Chapter 10

H7: Reversing Flow through a Gate

Contents

10.1 Problem Specification

H7 Reversing flow through a channel gate

Focus reversing flow through gate

Channel geometry, channel friction, gate characteristics and the initial conditions are the same as schematic application H6.

Open boundary conditions at the downstream end A (see Figure 9.1) are

$$\eta_A(t) = \begin{cases} 0 & \text{for } t \leq 0 \\ 1 \sin \omega t & \text{for } t > 0 \end{cases} \tag{10.1.1}$$

where $\omega = 2\pi/T$, the tidal period T being 12.5 hours.
Open boundary conditions at the upstream end D (see Figure 9.1) are

$$\eta_D(t) = \begin{cases} 0 & \text{for } t \leq 0 \\ 1 \sin(\omega t - \phi)) & \text{for } t > 0 \end{cases} \tag{10.1.2}$$

where the phase lag is 1 hour, i.e. $\phi = \omega\tau$, where τ is 1 hour.

Use a fixed computational space step $\Delta x = 500$ ft and a fixed computational time step $\Delta t = 30$ s.

Compute and write to file in the STANDARD FORMAT the initial conditions at $t = 0$ and the model predictions for every 900 s (30 time steps) for 25.0 hours.

10.2 Background

Extension of Problem H6 to investigate gate potential transients in tidally-reversing flow.

10.3 Contra Costa Water District

Figure 10.1 shows the CCW-predicted η and Q evolution toward the steady state. Figure 10.2 shows a detail in the neighborhood of the gate. Initial transients appear and decay as expected, most clearly in the Q evolution. This seems a credible result.

Figure 10.3 shows the time history of the mass and momentum balances at locations $x = 3{,}000$ ft and 23,000 ft. These show the expected tidally-induced cycling in the terms in the mass and momentum balances. Spikes mark the passage of initial transients from A and D. There is no suggestion that this is not a credible prediction.

