

Initial Study Report Meeting

Study 6.5 Geomorphology

October 16, 2014

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Study 6.5 Objectives

1. **Geomorphically characterize** the Project-affected **river channels and floodplain**
2. Collect **sediment transport data** to supplement historical data (USGS)
3. Determine **sediment supply and transport** in Susitna MR and LR
4. **Assess geomorphic stability/change** Susitna MR and LR
5. Characterize the surface area vs. flow relationships for **riverine macrohabitat** in the Susitna MR
6. Conduct a reconnaissance-level **geomorphic assessment of potential Project effects** on the Susitna MR and LR

Study 6.5 Objectives

7. Conduct a phased characterization of the surface area versus flow relationships for **riverine macrohabitat** types in the **Lower Susitna River** Segment
8. Characterize the proposed Watana **Reservoir geomorphology and changes** due to the reservoir
9. Assess **large woody debris** transport, recruitment, and influence on the geomorphology of the Susitna River
10. Characterize geomorphic conditions at **stream crossings** along **access road/transmission line** alignments
- 11. Integration with the Fluvial Geomorphology Modeling** below Watana Dam Study

Study 6.5 Components

1. Delineate Geomorphically Similar Reaches and Characterize the Geomorphology of the Susitna River (4.1, 4)*
 2. Bed Load and Suspended-load Data Collection (4.2, 10)
 3. Sediment Supply and Transport Susitna MR and LR (4.3, 15)
 4. Assess Geomorphic Change in Susitna MR and LR (4.4, 23)
 5. Riverine Habitat versus Flow in Susitna MR (4.5, 32)
 6. Reconnaissance-Level Assessment of Project Effects on Susitna MR and LR (4.6, 40)
 7. Riverine Habitat Area versus Flow in Susitna LR (4.7, 47)
 8. Reservoir Geomorphology (4.8, 53)
 9. Large Woody Debris (4.9, 58)
 10. Geomorphology of Stream Crossings along Transmission Lines and Access Alignments (4.10, 61)
 11. Integration with Fluvial Geomorphology Modeling below Watana Dam Study (4.11, 63)
- *(ISR Part A, Section #, pg. #)

Study 6.5 Variances

- The **bed-material samples were not collected** by the USGS in 2012 (ISR Part A, Section 4.2.3).
- **Bed load samples Susitna River at Tsusena Creek were terminated** after 2012 (ISR Part A, Section 4.2.3).
- The initial sediment balance task calls for comparison of the total sediment load at the Sunshine and Susitna Station gages for wet, average, and dry years between pre- and post-Project conditions. Entire 61-year extended record was used (ISR Part A, Section 4.3.3).
- The determination of effective discharge of the Susitna River below Tsusena Creek and at Gold Creek and Sunshine. Tsusena Creek location was not analyzed but additional locations were calculated at Susitna Station, Chulitna River, Talkeetna River and the Yentna River (ISR Part A, Section 4.3.3).

Study 6.5 Variances

- **Rather than obtaining three sets of aerial photography in 2012 at 23,000, 12,500, and 5,100 cfs a single target flow of 12,500 cfs will be supplemented with Focus Area analyses (ISR Part A, Section 4.5.3).**
- Literature review of the downstream effects of dams delayed from Q4 2013 to 2014 to allow for integration with the Riparian IFS (Study 8.6) to produce a single, comprehensive document (ISR Part A, Section 4.6.3).
- Initial analysis of the modified braiding index (MBI) planned for Q3 2013 will be performed in 2014 when information will be available from the 1-D Bed Evolution Model (ISR Part A, Section 4.6.3).
- Hydrologic analysis of operational scenarios beyond the initial streamflow assessment will be performed in the Fish and Aquatics IFS (Study 8.5) (ISR Part A, Section 4.6.3).

