MUSSELSHELL RIVER and ANTELOPE CREEK CONFLUENCE FLOOD STUDY

Photo by Kestrel Aerial Services, Inc.

Where?

Harlowton
Montana

When?

May 2011

Flood Event?

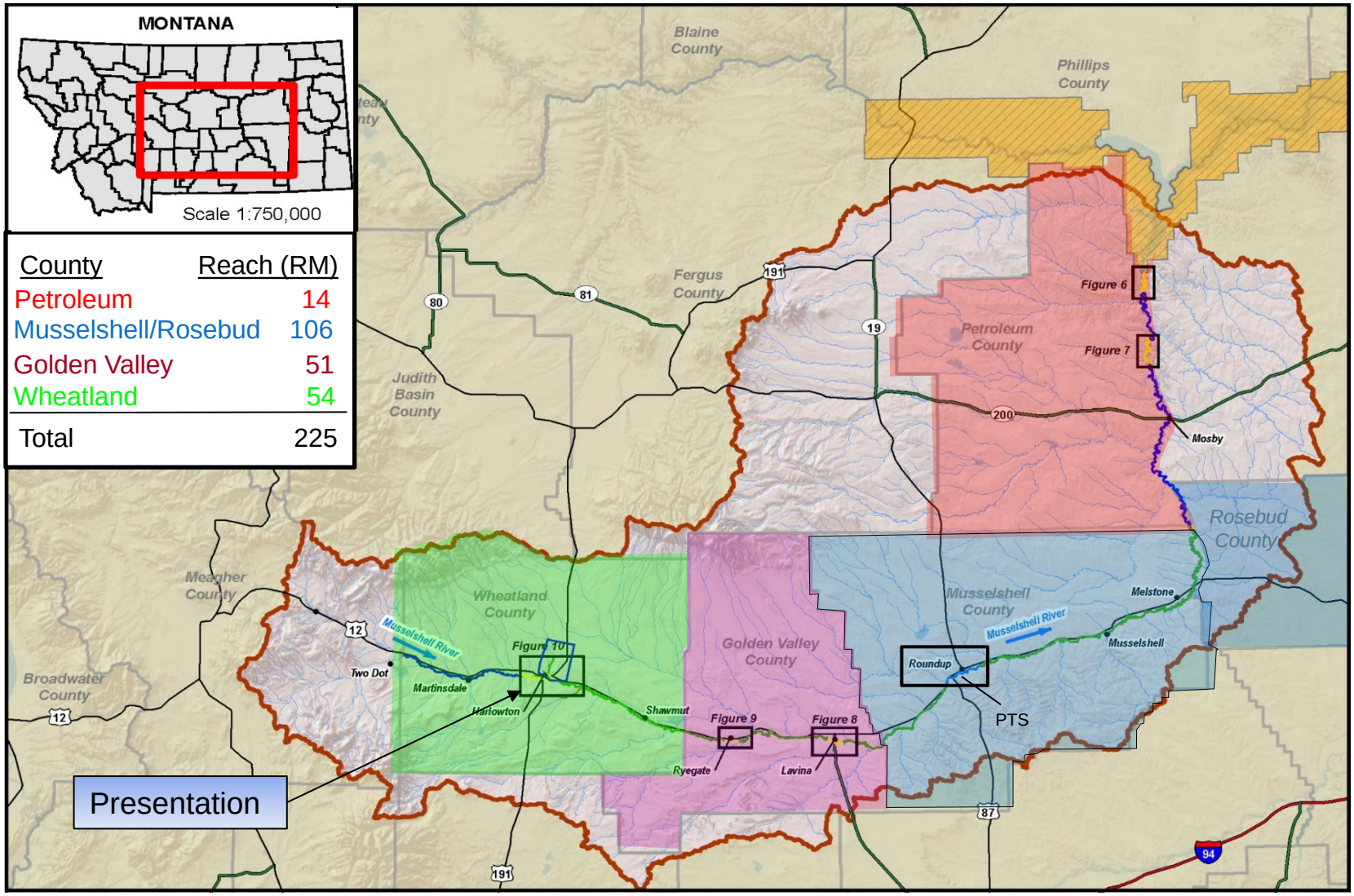
1% AC
(100-year)

Wheatland County, MT

Presentation:

Mark A. Franchi, PE, CFM
Luke D. Carlson, PE, CFM

Musselshell Watershed Flood Study



County	Reach (RM)
Petroleum	14
Musselshell/Rosebud	106
Golden Valley	51
Wheatland	54
Total	225

