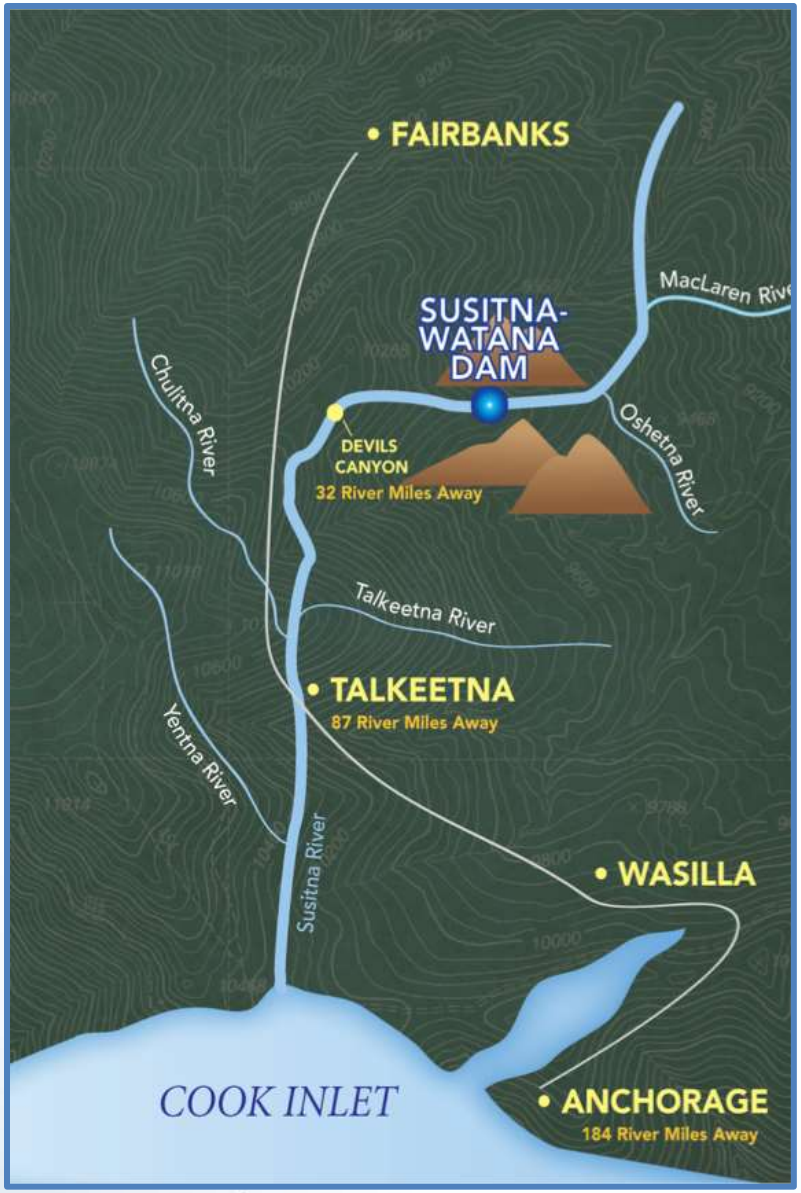

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Technical WorkGroup Meeting

Q4 2013 TWG

Geomorphology Studies

December 2, 2013

Prepared by

Tetra Tech, Inc.

Watershed GeoDynamics

RSP 6.5 and 6.6 – Presentation Overview

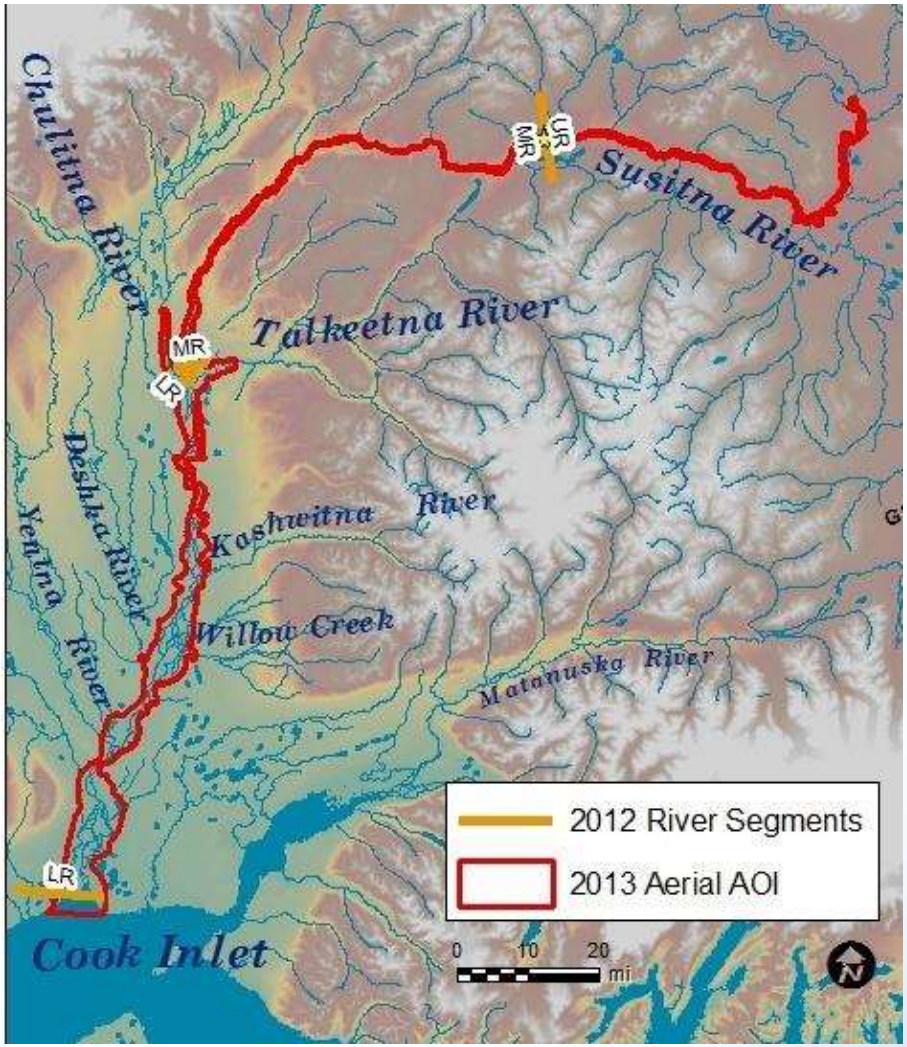
- *Aerial and LiDAR (RSP 6.5.4.4 and Modeling Approach TM)*
- *Assess Geomorphic Change (RSP 6.5.4.4)*
  - *Geomorphic Feature digitization for 1950s and 2013 aerials*
- *Geomorphic Characterization (RSP 6.5.4.1)*
  - *Geomorphic Field Observations*
  - *Geomorphic Surface Mapping*
- *Large Woody Debris (RSP 6.5.4.9)*

Presentation Overview (Cont.)

- *USGS Sediment Data (RSP 6.5.4.2)*
- *1-D Model (RSP 6.6.4.1 and Modeling Approach TM)*
  - *Current Status and Updates*
- *2-D Morphology Model (RSP 6.6.4.1 and Modeling Approach TM)*
  - *Current Status and Updates*

Acquire Aerials (RSP 6.5.4.4)

- *Complete the effort started in 2012*
- *Upper River*
  - *PRM 183 to 262, 9/15/13 @ 21,700 cfs**
- *Middle River*
  - *PRM 102.5 to 149, 9/24/13 @ 11,300 cfs**
  - *PRM 149 to 183, 11/6/13, ~6,000 cfs**
- *Lower River*
  - *PRM 1 to 102.5, 9/20/13 @ 35,500 cfs**



*Provisional Discharge from USGS gages

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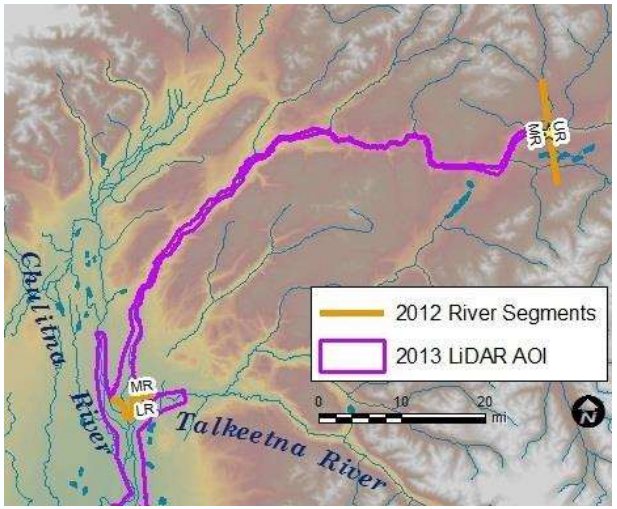
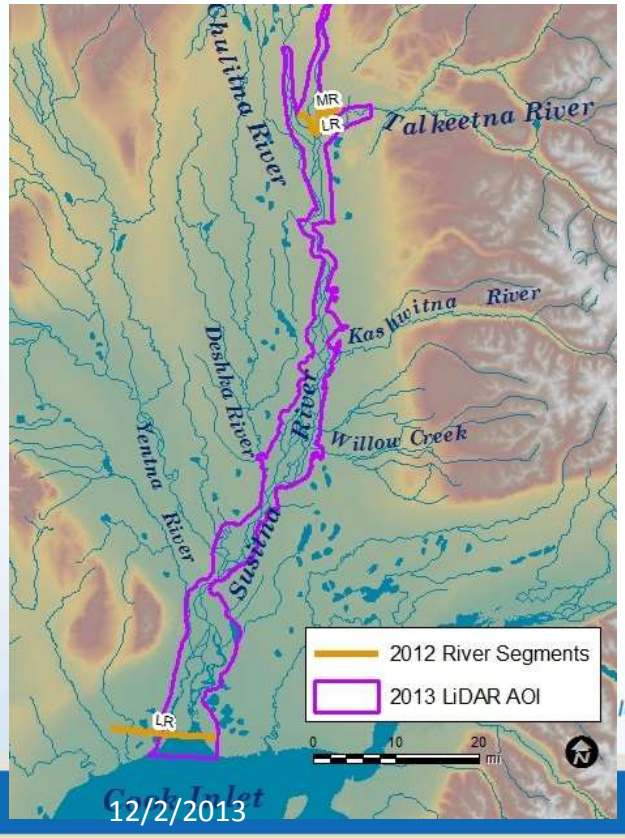
LiDAR (Modeling Approach TM)





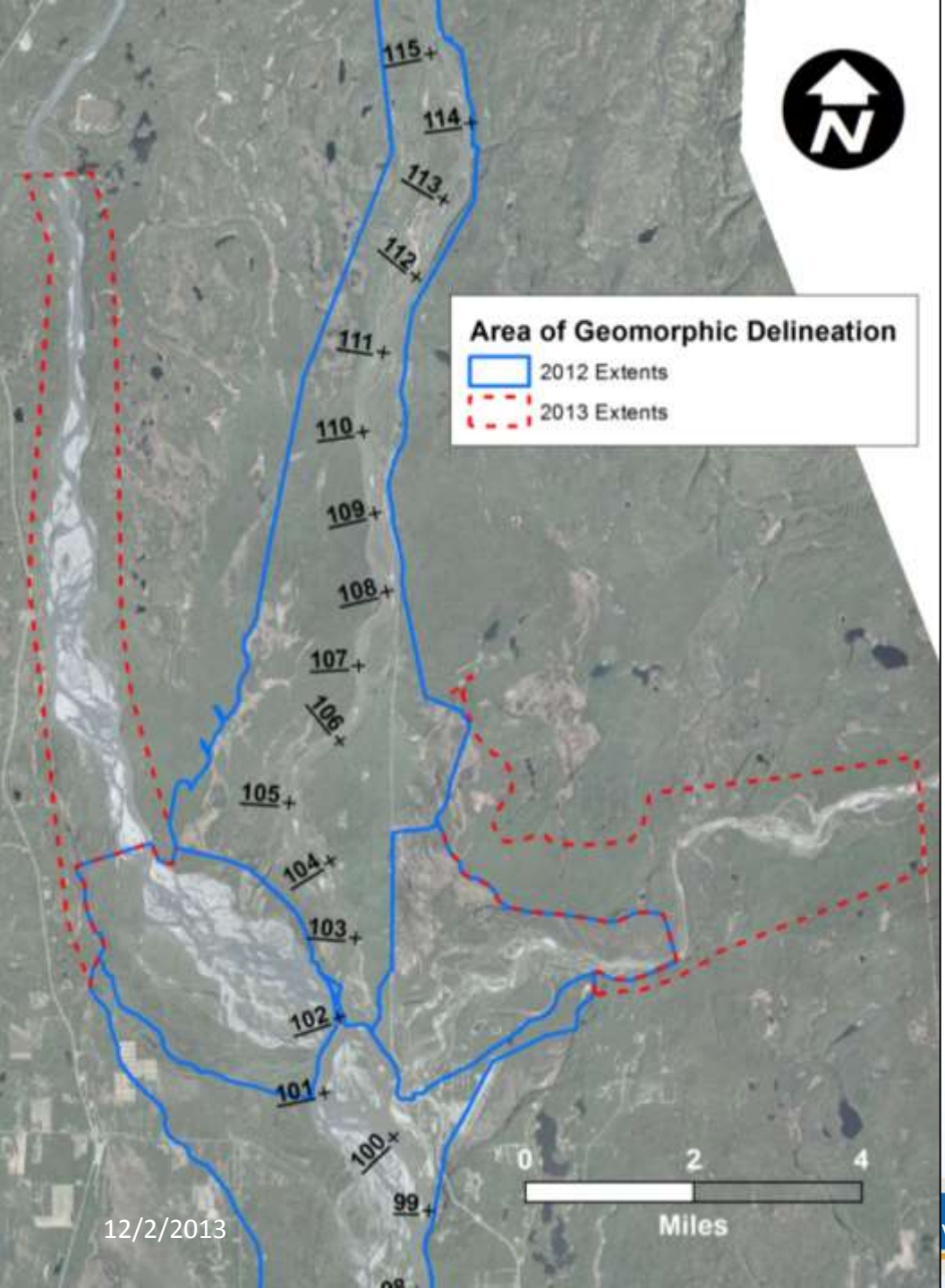
- *Acquisition hampered by weather and high flows*
- *37% of river corridor flown*
- *Locations collected:*
  - *Lower River: PRM 102.3 to PRM 66*
  - *Middle River: PRM 102.3 to PRM 109*
  - *10 miles of the Chulitna*
  - *6 miles of the Talkeetna*
  - *Portions of FA-128*
  - *Portions of Yentna Confluence*
- *Indexing 2011 Mat-Su LiDAR*

le energy for the next 100 years.

Assess Geomorphic Change (RSP 6.5.4.4)

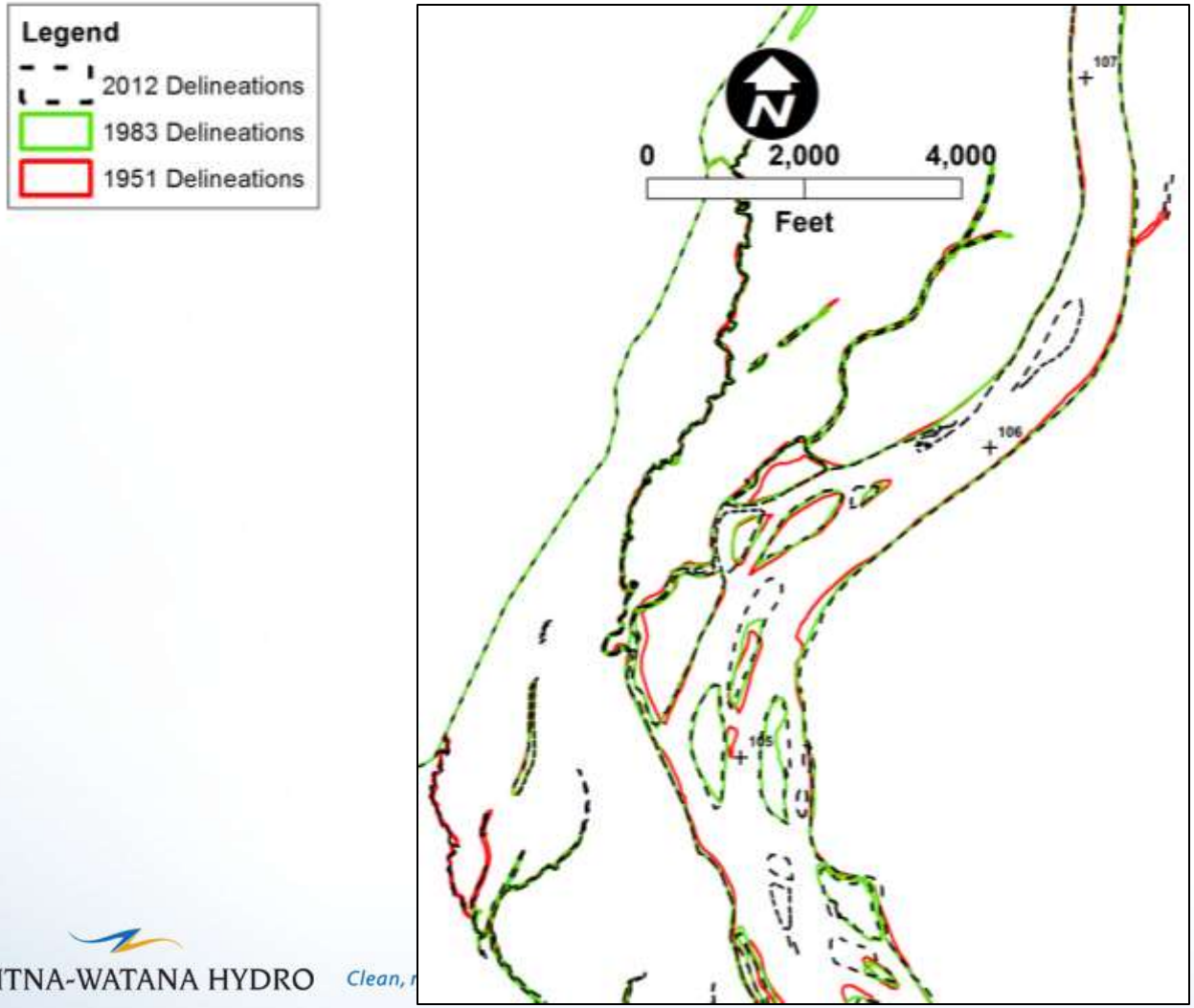
- *2013 geomorphic feature delineation extension*
- *Geomorphic features digitized from 1950s aerials*
- *Floodplain/channel turnover analysis*

