Memorandum

WATERSHED SCIENCE & ENGINEERING

110 Prefontaine Pl S, Suite 508
Seattle, WA 98104
Phone: 206-521-3000
www.watershedse.com

Date: June 4, 2015 Project No.: 13-019

From: Chris Frei and Larry Karpack

To: Scott Boettcher

Regarding: Skookumchuck River Floodplain Mapping in Bucoda

Scott;

The following technical memorandum documents the hydraulic investigation completed by Watershed Science and Engineering (WSE) to determine base flood elevations (BFEs) for the Skookumchuck River at Bucoda, WA. WSE produced new floodplain maps and water surface profiles using a recently developed HEC-RAS model and updated hydrologic data for the 100-year flood. Results of our analysis will be provided to the Town of Bucoda to supplement existing (effective) FEMA floodplain mapping and to support better floodplain management and the design of flood damage reduction projects.

Hydraulic Model

The base hydraulic model used for this analysis was an unsteady HEC-RAS model of the Skookumchuck River developed for the Chehalis River Basin Hydraulic Modeling and Analysis project completed by WSE for the Chehalis River Basin Flood Authority in 2012. That model was last updated in 2014 as part of the subsequent Chehalis River Basin Flood Hazards Alternatives Analysis Project.

As a component of the 2012 project, WSE completed a flood hazard assessment for the town of Bucoda that included updating the Skookumchuck River hydraulic model using new surveyed channel cross sections and 2002 LiDAR data. A “Bucoda Bypass” reach was added to the model to allow a more accurate representation of the split-flow flooding that occurs through the town of Bucoda, and the model was calibrated to high water marks from the January 2009 flood event.

As part of the current investigation, WSE refined model calibration to the 2009 flood event. The model was run to simulate the January 2009 flood, and Manning’s n roughness values were adjusted to better match observed high water marks, including one additional high water mark not considered in the 2012 analysis. Following calibration, WSE trimmed the Skookumchuck River reach at a location near the USGS Bucoda gage (River Mile 6.4), and input a stage-discharge rating curve as the downstream model boundary. The model was then run to simulate an updated 100-

year flood event with a peak discharge of 12,600 cubic feet per second (cfs), WSE's revised estimate of the 100-year flow at Bucoda.

Hydrology

WSE computed an updated 100-year instantaneous peak flow of 12,600 cfs based on the USGS gage on the Skookumchuck River near Bucoda (located downstream of Bucoda near the Highway 507 crossing). The updated 100-year flood is approximately 40% higher than the FEMA 100-year flood of 9060 cfs - primarily because the current analysis is based on a longer gage record that accounts for a number of flood events that occurred after the FEMA study was completed in 1979 (see Table 1).

Table 1. Skookumchuck River Peak Flow at USGS Bucoda Gage

Event	Peak Flow (cfs)
Updated 100-Year	12,600
Feb 1996*	11,300
January 2009*	10,500
FEMA 100-Year	9,060

*USGS Observed Flow

WSE then developed a 100-year flood hydrograph by scaling the hydrograph from the February 1996 flood of record such that the peak flow in that hydrograph matched the 100-year peak flow of 12,600 cfs. This hydrograph was routed through the updated hydraulic model to determine peak water surface elevations for the updated 100-year flood.

Hydraulic Modeling Results

Hydraulic model results, including updated 100-year Base Flood Elevations (BFEs) and water surface extents, are shown in Figure 1. Water surface extents are based on a comparison of peak water surface elevation to a 2012 Thurston County LiDAR ground surface. Water surface profiles for the Skookumchuck River and the Bucoda Bypass Reach are provided in Figures 2 through 4, and a GIS grid containing 100-year water surface elevation results is included with this report.

Comparison to the effective FEMA mapping reveals that the updated 100-year BFEs are lower than FEMA BFEs in most areas upstream of the Tono Road bridge (see Figure 5). This is in spite of the fact that the effective study is based on a smaller peak flow of 9,060 cfs. The updated model contains a number of improvements on previous modeling including updated topography based on survey and LiDAR, improved model representation of the Bucoda flow split, and calibration to an observed high flow event (Jan 2009). This new study represents the "best available data"; however, Bucoda may still need to regulate to the effective FEMA BFEs in areas where FEMA maps are more conservative. For this reason, WSE created a composite water surface grid representing

the greater of the effective FEMA water surface and the updated 100-year water surface elevations. WSE delineated the FEMA water surface grid based on the Effective FEMA BFEs at each FEMA cross section and the 2012 Thurston County LiDAR surface. Because the current work used the newer and more detailed topographic surface the floodplain extents may vary slightly from the effective FEMA mapping which was based on an older topographic surface.

