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Memorandum

To: Chehalis River Basin Flood Authority

From: Chris Frei and Larry Karpack, WATERSHED Science & Engineering

Date: March 12, 2012

Re: **Skookumchuck River Model Update and Bucoda Flood Reduction Alternative Investigation**

WATERSHED Science & Engineering (WSE) and WEST Consultants (WEST) are currently working with the Chehalis River Basin Flood Authority to develop a hydraulic model of the Lower Chehalis River (from Grand Mound to Aberdeen). This model will be used to evaluate the effects of potential flood relief alternatives in the basin. In addition to work on the mainstem hydraulic model the Flood Authority authorized WSE to collect data and/or refine portions of the model on significant Chehalis River tributaries, including the Skookumchuck River.

The Skookumchuck River, from the outlet of the Skookumchuck dam to its mouth, is included as a branch in the Chehalis River hydraulic model. Cross sections are from the 1989 Corps Model with additional field survey taken for the Corps by W.H. Pacific in 2001. The town of Bucoda, near River Mile 10, has a history of flooding problems associated with the Skookumchuck River, and community officials believe that a constriction caused by the railroad bridge at River Mile 9.8 is aggravating upstream flooding. The following tasks were completed to update the Skookumchuck River Model in the vicinity of Bucoda, to evaluate the impacts of the railroad bridge on flooding within Bucoda, and, if found, to evaluate options to reduce those impacts.

Collection of new channel survey data for the Skookumchuck River in the vicinity of Bucoda
Twenty one (21) cross sections were surveyed along the main stem of the Skookumchuck River in the vicinity of Bucoda (RM 9.8 -12). The survey locations were selected to replace and update existing cross sections in the Corps Twin Cities 1989 hydraulic model, and to provide adequate model resolution to investigate the impacts of the existing railroad bridge at RM 9.8.

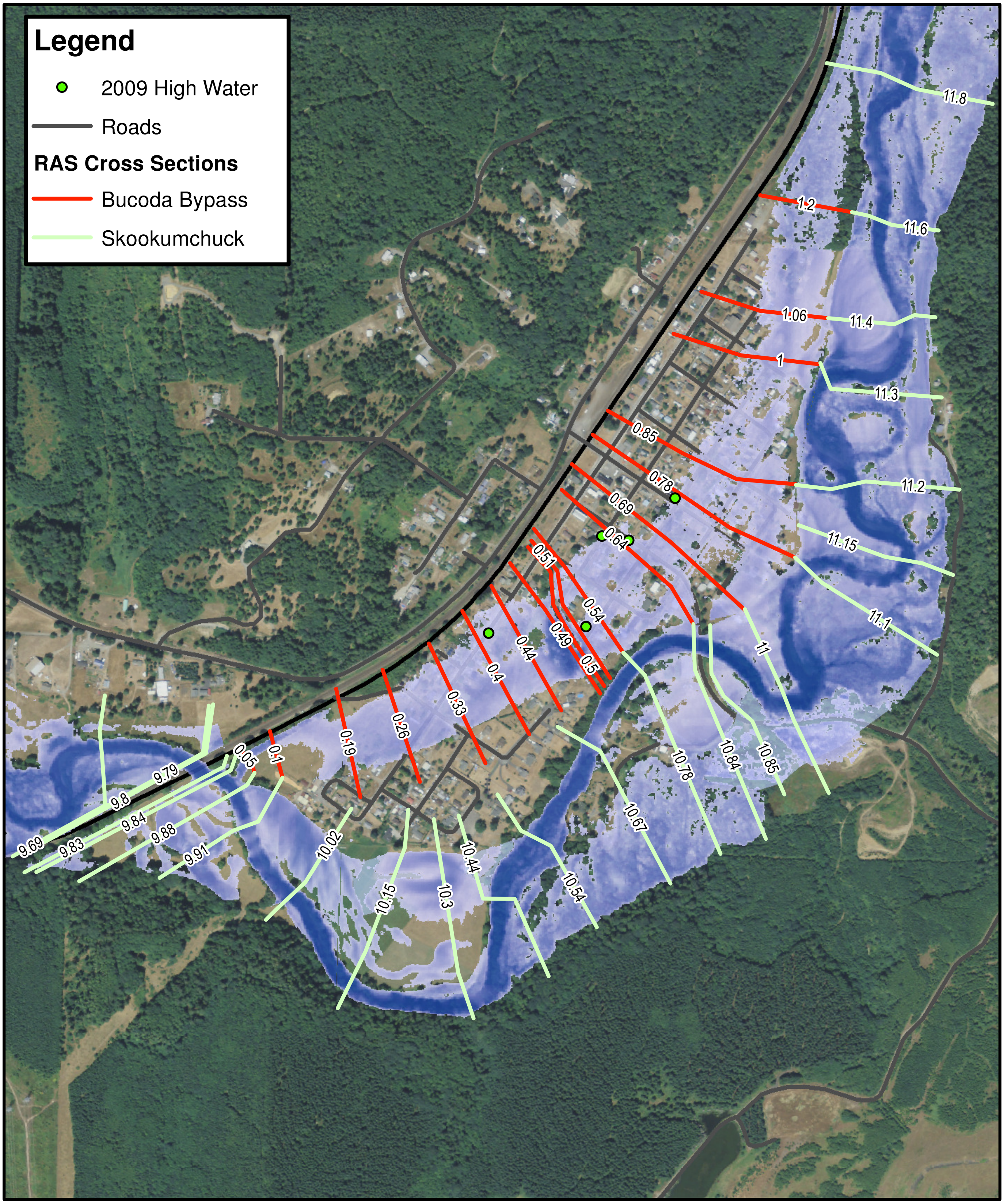
Refinement of the Skookumchuck River Model - The Twin Cities hydraulic model was georeferenced (from RM 6.42 to 21.77) and the data for the channel overbanks were re-cut using 2002 PSLC LiDAR. The model was then refined in the vicinity of Bucoda (RM 9.8 - 12) using the surveyed cross section data described above, and calibrated using high water elevations from the January 2009 flood event. Figure 1 depicts the model's cross section layout and flood depths within the town of Bucoda as predicted by the calibrated model. Each of the January 2009 high water marks (shown in Figure 1) were matched within 0.5 feet, and generally much closer.