2013 Geomorphic Feature Delineation (RSP 6.5.4.4)



- *Extension of 2013 Geomorphic Delineation for areas in Talkeetna River and Chulitna River*

Comparative Geomorphic Features (RSP 6.5.4.4)



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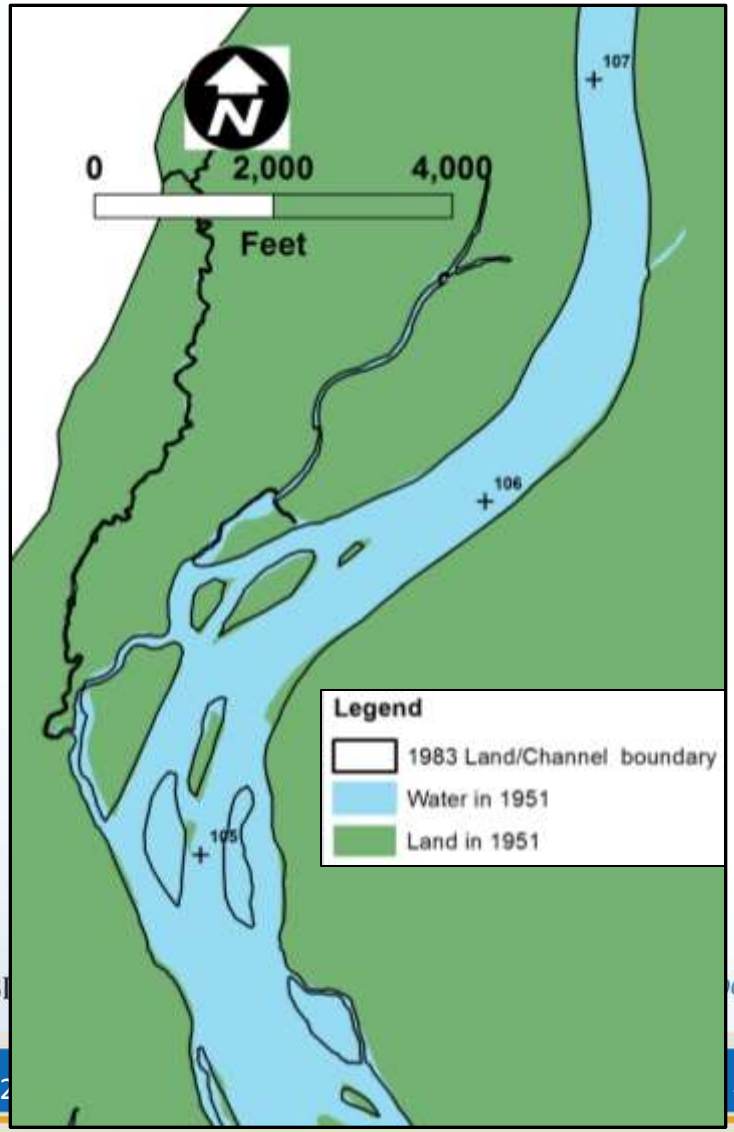
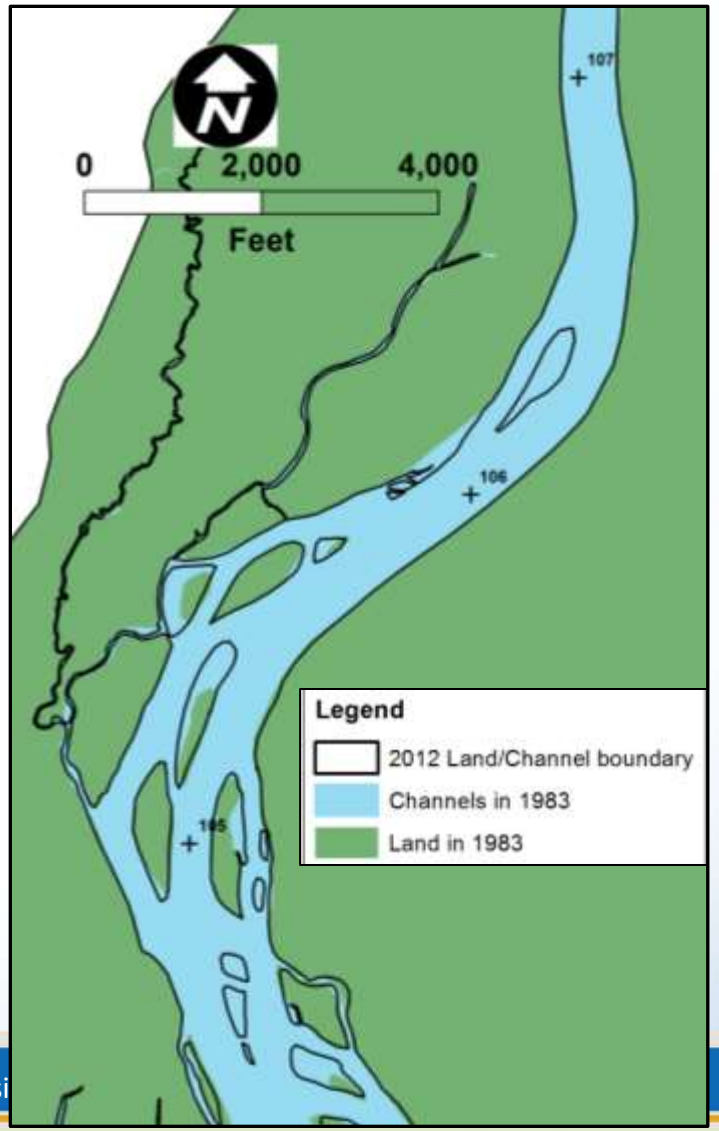
Turnover Analysis (RSP 6.5.4.4)

1951 to 1983



1983 to 2012

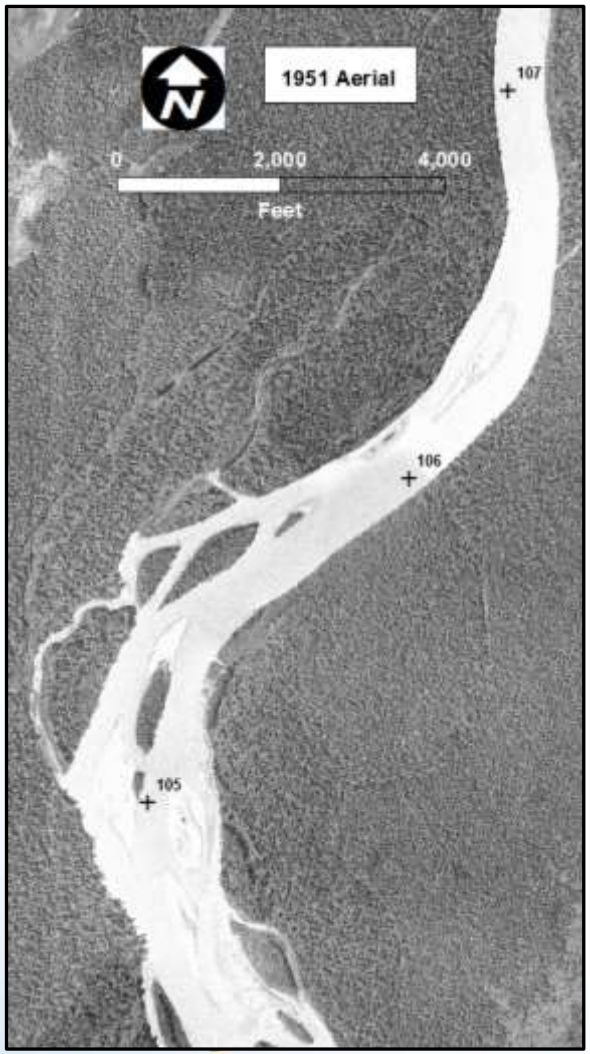


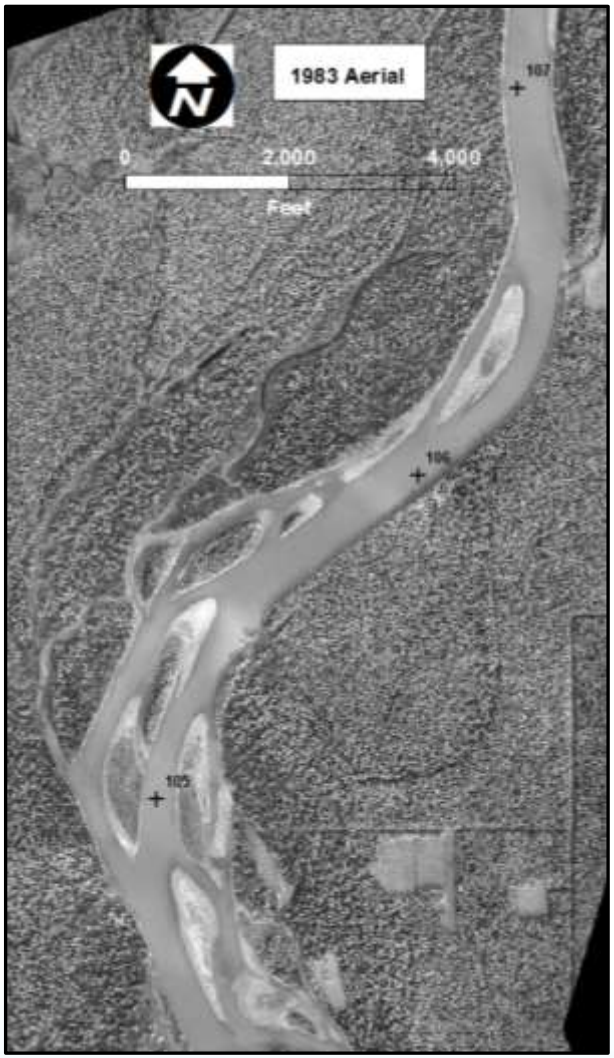
Geomorphic Characterization (RSP 6.5.4.1)

FA-104 Whiskers Slough

- *Observations and processes compiled and identified for Initial Study Report*
- *Concepts developed from 2013 field work*

Comparative Era Aerials (RSP 6.5.4.1)





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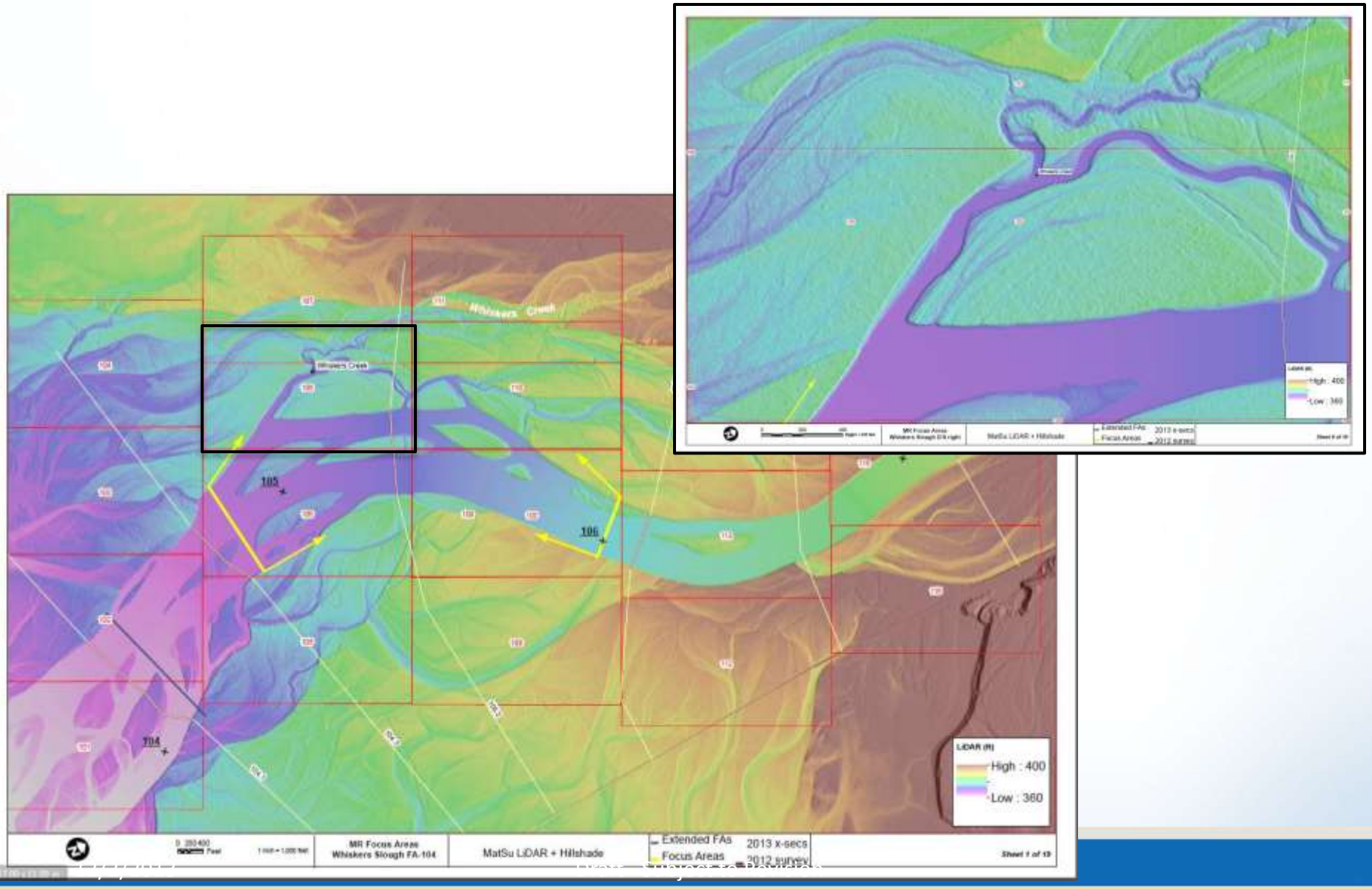
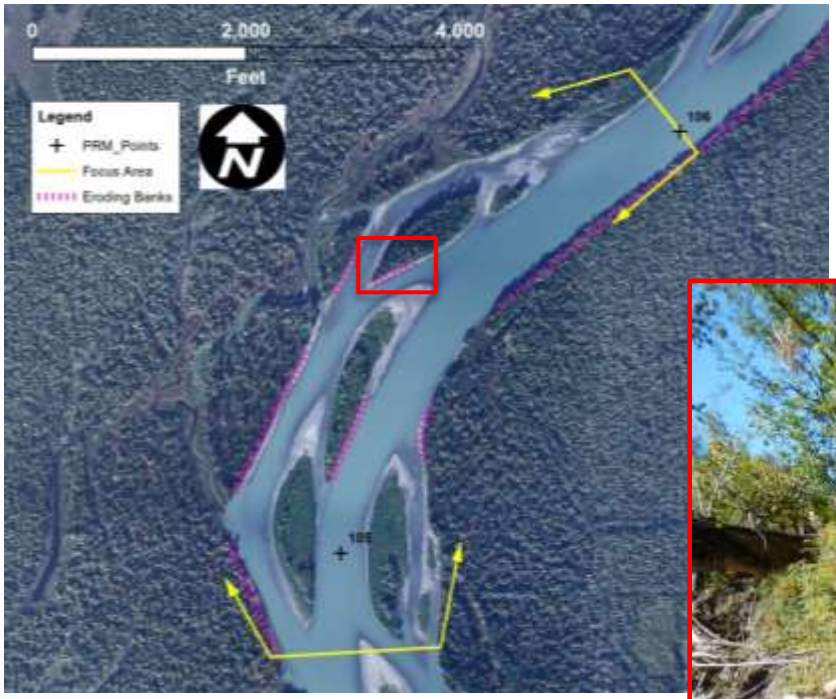
LiDAR and Hillshade (RSP 6.5.4.1)



2013 Field Observations (RSP 6.5.4.1)



- *Observed eroded bank*
  - *Fluvial and ice scraping*

TCE

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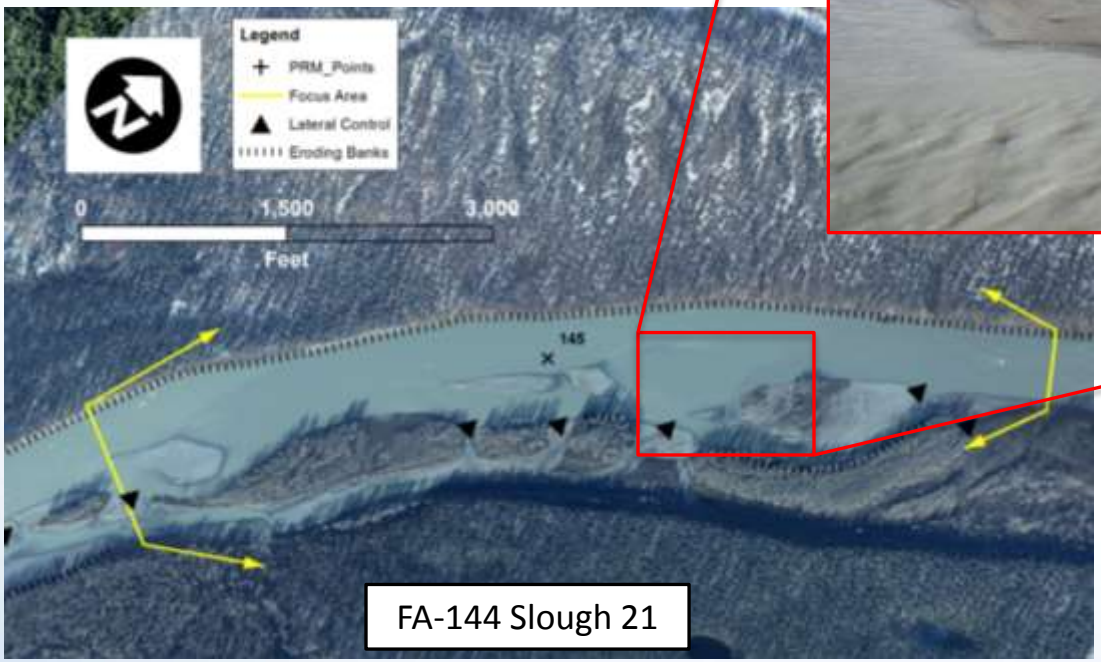
2013 Field Observations – Beaver Dams (RSP 6.5.4.1)