Study 6.5 Variances

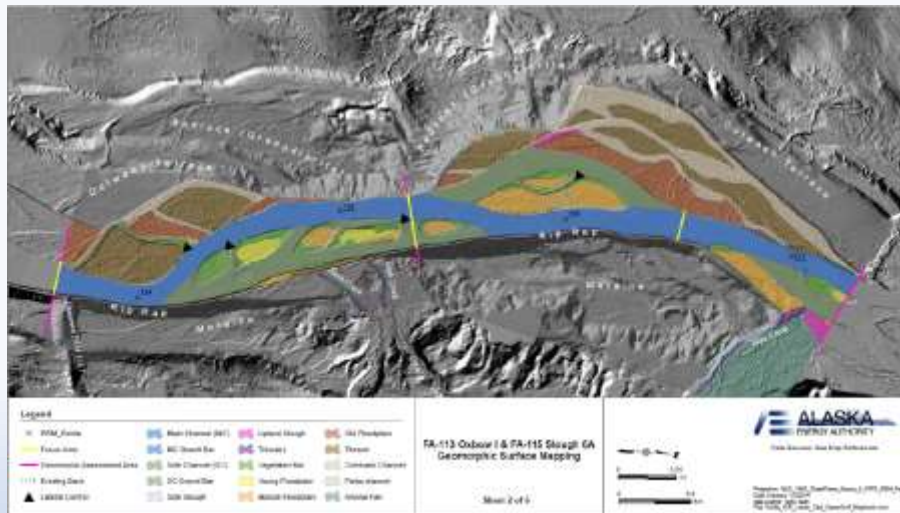
- Concurrent flow analysis planned in Q4 2013 will now be performed in 2014 (ISR Part A, Section 4.6.3)
- Assessment of reservoir erosion planned in 2013 will be performed in 2015 (ISR Part A, Section 4.8.3).
- LWD study component opportunistically included August 2013 high-flow event; this was an unanticipated event and was not included in the Study Plan (ISR Part A, Section 4.9.3).
- Planned data collection for LWD study component in summer 2013 will be completed in 2014/2015 (ISR Part A, Section 4.9.3).
- Planned field assessment of stream crossings would take place in 2013 is now planned for 2015 (ISR Part A, Section 4.10.3).

Study 6.5 Summary of Results in ISR (ISR Study 6.5, Part A – Section 5)

- Completed 7 Technical Memoranda presenting results of 2012 study efforts conducted under Study 6.5
 - Initial **Geomorphic Reach Delineation and Characterization**, Middle and Lower Susitna River Segments (ISR Part A, Sections 5.1.1, 5.1.2 and 5.6.2)
 - Development of **Sediment Transport Relationships** and an Initial **Sediment Balance** for the Middle and Lower Susitna River Segments (ISR Part A, Sec. 5.2 & 5.3)
 - Reconnaissance Level **Assessment of Potential Channel Change in the Lower Susitna River** Segment (ISR Part A, Section 5.6.3)
 - **Stream Flow Assessment** (ISR Part A, Section 5.6.1)
 - **Synthesis of 1980s Aquatic Habitat Information** (ISR Part A, Section 5.7.2)
 - **Mapping of Aquatic Macrohabitat** Types at Selected Sites in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials (ISR Part A, Sections 5.5 and 5.7.1)
 - **Mapping of Geomorphic Features and Assessment of Channel Change** in the Middle and Lower Susitna River Segments from 1980s and 2012 Aerials (ISR Part A Sec. 5.4)

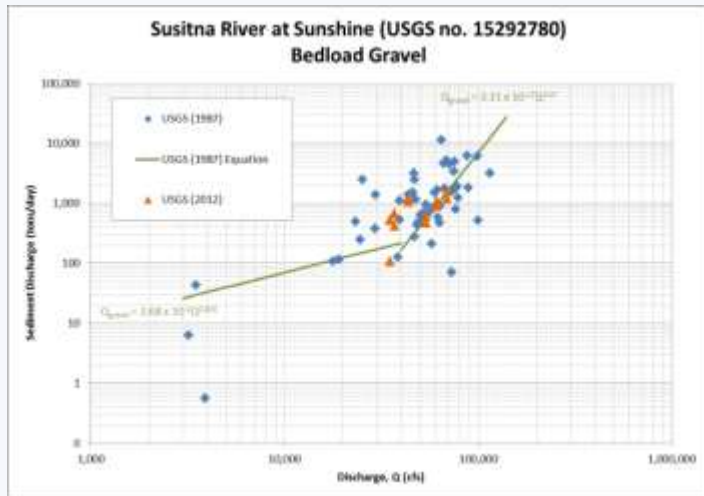
Study 6.5 Summary of Results in ISR (ISR Study 6.5, Part A – Section 5)

