APPENDIX J

DETAILED PROCESSING DESCRIPTION FOR THE SFWMM V5.5

The following outline shows the sequence of computations used in the South Florida Water Management Model. Related subroutines and functions are given below each major model task. A brief description of all subroutines is also given at the end of this section. Some key points needed in interpreting the SFWMM's program structure are:

1. The model runs on a fixed time step of one day and a fixed grid size of 2 miles by 2 miles and is CPU-intensive. The simulation period ranges from a minimum of one entire month to a maximum of 36 years. Local phenomena, such as delineation of floodplains or groundwater cones of depression, are beyond the degree of resolution provided by the model. The overland flow algorithm uses a smaller time-step in order to maintain model stability. Refer to Section 2.4 for more details.

2. Hydrologic processes are simulated independently within a single time step. The management routines are interconnected with the hydrologic components as necessary within the two time loops (monthly and daily). The need to simulate feedback between related processes during the day, e.g. surface and subsurface processes, is minimized by arranging the sequence of calculations from more transient processes such as infiltration, to fairly static processes such as groundwater flow. This scheme is beneficial in two ways: (1) model execution time is reduced compared to algorithms that involve more complex (iterative) schemes; and (2) debugging can be isolated to specific subroutines or functions.

Detailed Model Process Description:

GETENV.F

- Check for existence of environment variable that sets the data directory path for output files to be stored in.
- If environment variable is not set prior to execution of the model, the current directory is assumed to be the path for output.

OPEN_INPUT_DATA_FILES.F

- Opens FC=51; reads file list (ALTWMM); cleans local files using *REMOVE_COMM_INP_FILES.F*.

GEN_MODEL_RUN_DEF_PARAM.F

- Input run definition parameters.

GEN_MODEL_DEF_PARAM_DATA.F

- Input general definition data for areas (EAA, WCAs). Reads:
    - MODEL_DEFINITION_INFO.DAT (2) See Note.
    - EAA_CANAL_PROFILES_V2.2 (13)
    - MAX_GO_TBL (15)
    - CANAL_GRID_LOC.DAT (23)
    - STAGE_IMPORT_SPECS.DAT (105)

NOTE: (xx) where xx = file code number set in the model code.

LEC_ET_INITIAL_READ.F

- Sets up reading grid_io. Reads:
    - /INPUT/COMMON/DAILY_ET_INPUT.BIN (16)

    - /INPUT/COMMON/DAILY_NIRRDMD.BIN (08)

MAP_LEC_NODE_TO_MODEL.F
- Transforms the indices of a model 1-D array to an LEC developed area 1-D array.
- This routine checks to see if a model node is in the LEC developed area. If so, then the model node number is mapped to the LEC node.
- Array model_node_in_lec contains the model node number associated with each LEC node.
    - lec_node = isum_lec(y) – min_x_lec(y) + x + 1
    - model_node_in_lec(lec_node) = model_node
- Array lec_node_in_model contains the LEC node number for each model node.
- NOTE: This is only used in the *LEC_ET_INITIAL_READ.F*. This is used to notify the model which model nodes are LEC nodes.

OPER_SCHED_DATA.F
- Operations schedule for LOK, WCAs, Holey Land WMA, and Rotenberger WMA. Reads:
    - LOK_WCA_OPER_SCHED.DAT (102)

RESERV_INPUT_DATA.F
- Physical and operational data for LOK outlet structures. Reads:
    - RESERVOIR_INPUT.DAT (103)
    - RESERV_GRID_LOC.DAT (145)

LOK_O_WCA_IN_STRUC_DTA.F
- Input structures to be simulated explicitly. Reads:
    - GEN_NODAL_DEP_STRUC.DAT (103)

WCAS_INPUT_DATA.F
- WCA names, initial stages, basin number, option for rain driven operations. Reads:
    - WCA_OUT_STRUC_SPECS.DAT (21)
    - WEIR_SPECS.DAT (133)

ASR_INPUT.F
- Parameter for each ASR bubble; canal, reservoir, and EAA basin source and destination. Includes grid cell in source/destination type and column and row for source/destination number. Reads:
    - ASRINPUT.DAT

OPEN INPUT and OUTPUT FILES
- *OPEN_ASCII_OUTPUT_FILES.F* - Basin/Reservoir/ASR/CNL budget components; inflow to STAs; Caloosahatchee and St. Lucie components; set up minimum flows and levels.
- *GRID_CELL_BASED_DATA.F* - Grid data from STATDTA; elevation, storage coefficient, etc. Reads:

    - Input file Etp_WEIGHTS_17STN_TIN_.DAT (12)
    - Output file RESTART_OUTPUT (55)
    - Input file STATIC_GRID_VALUES.DAT (60)
- *OPEN_BINARY_OUTPUT_FILES.F* - Opens RF, ET, ponding, GW, etc monthly or daily [based on lp flags].
- Position input files or set up for loop parameters. Reads the following input files:
    - WELL_PUMPAGE_061303_ASR.DAT (18)
    - ETP_1965-2000_17stn_plsLOK_Kr.DAT (28)
    - MONTHLY_LOK_ET_RF_1965-2000.DAT (36)
    - SRS_RF_PLAN_RF_ET.DAT (59)
    - IMPORT.EAA_VERIF_2000_1 (83)
    - NUM_TROP_STORM.DAT (108)
    - CLIM_ANN_INDEX2.DAT (109)
    - WEEKLY_EXCESS2_65_S65EINT.DAT (134)
    - MULTI_SEAS_INDEX_65_00.DAT (135)
    - PDSI_14_00.DAT (148)

CNLDATA.F

- Data for each canal and corresponding outlet structure; storm drawdown; known flow specifications, levee specifications to canal levee seepage, reservoir operations drawdown; dual operations. Reads:
    - CANAL_STRUC_SPECS.DAT (11)
    - KNOWN_FLOW_ROUTE_SPECS.DAT (22)
    - RESTART_OUTPUT (55)
    - LEVEE_SPG_INPUT.DAT (104)
    - DRAWDOWN.DAT (136)
    - STORMS.DAT (137)
    - RES_OPS_DRAWDOWN (No data is in this file) (147)
    - DUAL_OPS.DAT (157)

TRIGGER_INPUT.F

- Read cutbacks for PWS and individual wells as a fraction of total required. Reads:
    - TRGINPUT.DAT(94)

INITIALIZE (*INIT.F*)

- Structure and canal indices, node locations, BSN ID number, service area ID number, etc.
- Initialize volume of water for each reservoir.
- Initialize volume of water STAs can receive. Remains 0 through the simulation if no STAs exist.
- Initialize reference LOK stage array for pulse releases from LOK to Caloosahatchee and St. Lucie.
- Sets up node name identifiers.
- Matches up structure names with model variable names.
- Initializes all node based variables.
- Initialize basin logicals.

- Sets up data to be used by get_tide function. Mean sea level for 7 stations – monthly tide info. Flamingo, mainky, virgkey, hollywd, delray, pbeach, stuart.

MAIN

- Monthly loop process. Sets the year.

MAIN – month loop initialization

- Reinitialize elevation, ponding, EAA maximum soil moisture for each node. Any changes made in the previous time step are reset.
- Zero out sum rain, area adjustments, daily outflow parameters; recalculate stage_res, pond_in_res, outflow parameters, and lpump/lgrav/lpumpf logicals for each substructure based on the reinitialized H, POND, POND_IN_RES, and ELLS_IN_RES. NOTE: lpump/lpumpf =hw >rmnstg; rmxstg =stage, in ft NGVD, at downstream end of canal the gates (spillways and gated culverts) are closed for flood control purposes. For pumps, stage pumps are turned off for flood control purposes.

LARGER_RESERV_STOR.F
SMALL_RES_STOR.F

- Calculate available storage for flow into reservoirs for next time step.
- Based on small (treat as a separate entity) or large reservoir;
- Large reservoir = sfactor(ia).GE.sfactmin .OR. ires_small_sim=NO'
- Both routines will be processed after computing discharges for LOK outflow structures to meet EAA demand and for inlet structures to WCAs. This is used in computing volume of demand to maintain STAs at minimum level for environmental purposes.

HIST_LOK_BNDRY_INPUT_DATA.F

- This history file is only used for calibration. Extracts history boundary conditions and MDS; S-65E, TCNS, FLP reservoirs flows.
- Also includes demands of Seminole Indians on north side of LOK.
- Also selects one year of monthly ET and RF data for LOK.
- Reads:
    - MONTHLY_LOK_ET_RF_1965-2000.DAT

LOK_BNDRY_INPUT_DATA.F

- Used only for simulation and includes climate variables for LOK operations, WSE schedule, flow into reservoirs using BMP makeup water rules, estuary demands, etc. Reads:
    - MONTHLY_LOK_ET_RF_1965-2000.DAT(36)
    - NUM_TROP_STORM.DAT(108)
    - CLIM_ANN_INDEX2.DAT(109)
    - MULTI_SEAS_INDEX_65_00.DAT(135)
    - PDSI_14_00.DAT(148)
- Read in MDS, S-65E (s65ernff) into LOK, TCNS flows, basin demand/runoff(see below), St. Lucie tributary flows, BMP makeup water, flows to FLP reservoir, Seminole

Indian demand on north side of LOK, rainfall driven SRS current base demand, estuarine demands, C43/C44 basin rainfall applied to detention basin/reservoir option, No. storage reservoir RF applied to detention basin/reservoir option, Seminole Indian agricultural demand in BCNP, runoff reduction due to BMPs for major EAA basins. NOTES: S65ERNFF= Boundary flows/runoff adjusted for increase/decrease in rainfall using ro_factor(imo). Read in 8 different basins based on DMDRONM - define B part of DSS pathname for the dmnd/ro file:
    - dmdronm(1)='STLUCIE'
    - dmdronm(2)='CALOOS'
    - dmdronm(3)='ISTOKPBB'
    - dmdronm(4)='S4DISTON'
    - dmdronm(5)='S4OTHER'
    - dmdronm(6)='NLKSHORE'
    - dmdronm(7)='NELKSHORE'
    - dmdronm(8)='ISTOKPAB'
- Adjust boundary flows/runoff (kflo0-adjusted by ro_factor) for increase/decrease in rainfall. NOTE: RO_FACTOR=multiplier for runoff from basins not in model domain (boundary flows) for January-December (2). KFLO(max_n_struc_flw) - Calculate flows for each structure in [*LAKE_REQ_WCA.F* and *LAKE_NONREG_WCA.F*]. Sets the flows for given period day in [*AGAREA.F*]. This is the inflow from DSS file. Then *STRUC_LOK_IN_WCA_FLW.F* calculates kflo using either general or specific code.
- Read in one year of monthly ET and RF for LOK.
- Try to meet NLS demand with TCNS flow.
- This is where the flows for each structure are set up as KFLO0 (see FLNM=MASTER LIST of names of structures)

ACCUM_ESTUAR_DMNDS.F

- Calculations only occur if es_dmnd_acc_freq NE 'DLY'
- Routine will only process basin RO and estuary demand if caloos(simcaes) and stlucie(simsles) options are invoked. See below.
- Accumulate estuarine demands and calculate LOK supplemental release and maximum backflow capacity for all months of current year.
- Set up monthly estuarine demands and RO used to determine LOK supplemental release for the C43/C44 basins based on simsles and simcaes options - options to have St. Lucie and Caloosahatchee Estuary demand. Currently, the input data to the model has options turned off. NOTE: SIMCAES = options to have Caloosahatchee Estuary demands(YES or NO) data=NO; SIMSLES = option to have ST. Lucie Estuary Demands(YES or NO) data=NO

MUNIC_WELL_PUMP_SETUP.F

- Input municipal and industrial- residential self supplied withdrawals and set up necessary arrays. Reads:
    - WELL_PUMPAGE_061303_ASR.DAT (18)
    - WELL_IND_RSS_2000BASE.DAT(37)

- Read in each year’s pumpage figures. Note if multiplier of municipal wellfield pumps are not supplied then warning is printed and multiplier is set to 1.0. This multiplier is processed with (PUMP). Average pumpage, by month, for each well (MGD).

SIMCSTG2DSS.F

- Stores (CNLSTAGE) regular interval time series data (ZSRTS) - writes daily simulated canal stages into output DSS file ‘CANAL.DSS‘. If pathnames already exist then it writes over them.
- This process only occurs in the first month of the first simulated year. All it does here is just initialize CNLSTAGE array.
- Afterwards: CNLSTAGE{canal stage} is initialized for each day and for each structure.
- This routine is processed at the end of the monthly simulation loop **-** after *SUM_TRIG_HEADS.F*.

SIMQ2DSS.F

- Stores (STRFLW) in regular interval time series data (ZSRTS)– writes daily simulated structure discharges into output DSS file 'STR2X2.DSS‘ - will overwrite existing file.
- This process only occurs in the first month of the first simulated year. All it does here is just initialize STRFLW array.
- Afterwards: STRFLW{structure flow points} is initialized for each day and for each structure.
- This routine is processed at the end of the monthly simulation loop **-** after *SUM_TRIG_HEADS.F*.

ANNUAL_INIT.F

- Initialize variables that are accumulated annually.
- Only initializes overflow variables for each node for given year.
- This process only occurs in the first month of each simulated year - initializes yearly information.

MTHLY_VARIABLES_INIT.F

- Initialize variables that are accumulated monthly.
- If LP(20)=[print monthly volumes of surface and groundwater that flows to neighboring nodes to the east and to the south] THEN OVLFLO calculation in [*OVLNF.F*] and HMVOL calculation in [*GWF.F*] are initialized.
- DRYSEAS and HURRPRED indexes are set. ET, RAINFALL, and WELL counters are set to 0. [ETM; RFM; WELLS].
- Mimic operations of S-39 to maintain lower water levels in northern Broward County in 1989 and 1990 (only for calibration run).
- Account for hurricane Andrew in temporary change in landscape.
    - o August 1992 - May 1994 (nodes 12-30 – for land use types 17/18/21/23) – use 40 % of A and b coefficients for overland flow (node-to-node); minimum resistivity for each land use = 0.2; - ponding depth (ft) to be considered open water = 2.5.

- Initialize PWS monthly arrays. Sets demand_month_pws=unadjusted pumpage totals over all wells. NOTE: pumpage for industrial and self_supplied wells are assumed not to be subject to cutbacks.

RAIN_PET_SETUP.F

- Input data and set up RF and PET arrays. Map RF array for NSM model into SFWMM grid network.
- Sets up rainfall array after reading in rain_nsm from daily rainfall binary file. Reads in one month of daily rainfall data to calculate monthly sum (used later for ET reductions).
- Reads (FC=28) in daily Penman-Monteith PET (reference to grass) for each day for each of the seventeen ET basins into petstn array. Daily reference ET for the seventeen weather stations used to assign reference ET for each grid cell in the model. Reads:
    - ETP_1965-2000_17stn_plsLOK_Kr.DAT (28)
- Calculate reference ET for each node (potet array) based on petstn(j)*weights(node,etzon). POTET data summed monthly to be used later for ET reductions.
- Set up c43pet, c44pet, and norstorpet variables using petstn(1). All uses input from the first station.

MTHLY_UNSAT_ET_IRR_COMP.F

- Only if use_lec_et > 0.
- Using *LEC_ET_TIME_SERIES_READ.F*
    - Reads time series data for file DAILY_NIRRDMD_V2.2.BIN in GRID_IO format to be used in LEC (NOTE: Changes with project or version).
    - Reads one month of daily ETU components and net irrigation demands.
        - [ET_POTEN] - LEC potential evapotranspiration
        - [ET_UNSAT] - LEC unsaturated zone evapotranspiration for entire cell
        - [ET_UNSAT_IRR] - LEC unsaturated zone evapotranspiration irrigation only for each cell.
        - [NET_IRR(1,TYPE))] - net irrigation demands for each use type
    - Reads three ET components - pet, etu, etui.
    - Reads six net irrigation components - landscape, nursery, golf, ag_lowvol, ag_overhd, ag_other.
    - Uses *MAP_LEC_ARRAY_TO_MODEL.F* to map et_poten_lec->et_poten ; et_unsat_lec->et_unsat ; et_unsat_lec->et_unsat_irr
- Compute monthly sums for ONLY the net irrigation demands and the unsaturated zone ET for irrigation areas. The monthly net irrigation demands and et_unsat_irr are needed for computing reductions in ET via the est_etiu function, as follows:
    - EST_ETIU FUNCTION Returns estimate of monthly unsaturated zone et for 1-6 irrigated use types using regression coeff(AFSIRS) - returns an estimate of monthly unsaturated zone et (1-6) irrigation use types (urban landscape, nursery, golf course, ag-low volume, ag-overhead, and ag-other) for LECSAs.
    - This equation mimics the AFSIRS model and is used primary to compute the reduction in unsaturated zone ET resulting from a water shortage.