Focus Area	Active	Height (ft)	Latitude	Longitude	Notes
FA-104	YES	5.5	62.38251	-150.16148	Large beaver dam in upland slough
FA-104	UNKNOWN	n/a	62.38379	-150.15707	True right bank of beaver pond across from side channel and upland slough
FA-113	NO	n/a	62.49256	-150.11053	Center of old beaver dam
FA-113	NO	n/a	62.51766	-150.12950	Abandoned beaver dam that has partially filled in -- raised water table
FA-113	NO	n/a	62.51711	-150.12426	Old beaver dam - intact but doesn't appear to be active
FA-115	YES	n/a	62.51861	-150.12316	Active beaver dam in upland slough
FA-115	NO	5.0	62.50936	-150.11909	Old abandoned breached beaver dam
FA-128	YES	n/a	62.66334	-149.92648	Upstream end of side slough - 2 beaver dams
FA-138	NO	n/a	62.76393	-149.70025	Downstream end of blown out beaver dam
FA-138	NO	n/a	62.76409	-149.70043	Blown out dam
FA-138	YES	1.5	62.75810	-149.70290	Beaver dam across side channel
FA-138	YES	2.0	62.75723	-149.70461	Beaver dam - head of coarse riffle
FA-138	YES	2.0	62.75803	-149.70290	Beaver dam on side slough
FA-138	YES	3.0	62.75481	-149.70786	Downstream end of beaver dam
FA-141	UNKNOWN	3.0	62.78940	-149.64857	Beaver dam across upland slough
FA-141	YES	4.5	62.78810	-149.65013	Active beaver dam in upland slough
FA-144	YES	n/a	62.81134	-149.58243	Confluence of side slough at beaver dam & channel coming in from mainstem
FA-144	NO	n/a	62.81362	-149.57591	Old beaver dam at mouth of side slough (backed up from beaver dam @ WP107)

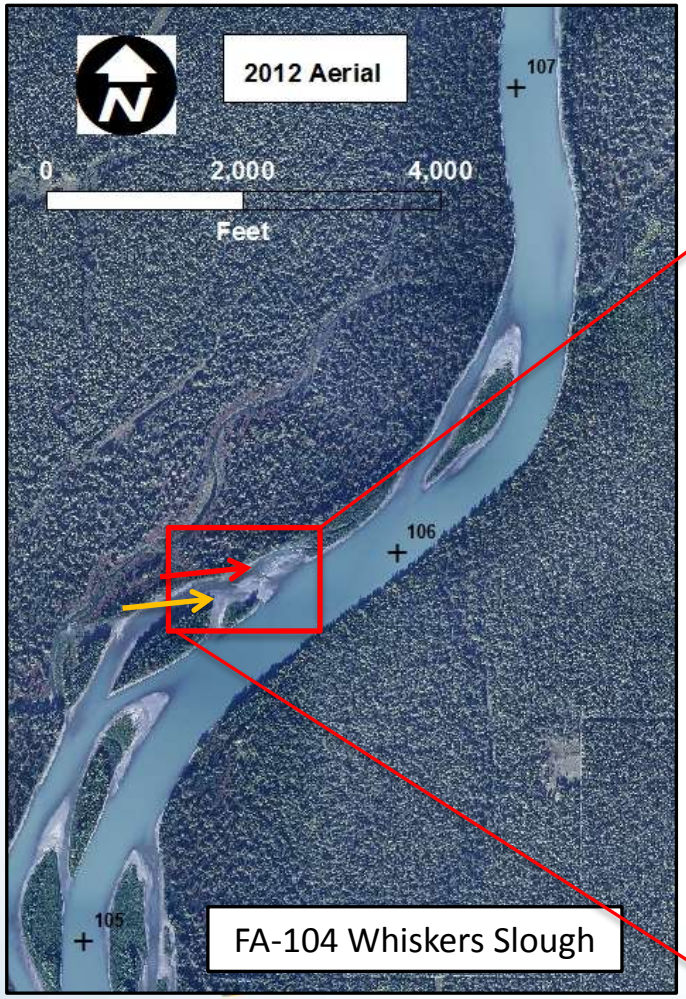
r the next 100 years.

2013 Field Observations (RSP 6.5.4.1)

- *Sediment deposition in expansion zone*



2013 Field Observations (RSP 6.5.4.1)



- *Lateral control at heads of secondary channels*

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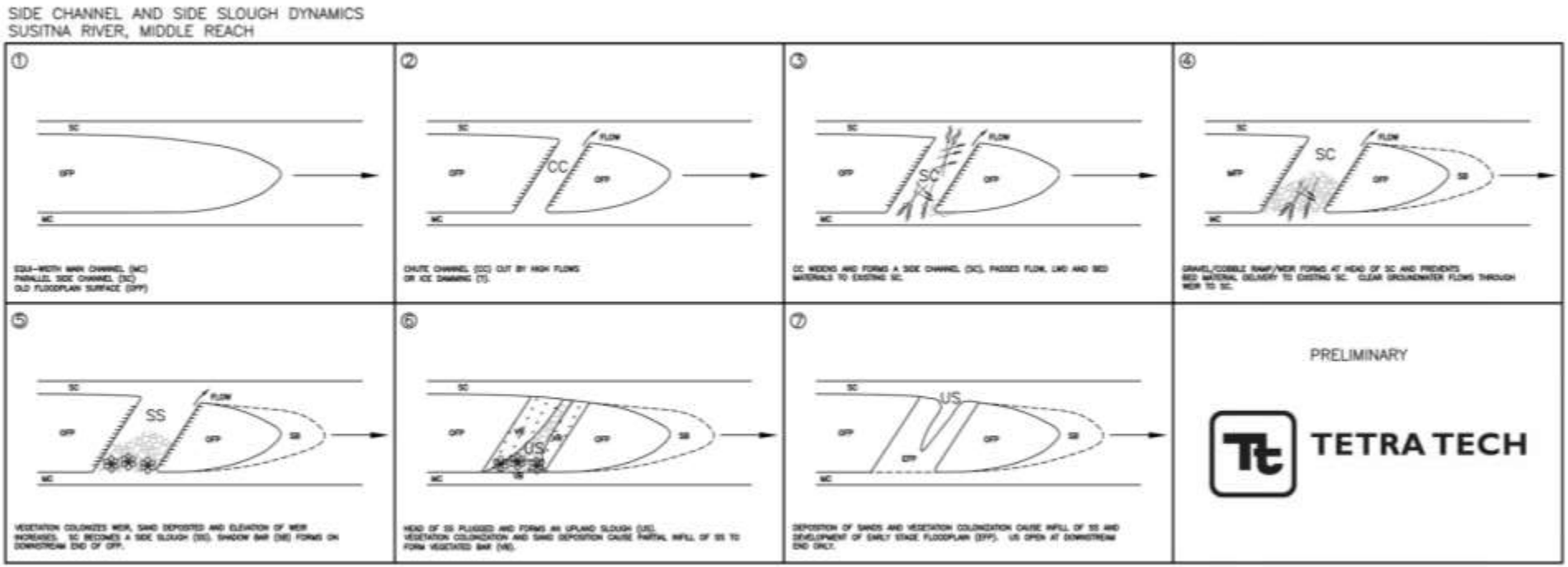
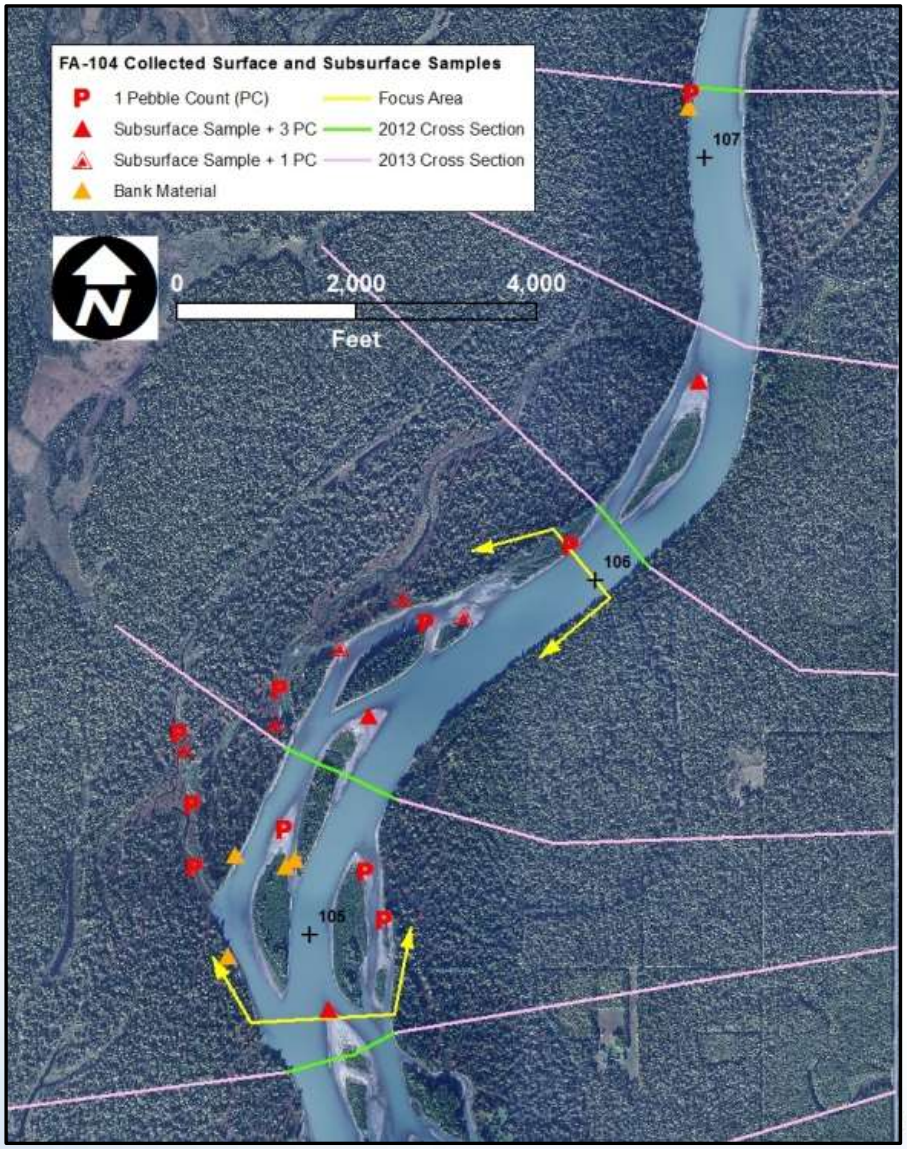
2013 Field Observations (RSP 6.5.4.1): Side Channel and Side Slough Dynamics

Conceptual Geomorphic Model (RSP 6.5.4.1) Side Channel and Side Slough Dynamics



2013 Data Collection – Banks (RSP 6.5.4.1)

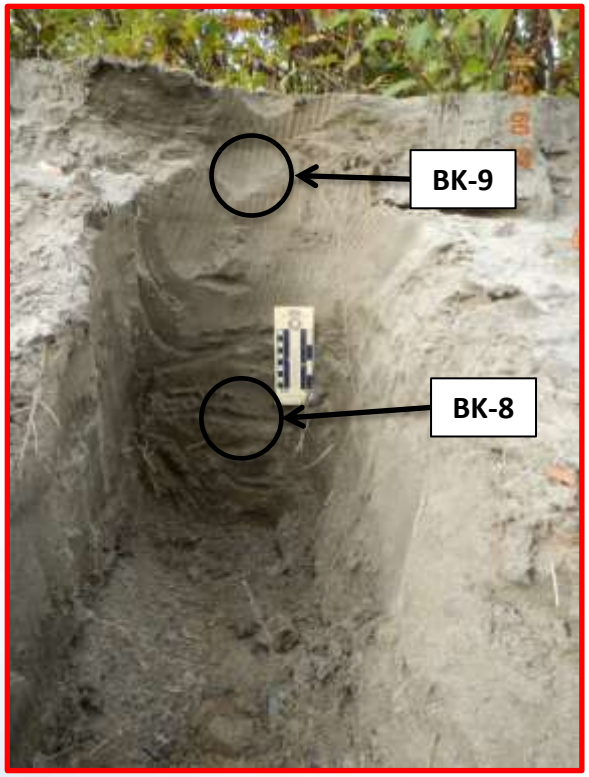


- *> 3 bank samples performed in each Focus Area*
- *Goal to sample banks of variety of geomorphic surfaces*
- *FA-104 sampled bank surfaces*
  - *Young Floodplain*
  - *Mature Floodplain*
  - *Terrace*

- *Surfaces lower than Young Floodplain (Vegetated Bar) not sampled. Observed primarily sand above basal gravel layer in these lower surfaces. This stratification could be found within sampled older surfaces.*

2013 Field Observations (RSP 6.5.4.1)

BANK SAMPLE:
Young Floodplain Surface



Bank Profile Log

SUSITNA-WATANA HYDRO

River:	Susitna River	Waypoint	WP4
Date/Time:	09/23/2013	Sampled By:	Mike Harvey
Field Book #:	Book 2 - MDH	Photos:	P5664 - MDH
Bank Height (ft):	3 feet	Focus Area:	Whiskers Slough
Bank Angle (deg):	Vertical	Geomorphic Surface:	

(ft)	Lithology	Lithologic Description	Samples
0		FINE - MEDIUM SAND	BK - 9
-1		SILTY SAND	BK - 8
-2		GRAVEL	
-3			

QC1 Check: Photo Backup: Page:

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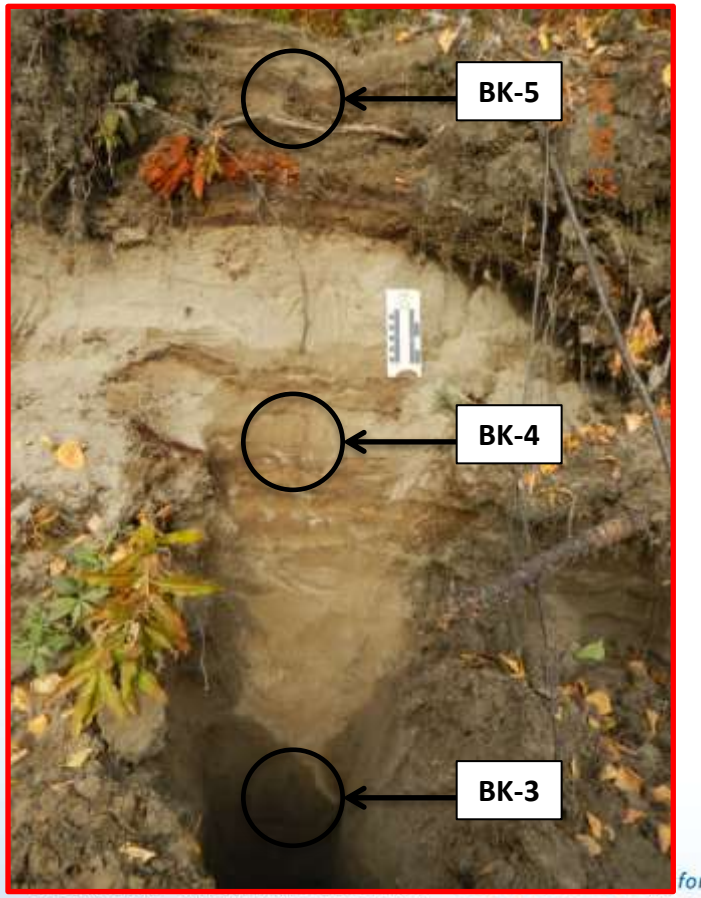
2013 Field Observations (RSP 6.5.4.1)

BANK SAMPLE:

Terrace Surface



Bank Profile Log

SUSITNA-WATANA HYDRO

River:	Susitna River	Waypoint	WP2
Date/Time:	09/23/2013	Sampled By:	Mike Harvey
Field Book #:	Book 2 - MDH	Photos:	P5662 - MDH
Bank Height (ft):	7 feet	Focus Area:	Whiskers Slough
Bank Angle (deg):	Vertical	Geomorphic Surface:	

(ft)	Lithology	Lithologic Description	Samples
0		SAND	
		SILTY SAND	BK - 5
		SAND AND SILT WITH ORGANICS	
-1		SAND	
		SAND, SILT AND CLAY WITH ORGANICS	
		FINE - MEDIUM SAND	
-2		SILTY SAND AND SAND INTERBEDDED	
			BK - 4
-3			
		MEDIUM SAND	
-4			
			BK - 3
-5			
-6		GRAVEL	
-7			

