

East Fork Lewis River Ridgefield Pits Restoration Design Study: Data Collection and Model Review

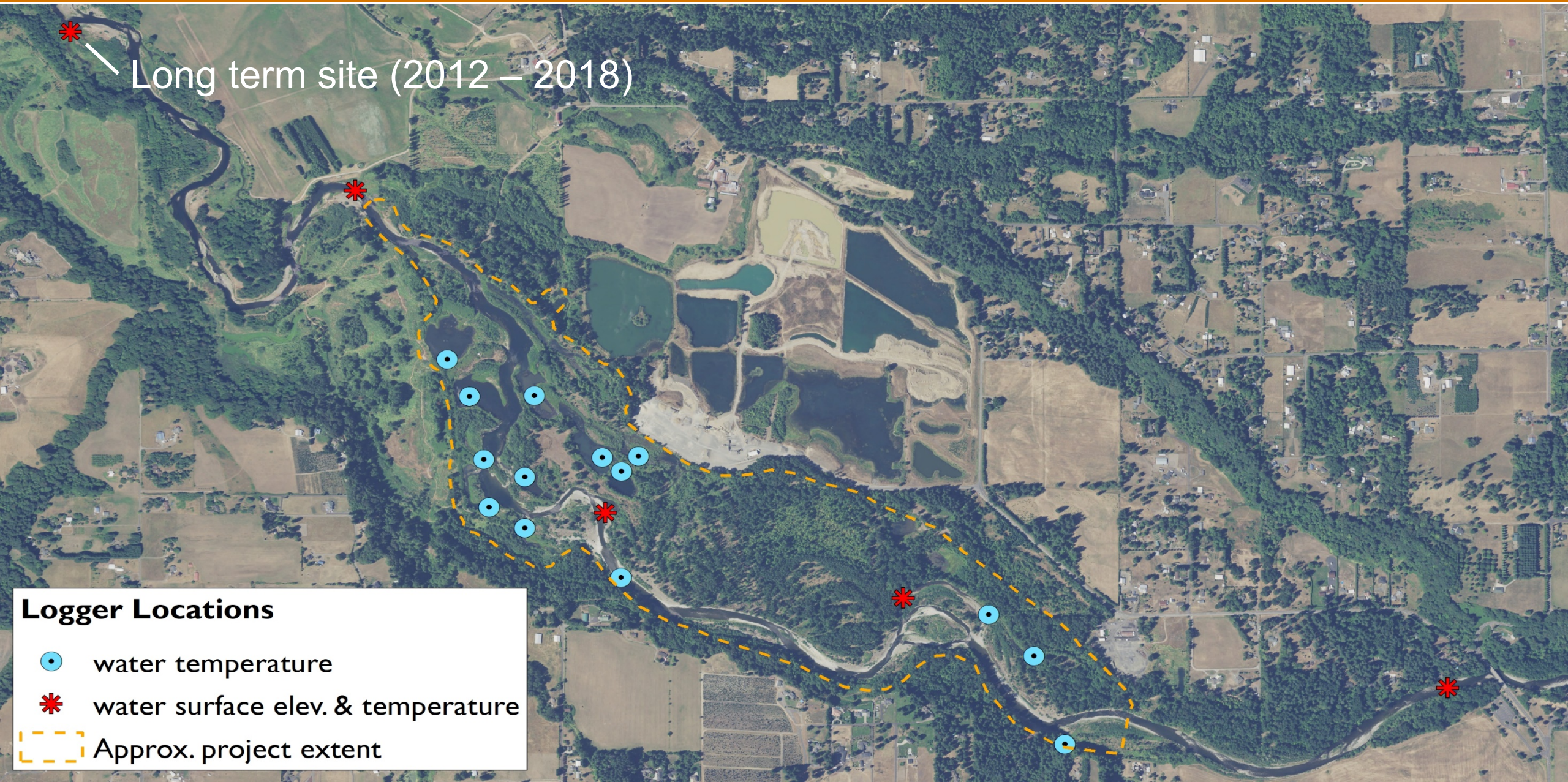


Data Collection Summary

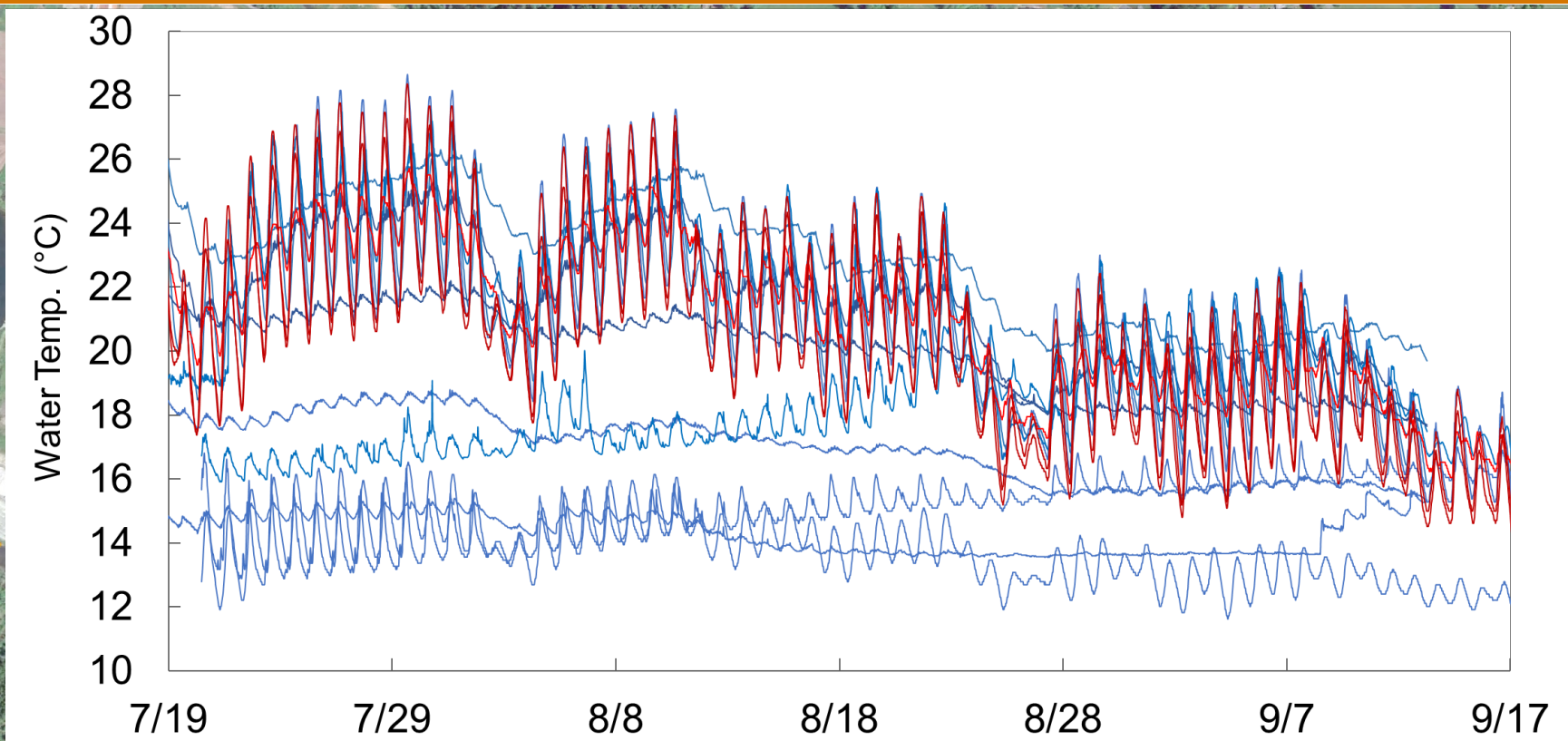
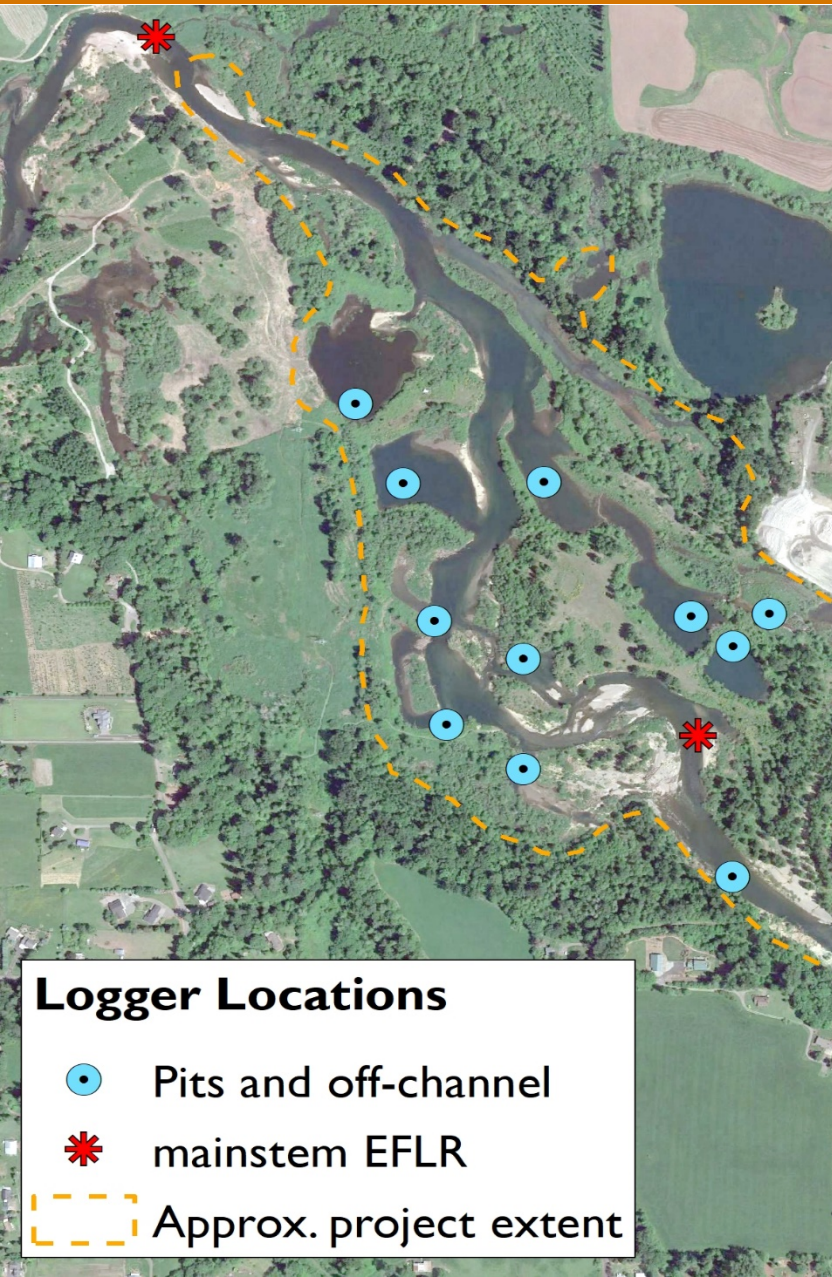
- ▶ Water Elevation & Temperature
 - LCEP/Clark Co. 2018
 - Informs hydro/water quality modeling
- ▶ Sediment Sampling
 - Interfluve/LCEP 2018
 - Informs geomorph assessment and model
- ▶ Bathymetric and Topographic Survey
 - Interfluve 2018
 - Informs hydro/geomorphic models and geomorphic assessment



Water Elevation and Temperature (2018)



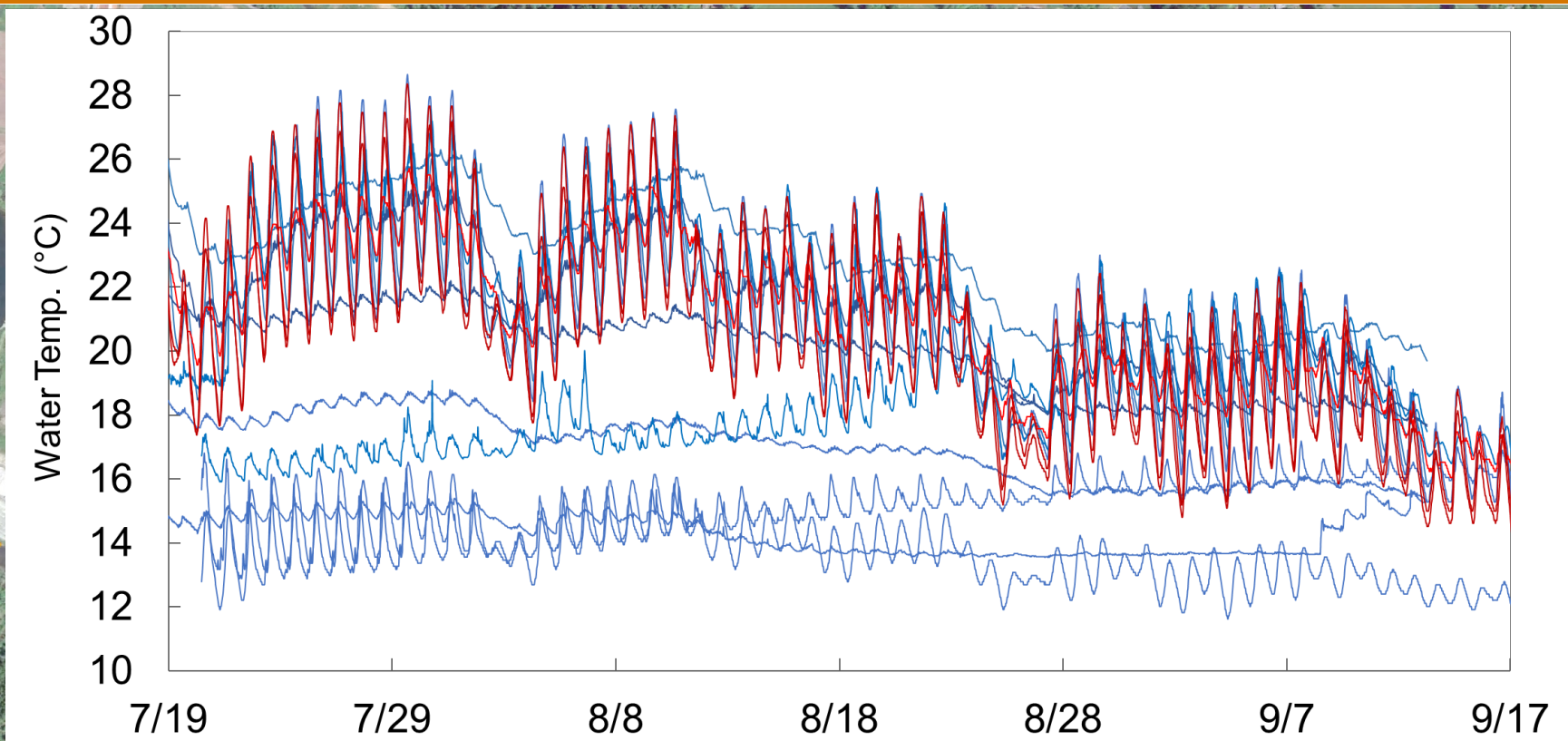
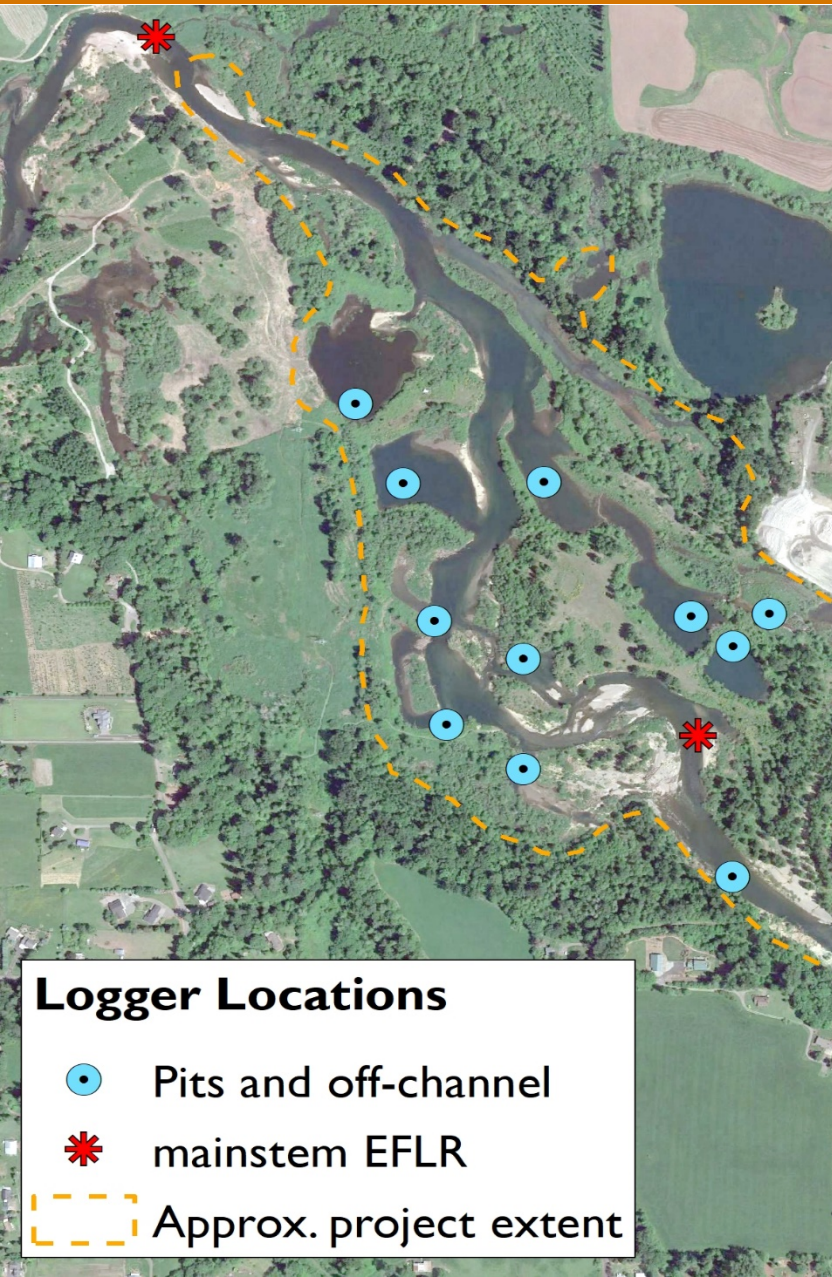
Water Temperature (2018)