Refinement of the Skookumchuck River model reach included the addition of a "Bucoda Bypass" reach, which allows a much more accurate representation of the split-flow flooding that occurs through the town of Bucoda. The resulting model can be easily updated to incorporate and test the flood impacts or benefits of future projects, and provides a useful tool for the evaluation of flood risk and flood reduction alternatives in the town of Bucoda.

Using the calibrated HEC-RAS model two runs were completed to evaluate the hydraulic impacts of the existing railroad bridge (RM 9.8): One in which the bridge and its associated fill was completely removed from the model, and a second in which the bridge opening was artificially encroached (e.g. the opening was artificially reduced) to force a 5 foot increase in water surface elevation. Figures 2 and 3 compare the resulting flood profiles for the January 2009 flood event within the Skookumchuck River and Bucoda Bypass, respectively (model cross sections and river mile stationing are shown in Figure 1).

The model indicates that complete removal of the railroad bridge would reduce water surface elevations within the Skookumchuck River by 1.1 feet near the bridge, tapering to zero benefit at a location approximately one half mile upstream of the bridge (see Figure 2). Corresponding water surface elevations within the Bucoda Bypass reach are not affected by the bridge removal (Figure 3), suggesting that bridge removal or widening would provide no reduction in flood levels within the town of Bucoda.

To evaluate the effect of a theoretical bridge constriction - such as a large debris blockage - the bridge opening was encroached by 2/3, leaving only 1/3 of the opening available to flow. This constriction caused a 5 foot increase in water surface elevations in the Skookumchuck River just upstream of the bridge (Figure 2), but water surface elevations within the town of Bucoda were increased by less than 0.1 feet (Figure 3) with the exception of the lower 0.4 miles of the Bypass reach. The modeled bridge constriction is much more severe than anything we would expect at this location, and there is no anecdotal evidence to suggest that such a blockage has ever occurred. Regardless, the modeled results from the theoretical blockage further support the conclusion that the railroad bridge did not have a major impact on flooding in the town of Bucoda during the January 2009 event.



