

- Project Background [5]
- CMZ mapping approach [5]
- Study methods and data sources [5]
- Draft CMZ delineation [10]
- Q&A and discussion



Draft Lower Elwha River Channel Migration Zone

April 23, 2025



This project is funded in part by WA Dept. of Ecology (Grant # SEASPC-2325-CLoCD-00006)





Channel Migration Zones (CMZ) are areas in a floodplain where a river or stream channel can be expected to move naturally over time.

- Overall goal is to better understand the current and future patterns of erosion and flooding along the Lower Elwha River, Indian Creek, and Little River systems to incorporate risk-informed decisions into various planning processes to benefit public safety, infrastructure, and aquatic and riparian ecology.
- The Elwha River is a shoreline of statewide significance under the Shoreline Management Act (SMA).
- The removal of two dams in the Elwha River has dramatically affected the river environment downstream and at the delta.
- A detailed CMZ delineation gives planners and resource managers science-based reach scale information necessary to establish jurisdictional boundaries; better protect people, development, and natural resources from flood and erosion hazards.
- Shoreline use and development activities are regulated locally by the Clallam County Shoreline Master Program (SMP), which establishes limitations and requirements specific to CMZs.

Delineate a detailed CMZ for the Lower Elwha River, Indian Creek, and Little River for the 100-year timescale.

➤ Predict areas that are at risk of erosion along creeks and rivers in this timeframe

1. Project Background
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Channel Avulsion along Hot Springs Road, Upper Elwha (1/12/2016)

Flooding – inundation from high river flows.

The FEMA 100-year floodplain is a standard definition of risk area

- *1% chance in a given year*

Erosion – removal and transport of soil or rock by river processes.

- Bank erosion
- Channel avulsion
- Mass wasting

Study Area

Show former dam sites

Elwha River

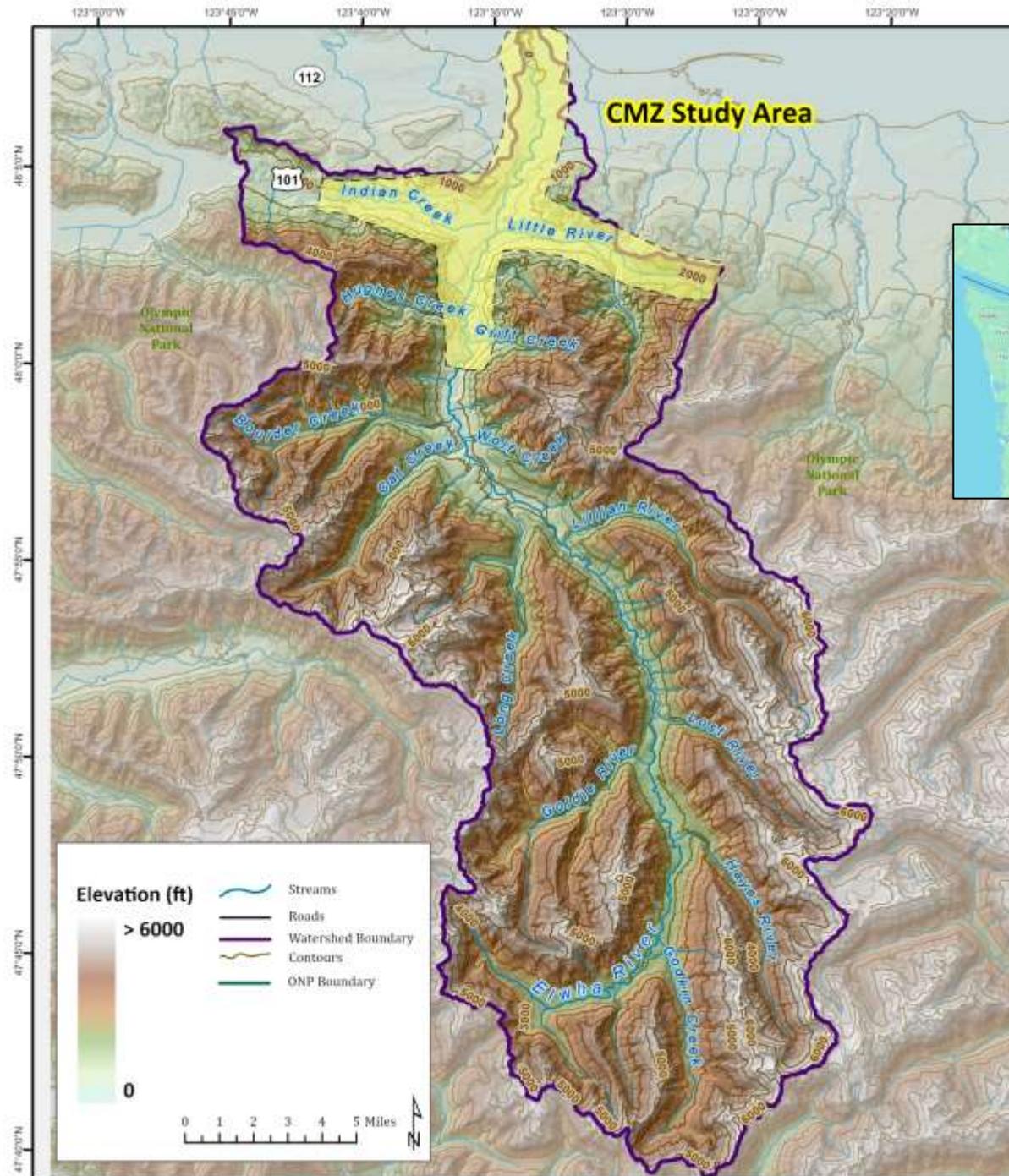
- ▶ Altair to Strait of Juan de Fuca
- ▶ 12.5 RM

Indian Creek

- ▶ Lake Sutherland to Elwha River
- ▶ 6 RM

Little River

- ▶ NPS to Elwha River
- ▶ 7 RM



- Flow and sediment transport regimes
- Geomorphic reach setting
- Dam operation and removal
- Ongoing channel evolution
- Existing infrastructure



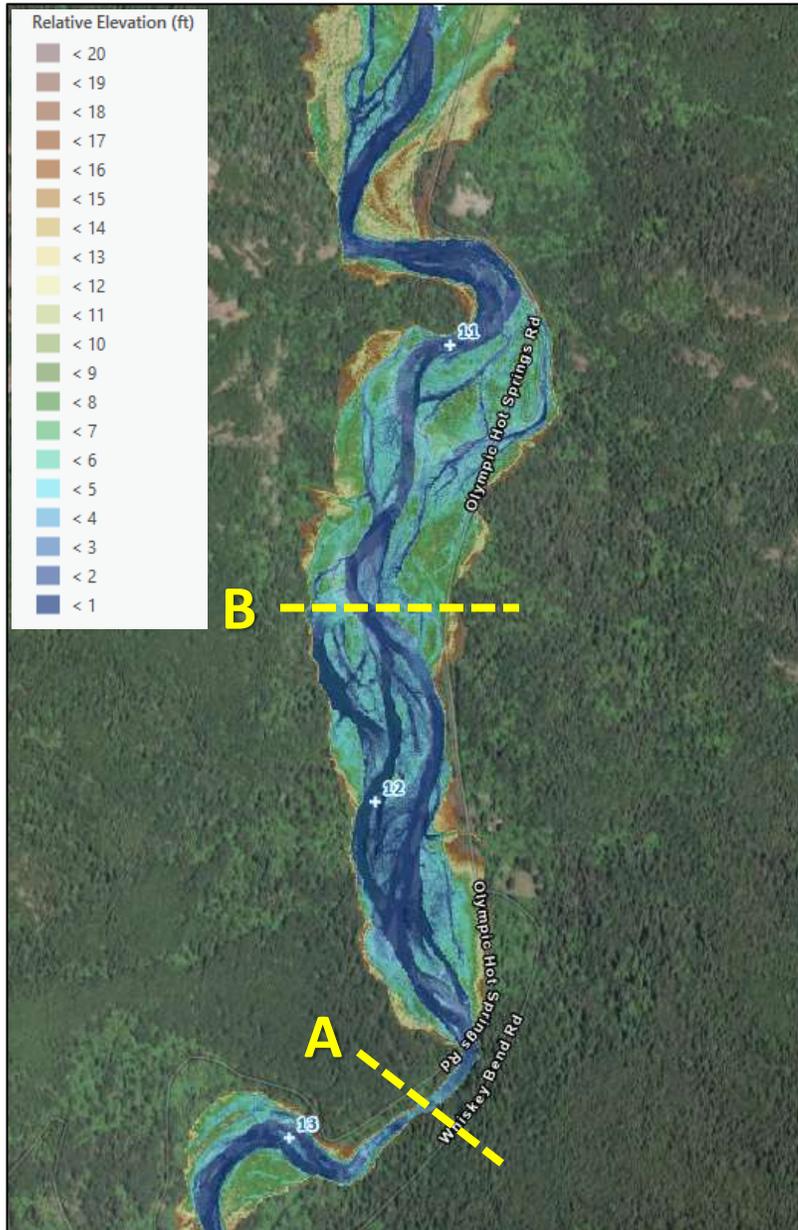
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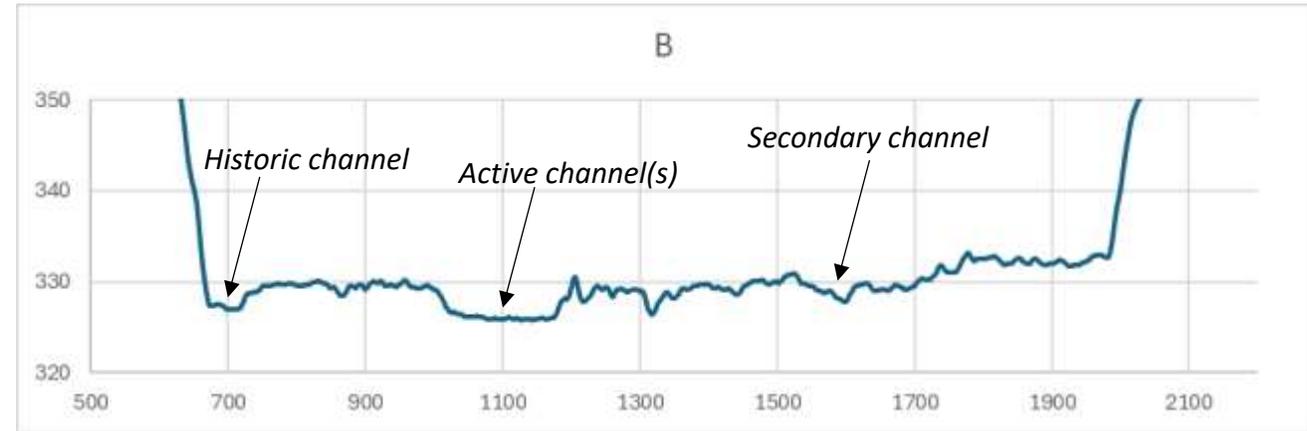
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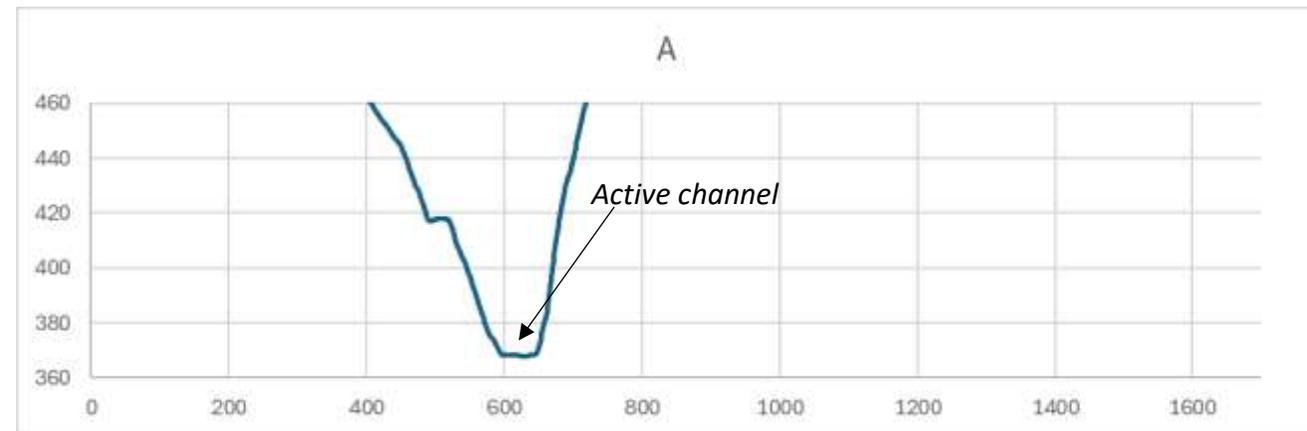
<https://www.opb.org/article/2022/08/02/elwha-river-transformed-10-years-after-dam-removal/>

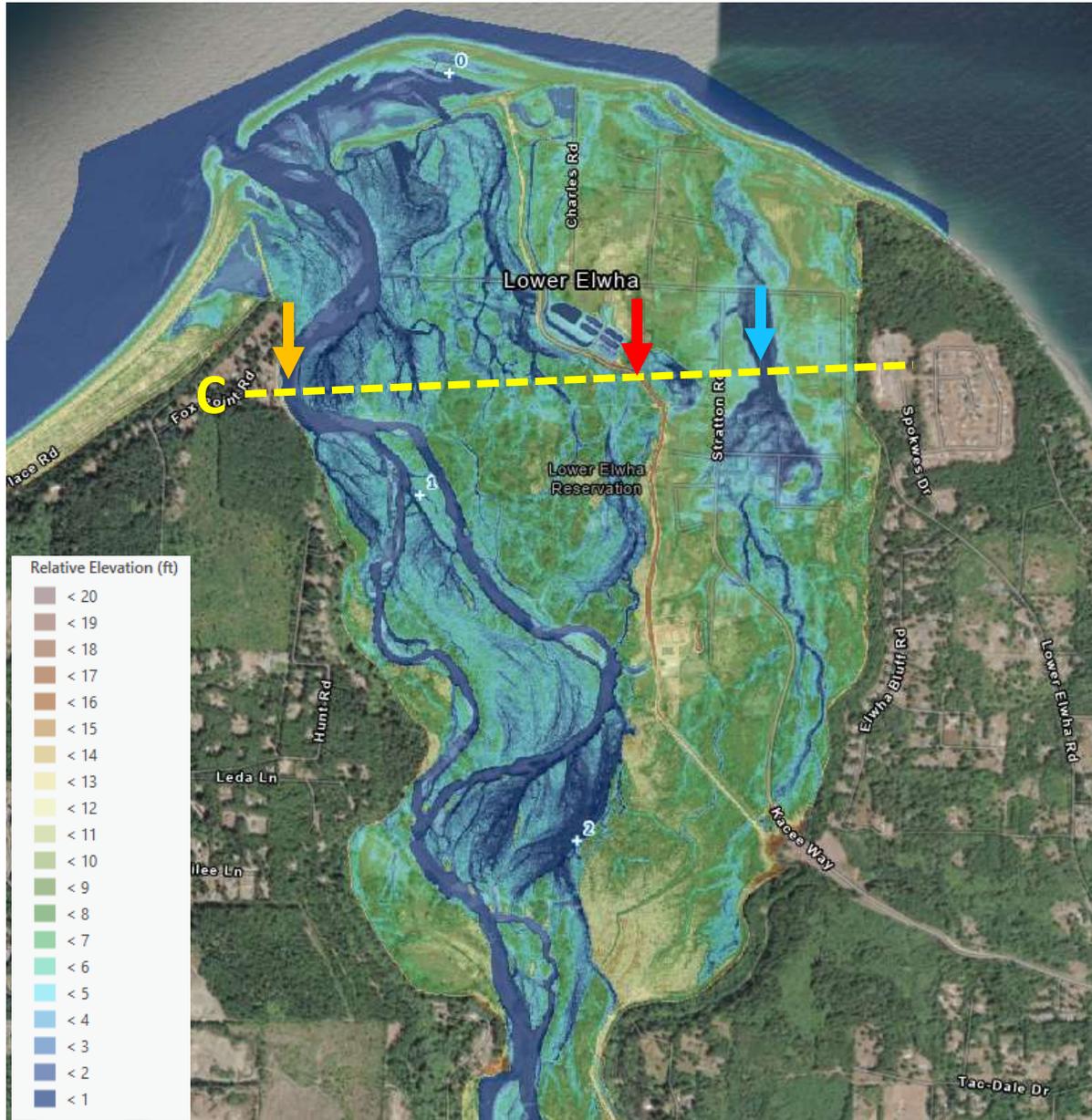


Wide floodplain with multiple channels

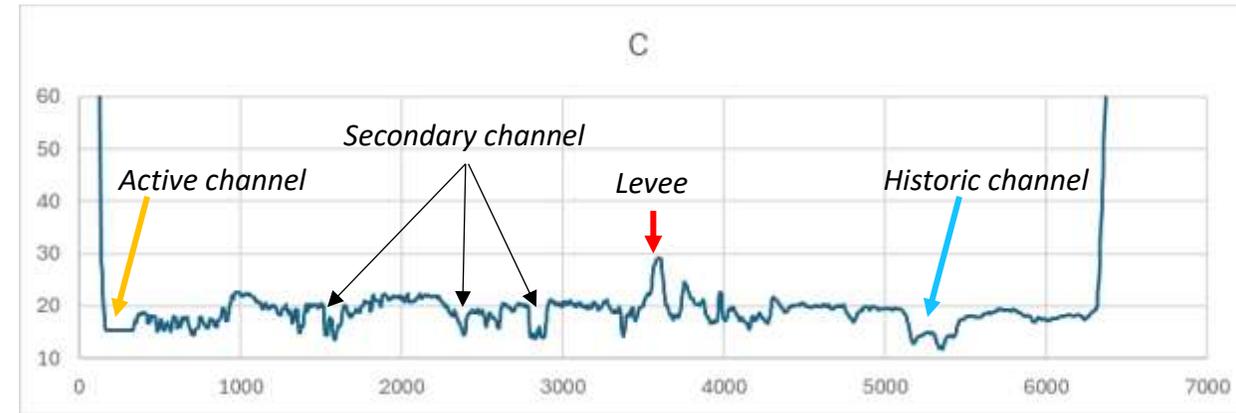


Narrow canyon with a single channel





Wide river delta with active and historic channels



Detailed CMZ delineation protocol

Rapp and Abbe (2003) for 100-year study lifespan

Study methods

- Community and Co-Manager outreach
- Historical mapping and analysis
- Hydraulic modeling (2D)
- Geomorphic reach delineation
- Field reconnaissance
- Detailed CMZ delineation



A Framework for Delineating Channel Migration Zones

November 2003
Ecology Publication #03-06-027 (Final Draft)

 Washington State
Department of Transportation



Elwha River

Geomorphic Reaches

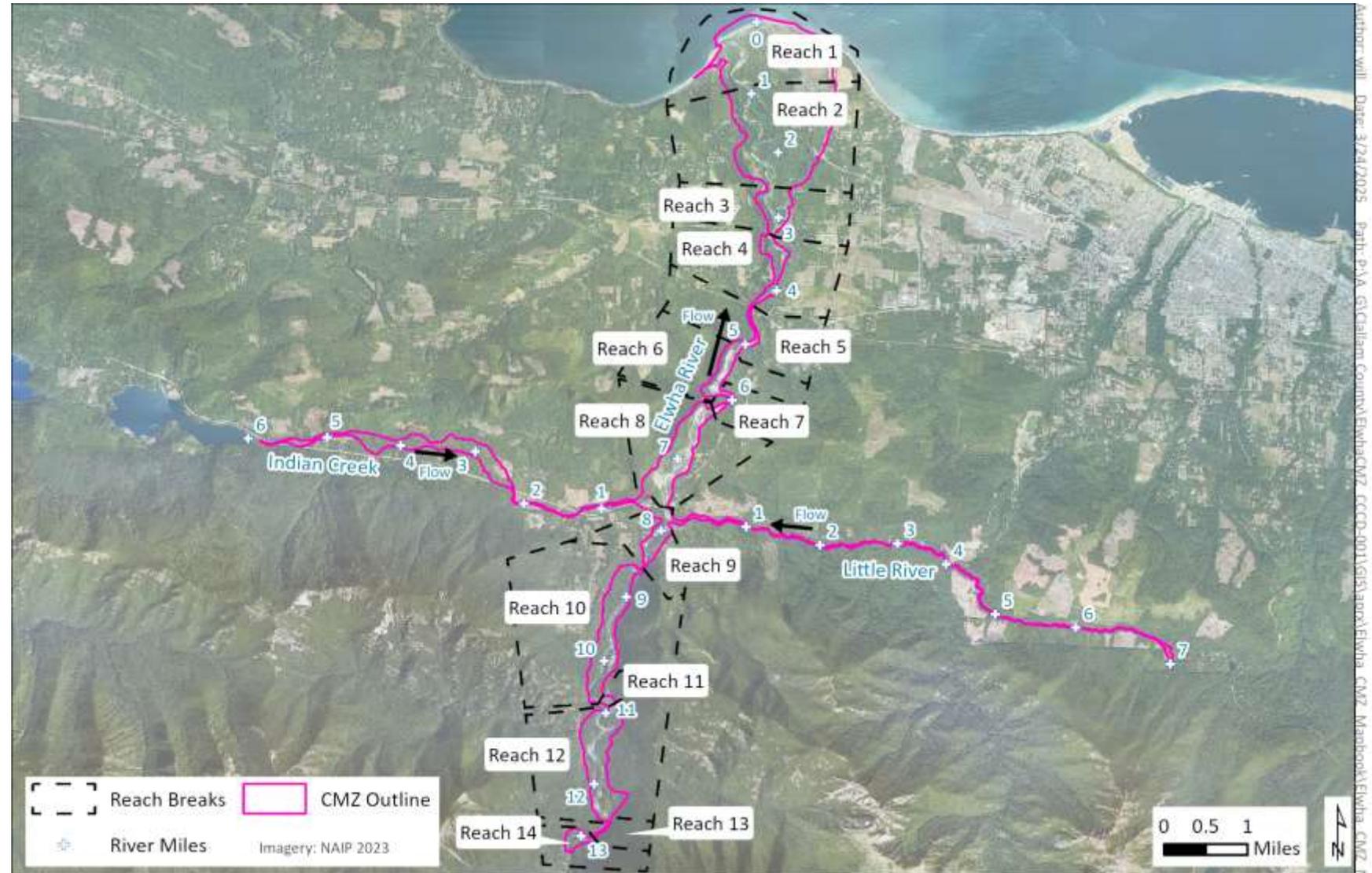
- ▶ Valley confinement
- ▶ Slope
- ▶ Channel planform
- ▶ Topographic/Geologic controls

Indian Creek

- ▶ Lake Sutherland to Elwha River
- ▶ 6 RM

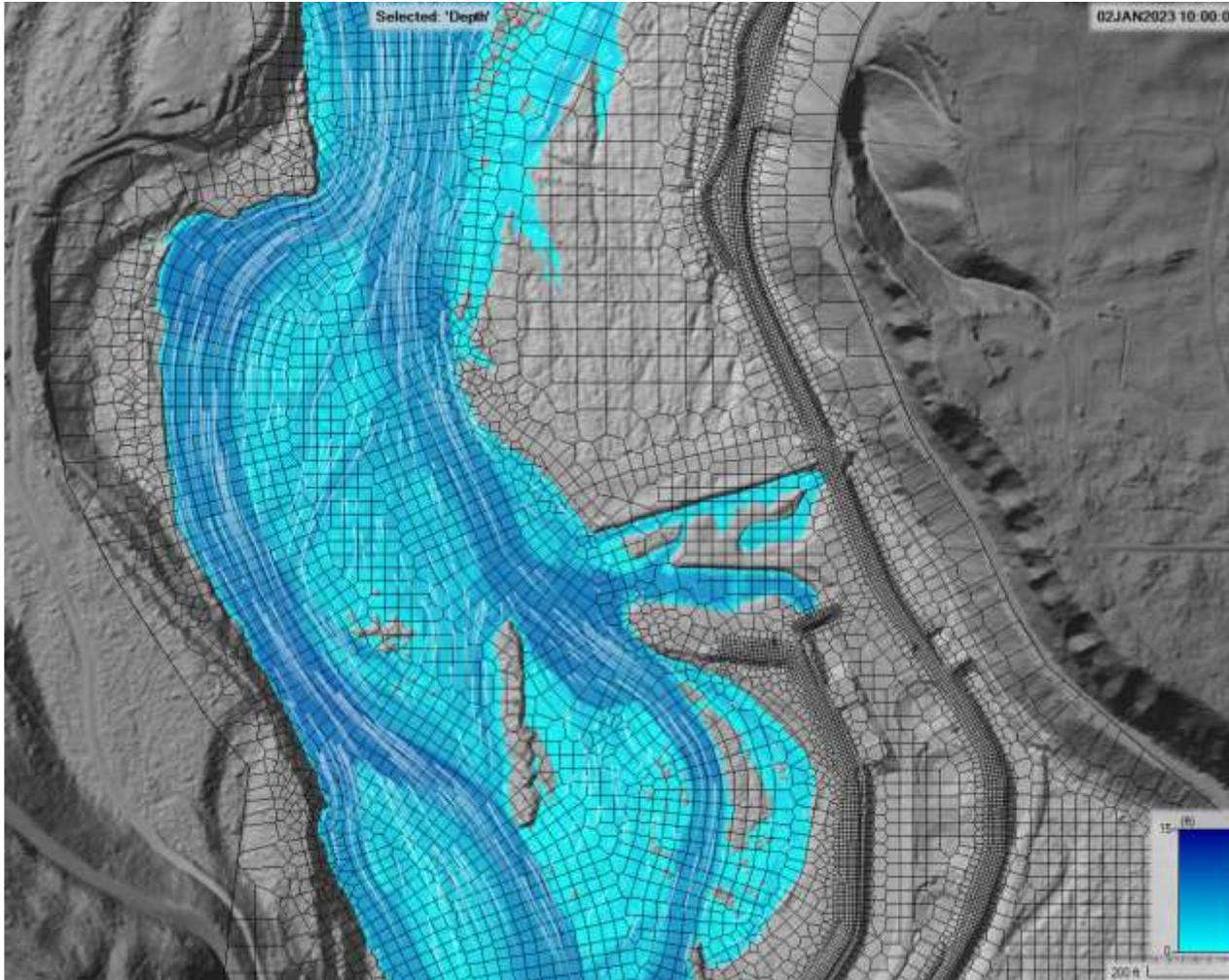
Little River

- ▶ NPS to Elwha River
- ▶ 7 RM

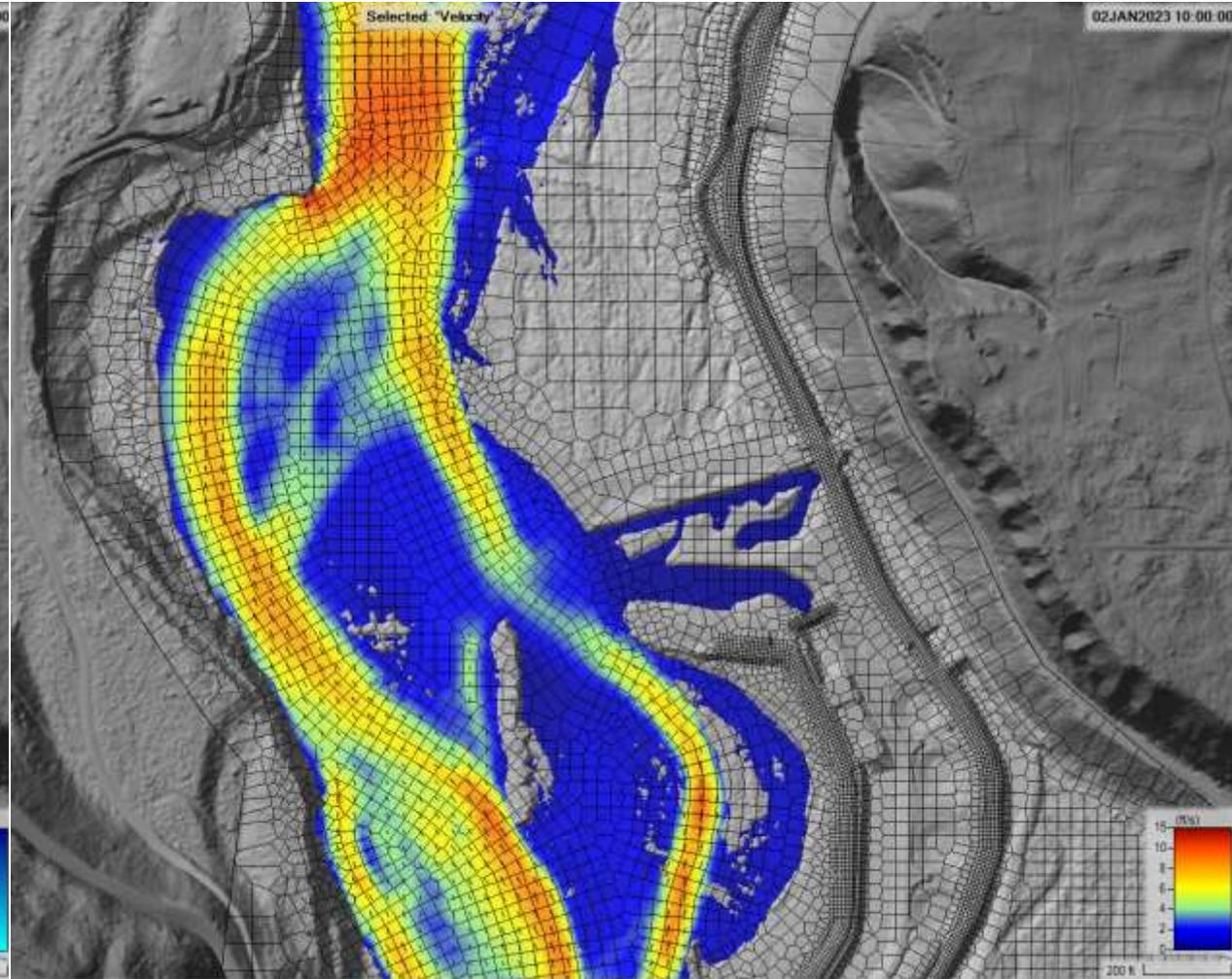


- Topography (2018 LiDAR)
- Historical maps and aerial imagery (1873-2023)
- Surface geology
- Landslides
- Hydrology (USGS 12045500)
- Highways, levees, critical infrastructure
- Field observations
- Anecdotal records