Presentation

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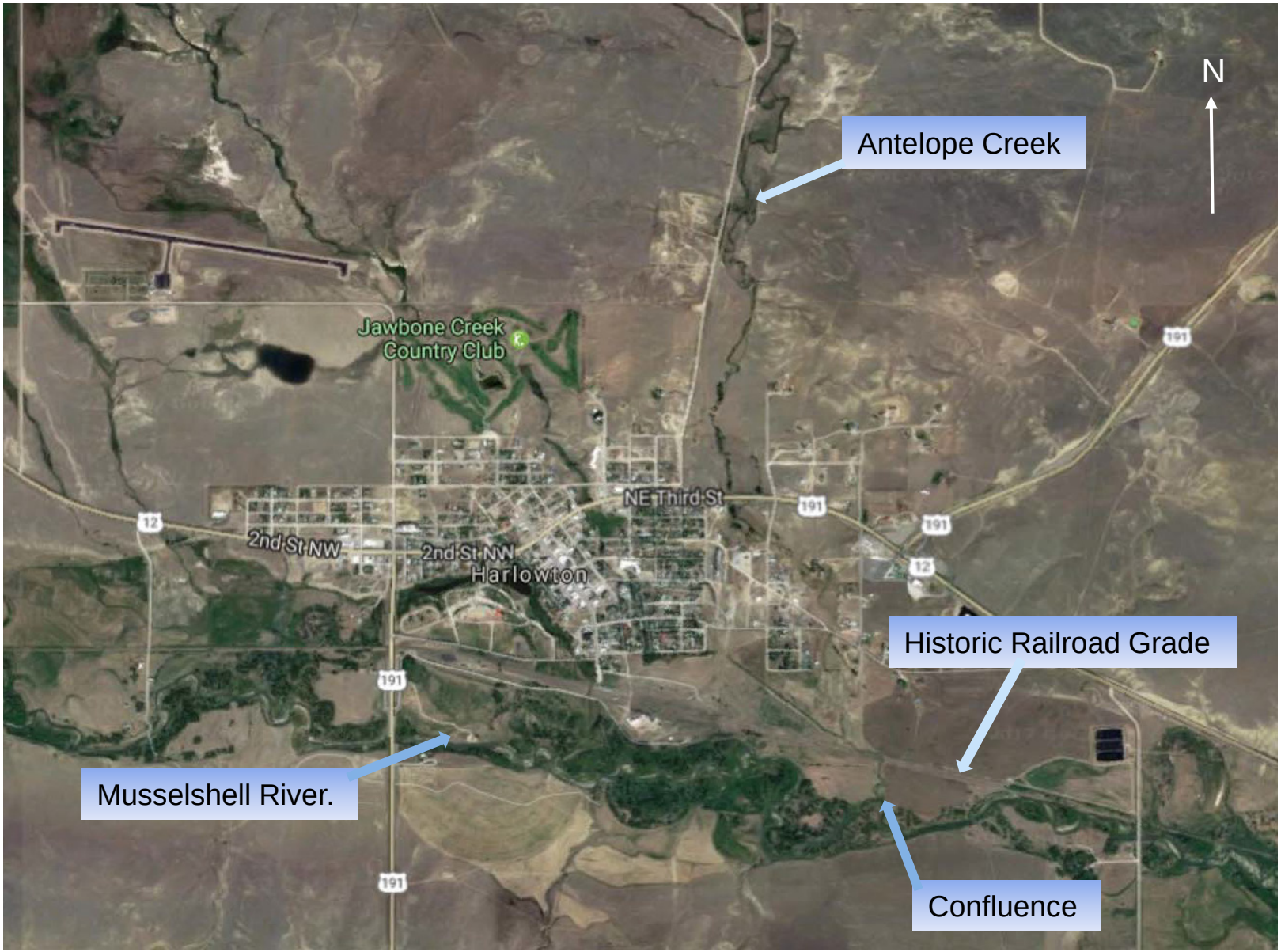
Musselshell and Antelope Creek at Harlowton, MT



