Chapter 1. Channel Volume Correction in DSM2-Qual Version 8.1

1.1 Introduction

DSM2-Qual (Qual) calculates the volume of a channel by starting with the initial channel volumes read from the DSM2-Hydro (Hydro) tidefile at the beginning of a run, and then using flows from the Hydro tidefile to calculate the volume into or out of a channel at every time step. This calculation determines the water volume left in the channels (represented by parcels). The channel volumes at other time steps are available in the Hydro tidefile but not used.

This method would be accurate if water mass balances in channels are perfect. However, when there are water mass balance errors in Hydro, the errors will accumulate in Qual. In rare situations the errors may accumulate significantly and stop Qual from running. This chapter describes a correction procedure that has been added to Qual and tested for accuracy.

1.2 Description and Testing Scenarios

The mass balance problem was encountered when a large tidally operated gate was added to a channel for a DSM2 study (i.e., a gate was added at Turner Cut near the San Joaquin River). Whenever the gate was opened, it caused flow fluctuations and mass balance errors in Hydro. When running Qual later, the error accumulated until the total parcel volume in channel 172 was 0. Qual stopped running with a "0 parcels in channel" message.

A correction procedure is added in Qual: after each time step, the total parcel volume in each channel is calculated using the channel's inflows and outflows, and comparing it to the channel volume found in the tidefile ($average\ channel\ cross\ sectional\ area \cdot channel\ length$). The volume difference is added to a parcel in the middle of the channel[1]. By handling it this way, the total parcel volume errors in channels will not accumulate, and volumes calculated by determining inflows and outflows to the channel will always be consistent with the channel volume in the tidefile. This will avoid the 0 parcel problem and ensure Qual to run without errors.

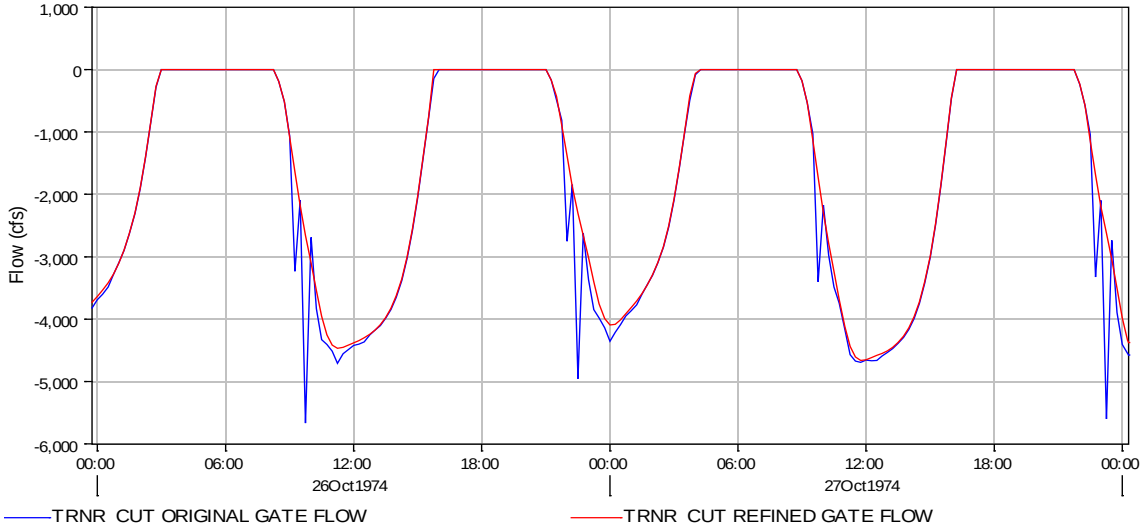
This modification was tested for accuracy. The following two setups were run from 1974 to 1984 (before a "0 parcels in channel" crash occurred) with both the original v8.1 and the modified v8.1 with channel volume corrections:

1. Original setup: original Turner Cut gate with 15 minute time step for Hydro. Flow fluctuates at channel 172 are shown in Figure 1-1 (blue line). Volume balances in some channels (including 172) are bad and cause the 0 parcel problem in channel 172.

[1] Originally the concentration of this parcel was also recalculated to conserve constituent mass, but we found it was not necessary, considering the changes in one time step are so small and the concentration recalculation may be problematic for nutrient models.

