Water Surface and Velocity Model Calibration For Selected Rivers in the South Saskatchewan River Basin, Alberta, Canada

Prepared for:

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Introduction

Watershed Systems Group was asked to conduct a technical evaluation of the hydraulic modeling conducted at a number of instream flow assessment sites of interest to the Alberta Environment. This technical evaluation involved converting the existing hydraulic calibration data to the Windows based version of the Physical Habitat Simulation System (PHABSIM), calibration of the water surface elevation models, calibration of the velocity models, and determination of the valid ranges of simulated discharges. This report provides a synopsis of the work and final model calibration details.

Review Process

Data Conversion and Initial Review

Electronic copies of PHABSIM data files for each study reach and river were provided. The files for a specific study reach were originally divided into high, medium, and low calibration/simulation data sets. These individual data files (high, medium, and low) for a specific study reach were combined into a single integrated data set when converted for use in the Windows version of PHABSIM (see Hardy 2000). Table 1 lists the river, study reaches (or segments) and number of cross sections. In Table 1, the study reach or study segment designation was retained.

Table 1. River, segment/reach, and number of cross sections .

Belly	Number of Cross Sections	RedDeer	Number of Cross Sections
Segment 1	7	Reach 1	5
Segment 2	8	Reach 2	5
Segment 4	7	Reach 3	4
Segment 5	8	Reach 4	6
Bow		St.Mary	
Reach 1	7	Segment 1	10
Reach 2	6	Segment 3	11
Reach 3	5		
Oldman		Waterton	
Reach 1	7	Segment 1	9
Reach 2	7	Segment 2	12
Reach 3	5		
Reach 4	8		
Reach 5	6		
Reach 6	6		

The converted data was imported and the cross section data was plotted to determine if there were any obvious data entry errors in the original data files. This included and examination of the calibration discharges, water surface elevations, and velocities. In addition, the simulated water surface elevation data contained in each of the original data sets (high, medium, and low) were plotted to examine the relationship between simulated discharges and the longitudinal profiles of the water surface elevations. Cross section profile plots were also used to determine if any simulated water surface elevations at higher flows exceeded the upper elevation of the channel coordinate data.

This review indicated no obvious data entry errors in the coordinate data or calibration data (water surface elevations and velocities). However, several study sites did show inconsistent simulated water surface elevation results using the original water surface modeling approach as noted below for specific high, medium, or low simulation data sets.

BELLY	Reach 1 High Flow: Simulated water surface elevations flow uphill between cross sections 5 and 6 at highest flow.
BELLY	Reach 1 Low Flow: Simulated water surface elevations flow uphill between cross sections 3 and 4 at lowest simulated flow.
BELLY	Reach 4 Low Flow: Simulated water surface elevations flow uphill between cross sections 4 and 5 at high flow.
BOW	Reach 1 Low Flow: Simulated water surface elevations flow uphill between cross sections 1 and 2 a lowest flow.
RED DEER	Reach 3 High Flow: Simulated water surface elevations cross between high, medium, and low data sets.
ST. MARYS	Reach 1 Low Flow: Simulated water surface elevations flow uphill between cross sections 3 through 6.
ST. MARYS	Reach 1 Medium Flow: Simulated water surface elevations flow uphill between cross sections 6 and 7.
ST. MARYS	Reach 3 High Flow: Simulated water surface elevations flow uphill between cross sections 5 through 7 and cross sections 9 and 10.
ST. MARYS	Reach 3 Low Flow: Simulated water surface elevations flow uphill between cross sections 1 through 4 and cross sections 8 and 9.
WATERTON	Reach 2 High Flow: Simulated water surface elevations flow uphill between cross sections 5 and 6 and cross sections 9 and 10.
WATERTON	Reach 2 High Flow: Simulated water surface elevations flow uphill between cross sections 5 and 6 and cross sections 2 through 8.

Calibration of Water Surface Elevation Models

Based on the review of the water surface elevation simulation results, it was decided to undertake a recalibration of water surface elevation models at each study site. Calibration of the water surface elevation model(s) for each study site was undertaken using a stage-discharge regression approach (STAGQ),

utilization of Manning's equation (MANSQ), and a step-backwater method (WSP). Model calibrations followed the protocols as described in Hardy (2000). Model performance was assessed by a comparison of predicted and observed water surface elevations at each calibration discharge and the behavior of simulated water surface elevations over both higher and lower ranges of simulated discharges. Selection of the final water surface elevation model(s) was determined by selecting the model(s) that had the lowest error between predicted and observed water surface elevations at each calibration flow and exhibited no anomalous simulations of water surface elevations over the desired range of simulated flows. The water surface elevation model(s) utilized at each study site, calibration flows, model parameters where appropriate (i.e., beta coefficients, Manning's n, Roughness Modifiers), and the difference between predicted and observed water surface elevations at each calibration flow are provided in Appendix A. Plots of the longitudinal profiles of simulated water surface elevations are provided in Appendix B.

Calibration of Velocity Models

Velocity model calibrations were undertaken at each study site following the protocols outlined in Hardy (2000). Model selection for each cross section for each calibration flow examined the predicted versus observed velocity profiles. The ranges for each calibration flow were established by comparing model predictions over simulated ranges of discharge in conjunction with the cross section morphology to guide where changing between velocity calibration sets should occur. The range over which each calibration velocity set was applied for each cross section at each study site are indicated in the model summary tables contained in Appendix A. Plots of the simulated velocity profiles at each cross section for each study site are provided in Appendix C.