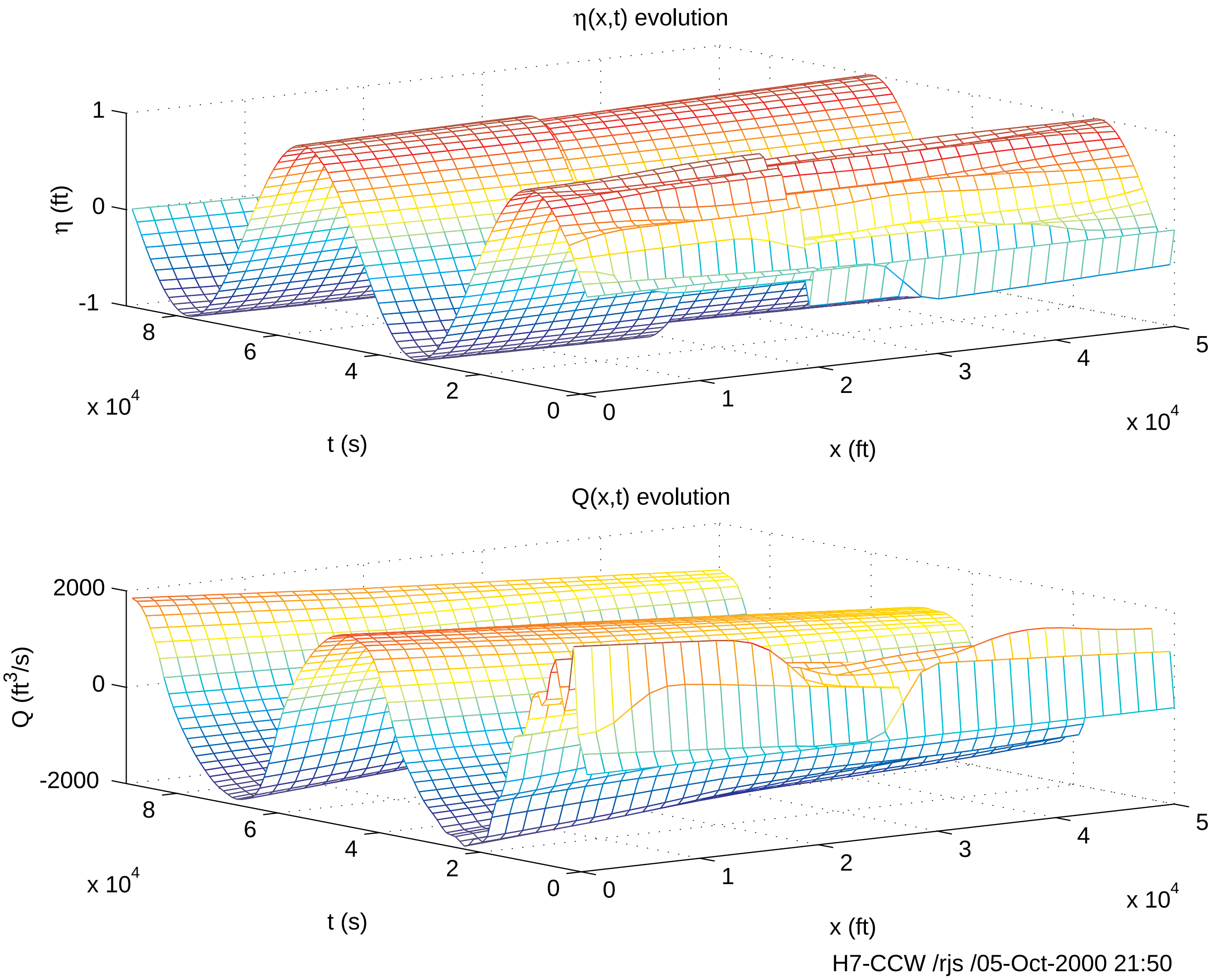

Figure 10.1: H7 CCW-predicted η and Q solution field evolution.

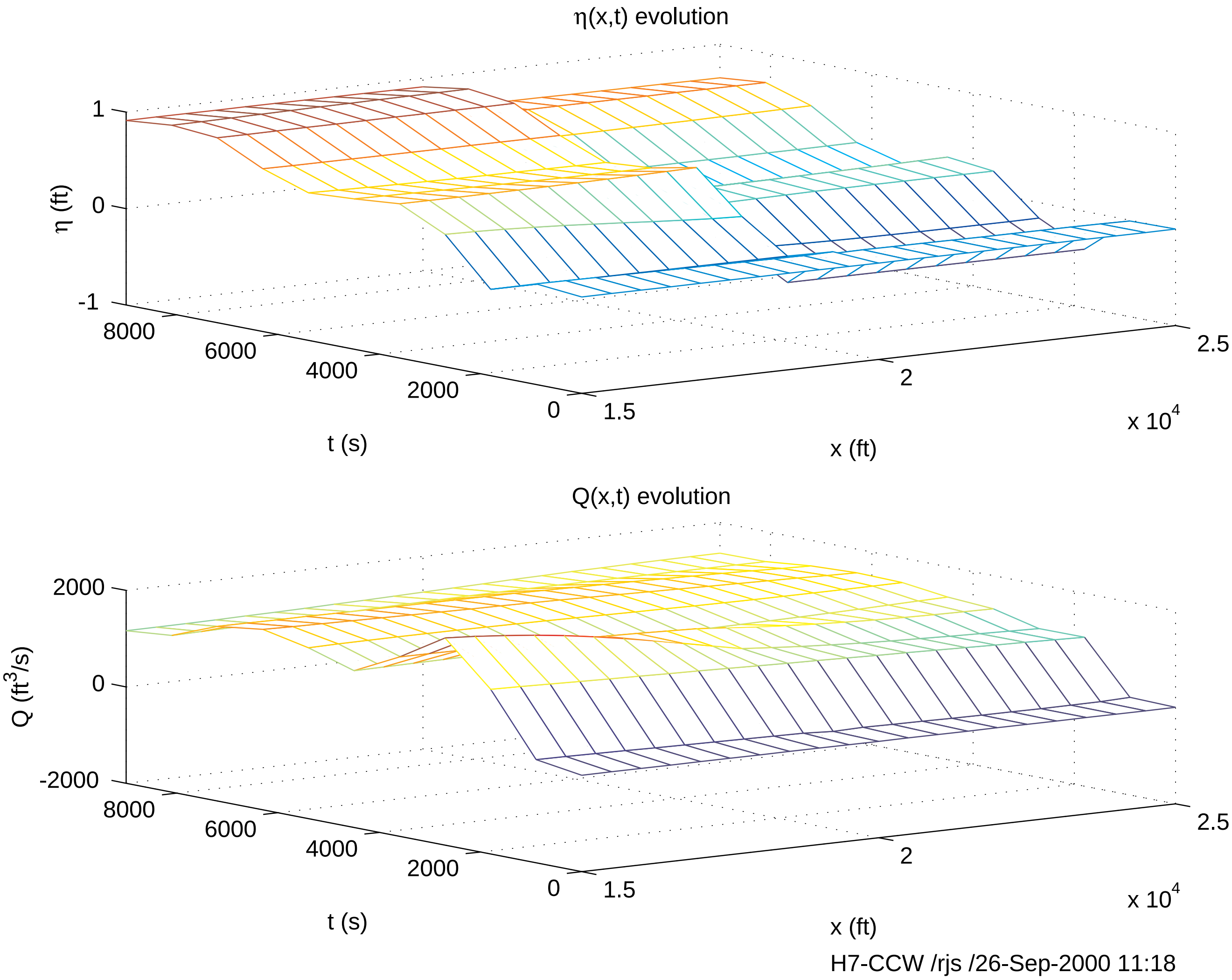

Figure 10.2: H7 CCW-predicted η and Q solution field evolution in neighborhood of gate.