2. Refined setup: Turner Cut gate coefficients changed to 0.5 to remove flow fluctuations at channel 172 (red line in Figure1-1). Volume balance is much better. Flow in the channel is not restricted by the gate coefficient change.

Figure 1-1 Simulated Flow at Turner Cut Gate before (blue) and after (red) Coefficient Change



For all four runs, electrical conductivity (EC) results were practically identical at key stations: RSAC081, RSAN007, RSAN018, ROLD024, and Clifton Court Forebay. The maximum difference between using the original v8.1 and v8.1 with volume correction was 0.05% at ROLD024 (Figure 1-2 and 1-3) with the original gate setup.

Volumetric fingerprinting[2] results are shown in Figures 1-4 and 1-5. With the original gate setup, the volume correction tended to make the volumetric fingerprinting slightly worse (i.e., the error was less than 0.01% as shown in Figure 1-4). The reason for such an error is because the volume correction is artificially adding (or removing) a small amount of water into a channel, which is not counted as an initial boundary condition. This additional amount of water would be spread out to other channels with time and cause some error in the volumetric fingerprinting. However, this error is quite negligible in this case.

With gate coefficients changed to 0.5, most flow fluctuations were eliminated and the mass balance was much improved. The volume correction did not cause any difference in volumetric fingerprinting results (see red and green lines overlapping in Figure 1-5). Also, we noticed in this figure that sometimes the total volume deviates from 100%. This is due to the fact that a very small amount of water is from the water originally in the Delta.

[2] Fingerprinting is a methodology for running DSM2 to determine sources of water or constituents at specified locations. Volumetric fingerprinting determines the portion of the volume of water contributed from each source at a specified location and time.

Figure 1-2 Simulated EC at Old River at Bacon Island (ROLD024)

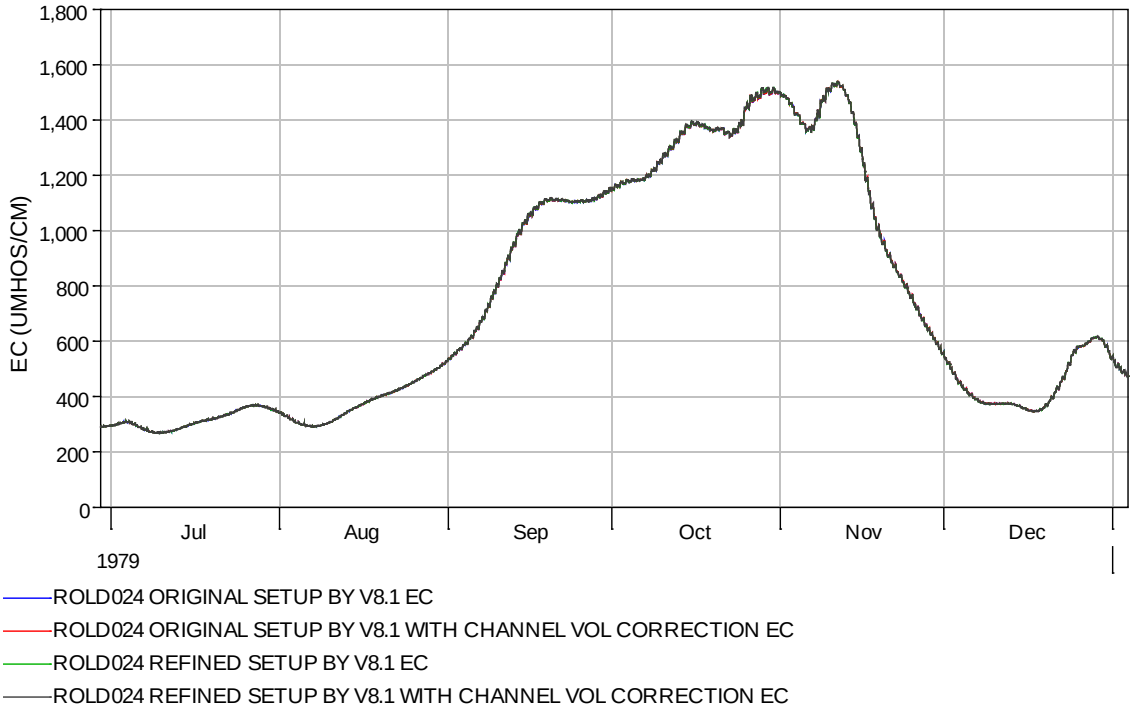


Figure 1-3 Regression Analysis of Simulated EC at Old River at Bacon Island (ROLD024)