Thurston County, WA

Skookumchuck River
Model Results for 2009 Flood
Bucoda WA

N

0 625 1,250
Feet

Scale: 1:10,850
NAD 1983 HARN StatePlane
Washington North FIPS 4601
Feet

12 Mar 2012

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Figure 1

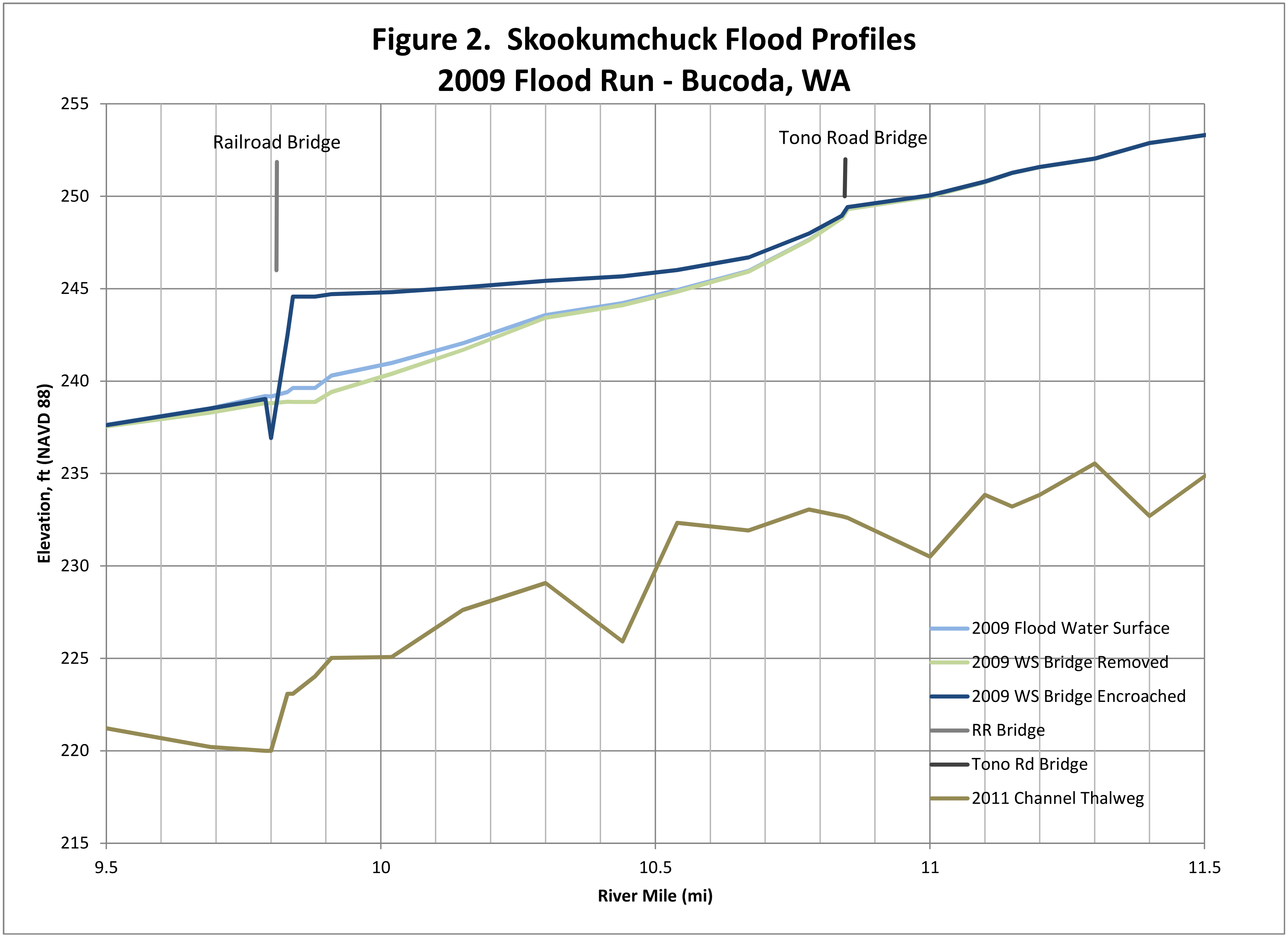

Figure 2. Skookumchuck Flood Profiles
2009 Flood Run - Bucoda, WA
Railroad Bridge
Tono Road Bridge
Elevation, ft (NAVD 88)
River Mile (mi)
255
250
245
240
235
230
225
220
215
9.5
10
10.5
11
11.5
2009 Flood Water Surface
2009 WS Bridge Removed
2009 WS Bridge Encroached
RR Bridge
Tono Rd Bridge
2011 Channel Thalweg