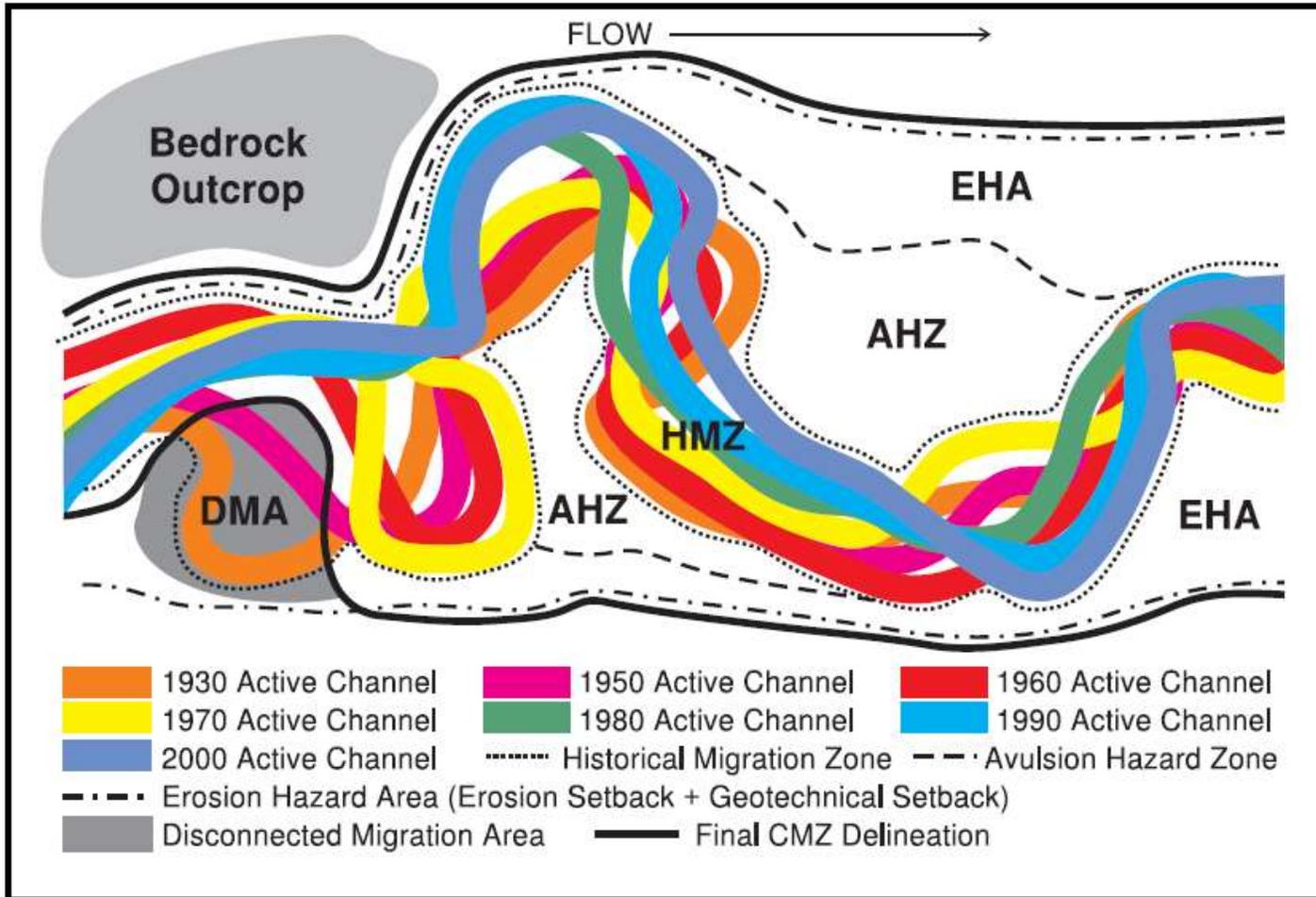
Depth (ft)



Velocity (ft/s)



Delineating Elements of a Channel Migration Zone

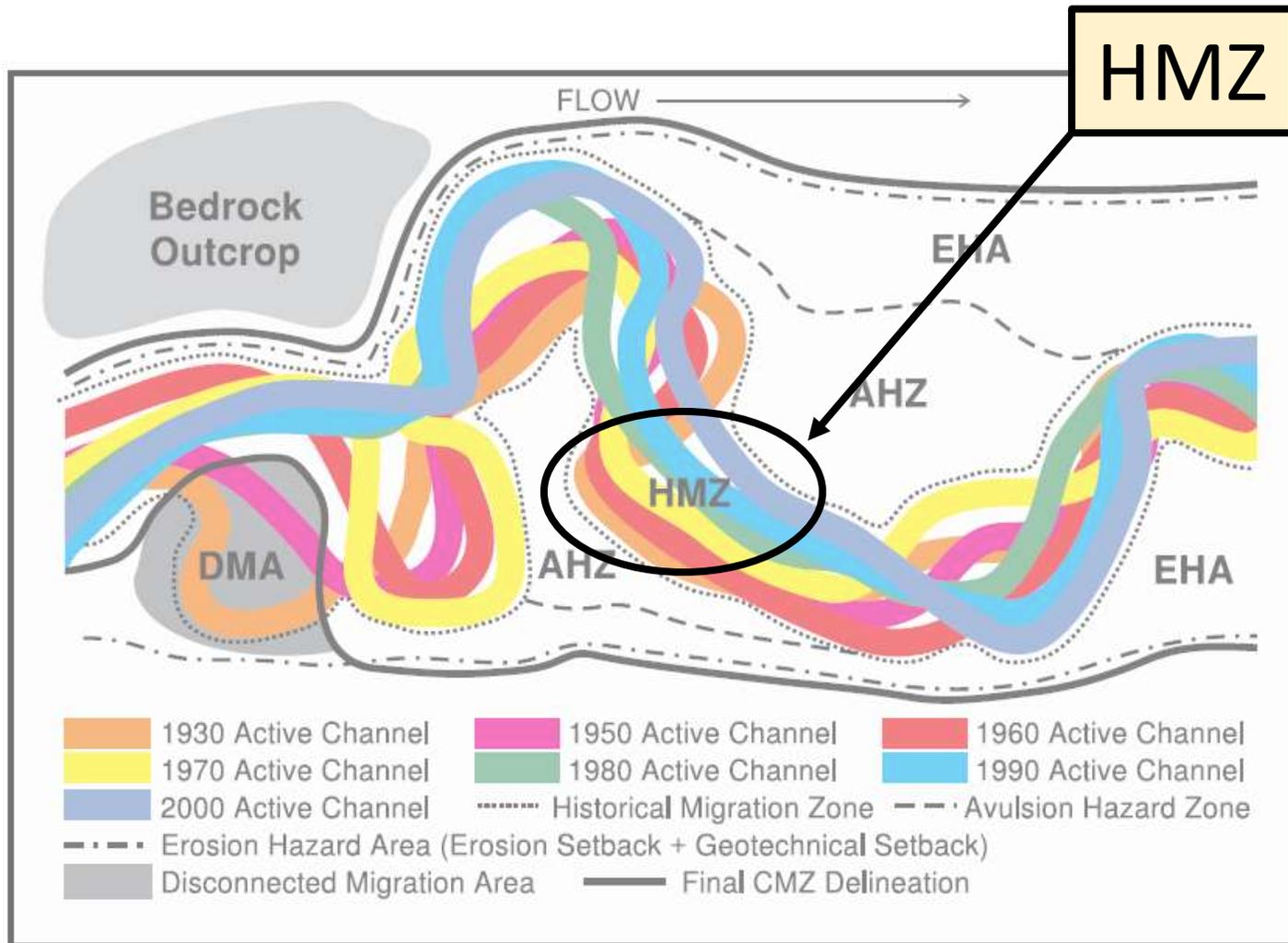


A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

The CMZ boundary delineates the area in which channel processes will occur over a specified period of time: 100 years

- Historical Migration Zone (HMZ)
- Avulsion Hazard Zone (AHZ)
- Erosion Hazard Area (EHA)
- Disconnected Migration Area (DMA)

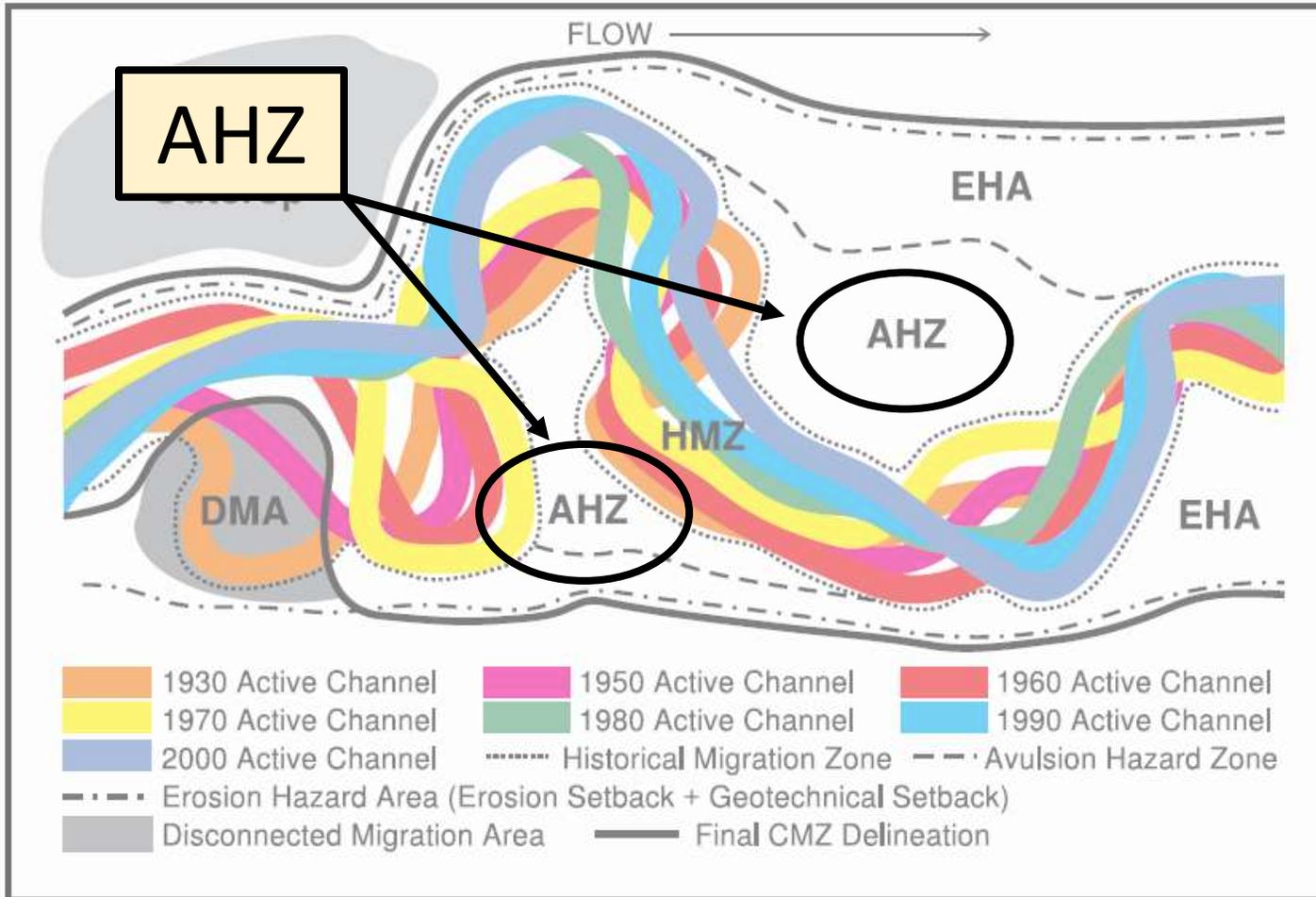
$$\text{CMZ} = \text{HMZ} + \text{AHZ} + \text{EHA} - \text{DMA}$$



The area the channel has occupied over the course of the historical record (1875 – 2023)

- Active channel (unvegetated area) only
- Based on aerial imagery, topography, field observations

A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)



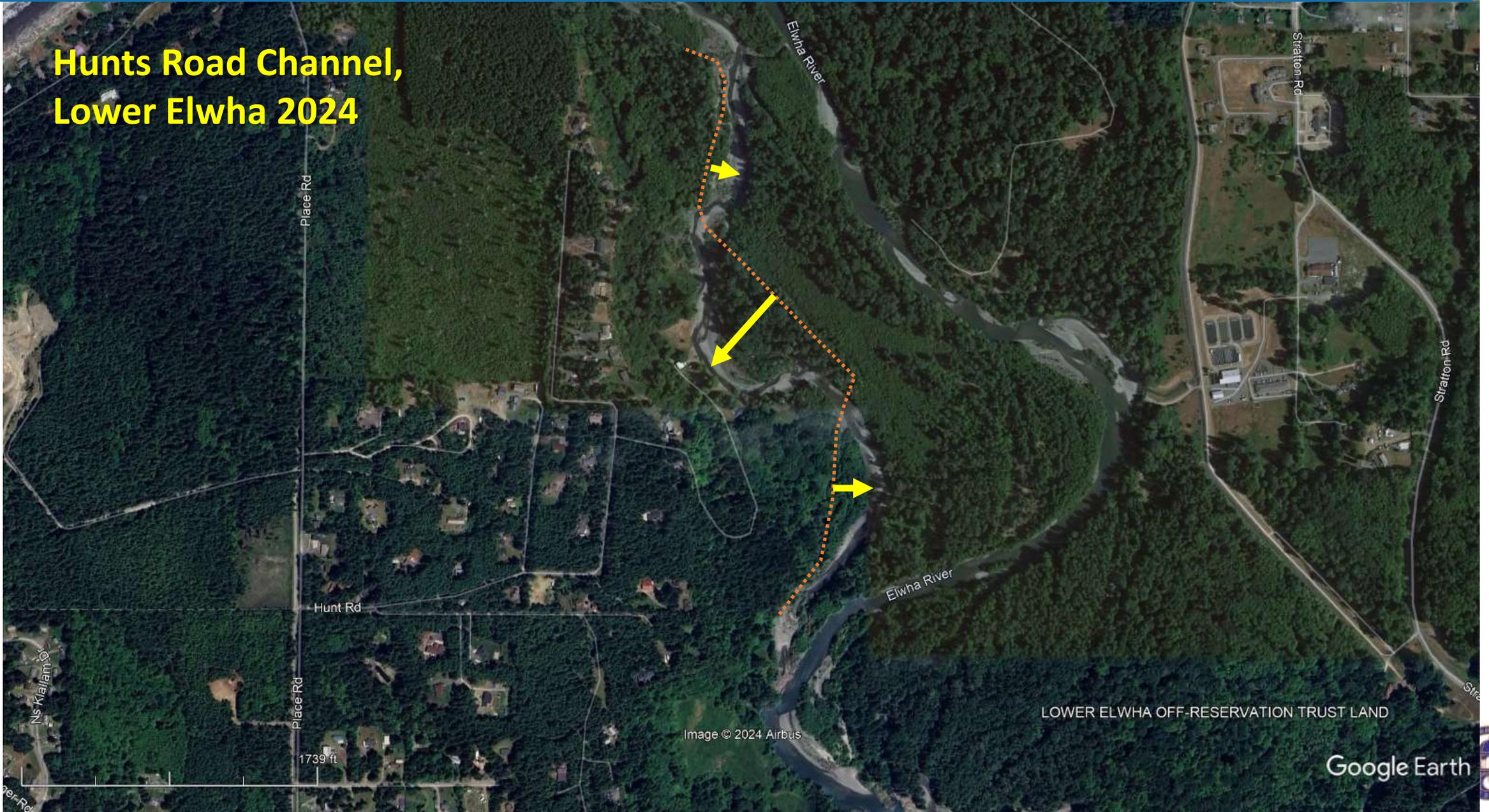
The areas of river landscape, located outside of the HMZ, at risk of channel occupation

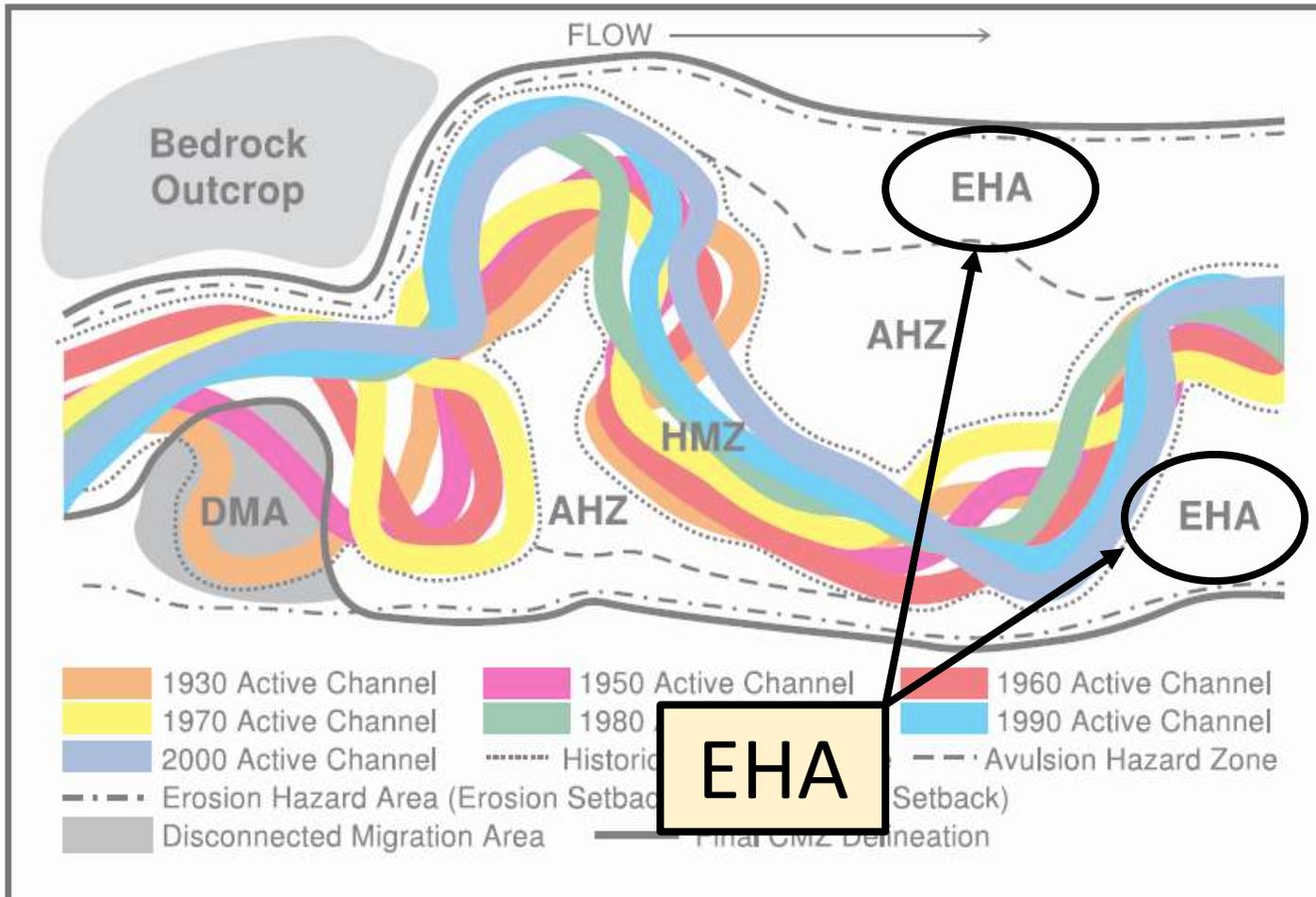
- Informed by topography, hydraulic modeling
- Accounts for 2 m range of vertical bed instability

A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

Avulsion Hazard Zone (AHZ)

Hunts Road Channel, Lower Elwha 2024





A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

Area outside the HMZ and AHZ which may be susceptible to bank erosion

EHA = Erosion Setback (ES) + Geotech. Setback (GS)

- Alluvial valley bottom erosion rate based on reach averages from 1939 – 2023
- Bluff erosion rates calculated at point locations where bluff erosion has occurred (Fox Point, Ranney reach)
- Overlaid mapped landslides (DNR mapping)
- Bedrock bluffs act as restrictive material (DNR mapping and field observations)

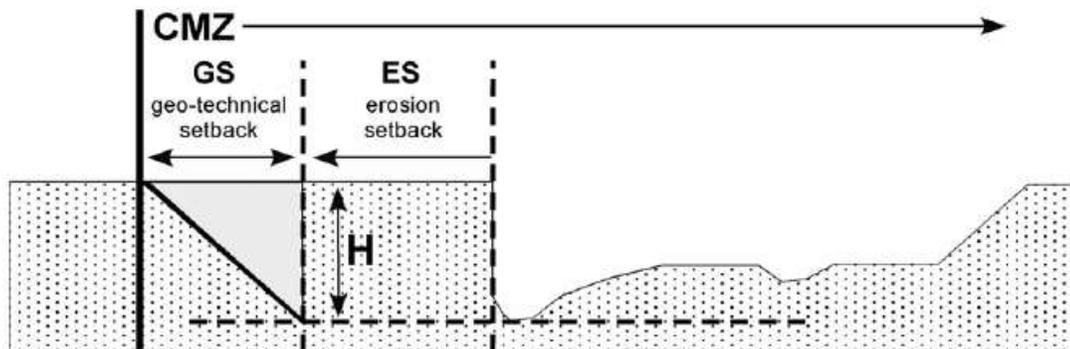
A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

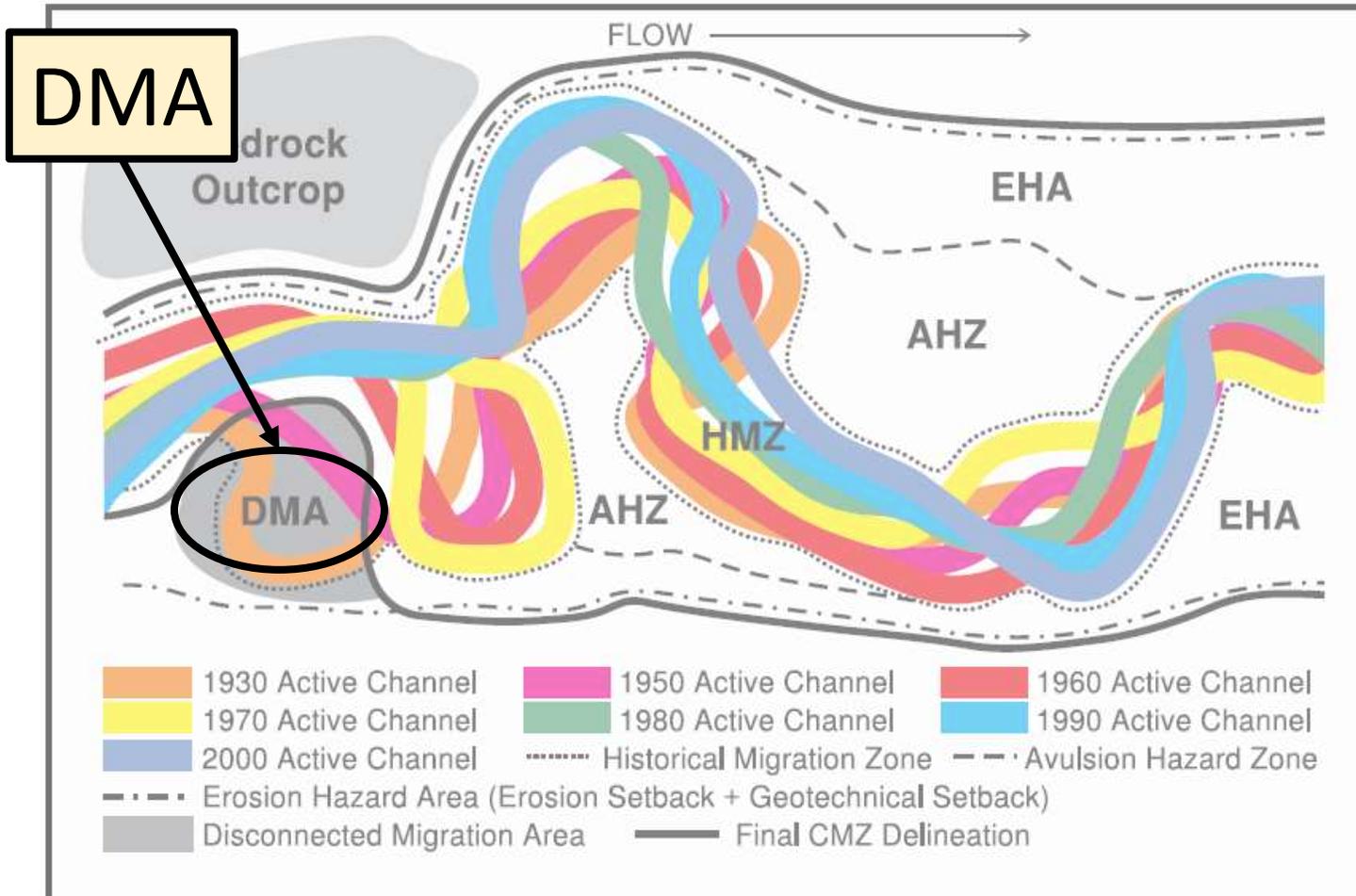


Geotechnical Setbacks (GS) account for natural adjustment of hillslopes that have been over-steepened by river erosion

- Part of the EHA

Over-steepened hillslope along west side of Lower Elwha River valley



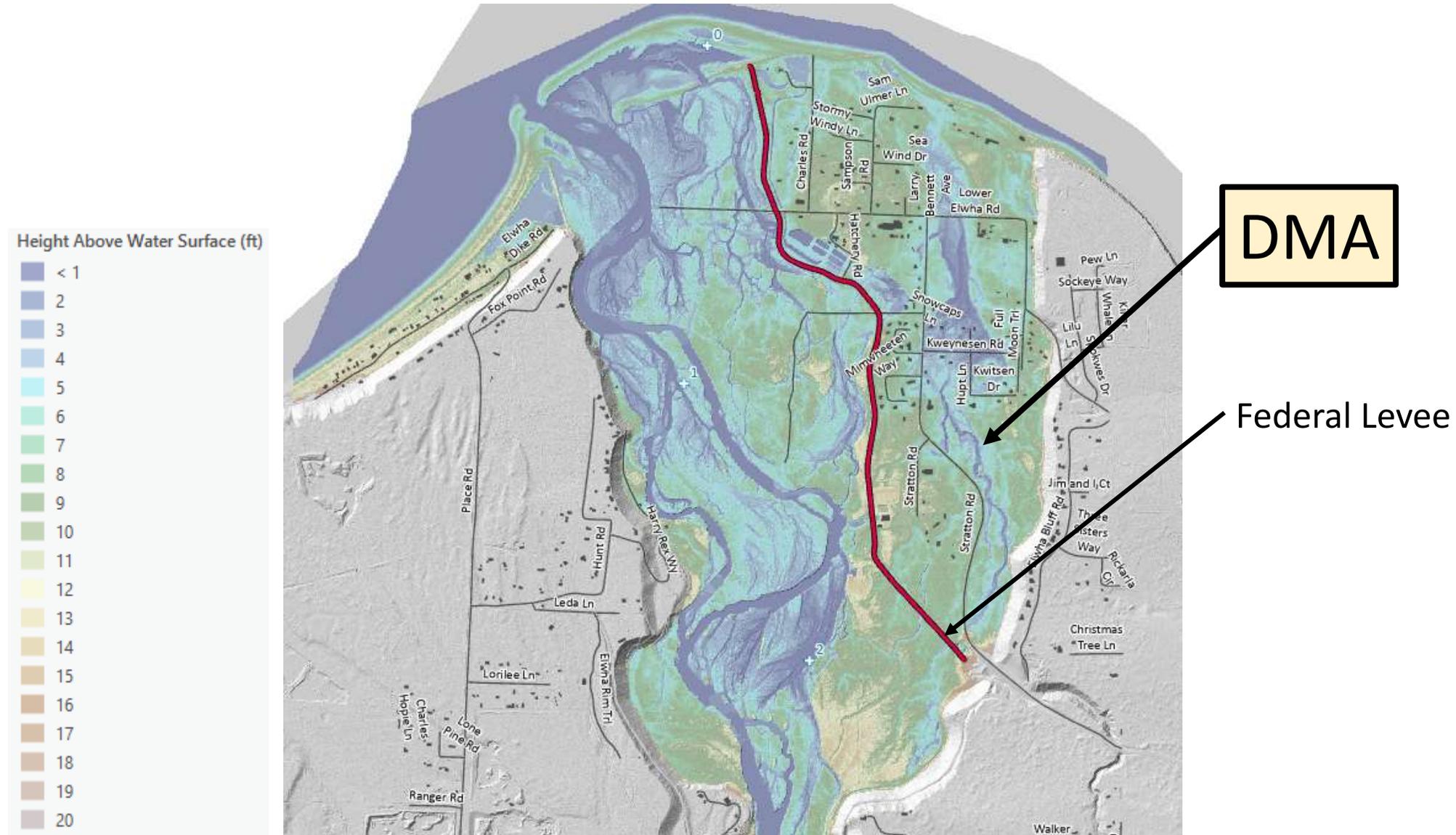


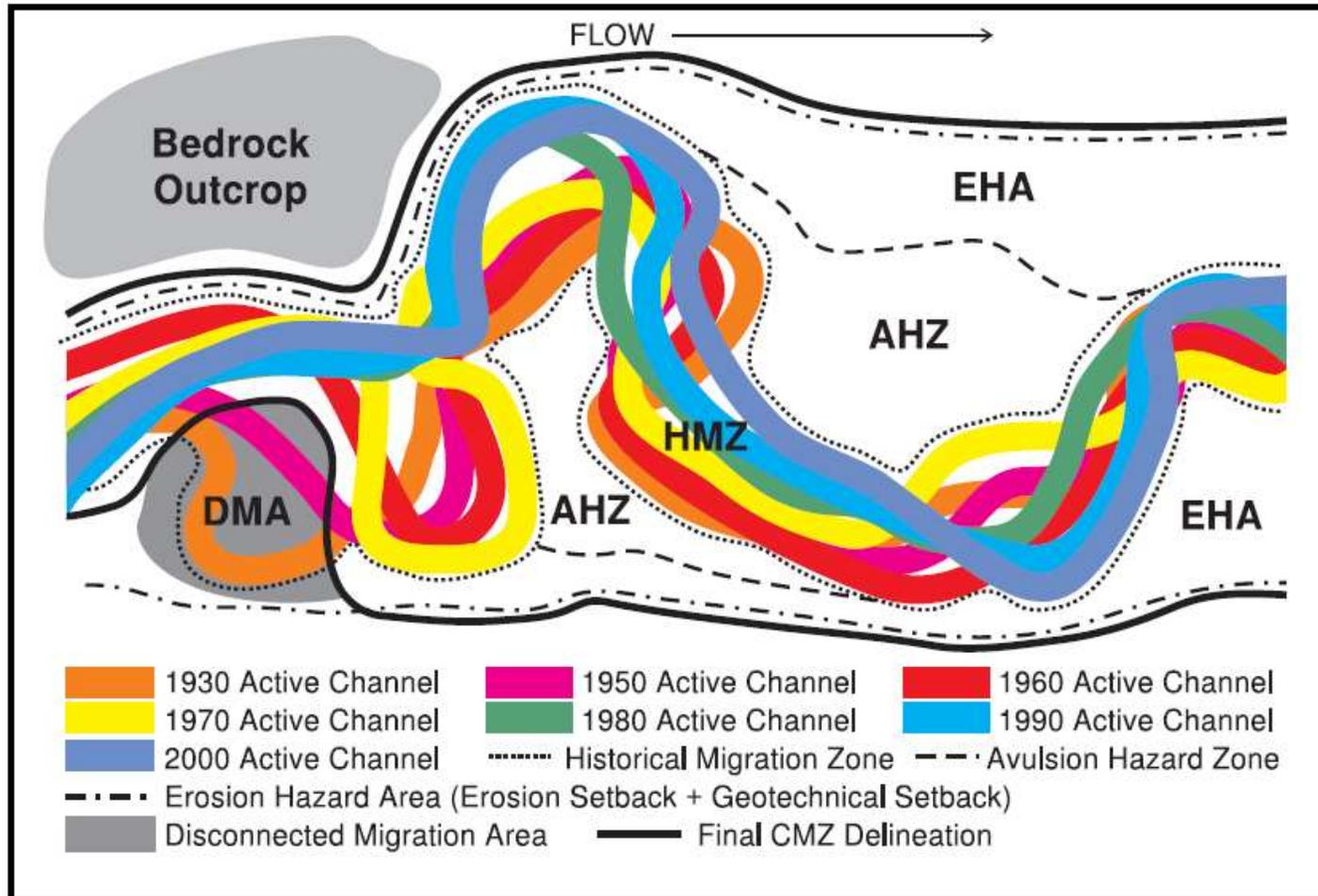
Indicates the impact of structures by delineating the areas in which they prevent channel migration; not part of regulatory CMZ

