HEC-ResSim Version 3.1 Technical Notes (May 2013) or What you should know if you are upgrading from a previous release of HEC-ResSim

Opening an older watershed in 3.1

It is strongly recommend that you make backup copies of your older watersheds before opening them in HEC-ResSim Version 3.1. The reason for this is that the format of the data that makes up your model changes, sometime substantially, between versions. Newer versions can read older data and will convert it to the new format; however older versions cannot fully read newer data and some data loss can occur.

When you open an older reservoir network in a newer version of ResSim, ResSim will display a message box explaining that the data is being "…updated to conform with several new enhancements…" and that you should "save your network to retain the updates". If you "Save Now" (or later), you should not open the watershed in an older version of ResSim. This message can be seen from both the Reservoir Network and Simulation modules in ResSim.

Comparison of Results

Due to a variety of program enhancements and corrections, you may find that results produced by HEC-ResSim 3.1 do not match those produced by an earlier version. We at HEC have tested this release under a wide variety of conditions and watershed models and believe that the results produced by this version are as good as or better than those produced by earlier releases. Below are descriptions of some of the changes that were made and why we believe these changes may produce different results.

Leap Year

We revised the algorithms in ResSim that handle seasonally varying data (zone definitions, rules, diversions, evaporation, etc) so that ResSim would be aware of the correct number of days that exist in a given year. In previous versions, every year was assumed to have 365 days and each day of the year was assigned an index number. Thus Jan 1 was day 1, Feb1 was day 32, Mar 1 was day 60, and so on. This was okay for most years, but in a leap year, Mar 1 should have been identified as day 61, not day 60, due to the addition of Feb 29th in leap years. Because ResSim was not accounting for the extra day in February, its interpretation of all seasonal data during a leap year (after Feb 28th) was 1 day off. With this issue corrected, inflection points in seasonally varying data that are specified to occur after Feb 28th

now occur “on time” in leap years, so results that are operationally constrained by this data will be somewhat different than those produced by earlier versions.

Evaporation

The last change made to ResSim 3.1 before release was to the computation of reservoir surface area which is used in the computation of evaporation. We found during testing that under some conditions, the computed area could be substantially out of phase in time (by one or more timesteps) from the computed pool elevation. The solution to the problem involved moving the computation of area (from the beginning of the timestep) to the end of the timestep where end of period elevation and storage are computed. This may not show up as much of a difference in most watersheds, but you may notice that the area and evaporation results now appear shifted by one timestep from previous results.

Rate of Change Constraints

Although the specification of Rate of Change rules has not changed, their influence within the release decision logic in ResSim has. Rate of change rules are now applied in 3 separate ways within the logic:

1. **As a Rule**. Like any other rule, Rate of Change rules are evaluated to determine a desired release limit that is then applied to the allowable range of releases – this application has not changed.
2. **As a constraint on the Guide Curve Release**. Typically, rules do not influence the determination of the release to “get to guide curve”, but because Rate of Change rules can have a varying window of applicability and, if not “planned for”, can cause the releases to overshoot the guide curve, logic was added to the guide curve release algorithm to include rate of change constraints so that guide curve releases could be cut back (or increased) earlier than they otherwise would be and unnecessary oscillations at the guide curve would be avoided. This application was in prior versions of ResSim, but the logic of it was reworked in the new release to be more effective for variable rate of change rules. And, this logic can now be “turned off” with a ResSim Compute option in the Tools-> Options editor.
3. **As a constraint on the release for downstream control**. This is a new feature in ResSim 3.1. In previous releases of ResSim, the downstream control logic did not account for rate of change limits, so there were occasions when the downstream control rule would call for cut backs (or increases) in the releases in order to meet downstream control limits but the releases for downstream operation would be overridden by higher priority rate of change limits, resulting in violations of the downstream constraint. With the addition of the new logic to account for rate of change constraints in the downstream control rule, ResSim’s downstream control logic can now “be smarter, earlier”. This was accomplished by widening ResSim’s look-ahead window in an effort to account for the rate of change influence. With the widened window, cutbacks (or increases) for downstream control can begin sooner so that a rate of change constraint is not violated. This new feature is ON by default but can be turned off through an option in the “Advanced Options” editor of the downstream control rule. With this option ON, models that include both Rate of Change rules and Downstream Control rules could produce different result than older versions did.

Downstream Control Logic

During Beta testing of HEC-ResSim Version 3.1, one of the beta testers encountered a problem with the basic downstream control logic in ResSim that was addressed before the release was completed. The problem showed up as a substantial violation (by more than 15%) of the downstream objective during a period that the reservoir should have been able to control for – that means during a period when the cumulative local to the control point was not in excess of the maximum flow objective. After significant investigation, we found that the existing downstream control algorithm had two weaknesses: it did not adequately account for attenuation due to routing and it did not handle rapidly varying (oscillating) flow. In an effort to address these weaknesses, we revised the downstream control algorithm to better handle a rapidly varying inflow hydrograph and added some “advanced options” to manage the attenuation adjustment. One of the attenuation adjustment options is ON by default with a set a parameters that allows the downstream rule to perform fairly well “most” of the time. These changes, of course, mean that most watersheds with downstream control may produce different results with this release than they did with prior releases. Our tests showed that for the cases we studied, *when the results were different*, the new algorithm seems to perform more “conservatively” than the old one did. This means that during an event, the reservoir may store water rather that attempt fill the “available space” at the control point; this was our tradeoff so that the algorithm could handle more rapidly varying inflow hydrographs.

Tandem Cascades

While development was still on-going, we used ResSim 3.1 to develop a study model of a watershed that had three reservoirs in series that operated together for an objective downstream of a fourth reservoir. The mechanism to operate these reservoirs together as a system in ResSim is the Tandem rule. But, we found that the Tandem operation would not quite perform as desired if one of the reservoirs in the middle had to operate to a higher priority objective – when it did so, the system balance would not track correctly through the other system reservoirs. This was due to the fact that the Tandem rule only saw one pair of reservoirs at a time as a system; it did not see the entire chain of tandem reservoirs as a single system. So, logic was added to the Tandem operation algorithm to see the Tandem chain or cascade and to balance the full set of reservoirs together as a single system, even if one or more of the reservoirs in the system was constrained by higher priority objectives. You should look for potential differences in your results if you have tandem operation in your model since this modification to the algorithm could affect your results.

Run Control Options

The ResSim package has been incorporated in two model integration products produced by HEC. The first is the Corps Water Management System, CWMS, which was developed for real-time decision support modeling. The second is the Watershed Analysis Tool, HEC-WAT, which was developed to assist modelers in streamlining the analysis of results from planning study models. CWMS strongly influenced the early development of ResSim, but the WAT has had some more recent impacts. To current users, the most obvious impact will be found when you run or edit an existing alternative or create a new alternative. You see, the specification of the compute interval or timestep has been moved – in previous versions, the timestep was specified when the simulation (time window) was created; in this version, the timestep is specified as part of the alternative definition on the new Run Control tab of the Alternative Editor. Existing alternatives in existing simulations should be able to determine the appropriate intended timestep on their own, but you may encounter instances where our "best guess" code is inadequate, so watch for possible errors.