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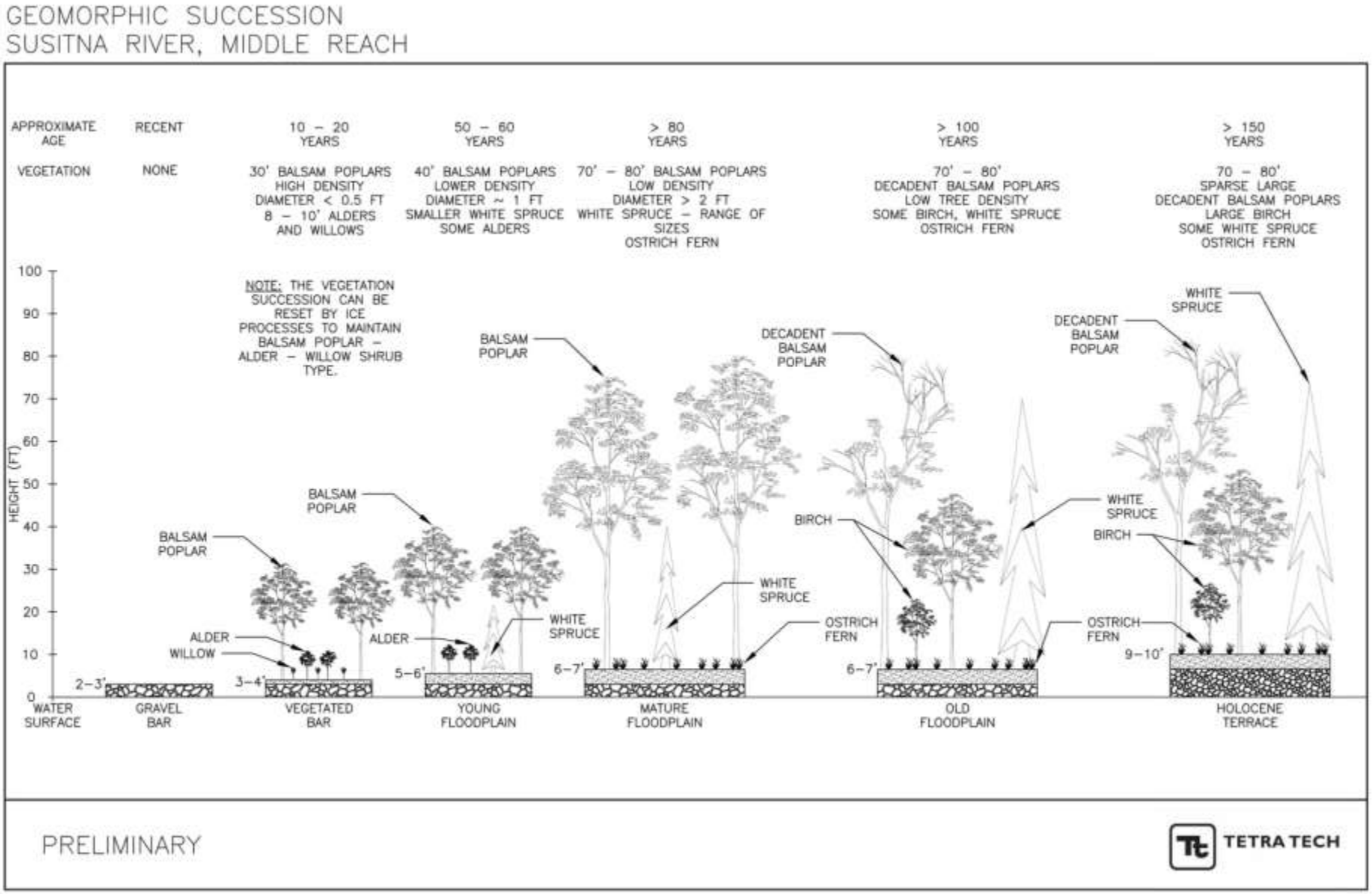
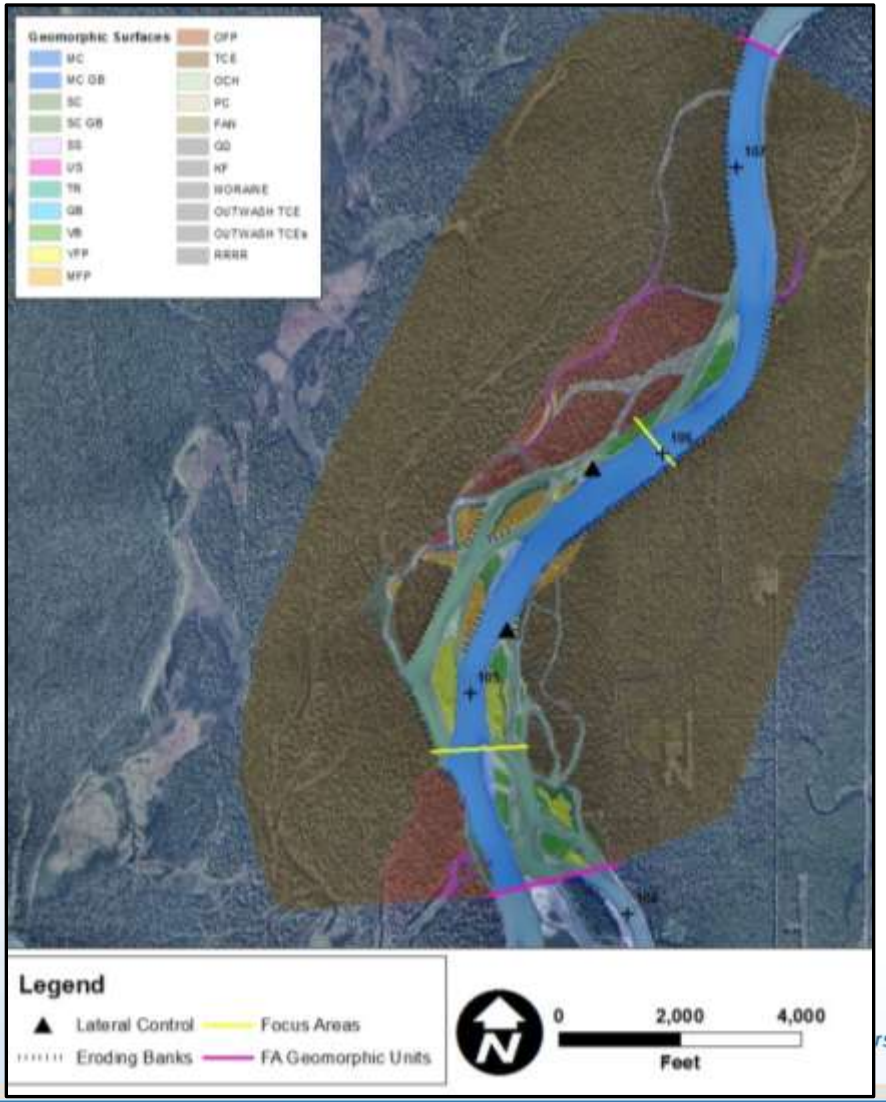
Conceptual Geomorphic Model (RSP 6.5.4.1): Geomorphic Succession



Geomorphic Surface Mapping (RSP 6.5.4.1) FA-104 Whiskers Slough



MC = Main Channel
MC GB = Main Channel Gravel Bar

SC = Side Chanel

SC = Side Channel Gravel Bar
SS = Side Slough
US = Upland Slough
TR = Tributary
VB = Vegetated Bar

YFP = Young Floodplain
MFP = Mature Floodplain

OFP = Old Floodplain
TCE = Terrace

OCH = Overflow Channel

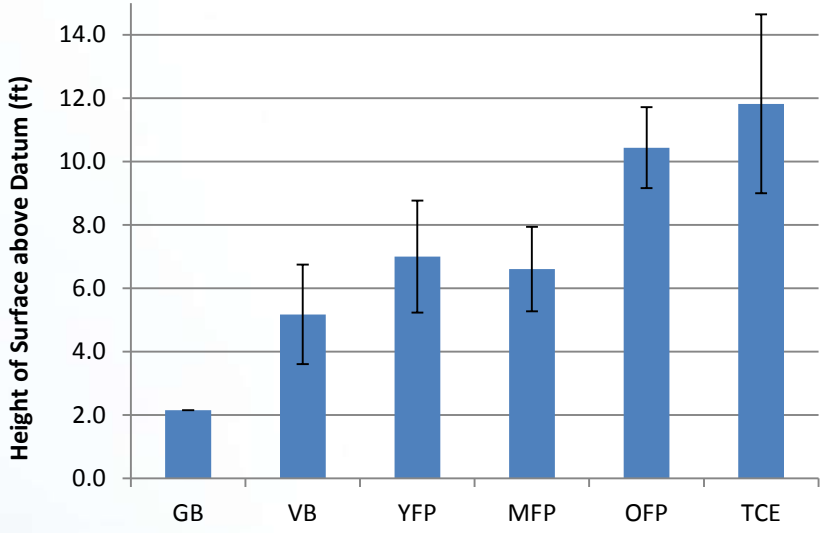
PC = Paleo Channel
FAN = Alluvial Fan
GD = Grano Diorite
KF = Kahlitna Flysch
RRRR = Railroad Rip-Rap

2013 Field Observations (RSP 6.5.4.1) Geomorphic Surface Heights

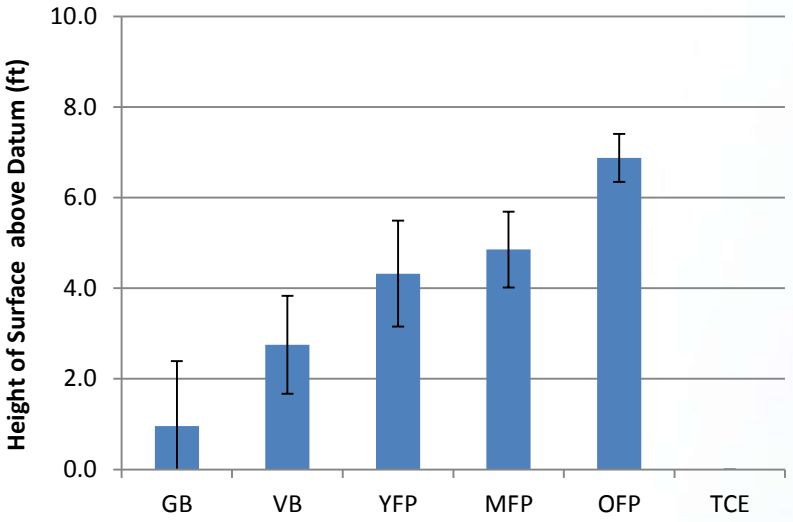
- *Geomorphic surface heights from datum (water surface) taken throughout Focus Areas*

Geomorphic Surface Heights (RSP 6.5.4.1): Mean and Standard Deviation

FA-104 (Whiskers Slough)



FA-144 (Slough 21)



KEY	
GB = Gravel Bar	MFP = Mature Floodplain
VB = Vegetated Bar	OFP = Old Floodplain
YFP = Young Floodplain	TCE = Terrace

Preliminary Analysis – Return Period of Overtopping Flows on Geomorphic Surfaces (RSP 6.5.4.1)

Focus Area	Return Period (yr)				
	VB	YFP	MFP	OFP	TCE
FA-104 Whiskers Slough	23	117	82	> 1000	> 1000
FA-113 Oxbow I	9	38	38	61	> 500
FA-115 Slough 6a	6	n/a	75	125	> 500
FA-128 Slough 8a	6	4	35	59	n/a
FA-138 Gold Creek	6	73	97	134	329
FA-141 Indian River	3	14	10	n/a	37
FA-144 Slough 21	13	82	153	> 1000	n/a

KEY

VB = Vegetated Bar
YFP = Young Floodplain
MFP = Mature Floodplain
OFP = Old Floodplain
TCE = Terrace

- Return period determined with mean elevation for each geomorphic surface
- Relative surface heights gathered in field. Respective elevations derived from flow-routing model rating curves
- No return period calculated if geomorphic surface was not observed/measured in field.

Role of Ice? (RSP 6.5.4.1)

- *Chute channel during 2013 ice break-up (left)*
- *Same chute channel post 2013 ice break-up (below)*

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Role of Ice? (RSP 6.5.4.1)

- *Rafted boulders on channel bank (left)*
- *Ice scars (6.5’) on trees adjacent to overflow channel (below)*

Role of Ice? (RSP 6.5.4.1)

- *Sand deposition on high old floodplain surface (left)*
- *Ice break-up flooding on floodplain surface (below)*

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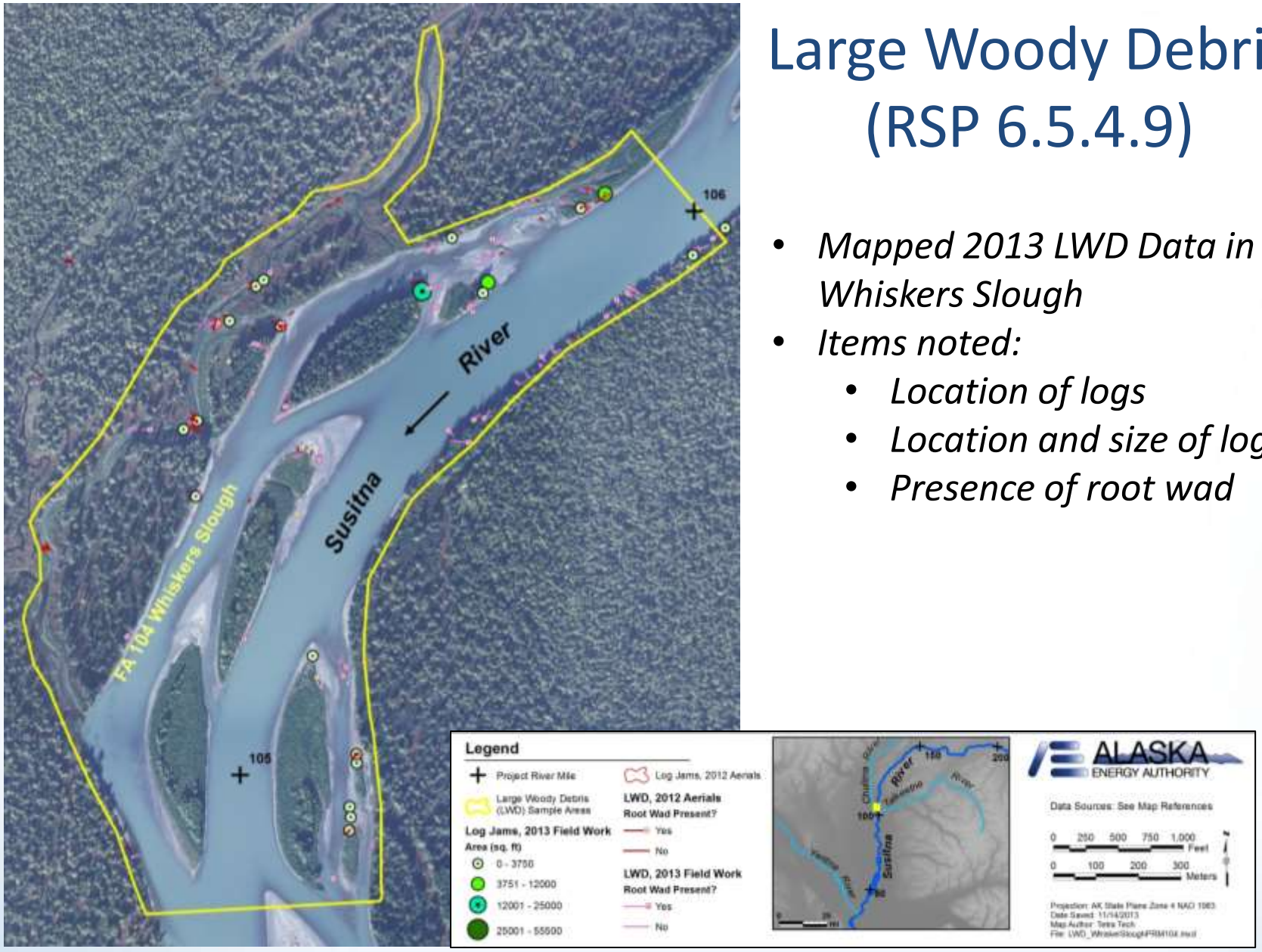
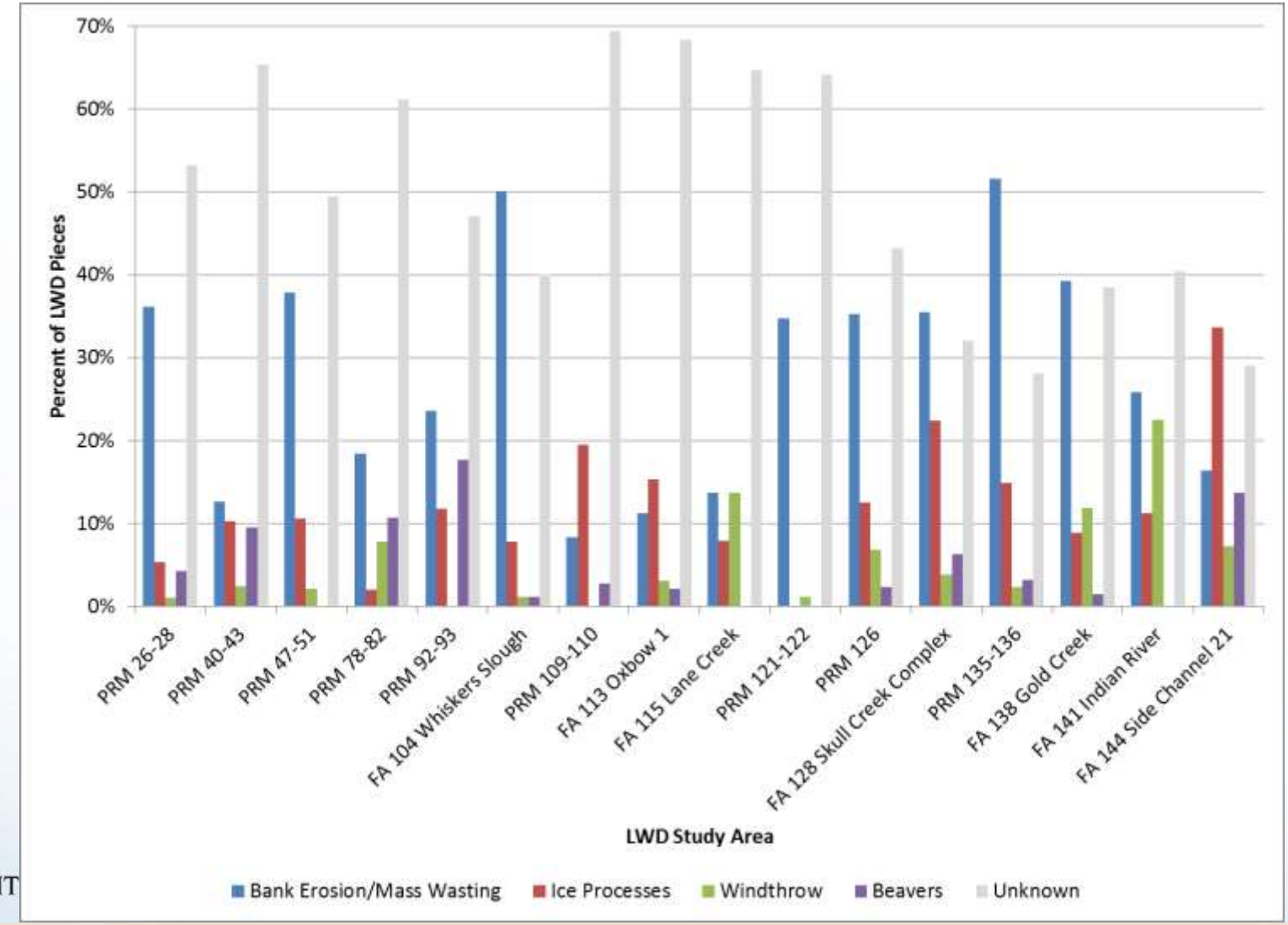
Large Woody Debris (RSP 6.5.4.9)

- *Mapped 2013 LWD Data in FA-104 Whiskers Slough*
- *Items noted:*
  - *Location of logs*
  - *Location and size of log jams*
  - *Presence of root wad*