- Significant Appendices Included in Study 6.5 ISR Part A
 - **Surficial Geologic Mapping** in the Lower and Middle Susitna River Segments (Appendix A.1)
 - **Geomorphic Surface Mapping in 7 Focus Areas** (Appendix A.2)
 - Initial **Effective Discharge Analysis** for the Mainstem Susitna River and Tributaries (Appendix B)
 - **Large Wood Debris** : Aerial Photography Digitizing, Field inventory Protocols and Study Area **Maps** (Appendix D)

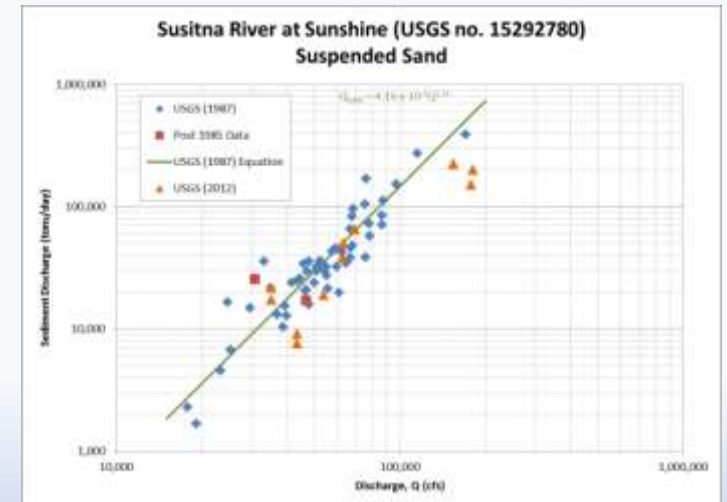
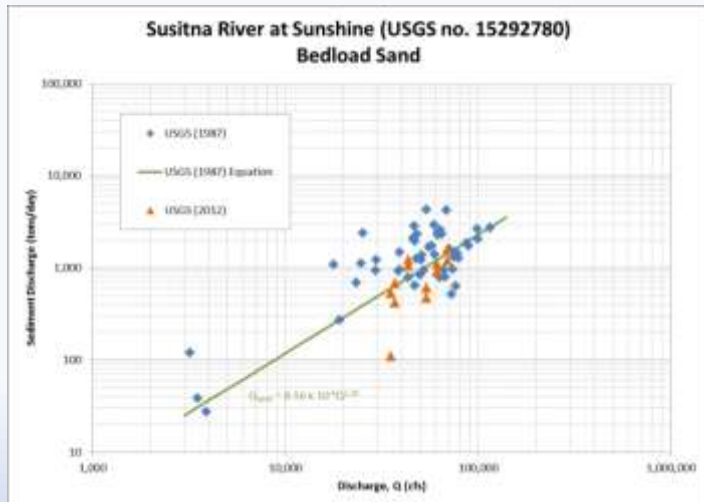
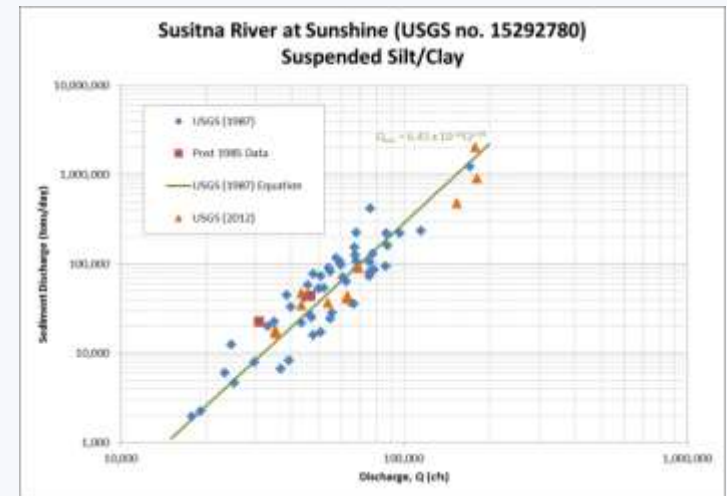


- Updated Technical Memorandum Filed May 2014
 - **Geomorphic Reach Delineation and Characterization**, Upper, Middle and Lower Susitna River Segments. Susitna-Watana Hydroelectric Project (ISR Part A, Section 7.1)

Study 6.5 Summary of Results in ISR (ISR Study 6.5, Part A – Section 5)