- The monthly sums for the actual ET, supply components, etc. will be computed and written to binary via *LEC_ET_SUM_MONTHLIES.F*.
- Set supply_month = net_irr_month IF the trigger module is off or IF no cutbacks are imposed for this month ELSE it will be set after *REDUCE_WELLQ.F* is called. *REDUCE_WELLQ.F* subroutine:
    - Computes public water supplies and shortages.
    - For public water supply, applies reduction factor to wells affected by water restriction.
    - For each irrigation use, returns a maximum application rate to grid cells affected by water restriction.
    - If lec_et.cf is used then compute irrigation supplies and shortages. For situations where a well is in more than one zone and cutbacks are set for each zone and cutbacks may be different values.
    - Called by *LEC_PWS_IRRIG.F* to reduce public water supply pumpage if trigger module is to be used and if LEC water restrictions are in effect for the current month.

MAP_LEC_ARRAY_TO_MODEL.F

- Used in *LEC_ET_TIME_SERIES_READ.F*. Sets model_array(model_node) = lec_array(lec_node).
- Transforms the indices of an LEC developed area 1-D array to a model 1-D array, and converts the units from inches to feet. Uses input from DAILY_ET_INPUT_V2.2.BIN and loads into lec_array and resets input into model node array.
- This is set in *MAP_LEC_NODE_TO_MODEL.F* model_node=model_node_in_lec(lec_node)
- Used in *GW_RCHG_UPDATE.F, LEC_ET_SET_CUTBACKS.F,* and *LEC_PWS_IRRIG.F*

LEC_PWS_IRRIG.F

- Only if use_lec_et>0
- Compute monthly ET and irrigation supplies and shortages in LEC developed areas using output from AFSIRS [AGRICULTURE FIELD-SCALE IRRIGATION REQUIREMENTS SIMULATION] for current month.
- Call REDUCE_WELLQ to reduce water supply pumpage if trigger module is being used and water restrictions are in effect for current month [USE_TRIGGER>=1 & LEC_RESTRICTIONS='T']. NOTE: For LEC_RESTRICTIONS if cutbacks are imposed for a given month then set to TRUE. If any zone requires cutbacks: IF(cutb_phase(zone) > 0) lec-restrictions = TRUE [in *TRG.F*].If the head is less than the trigger value for a given phase we have a violation for that phase. Store that phase in array CUTB_PHASE. Subroutine *SET_CUTBACK.F* computes which zones require pumping cutbacks. When cutback switches are set, subroutine *REDUCE_WELLQ.F* sets fraction of input pumping [fract_wellq]. cutb_phase = 0 means that no cutbacks are necessary.
- Compute monthly ETIU _UNRESTR, ETIU_RESTR, PWS and shortage as well as update well pumpage array in LEC developed areas. Shortage will be based on pumpage reduction from *REDUCE_WELLQ.F*. NOTE: For

ETIU_UNRESTR/ETIU_RESTR(max_ncells.max_n_type) if there is a shortage for current irrigation use types then compute estimated reduction in unsaturated zone using regression equations developed to mimic AFSIRS. This is unsaturated zone ET assuming no water and water restrictions imposed on the LEC for each irrigation use type.

- If there is a shortage for the current irrigation use type then compute the estimated reduction in unsaturated zone ET using regression equations developed to mimic AFSIRS.
- Update the accumulated well pumpage

MAIN

- Begin daily time step.

DAILY_VARIABLES_INIT.F

- Initialize variables on a daily basis.
- Initialize available capacity for injection into and recovery from ASR wells.
- Initialize MDS, makeup water, runoff reduction in EAA basin due to BMPs.
- Map daily Penman-Monteith PET (reference to grass) from the DAY_PET0 array back to original POTET array.
- Initialize SUM_HEAD array if the model is on first day of the month.
- This is where the daily time step starts.

MAIN

- Increment the number of days in simulation for (running) mean of EAA runoff for flood control backpumping (ndays_sim-initialized monthly). Used to evaluate backpumping in *EAA_FLOW_DISTRIB_CAPAC_SETUP.F* and calculate (running) mean of simulated lake stages to determine if lake is rising/falling for ASR injection. The 1st is used as a condition for backpumping of EAA water into LOK (max_days_mean_bkpump). The 2nd is also used in *LAKE_NONREG_WCA.F* as a condition for injecting LOK water into proposed ASR (max_days_mean_loktasr). NOTE: MAX_DAYS_MEAN_BKPUMP - number of days used in calculation of running mean of EAA runoff in determining volume of flood control backpumping from EAA to LOK read in via model_definition_info.dat. MAX_DAYS_MEAN_LOKTASR - number of days for calculation of running mean of LOK stages to determine whether LOK is rising or falling as a condition for ASR injection regardless of demand.
- Increment the number of days in simulation for pre-storm drawdown (ndays_sim_sd). Initialized in *INIT.F*. Used in nstorm_day array to evaluate drawdown effect on canals and structures.

GW_RCHG_UPDATE.F

- Update groundwater recharge (RCHG) due to wellfield withdrawal and supply for agricultural irrigation.
- Update daily GW recharge with average daily historical pumpage for each month.
- Update RCHG with public water supply well pumpages and with industrial and residential self supplied withdrawals.

- If LEC_ET is used then daily values of irrigation supplies, total irrigation demands, supplies and shortages, and daily adjusted unsaturated zone ET for all LECSA cells are computed->processed only for model nodes that are LEC nodes. This uses *LEC_ET_SET_CUTBACKS.F* which updates RCHG array with irrigation supplies taking into consideration fraction of landscape irrigation that is served by PWS. For each day, each cell in LEC developed area, routine calculates: rchg = -daily irrigation supply total + fraction of landscape irrigation receiving water from public water supply wells*supply + fraction of golf course irrigation from treated wastewater*supply.
- RCHG is updated with irrigation supplies taking into consideration fraction of landscape irrigation served by PWS.
- Determine irrigation supply from M-Canal for appropriate grid cells (BSN 41) and L8 canal for other than sugar cane for appropriate cells (BSN 43). This involves special recharge calculations.

LEC_ET_SET_CUTBACKS.F

- When USE_LEC_ET > 0 this routine is called each day for each cell in LEC developed area.
- NOTE: et_unsat_irr_adj [daily adjusted ET in the unsaturated zone for irrigated areas] = frac_etiu_red*et_unsat_irr [will be used later in *LEC_ET_COMP.F* called by *OVLNF.F*]. This ET reduction calculation occurs if the total ET unsaturated irrigation reduction does not exceed et_unsat_irr_month. Should this occur then the etiu reduction due to regression equations would be higher than total etiu. ELSE frac_etui_red =0.0.
- Computes values for daily net irrigation supply (per irrigation use type), daily shortages per irrigation use type, daily total net irrigation demand, daily total net irrigation supply, and daily total shortages.
- Daily adjusted ET in the unsaturated zone for irrigated area (ET_UNSAT_IRR_ADJ) is used in *LEC_ET_COMP.F*->called by *OVNLF.F* to make sure that this is fully accounted in et_unsat_irr_actual.
- Daily values are totaled [NET_IRR_T/SUPPLY_T/SHORTAGE_T] and summed to monthly values used later in routine *LEC_ET_SUM_MONTHLIES.F*).

MAIN

- Adjust detention depth when water table encroaches the unsaturated zone (h(node) > erzd(node)); erzd=mean effective depth of root zone(60){ERZ in static_grid_values.dat}.
- When this occurs the depth of surface water to infiltrate into ground before runoff takes place is limited to bring the soil moisture to its holding capacity.
- Calculates ponding depth below which no surface water-canal interaction is allowed to occur for each landuse type (DETEN_DEFC).
- Calculates ponding depth below which no overland flow is allowed to occur for each landuse type (DETEN_C).

LVSEEP.F

- Levee seepage from Everglades/reservoir(s) into canal system - calculates seepage beneath protective levees into borrow canals.

- Process four types of path of flow and for each reservoir cell, calculates seepage at maximum depth for determination of available storage. The four different types of flow are:
  - 1= grid cell to borrow canal
  - 2= borrow canal to grid cell
  - 3= borrow canal to borrow canal
  - 4= grid cell to grid cell
- Process four types of path of flow and make sure that seepage rate does not result in reverse of gradient. Then iterate to find rate of seepage that would result in stage to west of levee and canal stage in borrow canal being equal.
- Calculate volume limit for seepage during each time step on four different flow path types.

MAIN

- Input WEEKLY_EXCESS2_65_S65EINT.DAT (FC=134) weekly S65E flows and rainfall excess for LOK for climate conditions.
- Reads trib_rf_et and s65e_runff_wkly variables. This data file provides the SFWMM model with the ASCII data array of "pseudo" weekly Kissimmee net rainfall (inches) and weekly s65e flows (cfs) from 1914-2000. There are 48 weeks per year in this file or four periods per month (7.6 days / week) for any given simulation and includes the following: the initial year of climate data (1914 currently) and an array of the year, month, day, net rainfall and s65e flow. There is a provisional file prepared for the initial 2000 base. S65E_RUNFF_WKLY is used in *FLOW_TO_STAS.F* for comparison to determine frac_env_deliv(1500) and *LAKE_REG_WCA.F* is used to evaluate reservoir changes due to regulatory releases.
- Map daily rainfall values from day_rain array to rain array and update ponding with today's rainfall. Note rain is recalculated as effect_rain for LU type 14.
- The day_rain for each day was set up in *RAIN_PET_SETUP.F*.
- The rainfall array is set up using rain(j)=day_rain(j,iday)*rf_factor(month).

ETCOMP.F

- Calculate reservoir volume, VOLWTR, and then process ETCOMP. *ETCOMP.F* calculates the evapotranspiration based on IETOPT option (internal passing option) for small and large reservoirs.
- For large reservoirs GWD (distance from land surface to water table) is used to determine if land is flooded/not flooded. If land is not flooded use crop coefficient (see *READTK.F*), potential ET, deep and shallow root zone, and ground water depth. If land is flooded use KMAX - ET coefficient for open water (based on LU type). All land values are assumed to be open water when ponding depth is greater than OWPOND. As ponding gets greater this could mean that the pan coefficient grows or decreases. ET includes both in reservoir and outside of reservoir. This process is also used in the *EAACORR.F* routine. KMAX is read in via *GEN_MODEL_DEF_PARAM.F* for each LU.
- For small reservoirs only - ET is calculated based on GWD
  - if (GWD ≥ DRZ) then ET = 0.0
  - if (GWD > SRZ) then ET = kc*potet*(drz-gwd)/drz-srz)

- o if (GWD < SRZ) then ET = kc*potet

  where: GWD = distance from land surface to water table and SRZ = thickness of shallow root zone. There is no ET reduction when GWD ≤ SRZ.
- ETCOMP is also processed after *OVLNF.F* and *RESERVOIR_INIT.F*.

MAIN

- Determine indx_lok_del = 1 or 2 based on total_lec_dmnd_lok = dmnd_lec_sa3 + dmnd_lec_sa2 + dmnd_lec_s6 + dmnd_lec_s5a > 200
- Used to split the POT_DEL_TO_EAA_BASIN and ALOCNNR_POTDEL array and then set to vol_in in [*MAIN.F*] before *ASR.F* is called. Won't occur unless nasr_to_eaa > 0 and iasr_opt_eaa = 0 for each basin.
- Also splits N_DAYS_WEEK_DEL_EAA = number of days per week water will be delivered from LOK to EAA during times of LEC demands (see next item), for remainder of the week (if any) days_week_del_eaa_ssm(7,2) – both read in via MODEL_DEFINITION_INFO.DAT
- Index uses split of number of days per week water will be delivered from LOK to EAA when LEC demands are below a given threshold. For the remainder of the week (if any) water will be delivered to LEC/ENP only via S354, S351, and S352. IDAYS_WK_DEL_EAA_SSM_INDX(7,2) - days/wk water delivered LEC/NO LEC demand. This is set up from days_week_del_eaa_ssm(7,2).

AVAIL_RES_STOR_ADJUST.F

- Adjust available storage in reservoirs due to differences between actual reservoir area and grid area. Cumulates the total fraction of all large reservoirs in cell. This is processed for each reservoir in cell. Used to adjust large reservoirs throughout the model.
- Accumulates RF and ET for each cell for estimating stages in above ground reservoirs. The adjustment is based on rain, depth of groundwater from rain, daily seepage loss in reservoir, change in the levee seepage depth, daily adjust for overflow, etc.
- Calculates VOLWTR which includes adjust for available storage * (sfactor= reservoir area/grid area).

AGAREA.F

- For non wetlands calculates RCHG, ET_SAT, ET_UNSAT, ET_PONDING, et_reduction-> summed up later for AG cells in EAA. Then calculates total EAA demand->3 basin + sugar ranch EAA cells (does not use basin # 10 [EAA-WPB], 40[L8-LOK side]). Wetlands are treated differently.
- Determine RO/supplemental demands in EAA basins. Basin 40[L8] and basin 42[SUGH] are calculated separately. SUGH is used to adjust demand in the Miami Canal.
- Excess water is removed from the soil and routed through the outlet structures or to a reservoir. Water deficiencies are taken from a canal and added to recharge. Irrigation requirements are met from a source (LOK or reservoir) and added to the recharge term. G136 and G88 have special processing to calculate POND.
- Calculate solmx, pond, rchg, dpthrnff -> use to calculate demand for given basin (AGP, BAGP).

- Calculate for LU=agric (excluding basins 40, 10) ET reduction and determine portion of demand in EAA met by rainfall and/or met by local storage when no runoff is occurring.
- BAGP(EAA basin) is calculated in conjunction with AGP [demand in the AG area] for each EAA basin and sums AGP when taking into account efficiency factor in removing excess water from EAA. AGP is calculated for each EAA basin the total net demand. This is used to determine the supply for the AG area. It is adjusted for individual demands and pct_daily_removed in [*AGAREA.F*]
- Route RO from AG area in L8 basin to L8 and calculate demand for S4 and S236 basins.
- Computes demands in major EAA basins to be met via pot_del_to_eaa_basin. It is then set to vol_in in [*MAIN.F*] before *ASR.F* is called. Won't occur unless nasr_to_eaa > 0 and iasr_opt_eaa = 0 [Option to have runoff injected for each BASIN].

WSNEEDS.F

- Determine water supply needs to maintain canals in LEC. The need is defined as the volume of water required to maintain the canals at desired minimum levels during dry season.
- The water (if available) is delivered from the appropriate WCA or LOK. The needs are determined for every canal reach by the storage areas.
- Set minimum levels in canals which can be dependent on WCA stages [CRMIN0]. Then set time dependent floor elevation for each conveyance canal (RMNSTG). Set conditions for change in minimum canal levels from normal operations based on [starting/ending date for minimum level of canals to be maintained when WCAs are at or below floor]. Not currently used.
- Input lok_wca_oper_sched_.dat has 16 operational lines. Indexes for highest zone, bottom zone, bottom of schedule for S333 regulatory release thru S334, floor elevation line, bottom of zone D are all –901.
- CRMIN1 = CRMIN_BEL_FLR [which is minimum canal levels maintained during dry periods when WCAs are below respective floor elevations] is processed based on service area. Then checks for heavy rainfall during wet season and if storm data is used.
- Calculate volume of water required to maintain starting canals in each service area using complex procedure to handle tributaries. See list below.
    - SA1 starting canals LWD3,LWDSE,HLSP,LKMNG,ACMEA,C51
    - SA2 starting canals C9,C11,C12,C13,POMP,C14E
    - SA3 starting canals S197,C103S,L31W,C102,S148U,CMFT,SNCRE,C7

LOCWSLWDD.F

- Determine deliveries of excess water into LWDD from local sources of water such as C-51 & Hillsboro canals for WS purposes. Reads:
    - WEEKLY_EXCESS2_65_S65EINT.DAT (134)
      NOTE: [_65_S65EINT] depends on project/version.
- Determines structure flows as a function of GW level and/or canal stage, canal seepage, overland flow.
- Apply WS, FC, and environmental rules
- Meets WS needs from within LWDD with excess water (if any). If WSNDE1 < 0.0; WSNDE2 < 0.0; WSNDES < 0.0. Then recalculate WS deliveries. Then calculate

available volume of water in and need to be met by C-51 then by Hillsboro Canal. C51 is based on WSNDE1,WSNDE2,WSNDE3 and Hillsboro is based on S17W,WSNDE,WSNDES

- Calculate flows at S2, S9, S12, S17E, S17W using structure capacity and maximum WS from equalizer canals and C51/HLBR volume/need ratio.
- Determine WS needs from within the LWDD based on DQU = outflow from each canal and meet the need with excess water (if any) based on QU = daily upstream inflow for each canal.
- The available volume/need ratio in C51 and HLBR is used for WS delivery calculations.

