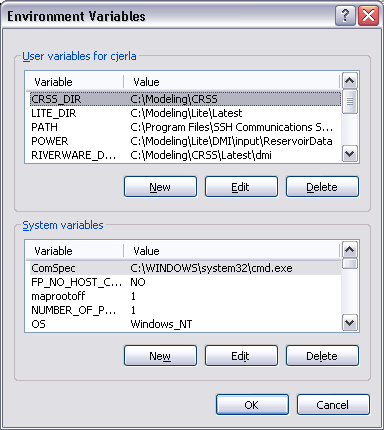
**Running CRSS**

Note: Areas that are highlighted yellow, indicate areas that are no longer relevant/necessary models newer than (and starting with) CRSS.V2.5.2018.Apr2017.mdl.

# Setting up the Model

1. Copy the CRSS directory and the sub-directories to a local computer, maintaining the existing directory structure.
2. Create an environment variable **CRSS\_DIR** that points to the contents of the copied CRSS directory. For example, if the CRSS directory is copied to C:\Modeling\ then the environment variable value should be C:\Modeling\CRSS
   1. The environment variable can be used in RiverWare to reference the path to different files. Ex: $CRSS\_DIR\ruleset\CRSS-IG.rls.gz is the path to a ruleset. Note the $ in front of the environment variable, which is necessary to resolve the environment variable to a path in RiverWare.
3. Environment variables can be created by either method listed below:
   1. Launching the “1.SetCrssDirecotry.bat” script provided in the CRSS package. This will automatically set CRSS\_DIR to the location of the unzipped directory. Be sure this location has no spaces in the path.  
      **or**
   2. Going to properties of the computer (right click on the “Computer” icon). Click the “Advanced system settings”, make sure its on the Advanced tab and finally click the Environment Variables button. The new environment variable will not take effect if it is set while RiverWare is open. With RiverWare closed, set the environment variable, before launching RiverWare.



1. There cannot be any blank spaces in the path name to the copied CRSS directory.
2. The names of the sub-directories and the structure of the CRSS directory cannot be modified.
3. Perl, an interpretive programming language, must be installed to run CRSS. Perl is needed to run the input DMIs in CRSS. The input DMIs are required to run CRSS, even for a single trace. Perl can be downloaded at no cost from the website: <http://www.activestate.com/products/activeperl/>
   1. Make sure that the path to Perl’s site\bin and bin are referenced in the “Path” environment variable. For example, if Perl is installed at C:\Perl, then C:\Perl\site\bin and C:\Perl\bin should be part of the “Path” environment variable.
   2. The path can be set through either the system variables or the user variables.

# Overall Model Structure

## Input

* Demand and natural flow input are found in the $CRSS\_DIR\dmi folder. There will be one or more scenarios for both supply and demand. Supply (streamflow) scenarios are contained in a folder structure. For example, the NFSinput folder contains the observed resampled scenario data. Demand data however, are contained in Excel workbooks. There is a unique workbook for the 2007 UCRC Demands. If included, all six of the Basin Study demand scenarios are contained in a single Excel workbook (Demand Input Tool [DIT]).
* Natural flow data are imported into the model at the 29 natural inflow points, e.g., UpperColordoReach.Inflow, GreenRWhiteToSanRafael:GainsAboveGreenRiverUT.Local Inflow.
  + Control files map slots in the model to input files found in the dmi folders, e.g., $CRSS\_DIR/control/NatFlowSalt.control
* Demand data are imported into the model and stored in data objects, e.g., CO Schedules and ArizonaPriority4Schedules. Initialization rules then move the demands from the data objects to the water users at the beginning of the simulation. This allows greater flexibility to modify demands during a simulation.
  + The ‘AllStateSchedulesAndExceptions’ and ‘AllStateSchedulesAndExceptions\_2007UCRC’ Name Maps (Utilities -> Name Map Manager) map the column names from the DITs to the correct slots in the model.
    - The ‘Basin Study Demands All States’ and ‘2007 UB and LB Demands’ DMIs imports the demands from the DITs to CRSS. The steps for running the Basin Study Demands DMI with different demand scenarios are covered in section 3.
  + Demands for the GCM Downscaled Projected supply scenarios (VIC supply scenario):
    - If the VIC supply scenario is being utilized, agricultural and outdoor M & I demands are assumed to change with changes in temperature and precipitation as modeled by the GCMs. Therefore, each downscaled GCM projected trace produces a unique set of demand adjustments. These demands are loaded into the model using the VIC Demands [Scenario Letter] DMIs. (One DMI exists for each demand scenario.) It is important to couple these demand scenarios with the VIC supply scenario which is why 6 other DMI groups were created: MRM VIC Hydrology and Demands [Scenario Letter]. These DMI groups are then selected in the MRM configuration to run the desired demand scenario with the downscaled GCM projected hydrology and corresponding demands.
* Evaporation
  + As with demands, if the VIC supply scenario is being utilized, each downscaled GCM projected trace produces a unique set of evaporation coefficients for each modeled reservoir. This DMI (VIC Evap) is part of the MRM VIC Hydrology [Scenario Name] DMI groups.
  + Since evaporation coefficients are changed when running the VIC supply scenario, the ‘Input Evaporation Coefficients’ DMI is coupled with all supply scenarios except the downscaled GCM projected scenario. This ensures that evaporation coefficients are ‘reset’ to the original, stationary values when not using the VIC supply scenario.
* The MeadFloodControlData.hydrologyIncrement slot should begin with a value of 1 for the first year of the simulation, a 2 for the second year, and so on for a total of 1244 years. If this is not the case, the values can be modified by selecting all time steps of the slot, and going to Edit -> Adjust Values.
  + This slot is used to seed the pseudorandom number generator, which is used in generating the error term on the Powell inflow forecast. By always starting the first simulation with 1s, the model can simulate a random error on Powell’s inflow forecast, while still being able to reproduce results.