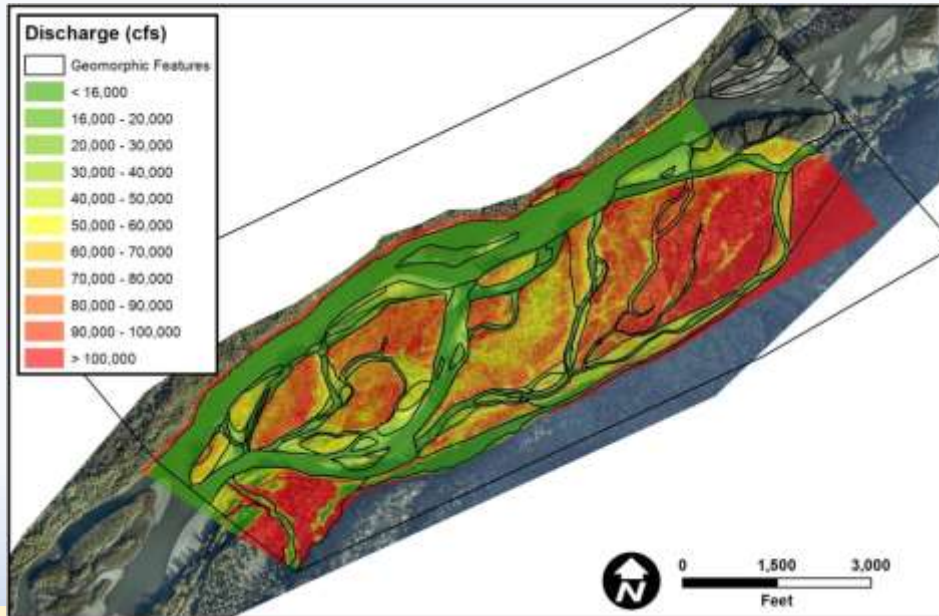
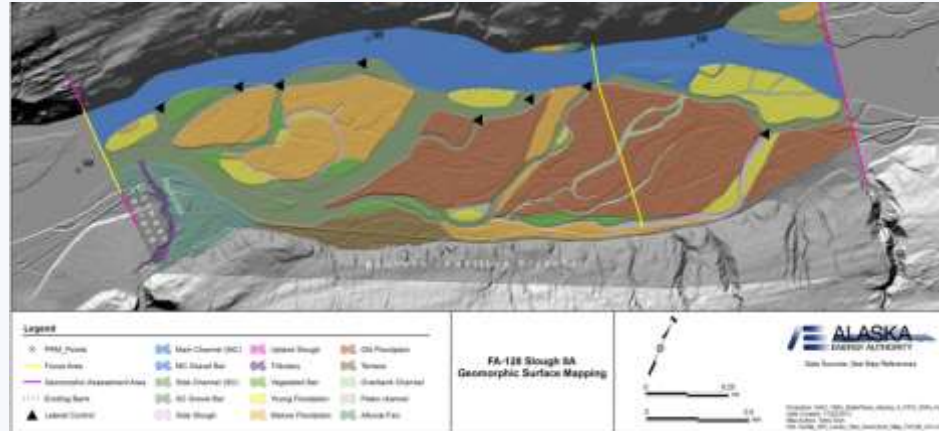
Development of
Sediment
Transport
Relationships
(Section 5.2 and
5.3)



Study 6.5 Summary of Results in ISR (ISR Study 6.5, Part A – Section 5)

- Developed Geomorphic Succession Model (Section 5.1.3.3.1)
 - Progression of surfaces
 - Frequency of inundation influenced by ice

Geomorphic Feature	Overtopping Discharge (cfs)	Flood Frequency (years)	Flow Duration (days/year)
		Pre-Dam	Pre-Dam
Main Channel			
Gravel Bar	16,190	<1	101
Side Channel			
Gravel Bar	24,030	<1	44
Vegetated Bar	48,320	2.7	1.2
Young Flood Plain	54,840	4.5	0.7
Mature Flood Plain	77,870	25	0.1
Old Flood Plain	87,570	50	--



Study 6.5 Summary of Results in ISR (ISR Study 6.5, Part A – Section 7)

- Six Reservoir Area Tributaries Selected for Assessment of Delta Formation (Section 7.1.1.8)