Future Work

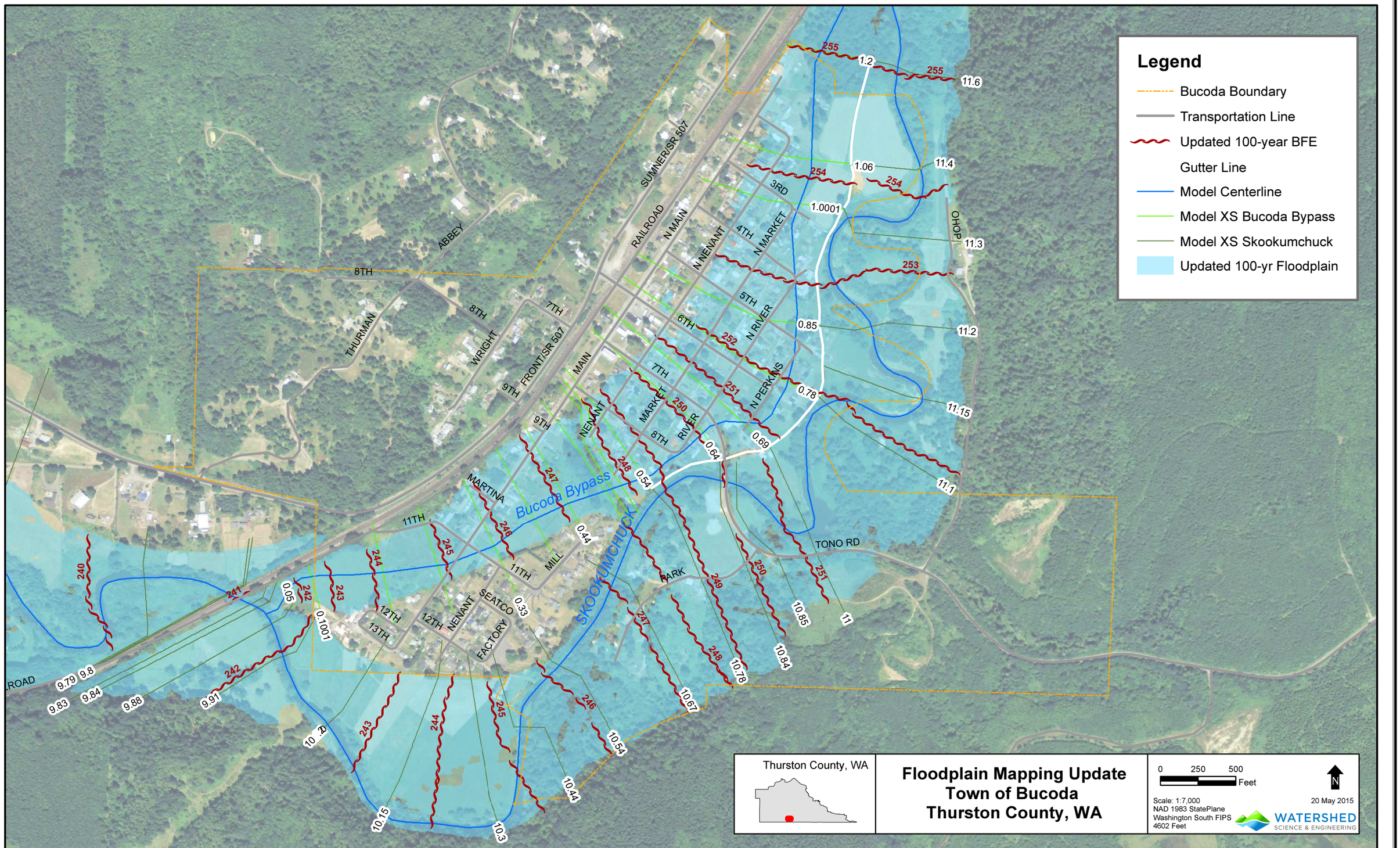
The work described herein was intended to supplement available FEMA floodplain mapping data and, in particular, to fill in gaps in the FEMA floodplain BFEs. This work was not intended to replace the FEMA study and WSE has not prepared all of the necessary supporting technical documentation that would be required for submittal to FEMA to request a Letter of Map Revision (LOMR). Updating the FEMA maps would require review and comparison to the effective FEMA model (which WSE does not have), delineation of a FEMA floodway, and additional map and profile formatting to conform to FEMA guidelines and specifications. FEMA would also require that the hydrologic analysis be evaluated to determine if any adjustments are required to account for flow reduction due to flood storage at the upstream Skookumchuck Dam.

References

Federal Emergency Management Agency (2012), "*Flood Insurance Study, Thurston County Washington and Incorporated Areas*", FIS No 5367CV00A, Effective Date October 16, 2012.

Watershed Science & Engineering (2012), "*Chehalis River Hydraulic Model Development Project"* Draft Report. July 23, 2012.

