# Hydropower Override Tool (prototype)

CWMS

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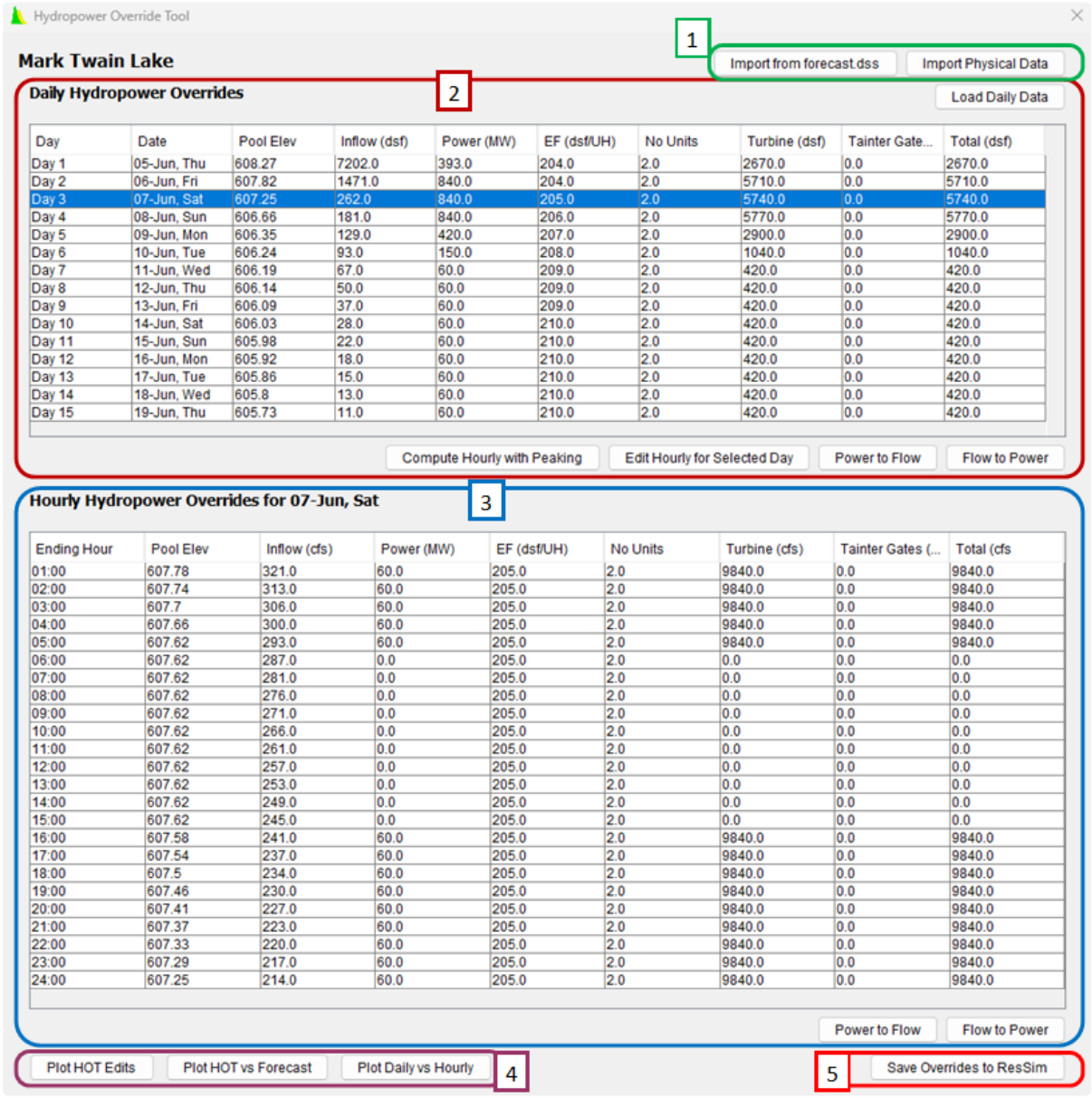
No headings included in this document

The hydropower override tool intended purpose is to support water managers in daily regulation and forecasting for reservoir projects that have hydropower. Currently the hydropower override tool is a prototype of the desired minimal variable product (MVP) and is a CAVI Jython script and aspects of the script can be easily repurposed and wrapped into the desired MVP in the future. The intent of this prototype is to get districts that manage hydropower projects and are or are attempting to regulate and forecast them within CVWMS to test this prototype and provide feedback on what the MVP needs to include and whether this prototype script can be packaged up as a stopgap tool until the more sustainable hydropower override tool can be developed and deployed.

The prototype currently creates outflow overrides for ResSim by allowing users to edit daily and hourly hydropower megawatts (MW) and other hydropower properties and the converting them to daily flows, or vice versa from daily flows and hydropower properties to hydropower MW. ResSim is limited in that it takes only flow data or elevation targets for overrides. However, regulating hydropower projects sometimes requires entering MW, unit outages, and/or unit efficiency overrides instead of strictly flow-based overrides. This prototype enables users to input daily MW values, unit efficiency vales, or unit outages, which are then used to calculate flow from the project. Alternatively, users can input flow, unit efficiency values, and unit outages to compute MW. A key advantage of having a tool like this in CWMS is the ability to make daily edits and then disaggregate those into hourly data. Since the typical CWMS model runs on an hourly time step and requires hourly data, this functionality allows users to make coarse daily edits, refine the hourly values for individual days, and feed those as overrides into ResSim.