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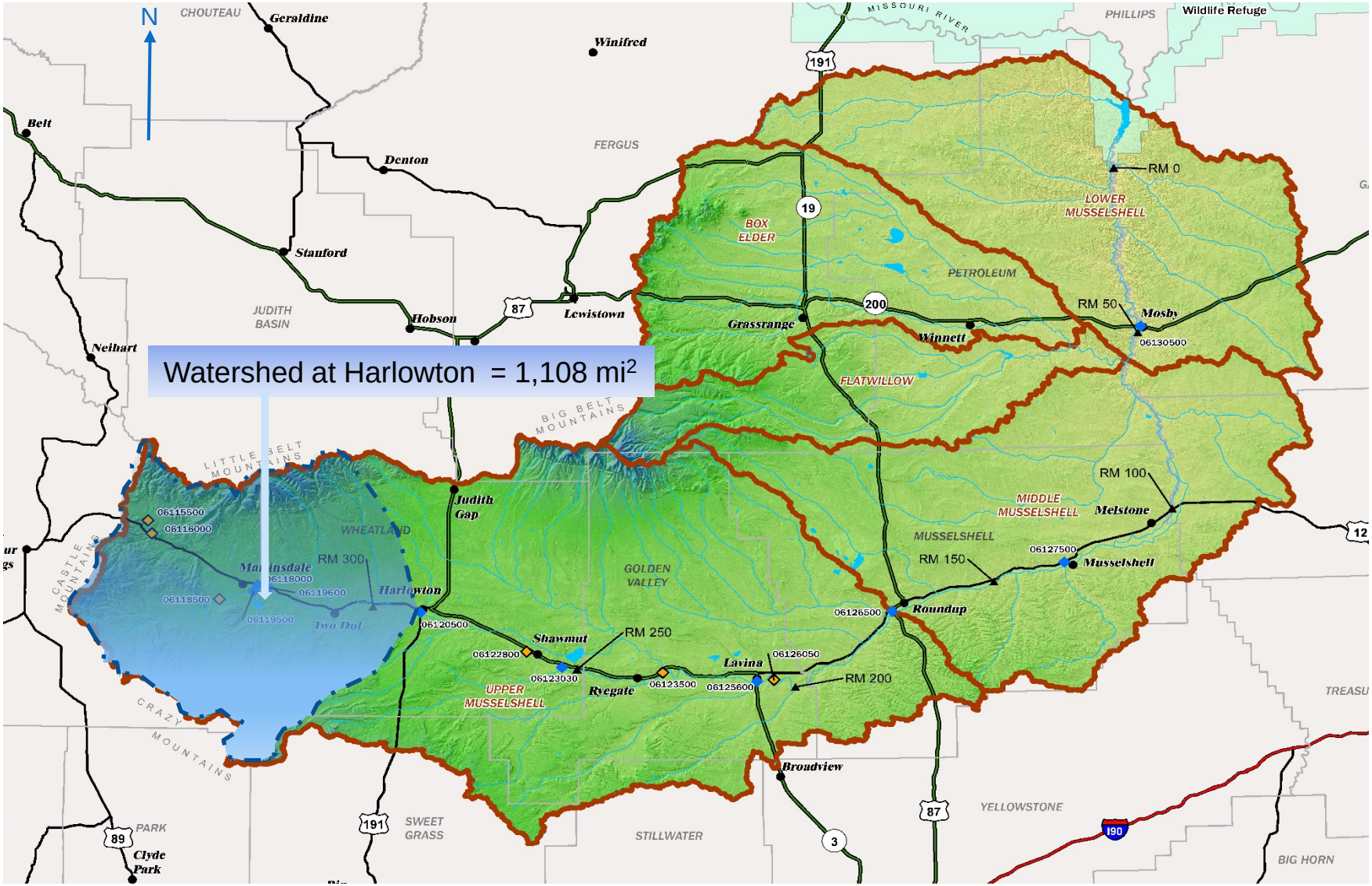
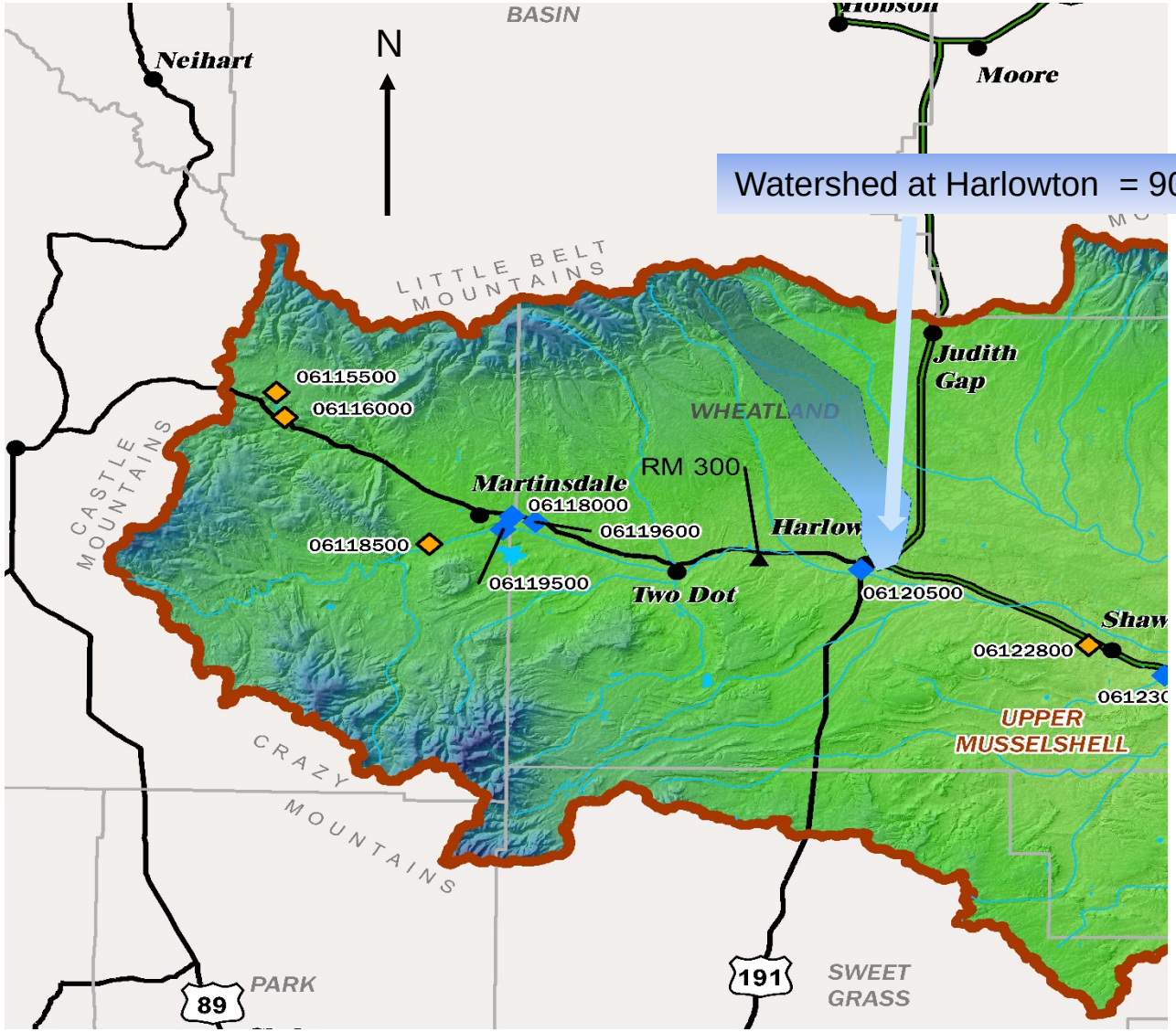
Musselshell Watershed = 8,651 mi²



Antelope Creek Watershed



Watershed Characteristics and Flood Frequency:

Musselshell River*

USGS Gaging Station	Drainage Area (square miles)	Annual Chance Peak Flow Rates (cfs)				Flood of Record (cfs/year)
		10% (10-year)	2% (50-year)	1% (100-year)	0.2% (500-yr)	
Musselshell River at Harlowton, MT	1,108	2,610	4,756	5,848	8,816	5,520/2011

* Pioneer Technical Services, Inc. *Musselshell River Floodplain Study - Phase 1, Musselshell River Hydrologic Analysis Report,* May 1, 2015.