MAIN

- Determine how the flag for (use ASR for Caloosahatchee allocation of water for LOSA first) will be set: iuse1_asr_first =1-> option to implement flexibility in prioritizing (based on LOK Stage) RES/ASR and LOK in meeting demands in Caloos/StLucie basins if opt_prior_use_asr_flex_cal = "NO" or 'YES" and stagelo< stgref_asr_rec & cal_asr_flag=1 ELSE iuse1_asr_first = 0. See list below.
    - *NTOTASR* = total number of ASR systems in model domain
    - *CAL_ASR_FLAG* = Flag for Caloosahatchee basin/reservoir(1-ASR exists, 0-ASR does not exist)
    - *STL_ASR_FLAG* = Flag for St. Lucie basin/reservoir(1-ASR exists, 0-ASR does not exist)
    - *IUSE_ASR_ENV1* = Option to use ASR to meet Caloosahatchee estuarine requirements (1-yes, 0-no)
    - *IUSE_ASR_ENV2* = Option to use ASR to meet St. Lucie estuarine requirements (1-yes, 0-no)
- Meet EAA basin demands with excess water from C51 ASR after taking into account demands in C51/LWDD. Only use C51 ASR for this purpose IF input exists in asrinput.dat file and no ASR systems are proposed within EAA. NTOTASR =0 then ASR system will not be used. C51 input data to model is set up to use this. Set VOL_IN [amount to be recovered] based on amount delivered to EAA basin and calculate total canal demand from ASR wells based on WS delivery to E1, E2, E3.
- This is for ASRs associated with EAA RO. The code for injection is not available nothing can be recovered here. Model uses C51 ASR and has no ASR systems proposed within EAA

ASR.F

- If injection phase for ASR, increment volume by amount that can be injected (limited by ASR capacity and volume available for injection). Volume incremented in the bubble during each injection (which is fully available to meet demand) is = vol injected*asreffic. If recovery phase from ASR then decrement ASR volume by amount that can be recovered (limited by capacity and available volume).
- Injection/Recovery is based on asr_inj_recv_flag = 1/2.
- Injection phase uses fraction of total ASR capacity each source can use. ASR_MAX_IN is based on input from asrinput.dat. Then ASR_INJ_VOL = amin1(vol_in,asr_max_in).

Then ASRVOL = vol incremented in the bubble during each injection (which is fully available to meet demand) = asr_inj_vol * asreffic.

- Recovery phase is based on: Total canal demand from ASR wells -total_cnl_dmd_asr.
    - AVAILABLE_VOL=amin1(***ASRVOL***,rem_asr_outcap*3.0689) NOTE: rem_asr_outcap is initialized available capacity for injection into and recovery from ASR wells.
    - available_vol=available_vol –tot_cnl_dmd_asr*1.9835
    - asr_rec_vol = amin1(vol_in,available_vol)
    - asrvol = asrvol – asr_rec_vol
    - bal_vol = vol_in - asr_rec_vol [Compute volume that could not be recovered].

MAIN

- Meet EAA basin demands with excess water stored in reservoir/ASR systems within EAA IF LOK is sufficiently low.
- WS to meet EAA demands from EAA reservoirs only if (for each structure in each reservoir) idshg_opt=1[discharge routing option = meet EAA basin demands] and stagelo < stgref_asr_rec OR iasr_opt_eaa(bsn) = 0 [opt to have RO injected into ASR wells 0:no wells]
- This is for simulation runs only and executes *WS_FROM_RES.F.*
- Again no EAA RO is injected to ASR. Code is not set up to use this.
- Model uses C51 ASR because input to model has no ASR systems proposed within EAA.

WS_FROM_RES.F

- Executed only if runmode='SIMUL' -> water supply to meet EAA demands from EAA reservoirs. Meet EAA basin demands with excess water stored in reservoir/ASR system within EAA if LOK is sufficiently low.
- For each outlet structure check the idshg_opt = 1 -> discharge to meet EAA basin demands and stagelo < stgref_asr_rec [=calc regulation stage for ASR when water supply is made available from reservoir discharges] OR iasr_opt_eaa(bsn) = 0 which is opt to have RO injected into ASR wells [0:no wells 1:have ASR wells] for each EAA basin.
- Calculate indx_lok_del [= internal index for condition for LOK delivery to major EAA basins. Used for segmenting potential delivery if total_lec_dmnd_lok > 200.
- Determine volume of water available for each outlet structure. Route water supply seepage [based on res_out_type="SEEPG'] to appropriate destinations ELSEIF (FLDC/WSPLY/ENVIR discharge) idshg_opt=0 [discharge to canal] route discharge through specific reservoir structures.
- Compute simulated stages for EAARES and EAARSN when idshg_opt = 1 [discharge to meet EAA basin demands]. Calculate res_outflow_to_basin.
- Compute reservoir stage and reservoir outflow when idshg_opt = 1 or 2.
- Route environmental WS from EAA Reservoir to STA34 = idshg_opt = 3. For reservoir coded STA3 and 4 only.
- Different types of calculations are made based on WCAENV=calendar or rain-driven operations for each WCA.

MAIN

- If RES/ASR systems exist within EAA then determine recovery from ASR wells within EAA basins.
- IF stagelo < stgref_asr_rec & iasr_opt_eaa(bsn) = 1 [option to have RO injected into ASR wells 1:have ASR wells for each EAA basin]
- Send vol_in = pot_del_to_eaa_basin to *ASR.F* for recovery; accumulate the flow from ASR to EAA WS adding pot_del_to_eaa_basin subtracting bal_vol; and set pot_del_to_eaa_basin = bal_vol [volume not recovered].
- Output from appropriate reservoirs for WS purposes in LECSA. Used only in simulation runs.
- IF idshg_opt= 2 [discharge to meet other WS needs (pre-processed time series demands (e.g. big cypress Seminole demands)] launch *WS_FROM_RES.F*-> calculates the following variables used in total_flow_g404.
    - total_flow_g404 = sta34_out_to_wca3anw + sta34_out_to_s140 + outflow_from_roten_to_west + holey_out_to_nwc + holy_out_to_s140.
    - Holey_out_to_nwc=This is HL to NW corner of the WCA-3A sta34_out_to_wca3anw= This is STA34 to NW corner of the WCA-3A

ASR_TO_LEC_WS.F

- Use ASR wells in maintaining canal levels in LECSA - calculate water supply and regulatory discharges from LOK to WCAs. (See below - based on nasr_to_cnl). NASR_TO_CNL is the number of ASRs associated with a particular canal "cnl_num" serving as its destination. This is a counter in [*ASR_INPUT.F*]. This is based on ncnl_dest_from_asr via (ASRINPUT.DAT) (17) which is number of canal destinations, if any, from which the ASR delivers water during recovery.
- Calculate recovery from ASR wells associated with reservoirs [declared as WS] if EAA basin RO is not diverted to reservoir. For each outlet the DS canal for each reservoir and INFLOW structure [not associated with 'LWDD' canal] send downstream canal flow to *ASR.F* and add recovery to upstream canal flow. Code for injection from canal is handled in [*CHNLF.F*]. Includes recovery from ASR wells to help public water utilities.
- Calculates recovery from ASR well injected with excess water from canal system and no reservoirs by sending downstream flow to *ASR.F* and add recovery to upstream destination canal.
- Use ASR wells in proposed central eastern PBC reservoir to meet western LWDD needs. VOL_IN=WSNDE1+WSNDE2+WSNDE3_WSNDES+WSNDESE is sent to *ASR.F* to recover ratio del of need * wsnde1,wsnde2,wsnde3,wsndes,wsndese and add to equalizer canal flow; then subtract from wsnde1,wsnde2,wsnde3,wsndes,wsndese.
- Similar process when using ASR wells near C-51 and Hillsboro canals to help meet needs in LWDD. VOL_IN = WSNDE1+WSNDE2+WSNDE3 then process *ASR.F*. The WSNDE(s) are recalculated based on RATIO_DEL_TO_NEED.
- For WCA1 and C60 ASR recovery send dqu to *ASR.F*; calculate ratio delivered to need and add ratio* dqu to QU.
- Calculate ASR recovery to be sent to WCAs for delivery to LEC via number of ASRs to each canal.
- Injection is set up in the *CHNLFF* routine to be recovered here in the next time step.

BEGIN LAKE INTERACTION

- Refer to Lake Interaction Spreadsheet (Appendix E).

MAIN

- Estuarine demands for St. Lucie and Caloosahatchee basins. Assumed to be cutback according to SSM.
- For simulation runs S235 inflow is adjusted based on stagelo <=13.0(NGVD).
- Adjust C43 basin demand or runoff due to S235 inflow. If s235inf > c43 bsn dmnd then ro+= s235inf-dmnd;dmnd=0.0 Else dmnd = dmnd-s235inf
- IF(es_dmnd_acc_freq = 'DLY) {see below} then determine allocation of water for LOSA defined by SSM policy and fraction of demand in LOSA to be met with allocation. [es_dmnd_acc_freq.NE. 'DLY'] then process *ACCUM_ESTUAR_DMNDS.F* = Accumulate estuarine demands and calculate LOK supplemental release and maximum backflow capacity for all months of current year if caloos(simcaes) and stlucie(simsles) options are invoked.
- Call SSM_CUTBACK.
- Call STLUCIE1.
- Call CALOOS1.
- Set the lok2caloos_est and lok2caloos_irrig variables for writing out to the str2x2.dss file.

SSM_CUTBACK.F

- Recomputes supplemental EAA demand to be met by LOK which is subject to SSM. (TDMDEAA+= pot_del_to_eaa_basin(ia,indx_lok_del)
- Calculate total supplemental demand in LOSA to be met by LOK. Total Supplemental Demand:
  - DEMAND_298 DMNDRO(3,2,itypern,jday)~ 'ISTOKPBB'
  - DEMAND_S236 DMNDRO(6,2,itypern,jday)~ 'NLKSHORE'
  - DEMAND_L8 DMNDRO(7,2,itypern,jday)~ 'NELKSHORE'
  - DEMAND_CALOOS DMNDRO(8,2,itypern,jday)~ 'ISTOKPAB'
  - DEMAND_STLUCIE where 3=location; J=to and from RO; K=demand_level_opt =[set = 1 if demand_level_opt = 'CURR' otherwise set to 2 in *INIT.F*]'; *L* = day
  - DEMAND_S4BSN
  - DEMAND_SEMIND
- Assume Everglades is subject to same cutbacks as LOSA (according to SSM).
- Calculate WS from LOK to meet demands in LOSA according to SSM. [Only if *USE_SSM = 'YES'*] then call *SSM.F* to incorporate schedule for SSM.
- Give credit to LOSA during dry season to delay implementation of cutbacks due to SSM policy.
- Adjust Brighton reservation according to SSM.
- Adjust LOK WS deliveries to all LOSA basins
- CHGDMDNLS= dmdro(6,2,itypern,jday)*pctmet
  CHGRNFNLS=dmdro(6,1,itypern,jday)

CHGDMDNELS=dmdro(7,2,itypern,jday)*pctmet CHGRNFNELS=dmdro(7,1,itypern,jday). [PCTMET=ssmlake/DMD<.994]->lok_ssm_cnt=lok_ssm_cnt+1= number of days LOK in SSM for cutbacks next month in LEC] where SSMLAKE - actual water supply release or delivery from LOK to lake service area.

- Adjust flows to S236 and S4 basins for WS according to SSM.

SSM.F

- Performs LOSA SSM calculations given LOK stage, storage, and date then computes WS releases to LOSA.
- This plan takes effect when LOK is projected to fall below 11' NGVD during the dry season.
- These calculations utilize projected ET, RF, water borrowed from a given month, and normal water use for dry season month.
- Will also do wet season (June-November) SSM if necessary. If the lake stage < schedule then ssmlake[actual delivery] is based on ssmwet routine. ELSE ssmlake[or lake service area demand met]= dmd. SSMWET =actual delivery or lake service area demand met. Given LOK stage, storage, date - Compute water supply releases to LOSA-proj< 10.5 ft NVGD-2mon-given LOK stage, storage and date/computes water supply release to LOSA/ plan takes effect when lake is projected to fall below 10.5 ft NGVD during first two months of the wet season.
- At the beginning of each week, daily and monthly allowable allocations, allowable daily borrowing, actual daily allocations, available storage, and remaining normal dry season water use is recomputed.
- If lake stage < SSM schedule then *SSM.F* determines whether adjustments to daily allocations are need to account for borrowing and then ssmlake [actual daily delivery] is determined.

STLUCIE1.F

- *STLUCIE1.F* calculates daily allocation and estimated delivery. Assume that LOK is always capable of meeting estimated portion of estimated demand.
- Determine LOK schedule zone and adjust St. Lucie estuary demand by St. Lucie tributary inflow. Allocation will be based on St. Lucie estuarine demand adjusted for inflows from other tributaries to estuary.
- Estimate portion of allocation to be met by C44 basin - determine required supplemental LOK release [discharge from LOK to meet estuarine demand].
- Determine where excess flow from C44 basin will go after estuary's allocation have been met.
- Backflow from St. Lucie basin is calculated and checked against the LOK stage to see if the LOK stage is too high then release to tide.
- If capacity of S80 is exceeded, portion of excess stays in C44 basin. LOK stage is low then allow backflow; may not be possible if LOK stage is higher than tailwater of S308.
- If S308 capacity is exceeded then portion of excess goes to tide then S308 flow is recalculated to see if rest of flow can go to tide.

- Calculate C44 basin demand and if fraction of C44 basin demand to be met exists then calculate C44 allocation which will be met by LOK followed by updating the estimated structure flows.
- The summary is written out to FC=74.

CALOOS1.F

- *CALOOS1.F* calculates allocation and estimated delivery.
- Estimated portion of allocation met by C43 basin RO, LOK. Determine where excess RO from C43 basin will go after estuary's allocation has been met -> LOK stage too high then release to tide; capacity of S79 exceeded portion of excess stays in basin;
- LOK stage is low then allow backflow: may not be possible if LOK stage is higher than tailwater of S77.
- If S77 capacity is exceeded then portion of excess goes to tide; rest of flow to tide if S79 can handle it.
- Calculate C43 basin demand and if fraction of C43 basin demand to be met exists then calculate C43 allocation which will be met by LOK followed by updating the estimated structure flows.
- The summary is written out to FC=73.

MAIN

- IF(es_dmnd_acc_freq = 'MTH) then
- Initialize monthly supplemental water to C43 and C44 basins [calculate daily] and monthly backflow capacity which is equal to the cumulative daily.
- If option to include proposed reservoir in St. Lucie Basin is set then check ASR flag to set injection/withdrawal, calculate bsn2est2[faction of estuarine demand needed which depends on demand*sl_ro] - sent to *RESASR_SIM.F*.
- Call *RESASR_SIM.F*.
- Calculate portion of original estuary supplement required for the day that cannot be met by reservoir/ASR system and has to come from LOK.
- For Caloosahatchee, use lateral inflow from S4 basin via S235 to evaluate if LOK supplemental release can be decreased and increase maximum avail BP.
- If Caloosahatchee basin/reservoir ASR exists and use Caloosahatchee ASR first and C43 basin demand > 0 then CALL *SSM_CUTBACK.F*. NOTE: if S235INF <= 0 then this check is not performed and goes directly to the next step.
- If option to include proposed reservoir in Caloosahatchee Basin is set then check ASR flag to set injection/withdrawal, calculate bsn2est1[faction of estuarine demand needed which depends on demand*cal_ro]-sent to *RESASR_SIM.F*.
- CALL *RESASR_SIM.F*. This calculates (RES_ASR_OUTFLOW) -> *MAIN.F* -> supp_day_c43_est_tmp = lok_supp_day_c43est – res_asr_outflow. SUPP_DAY_C43EST_TMP= revised requirement from today until end-of-month. Calculate portion of original estuarine supplemental requirement for the day that cannot be met by reservoir/ASR system and has to come from LOK for today only.
- IF IUSE_LOK1 is equal to 1 [opt to use LOK to help meet estuary demands in St. Lucie basin] where supp_day_c44_est_tmp=0] or 2 when using supp_day_c44est_tmp =

calculate portion of original estuarine supplemental required for the day that cannot be met by reservoir/ASR system and has to come from LOK which is included in arguments of called subroutine *STLUCIE2.F*.

- IF IUSE_LOK2 is equal to 2 [opt to use LOK to help meet estuary demands in Caloosahatchee basin] where supp_day_c44_est_tmp=0] or 2 when using supp_day_c44est_tmp = calculate portion of original estuarine supplemental required for the day that cannot be met by reservoir/ASR system and has to come from LOK which is included in arguments of called subroutine *CALOOS2.F*.
- Set the lok2caloos_est and lok2caloos_irrig variables for writing out to the str2x2.dss file.