Logger Locations

- Pits and off-channel
- * mainstem EFLR
- - - Approx. project extent

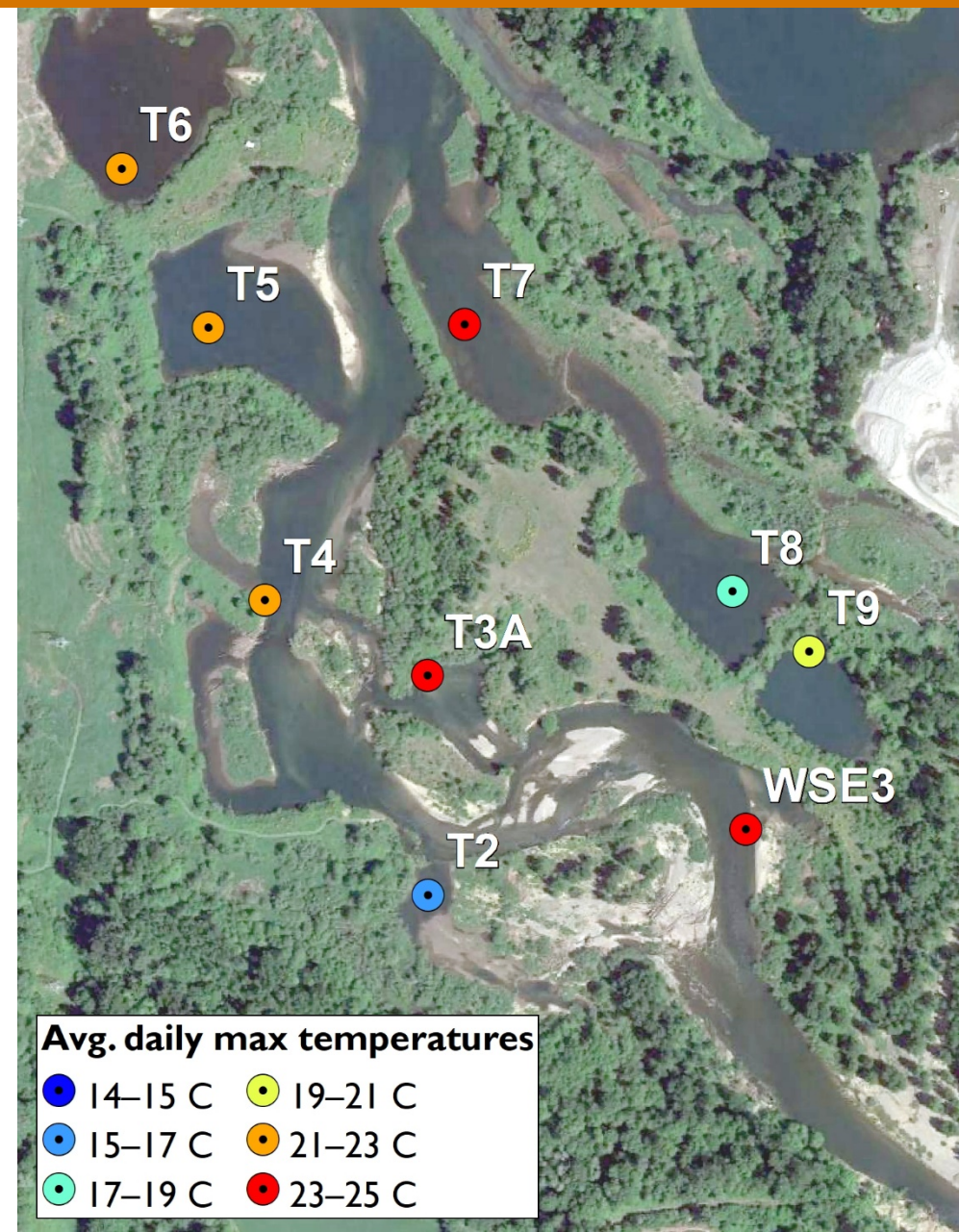
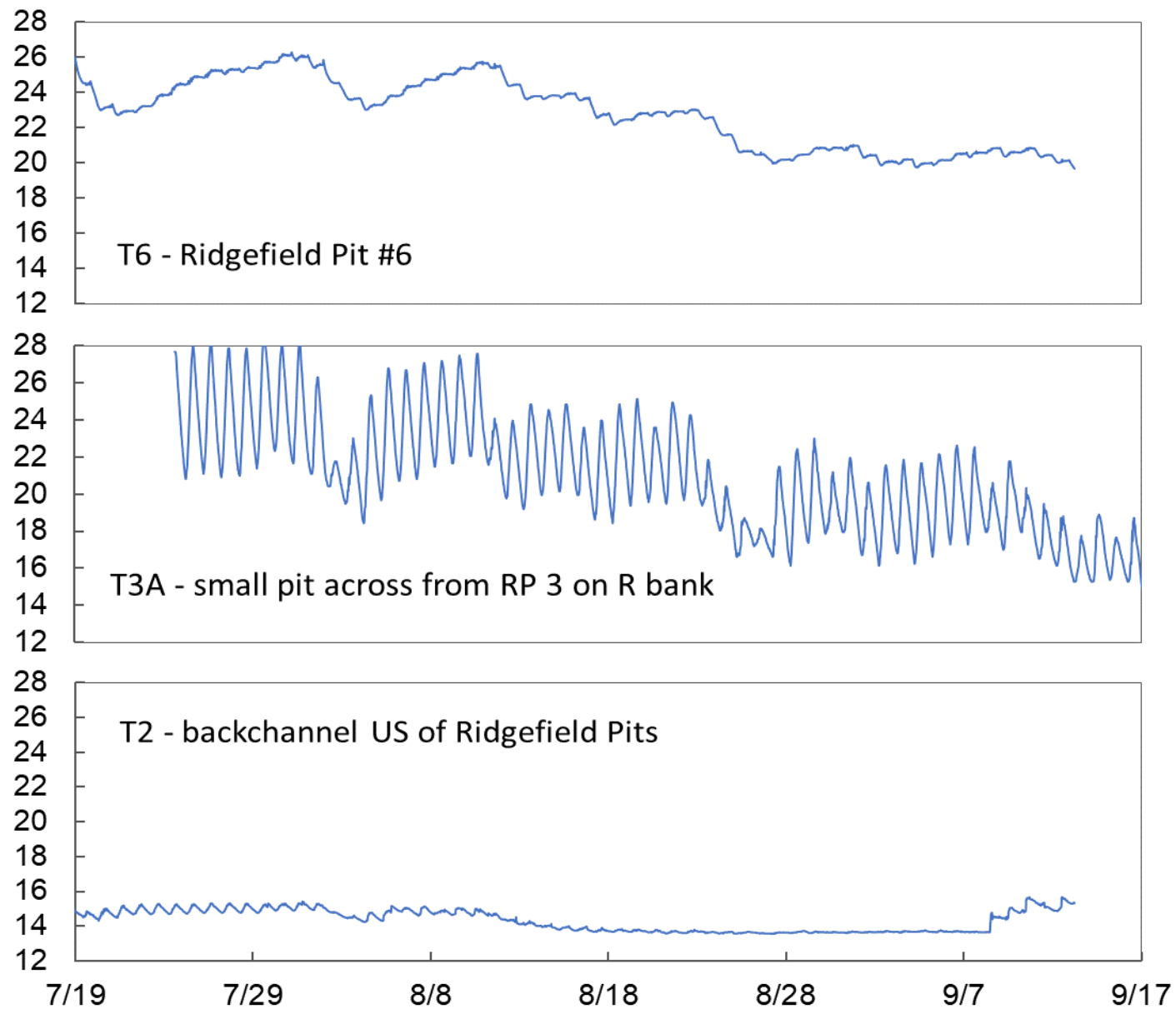
Water Temperature (2018)