- Federal Levee
- US-101
- Ranney Well facilities
- NOT Place Rd. Levee

A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

Disconnected Migration Area





A Framework for Delineating Channel Migration Zones (Rapp and Abbe, 2003)

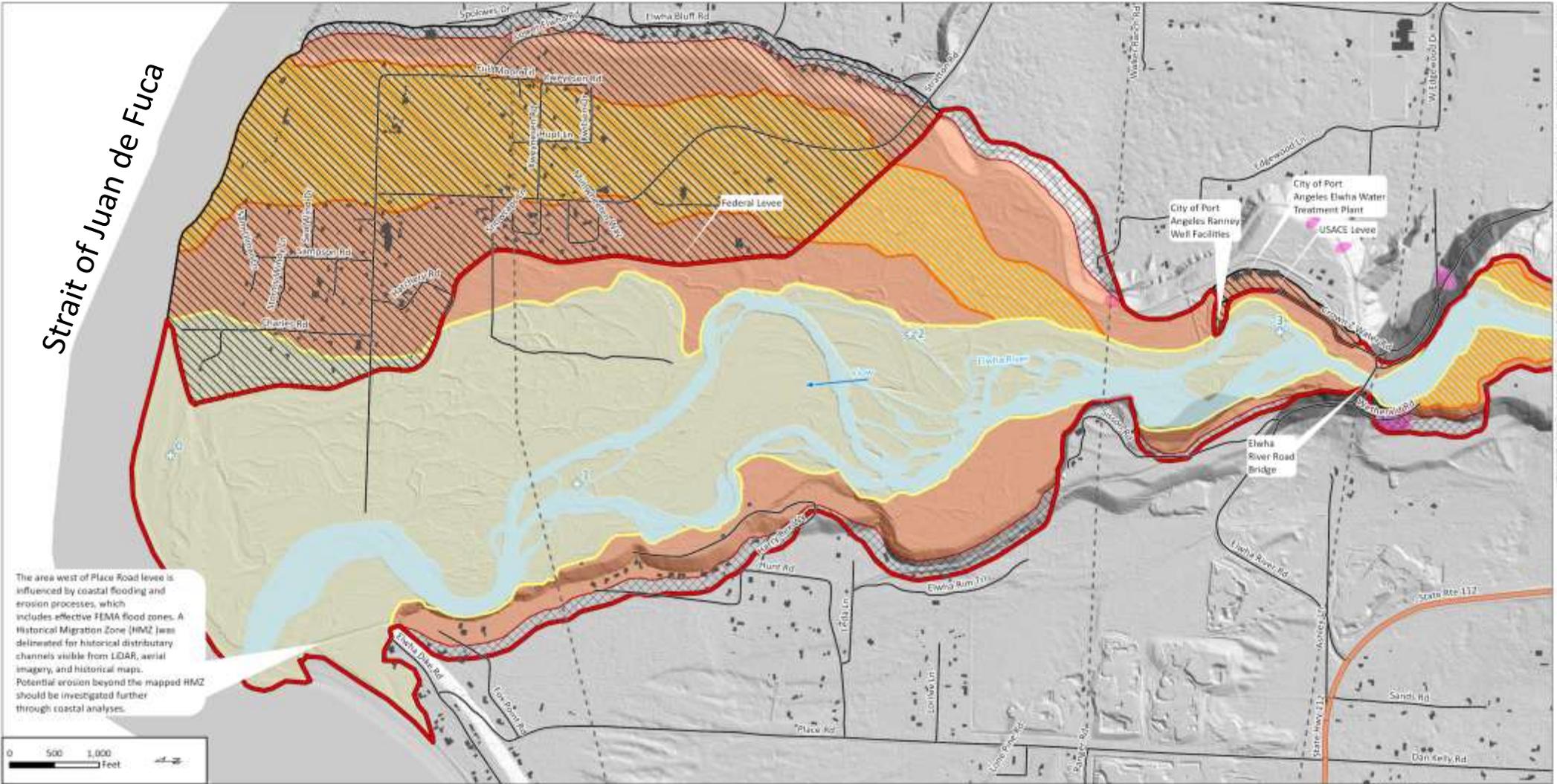
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$$\text{CMZ} = \text{HMZ} + \text{AHZ} + \text{EHA} - \text{DMA}$$

Draft CMZ Maps

Strait of Juan de Fuca



The area west of Place Road levee is influenced by coastal flooding and erosion processes, which includes effective FEMA flood zones. A Historical Migration Zone (HMZ) was delineated for historical distributary channels visible from LiDAR, aerial imagery, and historical maps. Potential erosion beyond the mapped HMZ should be investigated further through coastal analyses.

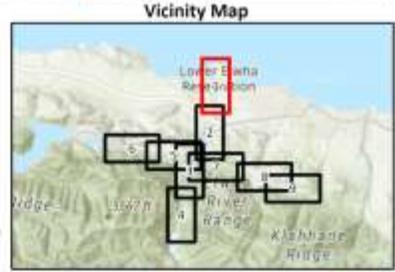


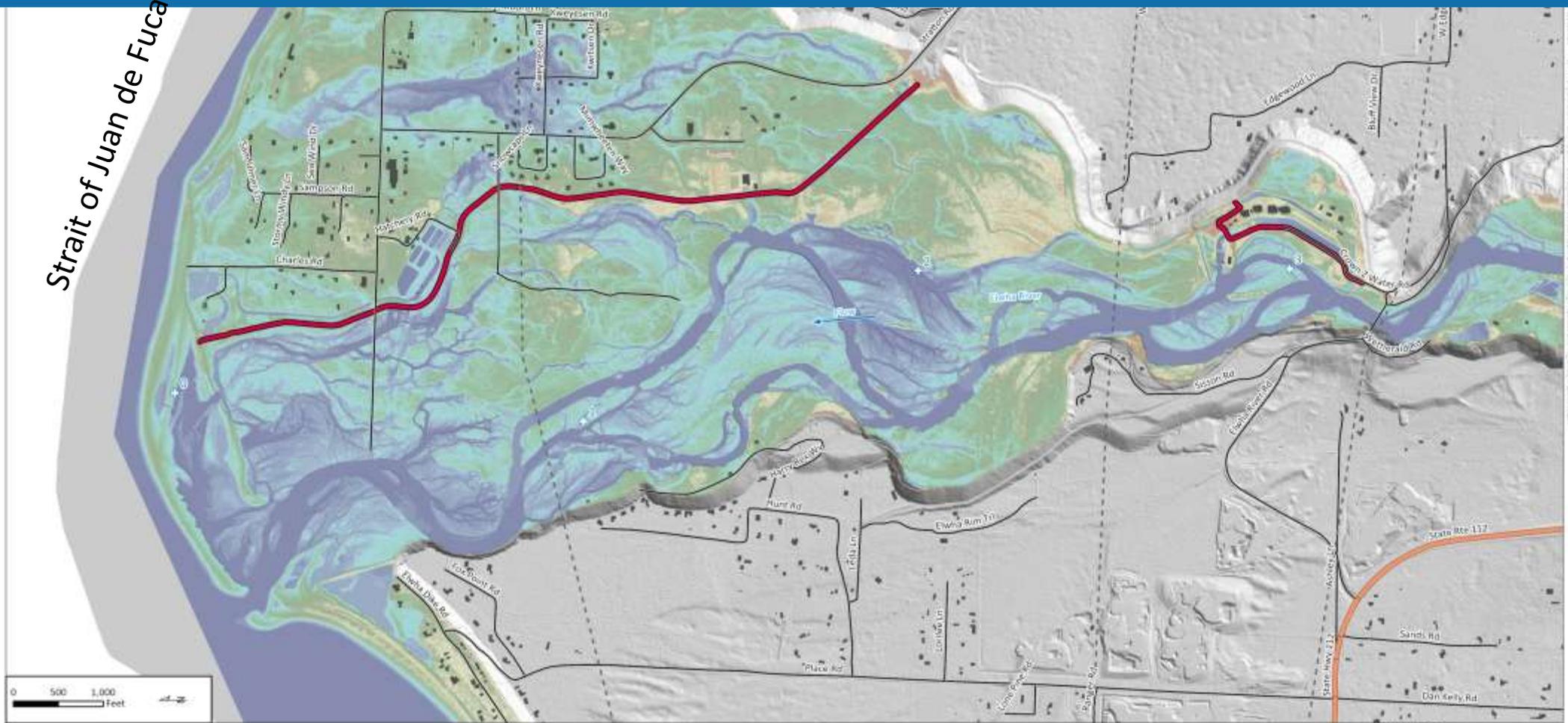
Elwha River CMZ Page 1 of 9
CMZ Detail
Elwha River 1

- - - Reach Breaks
- ⊙ River Miles
- State Highways
- Other Roads
- Buildings
- WGS Mapped Bedrock
- WGS Mapped Landslides
- Potentially Unstable Slopes
- Channel Migration Zone
 - Alluvial Fan
 - Avulsion Hazard Zone
 - Erosion Setback Area
 - Geotechnical Setback
 - Historical Migration Zone
 - Disconnected CMZ
- Regulatory CMZ
- 2018 Active Channel

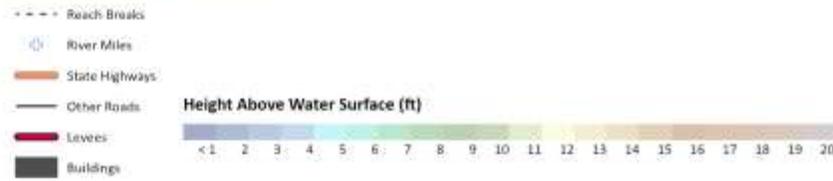
NSD Natural Systems Design
CCS Coastal Geologic Services

Sources:
River Miles: USGS / WSHA
Levees: USACE
Roads: Clallam County
Buildings: Microsoft Washington State Buildings
Elevation: 2011, 2025 WA LiDAR Portal
Geology: Washington Bedrock Series (W055 / 056)

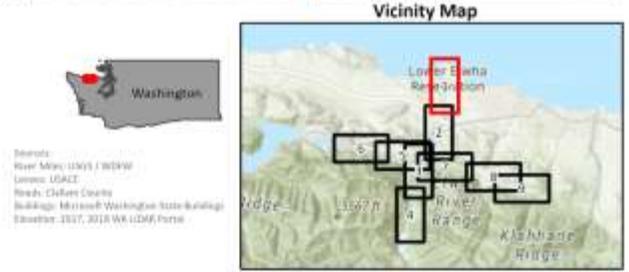


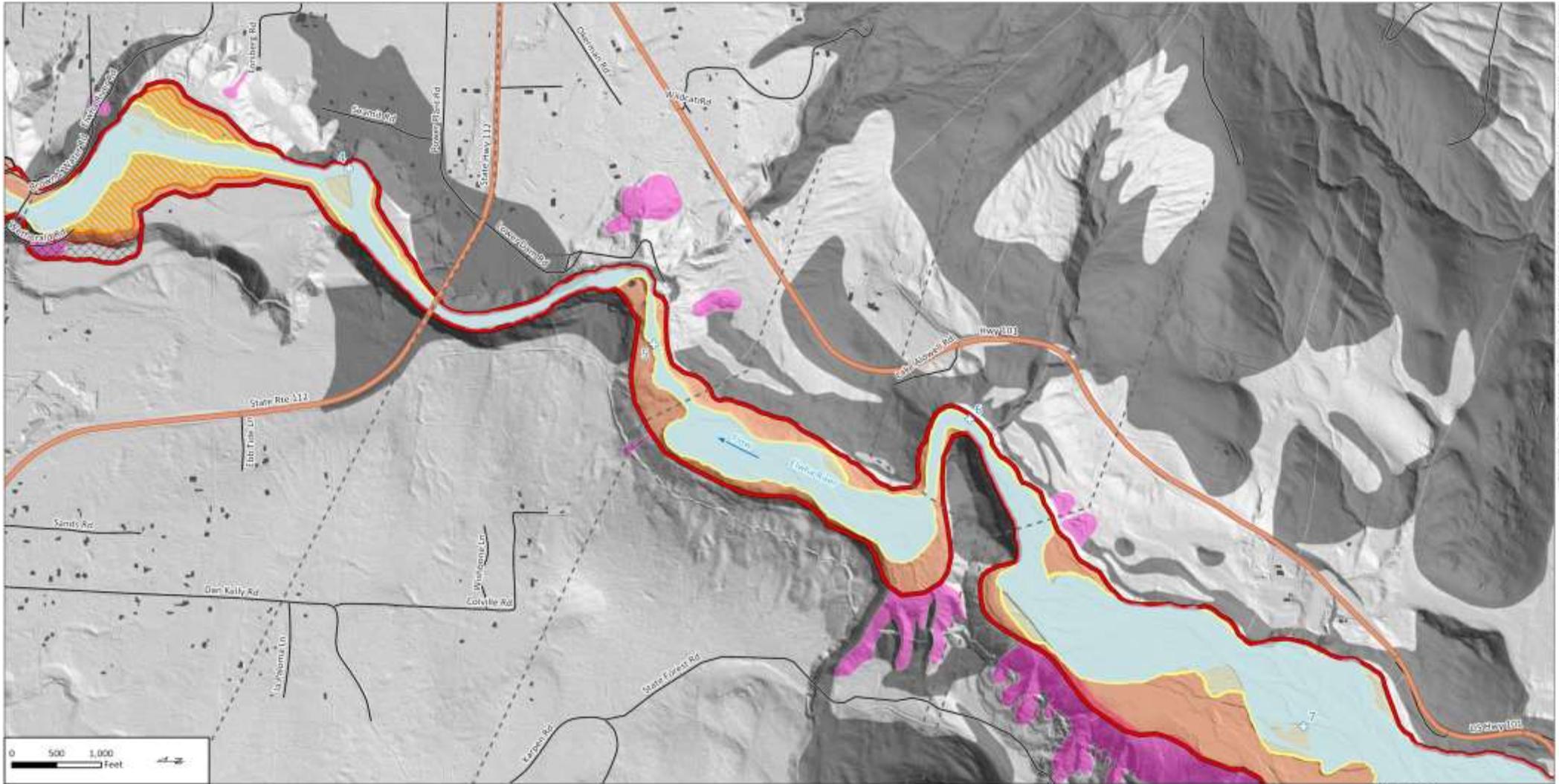


Elwha River CMZ Page 1 of 9
Relative Elevation Model
Elwha River 1



NSD National Systems Design
CCS Coastal Geologic Services



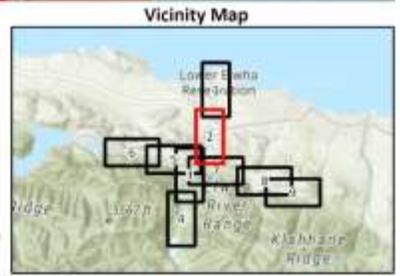


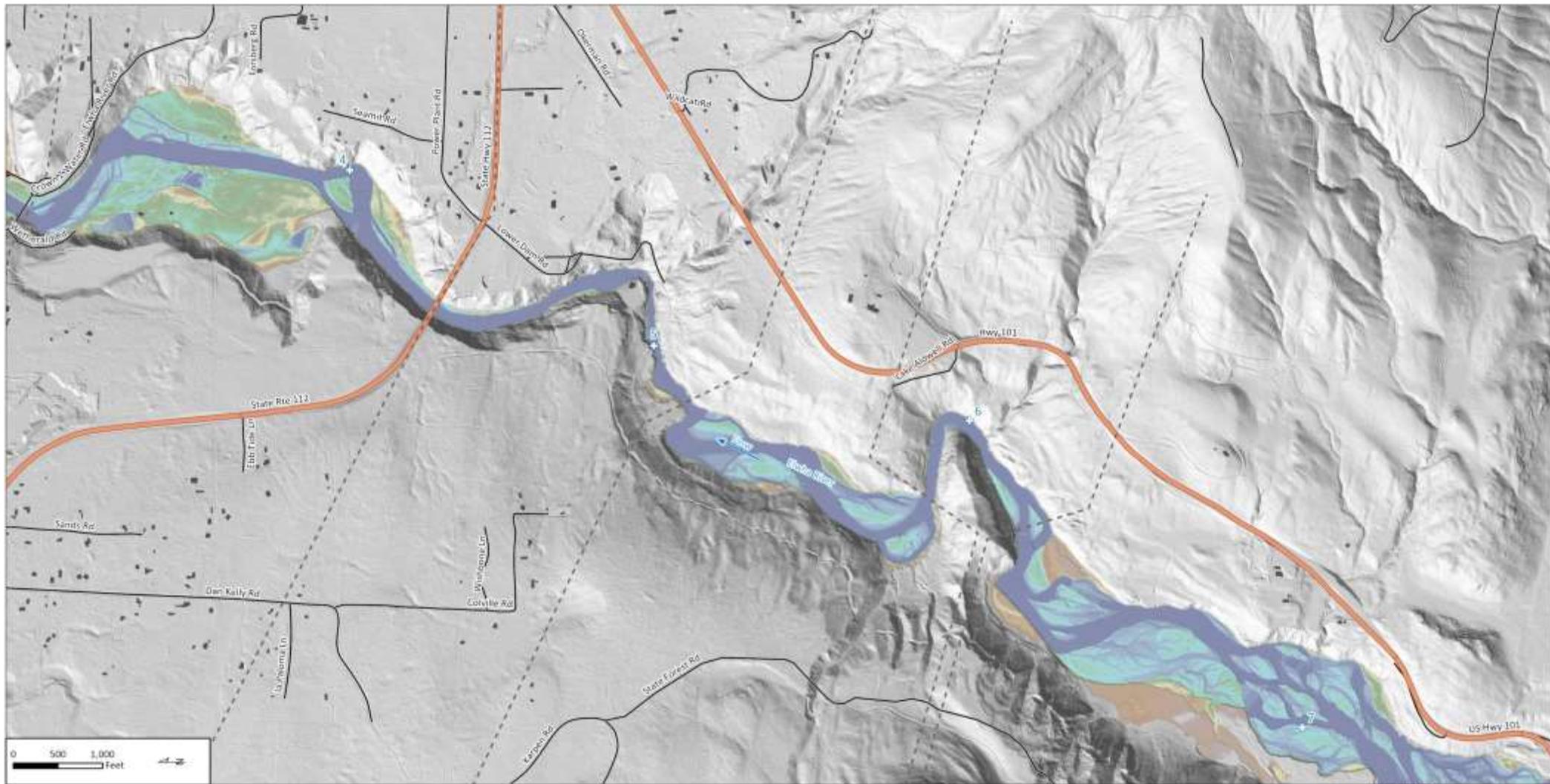
Elwha River CMZ Page 2 of 9
 CMZ Detail
 Elwha River 2

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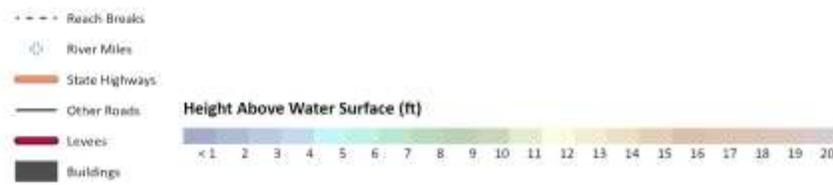
NSD Natural Systems Design
 CCS Coastal Geologic Services

Sources:
 River Miles: USGS / WSHA
 Geology: USGS
 Roads: Clallam County
 Buildings: Northwest Washington State Buildings
 Elevation: 2011, 2028 WA 3.044 Portal
 Geology: Washington Geologic Survey (WGS) / USGS

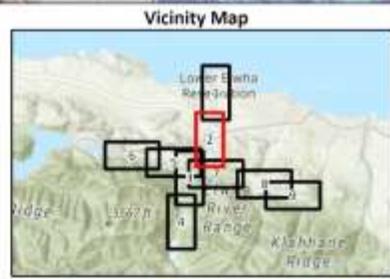


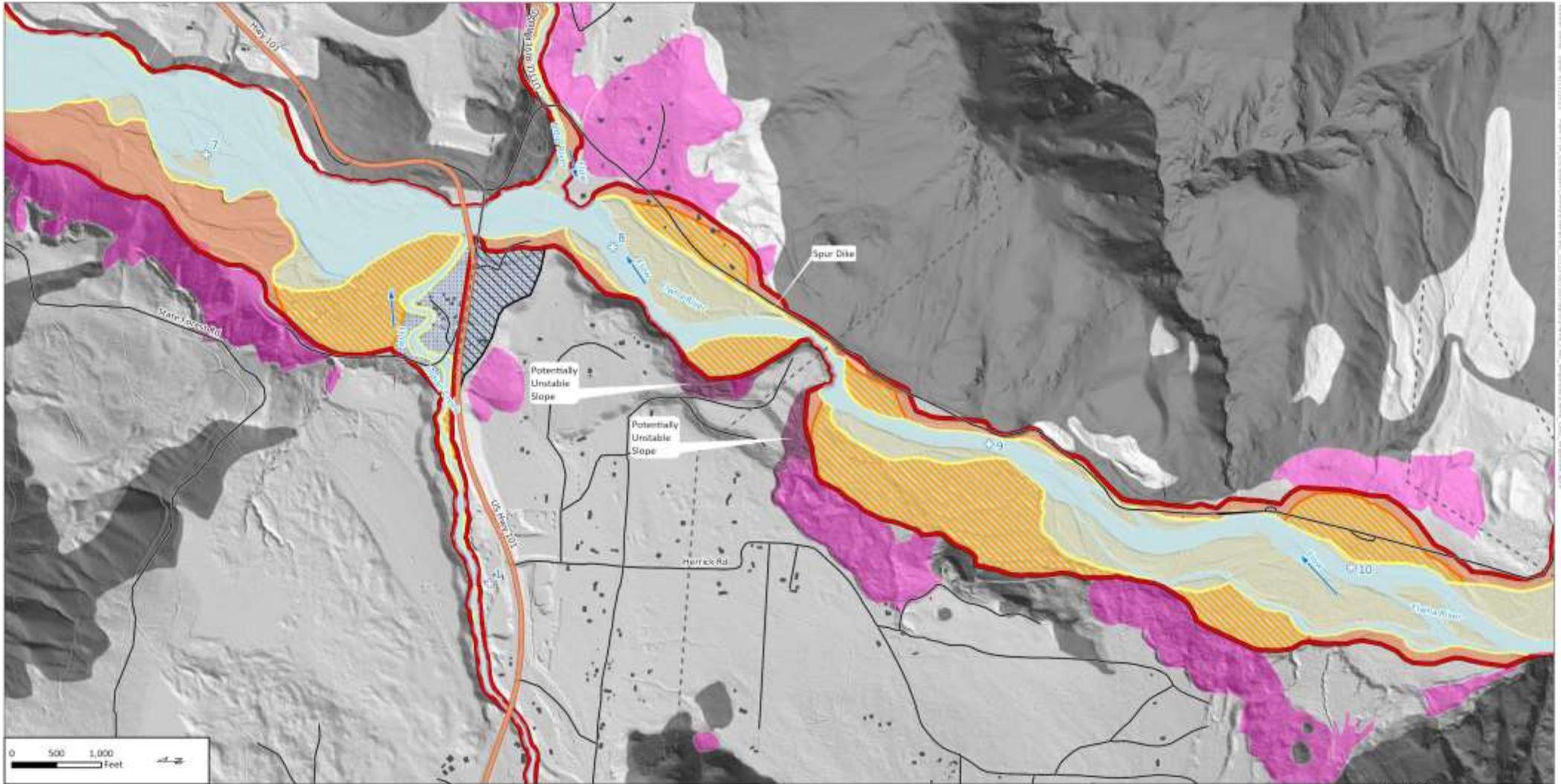


Elwha River CMZ Page 2 of 9
 Relative Elevation Model
 Elwha River 2



Source: River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LIDAR Point

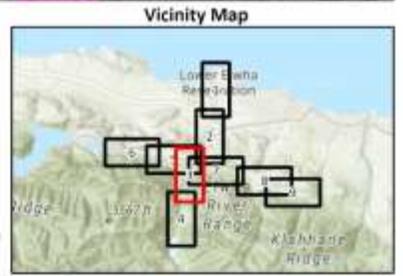


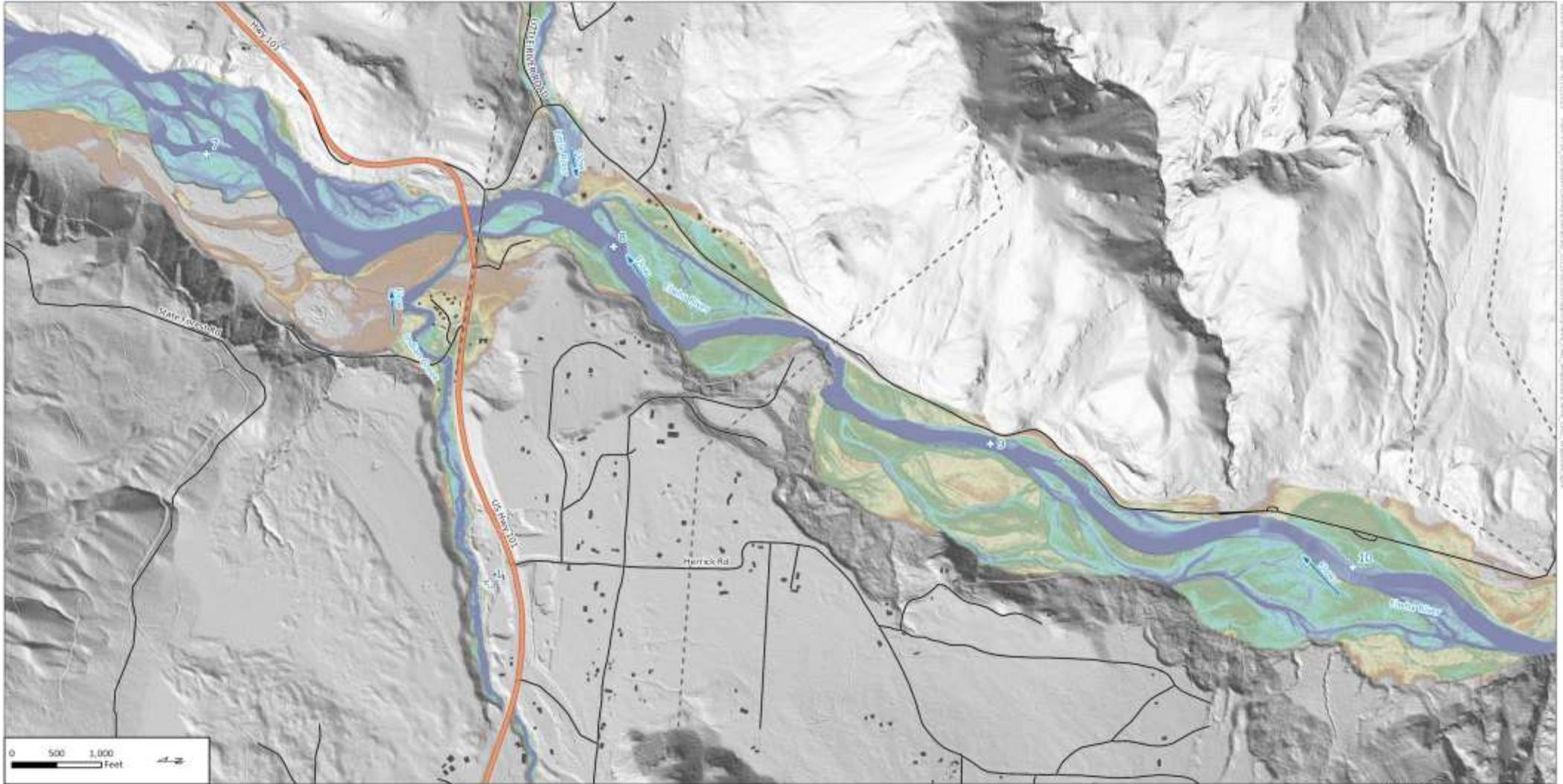


Elwha River CMZ Page 3 of 9
 CMZ Detail
 Elwha River 3

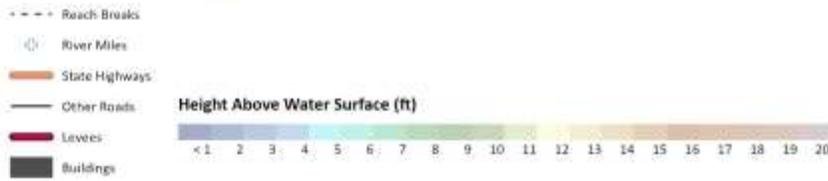
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Sources:
 River Miles: USGS / WSHA
 Geology: USACE
 Roads: Chelan County
 Buildings: Northwest Washington State Building
 Elevation: 2011, 2028 WA 3,048 Portal
 Geology: Washington Bedrock Series (W05) / USGS