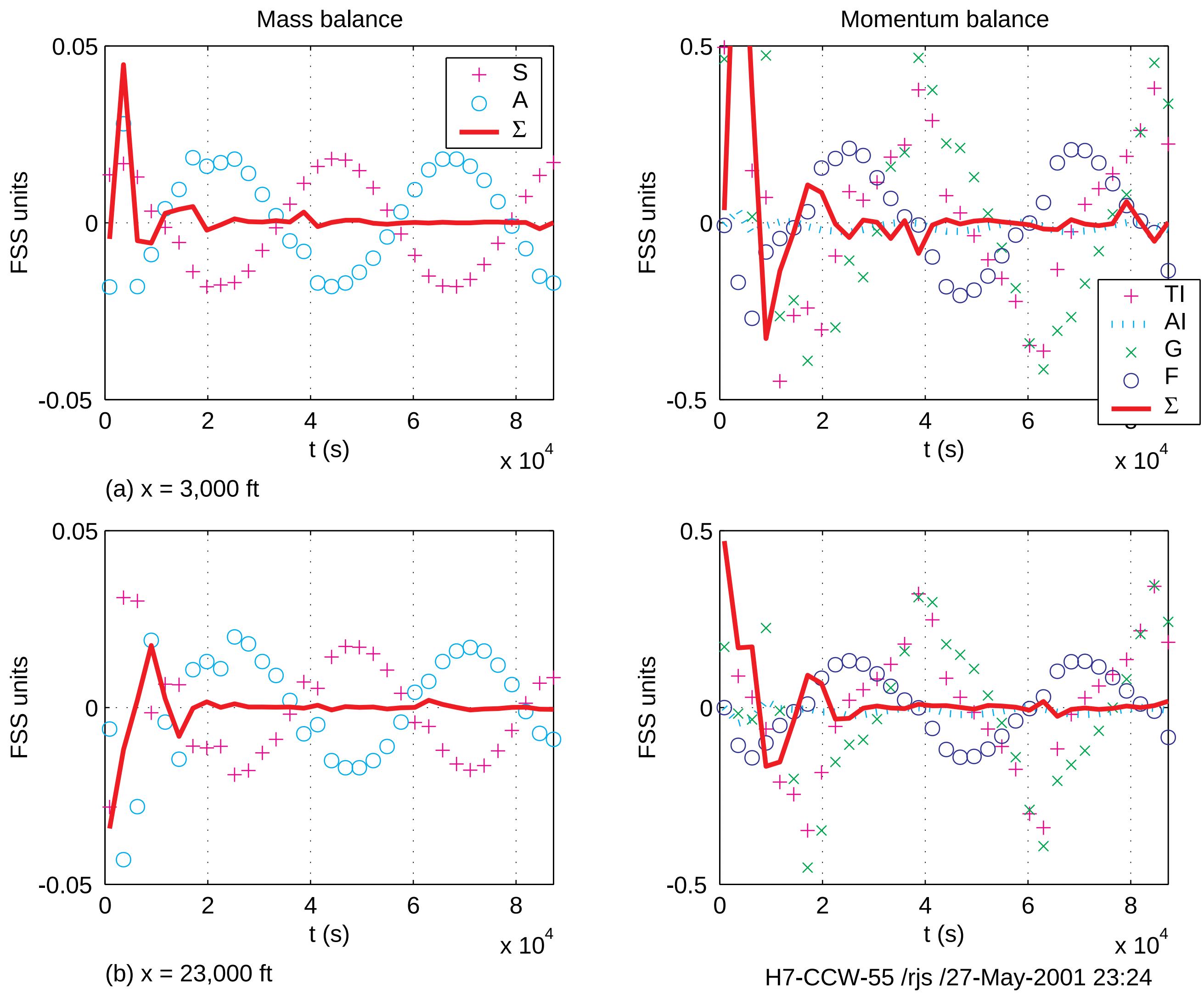

Figure 10.3: H7 CCW-predicted conservation balances at $x = 3{,}000$ ft and 23,000 ft.

10.4 Department of Water Resources

Figure 10.4 shows the DWR-predicted[1] η and Q evolution toward the steady state. Initial transients appear and decay as expected[2], most clearly in the Q evolution.

Figure 10.5 shows a detail in the neighborhood of the gate. The absence of gate-induced transients was noted in the H6 discussion in §9.5. Otherwise, Figures 10.4 and 10.5 seem a credible result.

Figure 10.6 shows the time history of the mass and momentum balances at locations $x = 3{,}000$ ft and 23,000 ft. These show the expected tidally-induced cycling in the terms in the mass and momentum[3] balances. The absence of spikes marking the passage of initial transients from A and D is noted, once again[4] drawing attention to the issue of numerical filtering in the DWR model. Otherwise, this seems to be a credible prediction.

[1] The DWR data file reports the output time step as 1 s; it was apparently not the specified 900 s, but 60 s. The data file time step has been changed to 60 s and data has been extracted every 900 s for the following analyses. For compatibility with other participants, intermediate data has been ignored. In addition, DWR have reversed the direction of the x axis.