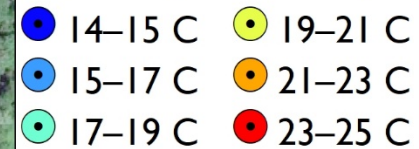
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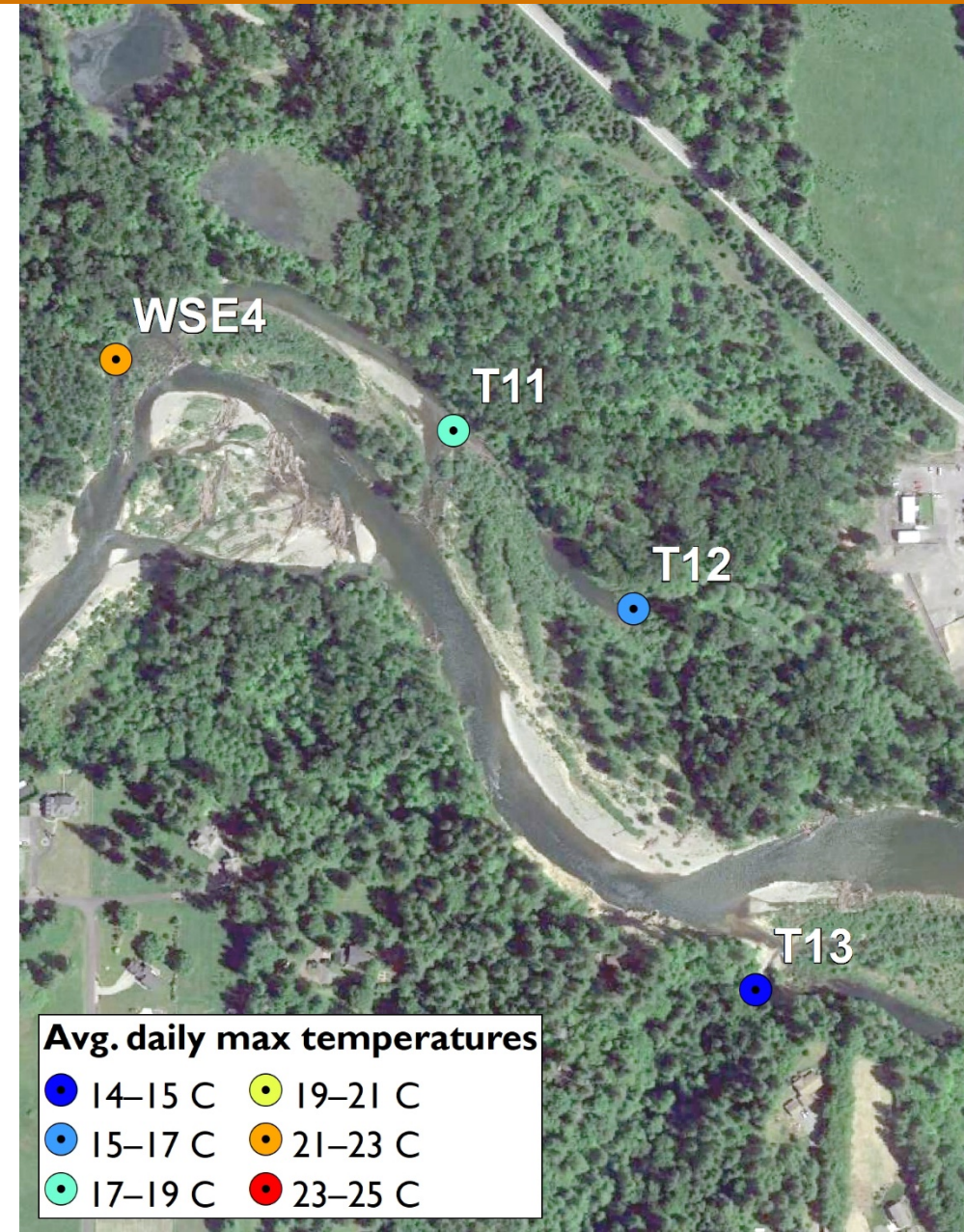
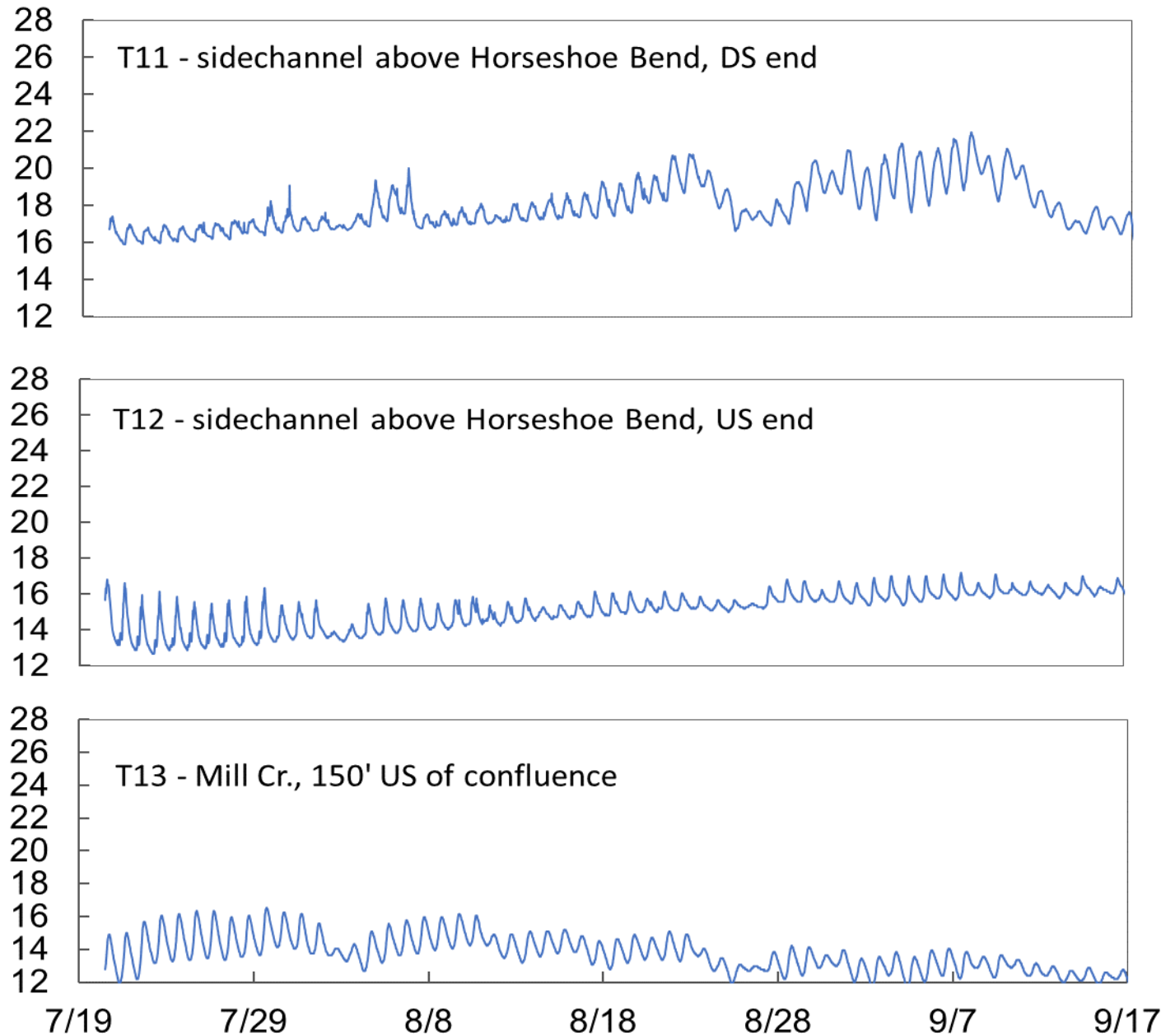
Water Temperature (2018)



Avg. daily max temperatures



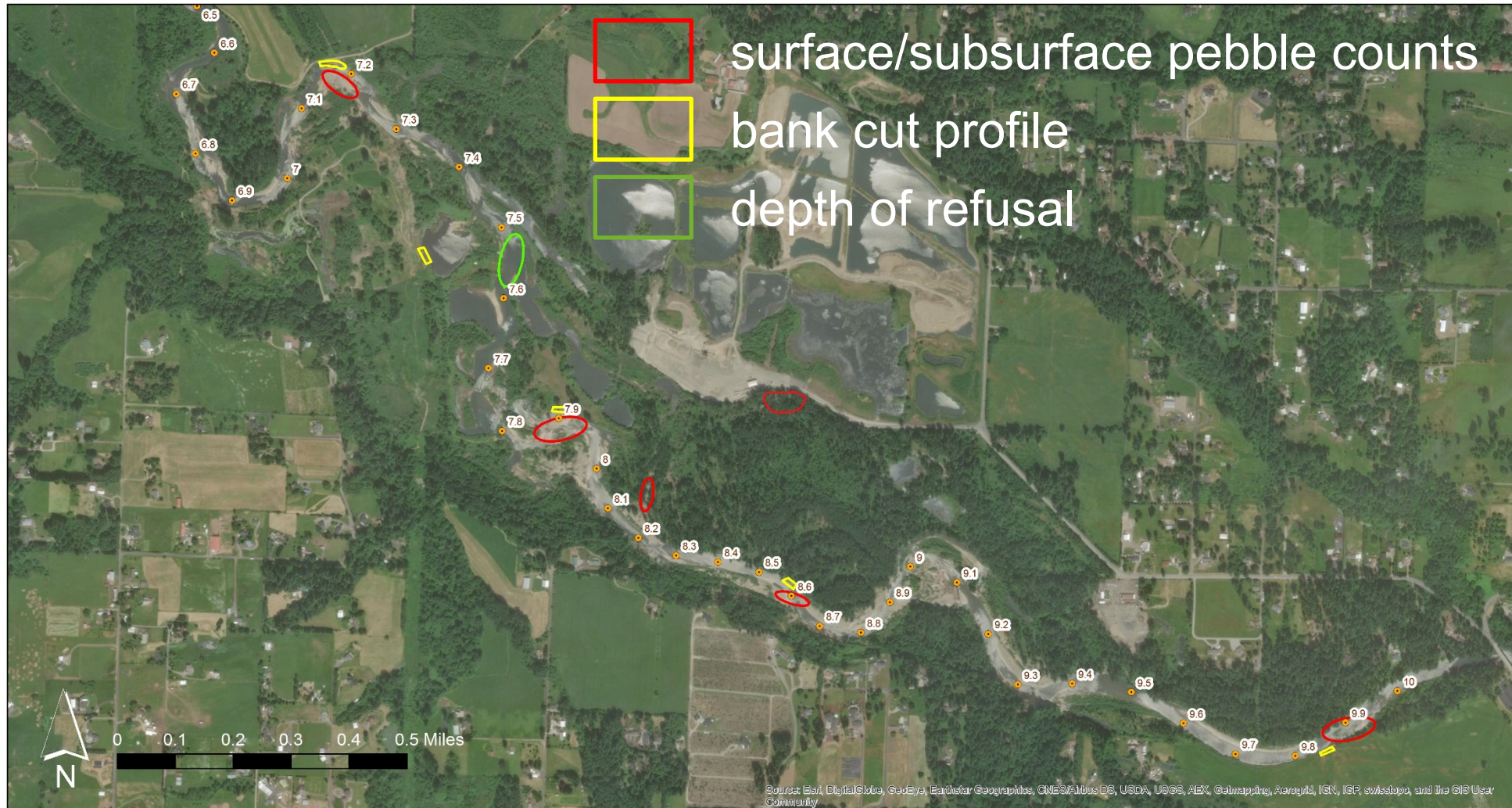
Water Elevation and Temperature (2018)



Avg. daily max temperatures



Sediment Sampling Plan (2018)



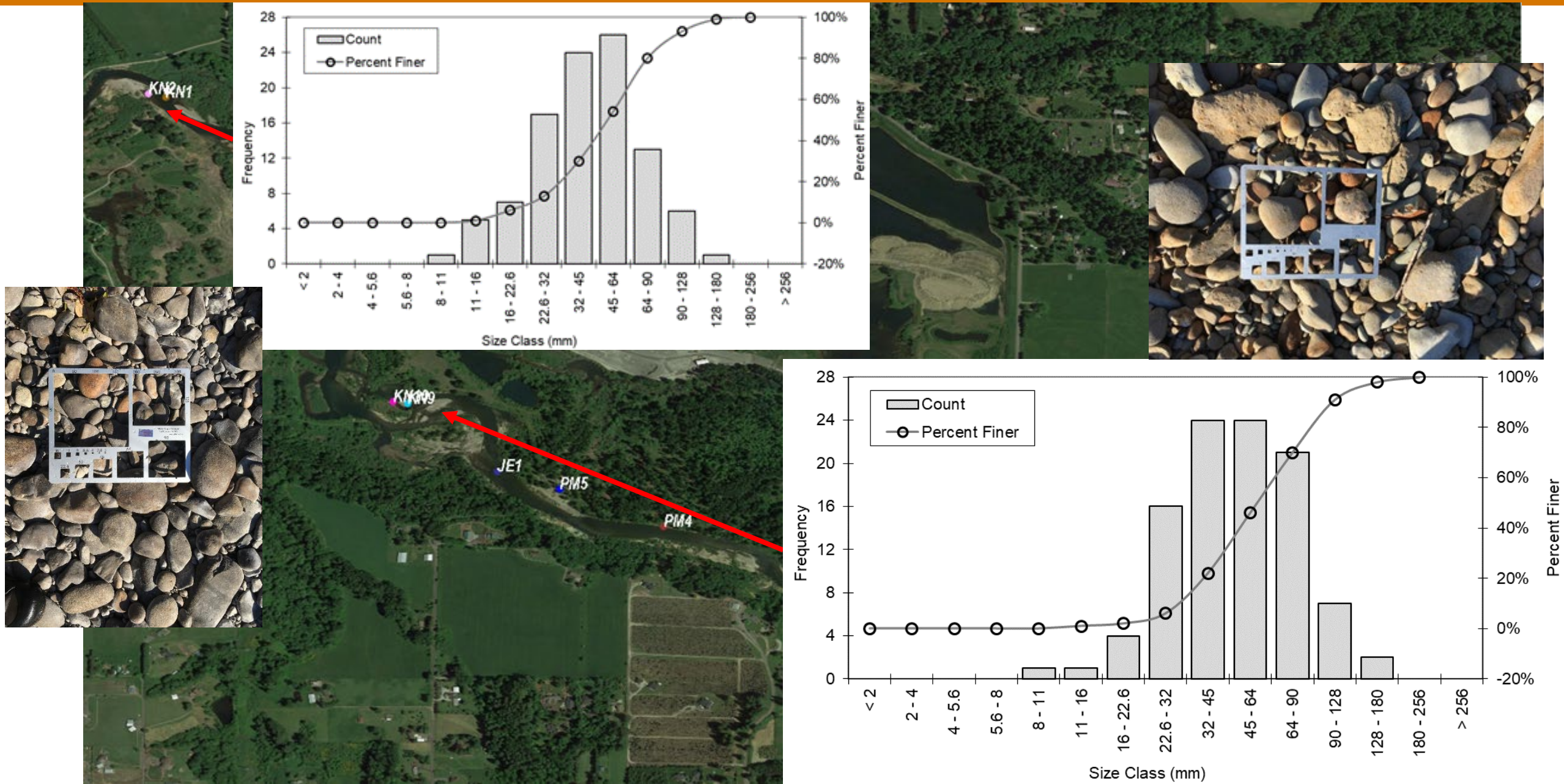
**EF Lewis Ridgefield Pits
Sediment Sampling Plan**
Created Oct 2018

Type

- ▭ Surface and subsurface pebble counts
- ▭ Bank cut profile (descriptive)
- ▭ Surface characterization and depth of refusal

Surface samples to be collected using pebble counts on transects across the active channel. Subsurface counts to be done by removing the surface layer at a representative sampling location and performing pebble counts on the subsurface material as described in Buffington (1996) as cited and described in Bunte and Abt (2001).

Sediment Sampling – Bed Material (Surface/Armoring)