RESASR_SIM.F

- Update water level in reservoirs based on HRES= RF-ET-SEEPAGE. If HRES < 0 then calculate ET and SEEPAGE to bring HRES to zero.
- SPILL_OVER goes to estuary not to basin/ then all reservoir SPILL_OVER will be used to meet part of remaining supplement estuary requirement:
  - spill_over = (hres-res_max)*ares/1.9835
- If roff_day > 0 then use reservoir to meet estuary supplemental requirement and then fill reservoir with remaining RO. Calculate RES2EST.
- Meet remaining estuarine requirement. IF ASR option is on and is allowed to meet environmental needs: IF(iopt_asr->[ASR in basin has to exist] and iasrenv and unmet_supp>0). Calculate ASR2EST.
- Fill up ASR well first: Do ASR injection if water is available from the reservoir and ASR well not yet used to supplement reservoir in meeting estuarine demand. Assumption: reservoir release does not exceed remaining runoff for the day. Calculate RES2ASR.
- Remaining RO is portion of original RO not used to meet estuarine requirement and can be used to fill detention basin (avail_res_stor).
- Fill up reservoir next. Calculate avail_res_stor used for BSN2RES
- ELSE IF (opt_bsn_prio_uncond='YES') see below - meet local basin demand before estuarine demands-if not all basin demands are met by res. Then other sources will have to meet portion of it (ASR, LOK). Calc RES2BSN.
- ELSE IF (supp_to_est_day>0.0 .OR. Dmnd_day >: 0.0) IF(stglok .GE. Rmin_lok_stg_del_est .OR. opt_bsn_prio_uncond='YES')-> meet local basin demands before estuary demands/ where opt_bsn_prio_uncond = option to have flows from proposed Caloosahatchee/St Lucie reservoir to basin a priority unconditionally over meeting estuarine demands.

STLUCIE2.F

- *STLUCIE2.F* calculates monthly allocation and estimated delivery. Assume that LOK is always capable of meeting estimated portion of estuary demand.
- Determine LOK schedule zone and adjust St. Lucie estuary demand by St. Lucie tributary inflow. Allocation will be based on St. Lucie demand adjusted for inflows from other tributaries to estuary.

- Using supp_day_c44est_tmp >0 [calculate portion of original estuarine supplemental requirement for the day that can't be met by reservoir/ASR system and has to come from LOK] determine required supplemental LOK release [discharge from LOK to met estuarine demand]. Then update S80 and S308 structure flows and capacity.
- Estimate portion of allocation to be met by C44 basin RO. Determine where excess flow from C44 basin will go after estuary's allocation have been met. (Excess C-44 basin RO accounting).
- Backflow from St. Lucie basin is calculated and checked against the LOK stage to see if the stage is too high -> release to tide.
- If capacity of S80 is exceeded, portion of excess stays in C44 basin. LOK stage is low then allow backflow; may not be possible if LOK stage is higher than tailwater of S308.
- IF bflo_cap GE bflo_frac*c44 [basin RO which can go to LOK, estuary or both]-> Release all RO to LOK within allowable fraction. Recalculate S308 capacity and total flow through S308 - exclude regulatory flows. Release remaining RO to estuary assume no C44 basin RO stays in storage.
- IF bflo_cap < bflo_frac*c44[bsn RO which can go to LOK, estuary or both]: Release portion of RO to LOK up to bflo_cap within allowable fraction. Release remaining RO to estuary.
- C44 basin demand > 0 then calculate C44 allocation which will be met by LOK followed by updating the estimated structure flows.
- The summary is written out to FC=74.

CALOOS2.F

- *CALOOS2.F* calculates monthly allocation and estimated delivery. Assume that LOK is always capable of meeting estimated portion of estuary demand.
- Determine LOK schedule zone.
- Using supp_day_c44est_tmp >0 [calculate portion of original estuarine supplemental requirement for the day that can't be met by reservoir/ASR system and has to come from LOK] determine required supplemental LOK release [discharge from LOK to meet estuarine demand]. Then update S77 and S79 structure flows and capacity.
- C43 basin RO (if any) can backflow if LOK stage is low enough or go to estuary as excess basin RO. NOTE: This RO may be considered as excess or partial excess relative to today's estuary demand but may all be needed to satisfy the estuary total month demand.
- LOK stage is low then allow backflow: may not be possible if LOK stage is higher than tailwater of S77.
- IF bflo_cap GE bflo_frac*c44 [basin RO which can go to LOK, estuary or both] then release all RO to LOK within allowable fraction. Recalculate S77 capacity and total flow through S77 - excluding regulatory flows. Release remaining RO to estuary assume no C43 basin RO stays in storage.
- IF bflo_cap < bflo_frac*c44[basin RO which can go to LOK, estuary or both]->Release portion of RO to LOK up to bflo_cap within allowable fraction. Release remaining RO to estuary.

- If iuse1_asr_first=1(See below) and c43dmd > 0 then calculate C43 allocation which will be met by LOK followed by updating the estimated S77 structure flows and capacity.
    - iuse1_asr_first =1-> option to implement flexibility in prioritizing (based on LOK Stage) RES/ASR and LOK in meeting demands in Caloosahatchee/St. Lucie basins if opt_prior_use_asr_flex_cal = "NO"or 'YES" & stagelo< stgref_asr_rec & cal_asr_flag=1 ELSE iuse1_asr_first = 0. (See list below).
    - NOTE: In asrinput.dat ->
        - *NTOTASR*=total number of ASR systems in model domain
        - *CAL_ASR_FLAG*=Flag for Caloosahatchee basin/reservoir(1-ASR exists,0-ASR does not exist)
        - *STL_ASR_FLAG*=Flag for St. Lucie basin/reservoir(1-ASR exists,0-ASR does not exist)
        - *IUSE_ASR_ENV1*=Option to use ASR to meet Caloosahatchee estuarine requirements (1-yes,0-no)
        - *IUSE_ASR_ENV2*=Option to use ASR to meet St Lucie estuarine requirements (1-yes,0-no)
- The summary is written out to FC=73.

END OF LAKE INTERACTION

ALLOC_TO_EAA.F

- Delivery of allocated water (SSM policy) in excess of current demand in LOSA to EAA basins if needed. Only used if USE_SSM='YES'.
- Passes SUPPLY_EXCESS from *SSM_CUTBACK.F*. Routine calculates total net demand for each EAA basin
    - (AGP(bsn) = ratio_supply_excess*sum_avail_stor(bsn) + add_sugh) and DMNDAGL8 = used to calculate total supplemental demand in L8 basin to be met by LOK.
- It takes excess supply/allocation to EAA and calculates the amount of water determined by supply-side management plan that is in excess of demand in LOSA.
- This excess is routed to the EAA to increase water levels.
- For land_use_type = 'AGRICUL' and for basin 40 calculate SOLMX(j) [equivalent depth of soil moisture in the soil column] and avail_stor for each cell.
- For land_use_type = 'AGRICUL' and for basin 7, 8, 9, 10, 42[Sugar Ranch] if agp [the total net demand for each EAA basin] .GE. O then calculate SOLMX(j) [equivalent depth of soil moisture in the soil column] and avail_stor for each cell.

EAA_NEUTRAL_CAPS.F

- Base and Future Case
- Determine structure flows and interior canal stages for EAA using canal profiles for neutral conditions (from HEC-2 runs). Only used if runmode="SIMUL'. (See below). This includes using the following subroutines:
    - US_FLOW=calculate equilibrium canal headwater and upstream structure discharge given canal tailwater, downstream structure discharge, and headwater for the upstream structure in a structure-canal-structure configuration in the EAA.

- DS_FLOW=returns equilibrium canal tailwater and downstream structure discharge given canal headwater, upstream structure discharge and tailwater for the downstream structure; uses look-up table values for canal conveyance capacity. Performed for major EAA canals only.
- USUS_FLOW=calculate equilibrium interior HW and TW stages and upstream discharge. Uses canal-structure-canal in EAA and uses look-up table values for canal conveyance capacity.
- DSDS_FLOW =calculate equilibrium interior HW and TW stages and dnstream discharge. Uses canal-structure-canal in EAA and uses look-up table values for canal conveyance capacity.
- EAA_PROF_TWO_REACHES=returns 1 of the 3 based on the other two [flow rate(Q); upstream stage(CLHW); downstream stage (CLTW)] for a 2 reach system with spillway in the middle. Uses eaa_prof_lu_table.
- EAA_PROF_LU_TABLE=returns 1 of the 3 based on the other two; flow rate(Q); upstream stage (CHW); downstream stage (CLTW);
- GO_LU_TABLE= returns 1 of the 3 based on the other 2 spillway flow variables; gate opening (GO); upstream stage (SHW); downstream stage (STW).

- Calculate conveyance capacities for the major EAA canals for the neutral (no EAA RO/no EAA demand) conditions.
- Compute demands in the EAA to be met during SSM.
- Determine condition of forward pumping (depends on LOK stage and rlok_stg_end_forpmp//LOK stage to begin forepumping at s354, s351, s352 (2))->LFORPUMP[s354,s351,s352->BSN#8,7,5a]. NOTE: LFORPUMP can determine specific spillway used. (See Below).
  - LFORPUMP(max_n_reach_eaa) –
    - initialized to .FALSE. In *INIT.F* then set in *EAA_NEUTRAL_CAPS.F* [s354,s351,s352] then checked in *EAA_FLOW_DISTRIB_CAPAC_SETUP.F* and *FLOW_TO_STAS.F* and *LAKE_NONREG_WCA.F* and *QMAX_ONE_REACH.F* and *QMAX_TWO_REACHES.F*.
    - [set to TRUE - if(stagelo.LE.rlok_stg_beg_forpump & stagelo.NOT.GT. rlok_stg_end_forpump)] - determine condition of forward pumping - dependent on LOK stage.
- Determine fraction of EAA demand for neutral condition to be met during days of delivery from LOK.
- Calculate the discharge to EAA based on discharge to meet EAA demand and canal capacity. Uses the EAASPILL routine- calc flow through a major spillway in EAA (using 12 spillway structure types) -> calculate actual gate opening.
- Calculate canal conveyance table (7 different EAA_CONVEY types) used in *LAKE_NONREG_WCA.F*; F*LOW_TO_STAS.F*; *EAA_FLOW_DISTRIB_CAPAC_SETUP.F*. INCLUDES 7 profiles:
  - 1=MIAMI[S354 - S8](gravity flow)
  - 2=MIAMI(pumped flow)
  - 3=NNRC(gravity flow)
  - 4=HLSB(pumped flow)

    - 5=NNRC(pumped flow)
    - 6=HLSB(pumped flow)
    - 7=WPB

RAIN_DRIVEN_FLOW_STAGE_TARG.F

- Setup rain driven flow and/or stage targets for Everglades/wetland areas.
- Rainfall formula variable is read in by assigning daily SRS demand OR input RF and ET and then calculate FRF. Reads:
    - RESTART_OUTPUT(55)
    - SRS_RF_PLAN_RF_ET.DAT(59)
    - IMPORT.EAA_VERIF_2000_1(83)
- Read in daily import stages for Everglades if runmode = "SIMUL' & wca_import_variation = 'DAILY'(T) .OR. opt_flow_to_ts [Identification of type of flow to Taylor Slough] = 'TSRFPLN' or opt_st_input [Option to input stage targets even though Everglades is not being restored.]
- IF(WCA_IMPORT_VARIATION = 'DAILY' [T].OR. OPT_FLOW_TO_TS='TSRFPLN'[T] OR. OPT_ST_INPUT[1])-> Either use time_varying (daily) targets ELSE target is constant.
- For time_varying, determine regulation schedule for WCAs on a daily basis and compute import simulated stages for (rain driven ops [if WCAENV='T' for the 5 WCAs or all other import areas] or operations in WCA(s) not rain driven).
- When target is constant -> calculate stages for total number of import constant areas. Needs data from stage_import_specs.dat read in by [*GEN_MODEL_DEF_PARAM.F*]

HIST_FLOW_ADJUST.F

- Only processed during calibration/verification.
- It provides kflo adjustment based on minimum of calculated avvol and existing kflo.
- This routine adjusts flows provided by data base when necessary;
- It is done for the following structures S11; S337; S339; S340; S140; S175; S197; S10(HLBS); S332; S38; S9; S5A3; S5A4.

EAA_FLOW_DISTRIB_CAPAC_SETUP.F

- Computes discharges for LOK outlet structure to meet EAA demands and for inlet structures to WCA. Determines fraction of EAA demand to be met during days of delivery from LOK plus calculates total RO from EAA.
- Approximate the portion of total RO thru S-8 and S3, S7+S6, S2, HG5A and S5A from historical data -> only if re_proport_eaa_rnff='TRUE'. Option to re-proportion simulated total agricultural runoff in EAA (based on recent history 1983-1990) in determining discharge through outlet structure. Input data is set to FALSE; not used.
- If simulation then determine moving average of daily RO for calculation of amount of FC backpumping to LOK if agp(bsn) > 0 ELSE IF re_proport_eaa>rnff='TRUE' then calculate flow_reduction_bmp; excess_reduction; rmonthly_loss_bmp followed by moving average calculation.

- Compute discharge capacities, max allowable gate opening, LOK stage & tail water at S-351, Hillsboro canal; S-7 spillway, S-8 spillway, S-354. NOTE: S-351, S-352, S-354 was done in [*EAA_NEUTRAL_CAPS.F*].

HOLEYLAND_INFLOW_MANAGMT.F

- Evaluates if water is to be released to STAs based on LOK stage.
- Calculates target stage of HL based on hlyenv= option for meeting environmental targets in Holeyland; calculate stage or set to holey_sched based on breakpoint regulation stage.
- Determines volume available for WS deliveries from the Holeyland reservoir. NOTE: VOLWSR is cumulated when pond > .5 for bsn=96. Then trigger depth that delivers water to HOLEYLAND to prevent brush fires for HL (trig_dpth_to_wt) is calculated if WS_TO_HOLY_OPT – water is delivered to prevent brush fires. Input data is set to BRUSHF.
- IF ELLS-H >trig_dpth_to_wt & holey_min_level_opt= 'YES' then calculate QHLWS =holeyland water supply used for available pump capacity.
- Determine total RO and/or crop demand from EAA. This is calculated based on 'DIRECT' OR 'INDIRECT' RO to HL. (See below). runoff_to_holeyland =Option in routing water into Holeyland:
    - DIRECT = Inflow into Holeyland is from a direct EAA runoff
    - INDIRECT = Inflow into Holeyland is from other sources than direct EAA RO.
- Recalculate pond in HL reservoir when pond > .5 for basin 96 which is based on FLWTRS=calculate net volume of flow into Holeyland reservoir=volwsr(volume available for WS delivery from HL reservoir).

STRUC_LOK_IN_WCA_FLW.F

- The actual transfer of water is performed in this routine while the adjustment of water levels and soil moisture is done in *AGAREA.F***.**
- Compute discharges for LOK outlet structure to meet EAA demands and for inlet structures to WCA.
- This involves calculating discharge for structures that are dependent on stages at one or group of grid cells. Only structure discharge from areas outside WCAs (E.G. S-8; S-140A, S-3) are included.
- Determine structure flows as a function of GW level and/or canal stage, and reservoir. Initializes kflo array to 0 for number of structures simulated in *CANL_DEP_STRUC_PARAM_SETUP.F, CANL_DEP_STRUC_CAPAC_SETUP.F, GEN_CANL_DEP_STRUC.FLW.F, SPEC_CANL_DEP_STRCU.FLW.F* subroutines. STRUCT_NAME_SPEC_CODE reads in structures via gen_nodal_dep_struc.dat.
- Apply WS, FC, and ENV rules.
- These calculations are based on ICODE option {GEN=all general structure or SPC=special code unique to structure}.
- Routine will return KFLO array [structure flows for 21 static structures] and iagflo [EAA basin flow] to KNFLOWS.
- Determine WS from LOK to L8 basin via WPB canal.

- Evaluates flows from LOK to WCA via [culverts G-261; G263; G262; culverts for L-8 restoration; culvert 10A].