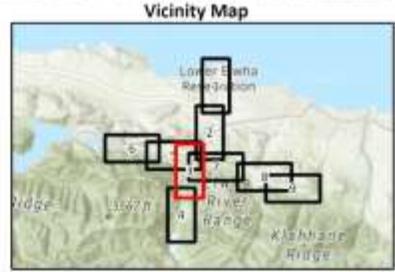


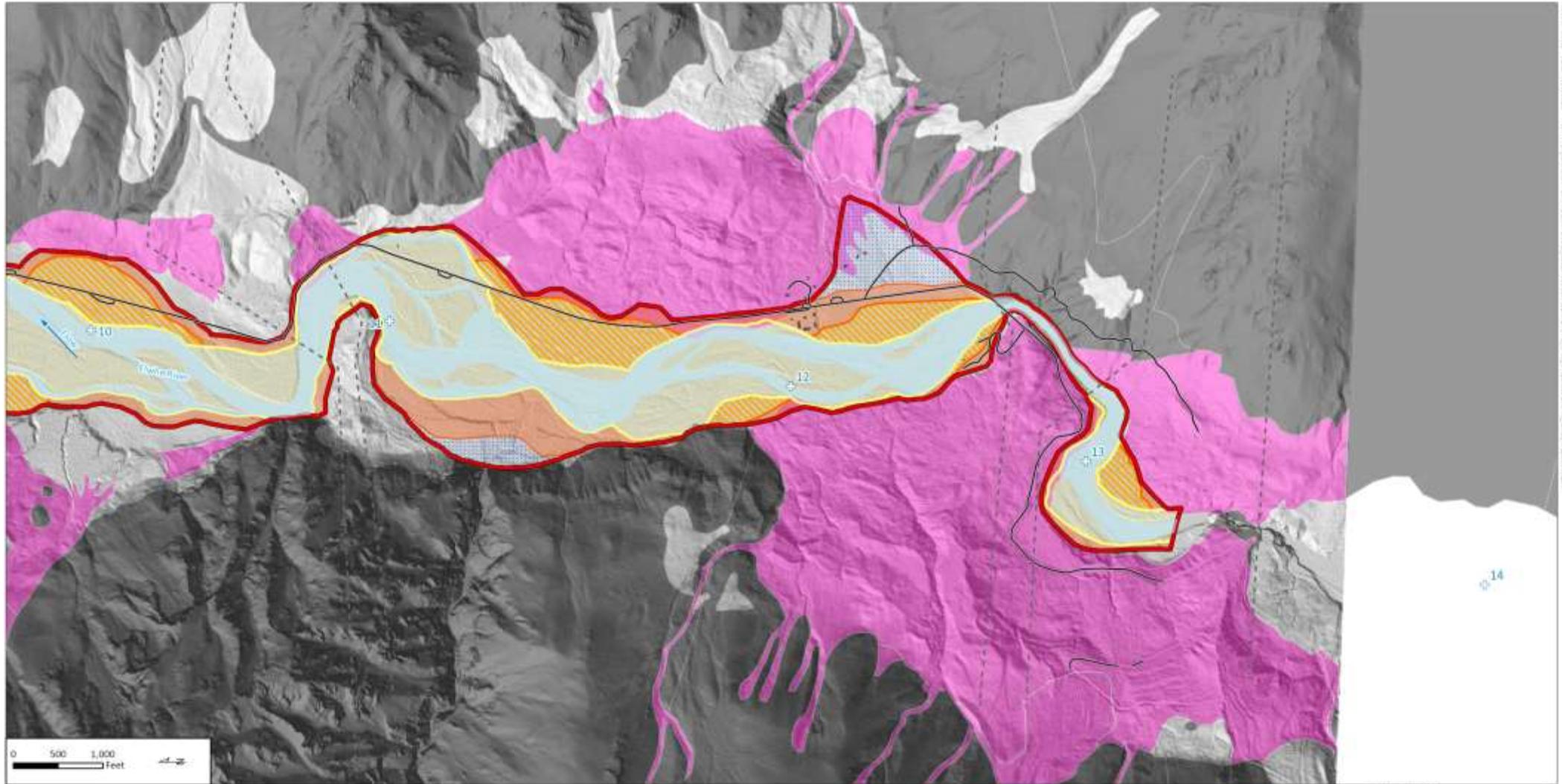


Elwha River CMZ Page 3 of 9
 Relative Elevation Model
 Elwha River 3



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clark County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LIDAR Point





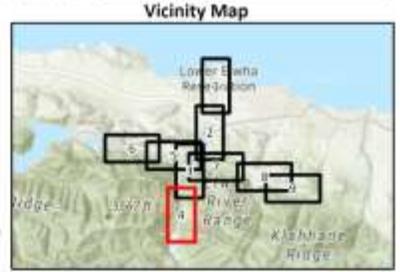
Elwha River CMZ Page 4 of 9
 CMZ Detail
 Elwha River 4

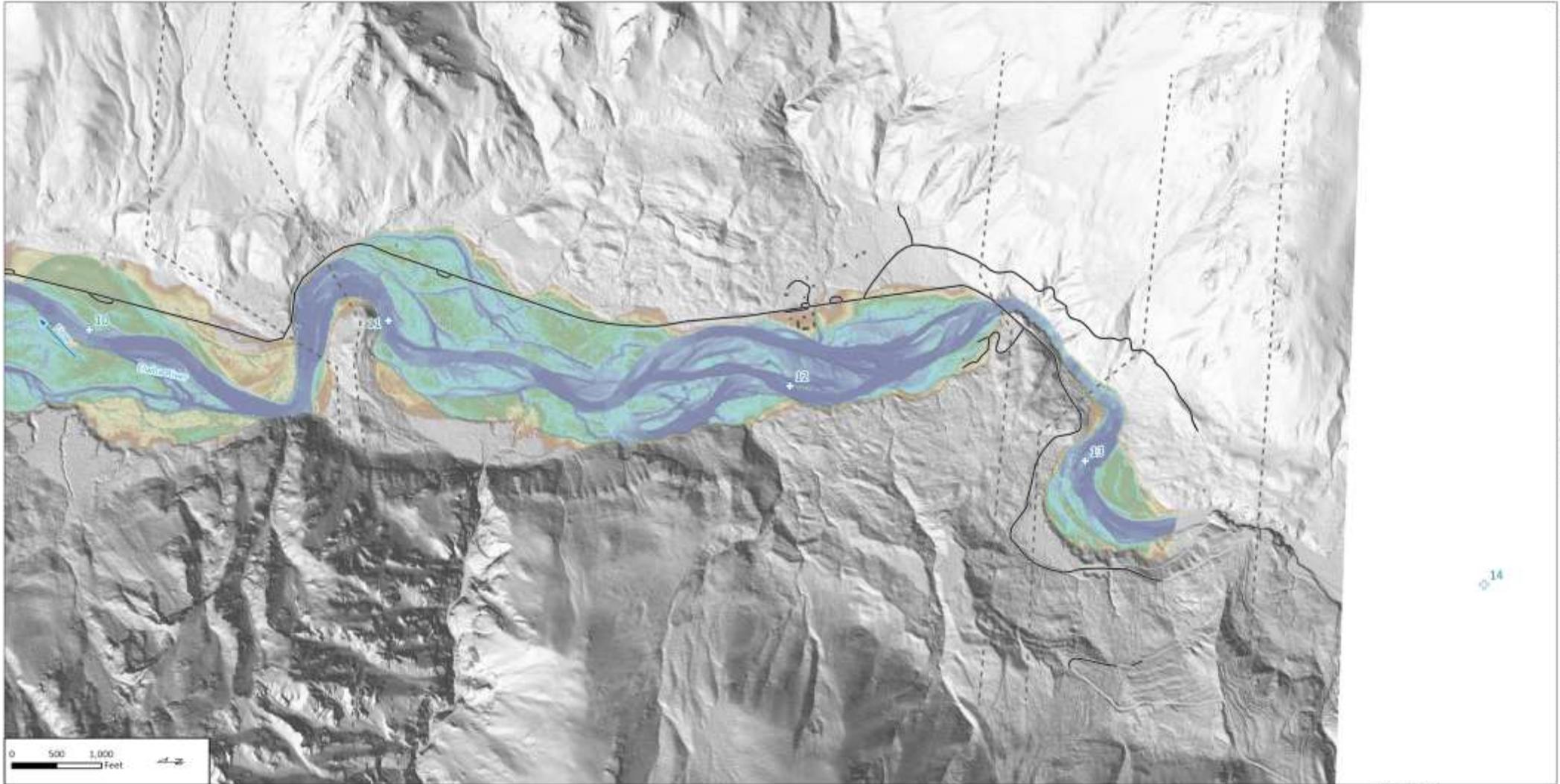
- - - Reach Breaks
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NSD Natural Systems Design
 CCS Coastal Geologic Services

Washington

Sources:
 River Miles: USGS / WSHA
 Geology: USGS
 Roads: Duglum County
 Buildings: Microsoft Washington State Buildings
 Elevation: 2011, 2028 WA 3,048 Portal
 Geology: Washington Bedrock Series TW05 / USGS



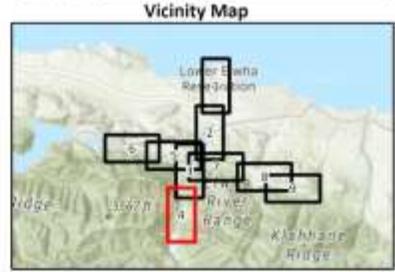


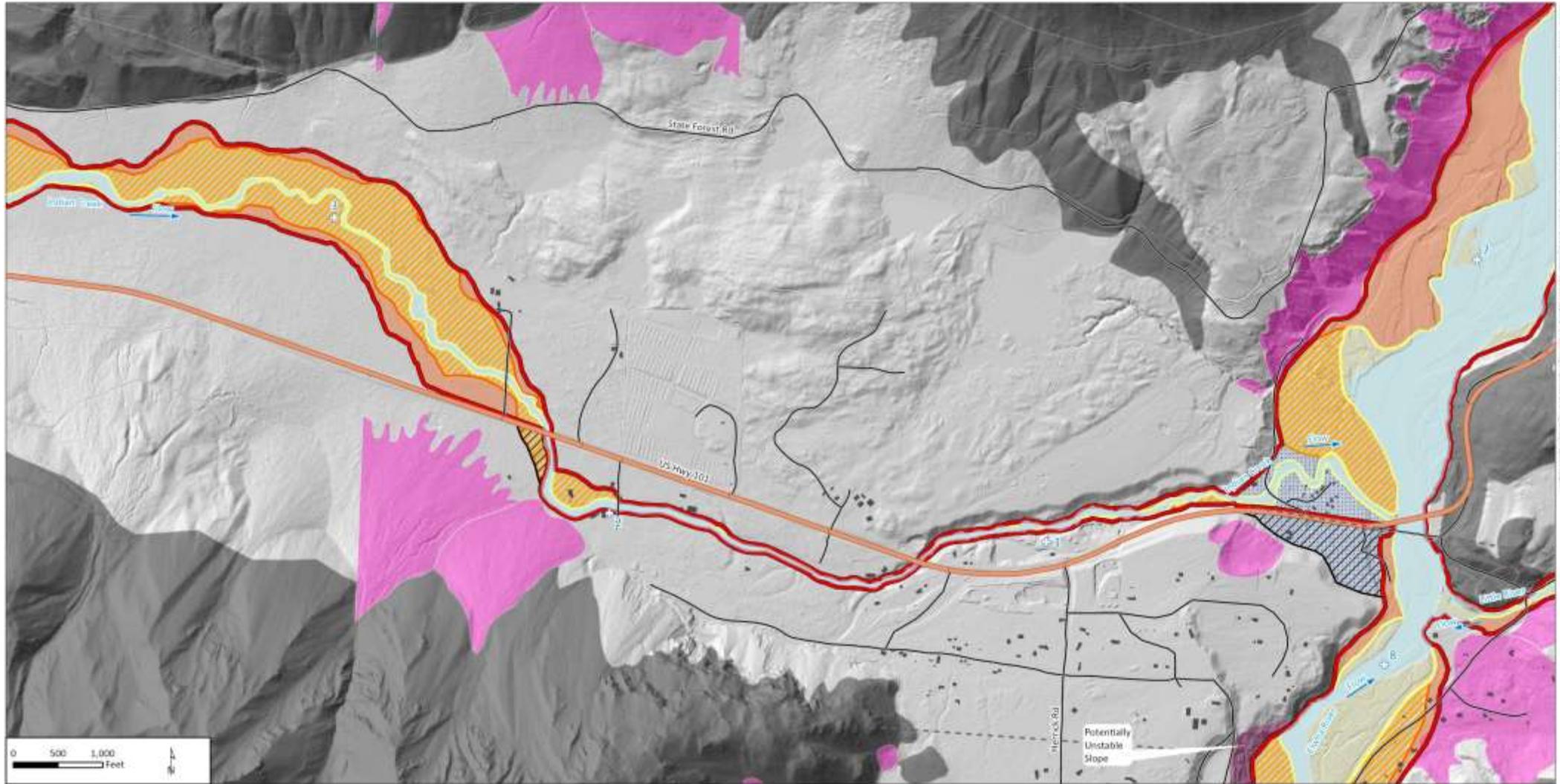
Elwha River CMZ Page 4 of 9
 Relative Elevation Model
 Elwha River 4

- Reach Breaks
- ⊙ River Miles
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- Other Roads
- █ Levees
- █ Buildings



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LDAR Portal



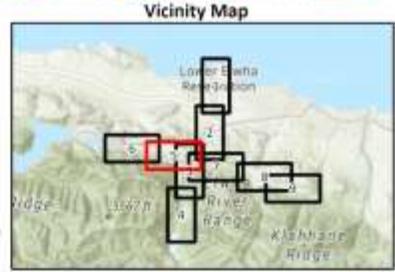


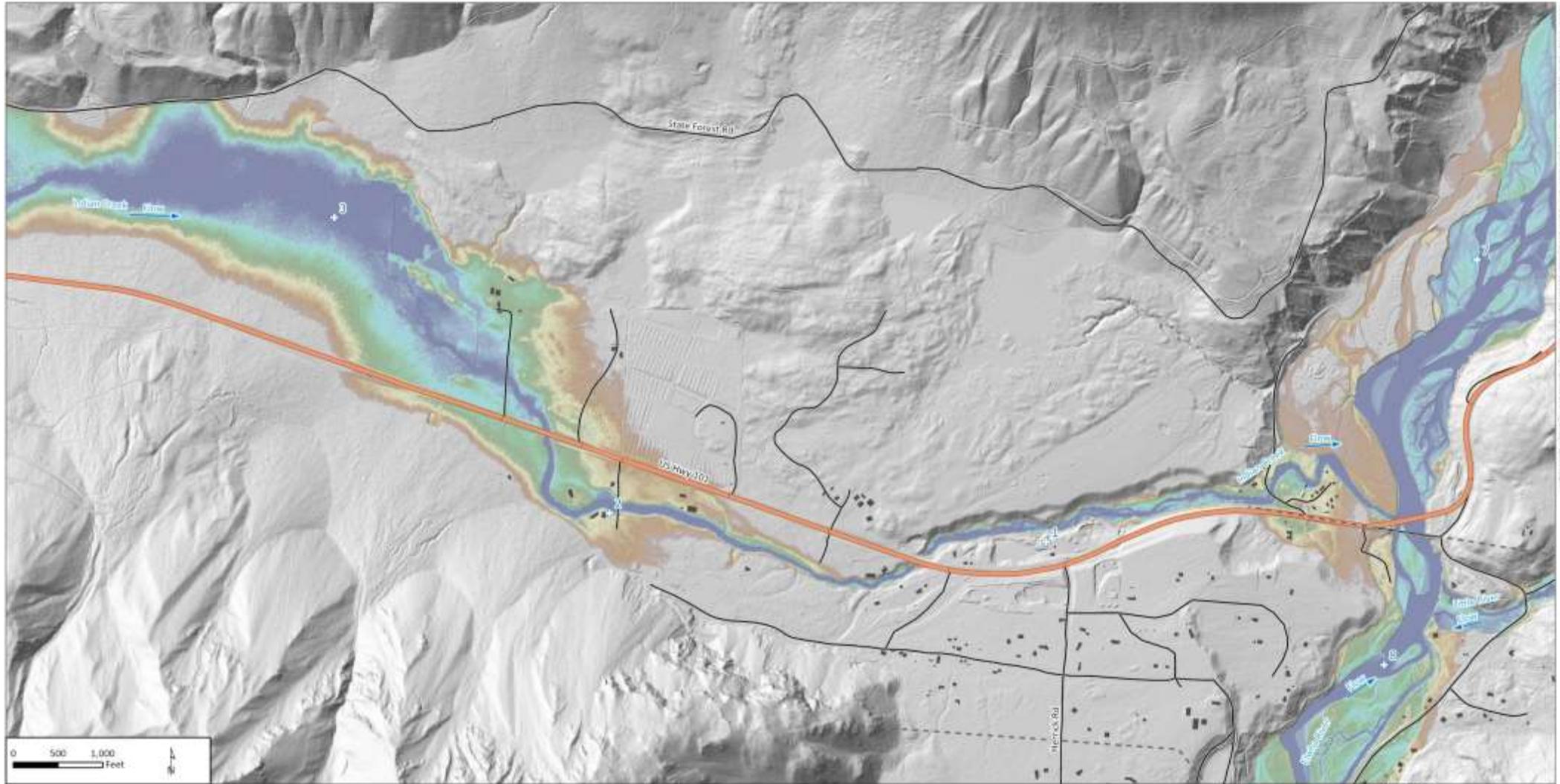
Elwha River CMZ Page 5 of 9
 CMZ Detail
 Indian Creek 1

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 CCS Coastal Geologic Services

Sources:
 River Miles: USGS / WSHA
 Geology: USGS
 Roads: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 2011, 2028 WA 3,048 Portal
 Geology: Washington Bedrock Series (WBS) / USGS



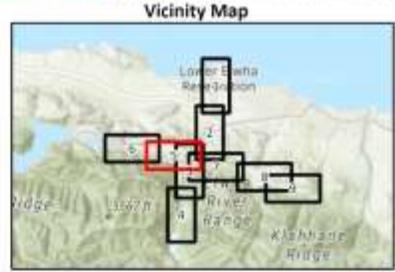


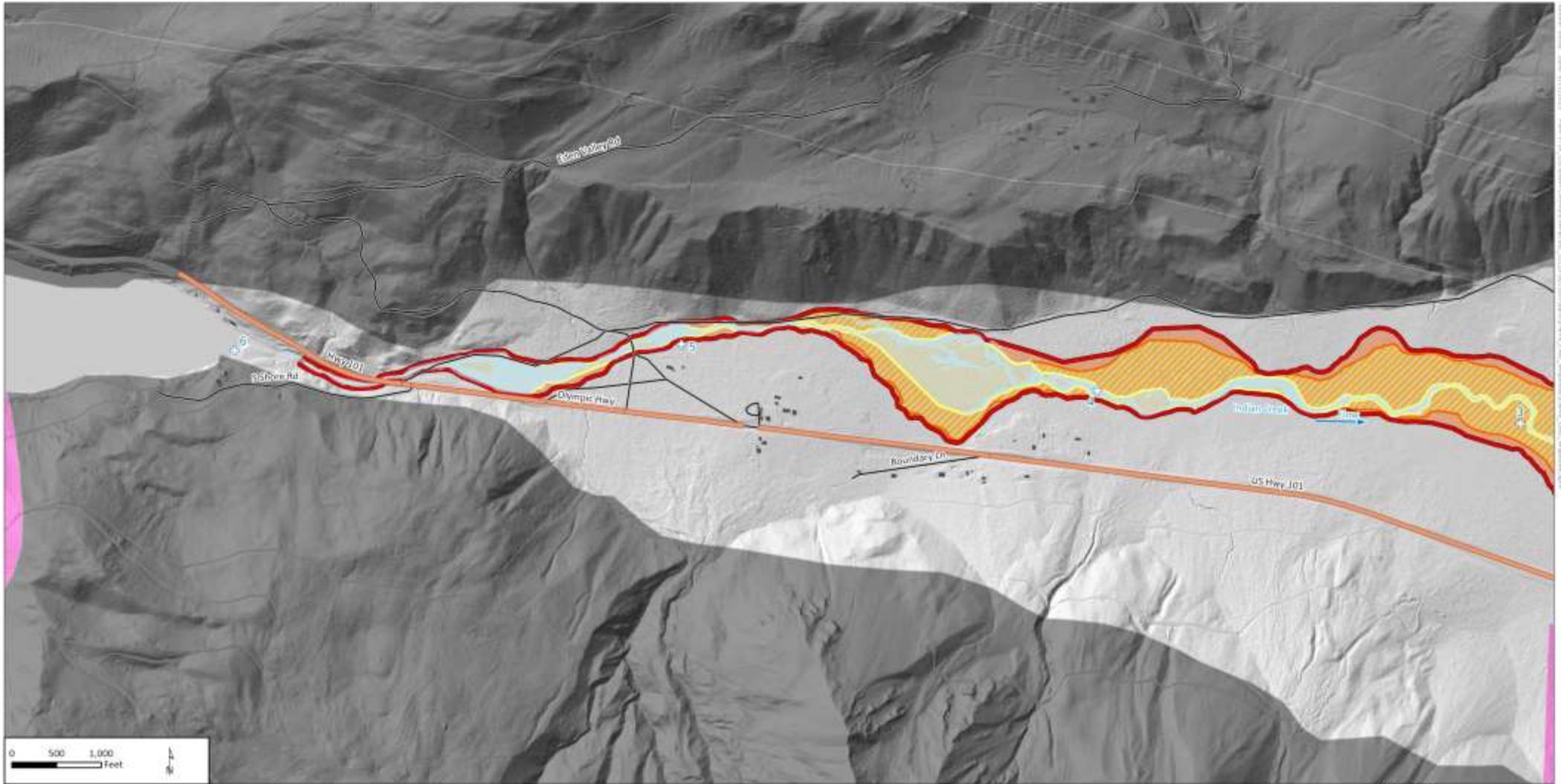
Elwha River CMZ Page 5 of 9
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- █ Levees
- █ Buildings



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Reach: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LIDAR Point

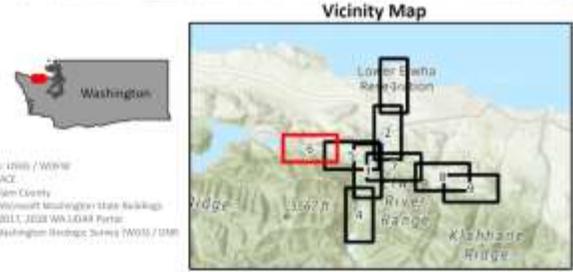




Elwha River CMZ Page 6 of 9
 CMZ Detail
 Indian Creek 2

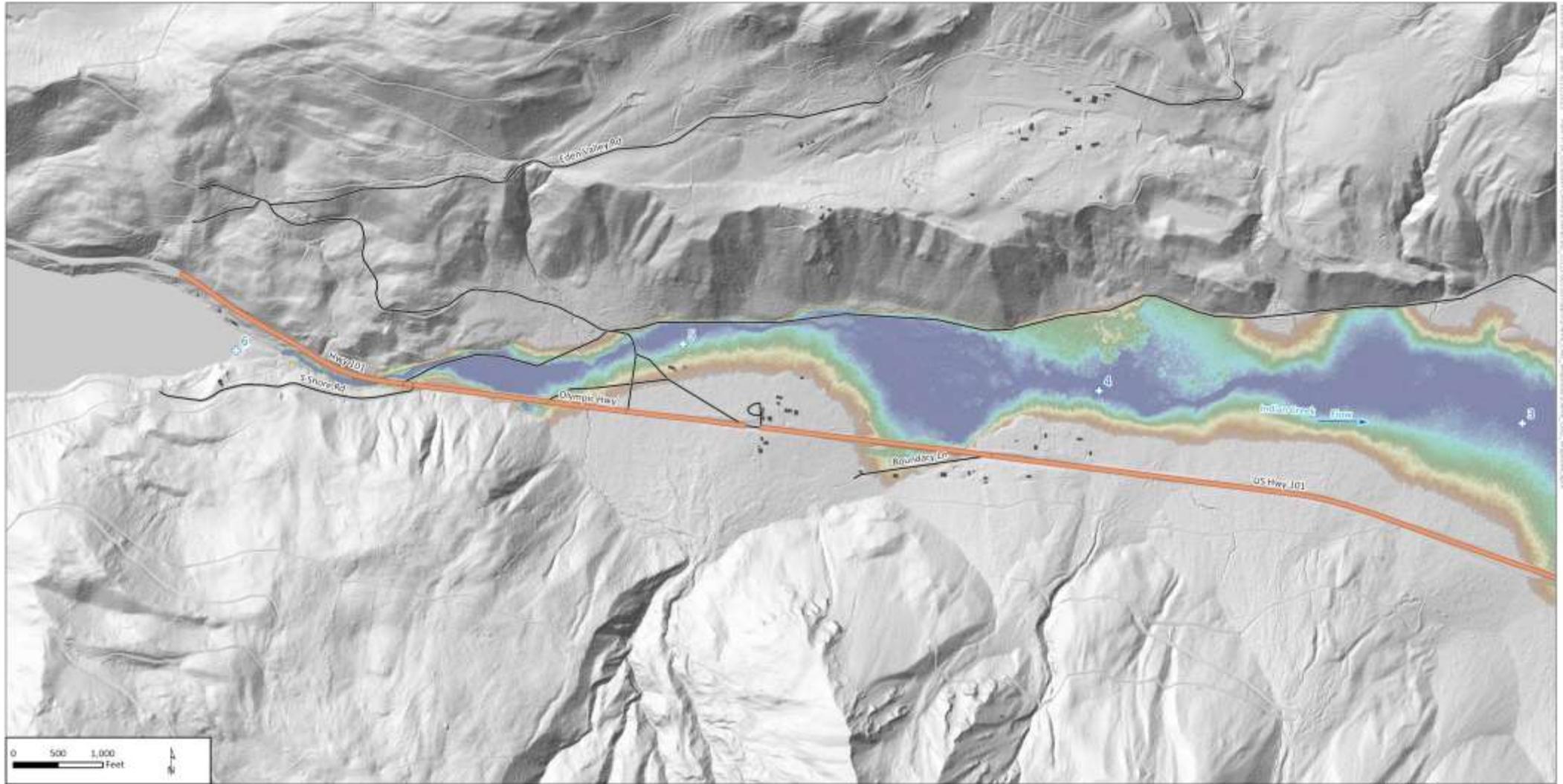
- | | | |
|-----------------------------|---------------------------|---------------------|
| - - - Reach Breaks | Alluvial Fan | Regulatory CMZ |
| River Miles | Avulsion Hazard Zone | 2018 Active Channel |
| State Highways | Erosion Setback Area | |
| Other Roads | Geotechnical Setback | |
| Buildings | Historical Migration Zone | |
| WGS Mapped Bedrock | Disconnected CMZ | |
| WGS Mapped Landslides | | |
| Potentially Unstable Slopes | | |

NSD Natural Systems Design
 CCS Coastal Geologic Services



Sources:
 River Miles: USGS / WSHA
 Geology: USACE
 Roads: Clallam County
 Buildings: Northwest Washington State Buildings
 Elevation: 2011, 2020 WA 3,048 Portal
 Geology: Washington Bedrock Series (WBS) / USGS



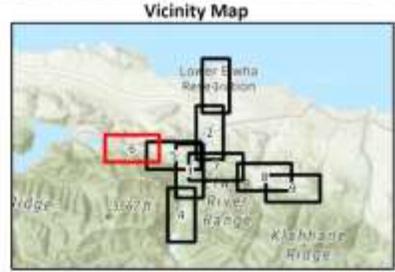


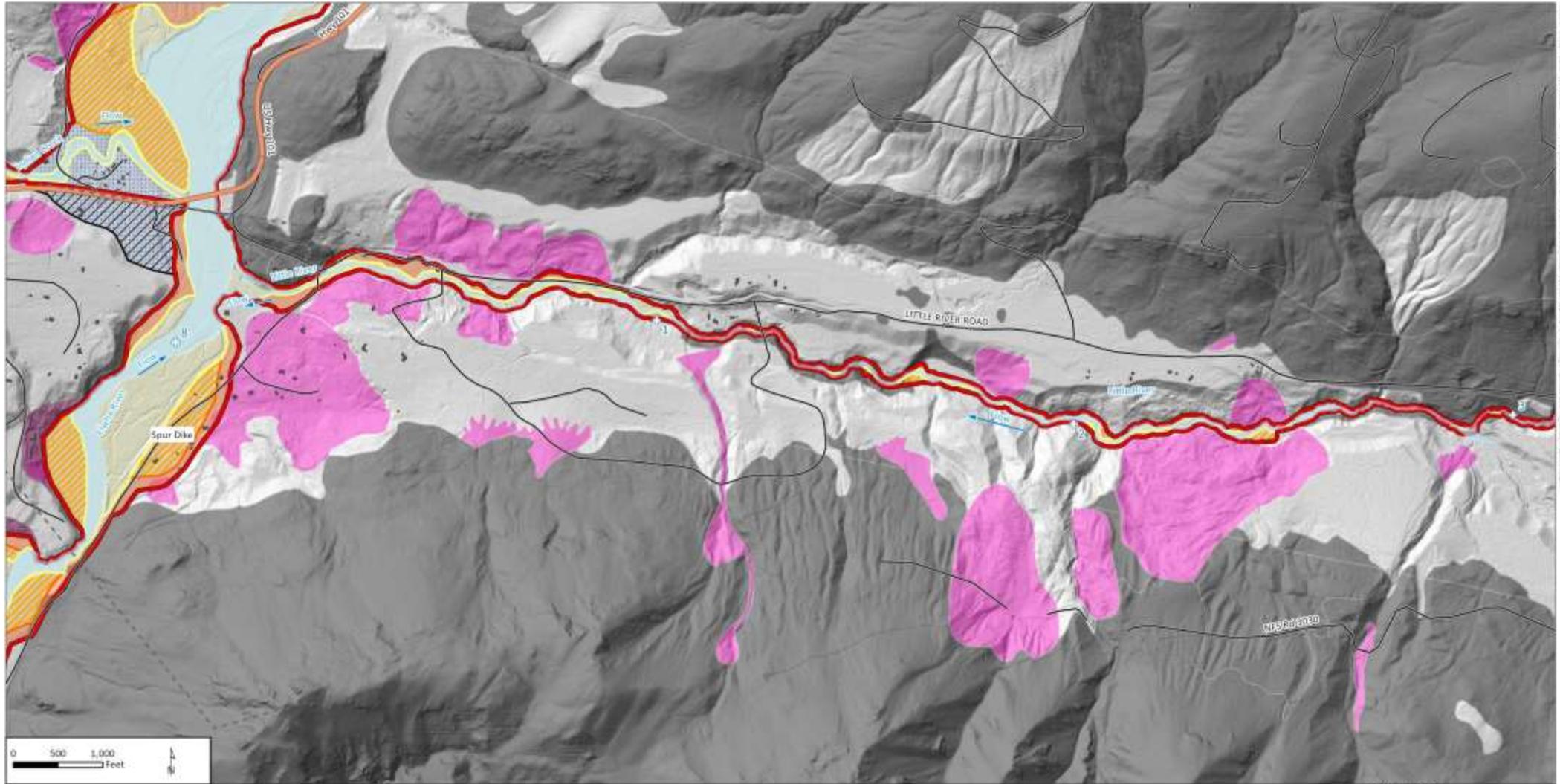
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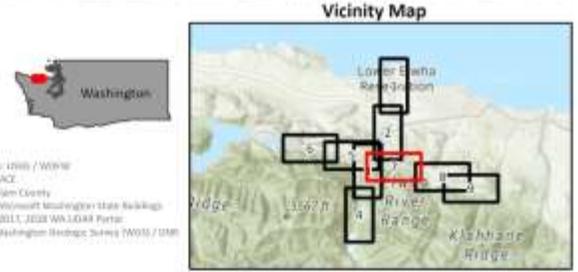




Elwha River CMZ Page 7 of 9
 CMZ Detail
 Little River 1

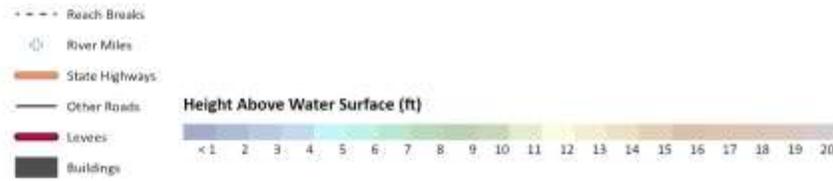
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|-----------------------|-----------------------------|---------------------|
| --- Reach Breaks | Alluvial Fan | Regulatory CMZ |
| River Miles | Avulsion Hazard Zone | 2018 Active Channel |
| State Highways | Erosion Setback Area | |
| Other Roads | Geotechnical Setback | |
| Buildings | Historical Migration Zone | |
| WGS Mapped Bedrock | Disconnected CMZ | |
| WGS Mapped Landslides | Potentially Unstable Slopes | |