Preliminary Analysis of LWD Data (RSP 6.5.4.9) Input Mechanisms



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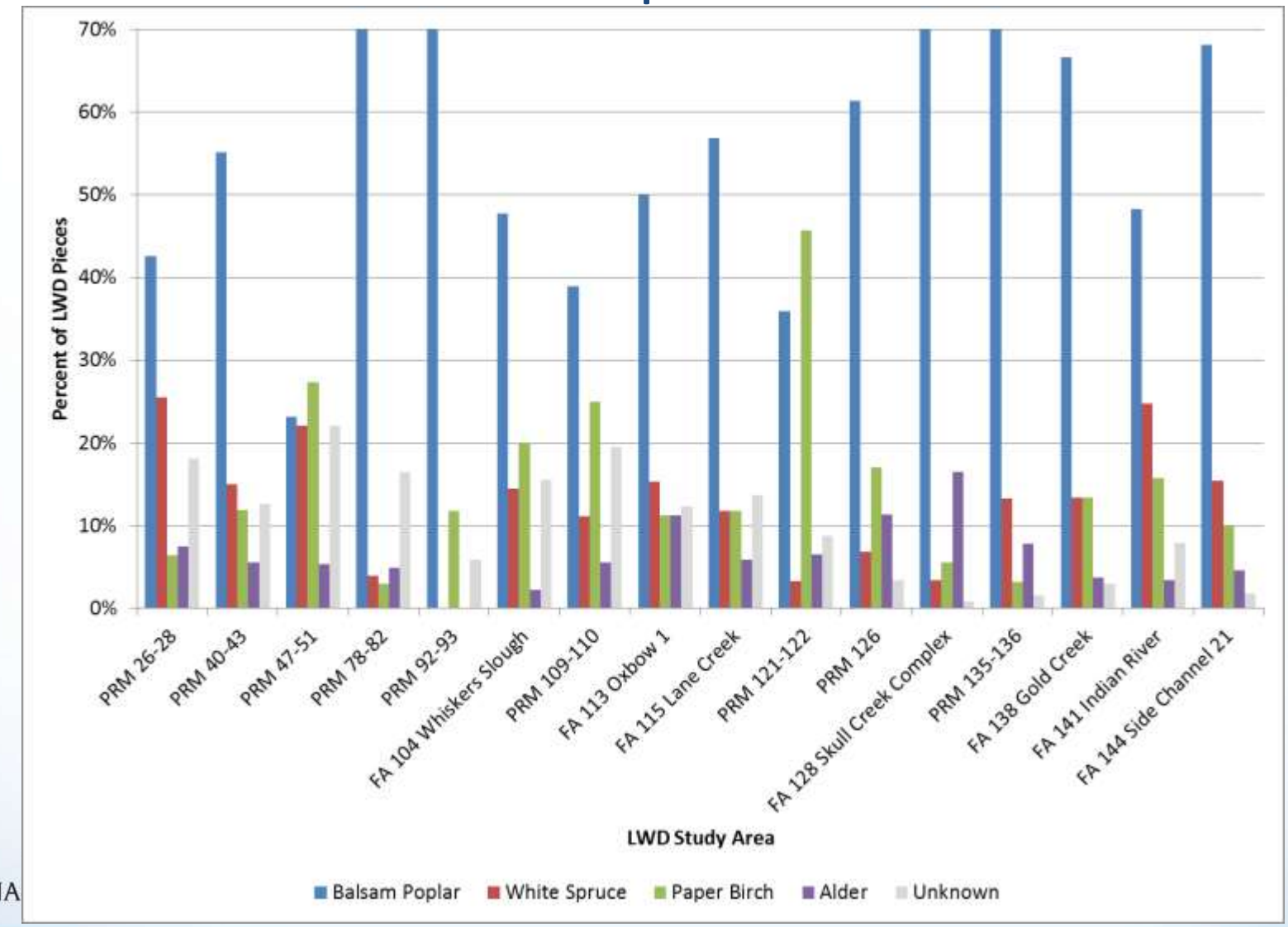
Preliminary Analysis of LWD Data (RSP 6.5.4.9)

Tree Species



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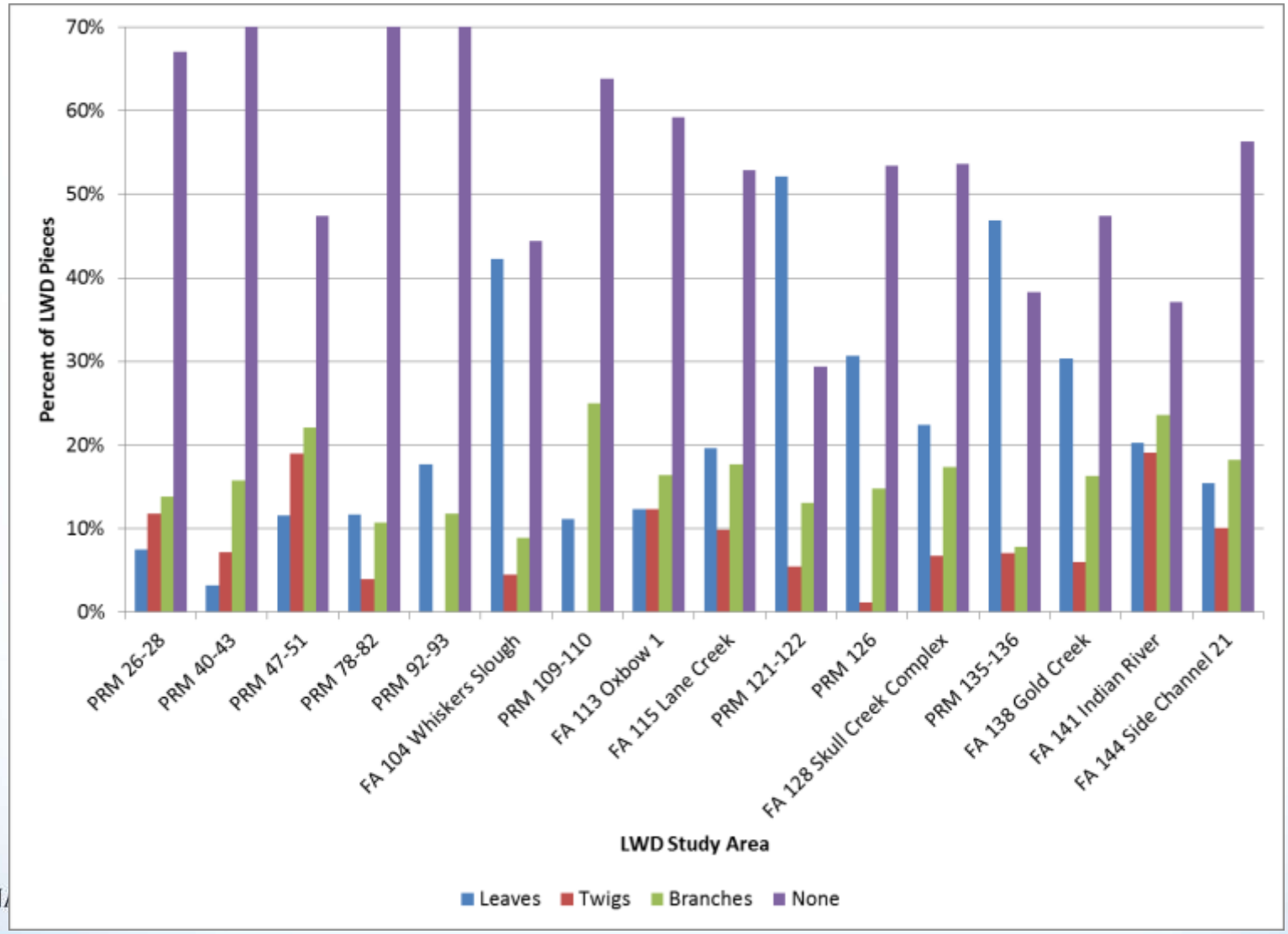
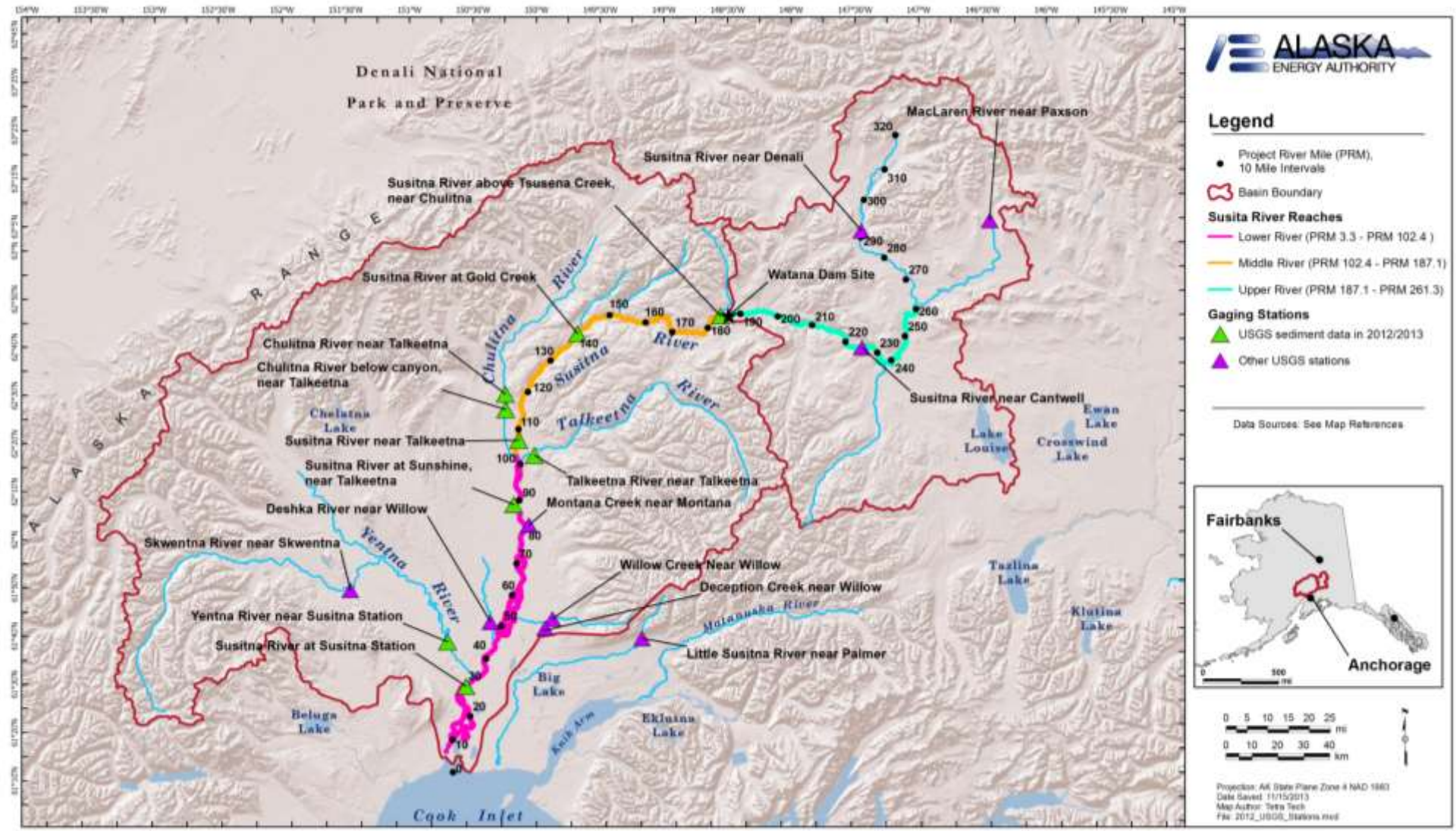
Preliminary Analysis of LWD Data (RSP 6.5.4.9)

How Fresh/Local is Wood?



SUSITNA

USGS Sediment Data (RSP 6.5.4.2)

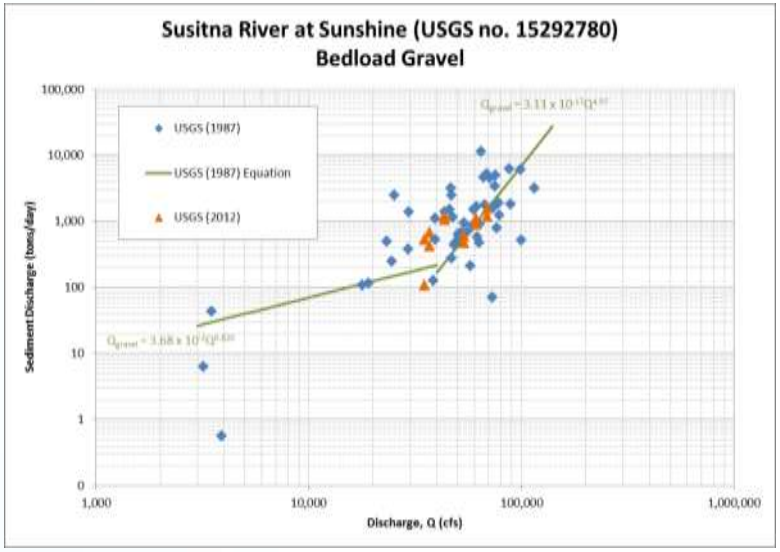


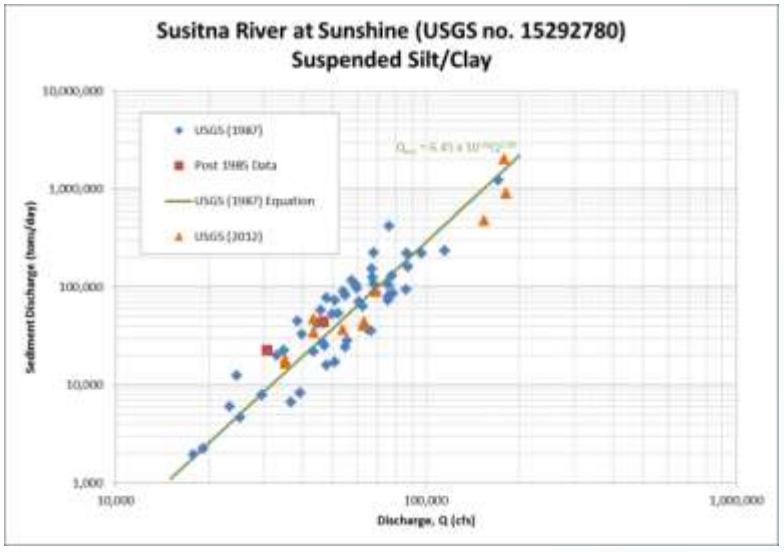
USGS Sediment Data (RSP 6.5.4.2)

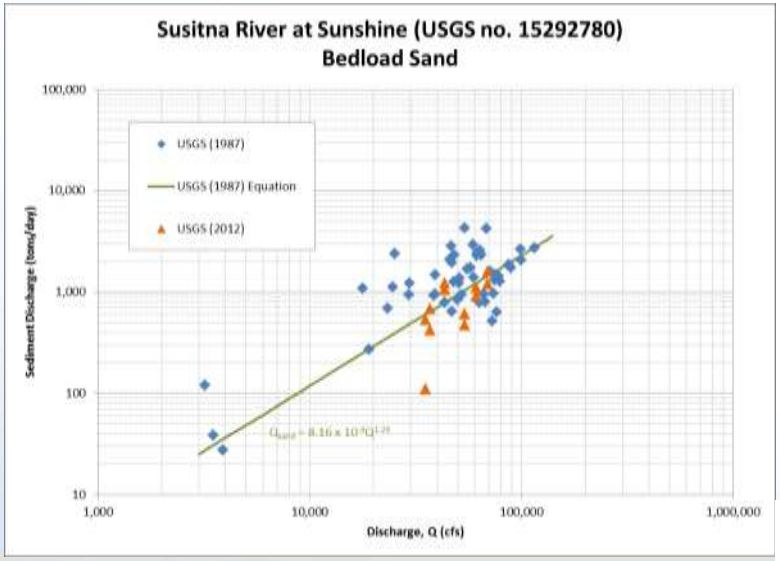
- *Summary of samples collected by USGS in 2013*

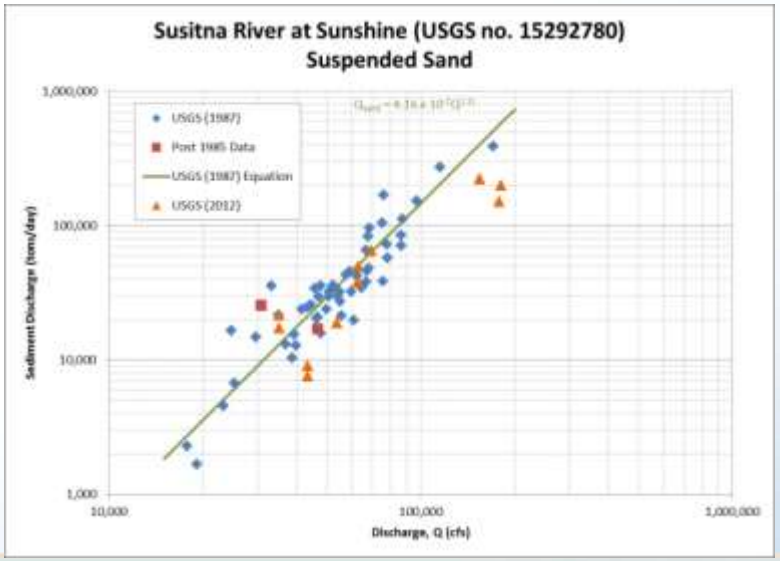
Gage Number	Gage Name	Year of Collection	Discharge Gage Station (Y/N)	Number of Samples Collected or Planned		
				Suspended Sediment	Bedload Sediment	Bed Material
15291700	Susitna R ab. Tsusena Creek Near Chulitna, AK	2013	N	3	1	1
15292000	Susitna River at Gold Creek	2013	Y	1	0	0
15292100	Susitna River near Talkeetna, AK	2013	N	3	3	0
15292400	Chulitna River near Talkeetna, AK	2013	N	2	0	0
15292410	Chulitna River below Canyon near Talkeetna, AK	2013	N	0	3	0
15292700	Talkeetna River at Talkeetna, AK	2013	Y	3	3	0
15292780	Susitna River at Sunshine near Talkeetna, AK	2013	Y	3	3	0
15294345	Yentna River near Susitna Station	2013	N	4	3	0
15294350	Susitna River at Susitna Station	2013	Y	4	3	0

USGS Sediment Transport Data Comparison 1980s and Current (RSP 6.5.4.2)









1-D Models (RSP 6.6.4.1 and Modeling Approach TM)

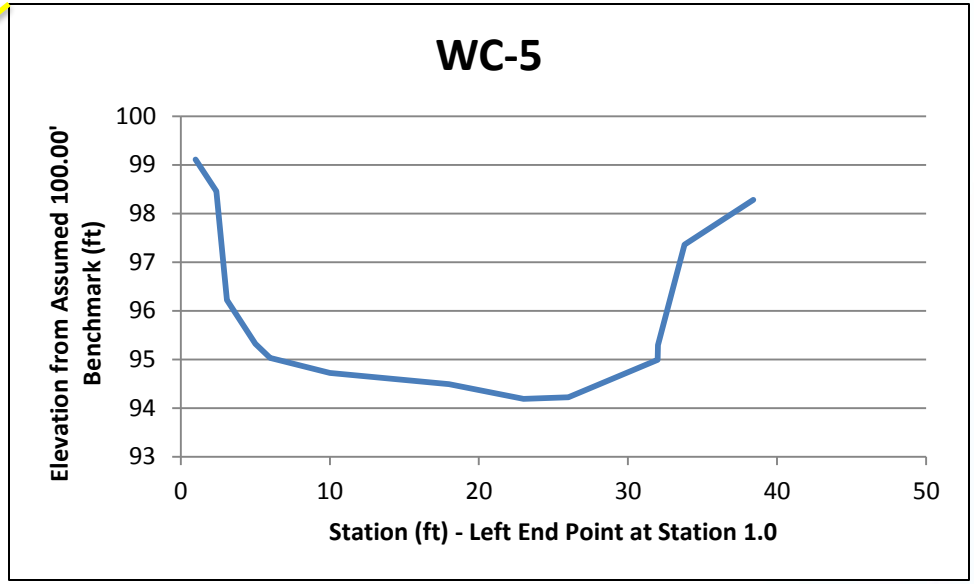
- *Middle River Tributaries*
- *Lower River Tributaries*
- *1-D Mainstem*
  - *Middle River*
  - *Lower River*
  - *Chulitna River*
  - *Talkeetna River*

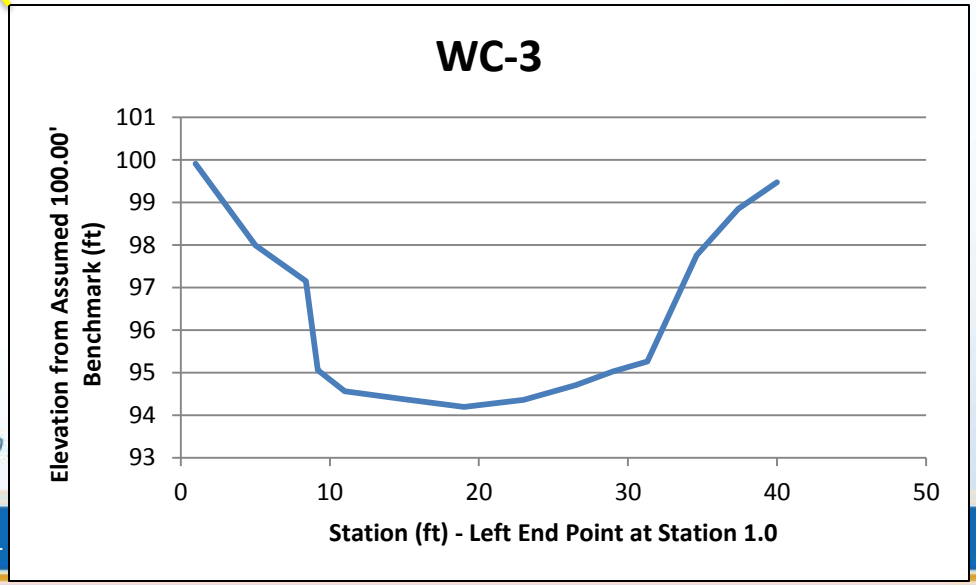
Middle River Tributary Whiskers Cr (RSP 6.6.4.1 and Modeling Approach TM)

- *Whiskers Creek Data Collected*
  - *Bed Material*
    - *2 surface samples*
    - *1 subsurface sample*
  - *Water Surface Elevations*
  - *Cross-Sections, 5 Total*

00 years.