MAIN

- Variables written out to FC=61 [DAILY EAA SUMMARY OUTPUT] and FC=66[LOSA SSM SUMMARY OUTPUT FILE] and FC=68[DAILY_LOSA_OTHER_SUMMARY.DAT] for processing outside the model.
- Potential deliveries for each basin are added to total EAA demand TDMDEAA. NOTE: pot_del_to_eaa is segmented by indx_lok_del.
- Calculate the total_eaa_supply_deliv (total WS delivery from LOK to EAA) via structures S2 and S3 and S5 minus WS to Holeyland and L8.
- Calculate total WS delivery to LOSA [total_losa_deliv {NEW} = total_eaa_supply_deliv + S236 dmd+ L8 dmd*pctmet+ C43 and C44 dmd met by LOK+ S4 dmd+ chg in dmd (each at istapoga, north lake shore, northeast lake shore) + flow at str. IFLAGQ].
- Calculate WS allocation to NNR, HLBR canals, and write to DAILY_EAA_SUMMARY.DAT.
- Caloosahatchee and St. Lucie estuaries and ASR/reservoir use to be processed after this.
- Writing out to FC=66; DAILY_LOSA_SSM_SUMMARY.DAT.
- This includes LOSA SSM SUMMARY~total supplemental demand; allocation from LOK to LOSA; total cutback volume for all LOSA according to SSM; fraction of LOSA supplemental demand to be met according to SSM; supplemental demand in LOSA met by LOK.
- SSMLAKE - actual water supply release or delivery from LOK to lake service area.
- IDAY_LOK_IN_SSM - index calc based on where stagelo is in relation to lake schedule and ssmwarn_l/ssmwatch_l.

  IF(stagelo .lt. sch) THEN iday_lok_in_ssm = 3
  ELSEIF (stagelo.le.ssmwarn_l) THEN iday_lok_in_ssm = 2
  ELSEIF (stagelo.le.ssmwatch_l) THEN iday_lok_in_ssm = 1
  ELSE iday_lok_in_ssm = 0. This is determined in *SSM.F* and *SSM_CUTBACK.F* subroutines and used in the *FLOW_TO_STAS.F* routine. The mission of this index is to help set targets to be met on a daily basis.
- DMD - lake service area demand.
- SUPPLY_EXCESS = difference between actual water supply release or delivery from LOK to lake service area and LOSA demand.
- PCTMET =this is the percent met fraction of demand satisfied by delivery from LOK to LOSA. NOTE: DMD=DMD*PCTMET. This is also used to reset LWDD demand.
- TOTAL_LOSA_DELIV = LOSA WS delivery from all sources.
- Writing out to FC=61; DAILY_EAA_SUMMARY.DAT.
- This includes SSM SUMMARY OUTPUT FILE - demand/water supply delivery, supplemental demand, excess water and runoff.
- Total_eaa_dmnd includes MIAMI + NNR_HILL + WPB basins + SUGAR RANCH.
- dmnd_met_by_rain= whenever there is runoff, demand is solely met by rainfall since rainfall is source of runoff.

- DMND_MET_BY_LOCAL_STORAGE - determine portion of demand in EAA met by local storage when no runoff is occurring supp_eaa_dmnd ~ total supplemental demands for EAA basins. First calculated in *AGAREA.F*.
- NOTE: dmnd_met_by_local_storage = total_eaa_dmnd - supp_eaa_dmnd - dmnd_met_by_rain [calculated in *AGAREA.F*].
- TDMDEAA1 = pot_del_to_eaa_basin(ia,indx_lok_del) ; first calculated in *SSM_CUTBACK.F,* recomputed supp EAA demand to be met by LOK subject to SSM.
- dmnd_sugh_orig ~ sugar ranch demand
- Allocation, WS delivery, tot_runoff_excess, runoff_south.
- Sets up agrnl8 which routes runoff from AGRIC area in L8 basin to L8 based on existing plumbing or the proposed system [routes from west and south].
- OPT_L8_PROP is not currently being used.
- Writing out to FC=68; DAILY_LOSA_OTHER_SUMMARY.DAT. This includes daily demand /runoff summary for LOSA basins, S-4, S-236, 298 DIST, Istokpoga change in RO/demand, NLS change in RO/demand, NELS change in RO/demand, etc.
- TOT_RUNOFF_EXCESS is set to= 0.0 for each basin and is reset for each day.
- For calibration only.
- Calculate LOK ET volume (LKETVOL).
- Calculate monthly ET volume (RMETVOL).
- Calculate volume sent to LOK (VOLTOLO).
- All of above used to calculate final storage (FINSTOR). This is also calculated in [*LAKE_REG_WCA.F*] - after regulatory releases are made from LOK to WCA.
- Write to FC=181: [DAILY_LOK_ET.DAT].
- Set STRFLW = KFLO for each ncalcpt {number of structures simulated explicitly in struc_lok_in_wca_flw }.
- Calculate stage at 3A28-stage used determine flow calc at S12s.

LOK_WS_TO_LARGER_RES.F

- Note that this is performed after processing WS demand/deliveries to EAA but before anything is processed in the WCAs- needs *FLOW_TO_STAS.F*.
- Compute volume of demand to maintain appropriate STAs at minimum levels for environmental purposes. This routine calculates WS deliveries to STAs 5E, 5W, 6, 1E, and 1W. STA2 and STA3 and 4 are handled in [*LAKE_NONREG_WCA.F*] -> RO.
- CALCS. RSIAP - supply from LOK to STAs. If stage in lake below this level do not release water to STAs.
- IF DPTHSW < critical depth (DPHWS) THEN must import water from LOK to keep depth of water in reservoir at critical depth.
- If [STAGELO .GE.RSIAP & IDIRFRLO = 0] or =1 [option for each reservoir to release water from LOK to maintain appropriate reservoir(s) if capacity exists regardless of LOK stage] (1=REGARDLESS; 0=Bottom of zone B of SSM is limit in LOK stage allowed for WS from LOK to STAs THEN calculate water suppply -> WSDEL_TO_STA variable. Input data is set to 0.
- NOTE: IDIRFRLO - number of reservoirs maintained at desired levels during dry periods. Only four are set up. Input does not include STA 1E.

- Adjustments for area (FC, SPG, OVLF-adjusted) are calculated and used to adjust depth -> calculate stage -> calculate WS.

LOK_WS_TO_SMALL_RES.F

- Compute volume of demand to maintain appropriate STAs at minimum levels for environmental purposes. Calculate WS for STAs 5E, 6, 1E, and 1W. NOTE: input (resname) does not include 1E.
- Compute DEPTH_IN_RES and check it against DPHWS [for each reservoir max depth (ft) of water to be maintained during dry period (source is LOK)]; read in from RESERVOIR_INPUT.DAT.
- IF the depth of water in reservoir < critical depth (DPHWS) THEN must import water from LOK to keep depth of water in reservoir at critical depth.
- This is used to calcualte WSPLY (For each reservoir maintained at desired minimum levels during dry periods) -> WSDEL_TO_STA variable.

MAIN

- Reduce demand for appropriate canals according to SSM. LWDD canals (E-1, E-2, E-3, near Boca Raton wellfield).
- Reset WSNDE1, WSNDE2, WSNDE3, WSNDESE
    - WSNDE1 = WSNDE1 * pctmet
    - WSNDE2 = WSNDE2 * pctmet
    - WSNDE3 = WSNDE3 * pctmet
    - WSNDESE = WSNDESE * pctmet

REUSENORES.F

- IN *MAIN.F,* reduce demand for appropriate canals according to SSM.
- If no_of_reuse_plnts =0 then code in this routine is not used.
- IF(iopt_rec_reuse(i)=0) THEN reuse water directly to canals (if no_canals_reuse(i) >0) or cells outside reservoir. Based on option for recipient of reuse ~ routine processes both individually; 0 = canal; 1 = grid_cell (2).
- This will be processed for the number of reuse plants simulated [read in via MODEL_DEFINITION_INFO.DAT].
- Adds water reuse to appropriate locations.
- Reuse (avg_daily_reuse-read in via model_definition_info.dat) is sent to canals via QU(canal_reuse_indx); UPSTREAM_INFLOW(icanal_reuse_indx); DQU(icanal_reuse_indx) or reuse is sent to grid cell locations.
- TOTAL_REUSE – This is the total reuse water sent to canals. *IF* RESNAME_REUSE(I,K) = 'NORES' *THEN* CALC. POND(NODE_REUSE(I,K)) ***&*** TOTAL_REUSE += avg_daily_reuse_vol(I,month)/ (1.9835*no_of_grid_cells_reuse(I)) reusable water not for res.(canals) *ELSE* calc AVAIL_VOL_REUSE which is used to calculate TOTAL_REUSE_RES[cumulated volume of daily reusable water for reservoir] This is the cumulated volume of daily reusable water if iopt_rec_reuse(i=reuse_plnt) = 1 [grid cell].

LAKE_NONREG_WCA.F

- Determine LOK deliveries for WS purposes to WCA and LEC.
- Main purpose is to call *WS_FROM_RES.F* which routes WS from reservoirs and *FLOW_TO_STAS.F* which routes excess and environmental WS (including makeup water) from appropriate areas into corresponding STAs. See *FLOW_TO_STAS.F* option list for RO routing to STA.
- Determine current WS BP zone for LOK and set condition for change in WS BP to LOK from normal operations. LWSBKP checks the canal depth < regstg_wca for each WCA. Used to determine if model needs to make necessary deliveries based on calculated total WCA and LEC needs -> ws_bkp_frac = below or above WCA floor (See below).
  - *TRUE=FRAC_WS_BKP_BEL_WCAFLR*(max_n_eaa_condt) - multiplier for amount EAA runoff backpumping to LOK from MIAMI, NNRHIL, WPB canal basin via S352 when WCA3A/WCA2A/WCA1 are below floor elevation (2).
  - *FALSE=FRAC_WS_BKP_ABV_WCAFLR*(max_n_eaa_condt) - multiplier for amount EAA runoff backpumping to LOK from MIAMI, NNRHIL, WPB canal basin via S352 when WCA3A/WCA2A/WCA1 are above floor elevation (2).
- Set up fraction of expected delivery to be made from WCA1, WCA2A, WCA3A to LEC.
- Calculate running means of simulated lake stages to determine if lake is rising/falling avg_lokstage) [used as a condition for injection of LOK water into proposed ASR].
- Determine if criteria are met for environmental WS release from LOK to WCA3A.
- Also calculates flow to LEC = portion of demand in WCA1 and LEC (RLKDLWS) to be satisfied by LOK thru WPB and Hillsboro canals.
- Routine will route excess EAA RO to ASR reservoir if iasr_opt_eaa(bsn)=ires_opt_eaa(bsn) =1. Also will route HLSB EAA RO to ASR reservoir if there are no LEC demands and no environmental demands in the Everglades if iasr_opt_eaa(2)=ires_opt_hill =1[Option to route runoff for HILLSBORO BASIN].
- Delivers water from LOK to maintain STAs during dry periods.
- Route water from LOK to Seminole dmd and Holeyland via Miami Canal.
- Determine amount of Miami Canal RO BP if LOK is low and no WS or environmental needs exist in WCA and LEC. If BP is desired then redistribute flows between S3 and S8.

WS_FROM_RES.F

- Called from *LAKE_NONREG_WCA.F*.
- In *LAKE_NONREG_WCA.F* -> Route environmental WS.
- If opt_for_hill_bypass =[TRUE] -> Route WS from Hillsboro Canal basin in EAA if istaopt(4)=1[input data = 1]. IF FALSE then routes WS through STA 2. Check the idshg_opt = 2 -> (discharge to meet EAA basin demands). Then *LAKE_NONREG_WCA.F* calls *WS_FROM_RES.F*.
- Compute WS discharges from reservoirs to appropriate destinations. Calculate indx_lok_del [= internal index for condition for LOK delivery to major EAA basins]. Used for segmenting potential delivery if total_lec_dmnd_lok > 200. This is the index for condition for LOK delivery to major EAA basins.
- Determine volume of water available for each outlet structure. Route water supply seepage [based on res_out_type="SEEPG'] to appropriate destinations ELSEIF

[res_out_type =FLDC/WSPLY/ENVIR discharge) then if idshg_opt=0 [discharge to canal] route discharge through specific reservoir structures.

- Compute reservoir stage and reservoir outflow when idshg_opt = 1 or 2. Calculate res_outflow_to_basin. This is used to add conveyance reduction to major canals.
- Route environmental WS from EAA Reservoir to STA34 = idshg_opt = 3. For reservoir coded STA3 and 4 only. Second check.
- Different types of calculations are made based on WCAENV=calendar or rain-driven operations for each WCA. *LAKE_NONREG_WCA.F* then calls *FLOW_TO_STAS.F* and process RO sequentially. *FLOW_TO_STAS.F* processing sequentially as follows:
    1. Compute RO from 298 Districts in EAA diverted to STAs. Option = 4.
    2. Make necessary delivery based on calculated total WCA and LEC needs. Option = 1.
    3. Route RO and flow-through (flow-through may exceed LEC demands) to STAs if RO exceeds LEC demands. Option = 1.
    4. Route environmental RO based on WS from EAA reservoir to STA34. Reservoir is primary source. Option = 1.
    5. Route RO from NNRC into STA34. Option = 2.
    6. Route RO & flow-through (flow-through may exceed LEC demands) to STAs if RO exceeds LEC demands. Option=2.
    7. Determine amount of RO in NNR canal basin in EAA to be BP to LOK for WS. Will be done only if LOK level is low and there is no WS or ENV needs in WCAs or LEC. Then route RO into STA34. Option = 2.
    8. Route RO from HLSB canal basin into STA2. Option = 3.
    9. Route RO and flow-through (flow-through may exceed LEC demands) to STAs if RO exceeds LEC demands. Option = 3.
    10. Deter WS BP if no demands exist for WCA or LEC. If STA exist or IWSBKPWSTA = 1- option to have water supply BP to LOK from EAA prior to or after routing of RO to appropriate STA 1= prior; 0=after (2). Then route RO into STA2. Option = 3.
    11. Route G155, G88mG89 to STA5 and RO from sugar ranch to STA6. Option = 4.
    12. Route makeup water to STAs. Option 6.

NOTE: Option number is hardwired in call to *FLOW_TO_STAS.F*. See below for definition of option number.

FLOW_TO_STAS.F

- Route RO based upon the ISTOPT option table as follows:
  ISTOPT
    - =1 -> runoff from S-8 basin into STA3 and STA4.
    - =2 -> runoff from S-7 basin into STA3 and STA4.
    - =3 -> runoff from S-6 basin into STA2.
    - =4 -> runoff from 298 districts into STA34 and STA 2, et al.
    - =5 -> route desired percentage of G-89; G155; and G-88 flows into STA5 and RO from sugar ranch to STA6.
    - =6 makeup water for STA option as result of BMPs.

- This option is set in *LAKE_NONREG_WCA.F* as a hardwired passed parameter when RO needs to be routed from in [*LAKE_NONREG_WCA.F*].

LAKE_REG_WCA.F

- Calculates WS and regulatory discharges from LOK to the WCAs.
- Management of excess water from LOK to WCAs and Caloosahatchee/St. Lucie estuaries based on regulatory releases from LOK.
- Routes excess water from LOK into PROP reservoir. If iprop_res_prior_opt_lok_reg=1 then have reservoir as main recipient of LOK excess water. (See below) If reservoir is priority then volume of excess water from LOK is subject to canal conveyance with pumped flow into reservoir with intake levels at pump the same as intake level at inflow pump into appropriate STA. Routes excess water from LOK into proposed reservoir(s) using option to prioritize (iprop_res_prior_opt_lokreg=option to prioritize prop reservoir(s) as recipient(s) of LOK) excess water {use neutral capacity for pumped flow instead of gravity flow}) then computes EAA conveyance capacity for neutral case for Miami and North New River canals with pumped flow [based on option to route water if STA exist/don't exist]. Input to model = 0.
- Routes excess water from LOK into proposed reservoir(s)/ Reservoir receiving runoff from EAA basin =IEAA_RES_ASR_REG(max_n_eaa_condt,5) - ieaa_res_asr_reg_name (name of reservoir receiving excess water from LOK) matched against resname and set to ieaa_res_asr_reg. NOTE: no input to model at this time.
- Calculate total limit on EAA RO and WS plus regulatory flows (TFLOWS#) and (S6 and S5A) discharge to WCA1/S7 - discharge to WCA2A /S8 - discharge to WCA3A.
- Determine the Everglades needs based on limit of regulatory releases from LOK to WCAs for each EAA basin- Are the Everglades needs met? This depends on FC stage trigger, calendar, or alternative calendar based option. Then route appropriate portion of RO into STAs.
- LOK volume of storage [updated in *LAKE_NONREG.F*] above regulatory calculation (LOK_REG_TO_EST) will be a limit for regulatory release through Caloosahatchee and St. Lucie canals. Converted back to LOK stage and used to determine if backpumping Caloosahatchee reservoir into LOK.
- Inject water into proposed ASR system when LOK stage is sufficiently high and retrieve from ASR when sufficiently low. Calls *NORTHLOK _RES.F* - Computes volume of water to be routed to North Storage reservoir from LOK or taken from North Storage to LOK based on hydrologic conditions. Only if inorth_stor_opt = 1 [current model data is set to zero].
- Then BP Caloosahatchee Reservoir water into LOK if reservoir stage is above threshold at prescribed rate.
- Compare regulatory releases to St. Lucie and Caloosahatchee rivers (REGS308 and REGS77). Release steady flow based on LOK stage/ZONE; season outlook/3 conditions: dry; normal to very wet; extra wet; pulse release zone; 10 day pulse cycle; multi-seasonal outlook.

