Klamath Basin RiverWare Operations Model Review

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Introduction

In CADSWES's contract, Phase 2, Task 3 "CU-CADSWES review of Klamath RiverWare Operations Model" states:

In this task, CU-CADSWES research staff will evaluate the Klamath RiverWare operations model for efficiency and overall quality. CU-CADSWES will perform diagnostics to identify and potential improvements that might be made to the model. CU-CADSWES will develop a memorandum summarizing their technical review of the model and recommendations. Reclamation's TSC will work collaboratively with CU-CADSWES on implementing recommended model improvements.

This document is the memorandum that summarizes the technical review and provides recommendations.

Original comments are in black. Responses to those comments are shown in blue.

Approach

The following areas of the model were reviewed:

- Table Data
- Method Selection
- Custom Slots
- RiverWare Policy Language (RPL) sets
  - Rulebased Rules
  - Initialization Rules
  - Global Function Sets
- Use of Accounting
- Miscellaneous areas of the model

The use of objects was not reviewed further as there has been much discussion on this topic and does not need to be revisited.

Table Data

The following table data looks suspicious:

- UKL.Max Release – This slot has only two rows so is probably not realistic.

4136 ft	0 cfs
4148 ft	100,000 cfs

- UKL. Elevation Volume Table – It has a relatively flat portion between elevations 4146.5 and 4147.0
- <Reservoir>. Max Iterations –The default is 20, the recommended default is 100. These slots should be increased to 100. Response: We changed each <Reservoir>.Max Iterations from 20 to 100

Keno, JC Boyle, and Copco1 data was not reviewed as they are assumed to not change elevations. Therefore the data doesn't really matter. These should be evaluated by Reclamation for correctness at some point in the future.

Method Selection

On IGD, the "Allow Specified Excess Outflow" method seems unnecessary, but this is OK for this effort. In the Dec 1, 2018 Operations Date test run, the method is triggered in April 2018. In this case the input Outflow is 6100cfs but the max out is only 2750cfs. Something isn't right if the specified outflow is that much greater than max.

We did not review the methods selected on the inline power reservoirs as they do not directly impact the comparison to the IGD calculator. A future step should investigate how power and spill are modeled on the inline reservoirs.

Custom Slots

Custom slots were added to simulation objects as necessary. Also, there are 5 data objects that contain custom slots. This section provides comments on some of these slots.

- Custom slots should either have spaces or not. Be consistent. I see IGD.ActualRampingFlow and IGD.Final Est Outflow.

  Response: We changed to the following to have spaces between variable names. Following is a list of Objects changed

  - IGD
  - Gerber
  - Clear
  - ReservoirOperations
  - Keno
  - UKL
  - Williamson River Inflow
  - A Canal
  - Dashboard Controls
  - Dilution and Flushing
  - Ady Canal
  - Refuge
  - Keno

  - Copco 1
  - Copco 2
  - JC Boyle Power Plant
  - Trinity River Inflow

- The data object Ag Sheet should be renamed to something more descriptive. I know the name was chosen to mimic the IGD calculator, but it should be renamed to something else, maybe Agricultural Deliveries. We Renamed Ag Sheet to Agricultural Deliveries
- Rename "IGD.with Accrete" to "IGD.with Accretions". Accrete is a verb, Accretion is a noun. We switched IGD.with Accrete to IGD.with Accretion.

RPL

This section provides comments on the RiverWare Policy Language (RPL) sets.

- Precision on all RPL sets should be set to a reasonable value, like 2 or 3.
- The largest comment on the ruleset is that there is no documentation, descriptions or inline comments in place. This makes it hard to understand the ruleset. These will be added in the next phase.

The following are comments on each specific set.

Rulebased Simulation Ruleset

The rulebased simulation ruleset represents the operating policy in the basin. In general, it mimics the IGD Calculator. Most slots computed and set by the rules are directly tied to rows or other variables in the IGD Calculator. The names used are typically the same.