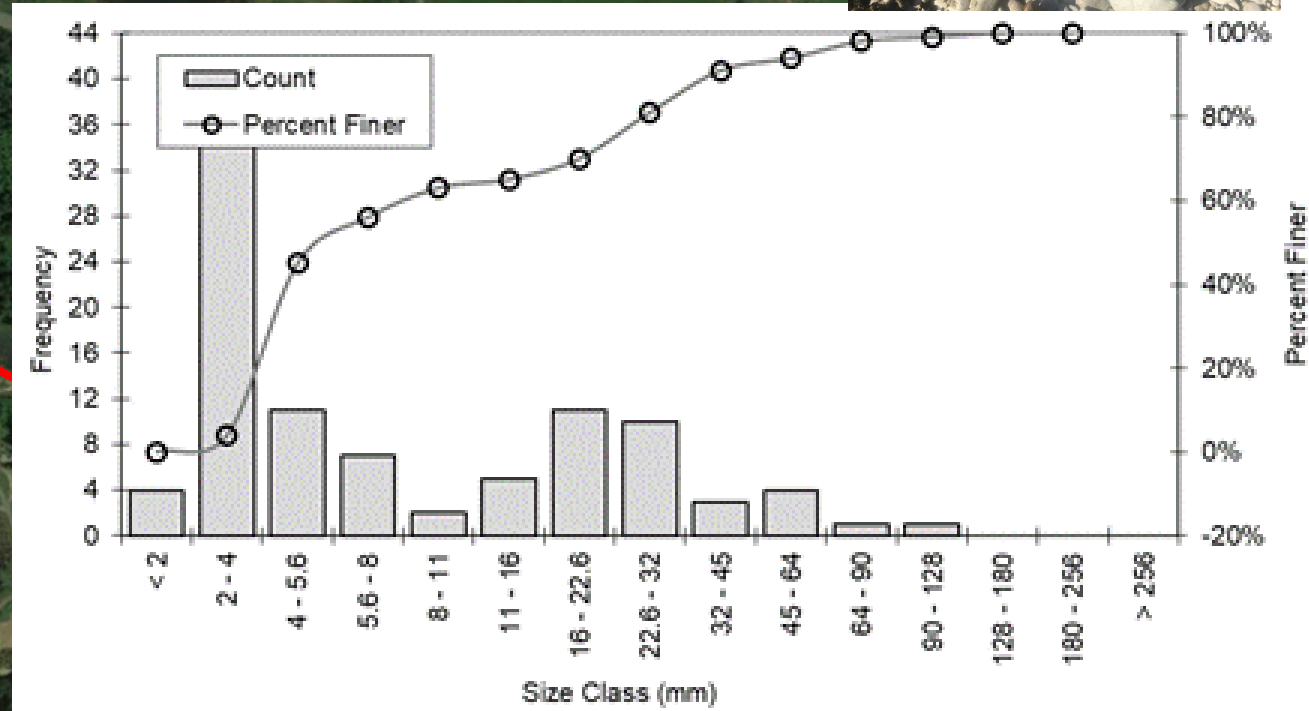
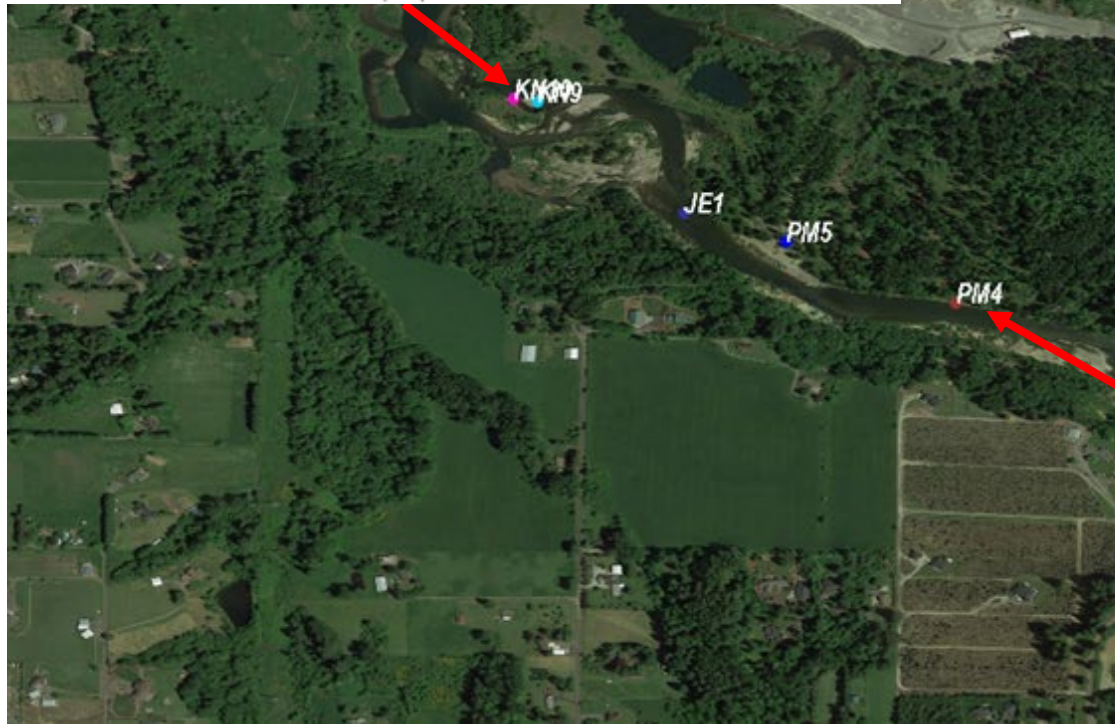
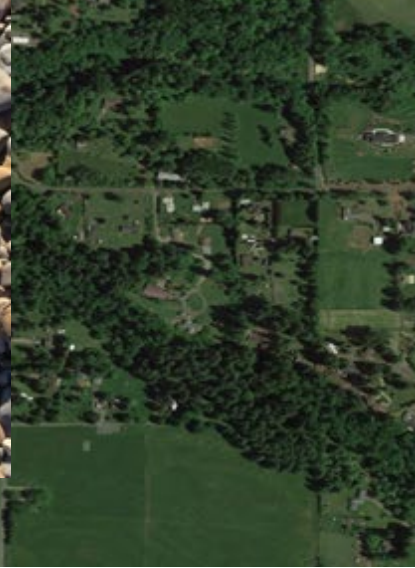
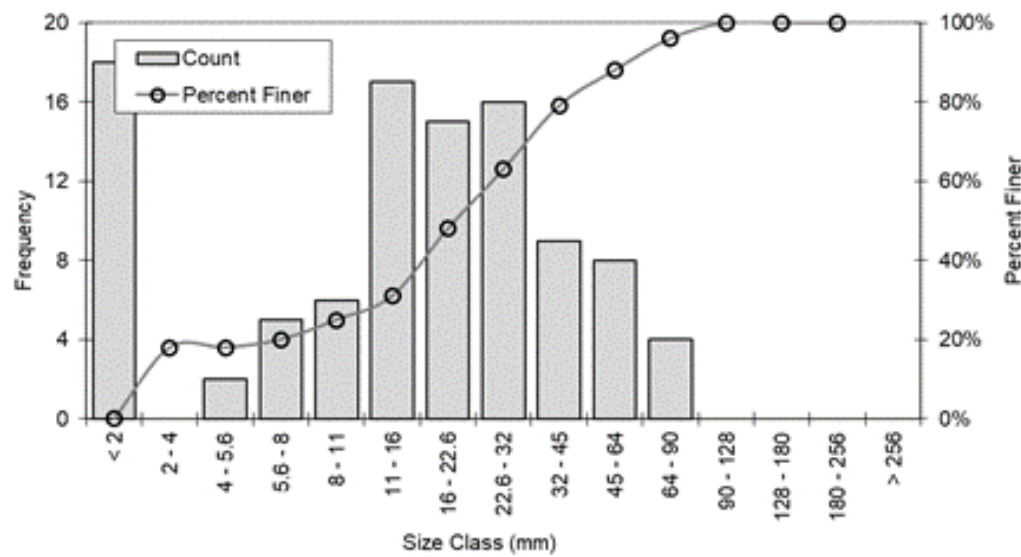


Sediment Sampling – Bed Material (Surface/Armoring)

- **Relatively consistent size distribution throughout the study area**
- D10 $\approx$ 20mm Coarse Gravel
- D50 $\approx$ 50mm Very Coarse Gravel
- D84 $\approx$ 100mm Cobble



Sediment Sampling – Bed Material (Subsurface)



Sediment Sampling – Bed Material (Subsurface)

- **Two peaks in grain size, i.e. mixture of:**
 1. Coarse components: Gravel/Cobble, ~ same as river bed
 2. Fine components: Sands, even silts (2mm and less)

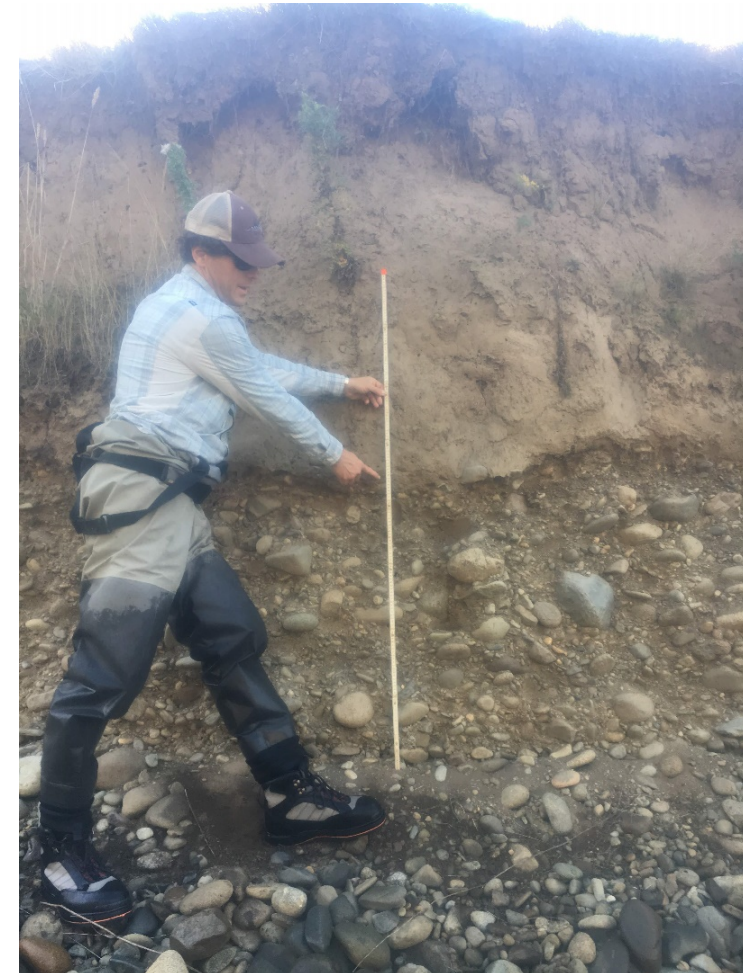


Sediment Sampling – Vertical Bank Profile

Type 1: Single layer of mixed sand, gravel, cobble. Forested floodplains.

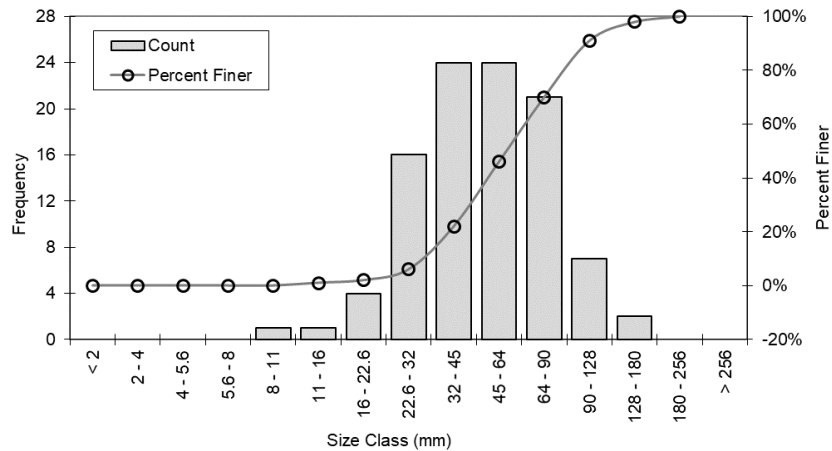


Type 2: Two layer structure with thick sand/silt layer over the Type 1 layer. More dominant.