Antelope Creek**

USGS Gaging Station	Drainage Area (square miles)	Annual Chance Peak Flow Rates (cfs)				Flood of Record (cfs/year)
		10% (10-year)	2% (50-year)	1% (100-year)	0.2% (500-yr)	
Antelope Creek at Harlowton, MT	90.9	1,520	4,950	21,490	91,550	24,400/1950

** Montana Department of Natural Resources and Conservation (DNRC), *Hydrology Design Report, Antelope Creek Detailed Floodplain Study Wheatland County, MT*, January 2016.

Hydraulic modeling of the detailed flood study:

- 1D modeling with HEC-RAS Version 4.1.0 within GeoHECRAS© computer program.
- Cross section geometry developed from:
  a) 2015 LiDAR survey by Quantum Spatial, Inc.
  b) 2015 bathymetric survey by Morrison-Maierle.
- LiDAR overbank cross sections placed at bathymetric survey and hydraulic structure locations.
- Split flow and secondary flow path modeling at flow junctions and overbank overtopping locations.
- Antelope Creek watershed is 1/12 the size of Musselshell watershed but the 100-year flood peak is 367% larger!
- Antelope Creek flood flows routed to the confluence with the Musselshell River floodplain east of Harlowton.

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Antelope Creek Hydraulic/Floodplain Mapping Challenge

1. Antelope Creek Hydrology
   - ≈ 24,400-cfs calculated by the USGS (Mel Johnson) as 1950 flood peak (indirect method).
   - Life and property loss during to flood event.
   - Flood peak attenuated to ≈3,000-cfs 30-miles downstream at Musselshell River USGS gage.
2. Gutter Line Hydraulic Modeling & Floodplain Mapping Technique
   - Modeling/Mapping approach coordinated with DNRC, FEMA, and COMPASS (FEMA reviewer).
   - Differing flood profiles and associated Base Flood Elevations (BFEs) are modeled & mapped in the vicinity of the confluence.
   - Floodway and floodplain delineation separated by a physical boundary (e.g. Abandoned Railroad Embankment) and a Gutter Line.
   - Iterative flow calculations required to determine Antelope Creek flow splits and flows lost from the Antelope Creek system to the Musselshell River floodplain to determine BFEs.

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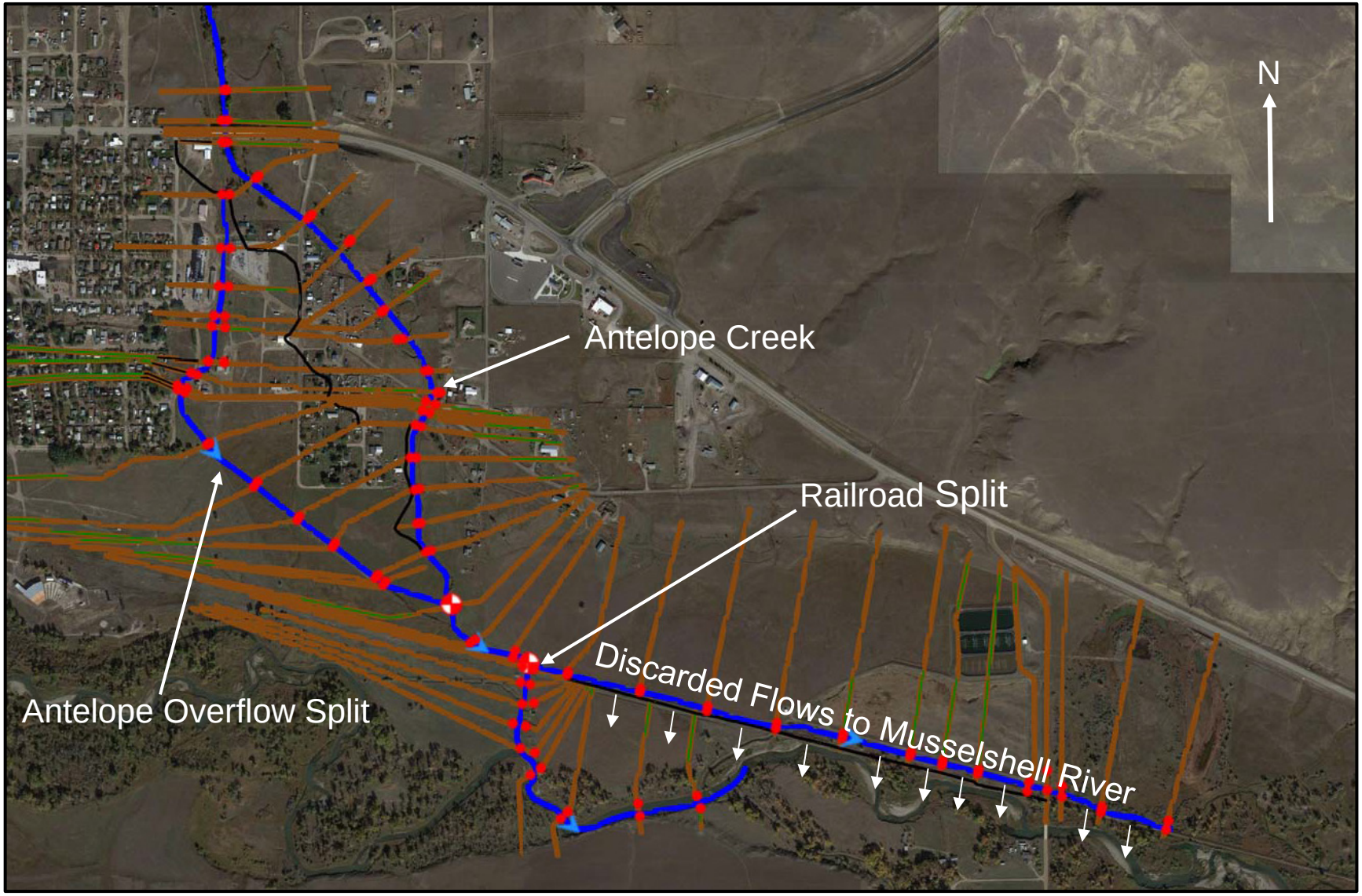
Antelope Creek Bridge After 1950 Flood Event