NORTHLOK_RES.F

- This routine is called from *LAKE_REG_WCA.F*.

- Performs water budget for proposed north Lake Okeechobee reservoir.
- Returns the release from the reservoir to LOK and inflow from LOK to the reservoir.
- Inflows from LOK to be pumped into reservoir when lake stage is rising >0.25 ft below the bottom pulse zone of the current regulation.
- Release back to lake when stage is falling > 0.5 ft below bottom pulse zone.

MAIN

- Recalculate total_flow_g404 += ws_frm_lok_to_semcyp
- Add ws_from_lok_to_semcyp [Big Cypress and Seminole Reservation.] (calculated in *LAKE_NONREG_WCA.F*) to total_flow_g404.
- Route excess water to reservoir/ASR system (adds flow_to_eaa-res_rnff to POND and flow_to_eaa_res_reg to POND). Currently this section of the code is not used-no RO injection to ASR.
- Recover water from EAA wells to meet remaining demands. For each reservoir and outflow structure and for each outlet-> if idshg_opt = 1[discharge to meet EAA basin demands] and stagelo_beg.GE. stgref_asr_rec and iasr_opt_eaa=1 then call *WS_FROM_RES.F*. The model does not currently use this because input is not set to 1.
- IF stagelo_beg >= stgref_asr_rec and if iasr_opt_eaa = 1 then load iagflo for each EAA basin and call *ASR.F* to retrieve WS from EAA RO. Coding for injection is not available.
- *FLOW_TO_EAA_RES_RNFF* (max_n_eaa_condt) =- This is flow to EAA from reservoir runoff. Used to calculate rem_weir_capac;volwtr;runoff_south. NOTE: Route EAA RO to ASR reservoir if there are no demands in LEC.
- *FLOW_TO_EAA_RES_REG* (max_n_eaa_condt,max_n_reg_rel_basin) += vol_to_inject for basin 6/7/8 in [*LAKE_REG_WCA.F*]- Initialized to 0.0 in [*LAKE_NONREG_WCA.F*]. This is the regulatory flow to EAA reservoirs using canal conveyance capacity for injection of LOK water into proposed reservoir (other than STAs) in EAA.

WS_FROM_RES.F

- Computes WS discharges from reservoirs to appropriate locations.
- This is also called by *MAIN.F* to compute WS discharges from reservoirs.
- Looks at each reservoir and outflow structure and is based on (if discharge option for each outlet goes to canal) and (if beginning LOK stage .GE. calculated regulation stage for ASR) [ASR retrieval line] then water supply is made available from reservoir discharges.
- Compute WS discharges from reservoir to appropriate destinations. Calculate indx_lok_del [= internal index for condition for LOK delivery to major EAA basins]. Used for segmenting potential delivery if total_lec_dmnd_lok > 200. This is the index for condition for LOK delivery to major EAA basins.
- Determine volume of water available for each outlet structure. Route water supply seepage [based on res_out_type="SEEPG'] to appropriate destinations ELSEIF [res_out_type =FLDC/WSPLY/ENVIR discharge) then if idshg_opt=0 [discharge to canal] route discharge through specific reservoir structures.
- Compute reservoir stage and reservoir outflow when idshg_opt = 1 or 2. Calculate res_outflow_to_basin. This is used to add conveyance reduction to major canals.

- Route environmental WS from EAA Reservoir to STA34 = idshg_opt = 3. For reservoir coded STA3 and 4 only. Second check.
- Different types of calculations are made based on WCAENV=calendar or rain-driven operations for each WCA.

ASR.F

- Performs the recovery from ASRs for each basin.
- The objective is to calculate the flow from ASR for WS to EAA which is the AG flow less WS that could not be recovered.
- This is then set to flow from ASR to meet remaining EAA demand which is written out to DSS output file.

WCA_AVAIL_STOR_DMND_SETUP.F

- Routine sets up WCA outflows demand.
- Sets REG_REL_FRM_LOK(1-4)=regs354(WCA3A), nnrreg(S351), regs352(WCA1), hlsbreg(S351). This was calculated in *LAKE_REG_WCA.F* and used in *WCAOUT.F* to calculate struc_flow and then determine avail_cap_reg [available capacity to deliver regulatory releases from WCA –1 to tide via C-51], kflo. This was regulatory releases from listed structure through appropriate STA.
- Calculate demand and storage=TNEED(WS needs for each service area); TINFLOW; ADD_NEED; TOTAL_OUTF_FRM_CNL. NOTE: addflw is added to tinflow and initialized to 0 after *WCAOUT.F*.
- Calculate the total LEC surface water needs (TNEED which includes ADD_NEED) to be met by each of the WCAs. Information is needed for pro-rating of available supply if supply is not sufficient to meet the needs. NOTE: WS needs is based on OPT_L8_PROP (wsneed_l8 = dqu(ifls8) or wsneed_l8 =wsneedl8 [needed WS from LOK to L8 basin via WPB canal calc in *STRUC_LOK_IN_WCA_FLW.F* and LWDD. IFLS8 - Contains the flow number e.g. IFLS8 = flow number of S8. S8 match based on structure name from eaa_str_name and matched with flnm (2); Initialized to ieaa_str_indx(1,2) in *GEN_MODEL_DEF_PARAM.F*.
- Routine determines total structure inflow for each WCA based on adding ADDFLW and KFLO to TINFLOW.
- Determines demands and available water for conceptual pipelines simulated, but currently not used.
- Finally available regulatory releases 'AVVOLRG' and available WS 'AVVOLWS‘ are calculated.

WCAOUT.F

- Determines Water Conservation Area outflows. Uses either general or specific code for discharges for outlet structures in WCAs based on user input in [wca_out_struc_specs.dat].
- Determines the discharge at the outflow structures of the WCAs. This takes in consideration structure capacity, calculated outflow, and volume of available water for outflow. The process identifies the number of known flows and the names of each flow.

This will be used to loop the structures with structural discharge from canals at known flow points in the *KNFLOWS.F* routine.

- Define the HW and TW stages for each structure. Options IHWOPT/ITWOPT are incorporated so the model knows if the HW and TW of a particular structure is represented by a canal or node.
- Discharges are stored in the KFLO array.
- Determines structure flows as a function of GW level and/or canal stage; apply water supply, FC, and environmental rules.
- Determine the outflow from each structure and then downstream needs are met via conveyance canal or grid cell.
  - Also includes special code unique for appropriate structures.

MAIN

- Addflw for each WCA and conveyance canal in each WCA is reinitialized to 0.
- This was previously calculated in [*WCA_AVAIL_STOR_DMND_SETUP.F*].
- ADDFLW is cumulated in [*LAKE_NONREG_WCA.F*] based on flow WS from LOK thru S6 via STA or just WS to S6. This can include untreated RO from runoff_south.
- ADDFLW and KFLO (calculated structure flow) is added to TINFLOW in [*WCA_AVAIL_STOR_DMND_SETUP.F*] which is the total inflow for individual WCA.

KNFLOWS.F

- Distributes known flows to the appropriate canal or surface ponding location.
- Seasonal adjustments to regulation schedules are also made in this routine.
- Place structural discharge from canals at known flow points with variable slope from-to specified locations (data from KNOWN_FLOW_ROUTE_SPEC.DAT).
- Structural discharge includes boundary structure flows and simulated flows from earlier routine.
- IOPT specifies how the flows are distributed. See list below:
  - IOPT=1 – FLOW TO PONDING
  - IOPT=2 – FLOW TO CANAL
  - OPT =3 – FLOW FROM POND1 to POND2
  - IOPT=4 – FLOW FROM POND TO CANAL
  - IOPT=5 – FLOW FROM CANAL TO POND
  - IOPT=6 – FLOW FROM CANAL TO CANAL
- Uses KNOWN_FLOW_ROUTE_SPEC.DAT file which contains the known flow specification data. This data is used to route measured (historical) discharges or simulated discharges computed in *STRUC_LOK_IN_WCA_FLOW.F*, *LAKE_REG_WCA.F* and *WCAOUT.F* routines to appropriate locations specified in the data.
- Loops on the number of known flows calculated in *WCAOUT.F*. Determines S313B, S32BR, S32A flow sent to DSS output. Then determines S9, G94AB- LWDD, S39, S11 flow, and [G155 flow IF istaopt(6)=1; Option to route water to an STA (0-sta no exists;1-sta exists)- from western basin G88, G89, G155, S332BR]. If none of these structures are found then processing is based on the known flow option (IOPT=KFL(II,1)) obtained from input [KNOWN_FLOW_ROUTE_SPECS.DAT. Also calculate TOTWSNEED, AVSUPPLY, QU, and KFO for G94AB- LWDD, S39.

- Will set today's regulation schedule to CREL-crest elevation which is the headwater stage above which outflow occurs for each structure. But only if /NREG_SEAS>0-model has no data/ number of structures (fixed crest weirs) with seasonally varying flood control stages (11). This includes seasonal flood control elevations for structures simulated as fixed crest weirs. This is used in [*CHNLF.F*] and then in [*LVSEEP.F*].

MAIN

- Storm drawdown is then step up.
- It is based on IDRWNRES = counter for each res_name_drawdown read from RES_OPS_DRAWDOWN (the model currently has no data in this file) in [*CNLDATA.F*] and used to read in drawdown reservoirs and structures.
- Loop on IDRWNRES parameter if nstorm_day =1 to set CRSTELEV= CRESTELEV_drwdwn (the crest elevation used in determining open/close decisions involved with specifying max stage for inflow to be used under drawdown) & STGMX= STGMX_drwdwn(the max stage for inflow to be used under drawdown) for each draw down reservoir and structure within each drawdown reservoir.
- Loop on IDRAWRES parameter if nstorm_day = 0 to set CRSTELEV=CRSTELEV2 (This is the 2nd level weir crest level which is set in reserv_input_data routine) and STGMX = STGMX2 (For each reservoir the maximum stage allowed for structural INFLOW (ft NGVD)). NOTE: nstorm_day determines if day in month is simulated for storm(ndays_sim_ed).
- This is not used because ndays_prestorm_drawdown = 0.
- Looping on each node -> process the number of small reservoirs in each node.
- For small reservoirs only, each outlet reservoir structure which is labeled 'ENV' or "FDC' calls ETCOMP to compute ET and then modified the stage [tail_p].
- If the type of reservoir is 'WSPLY' or "SEEPG' (WSPLY - water supply to meet urban or agricultural demands, SEEPG - represents seepage out of reservoir; becomes available for WS needs) then [tail_p] is calculated without using ET [*ETCOMP.F*] otherwise calculation uses [*ETCOMP.F*] if type is (FLDC - flood control, ENVIR – for environmental purposes).
- Tail_p is the stage outside the reservoir. *ETCOMP.F* was also processed after *LVSEEP.F* to calculate volwtr - volume of water in the reservoir for both small and large reservoirs.
- Use the present maximum outflow from each outflow structure for each reservoir (qoutmx) and maximum outflow from the stage outside the reservoir (qoutmx_p) to recalculate VOLWTR.
- NOTE: qoutmx = present max outflow from each outflow structure for each reservoir is previously calculated in *LARGER_RESERV_STOR.F* and *SMALL_RESERV_STOR.F*~ start of monthly loop. Also processed at the end of daily loop.

CHNLF.F

- Calculate mean channel depth, seepage, downstream outflow, and overland flow given inflows and mean depth at the end of the previous day.
- Prior to execution of *CHNLF.F*, storm drawdown is calculated for CRSTELEV and STGMX for each IDRAWNRES. Then ETCOMP is called for each NORESINCELL and

NOUTSTR with VOLWTR(IA) calculated for each IRES_INDEX_IN_CELL - used to keep track of each reservoir in cell.

- Set up operations for canals that will be drawn down during appropriate periods. Setup minimum and maximum stages (close/open for FC purposes) for canals that will be drawn down based on NSTORM_DAY during input based periods. Two different min/max stage levels loaded based on nstorm_day.
- Set up minimum and maximum stages for canals with dual ops based on the number of structures with dual operations (2/0/1) [ndual_canal_ops(1/2/3)]. (See below). Then incorporate dual ops for special cases. Two types of Min/Max stage to open/close gates based on S333FC, S333_REG_LEC, S337FC – regulatory stage levels for flood control. NDUAL_CANAL_OPS (max_n_dual_cond) - number of structures with dual operations for each specific condition [no_of_flow_conditions]. There are 3 specific conditions set. (this uses model input from FC = 157 [DUAL_OPS.DAT]) FIRST: When releases are made through S-334 or S-337 from WCA-3A to protect sparrow during nesting season. SECOND: When releases are made through S-334 from WCA-3A to protect sparrow during nesting season. THIRD: When releases are made through S-337 from WCA3A to protect sparrow during nesting season. Two types of Min/Max stage to open/close gates based on: S337FC=Compute regulatory flow from WCA3A to be routed through S-337 to help relieve high water in WCA3A and help the sparrow in western Shark River Slough. S333_REG_LEC = This is the regulatory LEC stage level at S333. S333FC=Compute regulatory flow from WCA3A to be routed through S-333 to help relieve high water in WCA3A and help the sparrow in western Shark River Slough.
- Channel routing using iterative mass balance procedure - calculate canal downstream stage and outflow, seepage and overland inflow given canal upstream inflows and downstream stage from the end of the previous day.
- Calculate overland flow for each reach [OVLFL] and total seepage [CGVOL] (using seepage routine) and injection into ASR wells (then call *ASR.F*)-> C51/HLSB/NNRC/L31 ASRs for canal source/destination. Then calculate outflow (cout) at downstream structure and discharge for canals with daily varying slope.
- Establish equilibrium canal stage by calculating canal budget components.
- CALL *CANL_DEP_STRUC_PARAM_SETUP.F* - Setting flow parameters for canal structures. CALL *CANL_DEP_STRUC_CAPAC_SETUP.F*- Flow calculations. CALL *GEN_CANL_DEP_STRUC_FLW.F*; CALL *SPEC_CANL_DEP_STRUC_FLW.F*.
- IF LP(7)=TRUE write to monthly components of canal budget FC=72 [MTHLY_CANAL_BUD.DAT].
- IF LP(6)=TRUE write to annual components of canal budget FC=82 [ANN_CANAL_BUD.DAT].

CANL_DEP_STRUC_CAPAC_SETUP.F

- Processes flow calculations - pump downstream no more than can be accepted without aggravating flood conditions, if applicable.
- Capacity is calculated based on irating of the substructure which is 1= Gated spillway or culvert; 2= Pump; 3= Culvert with flashboards.
- If ides_cap_limit = 1- Index indicating if additional structure discharge is limited to capacity -> reduces the capacity used.

- For each of the canals which have a maximum stage allowed for inflow of upstream flood control discharges calculate the downstream discharges.
- Calculate CAPACWS = this is the downstream capacity considering WS if applicable. Purpose of discharge for each component simulated for each structure is WS. Calculate CAPACFL = This is the downstream capacity considering flood conditions if applicable. NOTE: uses imgt = number of flow management regimes for structure outflow which would require different discharge coefficients.
- NOTE: Capacity is calculated as the minimum of the accumulated available volume or calculated capacity.