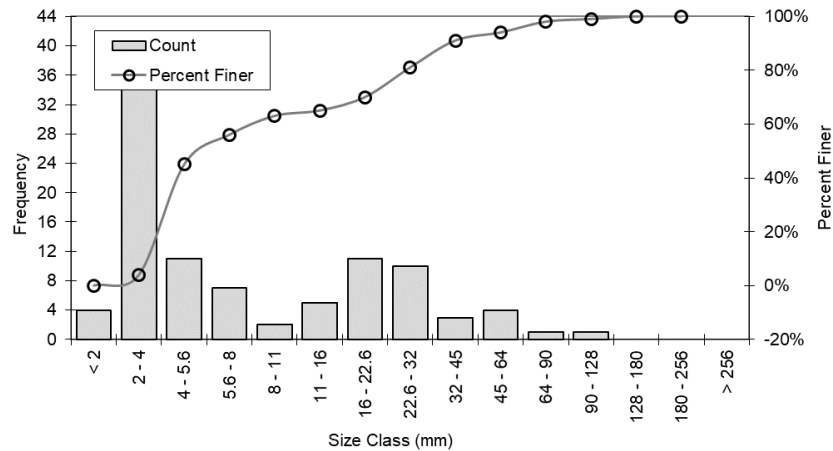


Proposed Sediment Parameters for Modeling

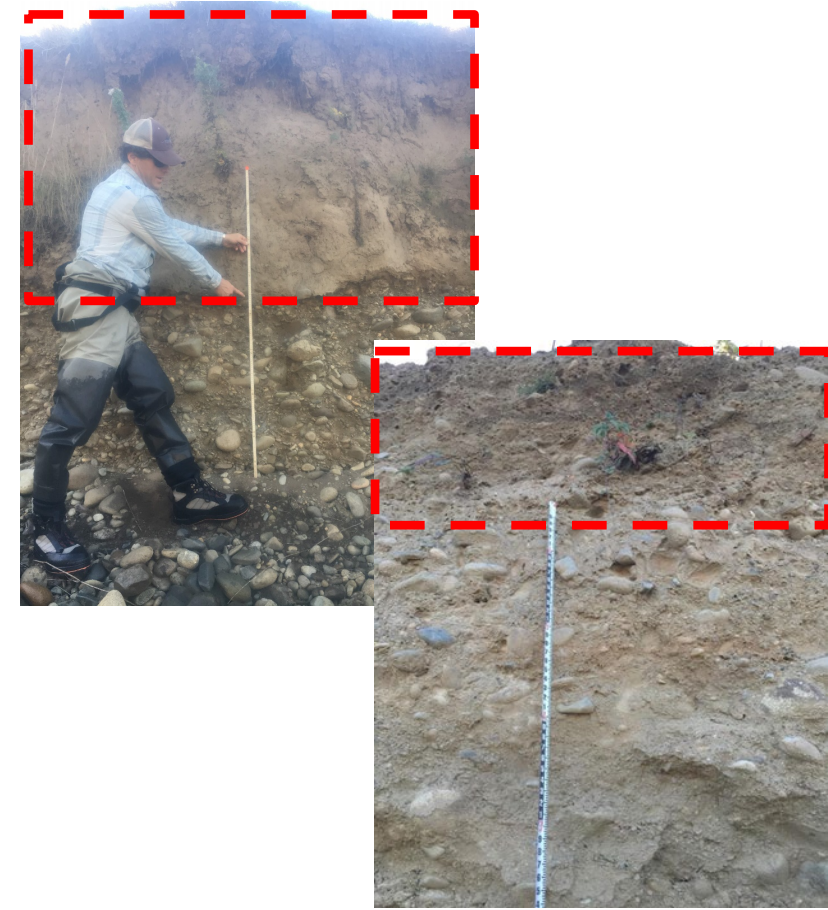
Sediment Type A: bed surface layer



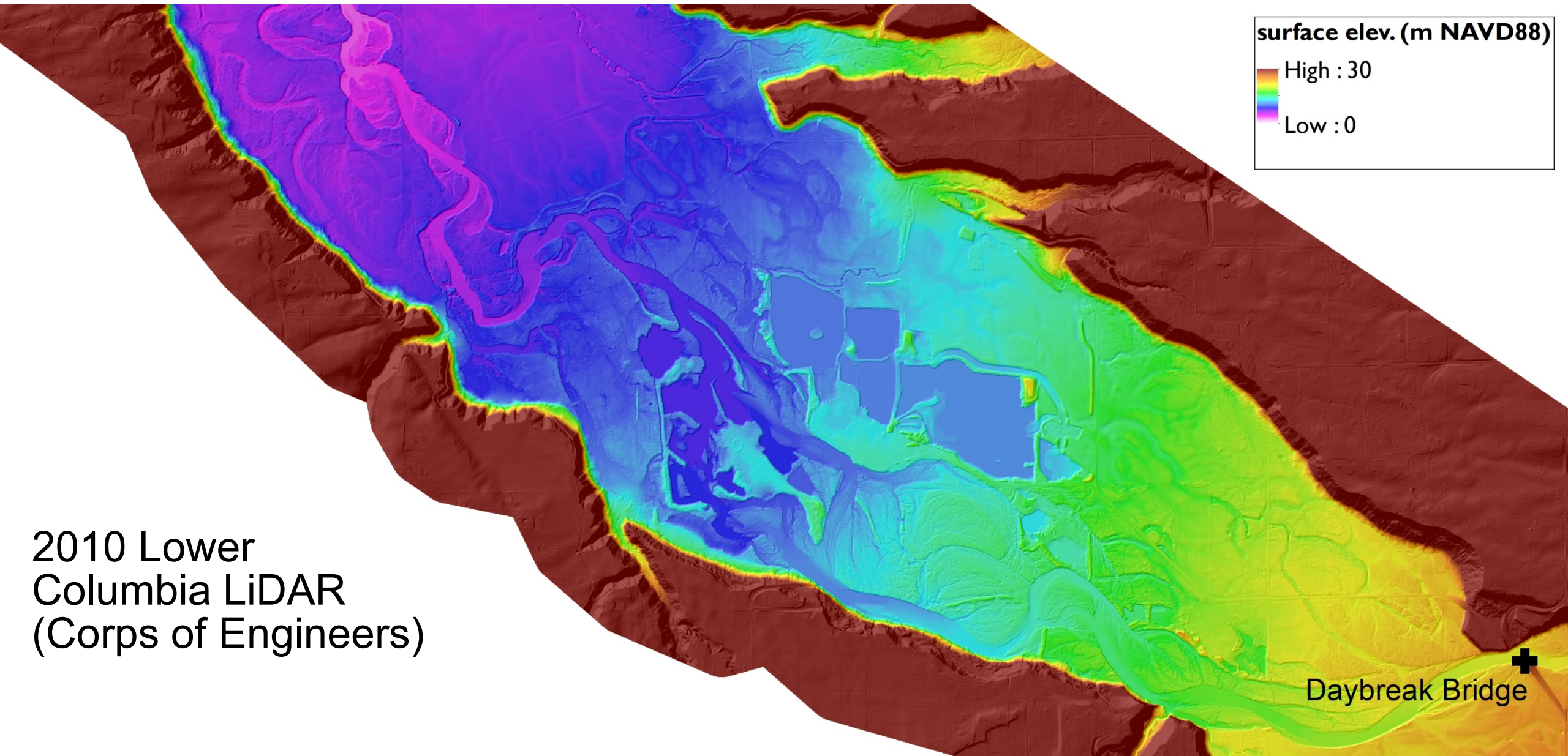
Sediment Type B: bed sublayer, forested floodplain



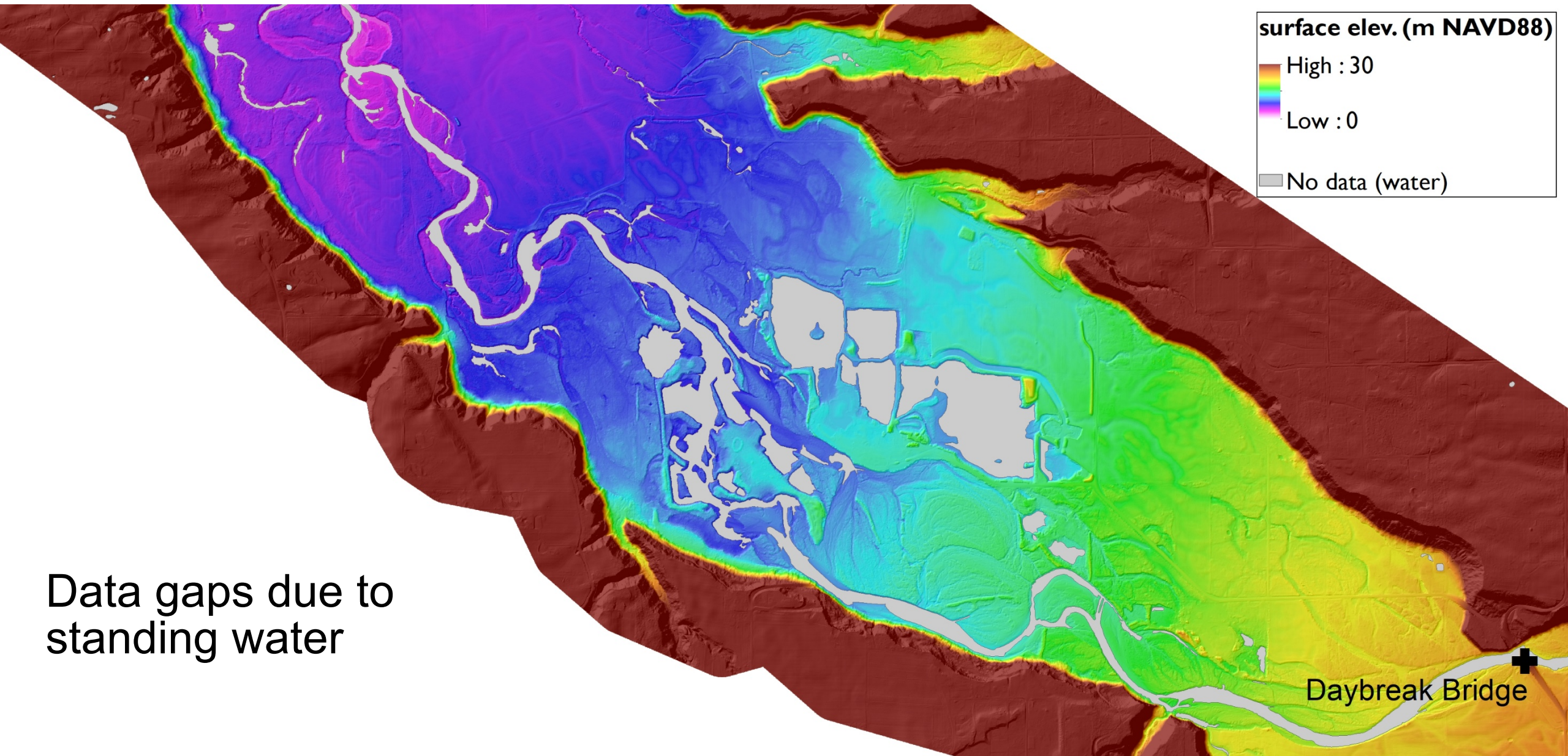
Sediment Type C: Bank top layer, uniform size of 1 or 2 mm