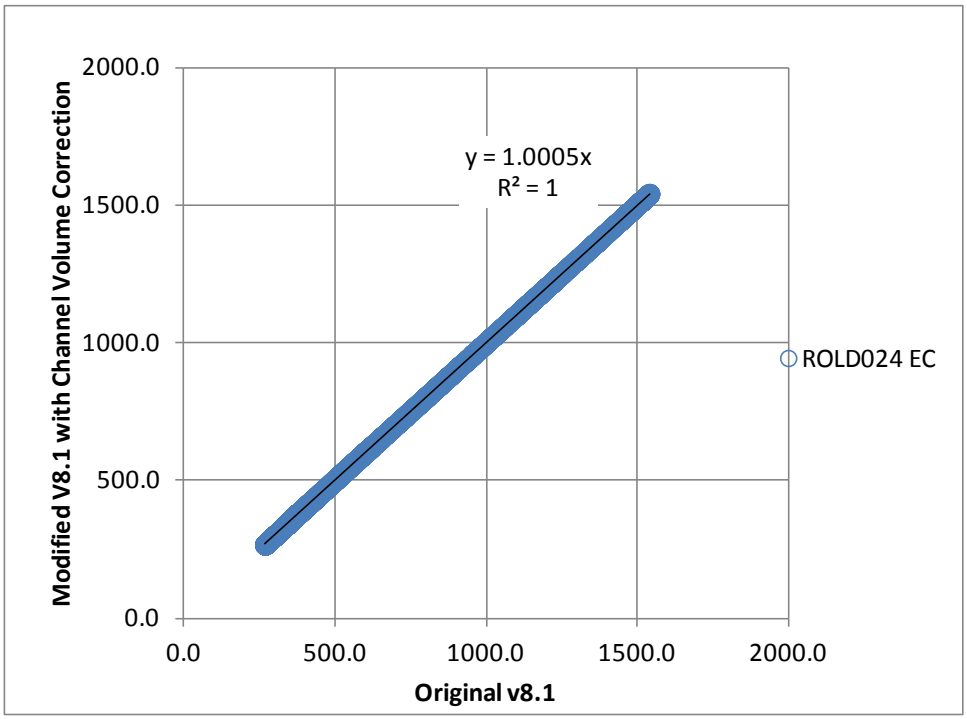


Figure 1-4 Volumetric Fingerprinting at Clifton Court Forebay with Original Setup