Middle River Tributary – Whiskers Cr (RSP 6.6.4.1 and Modeling Approach TM)





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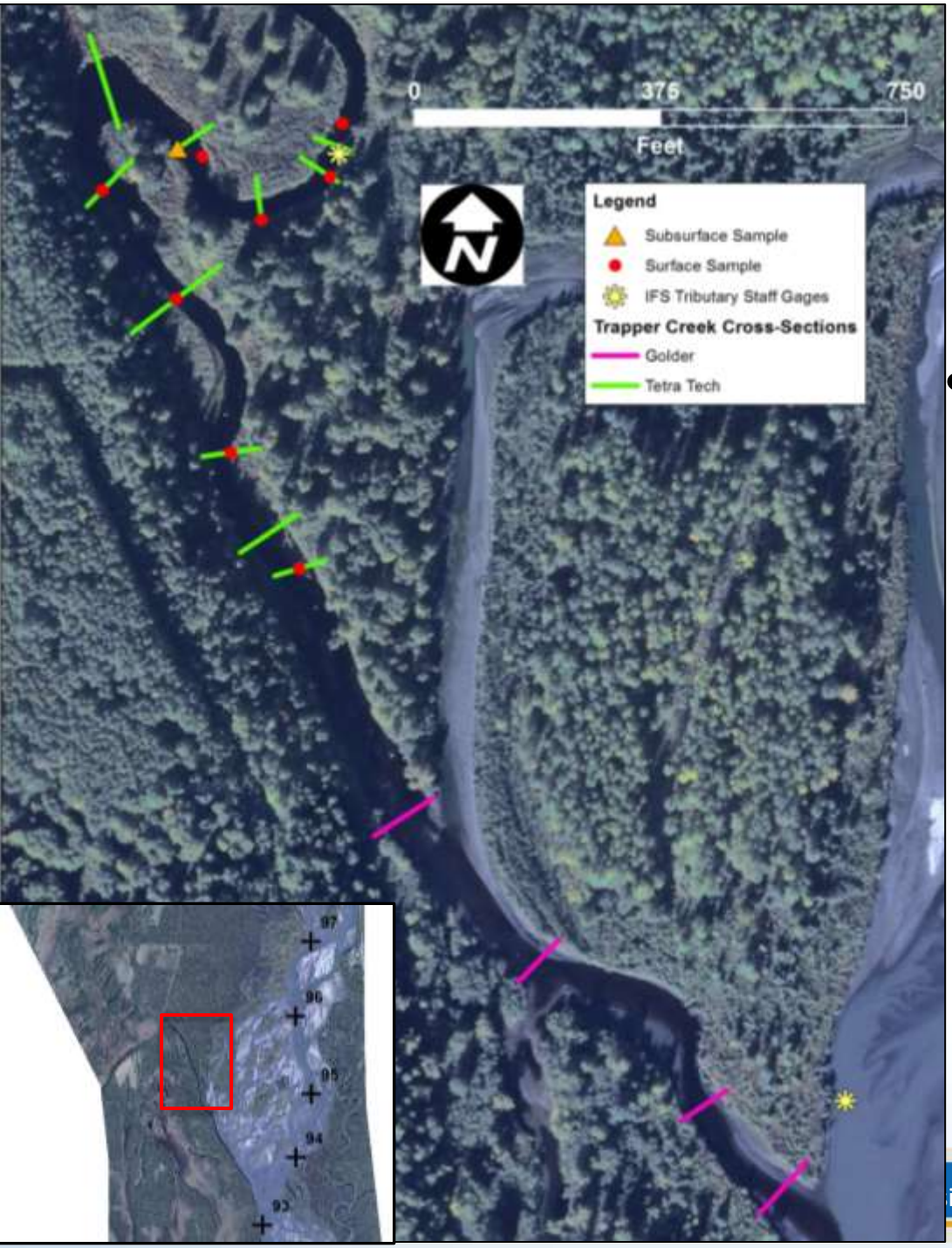
Lower River Tributary Trapper Cr (Modeling Approach TM)



- *Trapper Creek Data Collected*
  - *Bed Material*
    - *8 surface samples*
    - *1 subsurface sample*
  - *Water Surface Elevations*
  - *Cross-Sections, 14 Total*
    - *10 (Geomorphology)*
    - *4 (IFS)*
  - *Note: IFS installed tributary stream gages*

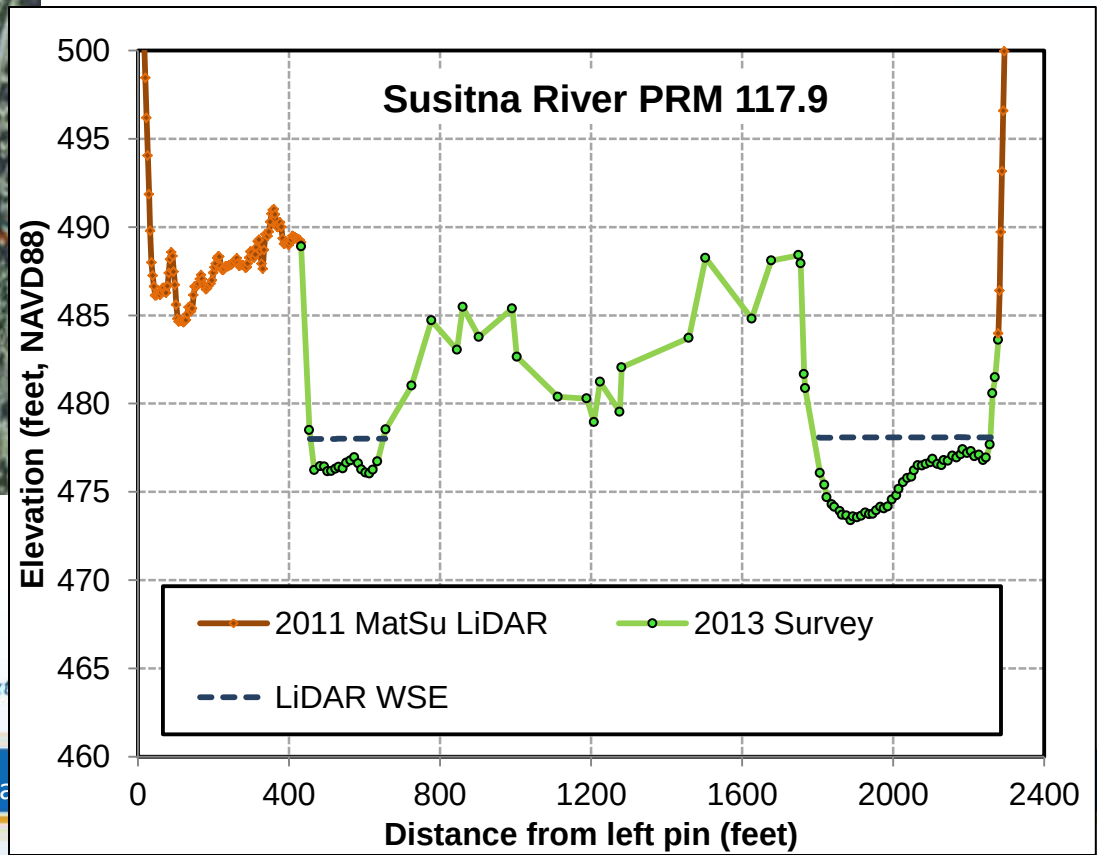
Lower River Tributary Trapper Cr (Modeling Approach TM)

TC -5 view upstream

TC-5 view downstream

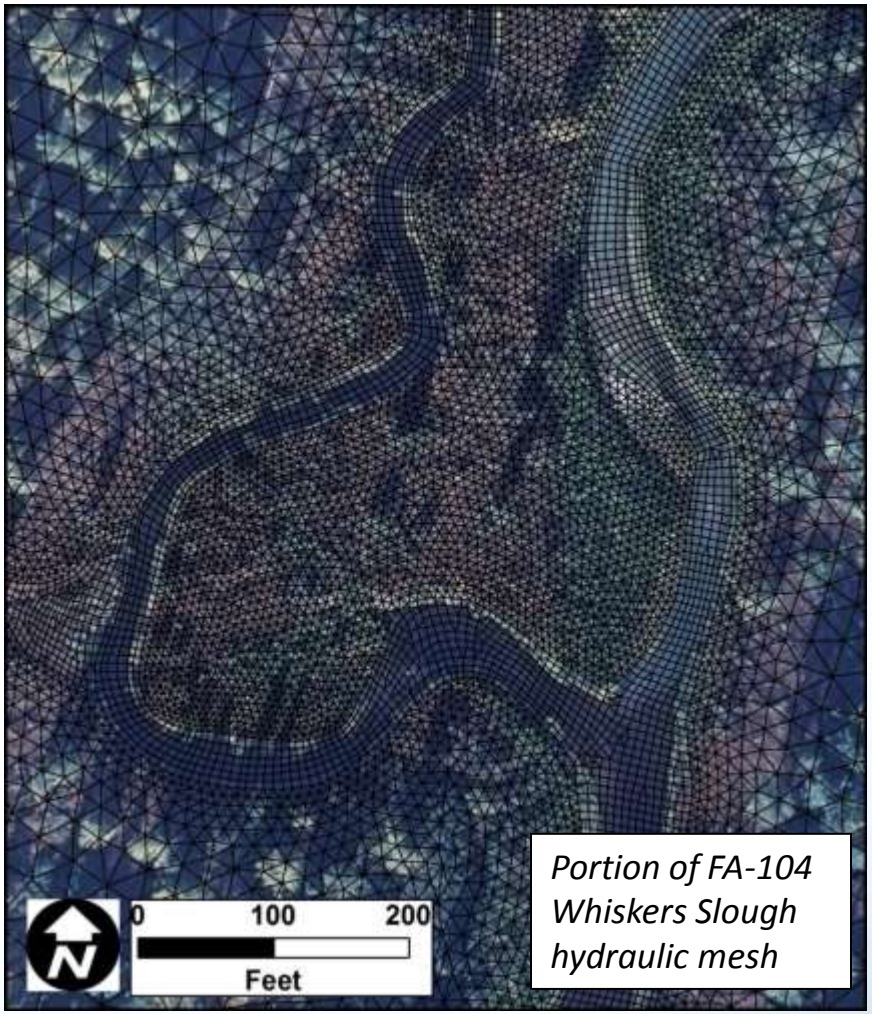
1-D Models (RSP 6.6.4.1 and Modeling Approach TM)

- *2011 LiDAR and 2013 survey locations at PRM 117.9 (left)*
- *1-D model cross-section at PRM 117.9 (below)*



2-D Models (RSP 6.6.4.1 and Modeling Approach TM)

- *Evaluate SRH-2D versus River2D*
- *Created hydraulic mesh FA-104*
- *Created sediment mesh FA-104*
- *Calibrating FA-104 hydraulic model*
- *Developing hydraulic mesh FA-128*
- *Developing sediment mesh FA-128*



Portion of FA-104 Whiskers Slough hydraulic mesh

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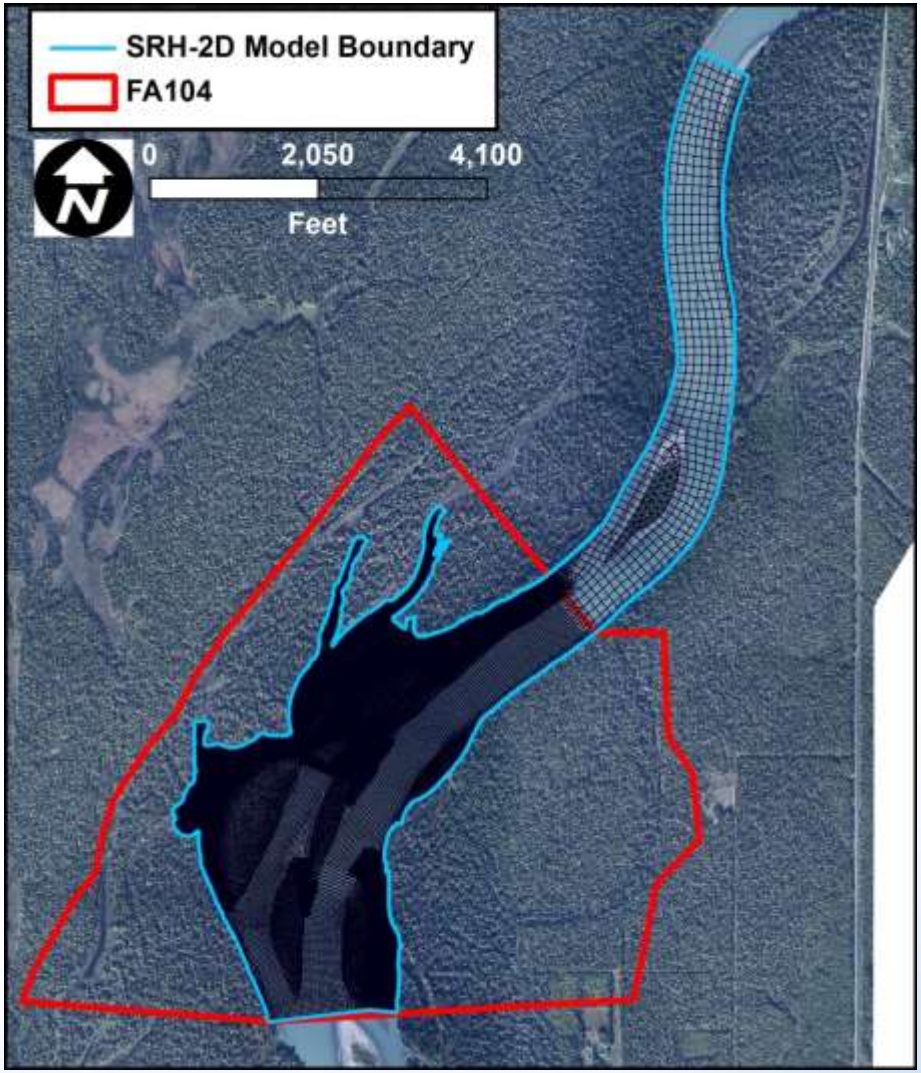
2-D Models: Hydraulic Model (RSP 6.6.4.1 and Modeling Approach TM)

- *SRH-2D hydraulic model mesh, FA-104 Whiskers Slough*
- *Entire mesh extent is 170,000 elements*
- *Range in size from 2 feet to 100 feet*