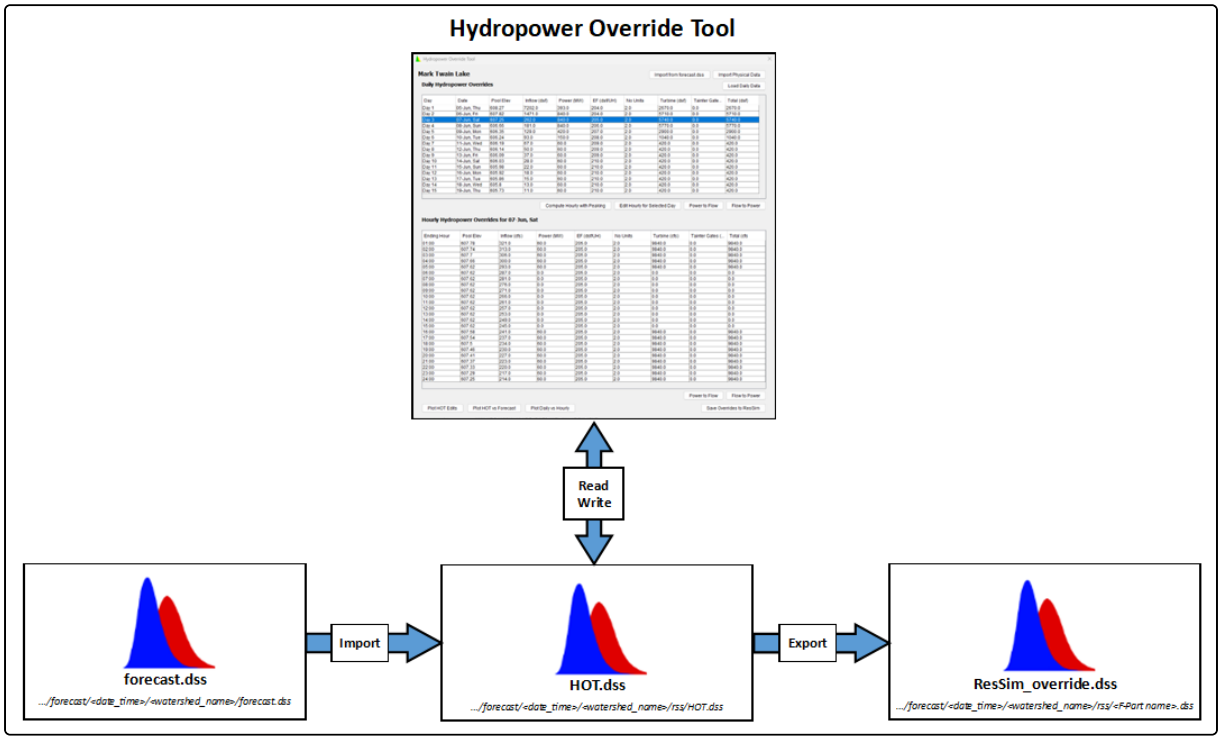
A description of the and current functionality of the prototype of the hydropower override tool is description below.




1 Hydropower Override Tool

The first section is for importing data for the Hydropower Override Tool (HOT) to use to initialize for the user to enter desired overrides. The first button "Import from forecast.dss" is for importing simulation results (currently ResSim) such as simulated pool elevation, inflow, hydropower MW, outflows from each outlet. This information is exported from forecast.dss to a separate dss file for the HOT to read and write computed results. The "Import Physical Data" imports physical curves from the ResSim network dss file such as Elev-Stor and Elev-Flow for powerplant and the SWPA demand curve from SWPA_Power_Demand.dss file in the database directory and then creates time series for the number of units available (all by default) and efficiency (either computed from the Elev-Flow curve or from the user defined value in the config part of the HOT script). The "Import Physical Data" button only needs to be run one time up front to set the initial unit efficiency values and the number of units available or any subsequent time the user wants to reset these values. The image below illustrates

how the HOT imports, read/writes data, and exports data via the various DSS files to and from CWMS.