The following are specific comments on rules:

- Rule 50: Set Baseline Ag Demands and Rule 49: Set Adj Diversion Requests
  - Change looping variable from "AgObj" to "DiversionObject" or similar. AgObj is ambiguous, is it an aggregate object or an agricultural object. Changed to Diversion Object
  - Move list of objects out of the rule and into a subbasin. Use ListSubbasin predefined function. Defined subbasin name: Primary Diversion Points
  - Move the Season computation to a function. Defined: Function Name: AssignSeasonType
- Rule 48: New UKL Ag Demand Logic – Why is it called "new"? Delete "Logic" from the name. Renamed to: Compute UKL Agriculture Demand
- Rule 47: Compute UKL Ag Demand – Delete this if it is not used. We deleted since not in use
- Rule 45: Set UKL Inflow – Take the UKL.Projected Inflow assignment out of the loop and set it with only one assignment. We removed UKL.Projected Inflow from the If loop and removed the else clause. We Added in new assignment to set UKL.Projected Inflow outside of the loop
- Rule 43: Compute Misc Flows -
  - Use NaNToZero instead of (If(IsNaN Slot) Then 0AF else slot). Use Max(0cfs, VolToFlow(TotalMisc,@t) instead of IF. We switched the first two With clauses to utilize NaNToZero rather than the If/Else logic. We switched the UKL.Hydrologic Inflow to use the Max Predefined function

  - It seems like Compute Misc Flows need to be higher priority, since it happens after the dilution and flushing. The first time it executes, it assumes those are zero.

- Rule 42: Compute UKL Flood Release – Why is Scenario different than Flood Scenario? We changed Scenario to ColumnNo.
- Rule 37: The local WITH variables should be renamed to be more descriptive. We made the following variable name changes
  - Pacificorp → PacificorpAccretion
  - LRDC → LRDCAccretion
  - ToAdyAndNorth → LRDCToAdyAndNorth
  - FandFF → FandFFOutflow
- Rule 35: This could be cleaned up using a WITH variable for the offsetDate expression. We added in With statement to clean up rule, the variable is named OffsetEndDate.
- Rules 31-35: These could be cleaned up using more functions or WITH expressions. We added in With expressions for logic such as Start Dates, End Dates, Ramping Flow, and Row Referencing
- Rule 27: Put 7 day in a slot or reference "Offset". Change name of variable from "Recent" to AvgPool. We switched variable from Recent to Avg Pool and changed "7 day" to Dashboard Controls.Downstream Lag[] * 1 "day"
- Rule 25: Compute Accretion Adj Factor. Put the GetColumnIndex into a user defined function that takes a string as an argument. We created a new function called: AccretionTableColumnIndex(NetOrAdj)
- Rule 21: Set UKL Outflow –
  - Break this into two rules, one at this priority for Winter Ops, and another at priority 1 for Summer Ops. This will make it clear when it switches form summer to winter. WE made a Set UKL Outflow Summer/Winter.
  - Rules that Set UKL and IGD outflows should have logic to implement overrides. See design doc from Dec for more information. Additional override slots can be configured as needed.

    In the Summer, there is a slot for an Override Flow that is used in calculations that contribute to the final calculation of IGD and UKL Release. Thus, I used this slot in the Winter to adjust flows and left Summer as is.
- Rule 19: Set IGD Outflow - See comment on override. See comment on Override Flow for UKL, the same process was used IGD.
- Rule 18: Compute F and FF Pump Outflow – Use NanToZero ; How do we forecast F and FF pump Outflow? We switched the first With Expression to use NanToZero

  F and FF Pump Outflow is set by an initialization rule. Within the Summer Calculator though there is a row that tracks reduction in this flow. This is not a physical reduction, it is an accounting reduction that says a certain quantity of water should not be used for other purposes other than PacifiCorp reservoir refills.
- Rule 17: Compute EWA & Will50 - Usually, you would set the current value to the previous value, not the next timestep to the current timestep. We switched to set the current value to the previous value
- Rule 15: Compute EWA Used - The slot being set is on "Dashboard Controls". This isn't a control but a result. Call the data object "Dashboard"? We switched data object name to Dashboard