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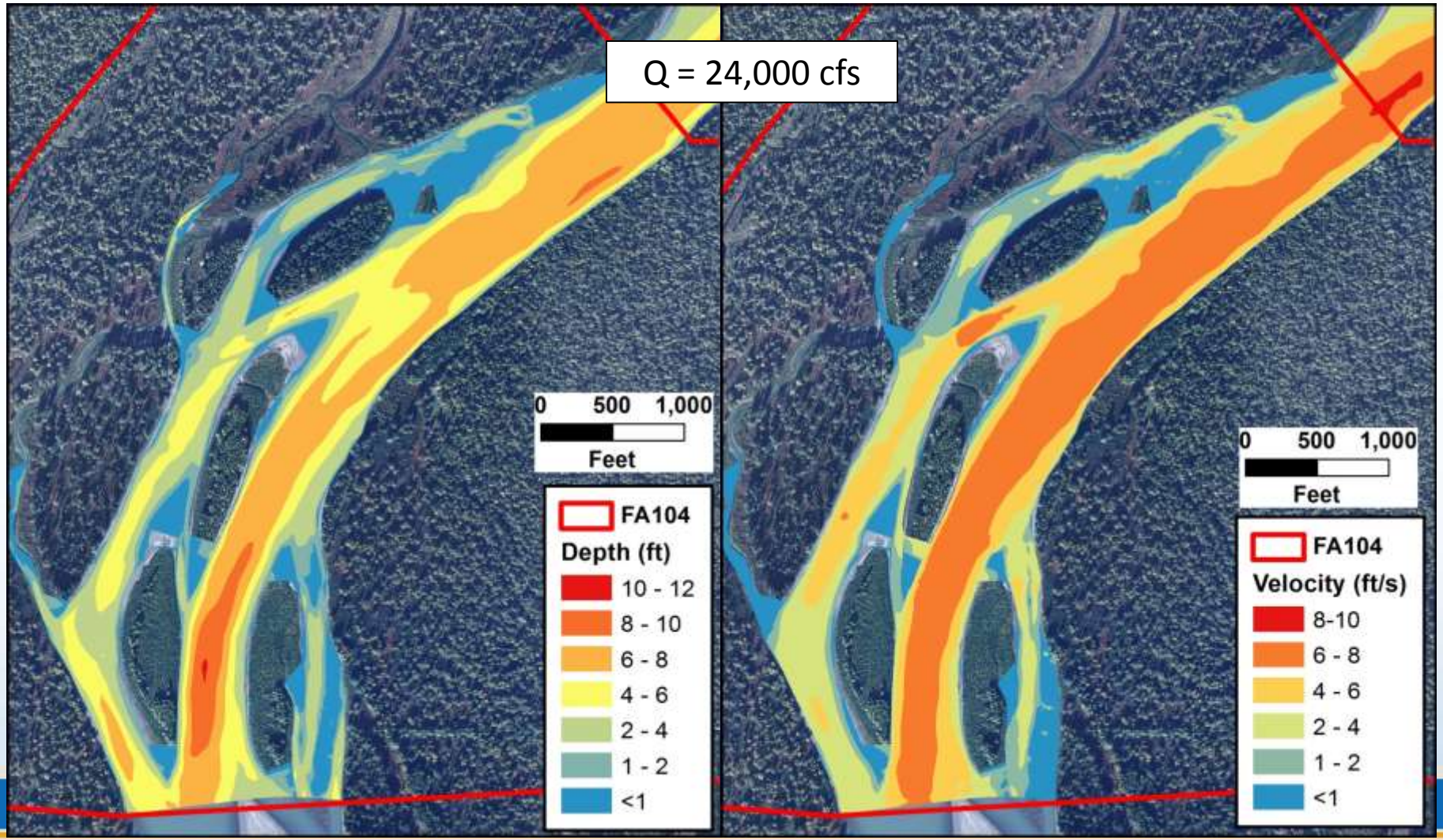
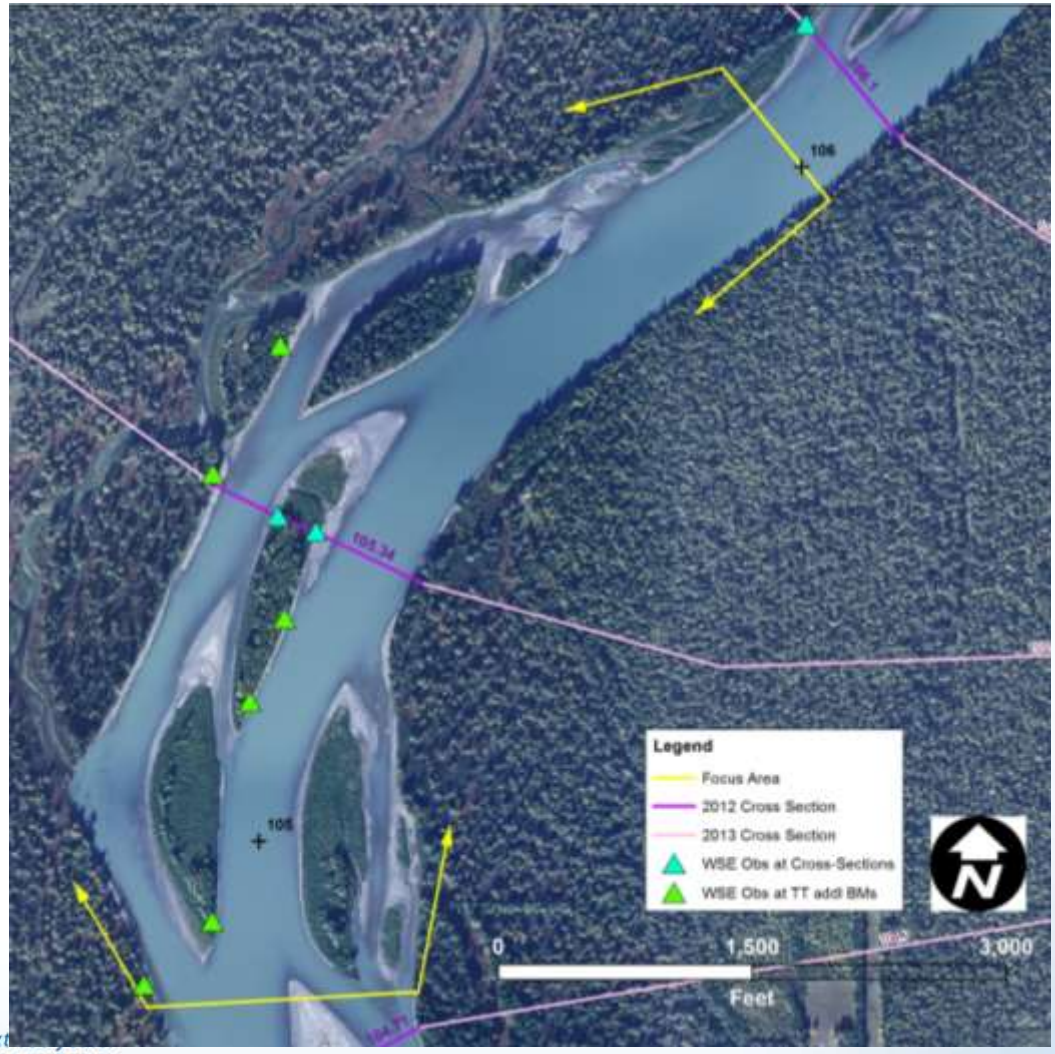
2-D Models: Hydraulic Model (RSP 6.6.4.1 and Modeling Approach TM)

- *Preliminary results (not calibrated)*



Model Calibration (RSP 6.6.4.1 and Modeling Approach TM)

- *Water Surface Elevations*
  - *2013 measurements by TT (illustrated in figure)*
  - *2013 measurements by Geovera*
  - *2012 measurements by Geovera*
- *ADCP Data*
  - *Velocity*
  - *Discharge*



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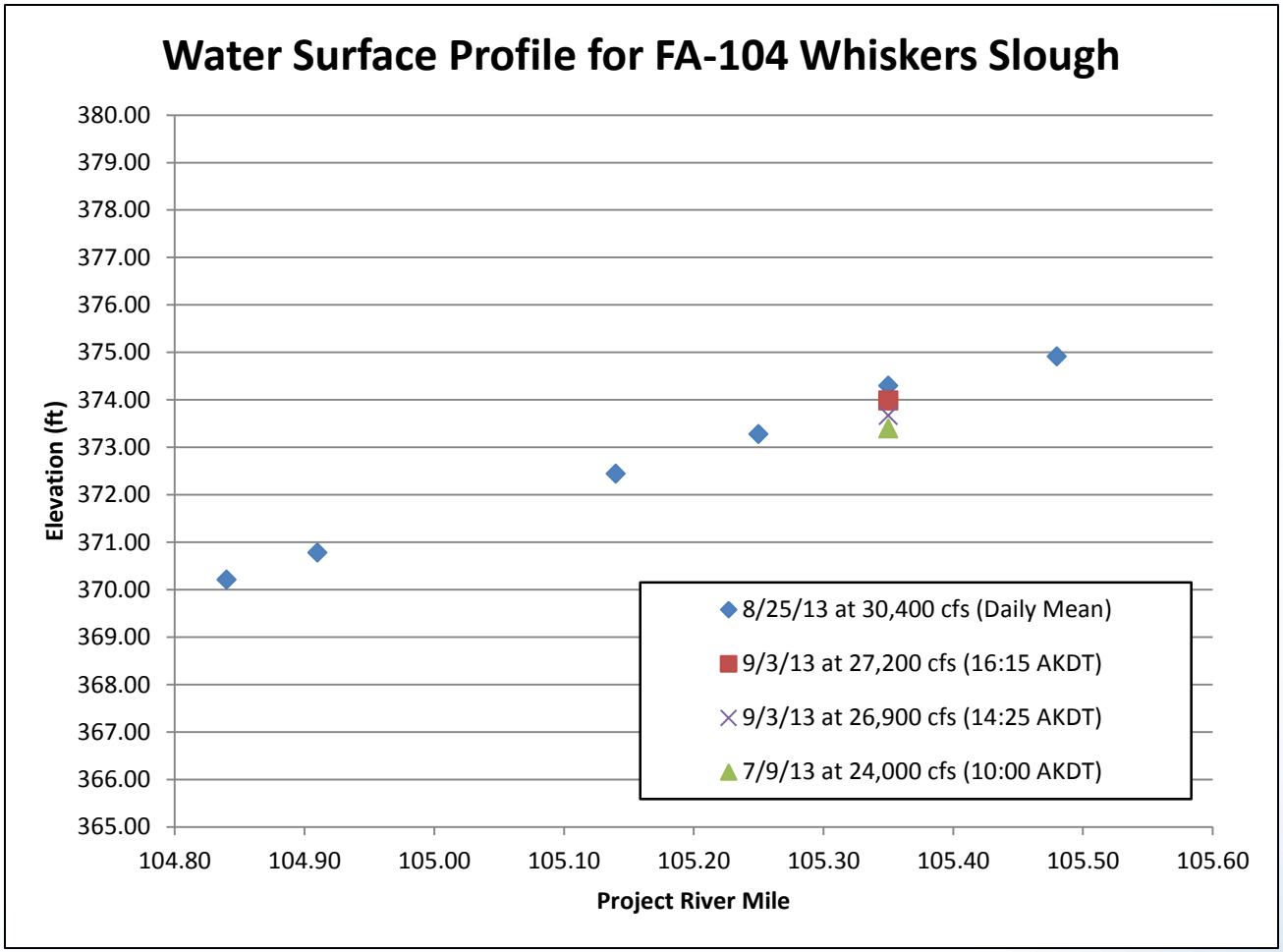
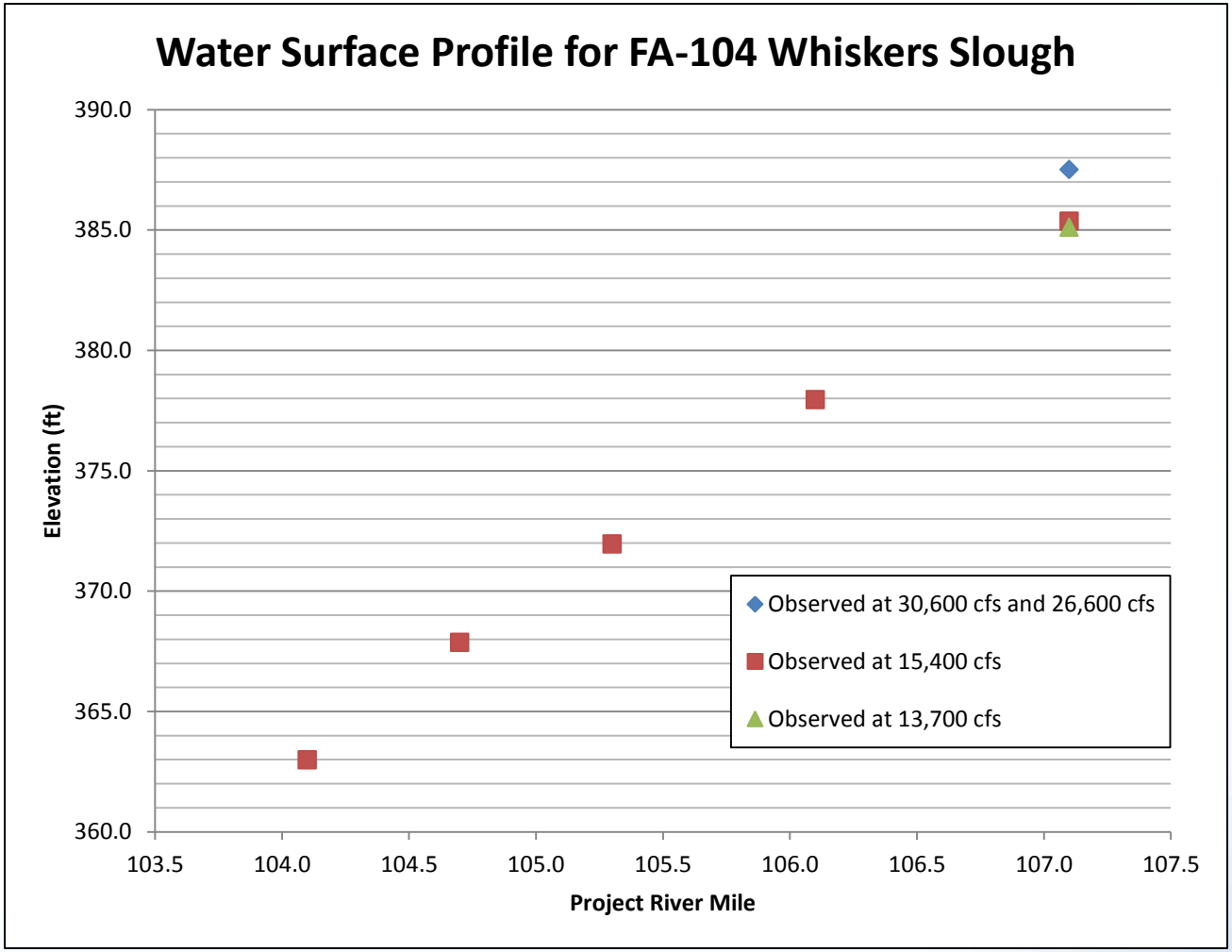
Model Calibration (RSP 6.6.4.1 and Modeling Approach TM)

- *Medium flow water surface profile*
- *2013 data gathered by Tetra Tech*



Model Calibration (RSP 6.6.4.1 and Modeling Approach TM)

- *Low flow water surface profile*
- *2012 data gathered by Geovera*



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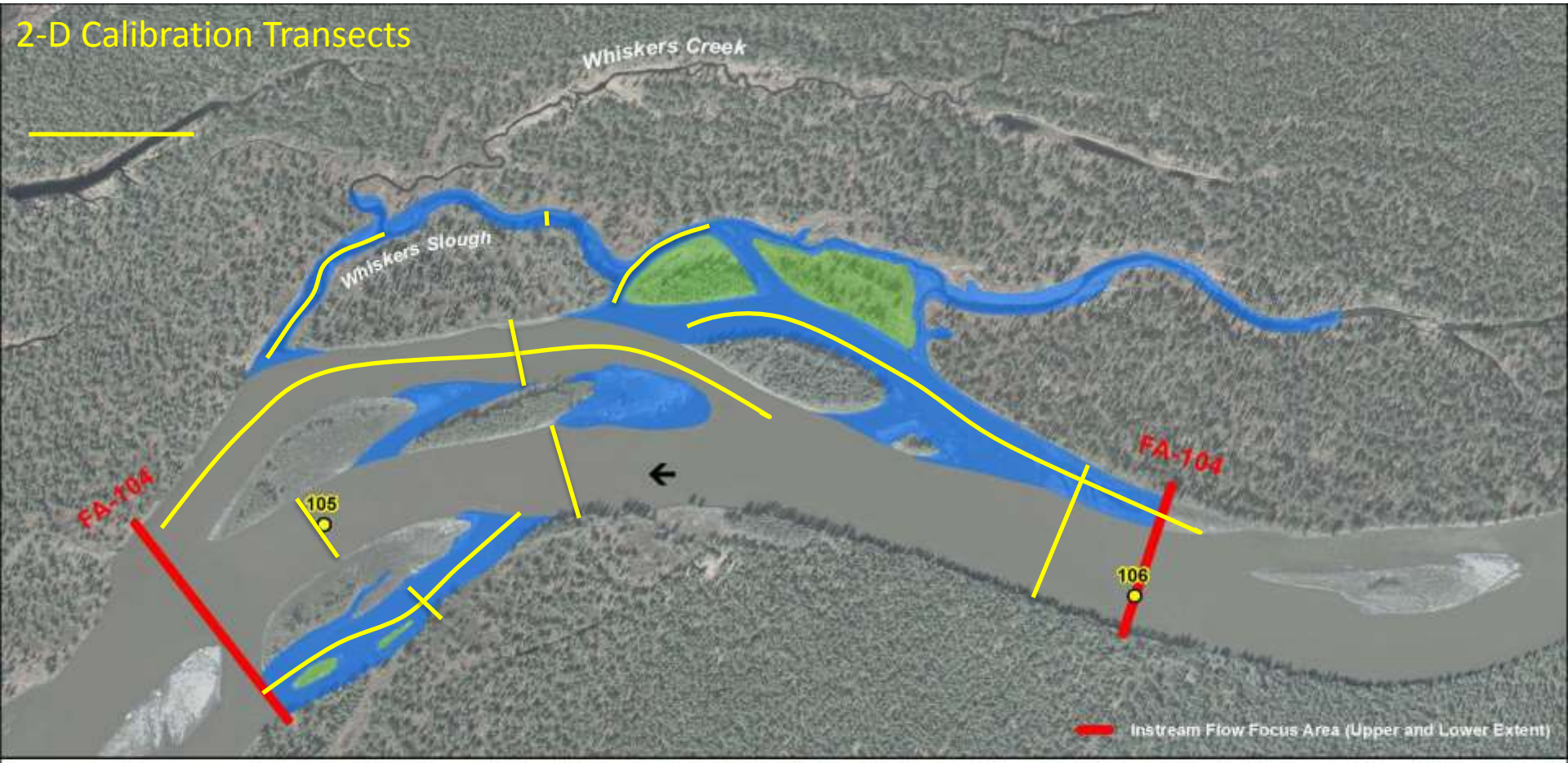
Model Calibration – ADCP Velocity and Discharge for FA-104 Whiskers Slough (RSP 6.6.4.1 and Modeling Approach TM)



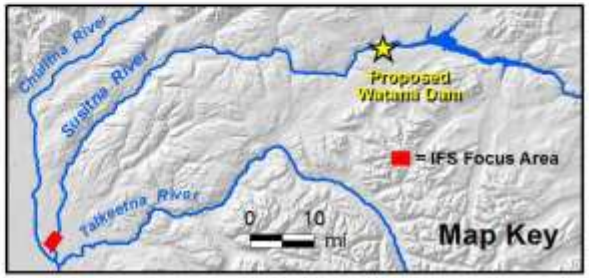
Legend

- 2-D Fine Mesh
- 2-D Coarse Mesh
- 2-D Coarse Mesh (Upland)
- Flow Arrow
- Project River Mile

ALASKA ENERGY AUTHORITY

0 1,000 Feet

Projection: Alaska Albers NAD 1983
Date Created: 6/20/2013
Map Author: R2 - Joetta Zablotney
File: Map_IFS_FocusAreas_Mesh.mxd