Tributary	PRM ¹	D.A. (mi ²)	Bank ²	2012/2013 Fish Distribution (Study 9.5)					Existing Fish Passage Barriers Eliminated by Reservoir ³			Selected	Rationale for Not Selecting ⁷
				Chinook	Burbot	Dolly Varden	Round Whitefish	Arctic Grayling	Type ⁴	Trib. RM ⁵	Elevation ⁶		
Oshetna River	235.1	556.4	L	X		X	X	X				Y	
Goose Creek	232.8	106.5	L	X	X		X	X				Y	
Un. Tributary	228.5	46.9	R									N	TOB elev. at 2,375 feet
Un. Tributary	215.2	2.3	L									N	TOB elev. at 2,200 feet; small D.A.
Jay Creek	211.0	62.4	R		X	X	X	X				Y	
Kosina Creek	209.1	402.5	L	X	X	X	X	X				Y	
Un. Tributary	204.5	12.3	L						Cmpd.	0.4 & 0.6	1,830 & 1,925	N	Steep channel; small D.A.
Un. Tributary	203.4	19.5	R									N	TOB elev. at 2,030 feet; small D.A.
Un. Tributary	198.4	1.8	L			X						N	Small D.A.
Un. Tributary	197.7	8.1	L						Falls	1.3	1,990	N	Steep channel; small D.A.
Watana Creek	196.9	176.4	R	X	X	X	X	X				Y	
Un. Tributary	194.8	23.2	R			X		X				N	Small D.A.
Un. Tributary	189.7	1.9	L						Chute	0.4	1,990	N	Small D.A.
Deadman Creek	189.4	175.4	R		X	X	X	X	Falls	0.6	1,760	Y	

Notes:

- PRM = Project River Mile
- Bank defines the location of the tributary confluence with the Susitna River, as viewed facing downstream on the Susitna River. L = left; R = right.
- Identifies existing fish passage barriers potentially inundated by the proposed Watana Reservoir. Reservoir low pool elevation is 1,850 feet (NAVD88) with an upstream extent at PRM 222.5; reservoir maximum pool elevation is 2,050 feet (NAVD88) with an upstream extent at PRM 232.5.
- Type of fish passage barrier, as identified in Study 9.12. Cmpd. = compound feature, such as a chute and falls.
- Trib. RM = tributary river mile, with RM 0.0 at confluence with Susitna River, to locate existing fish passage barrier.
- Elevation = elevation in feet (NAVD88) of the most upstream top of barrier (TOB) as estimated using 2011 MatSu LiDAR.
- Primary basis for excluding tributary from further studies of potential delta formation.

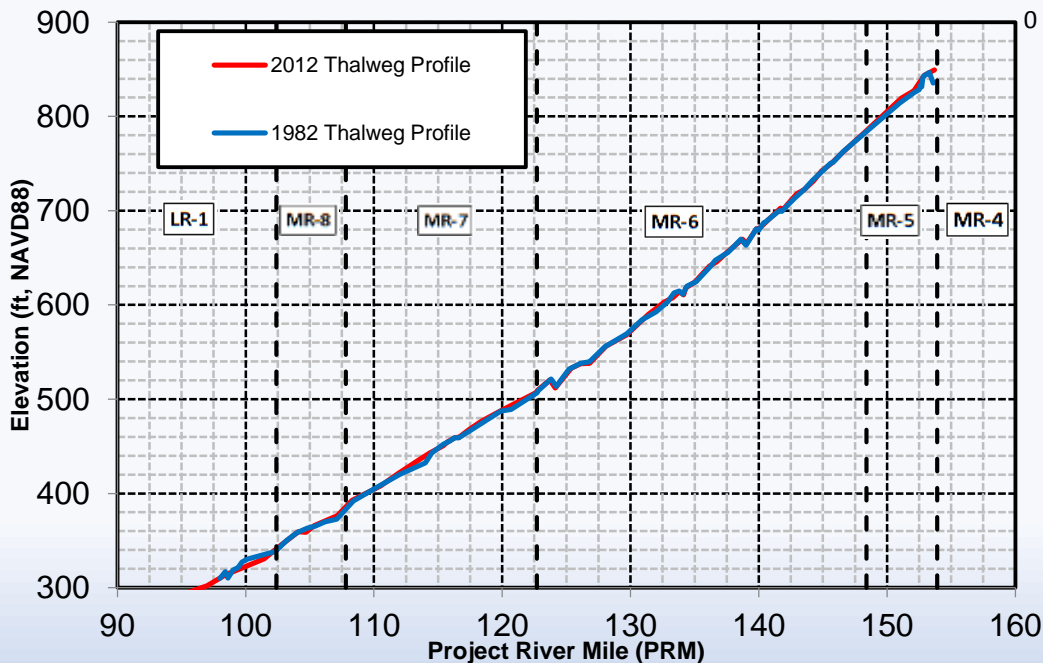
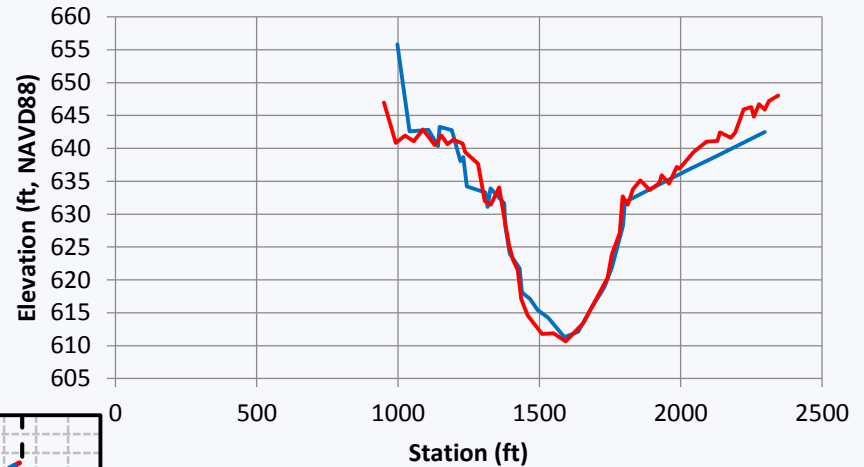
Study 6.5 Summary of Results since ISR Technical Memorandums