NSD Natural Systems Design
 CCS Coastal Geologic Services

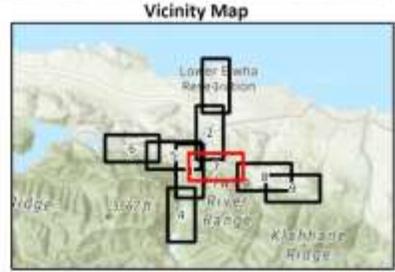




Elwha River CMZ Page 7 of 9
 Relative Elevation Model
 Little River 1



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LIDAR Point



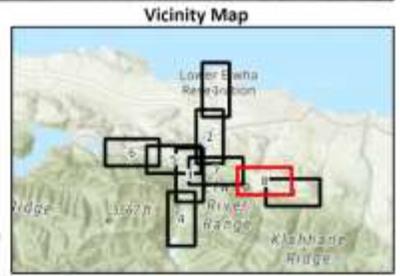


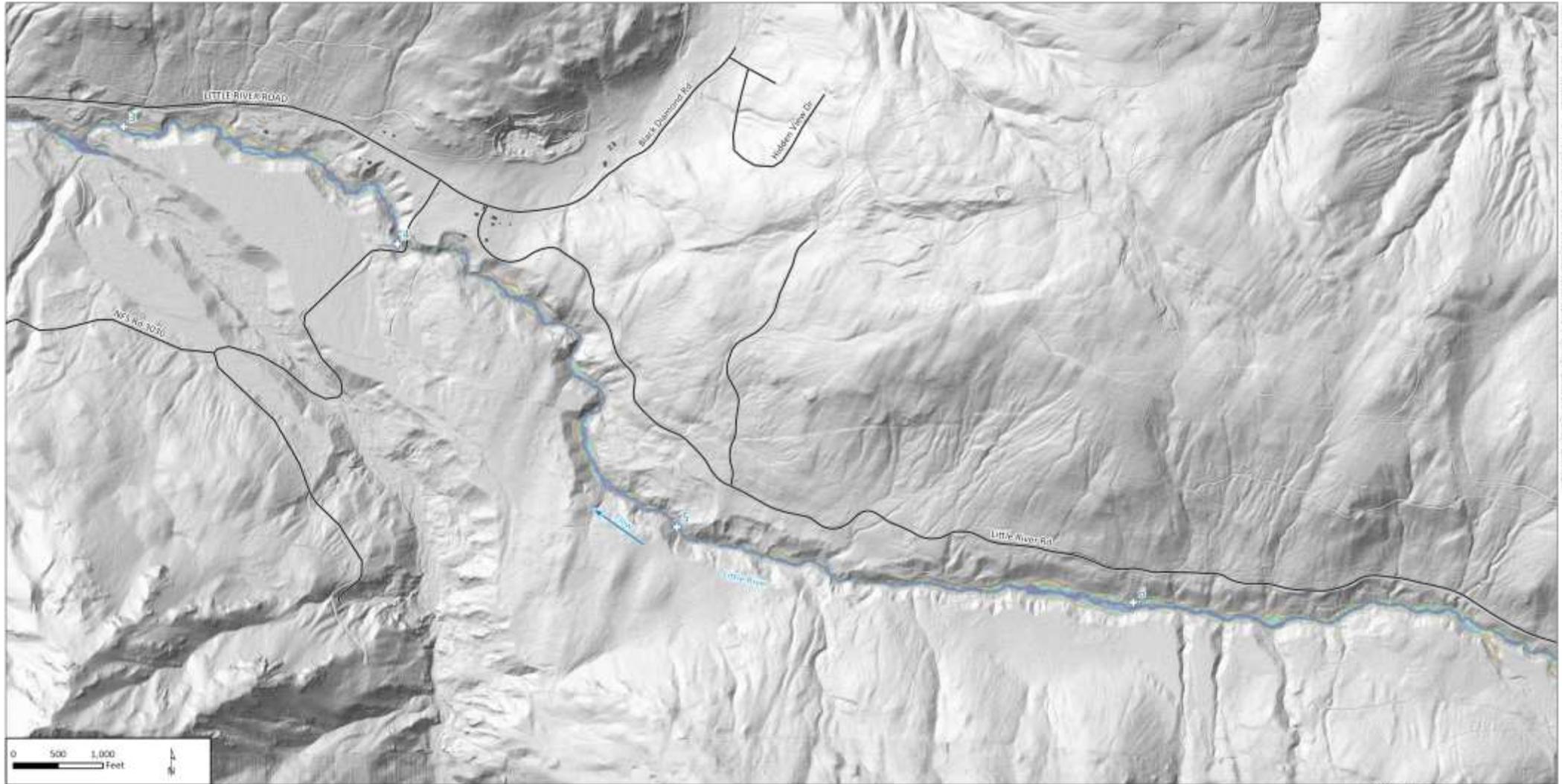
Elwha River CMZ Page 8 of 9
 CMZ Detail
 Little River 2

- - - Reach Breaks
 - ⊕ River Miles
 - State Highways
 - Other Roads
 - Buildings
 - WGS Mapped Bedrock
 - WGS Mapped Landslides
 - Potentially Unstable Slopes
- Channel Migration Zone**
 - Alluvial Fan
 - Avulsion Hazard Zone
 - Erosion Setback Area
 - Geotechnical Setback
 - Historical Migration Zone
 - Disconnected CMZ
- Regulatory CMZ**
 - 2018 Active Channel

NSD Natural Systems Design
 CCS Coastal Geologic Services

Sources:
 River Miles: USGS / WSHA
 Geology: USACE
 Roads: Clallam County
 Buildings: Northwest Washington State Building
 Elevation: 2011, 2028 WA 3,048 Portal
 Geology: Washington Bedrock Series (WBS) / USGS





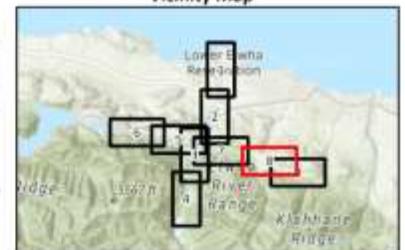
Elwha River CMZ Page 8 of 9
 Relative Elevation Model
 Little River 2

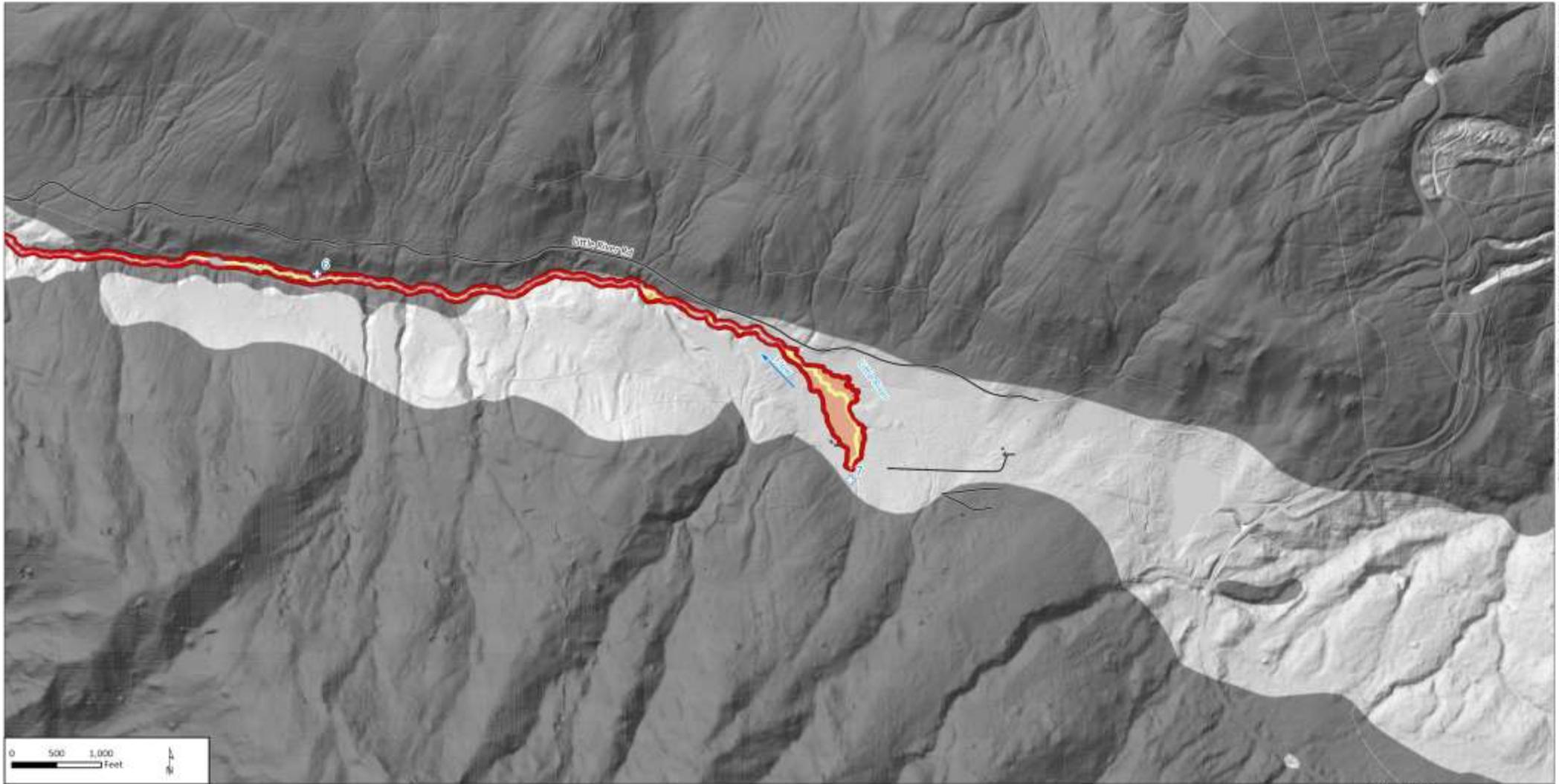
- Reach Breaks
- ⊙ River Miles
- State Highways
- Other Roads
- █ Levees
- █ Buildings



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clallam County
 Buildings: Microsoft Washington State Buildings
 Elevation: 1987, 2014 WA LIDAR Point

Vicinity Map

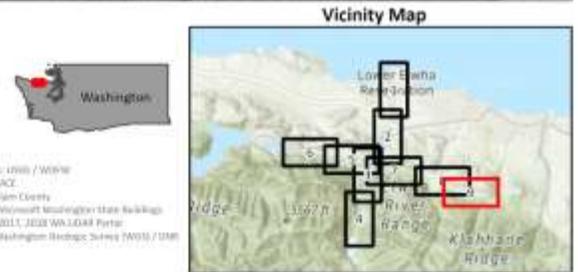




Elwha River CMZ Page 9 of 9
 CMZ Detail
 Little River 3

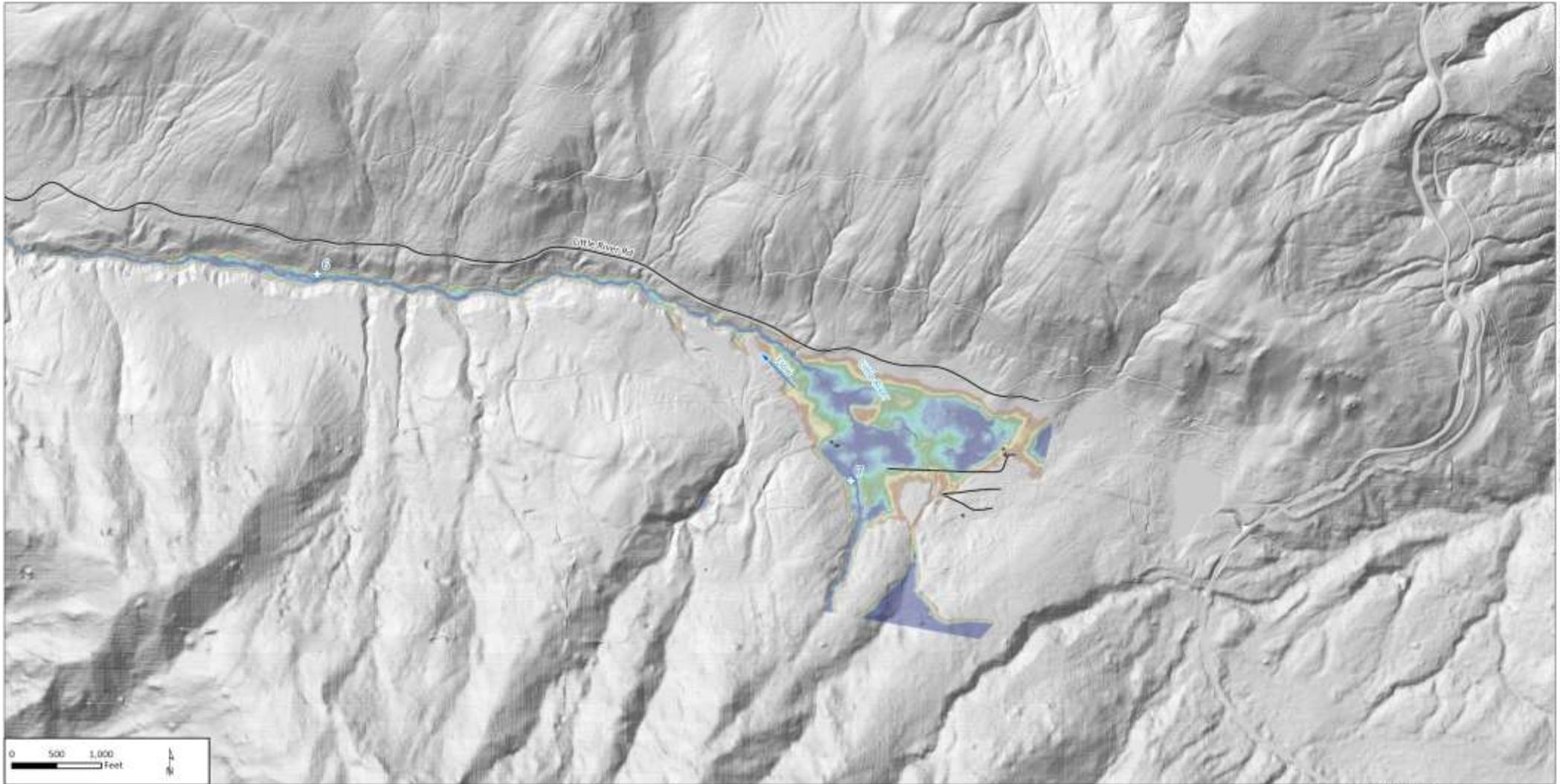
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NSD Natural Systems Design
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 Elevation: 2011, 2028 WA 3,048 Portal
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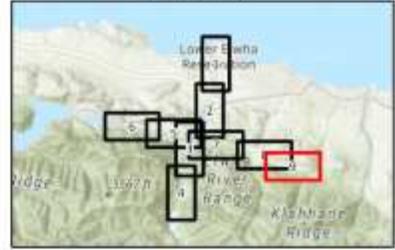
Elwha River CMZ Page 9 of 9
 Relative Elevation Model
 Little River 3

- - - Reach Breaks
- ⊙ River Miles
- State Highways
- Other Roads
- Levees
- Buildings



Source:
 River Miles: USGS / WDFW
 Levees: USACE
 Roads: Clallam County
 Buildings: Microsoft/ Washington State Building
 Elevation: 1987, 2018 WA LIDAR Point

Vicinity Map



Questions?

Clallam County DCD

Rebecca Mahan

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(360) 417-2322

Natural Systems Design

Tim Abbe, PhD, LEG, LHG

tim@naturaldes.com

(206) 681-8697

Aaron Lee, MS, PE

aaron@naturaldes.com

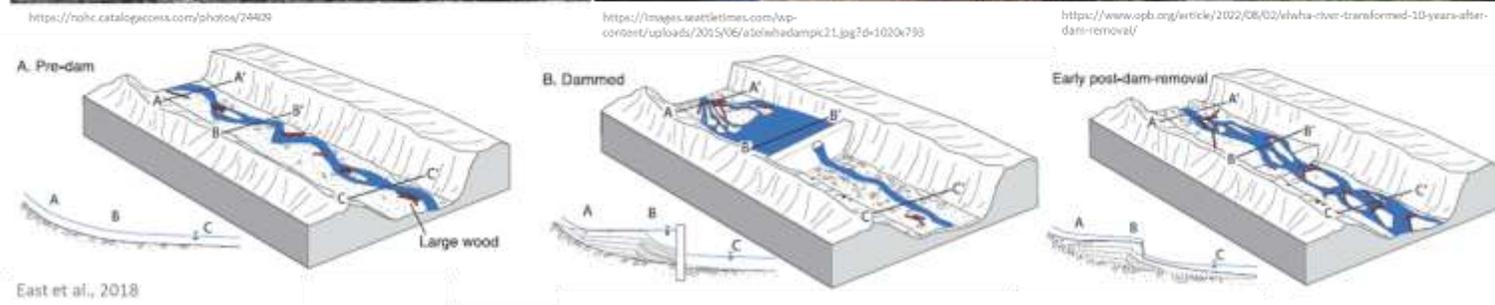
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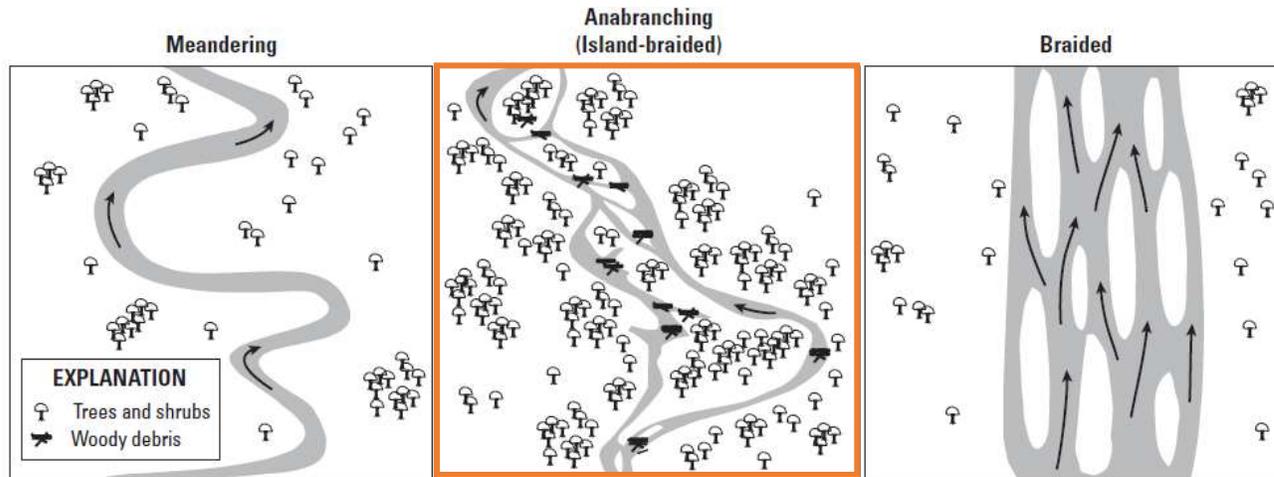
Olivia Vito, MNR

olivia@naturaldes.com

(360) 477-4848

- Flow and sediment transport regimes
- Geomorphic reach setting
- Dam operation and removal
- Ongoing channel evolution
- Existing infrastructure





Large wood influences stream morphology by slowing water and redirecting flow.

Anabranching planforms are characterized by channel splits around vegetated islands.

Logjams can increase stability and persistence of island/bars.

(a) Lower Elwha River at Rkm 4.0

Ritchie et al., 2018



The Elwha River is continuing to adjust from dam removal.

In the first 5 years...

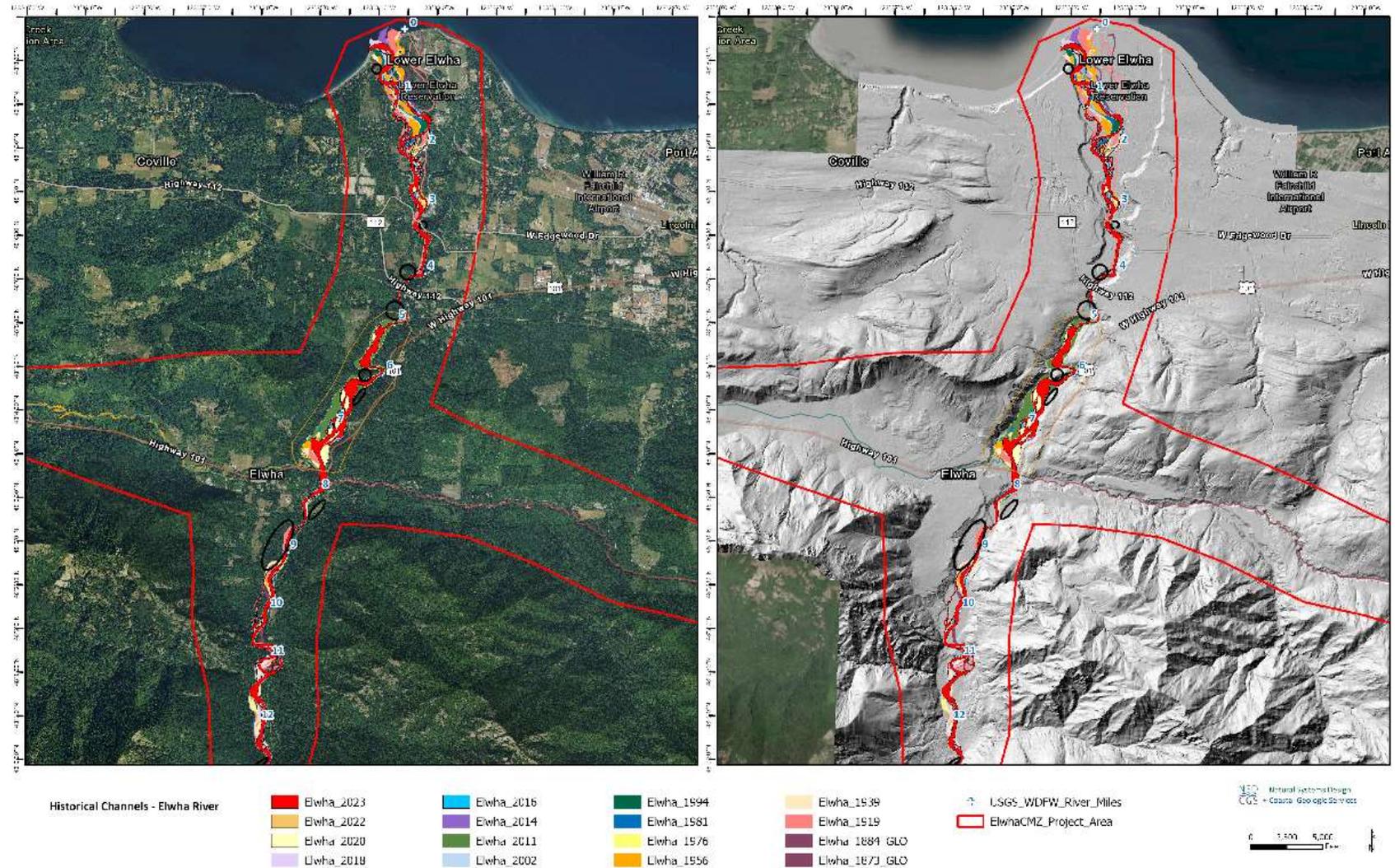
65% of reservoir sediment eroded (19Mt)

90% transported to Strait, expanding the delta

10% deposited in River

Update or Remove

1. Conduct draft CMZ mapping for Elwha R., Little R., Indian Cr. (ongoing)
2. Collect input from Co-Managers, Community, and Stakeholders (ongoing)
3. Revise draft CMZ maps (early 2025)
4. Presentation of final CMZ maps (Spring 2025)



1. Interactive mapping session - Today
2. Online Questionnaire
3. Website link: <https://www.clallamcountywa.gov/1827/Elwha-River-Channel-Migration-Zone-Delin>

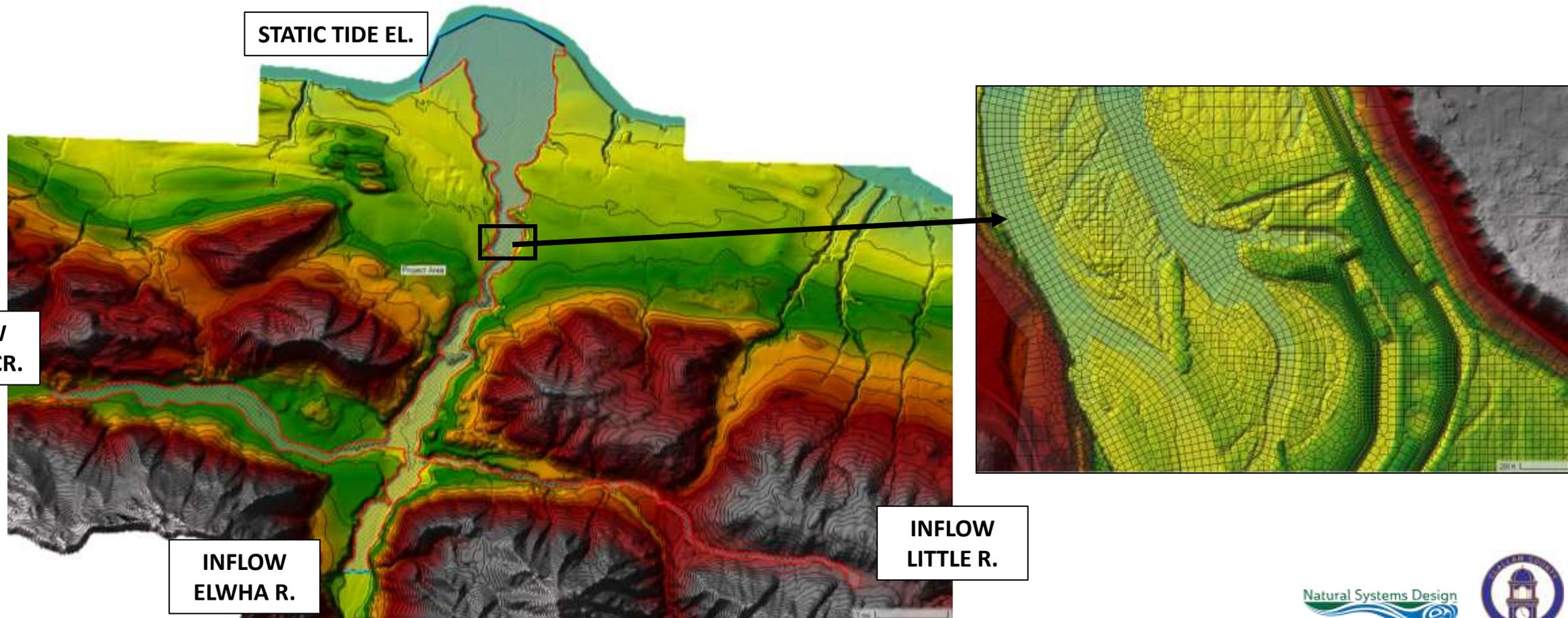
REMOVE?