Orthophoto Source: 2011 Matanuska-Susitna Borough LiDAR & Imagery Project

Variance - Use of LiDAR and FA Bathy/Topo for Macrohabitat Area: (RSP 6.5.4.5 MR and 6.5.6.7 LR)

- *2012 could not collect aerials at all target flows*
  - *Flow conditions*
  - *Weather conditions*
- *Use of bathy/topo in a hydraulic based approach is consistent with modeling effort in Focus Areas*

Large Wood Debris – Variances (RSP 6.5.4.9)

- *High flow midway through data collection provided additional information on wood transport:*
  - *Small debris became mobile at approximately 30,000 cfs at Gold Creek gage; large trees started to move at approximately 40,000 cfs*
  - *Wood in some Focus Areas already inventoried was re-checked after August high flow to determine if wood pieces moved or not*

Next Steps - Q1 2014 (RSP 6.5)

- *Planning 2014 summer field activities*
- *Submit Downstream Effects of Dams Technical Memorandum*
  - *To be performed in collaboration with Riparian Study Team (RIFS - RSP Section 8.6)*
- *Update 2013 digitized geomorphic features*
  - *Use 2013 aerials and 2013 field data*

Next Steps - Q1 2014 (RSP 6.5)

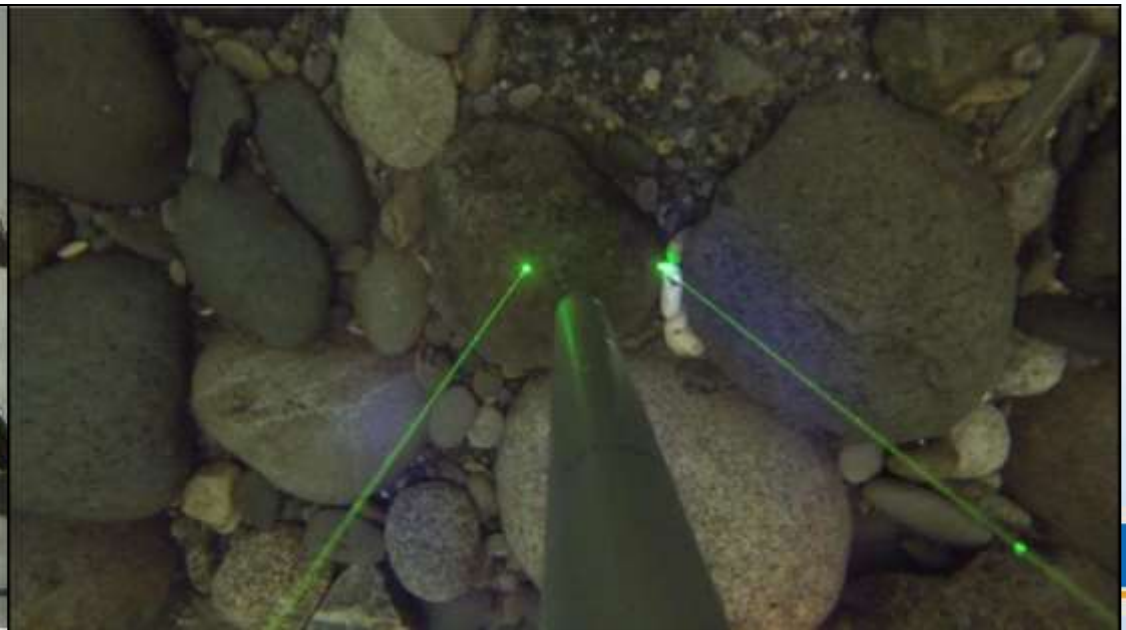
- *Perform Turnover Analysis for Middle and Lower Susitna River*
  - *Analyzing channel change between 1950s to 1980s and current aerials using digitized maps of geomorphic features*
  - *Quantify rate of conversion of channel to floodplain*
  - *Quantify rate of conversion of floodplain to channel*
- *Extend macrohabitat mapping from aerials in Middle River to entire segment*

Next Steps - Q1 2014 (RSP 6.5)

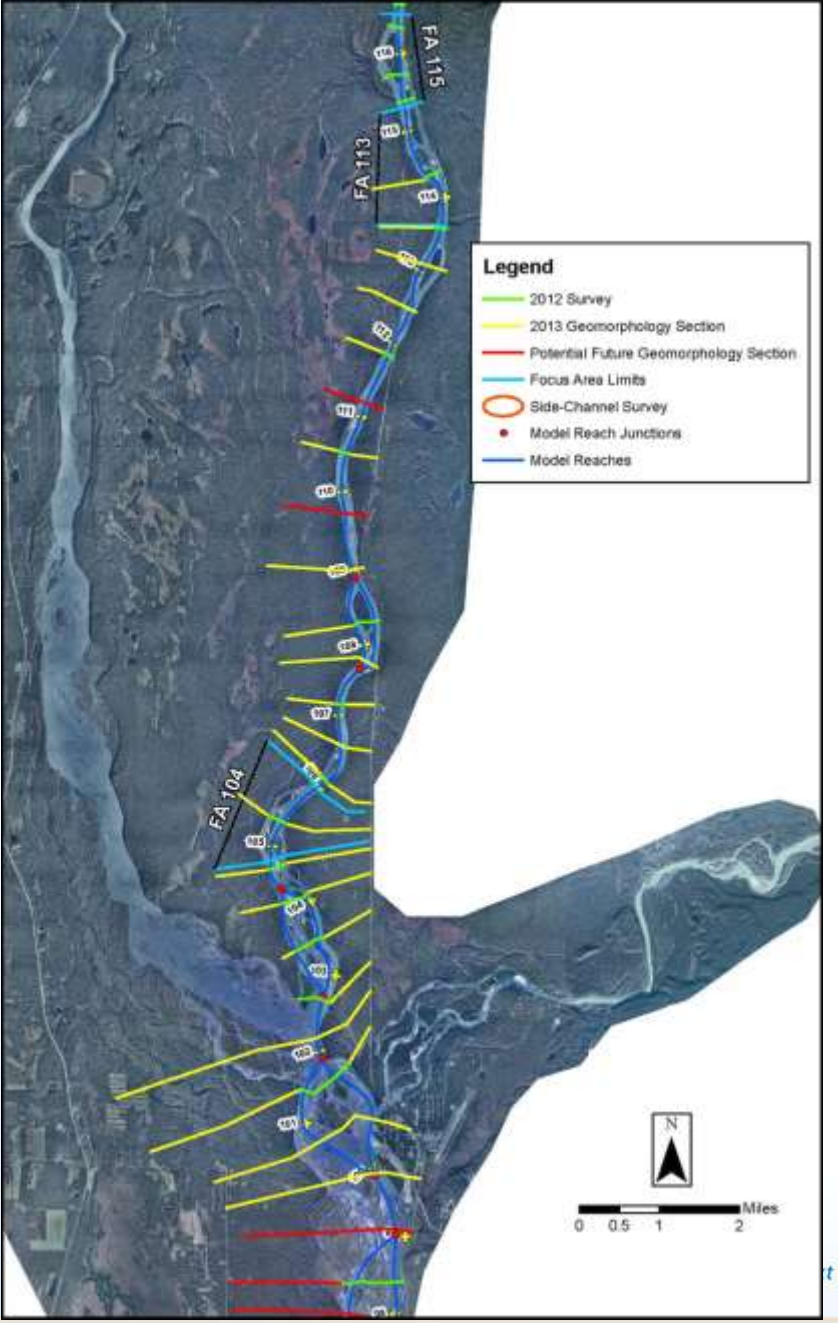
- *Finish digitizing LWD on 2012/2013 aerials (some upper and lower river 2012 aerials were at higher than target flows; waiting to see if 2013 aerials were taken under lower flow conditions)*

Next Steps - Q1 2014 (RSP 6.6)

- *Plan 2014 summer field activities*
- *Winter Field Work – Through-Ice Bed Material Sampling*
  - *Characterize substrate*
  - *Middle River: 1 – 2 samples per reach*
  - *Lower River: 1 – 2 samples per reach*
  - *Upper River: 2 samples*
  - *Tributaries: Talkeetna River & Chulitna River*



Next Steps - Q1 2014 (RSP 6.6)

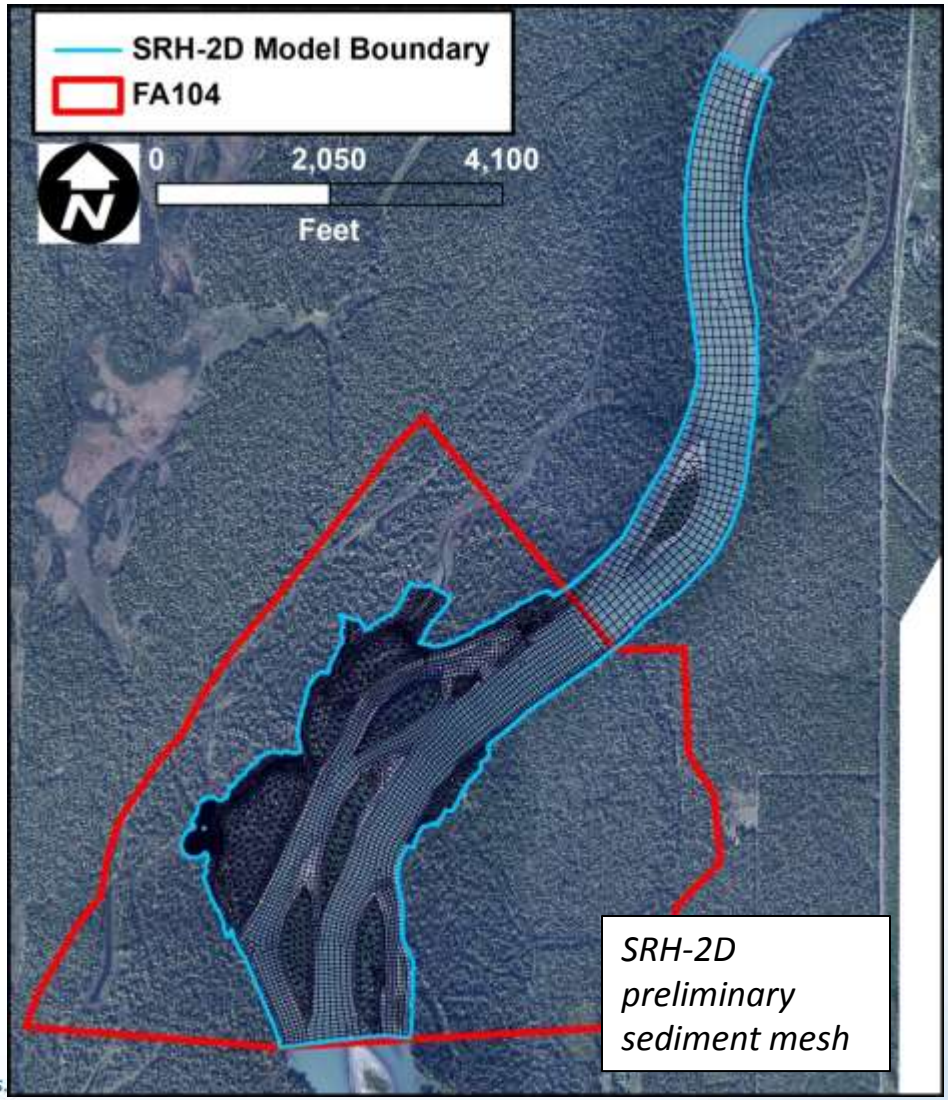


- *Run 1-D reach-scale model from Proposed Dam Site (PRM 187.1) to Susitna Station (PRM 30) for 2 scenarios*
  - *Existing Conditions scenario*
  - *Max Load Following OS-1*
  - *Evaluate possible extension of 1-D model downstream of PRM 30*

t 100 years.

Next Steps - Q1 2014 (RSP 6.6)

- *Select 2-D Model*
  - *SRH-2D vs. River2D*
- *Use 2-D models for FA-104 and FA-128 as test sites for comparison*
- *Complete calibration of hydraulic model*
- *Develop sediment model*
- *Perform test runs on hydraulic and sediment models at both FAs*



SRH-2D preliminary sediment mesh

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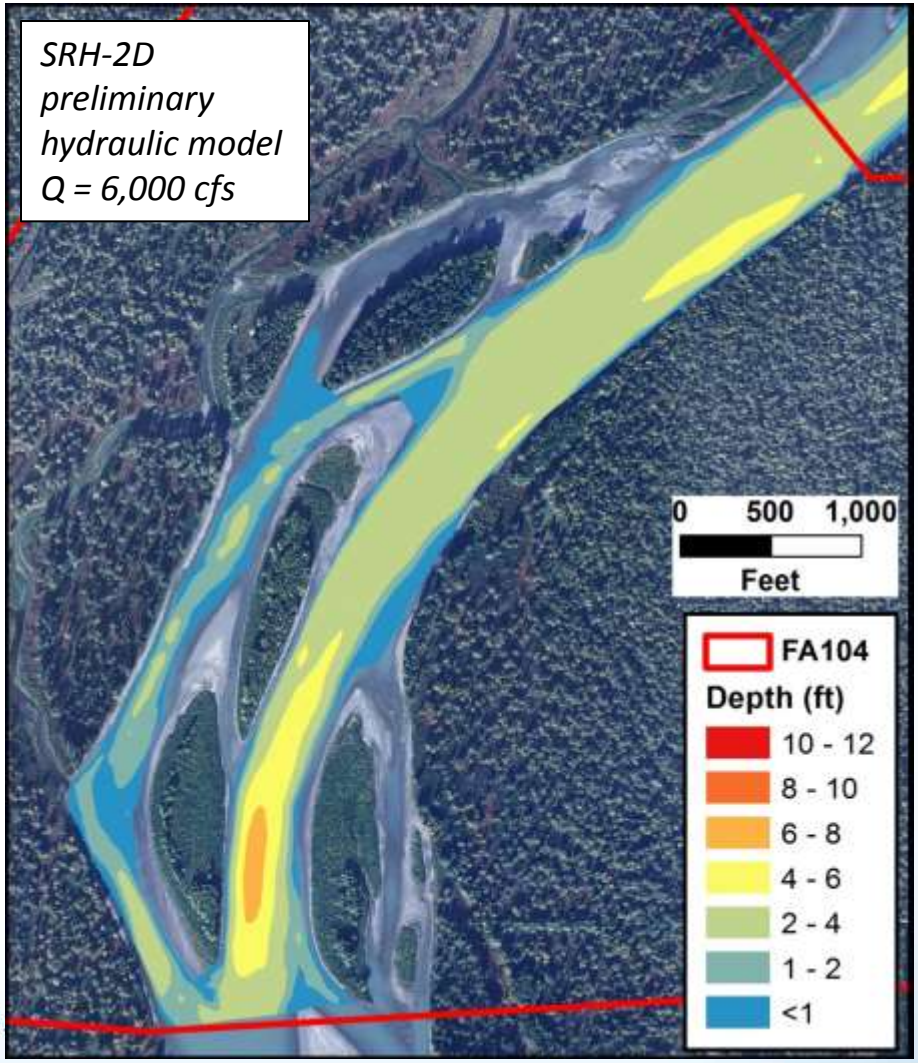
Next Steps - Q1 2014 (RSP 6.6)

- *2-D Model Development*
  - *Review TINS for remaining 5 FAs*
  - *Create meshes for remaining 5 FAs*
  - *Identify any additional 2014 survey needs*



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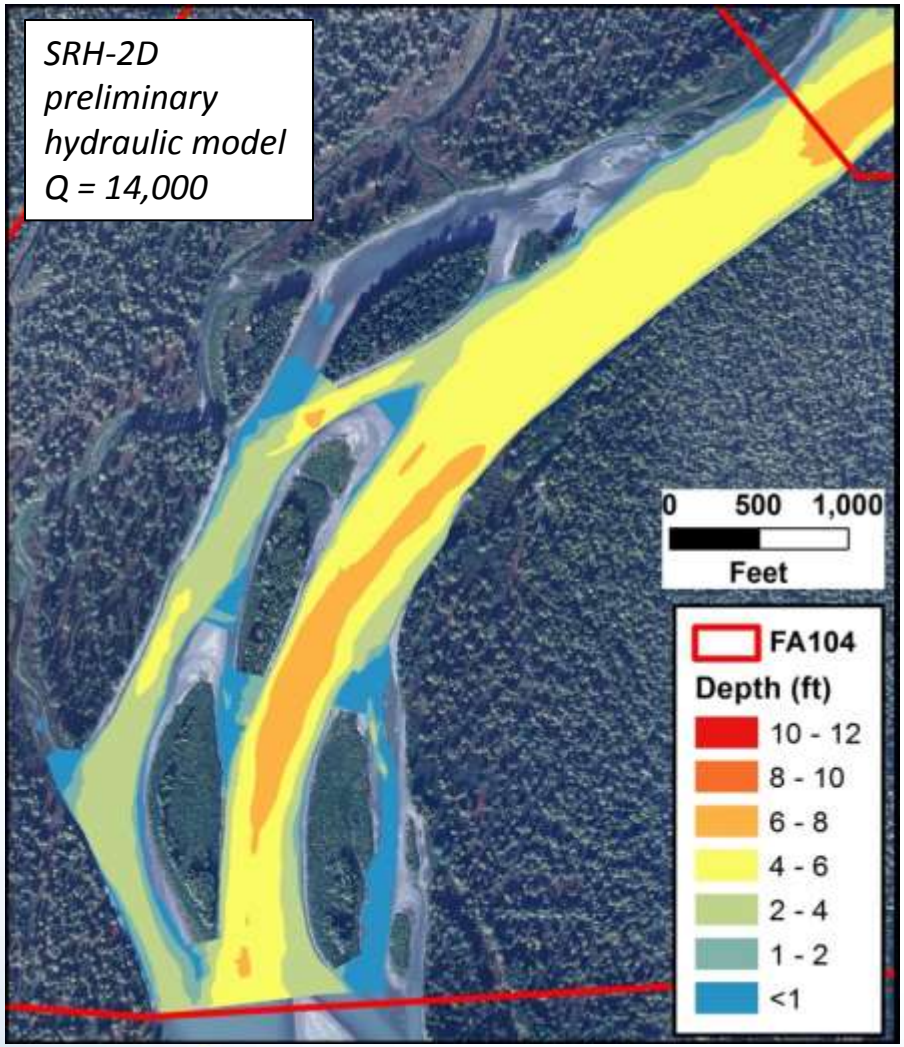
Next Steps - Q1 2014 (RSP 6.6)



- *Proof of Concept*
  - *Provide 2-D hydraulic model results to Fish and Aquatics Instream Flow Study (RSP 8.5)*
  - *Velocity, depth, water surface elevations*
  - *Range of flows*

QUESTIONS?

END