- Update of **Sediment-Transport Relationships** and a Revised Sediment Balance for the Middle and Lower Susitna River Segments (ISR Part C, Section 7.2.1.3)
- Susitna River **Historical Cross Section Comparison** (1980s to Current) (ISR Part C, Section 7.2.1.3)
- **Mapping of Geomorphic Features and Turnover** within the Middle and Lower Susitna River Segments from 1950s, 1980s, and Current Aerials (ISR Part C Section 7.2.1.4)
- **Updated Mapping of Aquatic Macrohabitat Types** in the Middle Susitna River Segment from 1980s and Current Aerials (ISR Part C, Section 7.2.1.5)

Study 6.5 Summary of Results since ISR

Historical Cross Section Comparison

- Identified changes in 1980s and 2012 cross sections and thalweg profile
- No consistent widespread trends of either aggradation or degradation



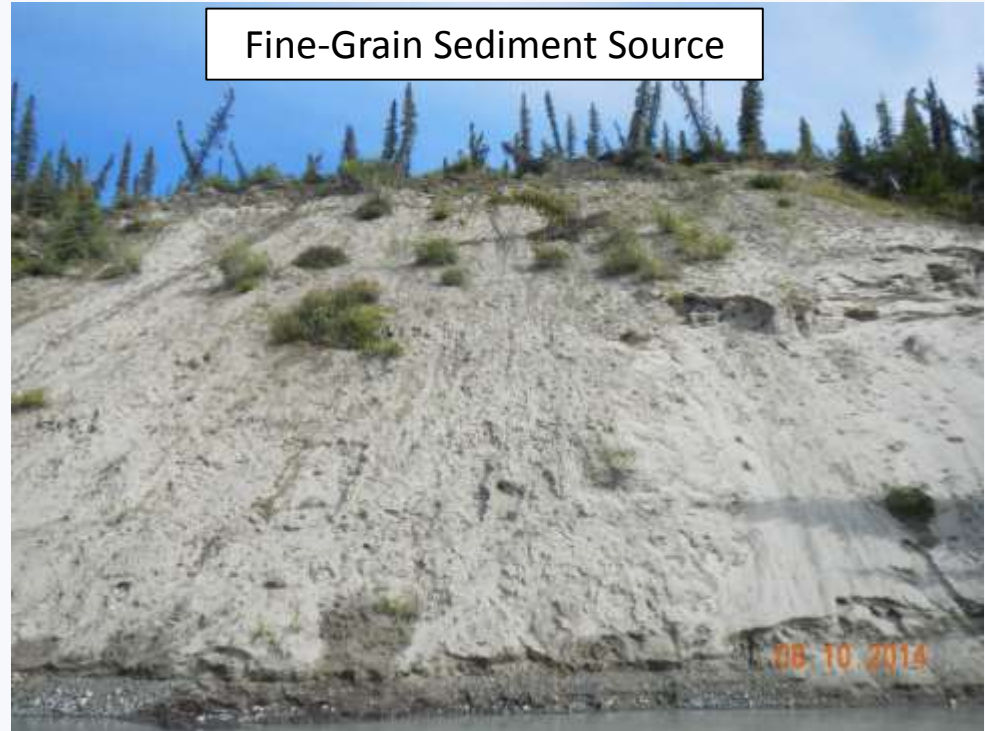
— LRX-35 (1980s) — XS 134.1 (current)