Antelope Creek Split Flow Hydraulic Model



Antelope Creek Split Flow Tracking

Recurrance Interval		Antelope Creek Upstream River Station													AntelopeCr-MID RS	AntelopeCr-DS RS
		20787	13306	4970	4501	4175	3887	3388	3132	2899	2716	2486	2257	1804	1361	580
Flow Rate (cfs)	10% AC	1290	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,520	1,435	1,520	879
	4% AC	4230	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,055	4,920	2,012
	2% AC	9230	10,640	10,484	10,484	10,484	10,484	10,484	10,484	10,484	10,484	10,415	10,230	8,135	10,640	3,778
	1% AC	18800	21,490	20,769	20,622	20,420	20,420	20,420	20,420	20,317	20,317	19,607	18,807	14,767	21,490	7,705
	0.2% AC	81310	91,550	84,480	78,360	71,200	69,270	68,323	66,117	63,477	63,227	59,407	55,972	46,157	91,550	45,798

Recurrance Interval		Antelope Creek Overflow Rver Station											Railroad Split River Station								
		4074	3696	3427	3216	3140	2894	2608	1701	1316	1001	626	4506	3978	3485	2982	2497	2001	1505	1136	1000
Flow Rate (cfs)	10% AC	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	85.1	641	641	641	641	641	641	641	581	576
	4% AC	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	865.1	2,908	2,907	2,907	2,907	2,907	2,769	2,106	1,509	1,414
	2% AC	156	156	156	156	156	156	156	156	225	410	2,505	6,862	6,721	6,721	6,721	6,705	6,155	4,156	2,749	2,489
	1% AC	721	868	1,070	1,070	1,070	1,070	1,173	1,173	1,883	2,683	6,723	13,785	12,884	12,884	12,509	11,375	9,503	6,893	4,422	3,962
	0.2% AC	7,070	13,190	20,350	22,280	23,227	25,433	28,073	28,323	32,143	35,578	45,393	45,752	37,226	32,170	26,710	21,427	16,347	11,419	7,563	6,776

Lateral Weir Flow Data Summary Table

Recurrance Interval		Antelope Creek River Station											Railroad Split River Station							
		5100	4700	4300	4000	3750	3200	3000	2775	2600	2350	2100	4200	3700	3250	2700	2200	1800	1300	1050
Flow Rate (cfs)	10% AC	0.1	0.0	0	0	0	0	0	0	0	0	85	0.0	0	0	0	0	0	60	5
	4% AC	0.1	0.0	0	0	0	0	0	0	0	0	865	1.0	0	0	0	138	663	597	95
	2% AC	156	0.0	0	0	0	0	0	0	69	185	2095	141	0	0	16	550	1999	1407	260
	1% AC	721	147	202	0	0	0	103	0	710	800	4040	901	0	375	1134	1872	2610	2471	460
	0.2% AC	7070	6120	7160	1930	947	2206	2640	250	3820	3435	9815	8526	5056	5460	5283	5080	4928	3856	787