QR Code to take
Questionnaire



HEC-RAS 2D hydraulic model

- Water surface elevation, depth, velocity output
- Peak flow analysis of Elwha River, Little River, and Indian Creek
- 2018 and 2014 LiDAR-based terrain
- Hydraulic roughness characterized by Manning's n-value (accounts for engineered logjams)



Elwha River – Dam removal



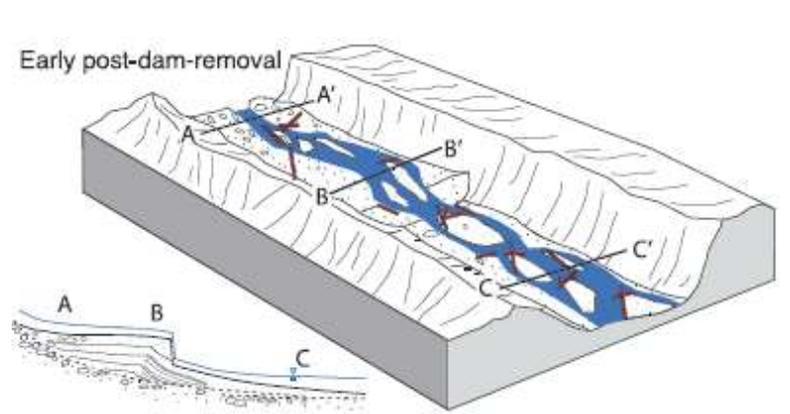
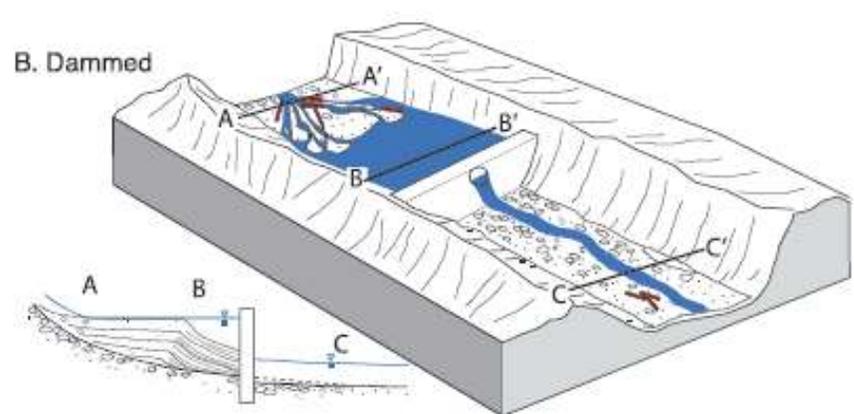
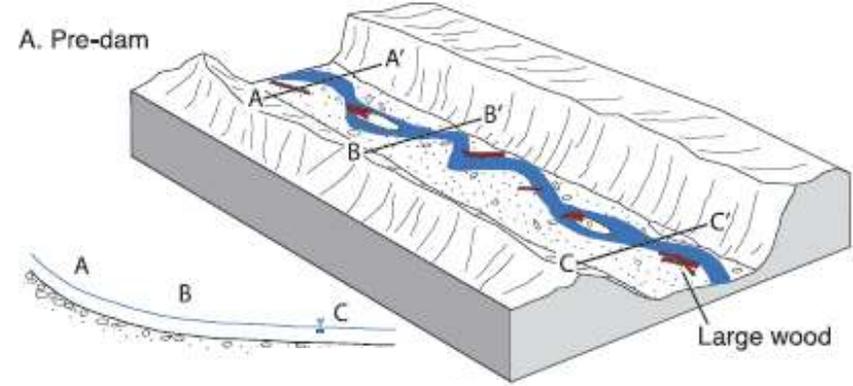
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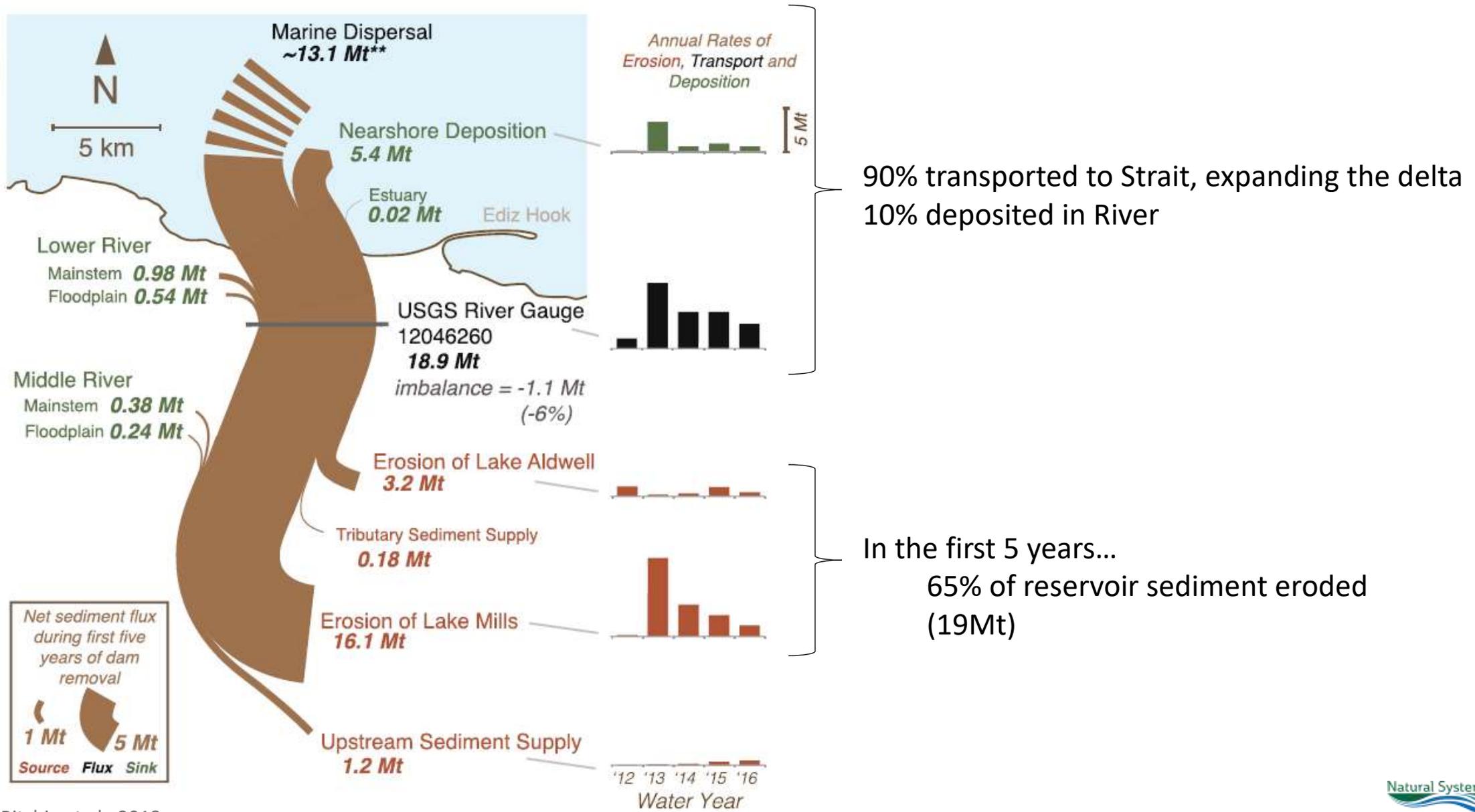
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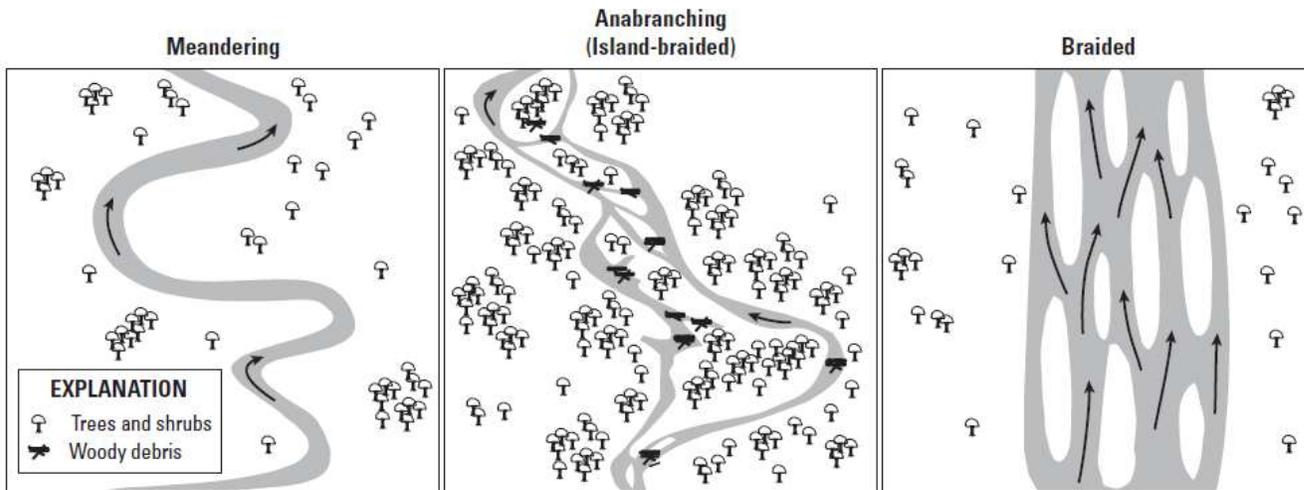


<https://www.opb.org/article/2022/08/02/elwha-river-transformed-10-years-after-dam-removal/>

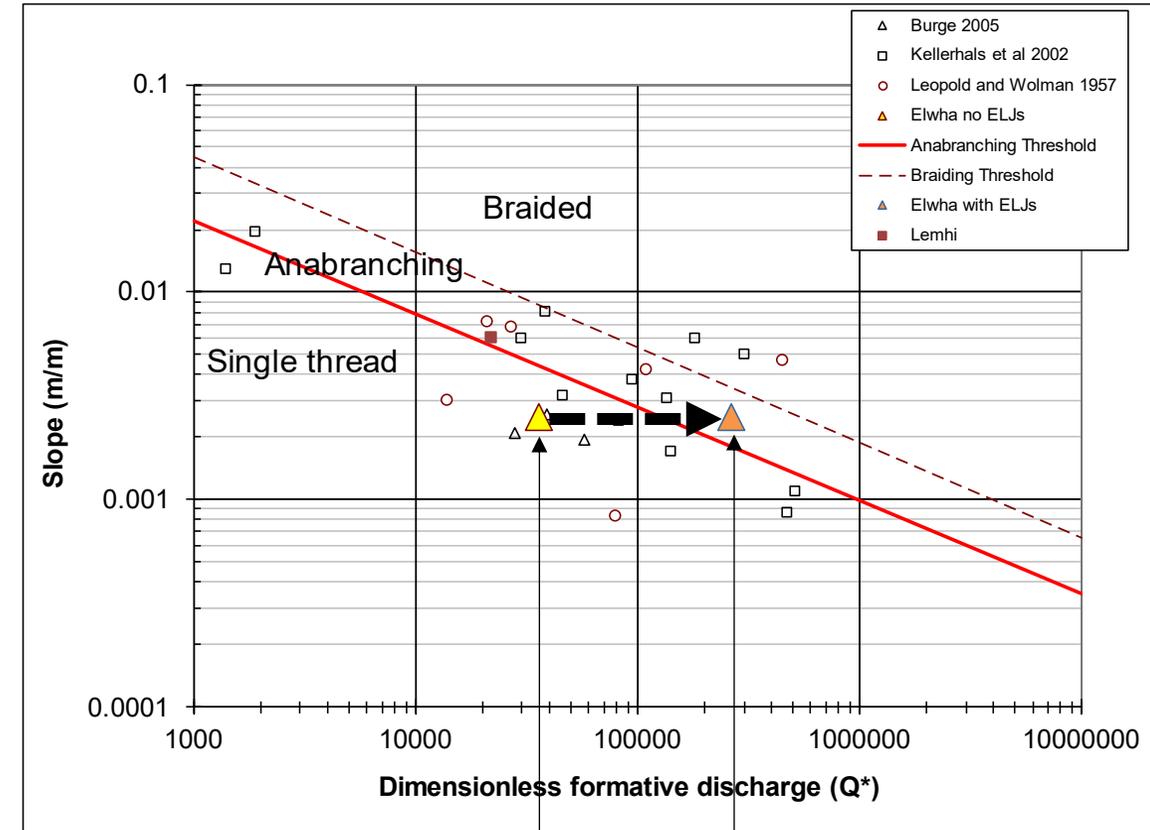


Elwha River – Dam removal





Large wood influences stream morphology by slowing water and redirecting flow.



Elwha without logjams

Elwha with logjams

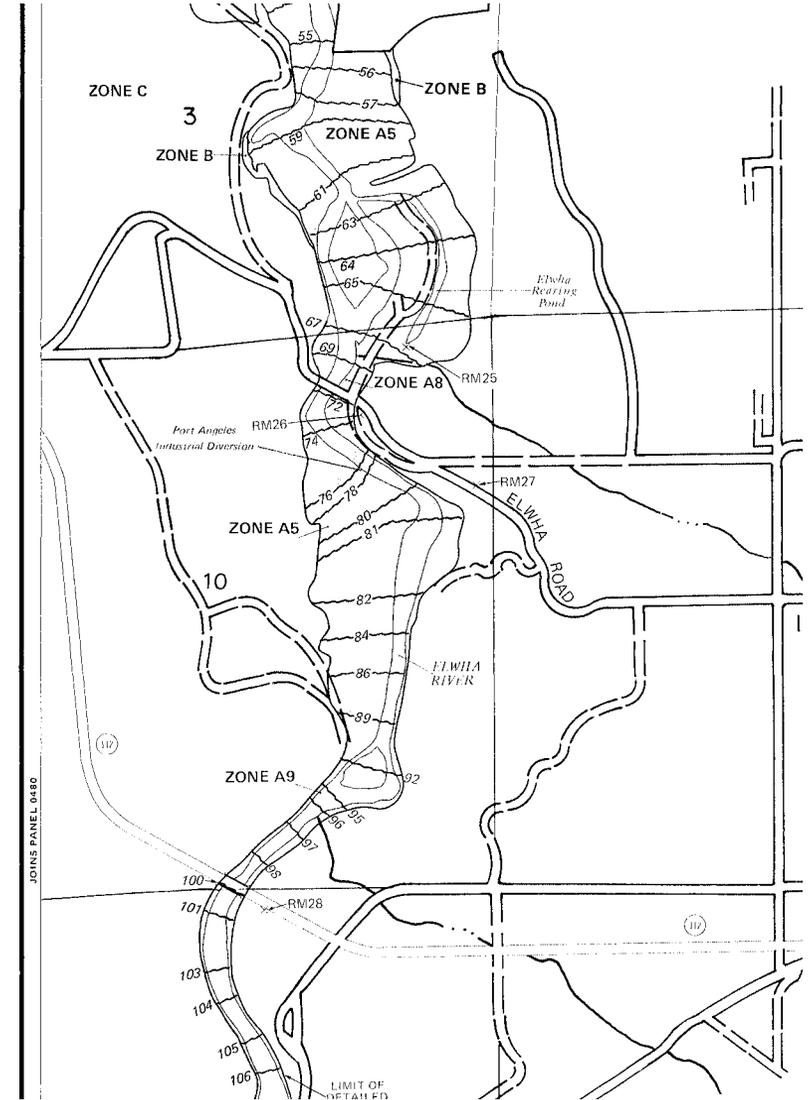
Lower Elwha River, 2016



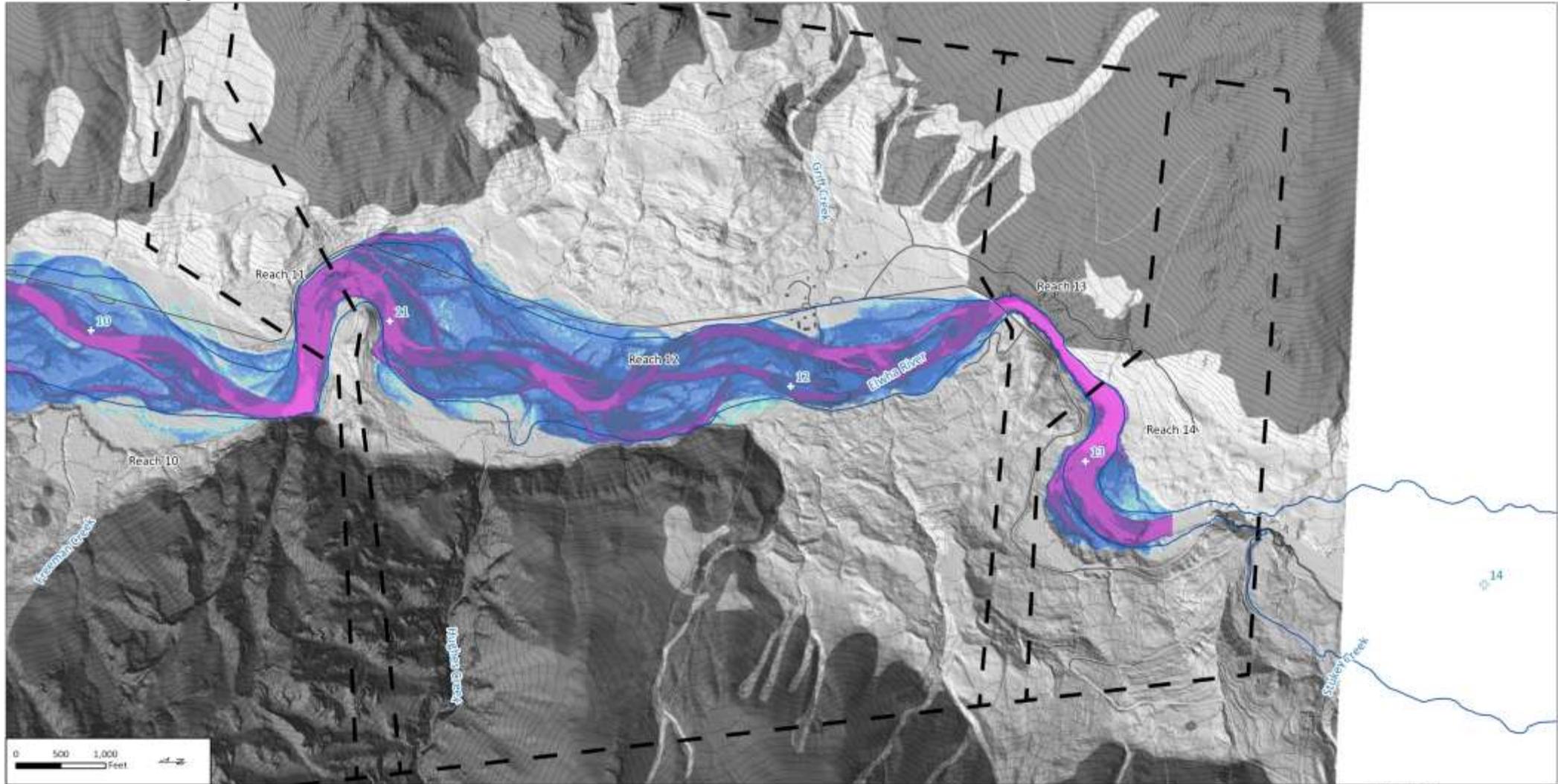
Flooding – inundation from high river flows.

The FEMA 100-year floodplain is a standard definition of risk area

- *1% chance in a given year*



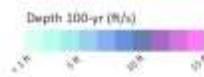
Elwha 4 - Depth



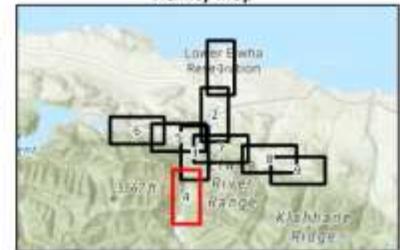
Elwha River CMZ Page 4 of 9
Elwha River 4
 HEC-RAS 2D Model Results - 100-yr

- Roads
- Buildings
- ⊕ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌞ Reach Breaks

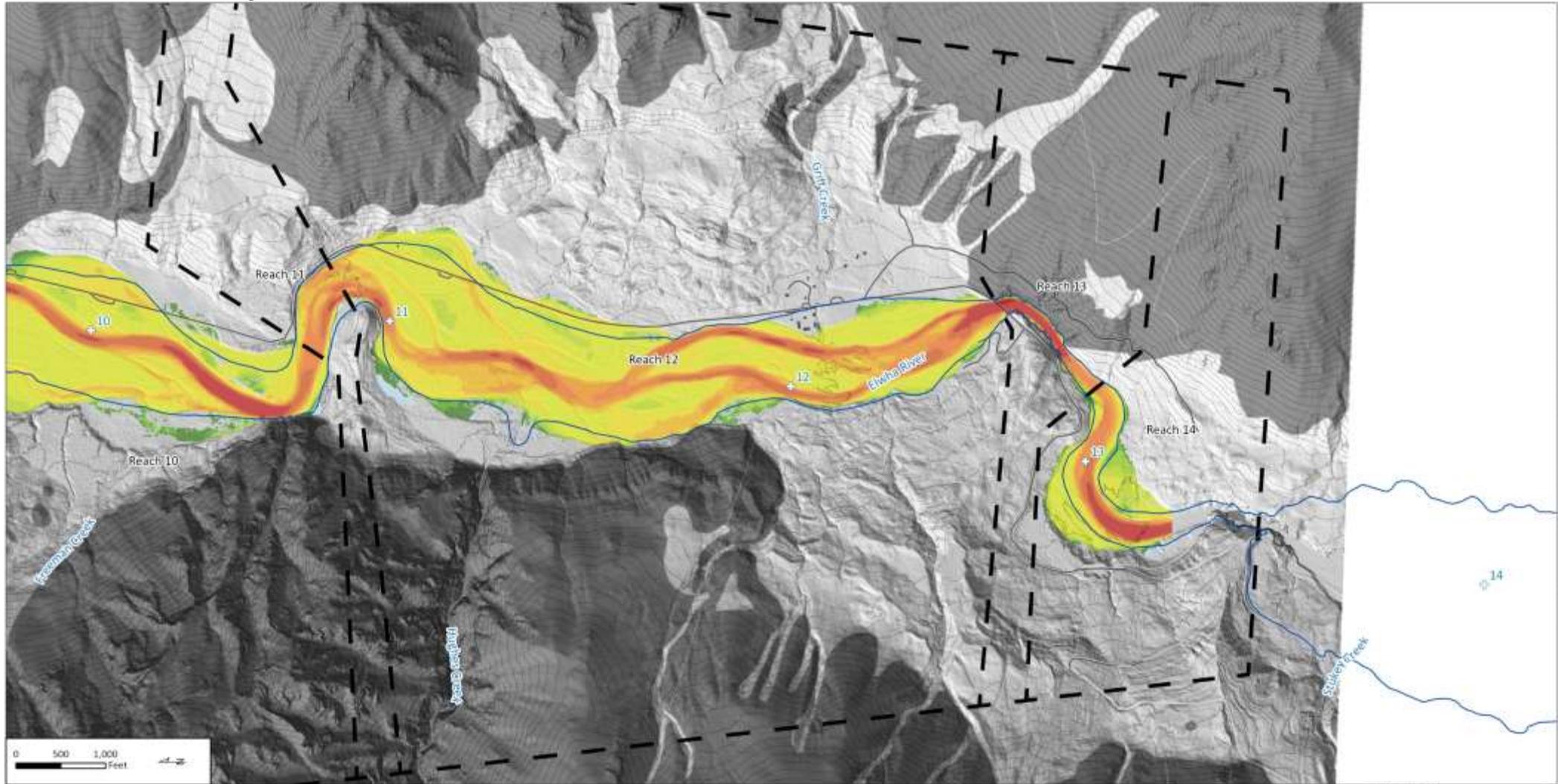
- Preliminary FEMA Flood Zone
- A
 - AE



Vicinity Map



Elwha 4 - Velocity



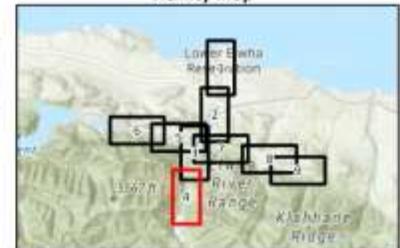
Elwha River CMZ Page 4 of 9
Elwha River 4
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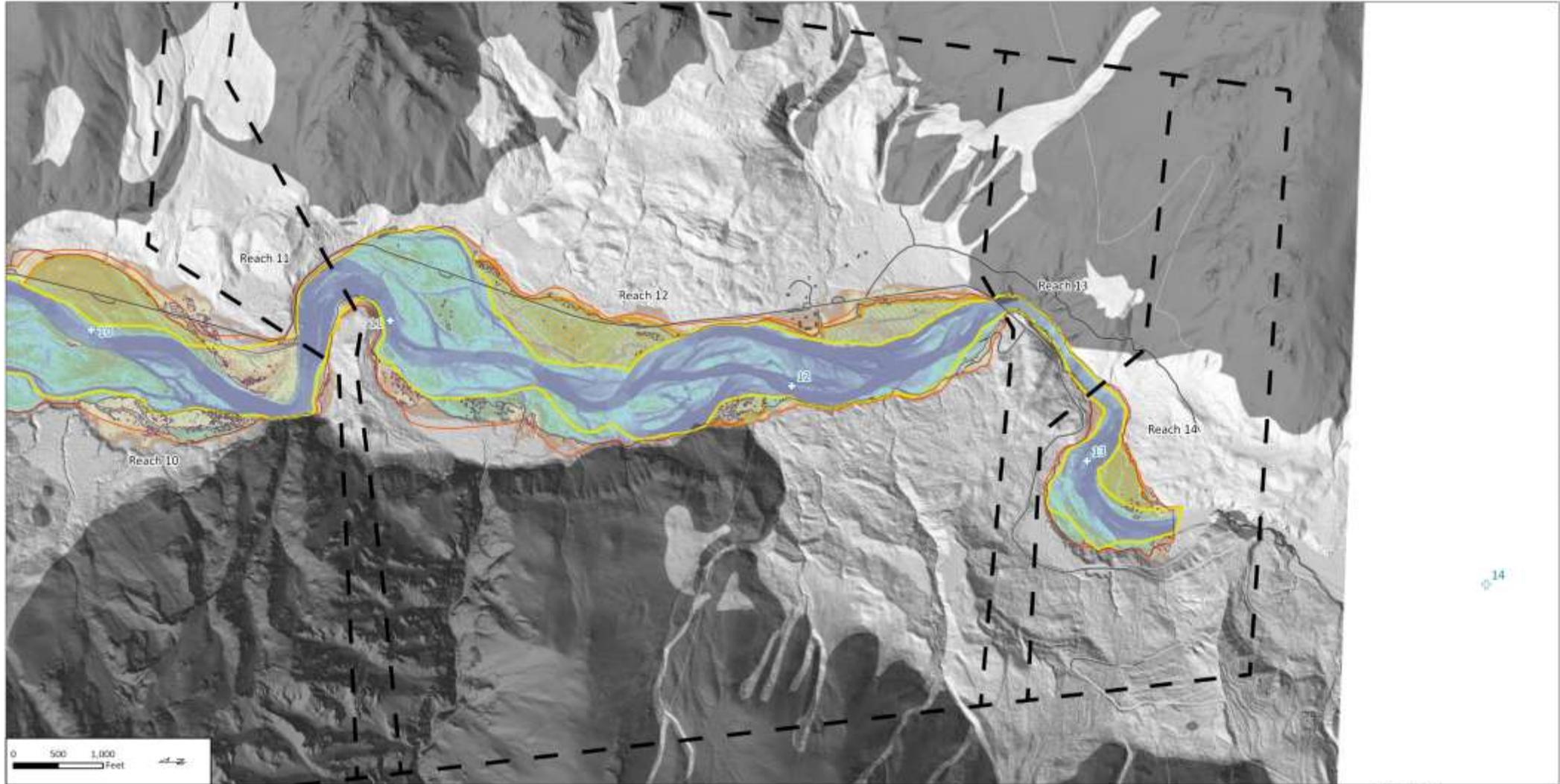
- Preliminary FEMA Flood Zone
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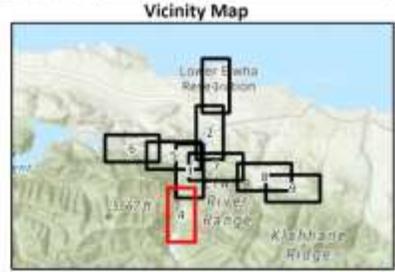
Vicinity Map



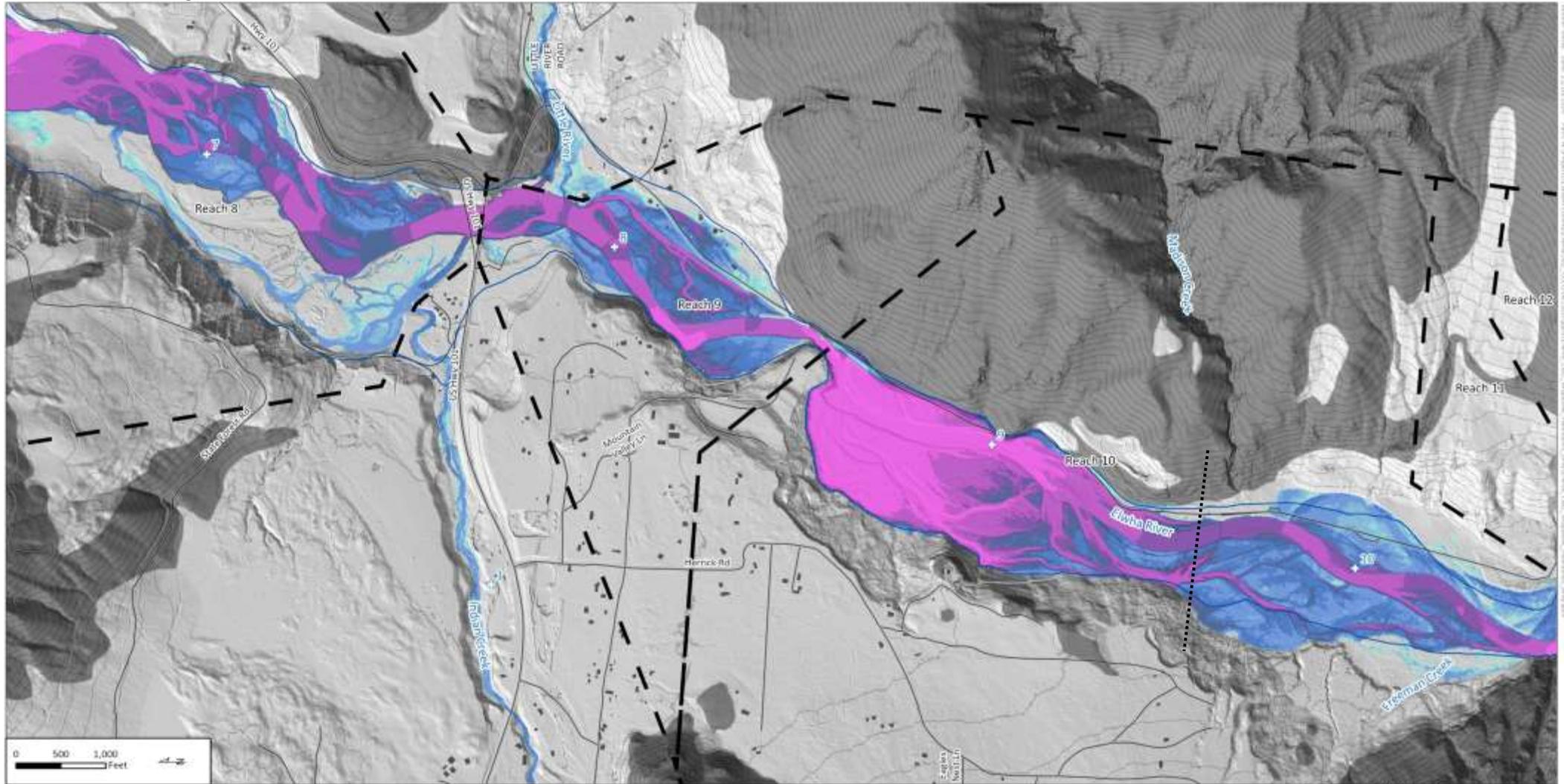
Elwha 4 - CMZ



Elwha River CMZ Page 4 of 9
Elwha River 4



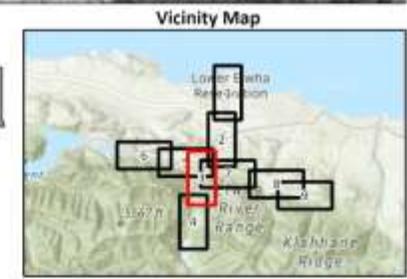
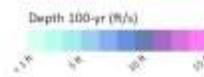
Elwha 3 - Depth



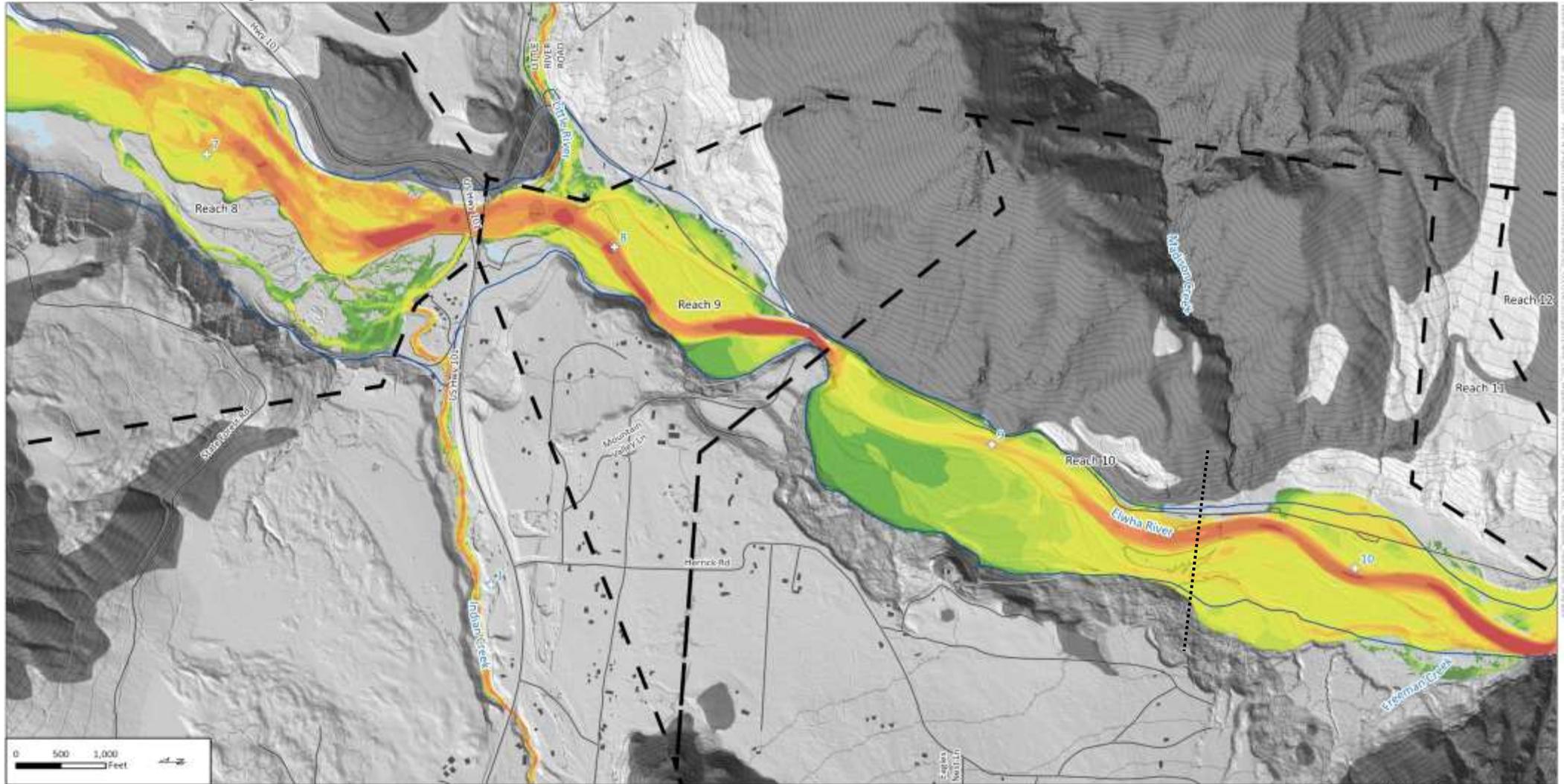
Elwha River CMZ Page 3 of 9
Elwha River 3
 HEC-RAS 2D Model Results - 100-yr