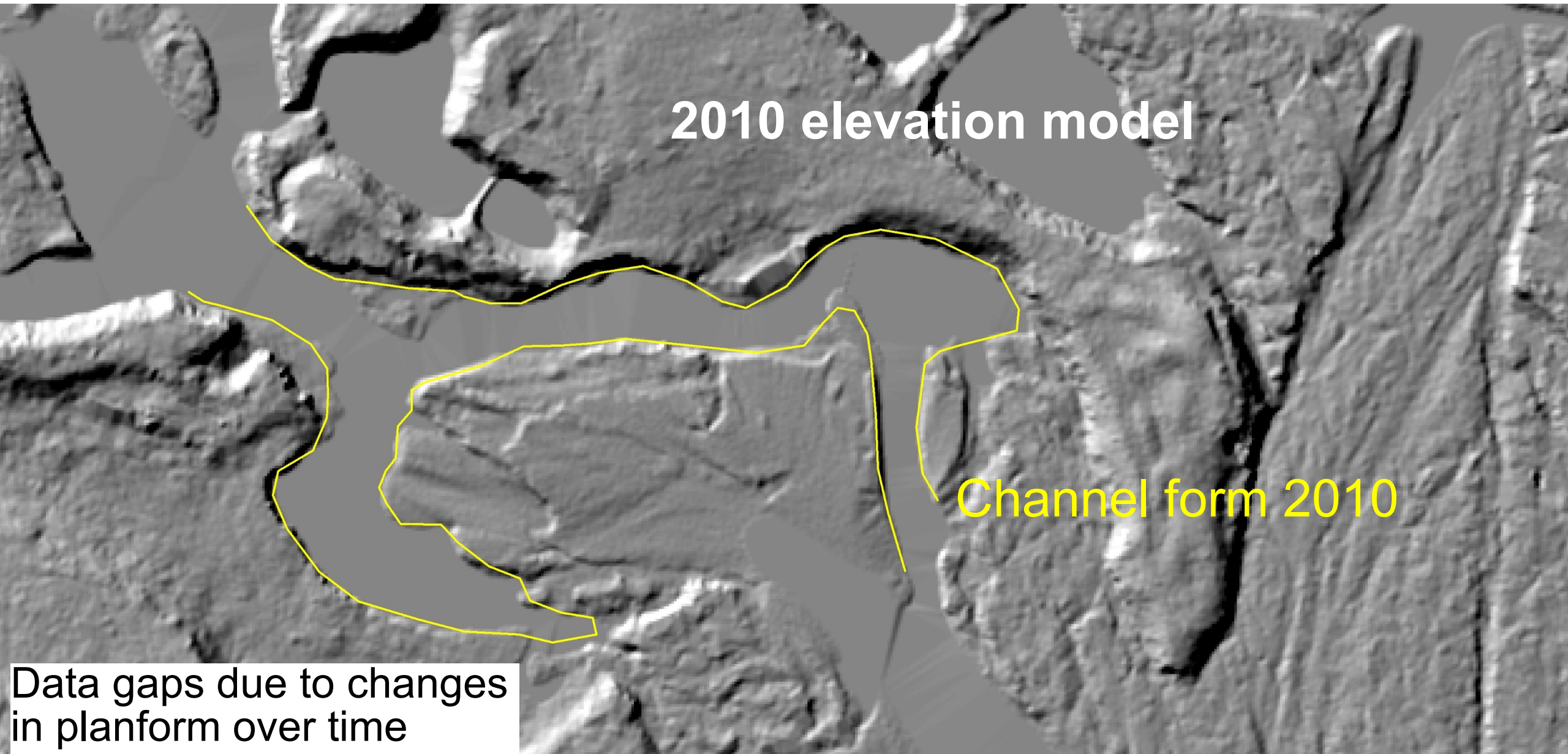
Elevation Model: Primary Source Data



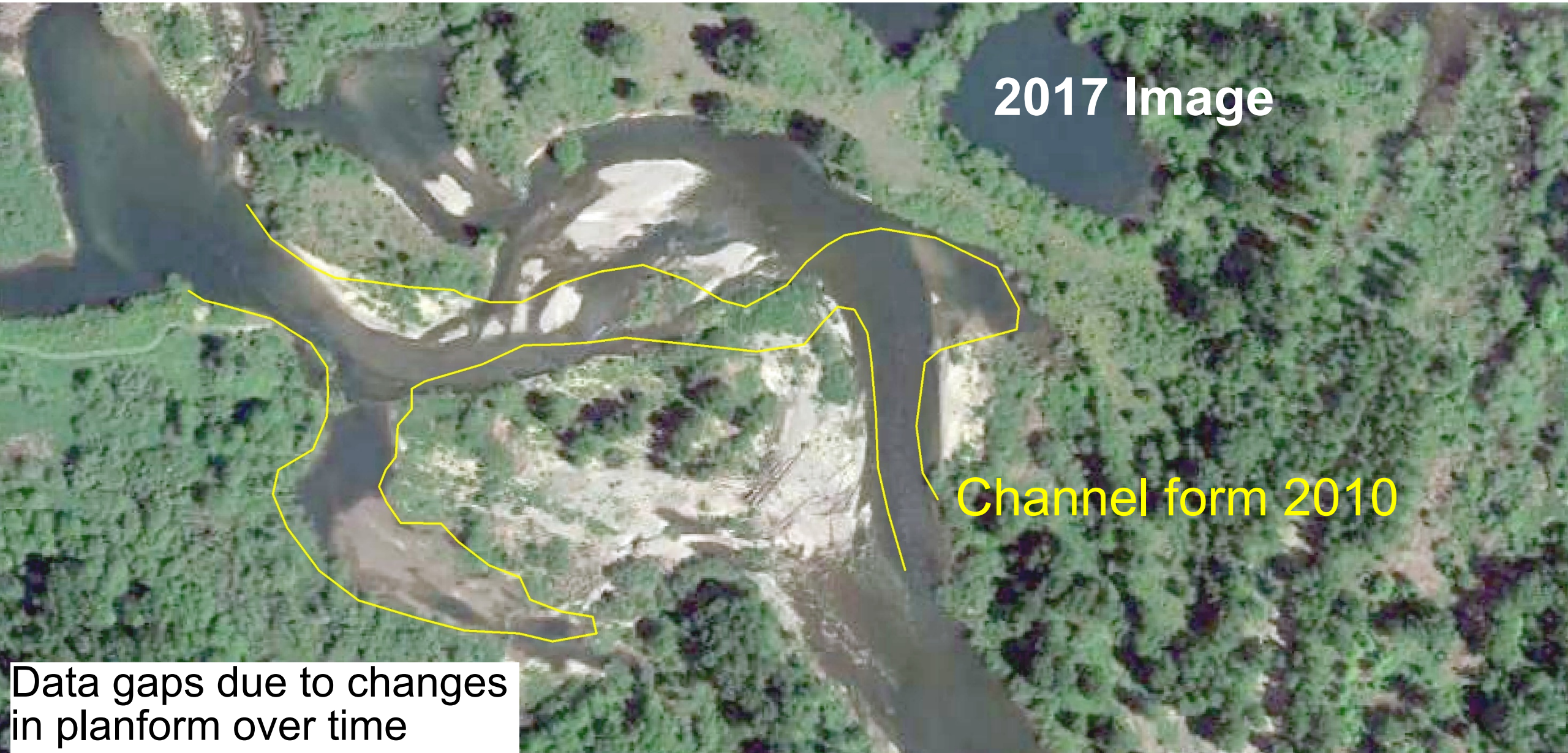
Elevation Model: Primary Data Source



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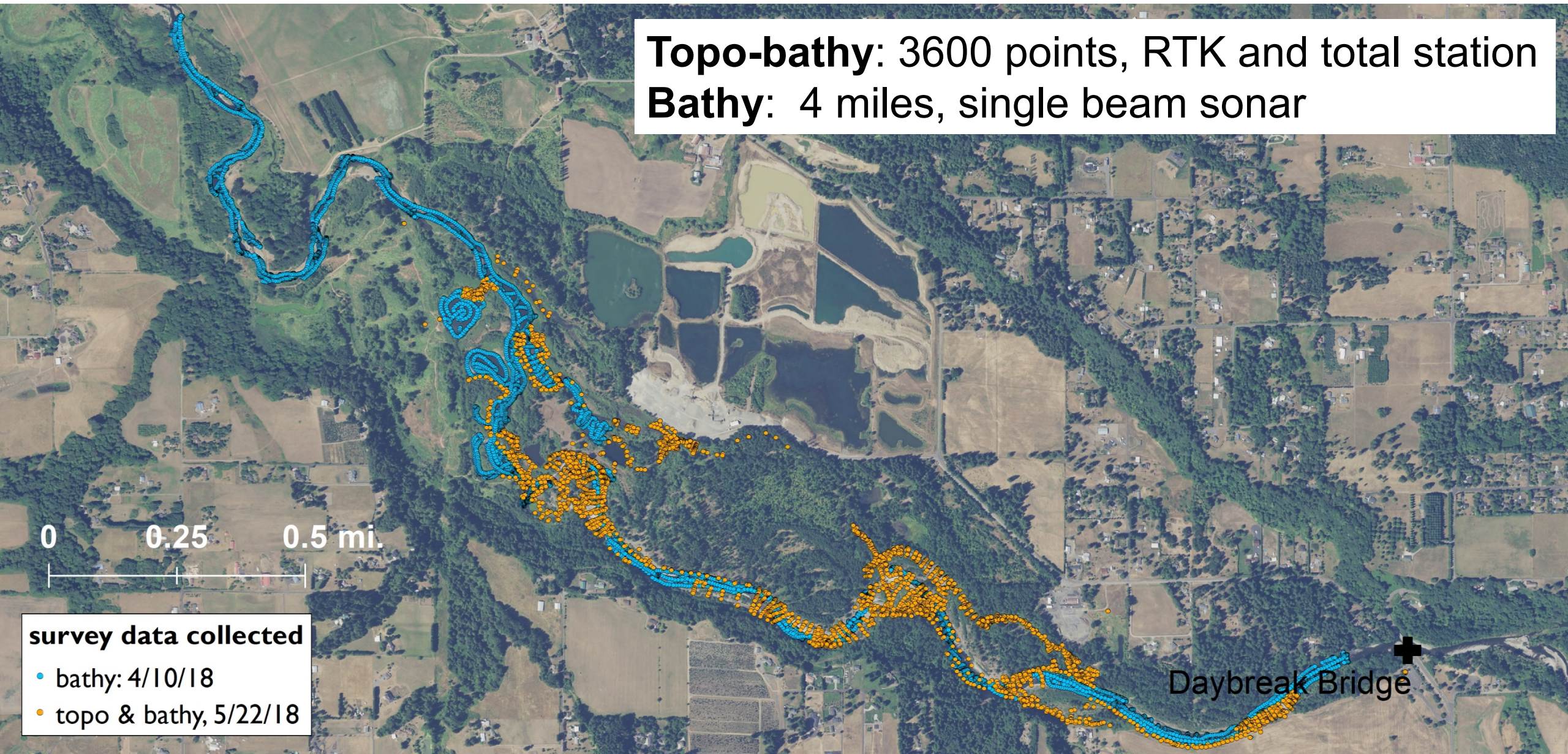


Elevation Model: Primary Data Source

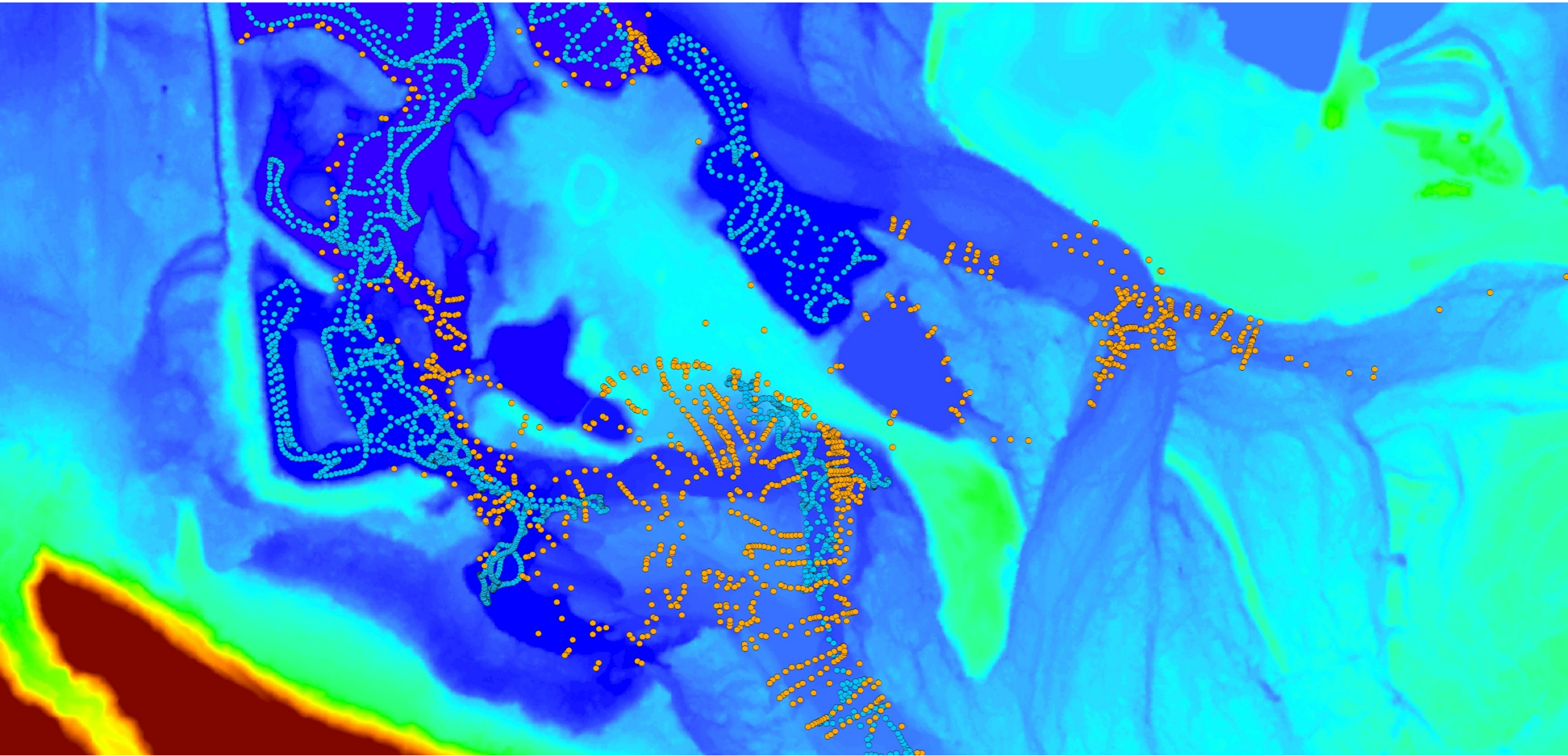


Bathymetric and Topographic Survey (2018)

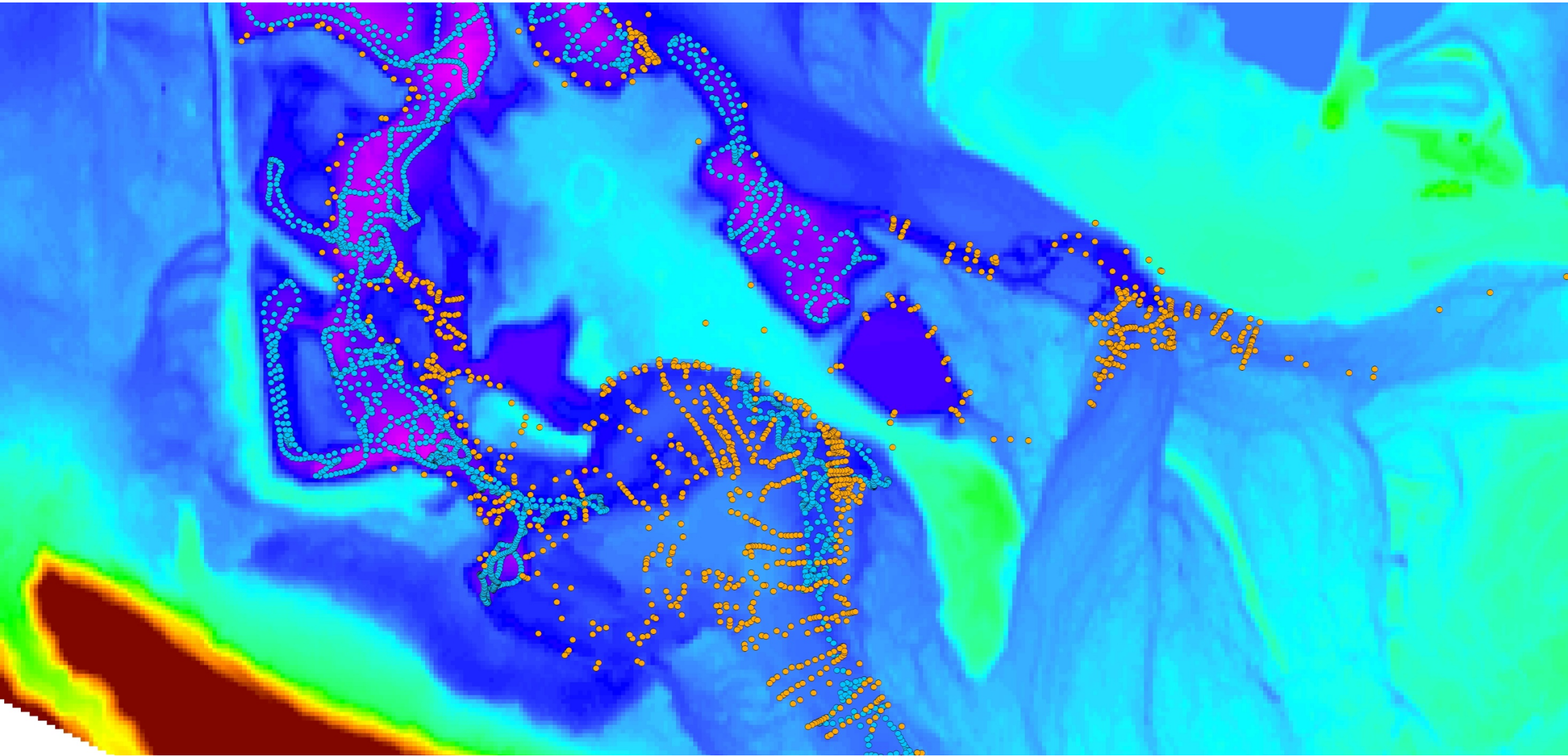
Topo-bathy: 3600 points, RTK and total station
Bathy: 4 miles, single beam sonar