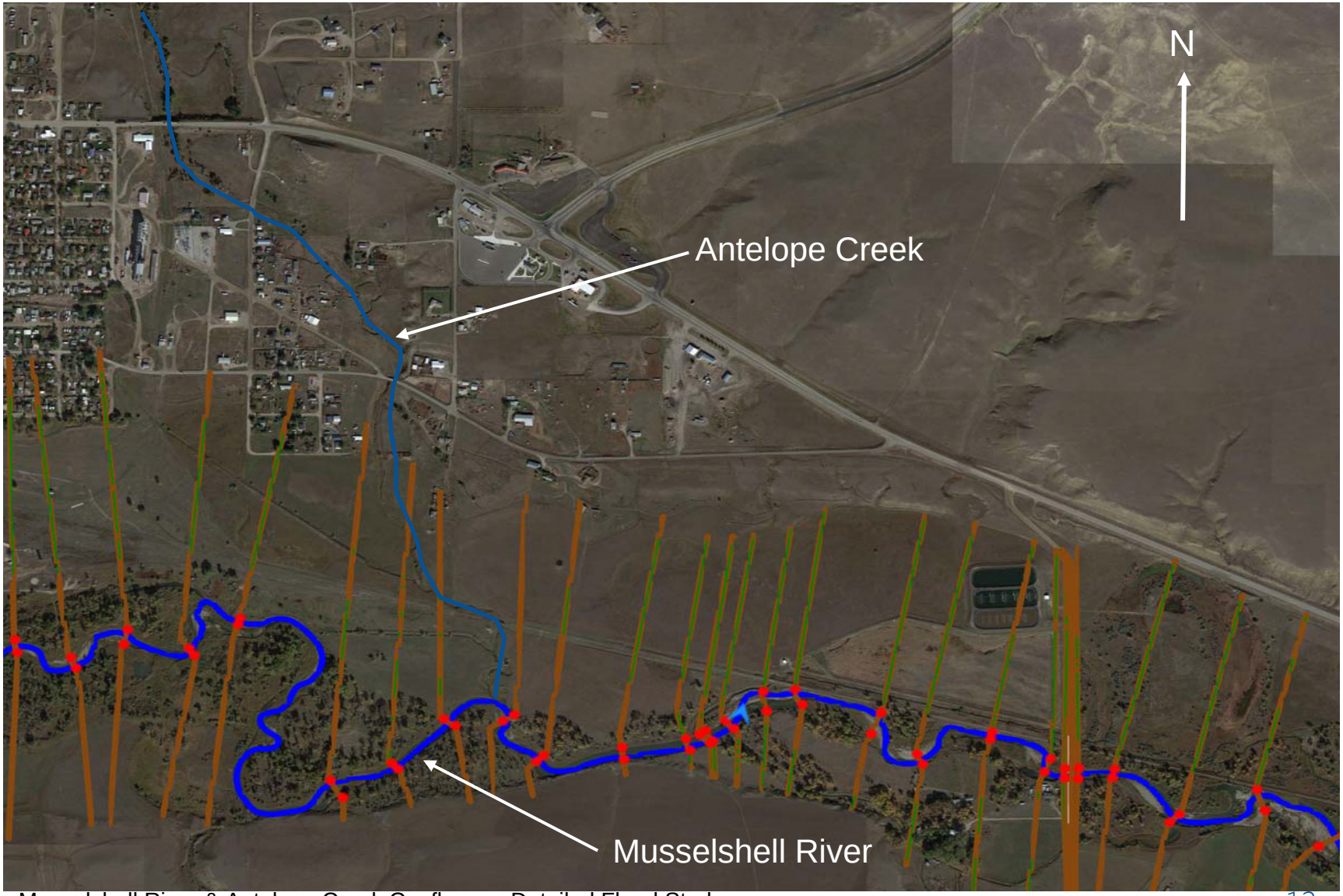
Lateral Weir Optimization Editor Data Format

River	Reach	River Station	10% AC	4% AC	2% AC	1% AC	0.2% AC
AC	AC-US	5100	0	0	156	721	7070
AC	AC-US	4700	0	0	0	147	6120
AC	AC-US	4300	0	0	0	202	7160
AC	AC-US	4000	0	0	0	0	1930
AC	AC-US	3750	0	0	0	0	947
AC	AC-US	3200	0	0	0	0	2206
AC	AC-US	3000	0	0	0	103	2640
AC	AC-US	2775	0	0	0	0	250
AC	AC-US	2600	0	0	69	710	3820
AC	AC-US	2350	0	0	185	800	3435
AC	AC-US	2100	85	865	2095	4040	9815
RR Split	RR Split	4200	0	1	141	901	8526
RR Split	RR Split	3700	0	0	0	0	5056
RR Split	RR Split	3250	0	0	0	375	5460
RR Split	RR Split	2700	0	0	16	1134	5283
RR Split	RR Split	2200	0	138	550	1872	5080
RR Split	RR Split	1800	0	663	1999	2610	4928
RR Split	RR Split	1300	60	597	1407	2471	3856
RR Split	RR Split	1050	5	95	260	460	787