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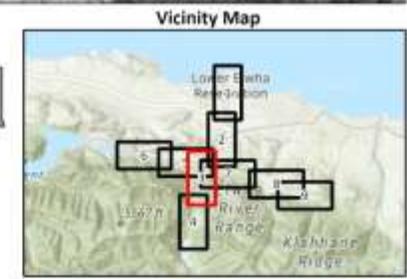


Elwha 3 - Velocity

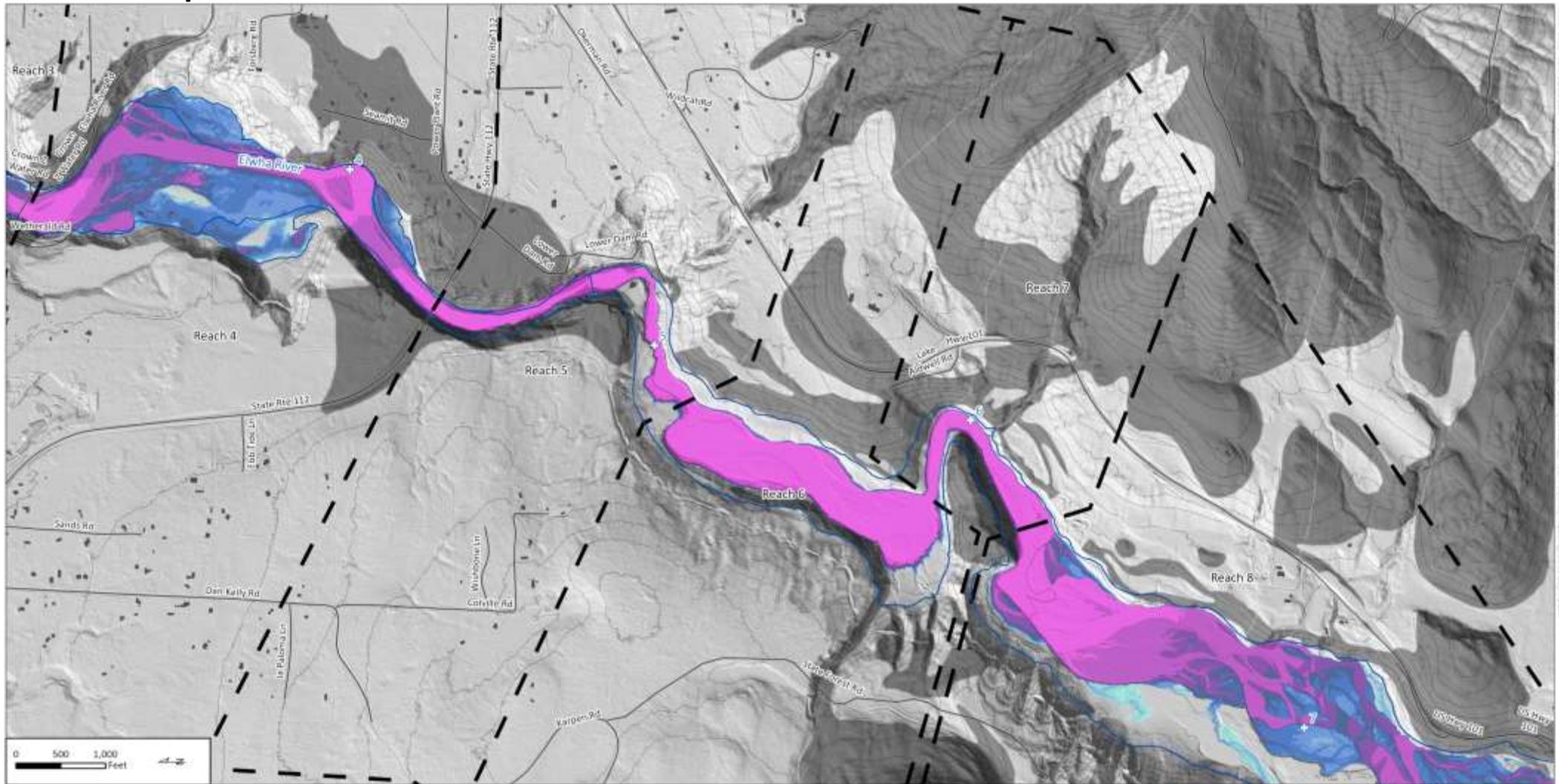


Elwha River CMZ Page 3 of 9
Elwha River 3
 HEC-RAS 2D Model Results - 100-yr

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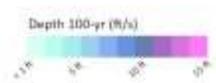
Elwha 2 - Depth



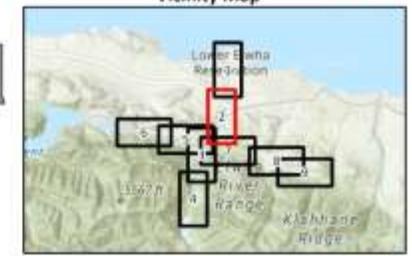
Elwha River CMZ Page 2 of 9
Elwha River 2
 HEC-RAS 2D Model Results - 100-yr

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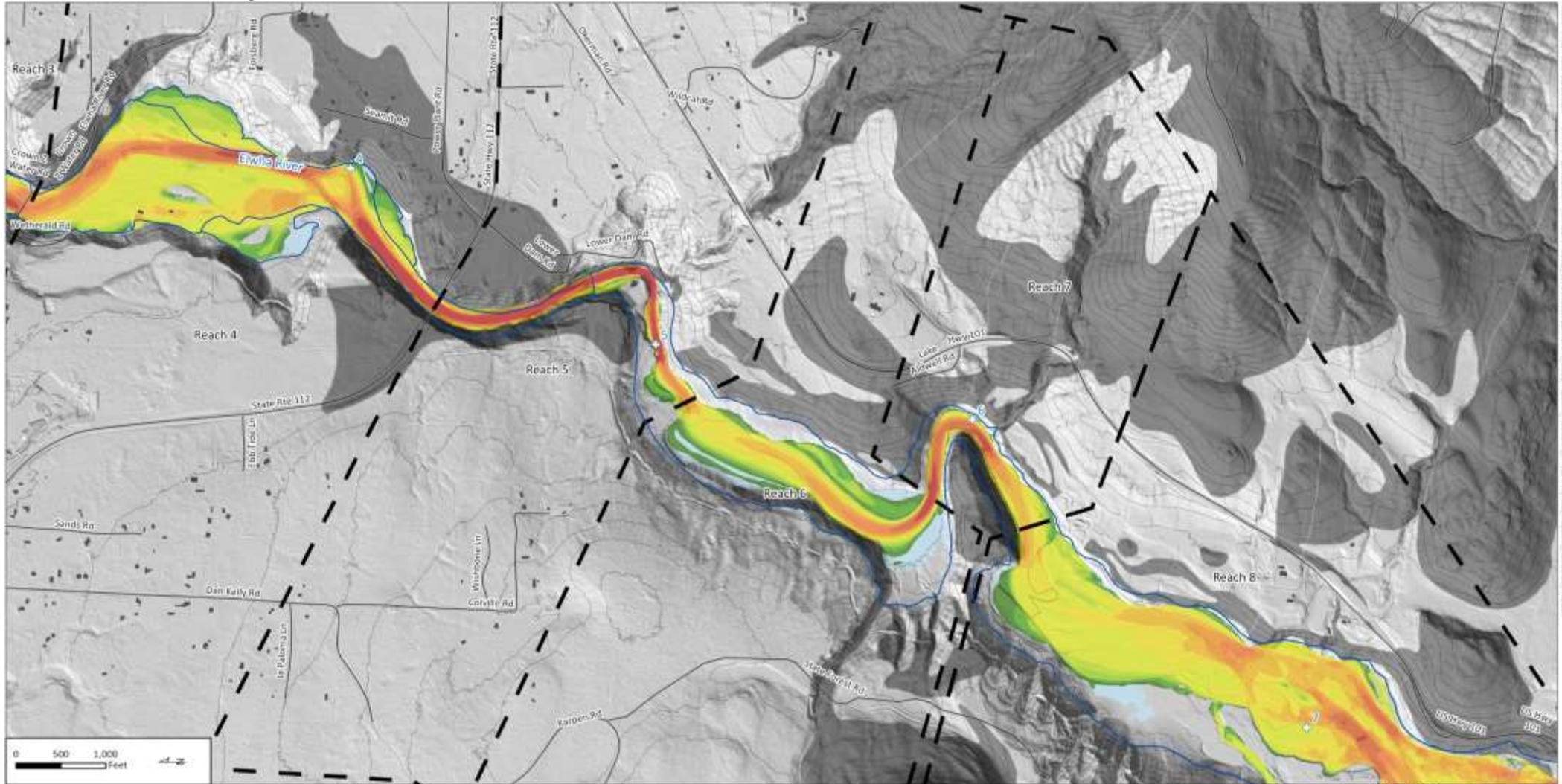
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Vicinity Map



Elwha 2 - Velocity



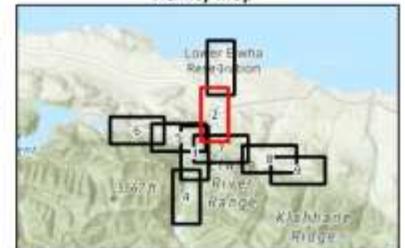
Elwha River CMZ Page 2 of 9
Elwha River 2
 HEC-RAS 2D Model Results - 100-yr

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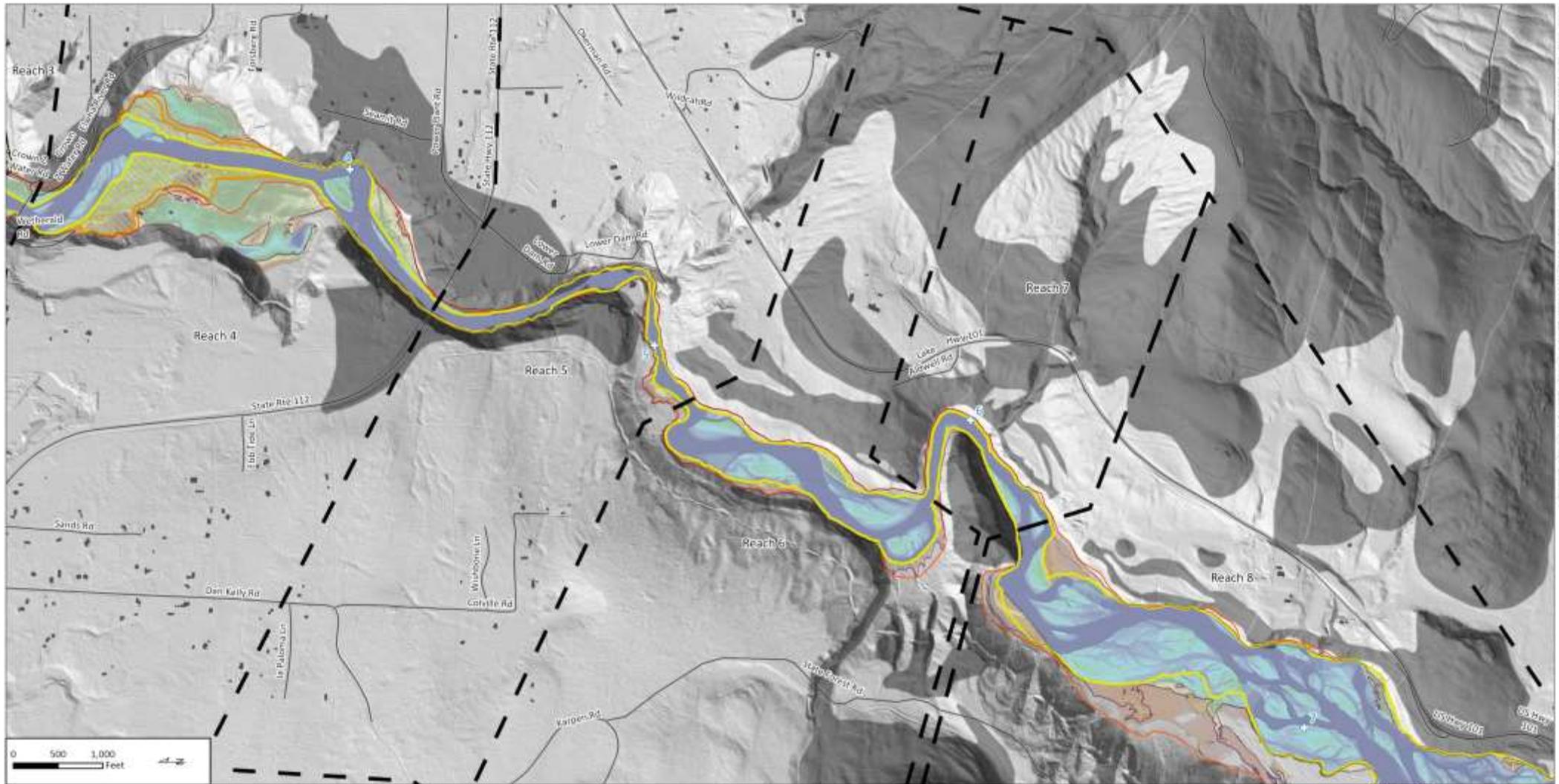
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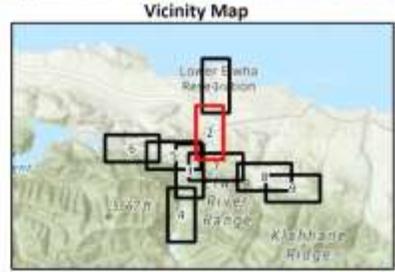
Vicinity Map



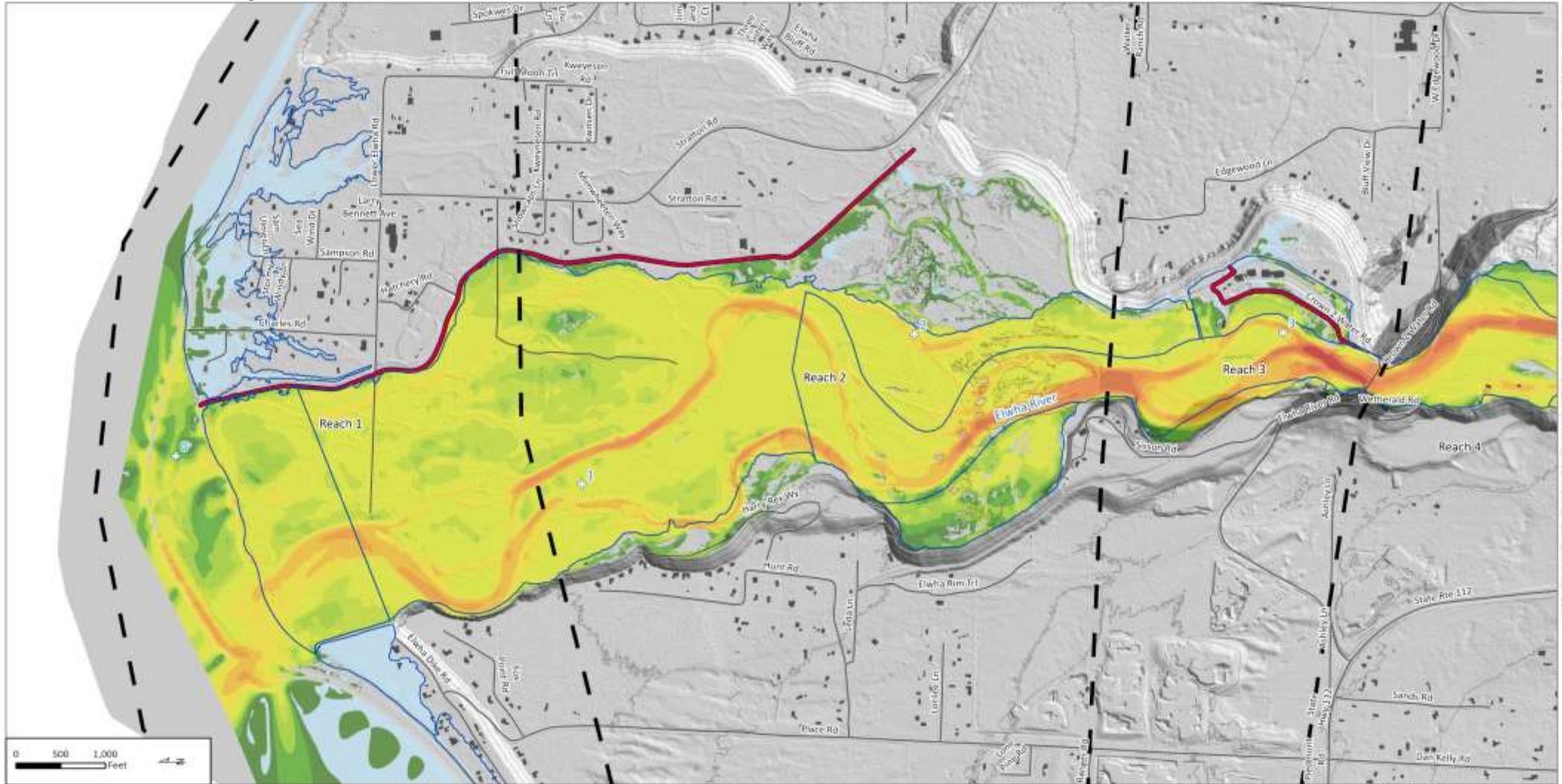
Elwha 2 - CMZ



Elwha River CMZ Page 2 of 9
Elwha River 2



Elwha 1 - Velocity



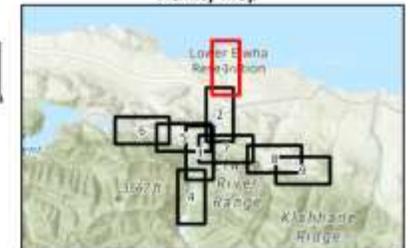
Elwha River CMZ Page 1 of 9
Elwha River 1
 HEC-RAS 2D Model Results - 100-yr

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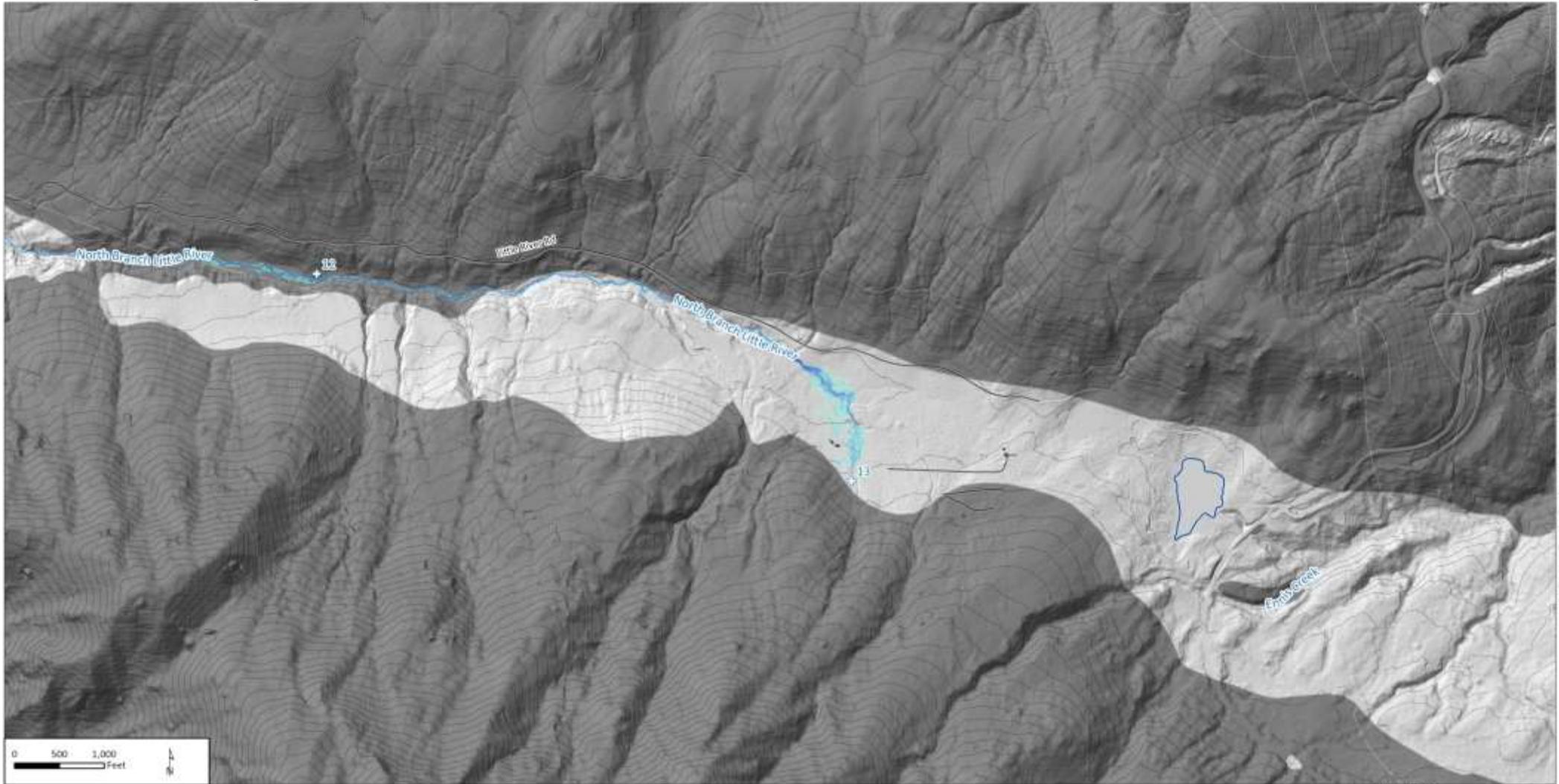
Vicinity Map



Data Source: Topographic: SRTM30 PLUS; Hydrography: NHDPlus; Buildings: ESRI; FEMA Flood Zone: FEMA; Contours: ESRI; Roads: ESRI; Levees: ESRI; Bedrock: ESRI; Reach Breaks: ESRI; Scale: 1:50,000; Date: 10/13/2011; Author: NSD/CCS; Project: Elwha River CMZ; Title: Elwha River 1 - Velocity; Version: 1.0; Status: Final; Contact: NSD/CCS; Email: nsd@ccs.com; Phone: (360) 885-1111; Website: www.ccs.com

LITTLE RIVER

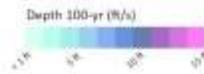
Little River 3 - Depth



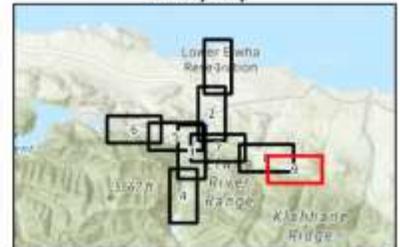
Elwha River CMZ Page 9 of 9
Little River 3
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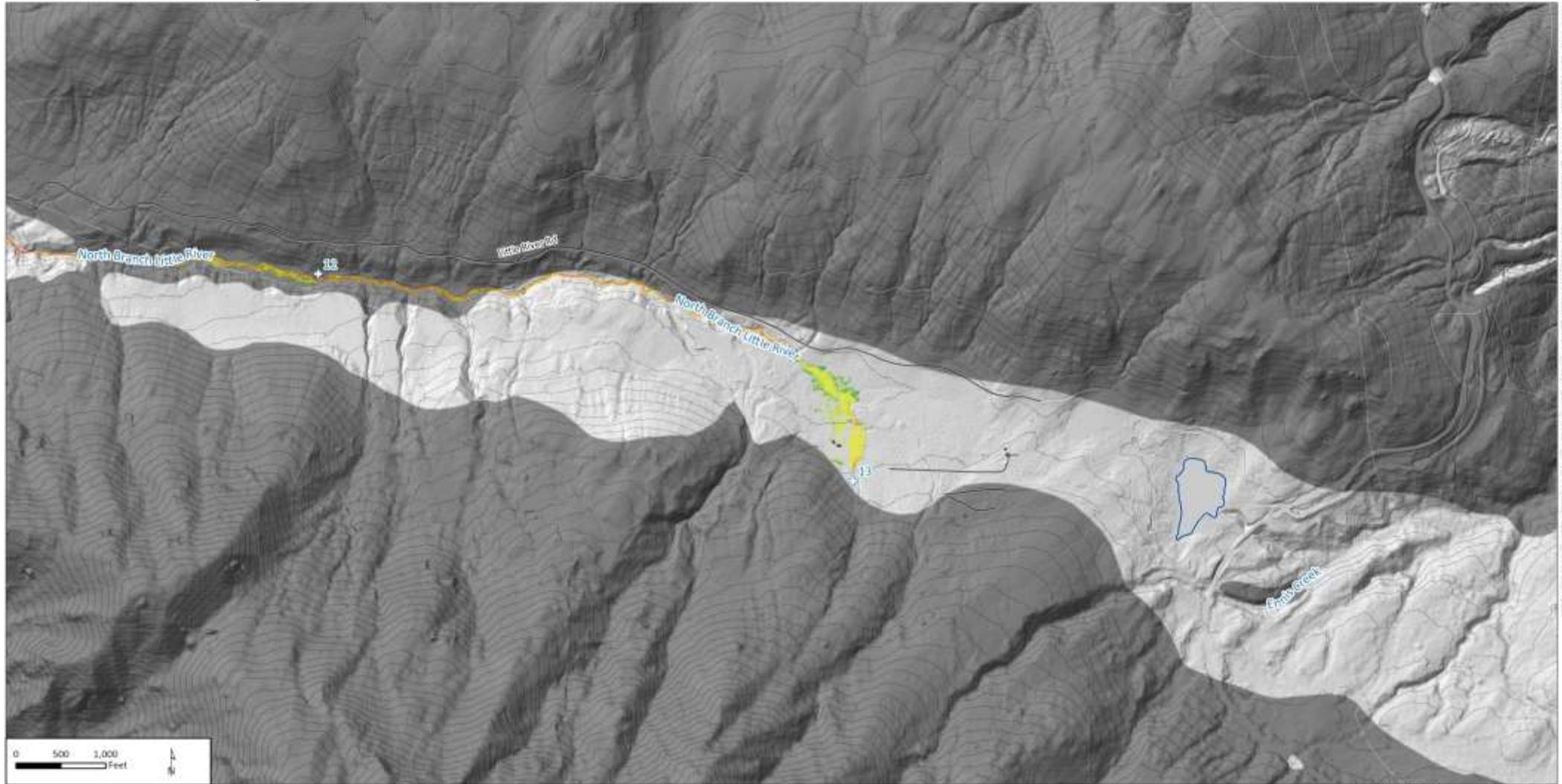
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Vicinity Map



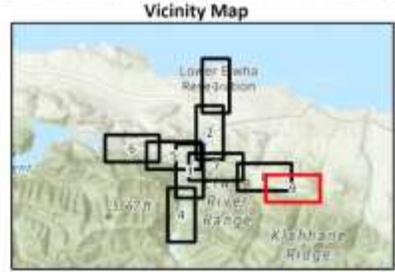
Little River 3 - Depth



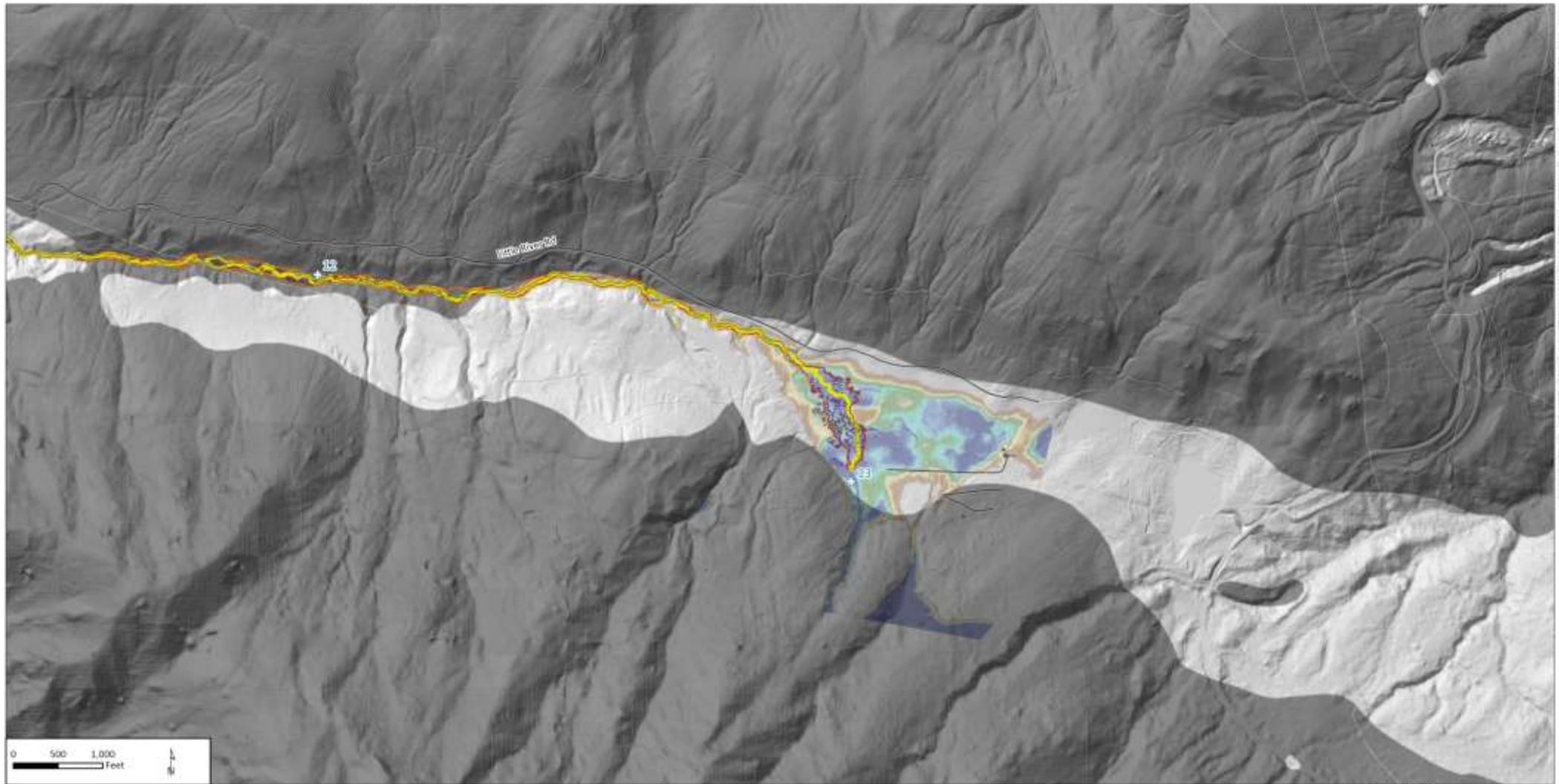
Elwha River CMZ Page 9 of 9
Little River 3
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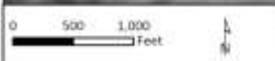
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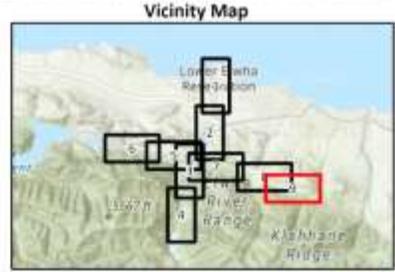
Little River 3 – CMZ