[2] There are obvious differences from Figure 10.1: a step up and not down in the η evolution at the gate, and Q increases and not decreases in the downstream direction. These are a direct result of the DWR reversal in the direction of the x axis.

[3] There is a sign reversal for all terms in the momentum balance (see Figures 10.3 and 10.9), but this is not significant. It is a consequnece of the DWR reversal in the direction of the x axis.

[4] See §9.3 and §9.5

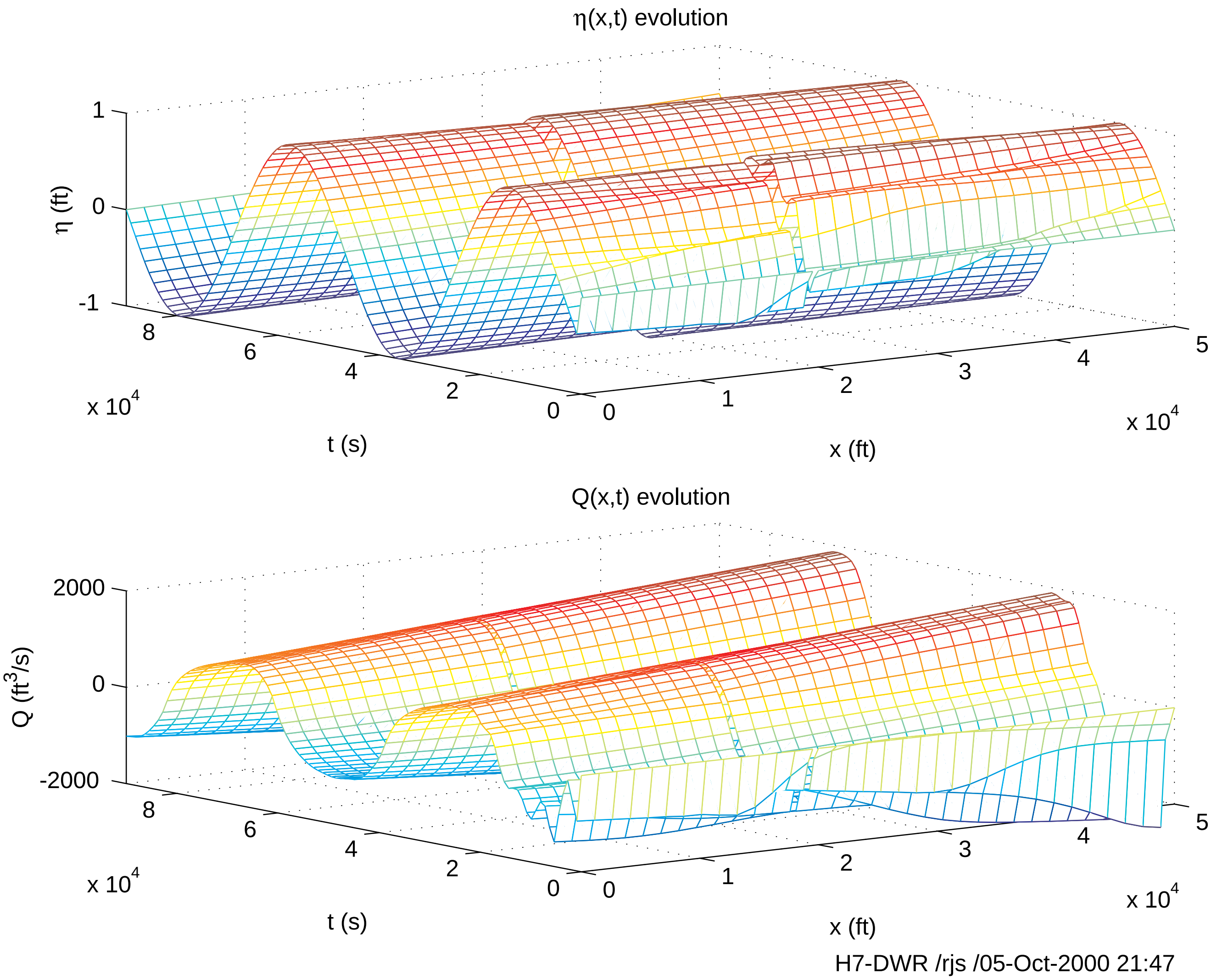

Figure 10.4: H7 DWR-predicted η and Q solution field evolution.