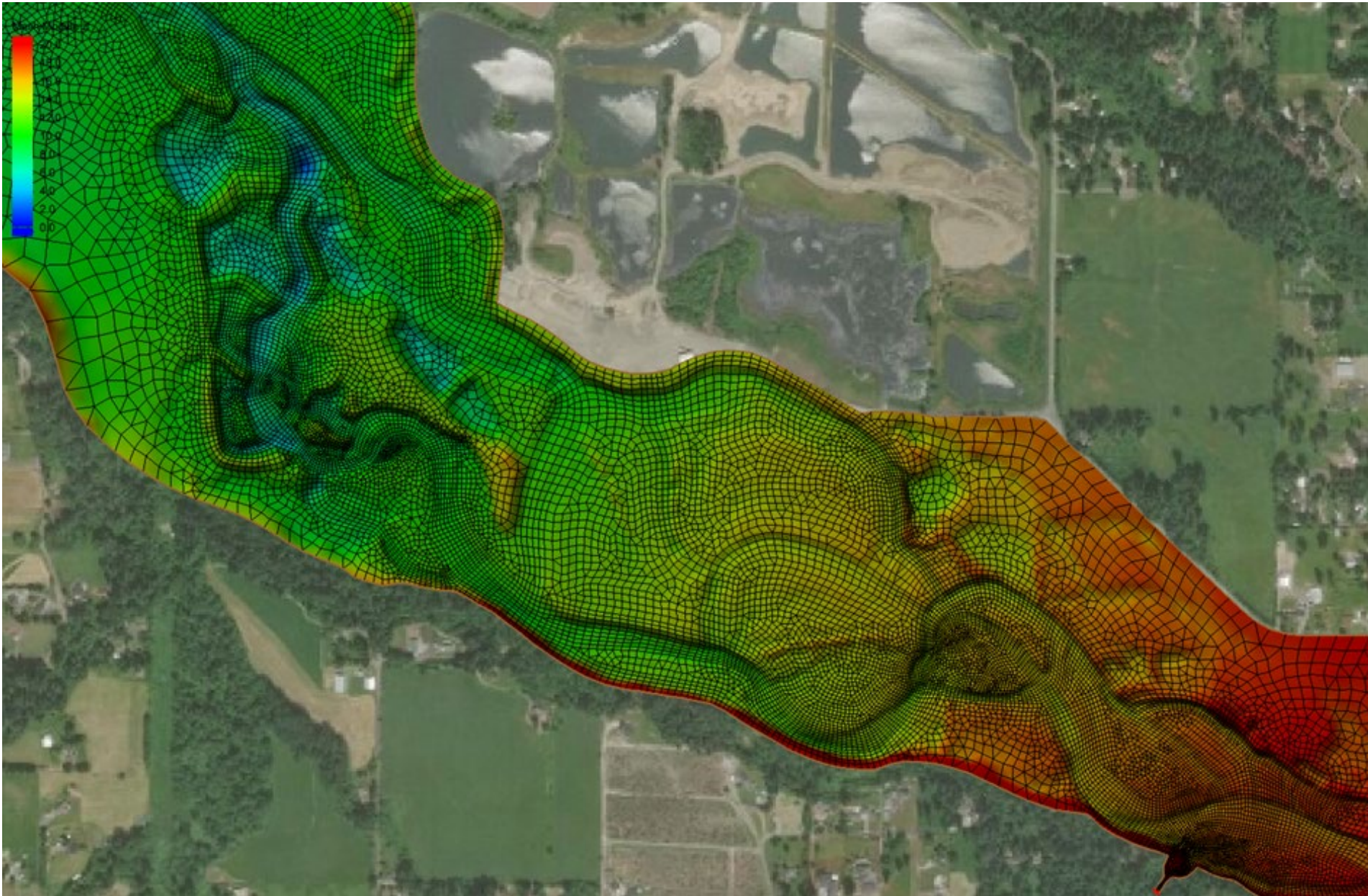
Elevation Model: pre-survey



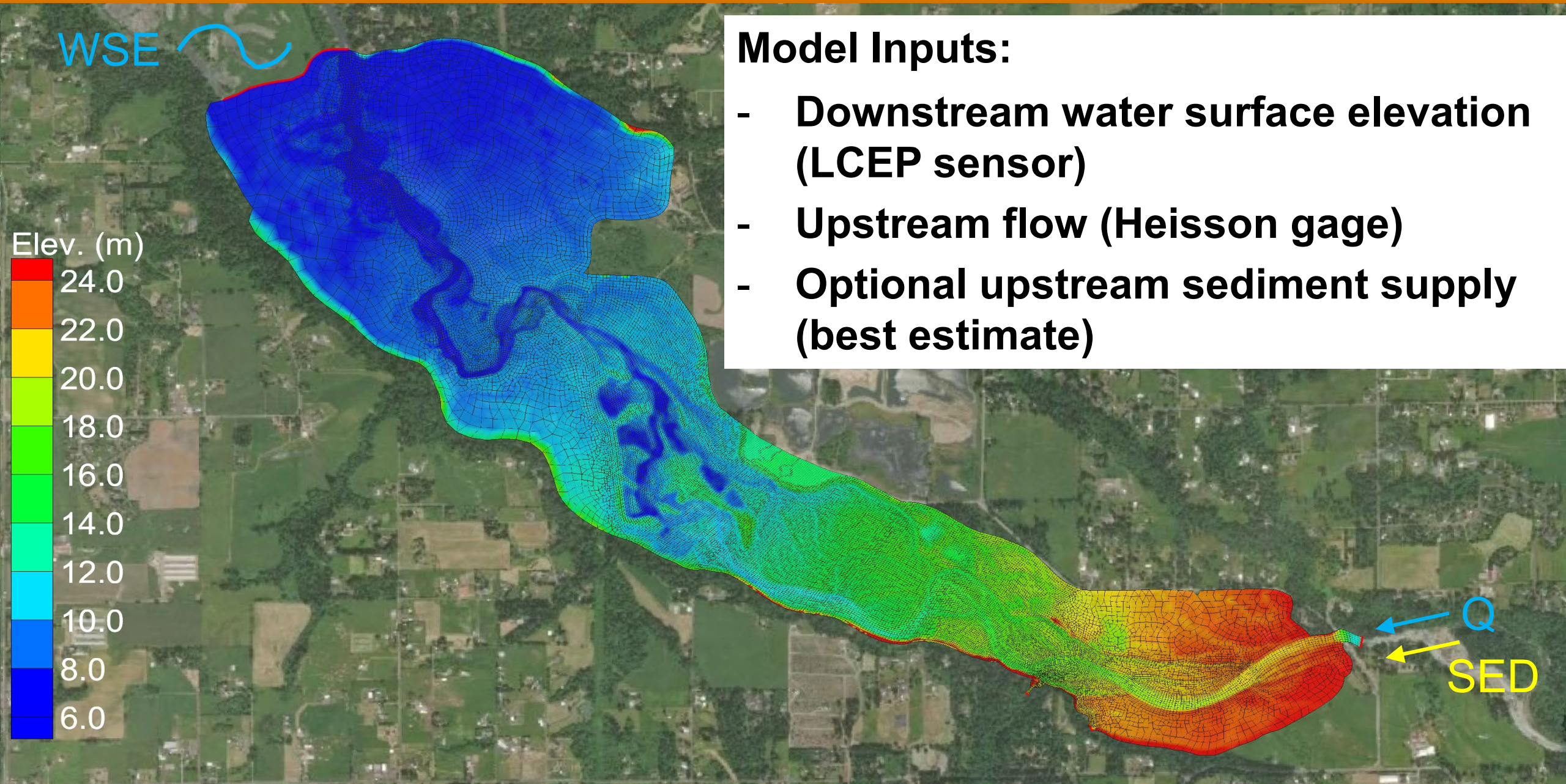
Elevation Model: post survey



Hydro/Morpho-dynamic 2D Model: surface



Hydro/Morpho-dynamic 2D Model: model extent & drivers



Flood Frequency Analysis, EFLR

Table 3-3. Flood-frequency values determined for E.F. Lewis River at Proposed Project site.

Probability of Exceedance (%)	Recurrence Interval (yrs)	Discharge (cfs)
50	2	11,200
20	5	15,800
10	10	18,800
4	25	22,800
2	50	26,000
1	100	29,300
0.2	500	37,200

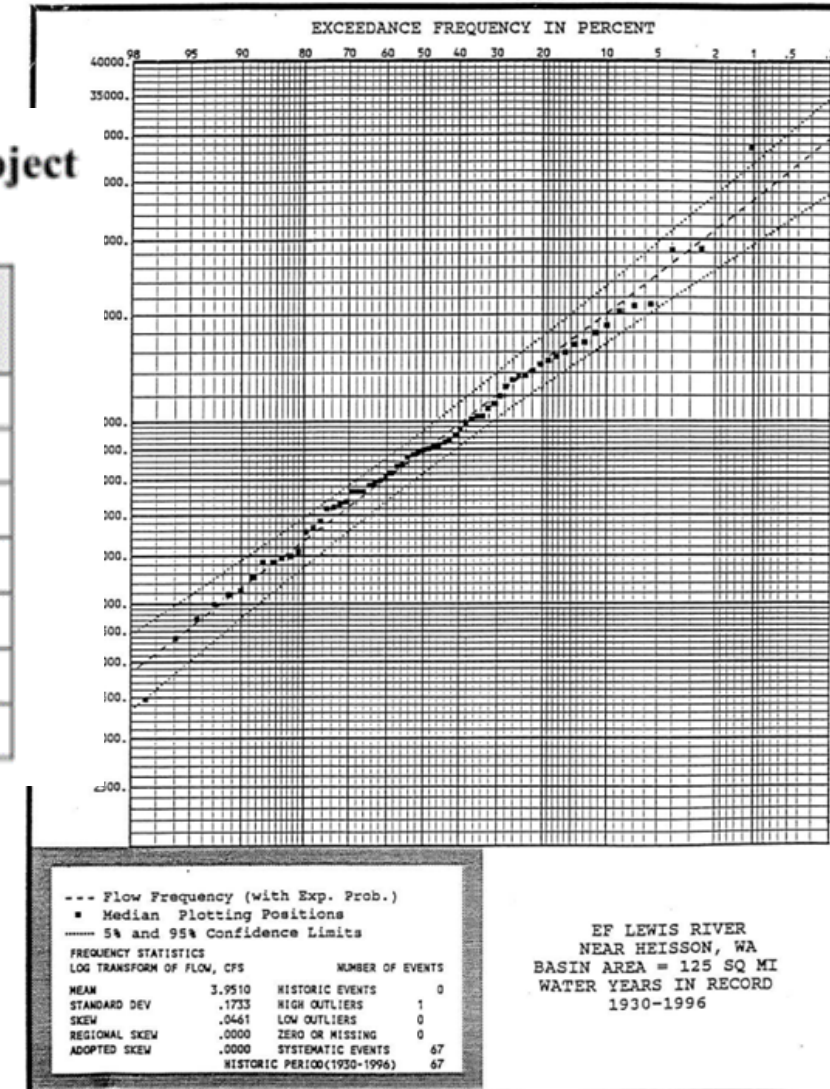
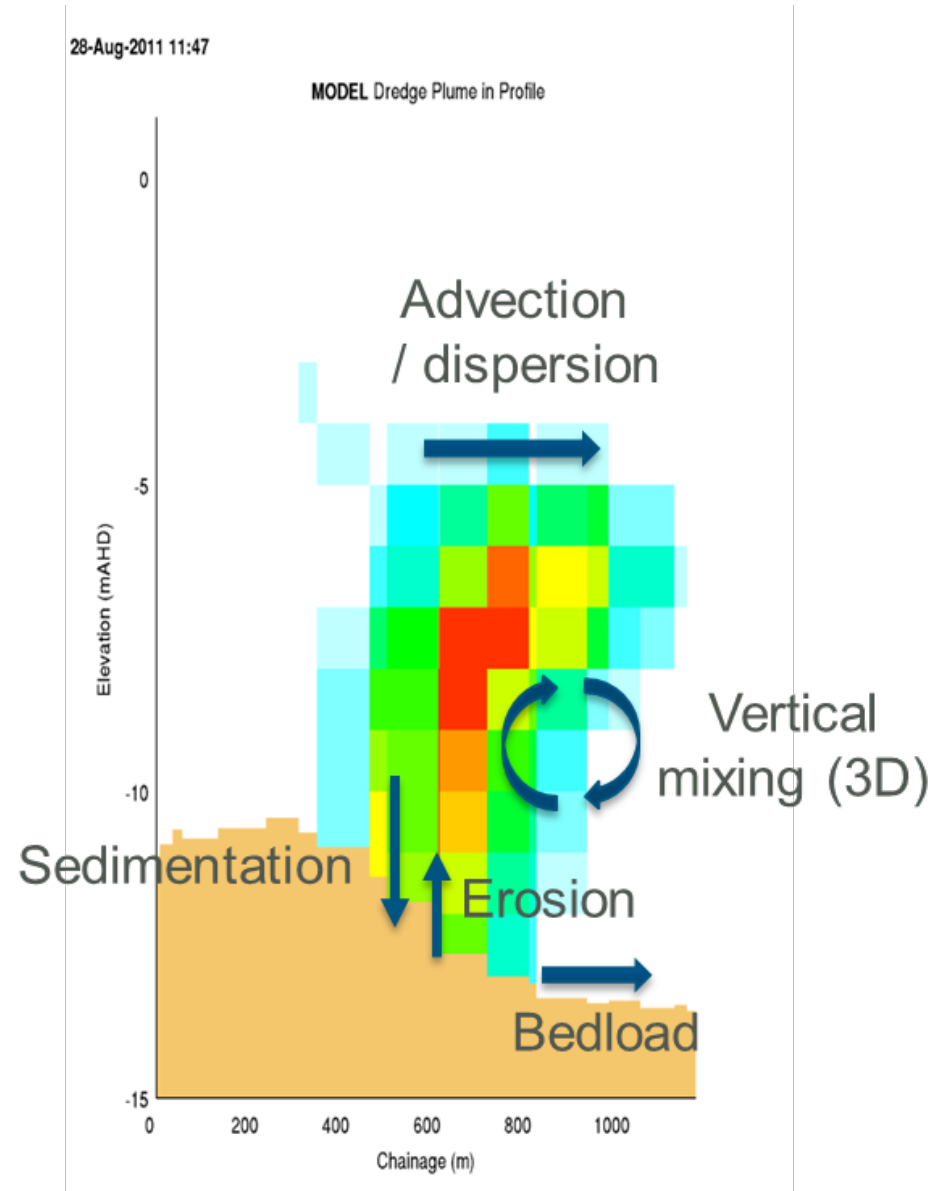


Figure 3-3. Flood-frequency curve for the East Fork Lewis River near Heisson, WA.

Tuflow FV Sediment/Morpho-dynamic Model Key Features

- **Suspended load**
 - Hydraulic module
→ advection / dispersion
 - Sedimentation / Erosion (Mehta Model)
- **Bedload** (Meyer-Peter Mueller Model)
- **Morphology** (adjusts bed elevation in response to sediment transport)
- **Multiple sediment fraction**
- **Multiple bed layer**
- **Armouring**
- **2D/3D**



Slide source: BWT-WBM (Tuflow FV)

Sediment Transport

- Condition for sediment transport: Bed shear stress (τ_b) > critical shear stress (τ_c)
- Look at τ_b values output by hydrodynamic (or sediment) model to get a sense of where sediment is predicted to move under different flow conditions.
- Compare to known sources (imagery) to see if model is making sense

Grain Size and Critical Shear Stress

Critical Shear Stress

$$\theta_{cr} = Y_{cr} = \frac{0.24}{D_*} + 0.055[1 - \exp(-0.020D_*)] \quad (23)$$

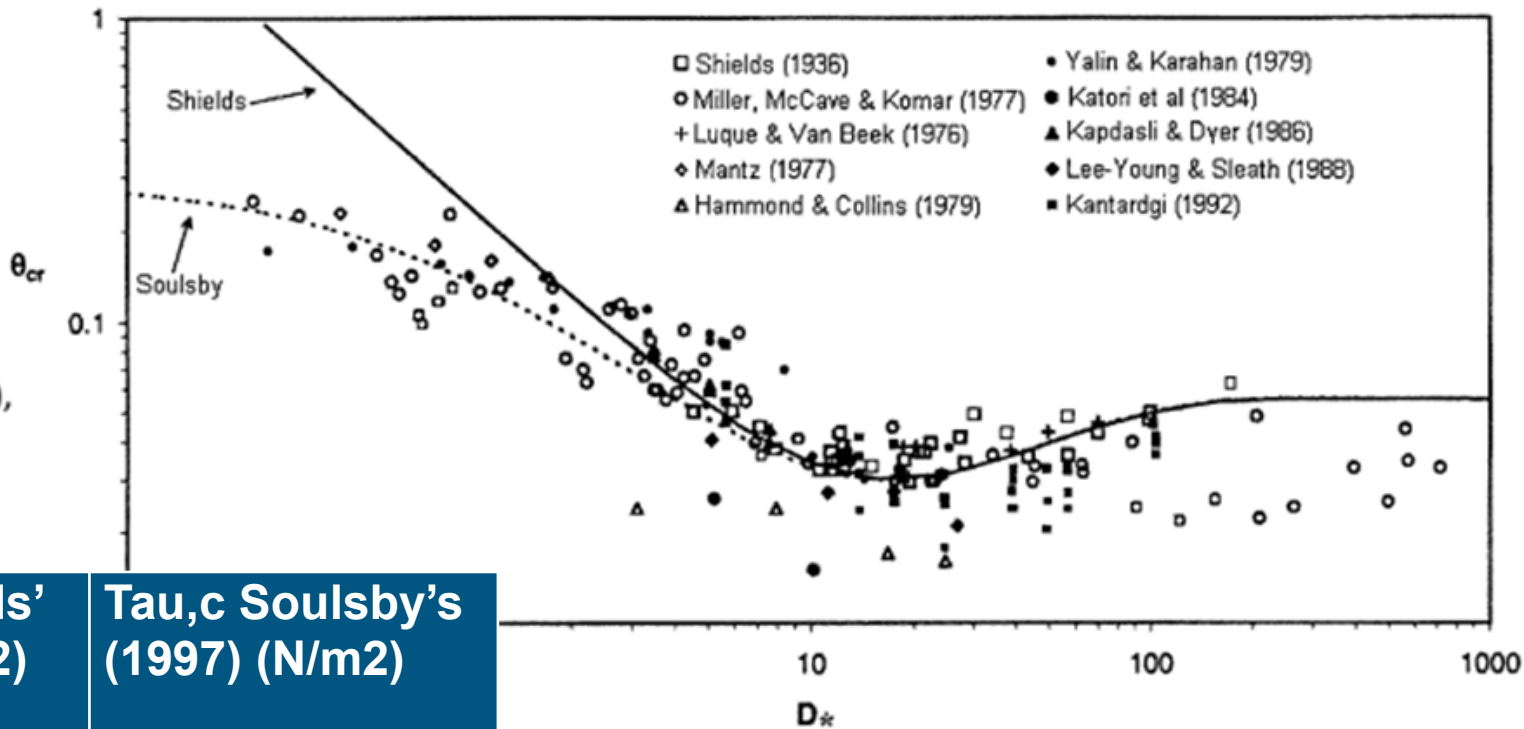
$$\theta_{cr} = Y_{cr} = \frac{0.30}{1 + 1.2D_*} + 0.055[1 - \exp(-0.020D_*)] \quad (24)$$

Eq. (23) is fitted to the original Shields curve, and (24) contains the modification for small D_* . The discussers have

with:

$D_* = d_{50} [(s-1) g/v^2]^{1/3}$ = dimensionless sediment size (m),

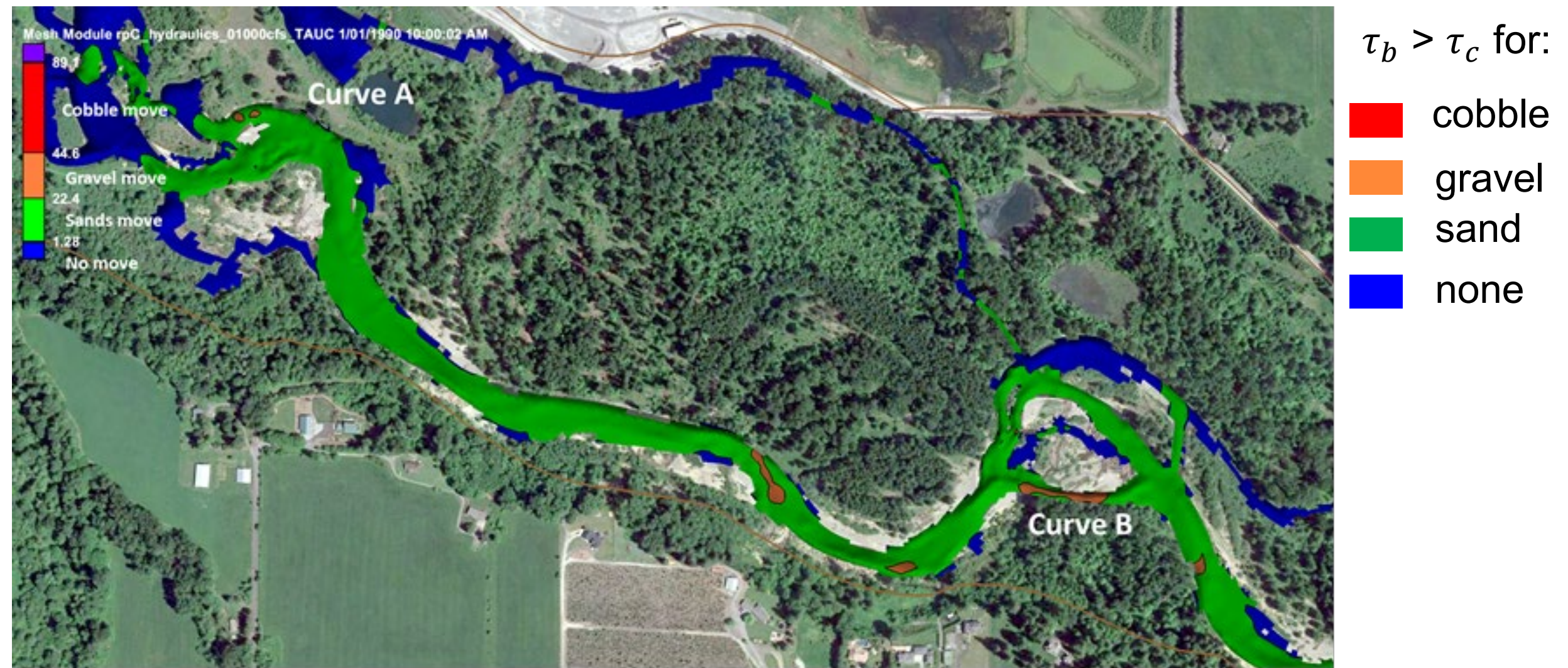
$\theta = \tau_{b,c}/[(\rho_s-\rho_w)gd_{50}]$ = Shields parameter (-),



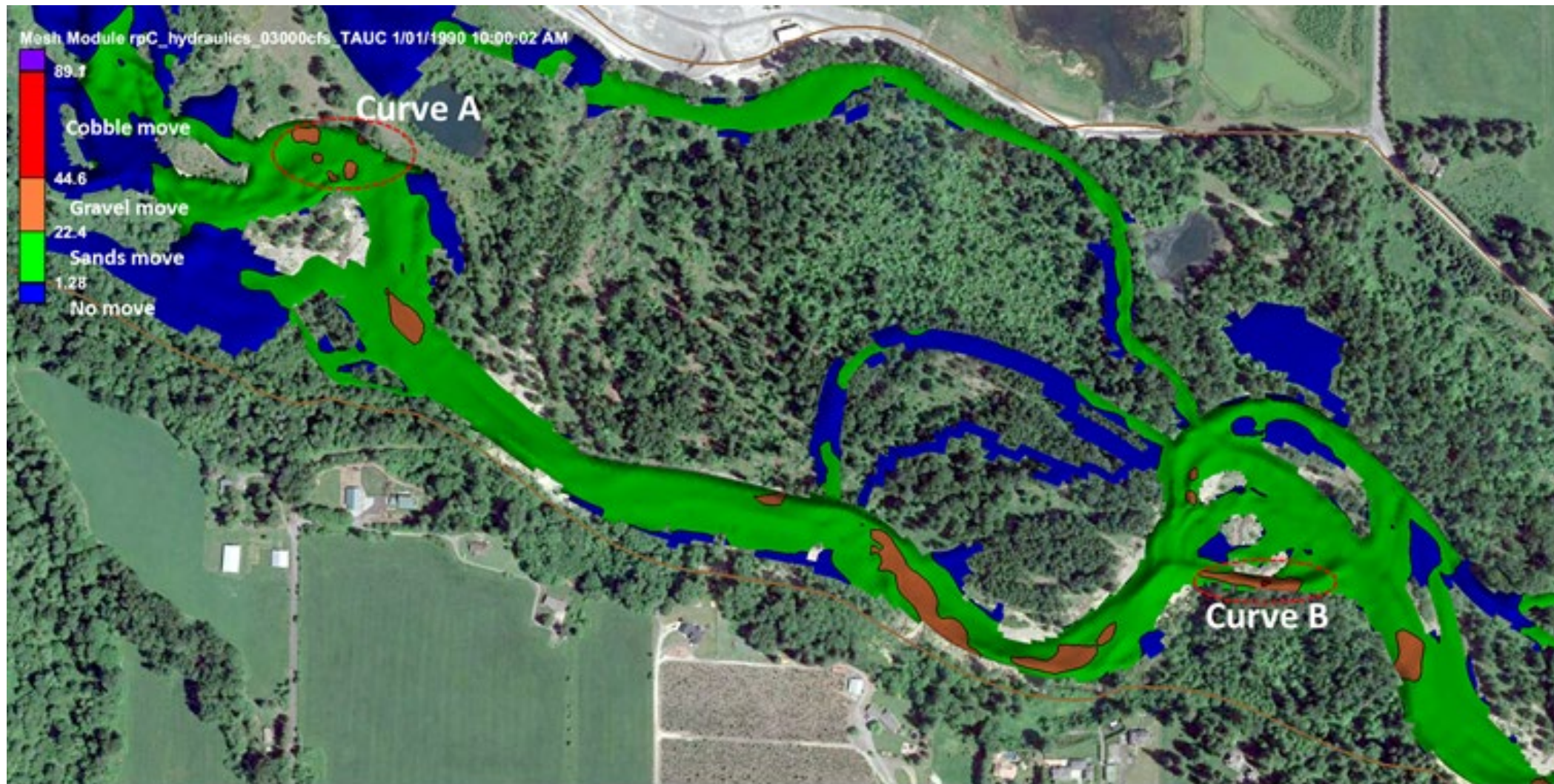
Horizontal Bed: Graph of $\theta_{cr} = Y_{cr}$ and D_* as Given by Eq. (22) [from Soulsby and White-

Description	Grain Size (mm)	Tau,c Shields' (1936) (N/m2)	Tau,c Soulsby's (1997) (N/m2)
Fine Sand	1	0.50	0.50
Gravel	10	9.0	9.0
Coarse Gravel	25	22.4	22.4
Cobble	100	89.1	89.1

Model Results: Bed Shear Stress, $Q = 1000$ cfs (base flow)



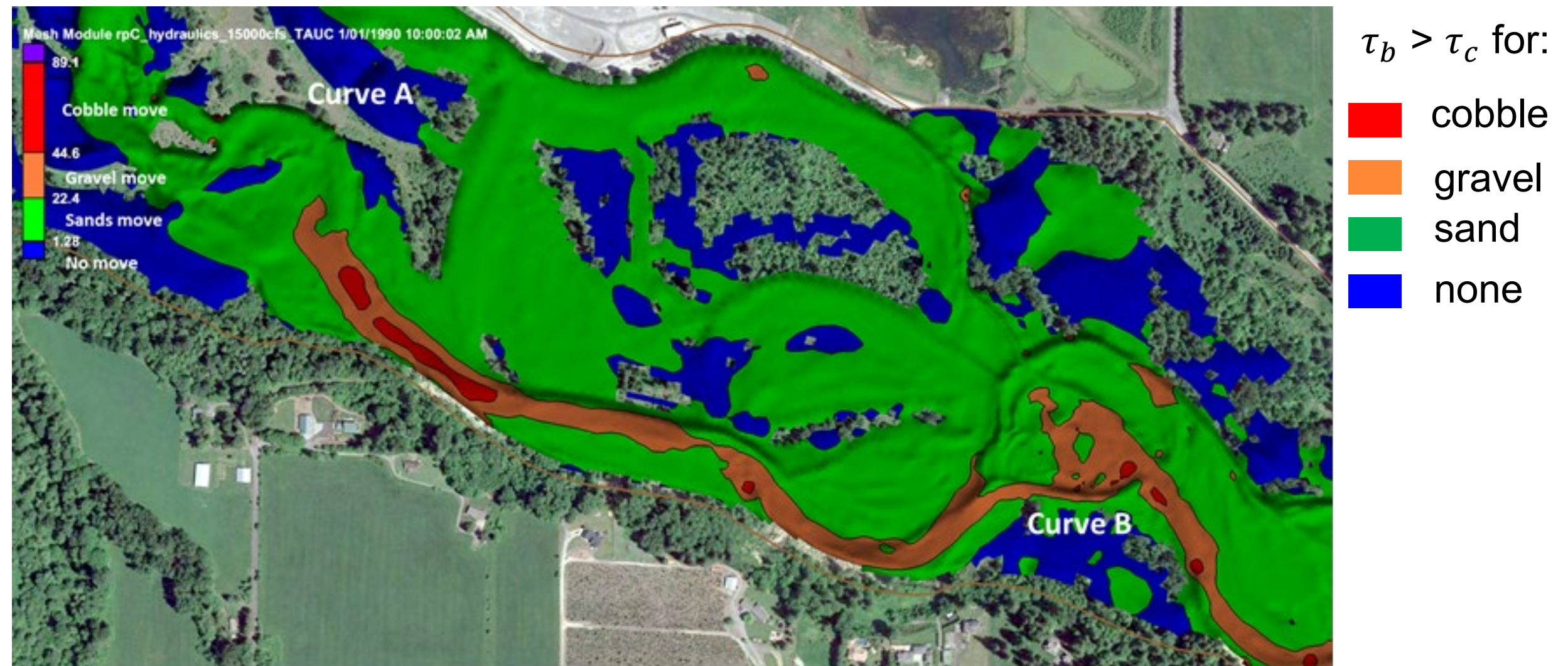
Model Results: Bed Shear Stress, $Q = 3000$ cfs ($\sim Q1$)



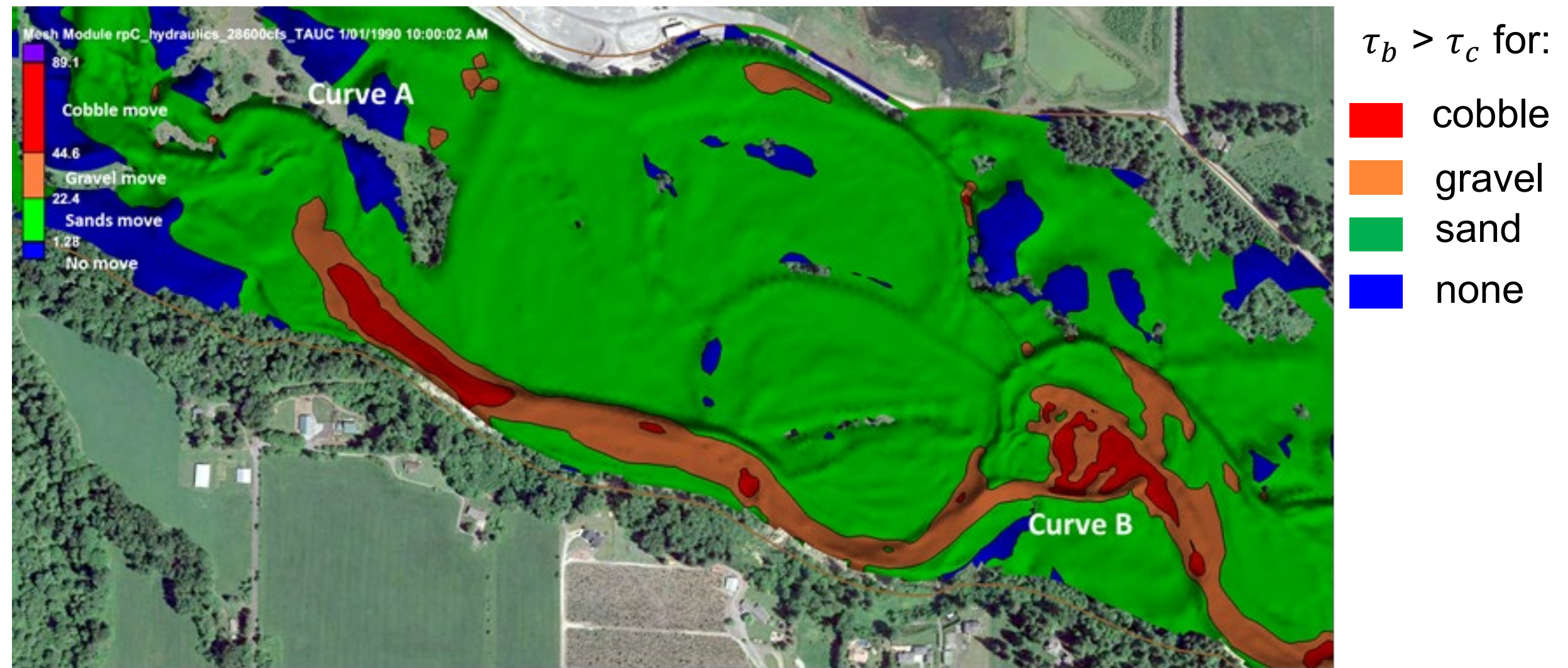
$\tau_b > \tau_c$ for:

- cobble
- gravel
- sand
- none

Model Results: Bed Shear Stress, $Q = 15,000$ cfs ($\sim Q_{20}$)



Model Results: Bed Shear Stress, $Q = 28,600$ cfs ($\sim Q_{100}$)



Model Results: Bed Elevation Change, post 5-yr event



Preliminary Model Observations

- Even at base flow condition, τ_b can reach 50N/m² in some areas, which is strong enough to move bed material smaller than “coarse gravel”.
- At a 1-yr flood event, τ_b can reach 100N/m² in limited areas. The majority of bed material ‘can’ move, but cobble forms an armouring layer in most areas. This is a high frequency event and the bank erosion may shift the stream banks over time.
- Under the 5-yr flood event, water can get almost everywhere. τ_b can reach 150N/m² even in the potential river course at the south side of the domain.
- Much more to come!

• Questions?