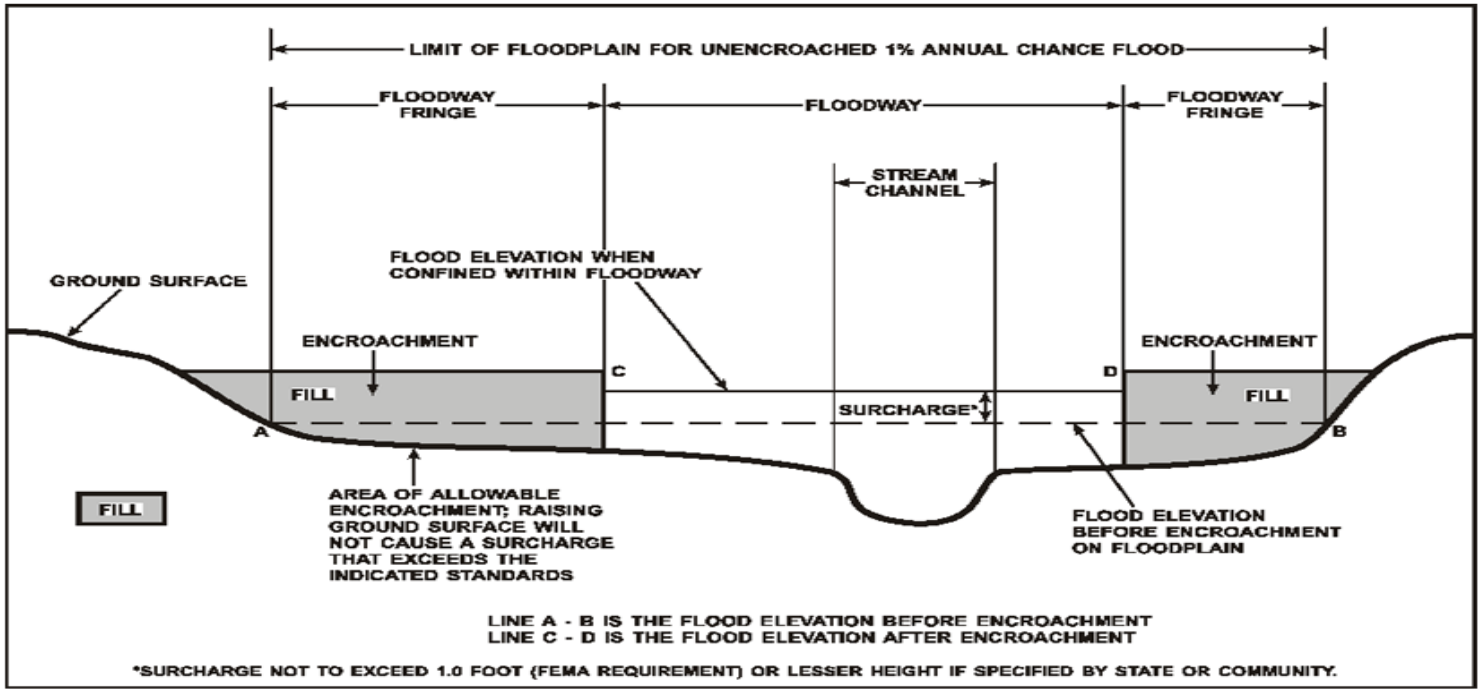
Junction Optimization

J2
641.1
2907.7
6862.3
13785.1
45752.3

Musselshell River Hydraulic Model

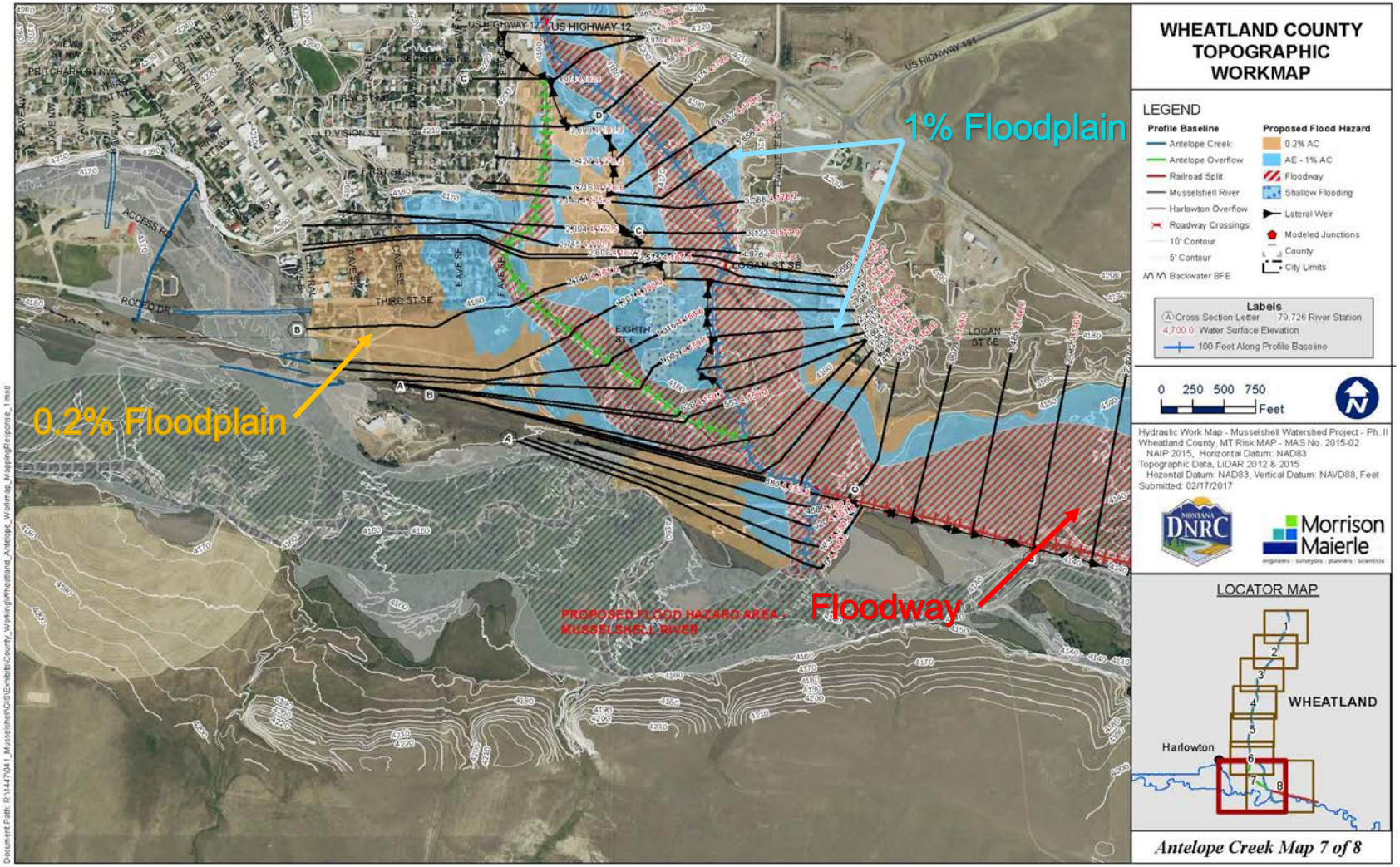


1% Annual Chance Floodway:



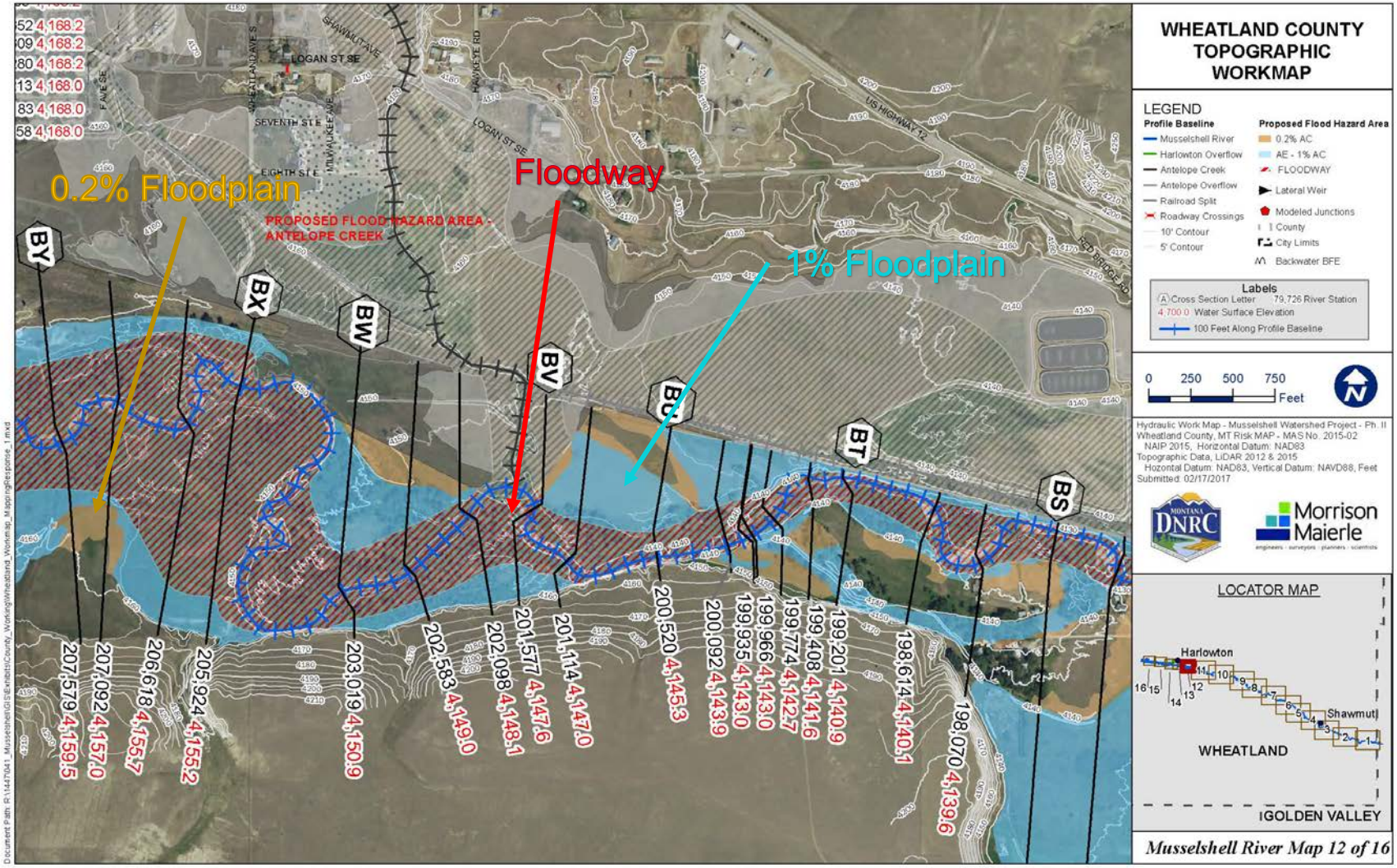
- Montana has a 0.5-foot maximum surcharge standard versus Federal one-foot maximum surcharge.

Antelope Creek Floodplain Work Map:



Musselshell River & Antelope Creek Confluence Detailed Flood Study

Musselshell River Floodplain Work Map:



Musselshell River & Antelope Creek Confluence Detailed Flood Study (*Luke Carlson*)

Musselshell Watershed Flood Study Phase II

- Project Status
  - Floodplain Mapping task under review by FEMA's independent reviewer (COMPASS).
  - Hydraulic and Floodplain Mapping tasks under review by local agencies.
- Next Steps
  - Presentation of Preliminary FIRM's at community meetings in 2017.
  - 90-day public review and appeal period for Preliminary FIRMs.
  - Final acceptance of the study will occur after the 90-day appeal period.
  - Revised effective FIS and FIRMs then published by FEMA.

Morrison-Maierle Floodplain Study Team:

- Mark Franchi, PE, CFM: Assistant Manager, Hydraulic Modeling
- Luke Carlson, PE, CFM: Assistant Manager, Hydraulic Modeling & GIS
- Kristyn Mayernik, PE, CFM: Task Manager, Work Map Preparation
- Matt Barnes, PE, CFM: QC Review
- Zachariah Campbell: Work Maps and QC Review
- Jeff Roe, PLS: Hydraulic Structure and Bathymetric Survey
- Ken Salo, PE: Principal-In-Charge and QA/QC Manager
- Russ Anderson PE, CFM, Project Manager

Questions?

Mark A. Franchi, PE, CFM

Thank you,

Luke D. Carlson, PE, CFM

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engineers ▪ surveyors ▪ planners ▪ scientists