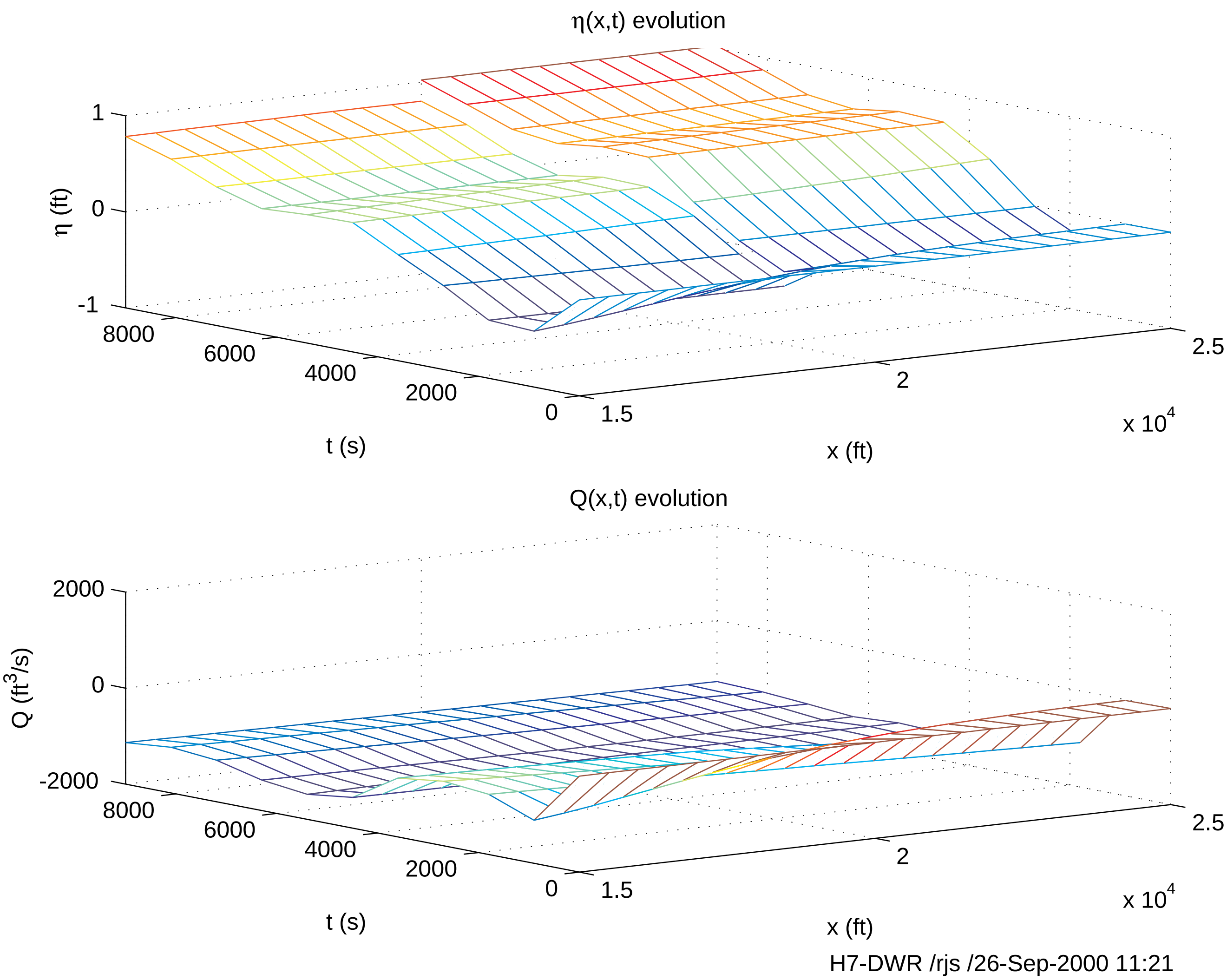

Figure 10.5: H7 DWR-predicted η and Q solution field evolution in neighborhood of gate.