- Rule 10: Compute Spring Fill Rate – That is a weird way to set up a BOOLEAN for the criteria: If (x) THEN <expr> ELSE true. We removed the With expression logic for criteria and moved the BOOLEAN to the If statement below

Initialization Rules

The following comments refer to the Initialization ruleset

- There are a few disabled statements, like in Init Rule 7. Clean these up. This was an initialization rule written previously. We need to discuss these rules.
- Init Rule 5 has many literal numbers defined, 13, 7. Move these to slots. We created slots to take place of the constants. These slots are the following:
    - Dashboard.Short Prediction Period
    - Dashboard.Long Prediction Period
    - Dashboard.Downstream Lag

  In addition, a function was added to convert these periods into days (current units as NONE)

    - ToDays() – in Global Function Set
- Init Rule 3 sets the initial pool elevation to literal numbers. Move these values to a slot and reference the slot. We made the following slots for the constants:
    - Keno.Init Elevation
    - JC Boyle.Init Elevation
    - JC Boyle Power Plant.Constant Demand
    - Copco 1.Init Elevation
    - Copco 2 Power Plant.Constant Demand
    - IGD.Init Elevation

Functions and Global Function Sets

In general, when a global function set is used, it is usually best to store all functions in there and not have separate utility groups in each other RPL set. This is strictly for organizational purposes and is preferred as it is a single location for all functions. It prevents confusion of where the function lives as there is just the one function set.

Both the Utility Groups in the Ruleset and Initialization Ruleset have been moved into the Global Function Set. A review should be done to see which of these functions are unused and could be moved.

There are a number of Date functions that return whether the current timestep is in the date range. These boolean functions don't need explicit TRUE or FALSE. For example "OctoberThruFebruary"

If (@t > March 1, current year OR @t > Sep 30 Current Year)

  TRUE

ELSE

  FALSE

END IF

This can be replaced with just the part in the IF

@t > March 1, current year OR @t > Sep 30 Current Year

The Date function have been changed to this new format

Use of Accounting

The following are specific comments on the implemented accounting system:

- Need to initialize the accounts – UKL^KDD Winter plus all others
- Set the Begin Accrual Date to Oct 1
- Change the Storage Account Carryover method on all accounts to Carryover All.

In general, the model was set up to match the IGD calculator. As a result, the current RiverWare Operations model uses custom slots and rule logic to do all of the accounting. There is very little use of RiverWare's accounting system. (Only KDD releases are currently modeled.) This approach was taken since there is a bit of a paradigm shift necessary to use RiverWare's accounting system. Instead of tracking EWA used and EWA remaining, RiverWare's accounting would track the EWA storage instead and a custom slot would be required to track the EWA Used.

Since the RiverWare model is matching the IGD calculator, we propose to not implement the RiverWare accounting system in parallel with the current slots and rules. We can revisit the need for accounting in the future.

Misc. Comments

The following are miscellaneous comments on the model:

- Accounting view needs reorganizing of objects.
- Geospatial view needs reorganizing of objects.
- It looks like IGD runs out of storage at the end of the run. Is that OK?
- All plots should be configured to show the x-axis from Start Timestep to Finish Timestep, and "apply each time plot is shown".
- UKL Threshold plot doesn't show max thresholds, the Red bars on IGD plot
- Flow only makes it down to Klamath Y Shasta.Inflow1. It would be nice to solve the system all the way down to the mouth. This will likely be fixed with the updated DMIs to the Pisces database.
- Similarly, the Lost River and West portion of the basin is not solving. TSC will work to get this solving. Ideally, all objects will solve with reasonable data or comments can be added to say why they are not solving.
- Similarly, the distribution of water once it is diverted is not modeled. Rules should be written to deal with the distribution system.