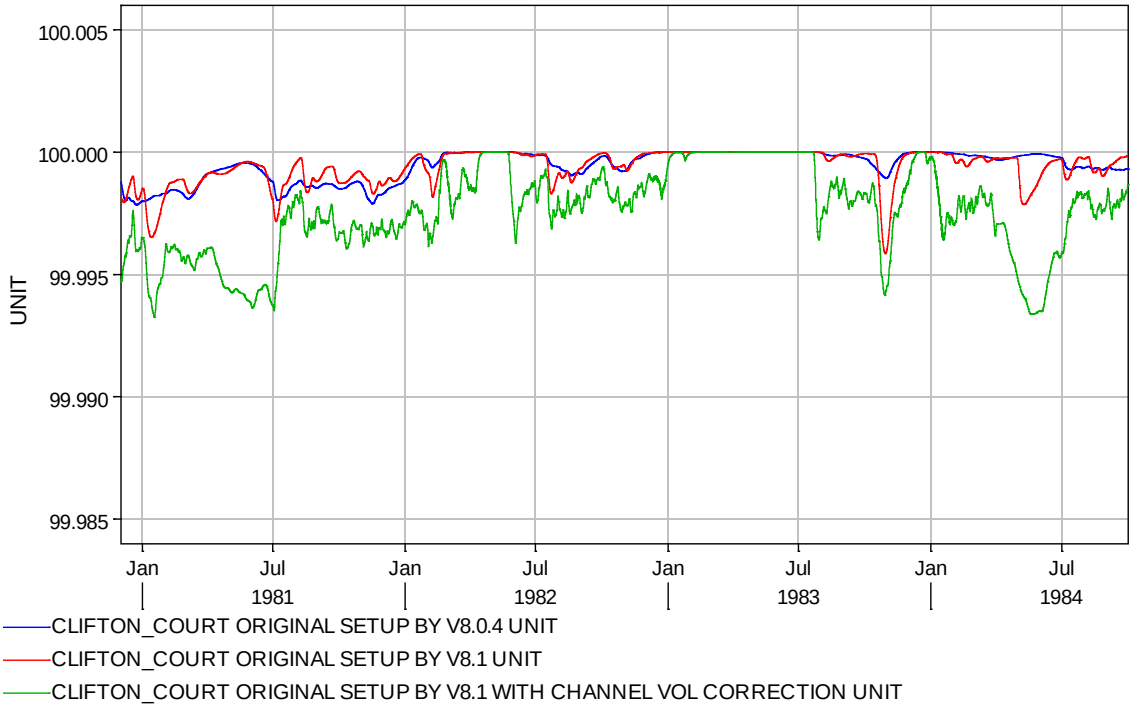
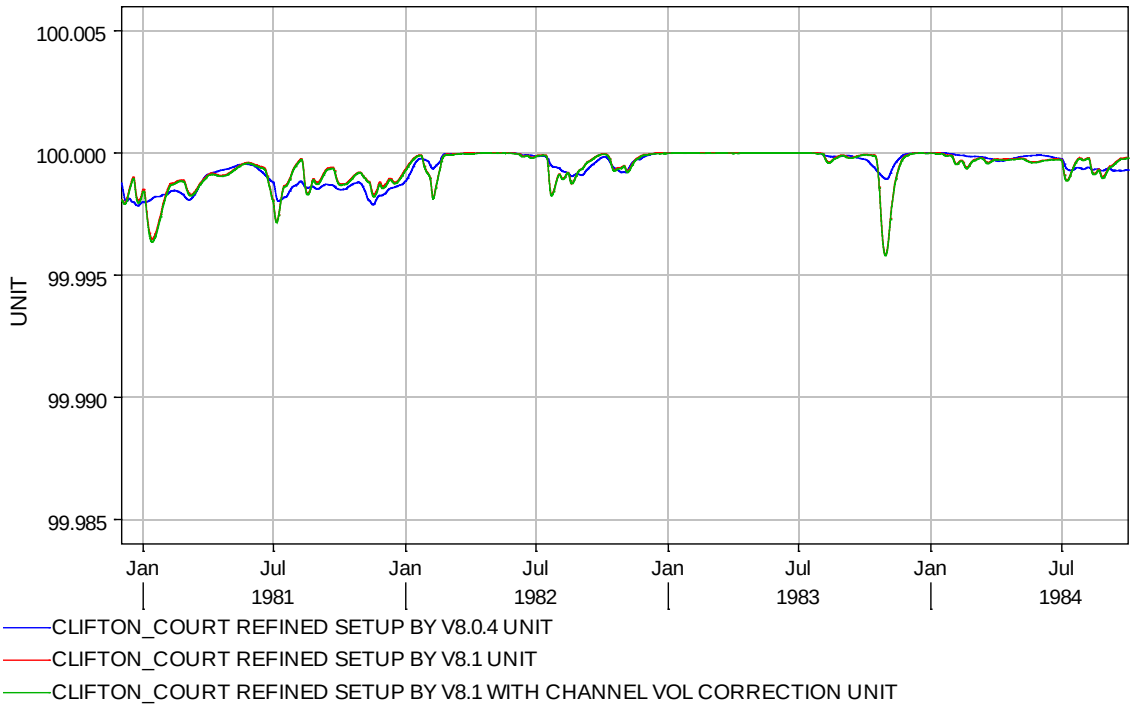


Figure 1-5 Volumetric Fingerprinting at Clifton Court Forebay with Gate Coefficients 0.5



1.3 Summary

A channel volume correction procedure has been added in v8.1. EC results were practically identical for all the runs. While large fluctuating flows occurred with the original gate setup, the volume correction has kept Qual running with some negligible error in volumetric fingerprinting runs. Under the refined setup, the simulated flows were much better and there was no difference in volumetric fingerprinting results.

A new message alert was added to warn users for accumulated volume balance errors at the end of a Qual run. Detailed channel volume balance errors for each channel are listed in the end of the output file (*.qof). By setting the value of "`checkdata`" to "`True`", Qual will check the channel volume balance before making the full run.