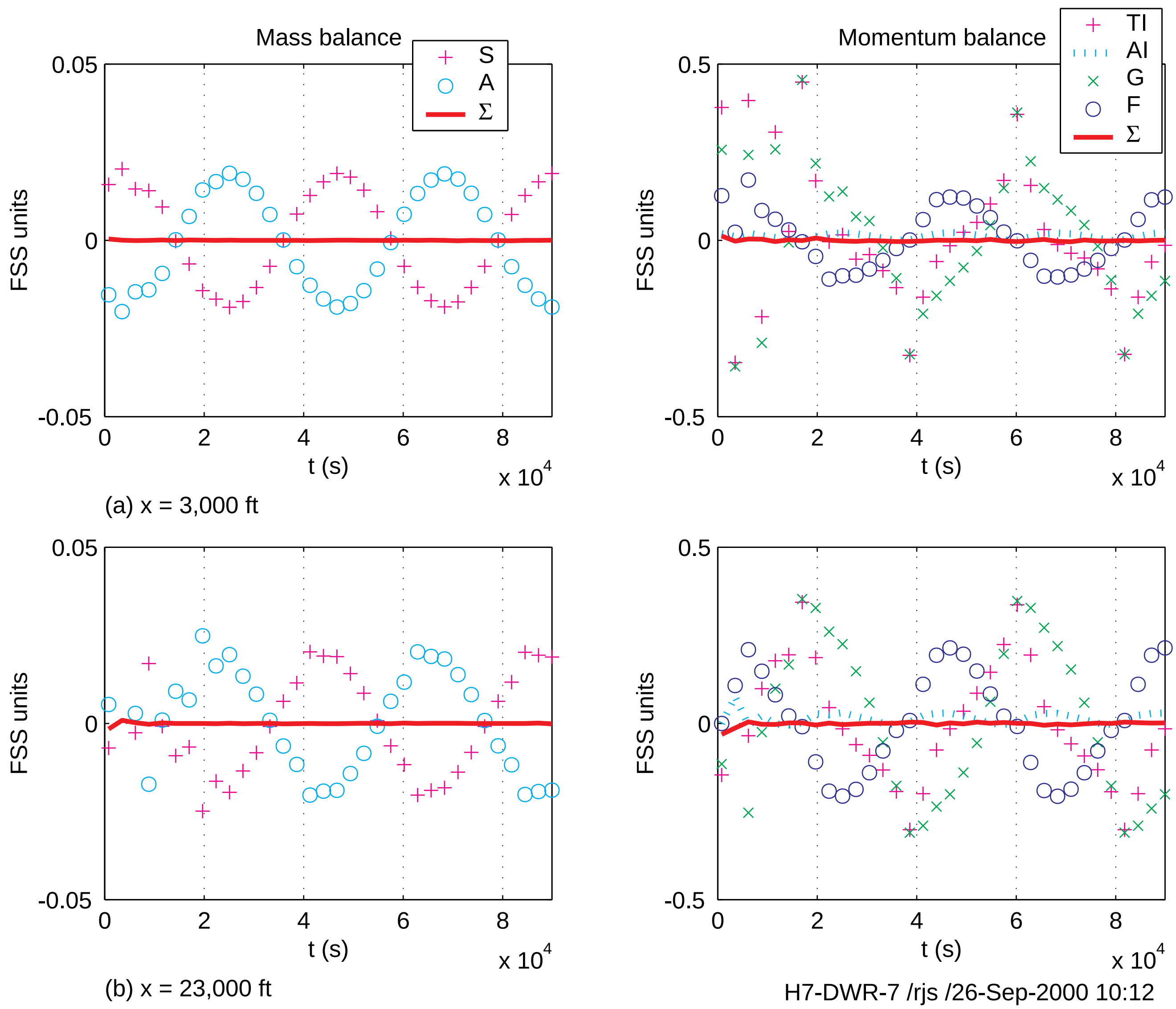

Figure 10.6: H7 DWR-predicted conservation balances at $x = 3{,}000$ ft and 23,000 ft.

10.5 Resource Management Associates

Figure 10.7 shows the RMA-predicted[5] η and Q evolution toward the steady state. Figure 10.8 shows a detail in the neighborhood of the gate. Initial transients appear and decay as expected, most clearly in the Q evolution. This seems a credible result.

Figure 10.9 shows the time history of the mass and momentum balances at locations $x = 3{,}000$ ft and 23,000 ft. These show the expected tidally-induced cycling in the terms in the mass and momentum balances. There is no suggestion that this is not a good prediction.

[5]The RMA predictions have used a space step Δx of 250 ft, not the required 500 ft.

