variables from both CalSim II and CalSim 3 with D418 (CalSim II) and D_OMR028_DMC000 (CalSim 3) to reflect realized diversions from the Jones pumping facility (C. Koizumi, personal comm.).

1.1.9 SWP_exp: Total exports for the State Water Project (SWP) in cms.

- CalSim II:
 - DEL_SWP_TOTAL
- CalSim 3:
 - DEL_SWP_PMI + DEL_SWP_PAG + DEL_SWP_PIN
- Important caveats or concerns:
 - Recommend replacing previous variables from both CalSim II and CalSim 3 with D419 (CalSim II) and D_OMR027_CAA000 (CalSim 3) to reflect realized diversions from the Banks pumping facility (C. Koizumi, personal comm.).

1.1.10 prop_diversion: Proportion of flow diverted for each watershed every month of every year in the simulation (1980-200).

- CalSim II:
 - Upper Sacramento River: $D104 / C104$
 - Antelope Creek: $(C11307 / (C11307 + C11308 + C11309) * D11305) / C11307$
 - Battle Creek: NA
 - Bear Creek: NA
 - Big Chico Creek: NA
 - Butte Creek: $(C217B + D217) / (C217B + D217 + C217A)$

- Clear Creek: *NA*
- Cottonwood Creek: *NA*
- Cow Creek: *NA*
- Deer Creek: $(C11309 / (C11307 + C11308 + C11309) * D11305) / C11309$
- Elder Creek: $(C11303 / (C11303 + C11304) * D11301) / C11303$
- Mill Creek: $(C11308 / (C11307 + C11308 + C11309) * D11305) / C11308$
- Paynes Creek: *NA*
- Stony Creek: $D17301 / C41$
- Thomes Creek: $(C11304 / (C11303 + C11304) * D11301) / C11304$
- Upper-mid Sacramento River: $(D109 + D112 + D113A + D113B + D114 + D118 + D122A + D122B + D123 + D124A + D128_WTS + D128) / C110$
- Bear River: $D285 / (C285 + D285)$
- Feather River: $(D201 + D202 + D7A + D7B) / C6$
- Yuba River: $D230 / (C230 + D230)$
- Lower-mid Sacramento River: $(D129A + D134 + D162 + D165) / C128$
- American River: $D302 / C9$
- Lower Sacramento River: $(D167 + D168 + D168A_WTS) / C166$
- Calaveras River: $(D506A + D506B + D506C + D507) / C92$
- Cosumnes River: *NA*
- Mokelumne River: *NA*
- Merced River: $(D562 + D566) / C561$
- Stanislaus River: $D528 / C520$
- Tuolumne River: $D545 / C540$
- San Joaquin River: $(D637 + D630B + D630A + D620B) / (D637 + D630B + D630A + D620B + C637)$
- CalSim 3:
 - Upper Sacramento River: $(D_SAC296_WTPFTH + D_SAC296_02_SA + D_SAC294_WTPBLV + D_SAC294_03_PA + D_SAC289_03_PA + D_SAC281_02_NA + D_SAC273_03_NA) / C_SAC273$
 - Antelope Creek: $D_ANT010_05_NA / C_ANT010$

- Battle Creek: *NA*
- Bear Creek: *NA*
- Big Chico Creek: *NA*
- Butte Creek: $(D_BTC045_ESL008 + D_BTC043_10_NA + D_BTC036_10_NA + DBTC012_09_SA2 + D_BTC012_CRK005) / (D_BTC045_ESL008 + D_BTC043_10_NA + D_BTC036_10_NA + DBTC012_09_SA2 + D_BTC012_CRK005 + C_BTC012)$
- Clear Creek: *NA*
- Cottonwood Creek: *NA*
- Cow Creek: *NA*
- Deer Creek: $(D_DRC010_05_NA + D_DRC005_05_NA) / C_DRC005$
- Elder Creek: $D_ELD012_04_NA / C_ELD005$
- Mill Creek: $D_MLC006_05_NA / C_MLC004$
- Paynes Creek: *NA*
- Stony Creek: $D_STN021_06_PA / C_STN026$
- Thomes Creek: $D_THM012_04_NA / C_THM005$
- Upper-mid Sacramento River: $(D_SAC240_TCC001 + D_SAC240_05_NA + D_SAC224_04_NA + D_SAC196_MTC000 + D_SAC185_08N_NA + D_SAC185_09_NA + D_SAC178_08N_SA1 + D_SAC162_09_SA2 + D_SAC159_08S_SA1 + D_SAC159_08N_SA1 + D_SAC146_08S_NA1 + D_SAC136_18_NA + D_SAC136_18_SA + D_SAC129_08S_NA2 + D_SAC122_19_SA) / C_SAC247$
- Bear River: $D_BRR017_23_NA / C_CMPFW$
- Feather River: $(D_THRMF_12_NU1 + D_THRMF_11_NU1 + D_THRMA_WEC000 + D_THRMA_RVC000 + D_THRMA_JBC000) / C_OROVL$
- Yuba River: $D_YUB011_15S_NA2 / (D_YUB011_15S_NA2 + C_YUB002)$
- Lower-mid Sacramento River: $(D_SAC121_08S_SA3 + D_SAC115_19_SA + D_SAC109_08S_SA3 + D_SAC109_19_SA + D_SAC099_19_SA + D_SAC091_19_SA + D_SAC083_21_SA + D_SAC082_22_SA1 + D_SAC081_21_NA + D_SAC078_22_SA1 + D_SAC075_22_NA + D_SAC074_21_SA + D_SAC065_WTPBTB) / C_SAC120$
- American River: $D_AMR007_WTPFBN / C_NTOMA$