- Changes were on the order of several feet or less
- Most cross sections showed less than 1 foot change in average bed elevation
- The most consistent trend – slight aggradation in MR-7 and MR-8

Study 6.5 Summary of Results since ISR Upper River Reconnaissance



Surface Material on Gravel Bar



Fine-Grain Sediment Source



Sand Dunes

- Geologic and Geomorphic Mapping
- Bed Material Sampling
- Approximate Cross Sections

Study 6.5 Summary of Results since ISR

Geomorphic Drivers in Upper, Middle, and Lower Susitna River Segments

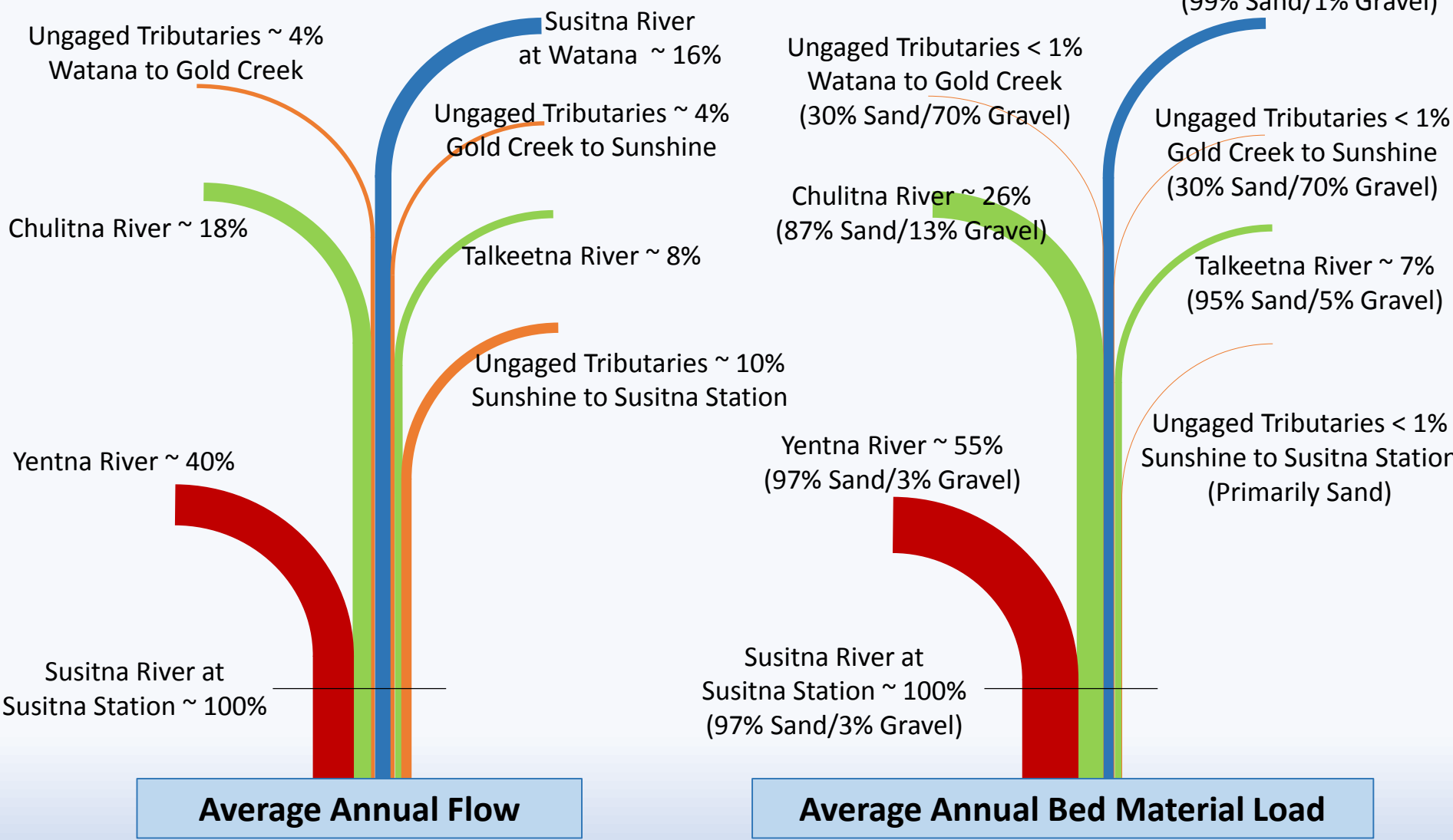


- UPPER RIVER
 - Ice-driven → ice-sheared banks, ice-paved wide channels, boulders on floodplain, very high geomorphic surfaces
- MIDDLE RIVER
 - Ice- and Fluvial-driven → ice chute channels, sheared banks, small boulders & cobbles on floodplain, high geomorphic surfaces
- LOWER RIVER
 - Fluvial Driven → absence of ice scars and deposits on floodplain, geomorphic surface heights typical of fluvial-driven system



Study 6.5 Summary of Results since ISR

Sediment Transport TM



Average Annual Flow

Average Annual Bed Material Load

AEA Proposed Modifications to Study 6.5 in ISR (ISR Part C – Section 7.1.2)

- There are no new modifications proposed for Study 6.5
- All modifications for the 2nd year of study are continuation of variances identified from the 1st year of study

Decision Points from Study Plan (Tech Memos Supporting Decision Point)

- Study 6.5 Tech Memos filed since ISR that support Study 6.6 Decision Point on 1-D Bed Evolution extension below PRM 29.9 (Study 6.6 ISR Part C, Section 7.1.1.1.2)
 - Update of **Sediment-Transport Relationships** and a Revised Sediment Balance for the Middle and Lower Susitna River Segments (ISR Part C, Section 7.2.1.3)
 - Susitna River **Historical Cross Section Comparison** (1980s to Current) (ISR Part C, Section 7.2.1.3)
 - **Mapping of Geomorphic Features and Turnover** within the Middle and Lower Susitna River Segments from 1950s, 1980s, and Current Aerials (ISR Part C Section 7.2.1.4)