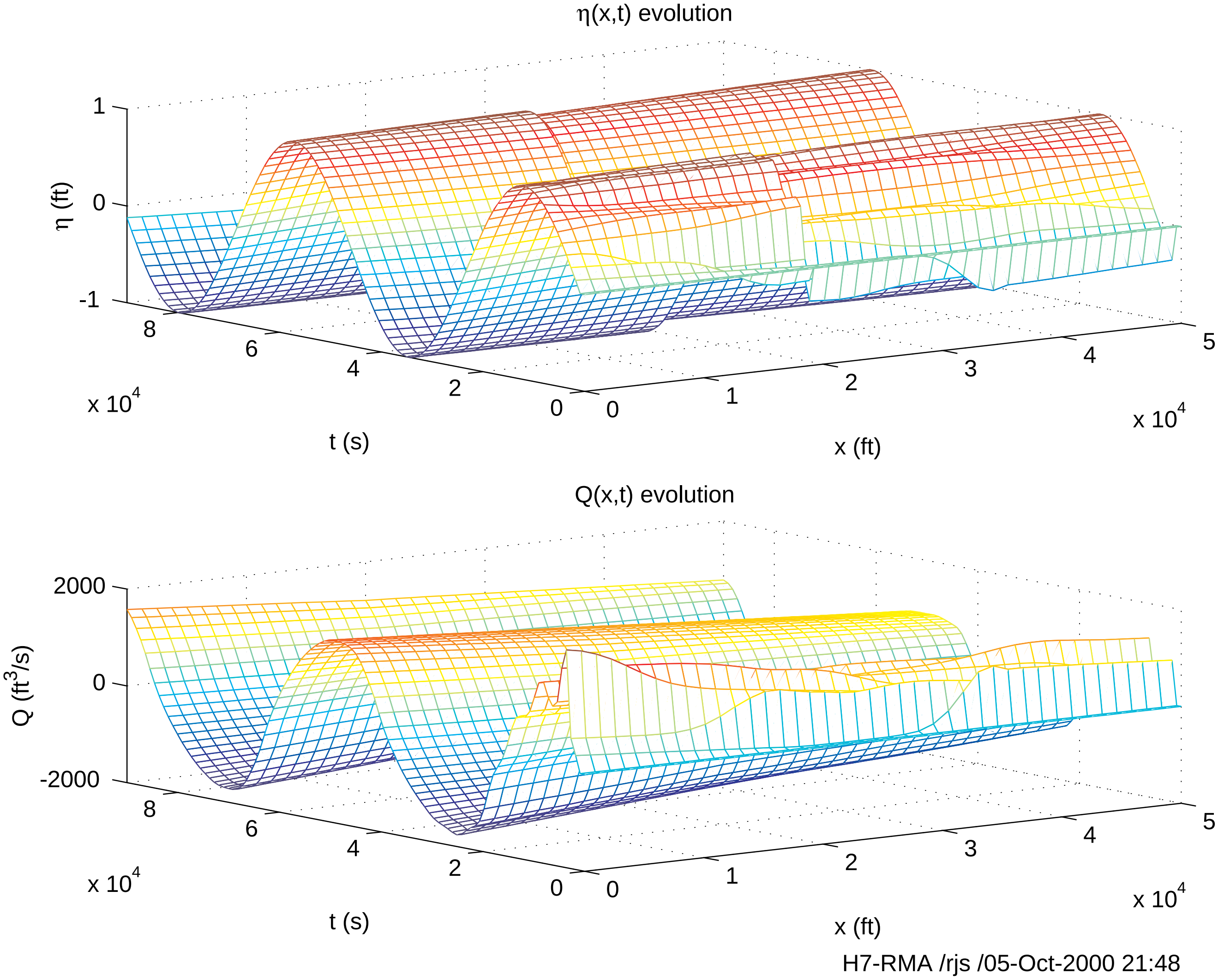

Figure 10.7: H7 RMA-predicted η and Q solution field evolution.