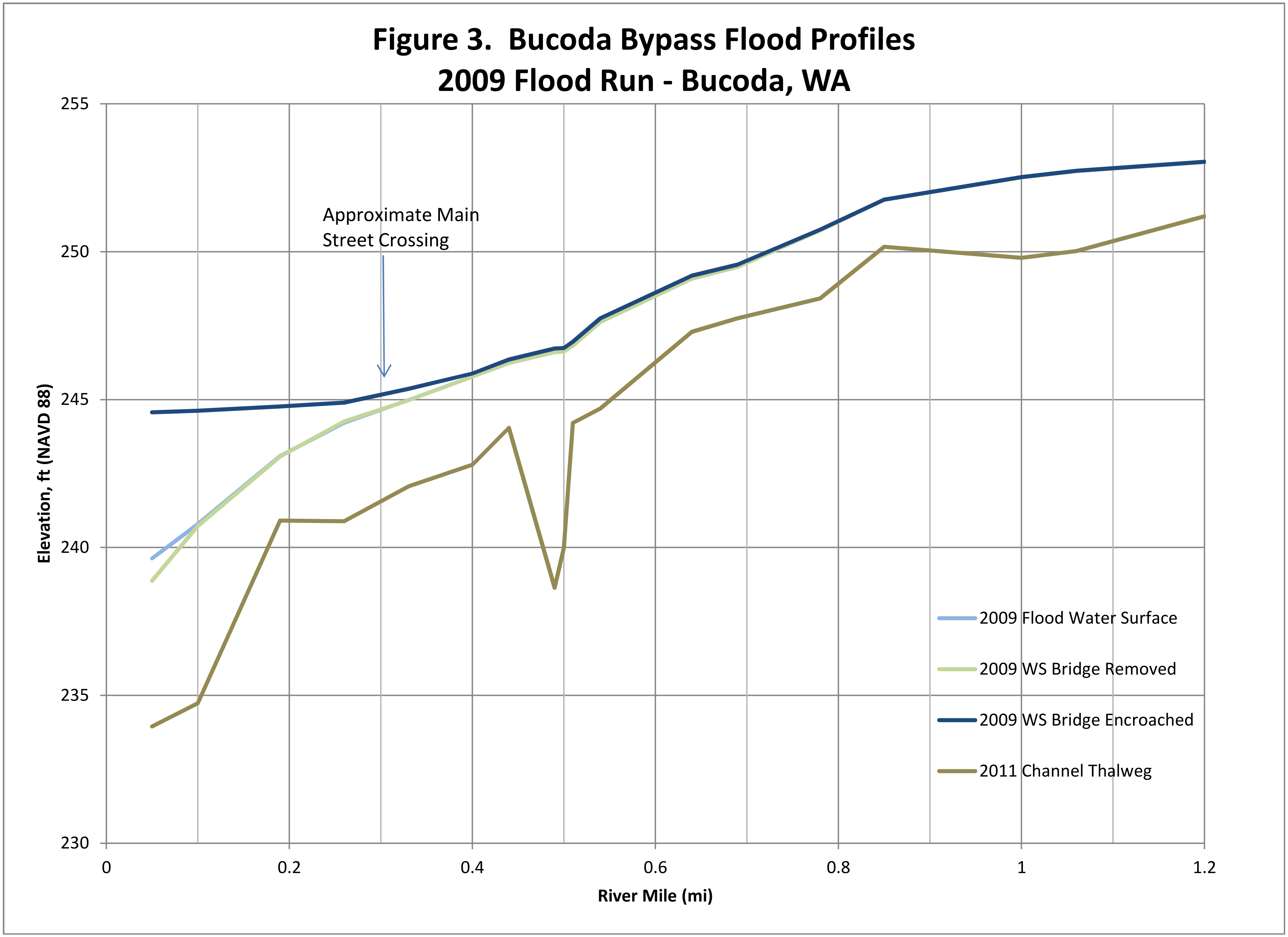
Figure 3. Bucoda Bypass Flood Profiles
2009 Flood Run - Bucoda, WA
Approximate Main
Street Crossing
255
250
245
240
235
230
Elevation, ft (NAVD 88)
0
0.2
0.4
0.6
0.8
1
1.2
River Mile (mi)
2009 Flood Water Surface
2009 WS Bridge Removed
2009 WS Bridge Encroached
2011 Channel Thalweg