CANL_DEP_STRUC_PARAM_SETUP.F

- Setting flow parameters for canal structures.
- Initializes LPUMP=FALSE; lpump is used in the pump section to calculate if hw > rmxstg. RMXSTG(max_ncnls,max_nostr_cnl,max_n_seas) - stage, in ft NGVD, at downstream end of canal the gates (spillways and gated culverts) are open full for flood control purposes. For pumps, stage pumps are turned on for flood control purposes.
- Initializes LGRAV=FALSE; for each substructure that computes discharge for calculation of daily varying slope of downstream canal (set to FALSE for all substructures that are pumps).
- LOGDISG - this is the logical discharge parameter. It is used to determine canal outflow for flood control structure. Used in *GEN_CANL_DEP_STRUC_FLW.F* and *SPEC_CANL_DEP_STRUC_FLW.F*. LOGDISG - this is the logical discharge parameter. It is based on number of canals which have a maximum stage allowed for inflow of upstream flood control discharge > 0 and number of discharge structures in simulation > 0. This is used to determine if canal outflow COUTFL will be calculated. For number of downstream grid locations limiting discharge from structure which is used to evaluate if dntrg_stg is calculated in [*CANL_DEP_STRUC_PARAM_SETUP.F*] evaluates if dntrg_stg > fl_trig_constrt {flood trigger constraint based on ndsglim}.
- Calculate WS demand only if option to use S-333 and S-334 to supply water to coastal Dade County. (use_enp_ws_to_lec – currently input is not used in the model). Add ws_need_l31nc_orig to WS demand. Then subtract S-334 flow from WS demand, add S336 flow to WS demand, and add S338 flow to WS demand.
- NDSGLIM=Number of downstream grid locations limiting discharge from structure (from *CHNLF.F*) is used to evaluate if dntrg_stg is calculated. Then counts number of canal discharge structures based on down stream trigger stage > flood trigger constraint for additional discharge structures. This set up LOGDISG.
- Initializes CAPACWS = This is the downstream capacity considering WS (if applicable) when the purpose of discharge for each component simulated for each structure is WS. Initializes CAPACFL = This is the downstream capacity considering flood conditions (if applicable) when the purpose of discharge for each component simulated for each structure is FC. NOTE: uses imgt = number of flow management regimes for structure outflow which would require different discharge coefficients.

GEN_CANL_DEP_STRUC_FLW.F

- Calculate maximum avail storage in reservoir receiving discharge from structure (if applicable).
- For each substructure in each canal structure calculate canal outflow based on type of structure, purpose and using general code.
- For type of structure for each [component] flow management regime simulated not PUMP calculate canal outflow limit for each canal in the master list.
- Calculate available downstream volume in the northeast corner of the park. Otherwise calculate canal storage and compare to available canal storage.
- For S334FC calculate the stage level for G3273 and canal outflow.
- Calculate maximum available storage in reservoir receiving discharge from structure (if applicable) for reservoirs receiving discharge from additional structures (for each structure in each canal). This involves calculating COUT from reservoir and adding to QU and is based on option (iopt_to_deiver_bel_targ) -outflow from structure is delivered to reservoir if stage at target location is ABOVE/BELOW target level and (lwslo) - avg_sim_wca_stg(isa) < stage_import_wca(isa) - offset(isa,1) ; isa = number target areas. iopt_to_deiver_bel_targ = index indicating criteria for routing outflow from structure to reservoir. 0: Outflow from structure is delivered to reservoir if stage at target location is ABOVE target level. 1: Outflow from structure is delivered to reservoir if stage at target location is BELOW target level. This is model input found in CANAL_STRUC_SPEC.DAT.
- Then calculate res_stage. Recalculate cout (using qu and dqu) for canal receiving discharge or pond if grid cell/hydrological basin receiving discharge. If the fraction of discharge from additional structures entering each reservoir < 1% then re-evaluate the amount of water STAs can receive.

SPEC_CANL_DEP_STRUC_FLW.F

- Calculate flows, pumpage, WS, backflow, WS release overflow and environmental flows for specialized canal operations (62 operations).
- Execution of canal structures are based on ISPEC =index for type of code used based on canal_struc_specs.dat (1= special code unique to structure; 0= general code).

OVLNF.F

- Calculate overland flow for each cell.
- Calculate vertical flux (infiltration and percolation).
- NTSTEP_OV is number of time steps per day (4).
- Impose boundary conditions for OVRLF on surface water part of ENP.
- Assume gradient of water level to be the same as land surface if slope of land surface is downward toward west coast.
- Calculate flows in west-east direction (1^{st} iteration); north_south direction (2^{nd} iteration).
- When BSN(NODE) .ne. BSN(NODE2) there is an intervening levee, don't calculate OVRLF. Node,node2= subscript value of up/down stream node.
- Calculate volume of OVRLF using Manning's Equation -> then make sure this amount does not cause gradient to reverse sign.

- Calculate OVRLF correction for estimate of stage in reservoir whose outflow is going into the same cell in which reservoir is located and OVRLF is allowed to/from cell.
- NOTE: For EAA cells do infiltration and ET computations in *AGAREA.F* [Calculate soil infiltration and ET assuming no unsaturated zone].
- For LECSA calculate soil infiltration assuming unsaturated zone exists and use *LEC_ET_COMP.F* to compute ET, infiltration, ponding, recharge, etc.

LEC_ET_COMP.F

- For non-EAA cells calculate soil infiltration and ET assuming unsaturated zone exists. If cell is in LECSA and LEC-ET routine is turned on, have *OVLNF.F* call *LEC_ET_COMP.F* to compute ET, infiltration, ponding, recharge, etc.
- Account for preprocessed ET for the unsaturated zone. Calculate WHC=soil moisture holding capacity and current root zone depth (RZD) to determine soil water supply capacity (swscap).
- This is used to check if ending solmx[equivalent depth of soil moisture in the soil column-moisture content in the unsaturated zone] exceeds swscap-> for each node:

    perc = solmx – swscap
    solmx = swscap
    perc=perc*(1-carfact); carfact-cnl area fraction in cell.
- Compute ET from the saturated zone. Land use types 7,8,9 - KC uses internally set monthly fractions. ET calculations are based on land flooded/not flooded.

EXCADJFRESSTG.F

- For large reservoirs use excess water to calculate head and adjust for overland flow as well as daily_excess_adjust. Excess water is used in calculating adjust_for_area in [lok_ws_to_larger_res.F]. This involves DPTH calculation which aids in obtaining stage_res. It is also used to adjust reservoir stage in [*RESOUT.F*].
- Calculate depth of excess water to be used to adjust estimate of reservoir stage.
- Calculate DAILY_EXCESS_FOR_ADJ IF SGN*TERM1_FOR_ADJUST_AREA > TERM2_FOR_ADJUST_AREA. Defined as follows: TERM1_FOR_ADJUST_AREA = (sumet_outside_res(node) + seep_loss_res(node) – sumrain(node)/12.0 – sum_chg_depth_levee_spg(node))
  TERM2_FOR_ADJUST_AREA = (outf_fc_frm_res_to_cell(node) + outf_seep_loc_to_res_cell(node) + daily_outf_fc_frm_res_to_cell(node) + adjust_for_ovlf)/afact

EAACORR.F

- Correct storage in EAA basins from flows in excess of structure capacity or for cutbacks in delivery to EAA.
- Make stage adjustments for US Sugar Ranch if treated separate from other EAA basins.
- Distributes excess runoff and irrigation requirements generated in the EAA water table management subroutine-*AGAREA.F*-for each EAA node.
- Account when runoff from EAA exceeds removal capacity. NOTE: Make adjustment for US Sugar if separate basin [this is now commented out].

- If land is flooded – value of KMAX represents that of open water surface. All landuses are assumed to be open water when ponding depth is > OWPOND (arbitrary).
- As ponding increases this could mean that the pan coefficient grows or decreases.
- Correct for demand not met by regional system in meeting agricultural demands in L-8 basin (other than sugar cane).
- IAGFLO is subtracted out of the RCHG term for each node and then initialize IAGFLO array to 0.0. Array includes number of AG points and 1=load flow, 2=basin number for the agricultural area.

MAIN

- For each grid cell calculate mean ponding depth in each reservoir to determine regional GW flow to/from reservoir.
- Only for large reservoirs -> set pond_prev_gw = pond for each node to be used in the next time step (used after *GWF.F* to calculate diff_pond) and gcell_mean_ponding_depth = pond (for each grid cell the mean ponding depth in each reservoir -> used to determine regional GW flow to/from reservoir.

GWF.F

- Calculate groundwater flows- computes groundwater head at each node. NOTE: solve the groundwater equation.
- Calculate surface ponding depth and add to GW head if GW level = land elevation. Does this for EAA and non_EAA*** cells. For non_EAA cell uses original [Calculate above ground infiltration and use SINF=Soil Infiltration Rate (ft/day) (60) and calc AVINF-available space for "residual" ponding to infiltrate] and revised [includes SOLMX= equivalent depth of soil moisture in the soil column] algorithms to calculate percolation, infiltration, and ponding. Uses standard algorithm for irrigated EAA cell.
- For NON_EAA cells with LU of 0-> H=GET_TIDE() which fetches the current cell's tide for today. GWHEAD=1.025*(h-2) –2. There is no infiltration. POND=H-ELLS; H=ELLS - Estimated boundary conditions for GW calculation->constant head at coastline; no flow at interior boundary nodes. Include any proposed (or current) curtain walls. Curtain walls simulated has no flow condition across appropriate cell interface(s). Find current transmissivity values for grid pts. Calculate harmonic means of transmissivities. Estimate GW flow vectors.
- NOTE: Percolation and infiltration are adjusted for small reservoir fraction and canal fraction in grid. Also adjust water levels in cells with small reservoirs for regional GW flow (1 – small reservoir and canal fractions). Reset correct ponding where H is above land surface or root zone. This is done for both NON-EAA (basin 40) and IRR. EAA CELLS.

MAIN

- Based on grid locations with reservoirs - calculate daily_seep_loss_res for both small and large reservoirs.
- This is used in calculate volwtr-reservoir volume.

SMALL_RESERV_OVLNF.F

- Calculate overland flow through multi-cell narrow reservoirs.
- Calculate overland flow with smaller reservoirs treated independently. Overland flow occurs if mean depth (HM) of flow>detention depth (DETEN_IN_RES).
- Routine checks for upstream head > downstream head then calculates pond_in_res; stage_res; OVLFLO based on VOF/HU, HD. Loop on each reservoir and time slice.

SMALL_RES_GW_FLOW.F

- Solve GW equation. Calculate volume of GW across cell boundary face. Adjust up/down stream reservoir stages
- First find current transmissivity values for each grid cell then calculate volume of GW flow across cell boundary face (HMVOL).
- Finally, adjust upstream and downstream reservoir stages [recalculates pond_in_res and stage_res based on hmvol = volume of gw flow across cell boundary face].

RESOUT.F

- Calculate structural outflows from reservoirs/STAs.
- Calculate FC releases from reservoir (outf_fc_res_to_cell) and WS releases from reservoirs to WCAs.
- Calculate adjustment in estimating reservoir stage due to difference in actual reservoir area and total area of grid cells in which reservoir is located. Final area adjustments are made.
- Calculate area based on if reservoir is large enough not to be treated as a separate entry in grid domain – area adjustments are made.
- Calculate available storage in reservoir to be injected into ASR. These calculations are based on separate entity status. Inject excess water from res. to ASR [CALL *ASR.F*]. Adjust water levels in reservoir based on separate entity status. For large reservoir-> recalculate pond and recharge -> stage then for small reservoir -> stage_res, pond_in_res.
- Recover water from ASR to reservoir based on separate entity status via-ASRVOL(asrid) -available volume in the ASR bubble that could be fully used to meet demands.
- Compute equilibrium stage for grid cell-reservoir system [*RESERV_CELL_EQUIL_STG.F*]. If no downstream reservoirs exist then use the tailwater stage. This is used to calculate AVVOLGR [this is the available volume which includes canal volume (depth-crest_elev_struct) + canal seepage (*CGSEEP.F*) + overflow to canal (*TOVFLC.F*) + canal flow (qu). Available volume for reservoir/structure outflows.
- AVVOLGR is calculated based on separate entity status. Determine if criteria are met for ENV WS release from LOK to WCA3A and outflow from grid cell followed by canal. [Then calculate hydraulic detention time for reservoirs if outflow from STA > 0.]
- Route total outflow from Rotenberger to appropriate area. ***IF*** runoff_to_holeyland= 'INDIRECT' then calculate outflow_from_roten_to_holey ***ELSE*** calculate outflow_from_roten_thru_s8.
- Incorporate small reservoirs as part of the grid system. This involves calculating GWHEADNODE - based on stage_res for each reservoir followed by

H+POND+SOLMX/S for each node. Then calculate total_cell_stor for each node which includes cell storage and canl_stor_in_cell.

RESERV_CELL_EQUIL_STG.F

- Compute the weighted mean water surface elevation for a grid cell containing small reservoir(s) which are treated independently.
- This mean elevation is needed for calculating maximum limit of seepage loss from reservoir to cell so no reversal of gradient between head in grid cell and gradient in reservoir occurs.
- Calculate depth of water in reservoir/depth of storage in reservoir above mean land surface elevation in grid cell outside reservoir.
- EQUIL_STG (which is the equilibrium stage) is calculated differently in the routine under the following conditions:
    - IF (equivalent depth of water in reservoir above mean land surface of grid cell ≤ depth of available storage in grid cell) and
    - IF (equivalent depth of water in reservoir above mean land surface of grid cell > depth of available storage in grid cell)
    - IF (equivalent depth of water in reservoir above reservoir bottom is > the equivalent available storage in area outside reservoir below reservoir bottom elevation)
    - IF (equivalent depth of water in reservoir above reservoir bottom is <= the equivalent available storage in area outside reservoir below reservoir bottom elevation)
    - IF (equivalent depth of water in reservoir above mean cell land surface elevation > the equivalent available storage in area outside reservoir).=
    - IF (equivalent depth of water in reservoir above mean cell land surface elevation ≤ the equivalent available storage in area outside reservoir).

LARGER_RESERV_STOR.F
SMALL_RES_STOR.F

- These routines are used to calculate available storage at the beginning of the daily simulation here as well as after calculating structure outflows from reservoirs.
- Calculate available storage for flow into reservoirs (for each reservoir) for next daily time step. Also calculate at beginning of monthly time step.
- Calculations are based on small (treat as a separate entity) or large reservoir.
- Large reservoir = sfactor(ia).GE.sfactmin .OR. ires_small_sim=NO'
- Routines will be processed after computing discharges for LOK outflow structures to meet EAA demand and for inlet structures to WCAs. This is used in computing volume of demand to maintain STAs at min level for environmental purposes.
- NOTE: SUMRAIN - accumulate rainfall and (ET) for each cell for estimating stages in above ground reservoirs ~ used for adjustment.
- TVOLWTRL - set = to volwtr in *RESOUT.F* and used to evaluate QOUTMX in *LARGER_RESERV_STOR.F* and *SMALL_RES_STOR.F*.

- QOUTMX -maximum flow of outflow structure for each reservoir. If res_out_type(ia,i).NE. 'WSPLY' then qoutmx is calculated and added to volwtr else qoutmx(iqa,i) = 0.0.

MAIN

- Write out FC=67:DAILY_TRIBAL_SUMMARY.DAT (NEW).
- This is the Seminole Big Cypress summary output file. Total demand; demand met by local S-190 flows/Rotenberger WMA/STA6/LOK.
- Also Seminole Brighton supplemental demand and demand met by LOK; Seminole Hollywood PWS pumpage demand and actual pumpage.

SPECSETUPFDSS.F

- Accounting of special volumes on a daily basis to be put into DSS output file. This includes WS from S351, S352, S354, WS_to_lec_s351, vol_rec_from_c51asr, vol_inj_to_c51asr, asr_rec_ws(nsvarea), etc.
- This subroutine calculates the total WS and regulatory discharges from LOK to the WCAs.
- Initially set up separate components of flow for S5A2; S5A3; S5A4 and LOKREG2STLUC and LOKREG2CALOOS. Then loads WS, DMND, RO, and WEIR FLOW.
- Variable groups are loaded given IF conditions. See list below.
- CHECKING FOR NAMES OUTPUT TO DSS (B-PATH)

COUNTER	CHECKED AGAINST	CONDITION
[n_flow_dss_calib]	[n_str_if_cond(1)]	runmode='CALIB'
[n_flw_dss_uncond]	[n_str_if_cond(1)]	runmode='SIMUL'
[n_flw_dss_nsta]	[n_str_if_cond(2)]	nmarea > 0
[n_flw_dss_import]	[n_str_if_cond(3)]	nmarea > 0 & make_up_water_opt = 'MAKEUP'
[n_flw_dss_sta34]	[n_str_if_cond(4)]	istaopt(is8bsn-6)=1 . OR.istopt(is7bsn-6)=1
[n_flw_dss_l8_no_s316]	[n_str_if_cond(5)]	.NOT.opt_l8_prop & runmode='SIMUL'
[n_flw_dss_w_s316]	[n_str_if_cond(6)]	opt_l8_prop
[n_flw_dss_rfops]	[n_str_if_cond(7)]	type_flow_across_ttrail .NE. 'MINDEL' & runmode='SIMUL'
[rlok_to_nort_stor]	[n_str_if_cond(8)]	inorth_stor_opt = 1
[n_flw_dss_semcyp]	[n_str_if_cond(9)]	isem_flg = 1
[n_flw_dss_lok_split]	[n_str_if(cond(10)]	lok_split_option = 1
[n_flw_dss_asreaa]	[nadstr_asr_eaa]	iasr_opt_eaa(5a/7/8bsn] =1 or nase_to_eaa(5a/7/8bsn)>0

- Minimum flows and levels variables are written out to (FC=106) - DAILY_MINLVL_SPECS.DAT.
- STRFLW written in DSS form = processed at the end of the daily loop via *SIMQ2DSS.F* and *SIMCSTG2DSS.F*.