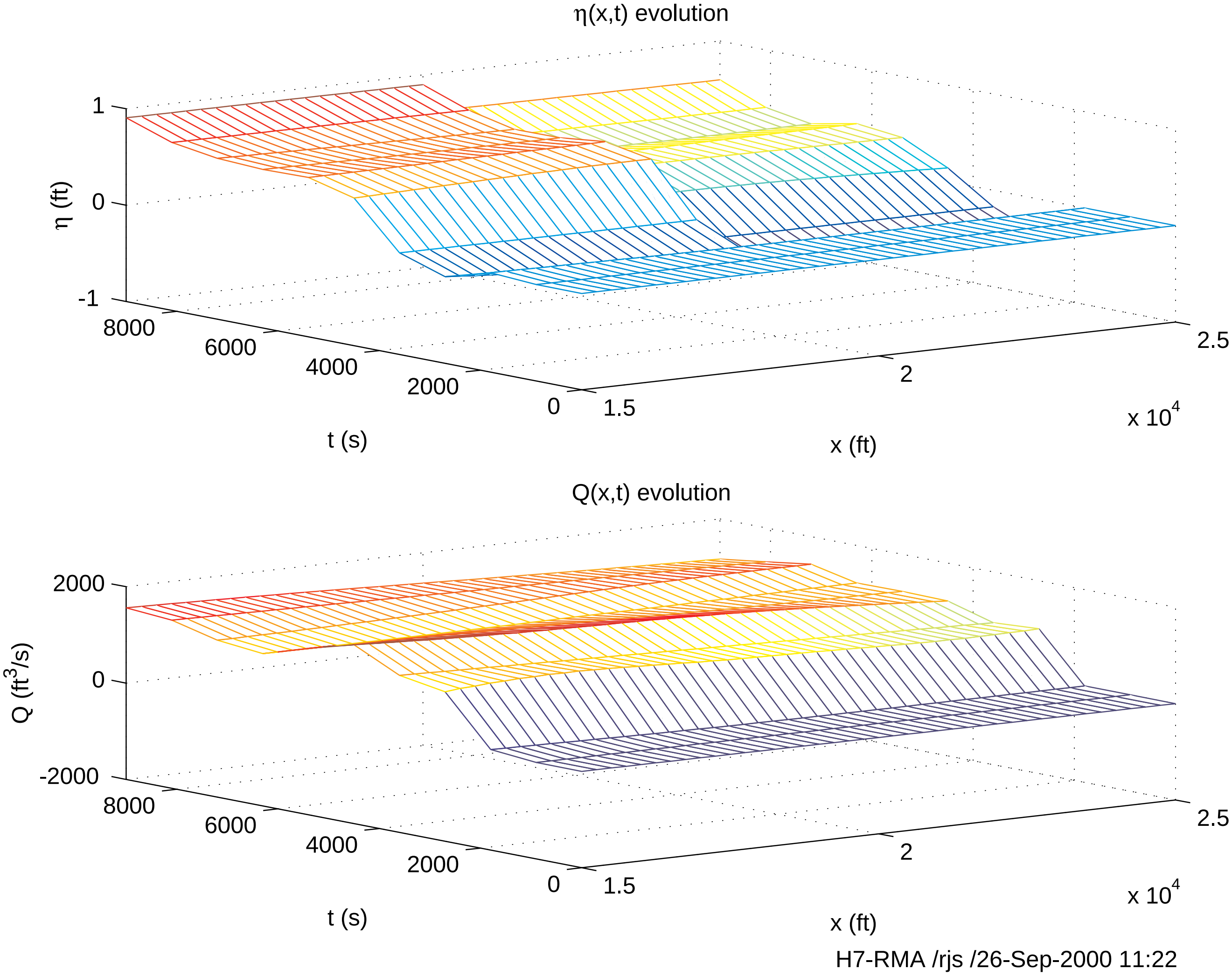

Figure 10.8: H7 RMA-predicted η and Q solution field evolution in neighborhood of gate.

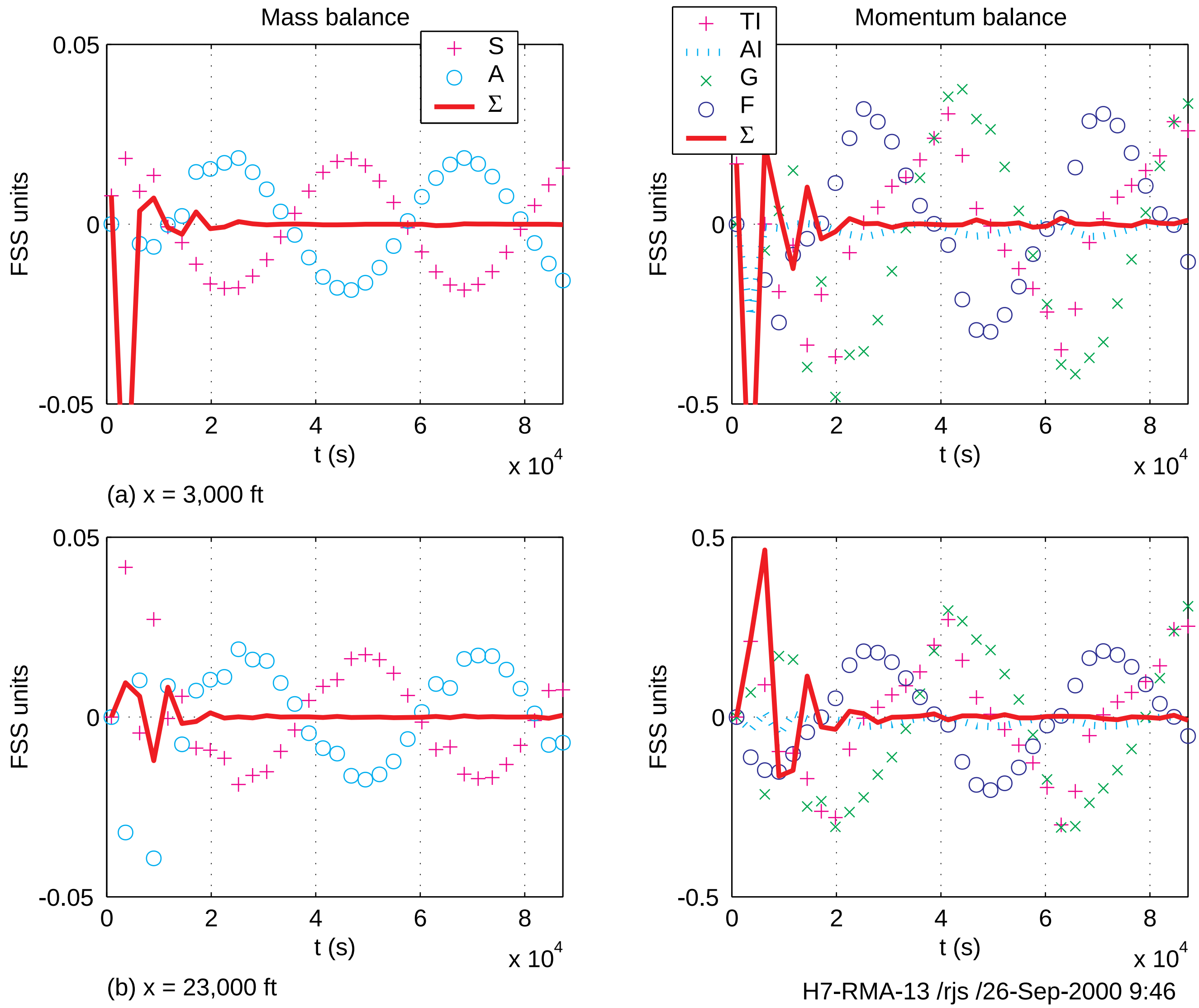

Figure 10.9: H7 RMA-predicted conservation balances at $x = 3{,}000$ ft and 23,000 ft.