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Elwha River CMZ Page 9 of 9
Little River 3



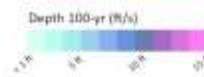
Little River 2 - Depth



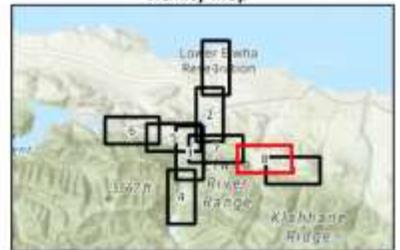
Elwha River CMZ Page 8 of 9
Little River 2
 HEC-RAS 2D Model Results - 100-yr

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- ⌚ Reach Breaks

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Vicinity Map



Little River 2 – Velocity

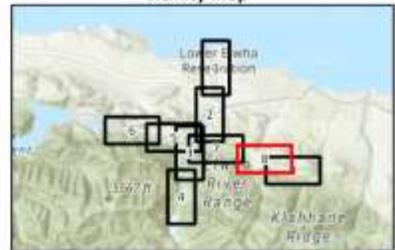


Elwha River CMZ Page 8 of 9
Little River 2
 HEC-RAS 2D Model Results - 100-yr

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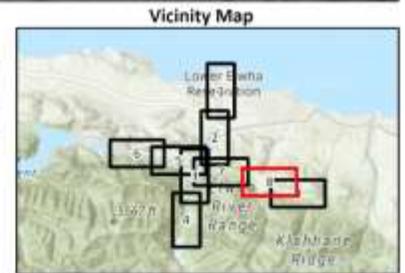
Vicinity Map



Little River 2 – CMZ



Elwha River CMZ Page 8 of 9
Little River 2



Little River 1 - Depth



Elwha River CMZ Page 7 of 9

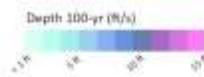
Little River 1

HEC-RAS 2D Model Results - 100-yr

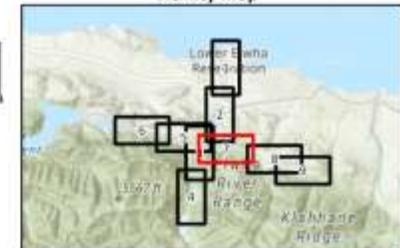
- Roads
- Buildings
- ⊕ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌞ Reach Breaks

Preliminary FEMA Flood Zone

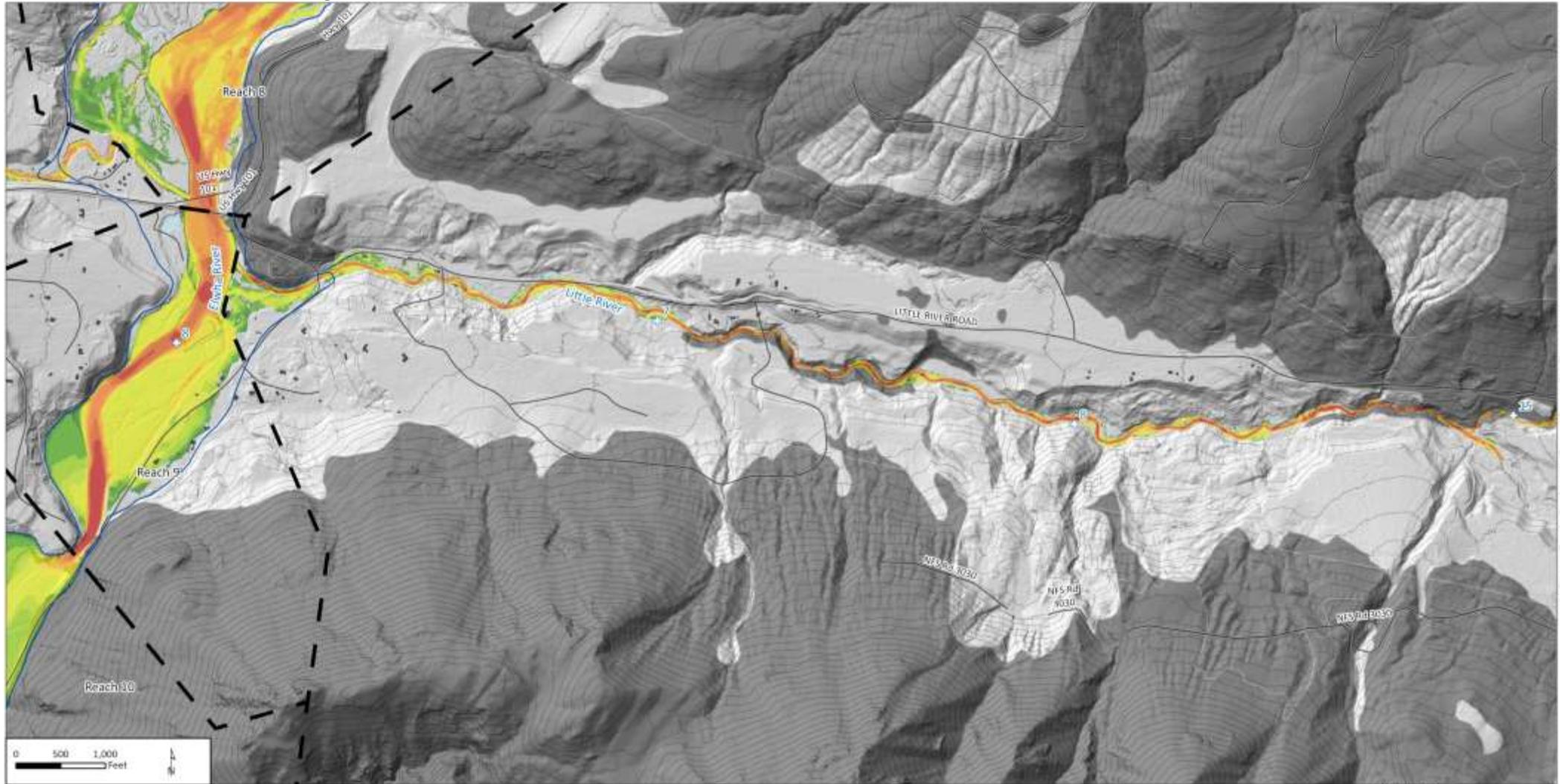
- A
- AE



Vicinity Map



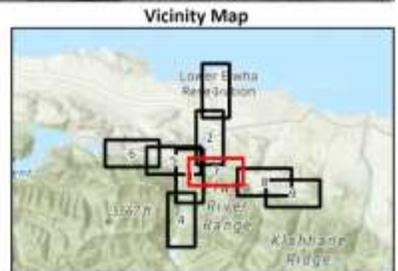
Little River 1 – Velocity



Elwha River CMZ Page 7 of 9
Little River 1
 HEC-RAS 2D Model Results - 100-yr

- Roads
- Buildings
- ⊕ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌞ Reach Breaks

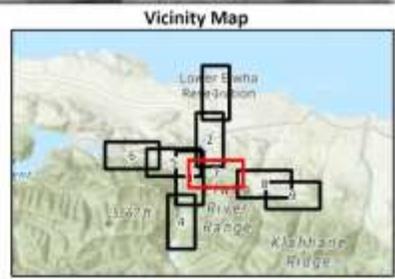
- Preliminary FEMA Flood Zone
- A
 - AE



Little River 1 – CMZ

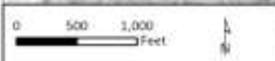
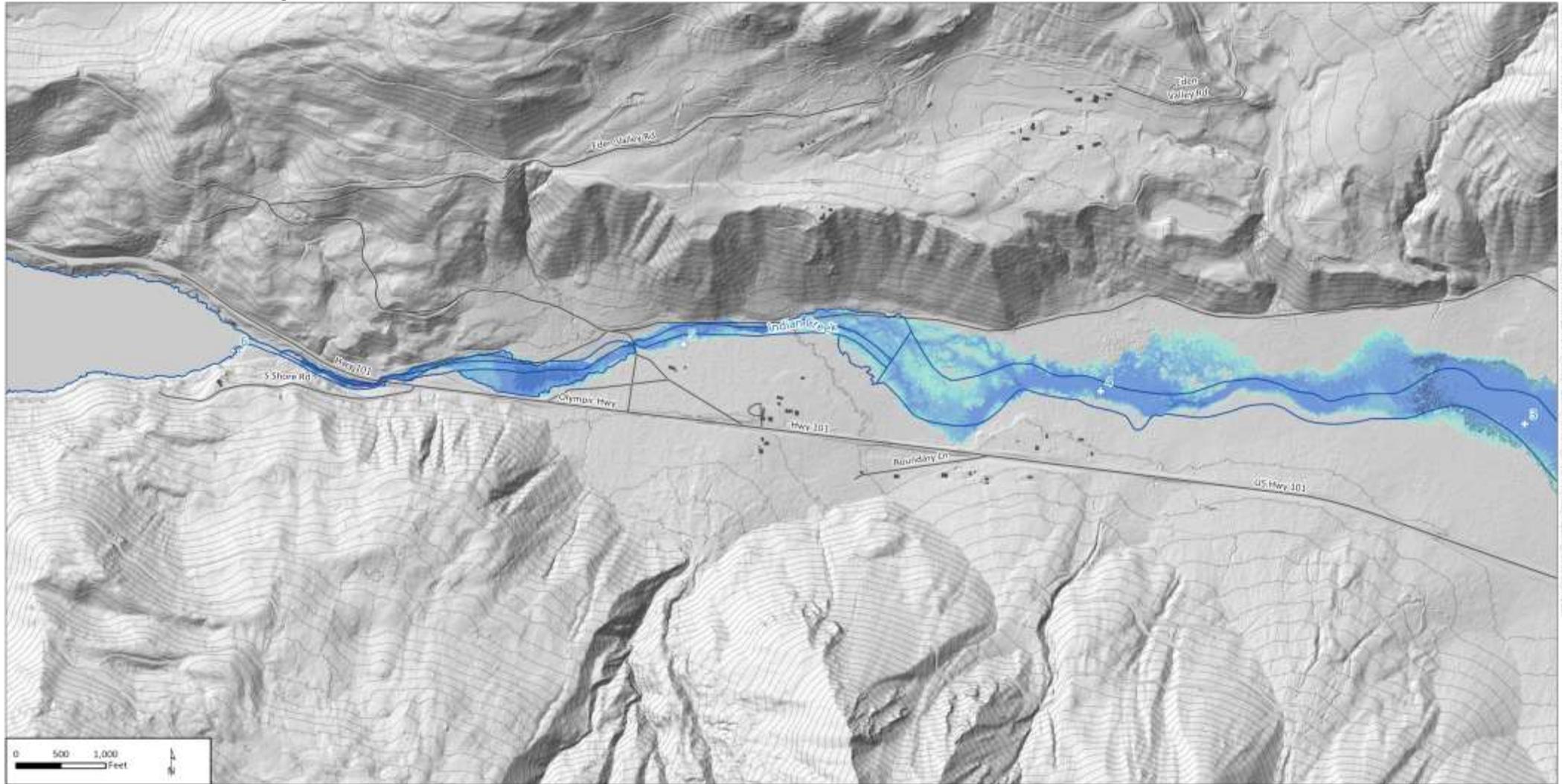


Elwha River CMZ Page 7 of 9
Little River 1



INDIAN CREEK

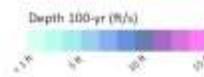
Indian Creek 2 - Depth



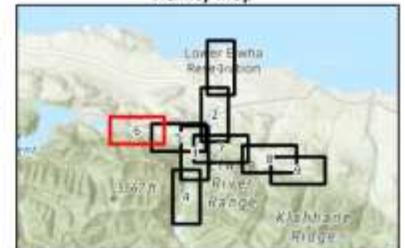
Elwha River CMZ Page 6 of 9
Indian Creek 2
 HEC-RAS 2D Model Results - 100-yr

- Roads
- Buildings
- ⊕ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌓ Reach Breaks

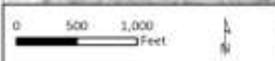
- Preliminary FEMA Flood Zone
- A
 - AE



Vicinity Map



Indian Creek 2 - Velocity



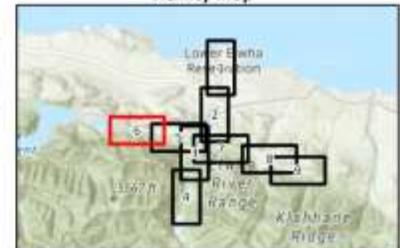
Elwha River CMZ Page 6 of 9
Indian Creek 2
 HEC-RAS 2D Model Results - 100-yr

- Roads
- Buildings
- ⊙ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌈ Reach Breaks

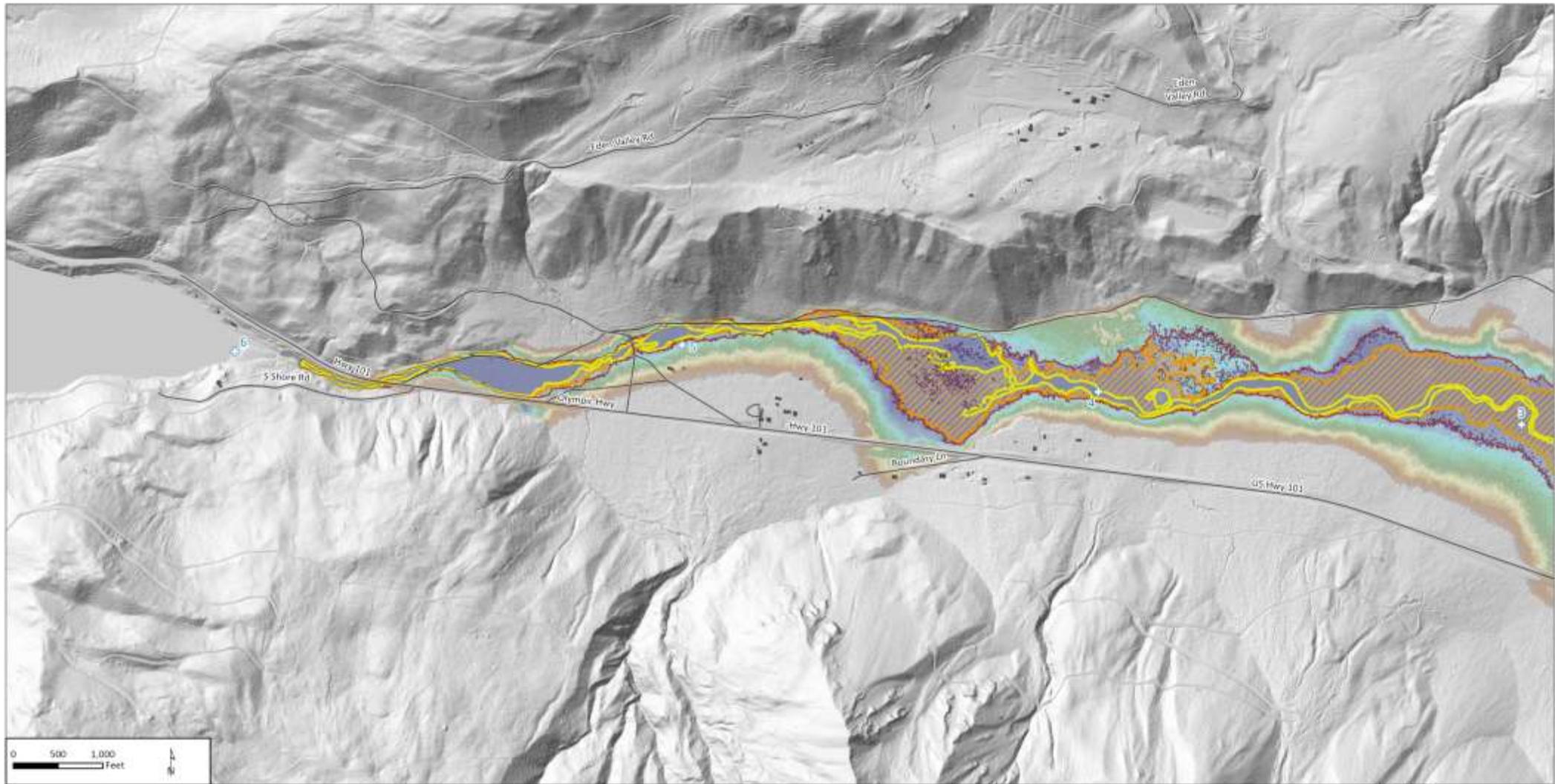
- Preliminary FEMA Flood Zone
- A
 - AE



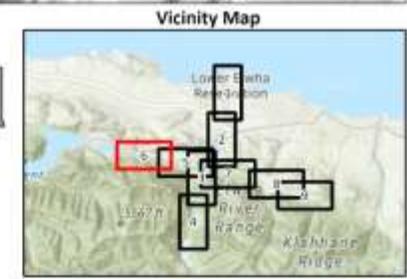
Vicinity Map



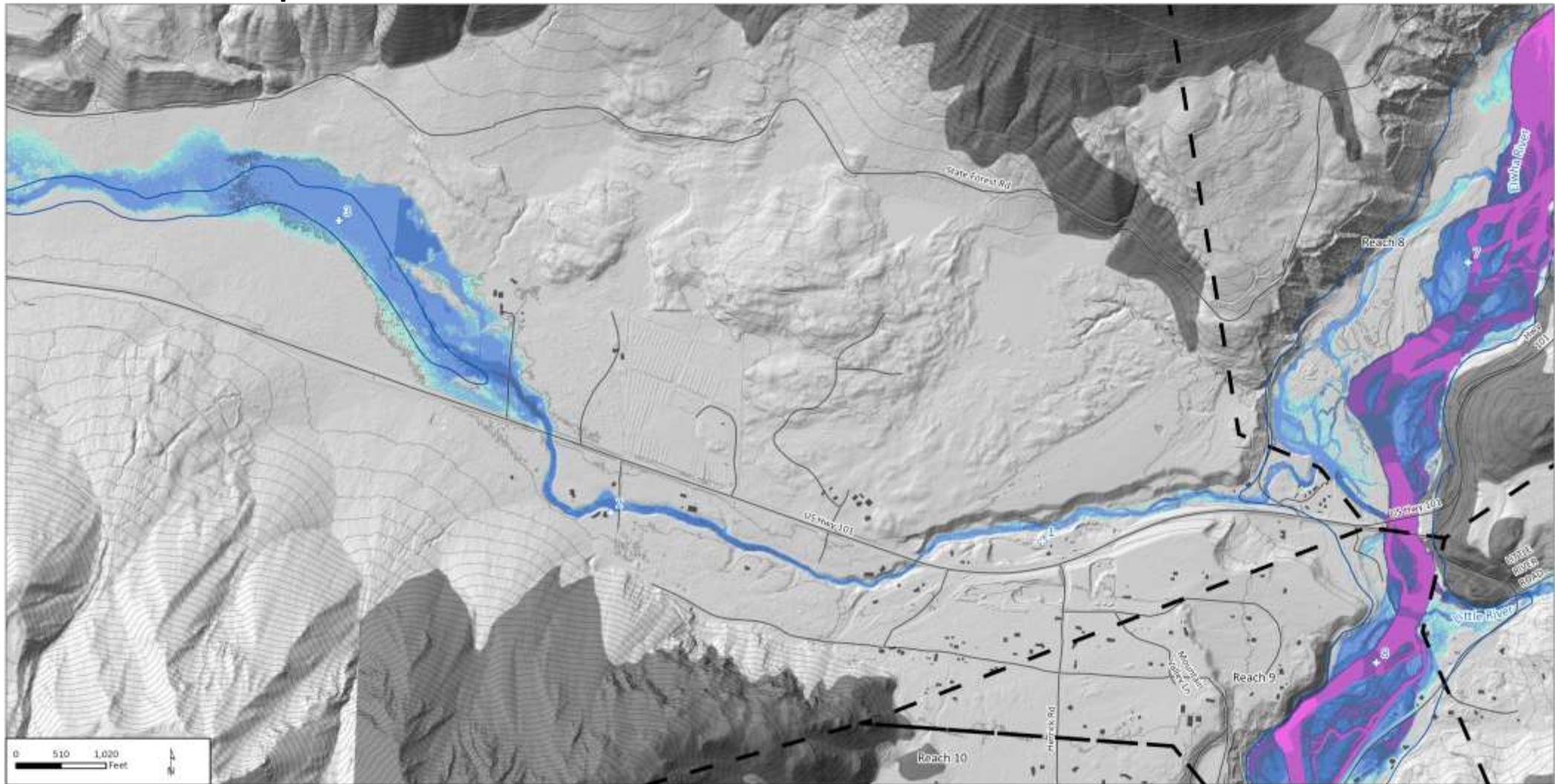
Indian Creek 2 - CMZ



Elwha River CMZ Page 6 of 9
Indian Creek 2



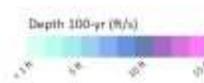
Indian Creek 1 - Depth



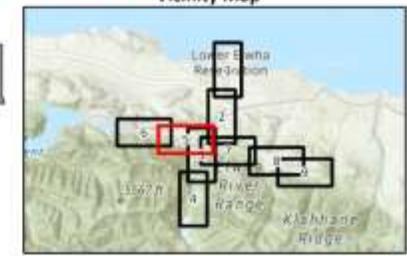
Elwha River CMZ Page 5 of 9
Indian Creek 1
 HEC-RAS 2D Model Results - 100-yr

- Roads
- Buildings
- ⊕ River Miles
- 50ft Contours
- Levees
- Bedrock
- ⌞ Reach Breaks

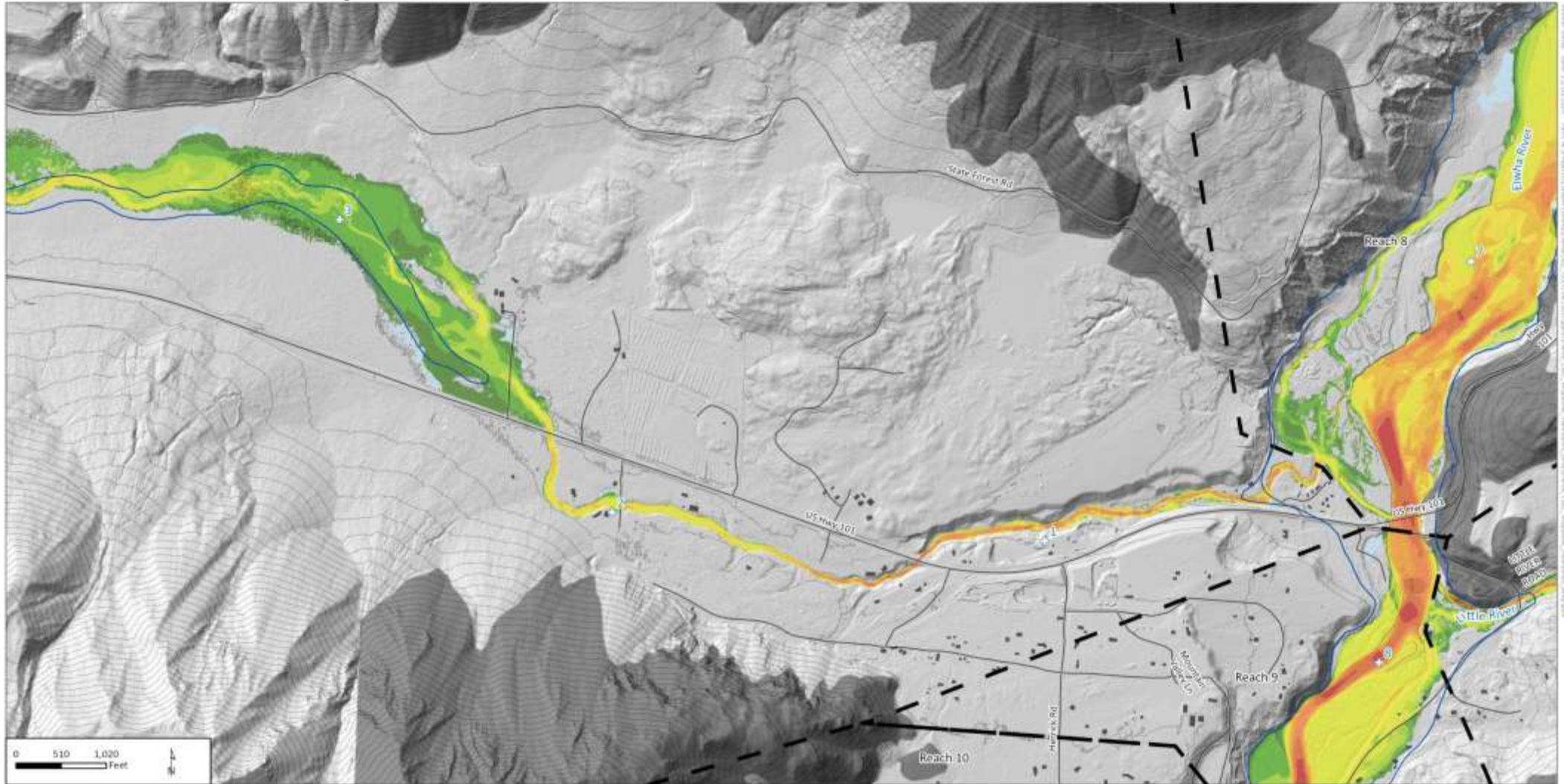
- Preliminary FEMA Flood Zone
- A
 - AE



Vicinity Map



Indian Creek 1 - Velocity

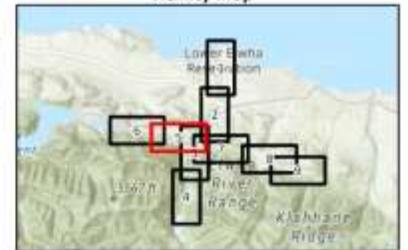


Elwha River CMZ Page 5 of 9
Indian Creek 1
 HEC-RAS 2D Model Results - 100-yr

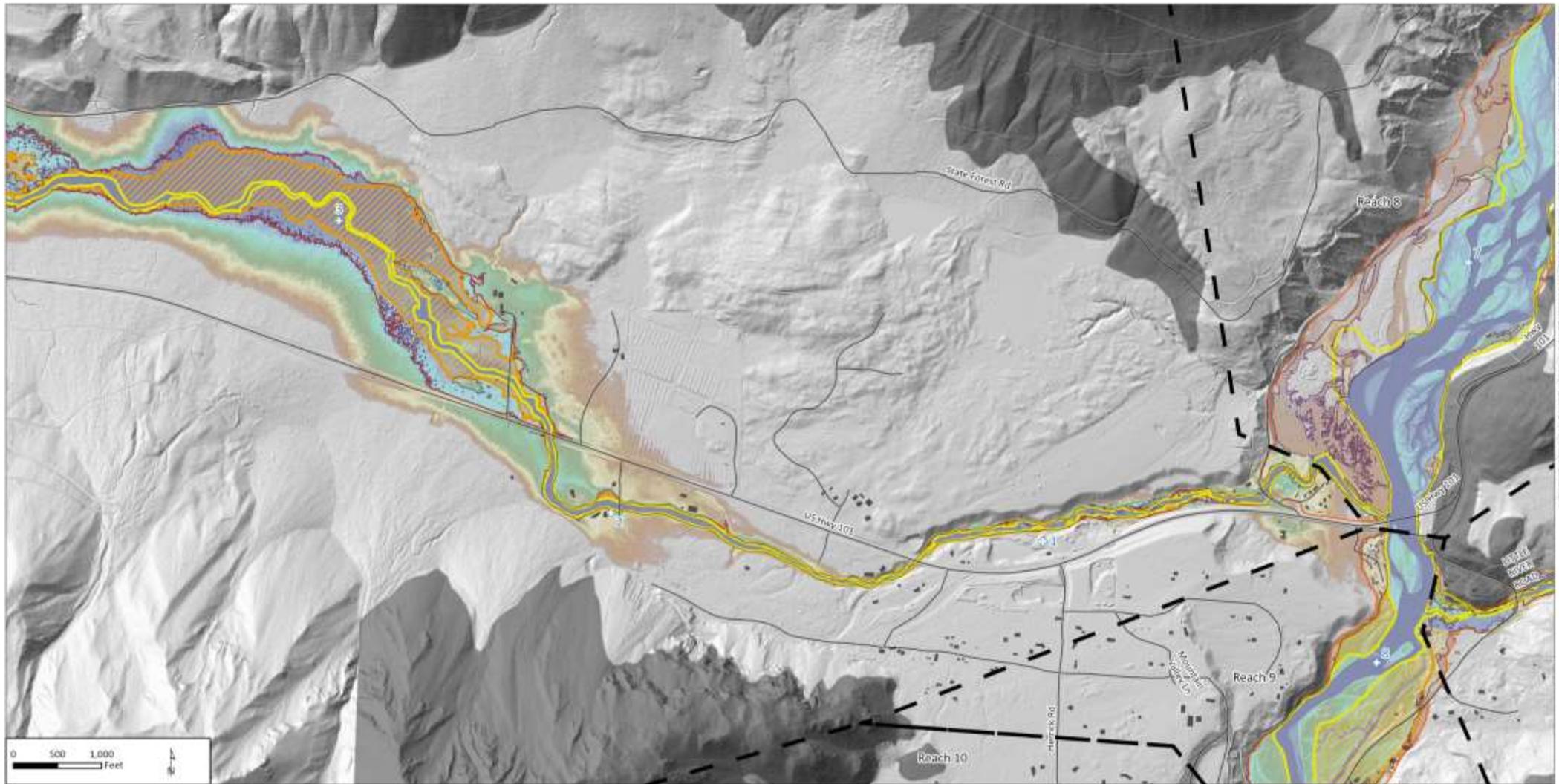
- Roads
 - Buildings
 - ⊕ River Miles
 - 50ft Contours
 - Levees
 - Bedrock
 - ⌋ Reach Breaks
- Preliminary FEMA Flood Zone
 - A
 - AE



Vicinity Map



Indian Creek 1 - CMZ



Elwha River CMZ Page 5 of 9
Indian Creek 1

- | | | |
|---------------|-------------------|------------------|
| Zone | 100-yr Inundation | Bedrock |
| EMA | Roads | Disconnected CMZ |
| AHZ | Buildings | Reach Breaks |
| HMZ | River Miles | |
| Non CMZ Lines | Levees | |