2 Hydropower Override Tool Data Exchange

The second section, referred to as Daily Hydropower Overrides, supports viewing and entering daily hydropower overrides. The first four columns are uneditable, followed by the next four editable columns representing the Power Plant information. These are then followed by columns for any additional outlets available at the project (e.g., spillway gates, sluice gates, or other types of controlled outlets). The last column is uneditable and shows the project's total outflow (i.e., the sum of all outlet flows). All column data are assumed to be period averages, except for the pool elevation, which reflects the ending period instantaneous value. Below is a description of each daily column:

1. Day number in the forecast (uneditable)
2. Date formatted as dd-Mmm and day of the week (uneditable)
3. End-of-day pool elevation (uneditable)
4. Daily average inflow (uneditable)
5. Daily total power (MW) (editable)
6. Unit efficiency expressed as average flow per unit hour (editable)
7. Number of units available (editable)
8. Power plant daily average outflow (editable)
9. Columns 9 through 9+n: daily average outflow for each individual outlet (example only has one) (editable)
10. Reservoir project daily average total outflow (uneditable)

The action buttons for the second section are first at the top "Load Daily Data". This button should only be needed after using "Import from forecast.dss" and/or "Import Physical Data" as the HOT script is unaware if the data is present and ready to loaded into the dialog. Below the Daily Hydropower Overrides table, the "Compute Hourly with Peaking" button will distribute the users power based upon a seasonal hourly demand curve (source from Southwestern Power Administration (SWPA)) utilizing the number of units available and compute hourly flows from that peaking cycle and then recompute daily flows and reload the Daily Hydropower Overrides table (if different). This button is only necessary if the user wants to refine hourly hydropower to reflect detailed hydropower peaking demands, otherwise the default is set to uniformly distribute the overrides over each day. The next button is "Edit Hourly for Selected Day" button and it requires one daily row to be selected in the Daily Hydropower Overrides table and it will render the hourly data for the selected day in the Hourly Hydropower Overrides table. Once executed, the title of the section has the selected days date and day of week appended to it so the user knows which day's hourly information they are viewing and/or editing. The next two buttons are for recomputing the projects data for either "Power to Flow" or "Flow to Power" depending upon which override the user wants to use to derive output from. For "Power to Flow", the columns of Power, EF, and No Units are used to derive outflow from the power plant and then any additional overrides to the additional outlets are then summed to the computed power plant outflow to determine the updated project total outflow. The logic and formula for computing power plat outflow is as follows:

The "Power to Flow" determination of power is done by first computing the daily power generation capacity from the Number of Units and megawatts per unit hour defined by the user in the configuration setup. The formula for computing daily power generation capacity is shown below.

**PowerCapacity = (No Units) * (MW/UH)**

- PowerCapacity = daily power generation capacity
- No Units = daily number of units available
- MW/UH = Megawatts generated per one hour of one unit generation (defined in the user configuration)

Once daily power generation capacity is computed, the daily power override is determined by taking the lower of either the daily power generation capacity or the user override for power. The resulting power is then used to compute daily average flow from the power plant by utilizing the daily efficiency value and the megawatts per unit hour defined by the user in the configuration setup. The formula for computing flow from power is shown below.

**PowerPlantOutflow = ((Power) * (EF)) / (MW/UH)**

- PowerPlantOutflow = daily average outflow from the power plant
- EF = daily efficiency value (DSF/UH)
- MW/UH = Megawatts generated per one hour of one unit generation (defined in the user configuration)

Once the above computations are completed, the daily average outflows for each subsequent alternate outlets are summed with the power plant outflow to determine the daily average project total outflow. Once the total outflow is compute, the pool elevations is then recomputed by simple using the total outflow and inflow (inflow is Net Inflow from ResSim which includes evaporation and other defined losses).

The "Flow to Power" determination of flow is done by first computing the daily power plant flow capacity from the Number of Units and daily efficiency value. The formula for computing daily power plant flow capacity is shown below.

**PowerPlantFlowCapacity = (EF) * (No Units) * 24**

- PowerPlantFlowCapacity = daily average outflow capacity of the power plant
- EF = daily efficiency value (DSF/UH)
- No Units = daily number of units available
- 24 = 24 hours * the No units determine the unit hours for the day

Once the daily power plant flow capacity is computed, the daily power plant flow override is determined by taking the lower of either the daily power plant flow capacity or the user override for power plant outflow. The resulting flow is then used to compute daily power generation by utilizing the daily efficiency value and the megawatts per unit hour defined by the user in the configuration setup. The formula for computing power from flow is shown below.

**PowerPlantPower = ((Flow) * (MW/UH)) / (EF)**

- PowerPlantPower = daily power generated from power plant
- MW/UH = Megawatts generated per one hour of one unit generation (defined in the user configuration)
- EF = daily efficiency value (DSF/UH)

Currently the configuration is defined within the script itself on lines 50-58 (line 57 does not need to be edited).

```
47 ####################################################
48 ####            Project Metadata Setup          ####
49 ####################################################
50 ReservoirProject = "Mark Twain Lake"
51 ProjectName = "Mark_Twain_Lake"     ##### Name of Reservoir in ResSim
52 PowerName = "Turbines"      ##### Name of Power Plant in ResSim
53 NumberUnits = 2
54 MW_UH = 30              ##### MW per Unit Hour (UH)
55 Turbine_EF = 0      ##### DSF per Unit Hour (UH) | Set to 0 to have it computed from ResSim Turbine Rating
56 OutletNames = ["Tainter Gates"]     ##### Name of other outlets in ResSim (i.e. ["Spill", "Sluice", "Orifice"])
57 NoOutlets = len(OutletNames)
58 ResSimNetwork = "Salt_River_Hydropower"     #### Name of ResSim Reservoir Network
59 ####################################################
60 ####################################################
61 ####################################################
```