DAILY OUTPUT.F

- Daily output to various ASCII files. Calculate ACSTG-for each monitoring station. A station can have more than one location. The RMEANS_ACSTG is adjusted for this number. This is adjusted for large reservoirs. (See *PRINTLP.F*).
- Output components of ASR budget (FC=65).
- LOK stage output (FC=76).
- Estimated flow to GWT [EST_FLOW_TO_GWT] ->Maximum available storage in reservoir receiving discharge from structure. Writes list to FC=131.
- Rain fall formula (FRF) (FC=141).
- Compute mean ponding for cells with separate reservoirs(s). This means incorporate small reservoir as part of grid system calculated in *RESOUT.F*.
- Write out water budgets for small reservoirs to (iunit_no_res_file). IUNIT_NO_RES_FILE - fc based on MAX_N_SM_RES to output files for daily_water budgets for small reservoirs. The tempfile is based on RES_FILE_NAME (145).
- Write out NSM flow targets S12; S333; S355 (if applicable; FC=151).
- Write out daily slopes for appropriate canals (FC=190).
- Write out levee seepage (FC=102).

RESERVOIR_INIT.F

- Initialize appropriate variables for reservoirs.
- Only processes large reservoirs to be maintained at desired minimum levels during dry periods.
- For each reservoir determines both the stage of reservoir and stage based on maximum depth (ft) of water to be maintained during dry period. REP_STAGE_RES = H(node_rep_res) + POND(node_rep_res) IF(REP_STAGE_RES .LE. ELLS + DPHWS*sfactor .OR. STAGE_RES .LE. DPHWS then calculate DEPTH_OF_DEFICIT -> ETCOMP. NOTE: DPHWS=for each reservoir maximum depth (ft) of water to be maintained during dry period (source is LOK) If -901=reservoir is not maintained.
- REP_STAGE_RES used to determine if avg_rain_res, avg_et_res, avg_seep_loss_res, avg_chg_depth_levee_spg, cum_loss_res will be calculated.
- For each node -> DEPTH_OF_DEFICIT [determines if land is flooded and checked against DRZ and SRZ to calculate ET_outside_reservoir]. Passed to ETCOMP. Calculate volwtr(calculated in *WCAOUT.F* used in *RESOUT.F*) for each reservoir.
- Final mission is to calculate average reservoir rain, average reservoir ET, average reservoir seepage loss.
- Initialize previously calculated reservoir adjustment factors, SUMRAIN, SUMET, levee seepage and seepage loss variables.
- Set the prev_stage_res = stage_res for all reservoirs. Used to calculate current transmissivity values in grid points and adjust upstream and downstream reservoir stages for next time step.

LEC_ET_SUM_MONTHLIES.F

- Only used if use_LEC_ET > 0.
- Sums monthly ET values and writes:

MTHLY_TOT_ET_COMPONENTS	(24)fc = et_comp_def
MTHLY_TOT_PWS_SUPPLY_BIN	(25)fc= supply_def
MTHLY_TOT_ET_UNSAT_UNACCT.BIN	(57)fc= 57
MTHLY_TOT_EST_ET.BIN	(31)fc = est_et_unit
MTHLY_TOT_PWS_SHORTAGE.BIN	(30)fc= shortage_def
MTHLY_TOT_EST_ETIU_UNRESTR.BIN	(93)fc= est_unres_et_def

NOTE: ( ) = file code assigned by the model.

- NOTE: Some monthlies are converted back to inches.
- Initialize sums –First day of the month.
- Some monthly sums are done outside of this routine (do not sum here).
- Write out monthly sums on last day of month-Do this for each ET(UNSAT, UNSAT_IRR, UNSAT_NONIRR, PONDING and SAT, SUPPLY- by use type).

PRINTLP.F

- If LP(25)=print daily information instead of end_of_month (including some binary files). Info used information from *LEC_ET_SUM_MONTHLIES.F*, *DAILY_OVLNF_OUT.F*; write surface flows. *DAILY_OVLNF_OUT.F*-writes out to binary file daily flow volume information from 2 dimensional overland flow calculations - based on iddump flag.
- IF NOT LP(25) & DAY1 & {initialize_annually_opt =0 or ifyr+iyear-1=ifyr}::NOTE initialize_annually_opt=opt to reinitialize LOK stages, and water levels during simulation.
  Model will write out the following:
  - SURFACE PONDING [POND_END(NODE)] TO FC=41 IF(LP(17))
  - ET TOTAL [ETM] TO ET_TOTAL.BIN [FC=42] IF(LP(18))
  - RAINFALL [RFM] TO RAINFALL.BIN [FC=44] IF(LP(18))
  - WELLS(NODE) TO PUMPAGE.BIN [FC=45] IF(LP(18))
  - INFILTATION MONTHLY [INFILT_MONTH(NODE)] & PERCOLATION MONTHLY [PERC_MONTH(NODE)] TO FC=46 IF(LP(18))
  - GWF & HMVOL_DAILY (NODE,1,2) [based on direction] TO FC=49 IF(LP(20))
  - SURFACE FLOWS [OVLFLO_DAILY(NODE,1/2) [direction] TO FC=43 IF(LP(20))
  - MONTHLY TOTAL NODAL SURFACE WATER FLOW TO CANAL [RMONTHLY_OVLFLO_TO_CANAL (NODE) TO FC=39 IF(LP(24))
  - MONTHLY TOTAL NODAL GW SEEPAGE FLOW TO CANAL [RMONTHLY_SEEP_TO_CANAL(NODE)] TO FC=35 IF(LP(24))
  - MONTHLY CANAL EVAPORATION [rmonthly_canal_evap] TO FC = 38 IF(LP(24))
  - LOK RF,ET,AND END OF MONTH STORAGE TO FC=80 IF(LP(16))
  - MONTHLY TOTAL LEVEE SEEPAGE [SEEPMON] TO FC = 32 IF(LP(25))
  - H+POND to FC=40; EOMTH_STAGE.BIN
  - STAGEND to FC=140; EOMTH_AVG_CELL_STAGE.BIN

- TOTAL_CELL_STOR to FC=142; EOMTH_CELL_STOR.BIN

FINALLY ***PRINT OUT*** BAGP FOR EACH EAA BSN and RMEAN_ACSTG FOR EACH MONITORING POINT (See Below) and STAGELO [& STAGELO_RES IF lok_split_option =1]. {DAY1 only}. NOTE: BAGP = Calculated for each EAA basin the total net demand. This is used to determine the supply for the AG area.

DAILY_OVLNF_OUT.F

- IN *MAIN.F*:if(lp(19))=print daily information instead of end_of_month (including some binary files). Information used: stage, ET, and ponding files; surface ponding; infiltration; ground water flows; surface flows; total levee seepage.
- Will only write if the iddump (day dump) flag is turned on in *DAILY_VARABLES_INIT.F*. This is input in MODEL_DEFINITION_INFO.DAT using julian date calculate based on read in range of dates to output some daily binary output information using iyout1,imout1,idout1 (2) Only exists in file if ip(19)=1 or ip(25)=1 to read range of dates.
- Writes out to binary file- daily flow volume information from 2 dimensional overland flow calculations to FC=43 [DAILY_SURFACE_FLW.BIN].
- First write flow in the x-direction then y-direction.

VAL2VAL_W_LOK.F

- Processed only if LP(22)=print output to binary files and LP(23)=print out active SFWMM cell stage.
- Main passes a hardwired option OPT=0/1 to either build isum, minx, maxx arrays for LOK and W_LOK systems or create values_w_lok array~will split LOK if option is set. Current model input uses lok_split_option = 0. *VAL2VAL_W_LOK.F* routine option is set 1.This will be used for SETGRID routine.
- Calculate surface ponding depth (VALUES) passed to this routine from *MAIN.F*. Creates an array containing active SFWMM cell stages (1746) and lake bathymetry values (176).
- *MAIN.F* writes VALUES_W_LOK(max_ncells_w_lok) = (stagelo - bathymetry) for LOK side and this array also contains active SFWMM cell stage (daily_stg – land_surface_elevation values) for SA1 side.
- Written out to (47) DAILY_STG_MINUS_LSEL.BIN; FC=47
- NOTE: Routine Option = 0 which build isum_w_lok array (does not use stagelo/stagelo_res) is used in [open_binary_output_file.F] to write header of a binary file in grid_io format.

MAIN

- If lp(21)=output daily total ET (daily_total_et.bin) and lp(22)= print output to binary files
- Writes out values = et_sat*12 +et_ponding*12 +et_unsat_actual*12* (1-carfact-total_small_afact) for each node to FC=127 [DAILY_TOT_ET.BIN].

SUM_TRIG_HEADS.F

- Call *SUM_TRIG_HEADS.F* to sum up the heads at canal trigger cells. The user is allowed to set minimum limits on heads at selected nodes. If these limits are exceeded during a run, then pumpage at certain wells will be cutback according to an input cutback schedule-4 phases. This is based on user supplied input –TRGINPUT.DAT.
- This file defines the parameter values for implementing short-term water supply restrictions in the LEC. It primarily contains trigger water levels (as indicators for saltwater intrusion) at pre-defined trigger well locations and corresponding irrigation and public water supply cutbacks.
- Keeps track of canal and/or grid cell stage at designed trigger locations used for LEC water restriction.
- Sums up the heads at trigger cells-sums simulated heads at trigger cells for a user specified number of days during the month. SUM_HEAD calculation is based on Trigger Type (is either GW Head or a canal depth) which is (h + pond) or chdep.
- Sums heads in trigger cells if we're in the right time during the month. This is based on TRIG_PERIOD - length of previous month cutback (fraction of month) for each head of 4 phases based on individual trigger.

MAIN

- END OF DAILY LOOP.

PRINTLP-MONTHLY

- If NOT LP(25)=does not print daily information instead of end_of_month (including some binary files). Model will write out the following:
    - SURFACE PONDING [POND_END(NODE)] TO FC=41 IF(LP(17))
    - ET TOTAL [ETM] TO ET_TOTAL.BIN [FC=42] IF(LP(18))
    - RAINFALL [RFM] TO RAINFALL.BIN [FC=44] IF(LP(18))
    - WELLS(NODE) TO PUMPAGE.BIN [FC=45] IF(LP(18))
    - INFILTRATION MONTHLY [INFILT_MONTH(NODE)] & PERCOLATION MONTHLY [PERC_MONTH (NODE)] TO FC=46 IF(LP(18))
    - GWF & HMVOL_DAILY (NODE,1,2) [based on direction] TO FC=49 IF(LP(20))
    - SURFACE FLOWS [OVLFLO_DAILY(NODE,1/2) [direction] TO FC=43 IF(LP(20))
    - MONTHLY TOTAL NODAL SURFACE WATER FLOW TO CANAL [RMONTHLY_OVLFLO_TO_CANAL (NODE) TO FC=39 IF(LP(24))
    - MONTHLY TOTAL NODAL GW SEEPAGE FLOW TO CANAL [RMONTHLY_SEEP_TO_CANAL(NODE)] TO FC=35 IF(LP(24))
    - MONTHLY CANAL EVAPORATION [rmonthly_canal_evap] TO FC = 38 IF(LP(24))
    - LOK RF, ET, AND END OF MONTH STORAGE TO FC=80 IF(LP(16))
    - MONTHLY TOTAL LEVEE SEEPAGE [SEEPMON]

TO FC = 32 IF(LP(25))

FINALLY ***PRINT OUT*** BAGP FOR EACH EAA BSN and RMEAN_ACSTG FOR EACH MONITORING POINTS and STAGELO [& STAGELO_RES IF lok_split_option +1].

MAIN

- Calls and executes entire *SIMQ2DSS.F* routine. Writes daily simulated structure discharges into output DSS file 'STR2X2.DSS'
- Calls and executes entire *SIMCSTG2DSS.F* routine. Writes daily flows for simulated canal stages into output DSS file ' DAILY_CANAL_STG.DSS.'
- Calculate ratio_excess_ovlflo(node,iyear,it*) = excess_vol_ovlflo(*)/vol_ovlflo(*) which was initialized in [*ANNUAL_INIT.F*] and calculated in [*OVLNF.F*].
  EXCESS_VOL_OVLFLO(max_ncells,max_n_year,2) += (VOLOV-OVMAX) accumulated in *OVLNF.F* .
  VOL_OVLFLO(max_ncells,max_n_year,2) += VOLOV/(43560.*1000) in *OVLNF.F*.
- This is the ratio of the excess volume of overland flow for each cell, year and direction of flow to actual volume over flow.
- This is used in the final output subroutine.

SET_CUTBACK.F

- If(use_trigger>0).
- Computes which zones require pumping cutbacks. Zones requiring cutbacks set a CUTB_PHASE switch > 0.
- Evaluate recorded heads at trigger locations, identify severity of water restrictions and set appropriate cutback levels for the next month.
- If zone was in a cutback phase the previous month and if we're in the dry season (November-May) then current zone must stay at least phase 1 this month.
  Otherwise, initial cutback to 0 for zone – no restrictions. (SEE discussion below.) The trigger package allows the user to set min limits on heads at selected nodes. If those limits are exceeded during a run, then pumpage at certain wells is cutback according to an input cutback schedule. The model works according to zones which are user-specified rectangles. In each zone there are trigger cells. If the average head in a trigger cell is lower than the standard for a prescribed period of time the program looks for each well in the zone and reduces the pumpage for the next stress period by a fraction specified in the input data.
  Model includes the following Zones with several locations within each zone:
  LECSA -1A, LECSA -1B North Interior, LECSA -2, LECSA -3, NORTH SERVICE AREA -A (NORTH), NORTH SERVICE AREA -B (S.COASTAL).
  ******TRIGGER_INPUT.F* (called by MAIN)
  Input data for trigger module- read cutbacks for PWS (public water suppliers) and industrial as a fraction of total required. Cutback for other LEC irrigation use (suppliers) is in maximum inches per month and minimum days LOK in SSM. Then location, trigger and heads of 4 phases, length of previous month cutback for each zone in each service area section.

*****_SET_CUTBACK.F_ (called by MAIN)
Evaluate recorded heads at trigger locations, identify severity of water restriction and set appropriate cutback levels for the next month. If zone was in a cutback phase the previous month and if we're in the dry season (November - May) then current zone must stay at least phase 1 this month. Otherwise, initial cutback to 0 for zone - no restrictions Note: if head is less than trigger value for a given phase we have violation. Kick out of loop once it finds a violation--only LOK SSM (or ssm+dry season) will trigger cutback next month (100) and only dry season will trigger cutback next month(cutb_code(zone) = 1) . This is the last item to be processed for a given month.
*****_REDUCE_WELLQ.F_ (called by _LEC_PWS_IRRIG.F_)
Computes public water supplies and shortages. For public water supply, applies reduction factor to wells affected by water restriction. For each irrigation use, returns a maximum application rate to grid cells affected by water restriction. If lec_et.cf is used then compute irrigation supplies and shortages. For situations where a well is in more than 1 zone and cutbacks are set for each zone and cutbacks may be different values. Note: this subroutine is called by _LEC_PWS_IRRIG.F_ to reduce public water supply pumpage if trigger module is to be used and if LEC water restrictions are in effect for the current month.
******_SUM_TRIG_HEADS.F_ (called by MAIN)
Keep track of canal and/or grid cell stage at designed trigger locations used for LEC water restriction. Sum up the heads at trigger cells-sums simulated heads at trigger cells for a user-specified number of days during the month - sums heads in trigger cells if we're in the right time during the month.

- NOTE: If head < trigger value for a given phase we have violation. Loop by phases, backward, to find most severe violation.
- IF cutb_ code(zone) =100 or 101 -> only LOK SSM+ dry season will trigger cutback next month(based on cutb_phase & MOY). IF cutb_code = 1 then only dry season will trigger cutback next month. This occurs when cutb_phase> 0 and period-November to May. Also 100 is added if period-November to January and _LOK_SSM_CNT_[counter in the _SSM_CUTBACK.F_ routine. { number of days LOK in SSM for cutbacks next month in LEC } >= _MIN_LOK_SSM_CNT_[min # of days LOK in SSM for cutbacks next month in LEC (94)]

MAIN

- END OF MONTHLY PROCESSING

ZCLOSE

FINAL OUTPUT.F

- Final output at the end of simulation.
- Output includes mean number of days/year volume limit for overland flow is reached.
- IF LP(2)= print stage(H), ponding(POND) and canal stage(CHDEP) for the last day of simulation to be used as a restart file for succeeding simulations (creates restart_output).

End.