## Output

* Output generated by running CRSS is sent to the $CRSS\_DIR/results folder if running CRSS from RiverWare. Output is sent to $CRSS\_DIR/Scenario if run using RiverSMART[[1]](#footnote-1)[[2]](#footnote-2).
* Control files dictate the names/number of rdf files and which slots will be saved to the rdf files, e.g., $CRSS\_DIR/control/Output.control or KeySlotsOutput.control. The control file can be edited to change the slots and or rdf files that are created with each simulation.
* **Note: if previous output already exists in the output folder, it will be overwritten by the next simulation, so it is necessary to move/save the results between simulations.**
* Results are generated as rdf (RiverWare Data Format) files. The rdf files can be converted to Excel files manually with the RdfToExcel tool2, or by selecting the option to ‘Generate Excel Workbooks’ under MRM Controller -> MRM Configuration -> Output.
  + Make sure the RdfToExcelExecutable file exist in the RiverWare folder of the version being used (e.g., C:/Program Files/CADSWES/RiverWare 6.2.8). When installing a new version of RiverWare, copy the RdfToExcelExecutable to the new RiverWare directory.

## Rules and Functions

* One global function set is saved with the model file and two rulesets are included in the $CRSS\_DIR/ruleset folder. The global function set contains all functions that either of the rulesets use; as it is saved with the model file, it does not have to be manually opened. The two rulesets (CRSS.Baseline.2027IG.rls.gz and CRSS.Baseline.2027NA.rls.gz) only differ in the assumption for the operations of Powell and Mead after 2026. The ruleset denoted ‘IG’, assumes that the2007 Interim Guidelines are extended through 2060, while the ruleset marked ‘NA’ assumes that Powell and Mead revert to the No-action Alternative from the Shortage EIS in 2027.
* An initialization ruleset is included with the model file. The initialization rules mostly perform data management tasks prior to the beginning of a simulation.
* All rules execute in lowest to highest priority, and initialization rules are given lower priority than the rules in the rulesets.

# Running the Model

## Importing a Demand Scenario

To import a different demand scenario, follow these instructions. **Note: there is no guarantee which demand scenario is currently saved in the model,** so the desired demand scenario should be imported as a first step before any model run.

To import the 2007 UCRC demand schedule for the Upper Division States and the Lower Division States’ demand schedules form the 2007 FEIS, run the ‘2007 UB and LB Demands’ DMI. To run a demand scenario from the Basin Study:

1. Open the ‘Basin Study DIT’ Dataset, either by opening the ‘Basin Study Demands All States’ DMI and then double clicking the dataset, or by selecting DMI Manager -> Utilities -> Datasets.
2. From the Excel tab, change the ‘Single Run Name’ field to one of the following (Baseline is used in place of the current projected demand scenario name/letter):
   1. Baseline Monthly Data
   2. B Monthly Data
   3. C1 Monthly Data
   4. C2 Monthly Data
   5. D1 Monthly Data
   6. D2 Monthly Data
3. Click OK and then run the ‘Basin Study Demands All States’ DMI. Note: some warnings will be listed in the diagnostics.
4. Save the model before running CRSS.

**Note:** after running any of the demand DMIs, there are many warnings posted to the Diagnostic Output window. These are warnings letting the user know several slots cannot be found in the Excel workbook and that these slots will be set to 0. These are expected warnings. Because the 2007 UCRC demand scenario and the Basin Study demand scenarios do not use the same “water users”, the unused users are set to 0.