Current Status and Steps to Complete Study 6.5 (ISR Study 6.5, Part C – Section 7.1 and 7.2)

Study Component	Completed ISR/2014	Planned 2014/2015
1. Geomorphic Reaches and Characterization	TM and Updated TM, Completed MR and LR Characterization	Complete UR characterization, update MR and LR characterization, final TM
2. Sediment Transport Data Collection	Collected 2012, 2013 and 2014 data, reported 2012 and 2013	<i>Report 2014 data (USGS) – No additional data collection</i>
3. Sediment Supply and Transport	TM and updated TM, sediment balance and transport eq.	Refine tributary MR and LR sediment loading
4. Geomorphic Change Middle and Lower Rivers	TM and Updated TM, 1950s/80s/current geomorphic feature mapping and Turnover	<i>Study component completed – interact with others on results</i>
5. Middle River Macrohabitat vs. Flow	TM and Updated TM (added 100% mapping 1980s/current), acquired aerials 2013 2014	<i>Study component completed – interact with others on results</i>

Current Status and Steps to Complete Study 6.5 (ISR Study 6.5, Part C – Section 7.1 and 7.2)

Study Component	Completed ISR/2014	Planned 2014/2015
6. Recon-Level Assessment of Proj. Effects LR	2 TMs, supported decision to extend 1-D model to PRM 29.9	Perform assessment for scenarios, MBI determination
7. Lower River Macrohabitat vs. Flow	TM, decision not to map additional sites	<i>Study component completed – interact with others on results</i>
8. Reservoir Geomorphology	Initial trap efficiency estimates, selection of tribs., aerial recon	Data and analysis for: tribs and res. erosion, coord study 5.6
9. Large Woody Debris	Appendix in ISR, completed MR and LR data	Mapping in UR, LWD assessment, coord w/ Study 6.6
10. Corridor Stream Crossings	Aerial recon and desktop assessment	Data collection and analysis
11. Integration with Fluvial Geomorphology Modeling Study	Geomorphic context of initial 1-D model runs, support LR decision pt.	Interpret results of 1-D and 2-D model runs as they become available

Licensing Participants Proposed Modifications to Study 6.5?

- Agencies
- CIRWG members and Ahtna
- Public