Watershed Science & Engineering, Science & Engineering (2014), "*Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species - Development and Calibration of Hydraulic Model*" Technical Memorandum. July 22, 2014.



C:\Users\GIS\Documents\WSE\Projects\13-019 Chehalis River Basin Flood Hazard Mitigation\GIS\MXD\Bucoda Mapping Figure 1.mxd 5/20/2015 9:43:29 AM

Figure 1

ELEVATION IN FEET (NAVD)

260
255
250
245
240
235
230
225
220
215

0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
6,500

STREAM DISTANCE IN FEET ABOVE RAILROAD BRIDGE

TONO ROAD

9.88
9.84
9.91
10.02
10.15
10.30
10.44
10.54
10.67
10.78
10.84
10.85
11.0

LEGEND

1% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION

FLOOD PROFILES

SKOOKUMCHUCK RIVER AT BUCODA

TOWN OF BUCDOA
THURSTON COUNTY, WA

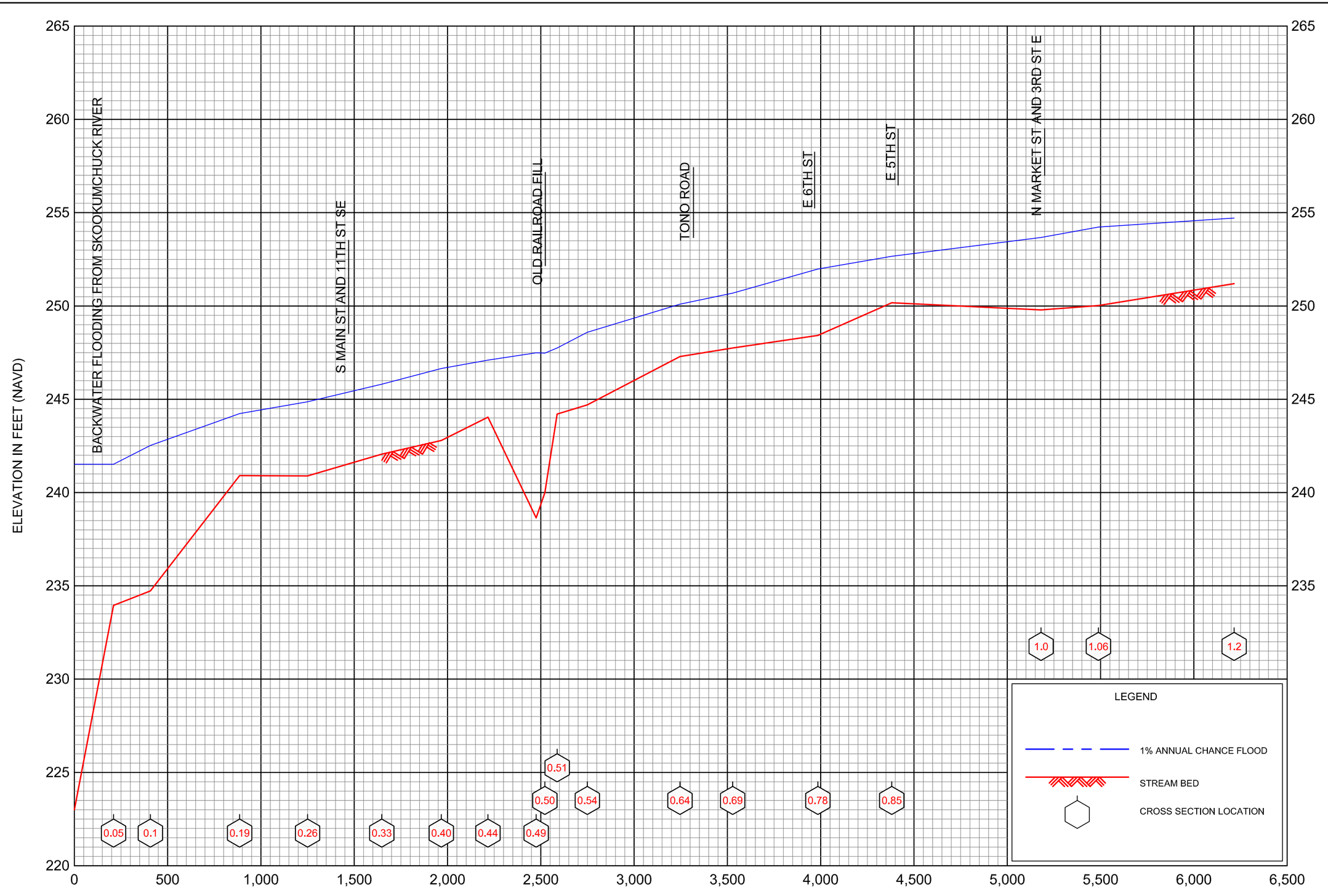
FLOOD PROFILES

SKOOKUMCHUCK RIVER AT BUCODA

TOWN OF BUCDOA

THURSTON COUNTY, WA

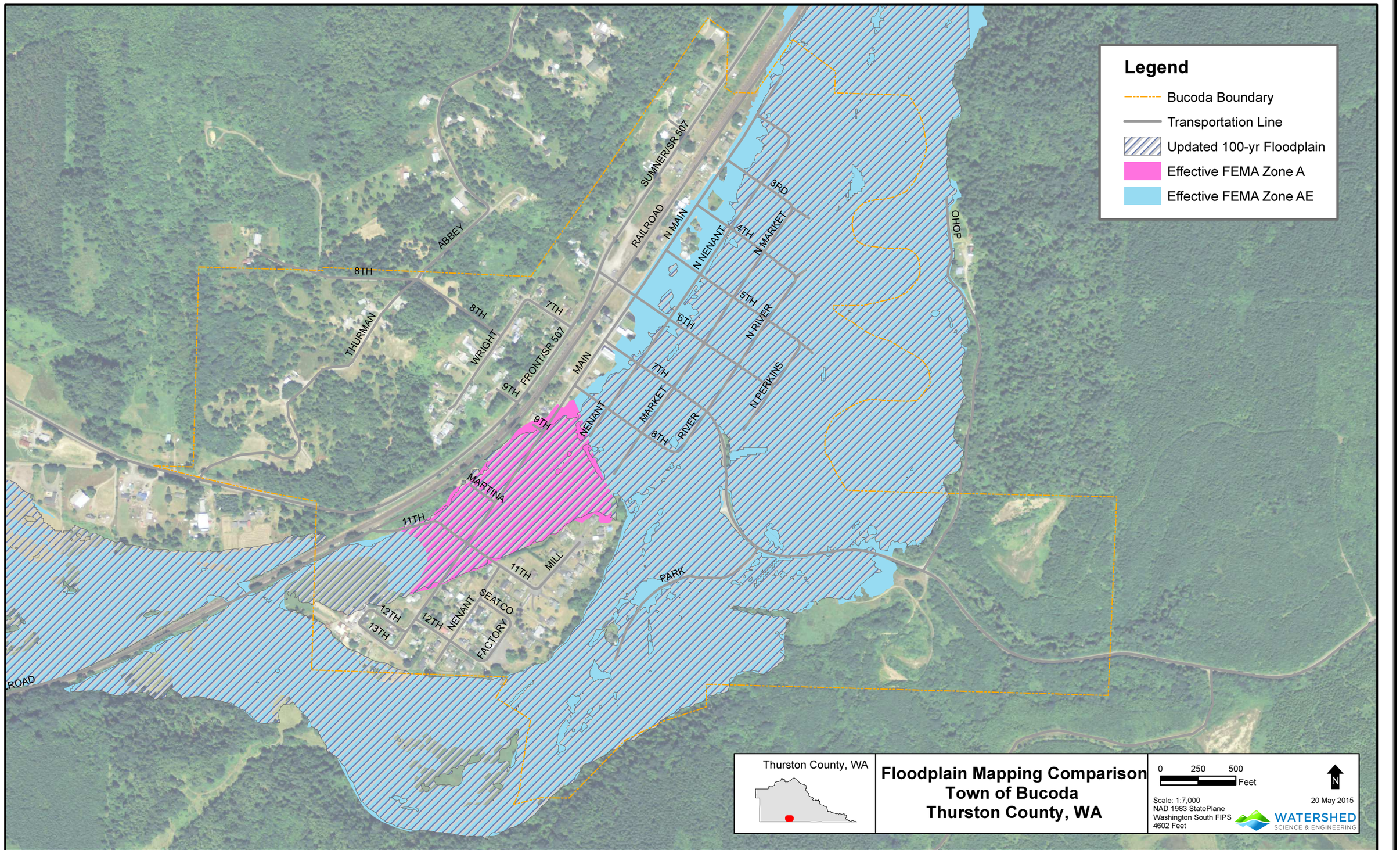
AND INCORPORATED AREAS



FLOOD PROFILES

SKOOKUMCHUCK RIVER BUCODA BYPASS REACH

TOWN OF BUCDOA
THURSTON COUNTY, WA



Thurston County, WA

Floodplain Mapping Comparison
Town of Bucoda
Thurston County, WA

0 250 500 Feet

N

Scale: 1:7,000
NAD 1983 StatePlane
Washington South FIPS
4602 Feet

20 May 2015

WATERSHED SCIENCE & ENGINEERING

C:\Users\GIS\Documents\WSE\Projects\13-019 Chehalis River Basin Flood Hazard Mitigation\GIS\MXD\Bucoda Mapping Figure 5.mxd 5/20/2015 9:05:46 AM

Figure 5