## Distributed vs. Individual MRM

Regular MRM runs each trace of a particular simulation in series, but there is an option to run multiple traces at a time by automatically launching multiple RiverWare instances across multiple computer cores. This results in a significant time savings, by utilizing all of the cores on a computer. The default for each of the MRM configurations is to distribute runs across all of the cores on the computer being used to run CRSS. RiverWare automatically determines the number of cores on the computer and distributes across all cores; this can be modified by modifying the options on the ‘Distributed Runs’ tab of the MRM configuration. Alternatively distributed MRM can be disabled by deselecting ‘Distribute Runs’ on the ‘Input’ tab of the MRM configuration. If utilizing the distributed MRM capability, the CRSS\_DIR environment variable listed in the ‘Distributed Runs’ tab needs to be updated to be the same as the path that CRSS\_DIR is set to under Section 1.

**Note**: CRSS is saved with the Distributed MRM option selected. If you do not intend to use Distributed MRM, you will need to deselect this option (and possibly save the model, depending on your intended use).

## Running the Current Trace

The following instructions will result in a single trace being simulated with the hydrologic trace and demand scenario that are currently loaded in the model. Unless you have run the demand DMI and the MRM with a single trace prior to completing these steps, it is uncertain which demand and hydrology combination will be simulated.

1. Open and load the desired ruleset.
2. Open the single run controller and select start.

## Running MRM (All Traces)

1. Loading the desired demand scenario (instructions above)
2. If running the Paleo Resampled supply scenario, run the ‘DirectPaleoNaturalFlowSaltInput’ DMI one time and save the model.
3. Open the MRM configuration of the desired supply scenario (abbreviations below). If running the Downscaled GCM Projected scenario, select the MRM configuration with the appropriate demand scenario.

|  |  |
| --- | --- |
| **Supply Scenario** | **Abbreviation** |
| Observed Resampled | DNF |
| Paleo Resampled | DPNF |
| Paleo Conditioned | PCNF |
| Downscaled GCM Projected (CMIP3) | VIC |

1. In the ‘Output’ tab, ensure the desired output control file is selected.
2. In the ‘Policy’ tab, ensure the desired policy set is selected.
3. If any changes were made to the MRM configuration, save the model.
4. Select the MRM Configuration and click ‘Start’.
   1. If using distributed MRM, then click ‘Start All’ on the new window that opens.

## Running MRM (Single Trace)

To run one particular trace from a particular hydrology, follow the steps in ‘Running MRM (All Traces) through step 6. In step 4, be sure to select an MRM configuration that is not distributing across multiple cores.

1. Now, on the ‘Input’ tab, change the number of runs to 1.
2. Change the initial offset to 1 minus the trace number that you wish to run.
3. Deselect the “Distributed Runs” check box on the ‘Input’ tab.
4. Click Ok, and then ‘Start’.
   1. Note, that after this simulation finishes, you can re-run the same hydrologic trace again, by following the instructions in ‘Running the Current Trace’.
   2. Do not save the model after running the model with the MRM controller, as this will modify the MeadFloodControlData.hydrologyIncrement slot. If you do save the model, then change this slot back to its original value.

# Modifying Lee Ferry Deficit Threshold

The threshold that determines a Lee Ferry Deficit is stored in the LeeFerryDeficit.10YearCompactAmount scalar slot. Modifying this value will change the flow at Lee Ferry that indicates there has been a Lee Ferry Deficit. The purpose of the Lee Ferry Deficit is described in Section 2.4.2 of appendix G2 to the Colorado River Supply and Demand Study[[3]](#footnote-3).

# Analyzing Output

Results generated by CRSS can be analyzed using the Graphical Policy Analysis Tool (GPAT). After installing GPAT as an Excel ‘Add-In’, open one of the Excel files generated by RiverWare or by the RdfToExcel tool, and then run the GPAT Add-In. Sometimes, it is necessary to aggregate the monthly data generated by CRSS into annual data. This aggregation can be performed in the model using expression slots, or it can be performed as a post processing step using the Yearly Aggregation Post Processor. GPAT, RdfToExcel, and the Yearly Aggregation Post Processor, and documentation for the three tools are available at [www.riverware.org](http://www.riverware.org).

1. RiverSMART is a new tool that allows for automated modeling of multiple supply, demand, and policy combinations [↑](#footnote-ref-1)
2. Available for download at www.riverware.org [↑](#footnote-ref-2)
3. Available at <http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/techrptG.html> [↑](#footnote-ref-3)