- Lower Sacramento River: $(D_SAC050_FPT013 + D_SAC062_WTPSAC) / C_SAC120$
- Calaveras River: $(D_LJC022_60S_PA1 + D_CLV037_CACWD + D_CLV026_60S_PA1 + D_CLV026_WTPWDH) / C_NHGAN$
- Cosumnes River: *NA*
- Mokelumne River: $(D_MOK050_60N_NA3 + D_MOK050_60N_NA5 + D_MOK039_60N_NA5 + D_MOK035_60N_NA4 + D_MOK035_60N_NU1 + D_MOK035_WTPDWS + D_MOK033_60N_NA5) / C_CMCHE$
- Merced River: $(D_MC042_63_NA2 + D_MCD021_63_NA4) / C_MCD050$
- Stanislaus River: $(D_STS030_61_NA4 + D_STS004_61_NA6) / C_STS059$
- Tuolumne River: $(D_TUO047_61_NA3 + D_TUO047_62_NA4 + D_TUO015_61_NA3 + D_TUO015_62_NA4) / C_TUO054$
- San Joaquin River: $(D_SJR062_50_PA1 + D_SJR090_71_NA2 + D_SJR081_61_NA5 + D_SJR116_72_NA1) / (D_SJR062_50_PA1 + D_SJR090_71_NA2 + D_SJR081_61_NA5 + D_SJR116_72_NA1 + C_SJR072)$
- Important caveats or concerns:
 - Watersheds with *NA* are assumed to have no diversions.
 - Some of the diversion terms in CalSim II corresponded to ‘Depletion’ terms that have no direct analogue in CalSim 3 (i.e., CalSim 3 uses ‘Closure-Terms’ that aggregate both accretion and depletion influences). These flow variables are therefore not accounted for in the CalSim 3 conversion.
 - In CalSim II, diversions for Antelope Creek, Deer Creek, Elder Creek, Mill Creek, and Thomes Creek were calculated by partitioning aggregate, multi-watershed diversion terms based on watershed-specific flows. Some of these aggregate diversion terms also encompassed diversions from the Sacramento River. This partitioning is not necessary in CalSim 3 due to finer resolution in diversion terms.
 - CalSim 3 includes flow and diversion values for the Mokelumne River.
 - We used CalSim II diversion variables for the four watershed regions along the Sacramento River to identify functional splits among regions, and then identified CalSim 3 diversion terms for each region based on these splits.

The numerator for each watershed, in orange, was used to calculate the total diversions for each watershed every month of every year, or *total_diversion*.

1.1.11 *bypass_prop_Q*: Proportion of Lower Sacramento River flow at each bypass weir.

- CalSim II:

- Sutter Bypass: $D117 / C116$
- Yolo Bypass: $D160 / (D160 + C160)$
- CalSim 3:
 - Sutter Bypass: $(SP_SAC193_BTC003 + SP_SAC188_BTC003 + SP_SAC178_BTC003) / C_SAC195$
 - Yolo Bypass: $SP_SAC083_YBP037 / (SP_SAC083_YBP037 + C_SAC048)$
- Notes:
 - A potentially better characterization of proportional flow diverted into the Sutter Bypass, and the characterization that is used in more recent versions of the SIT DSMs (e.g., v2021, v2023) is expressed in CalSim II and CalSim 3 as the following:
 - CalSim II: $(D117 + D124 + D125 + D126) / C116$
 - CalSim 3: $(SP_SAC193_BTC003 + SP_SAC188_BTC003 + SP_SAC178_BTC003 + SP_SAC159_BTC003 + SP_SAC148_BTC003 + SP_SAC122_SBP021) / C_SAC195$
 - The conversion of C116 to C_SAC195 CalSim 3 represents the best judgment of the Modeling Division.

1.1.12 *bypass_over*: Binary (yes/no) monthly record of the bypasses over topped

- CalSim II:
 - Sutter Bypass: TRUE if $(D117 + D124 + D125 + D126 + C137) \geq 100$
 - Yolo Bypass: TRUE if $(D160 + C157) \geq 100$
- CalSim 3:
 - Sutter Bypass: TRUE if $(SP_SAC193_BTC003 + SP_SAC188_BTC003 + SP_SAC178_BTC003 + SP_SAC159_BTC003 + SP_SAC148_BTC003 + SP_SAC122_SBP021 + C_SSL001) \geq 100$
 - Yolo Bypass: TRUE if $(SP_SAC083_YBP037 + C_CSL005) \geq 100$
- Notes:
 - The conversion of C137 in CalSim II to a CalSim 3 equivalent is problematic, as CalSim 3 changes the number and nature of connections among the Sacramento River, Sutter Bypass, Feather River, and Butte Creek. In fact, the best proposed replacement variable (C_SSL001) results in constant overtopping of Sutter Bypass in the model with the current flow threshold of 100 cfs.
 - Modeling also questions why C137 is included in the flow threshold in the first place, as the diversions terms should be sufficient by themselves.

1.2 References

Peterson, J. D., and A. Duarte. 2020. Decision analysis for greater insights into the development and evaluation of Chinook salmon restoration strategies in California's Central Valley. *Restoration Ecology* 28(6):1596–1609.

C. Koizumi, personal comm.