

Appendix C

Project Opportunities

Middle Twisp River (RM 7.8 – 18.12)

This table describes project opportunities by project area. Locator maps of the project opportunities are included below the table.

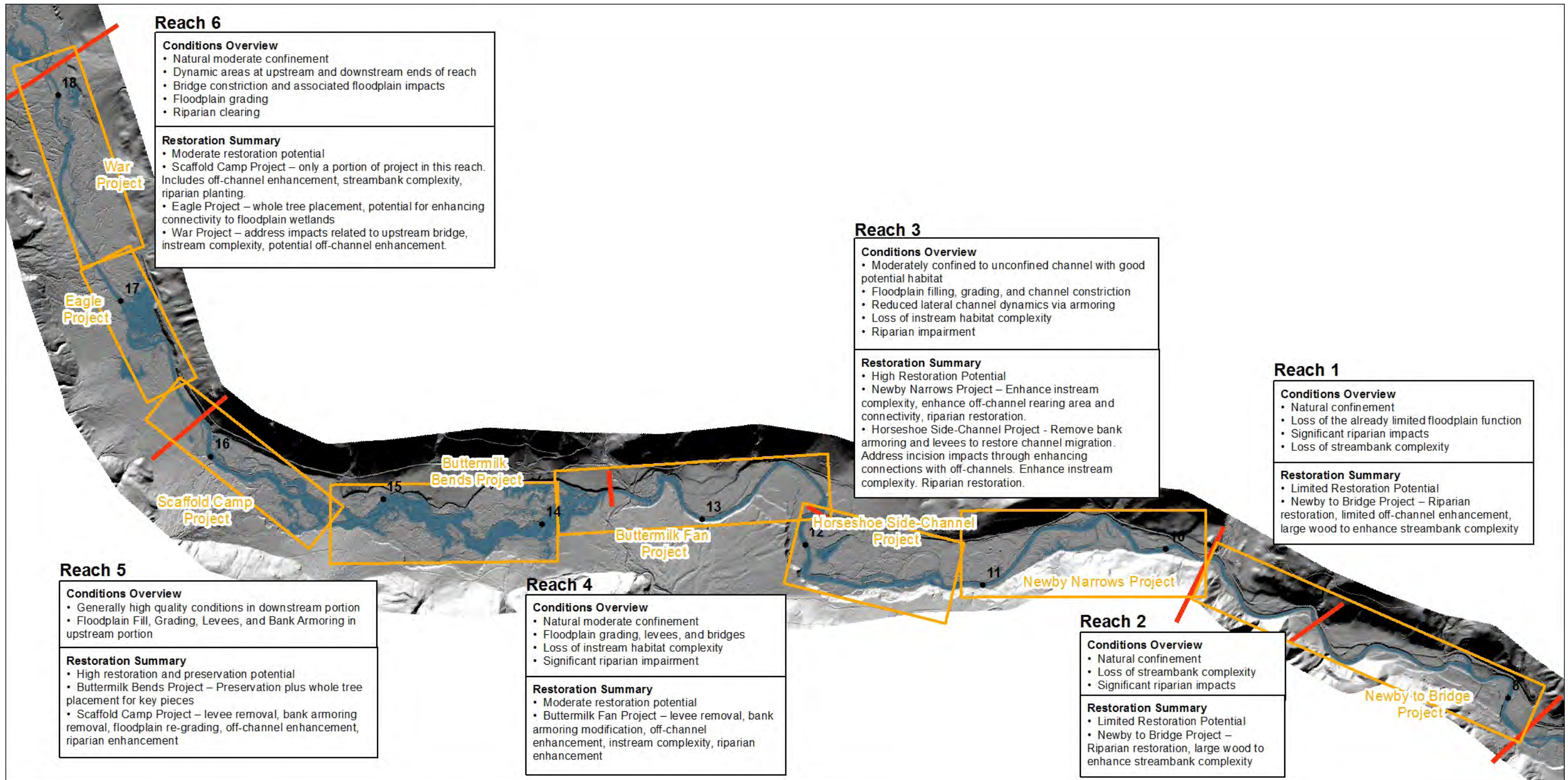
Reach	Project RM	Project Name	Project Elements	Considerations
6	17.2 – 18.2	War Creek	<p>Address floodplain disconnection at 4430 Road bridge and fill.</p> <ul style="list-style-type: none"> Perforations (culverts, bridge) through the road fill in east floodplain could provide upstream and downstream floodplain flow connectivity. <p>RM 18.05 left bank side-channel.</p> <ul style="list-style-type: none"> A side-channel could be created in the river-left floodplain downstream of the road fill that utilizes old channel scars. This could also be created as a flow-through side-channel through a new culvert under the road fill. Alternatively, a groundwater channel could be created. <p>RM 18.0 right bank alcove.</p> <ul style="list-style-type: none"> In river-right (west) floodplain downstream of bridge, seepage indicates that groundwater-fed alcove habitat could be created in old channel scars. Enhance connection to 1985 (left bank) side-channel Apex jam at head of channel inlet (RM 17.95) Apex jams and select excavation at head of secondary inlet (RM 17.65) Log jams within main channel will increase roughness <p>RM 17.23 left bank alcove.</p> <ul style="list-style-type: none"> On river-left there is an existing floodplain channel depression that could be excavated to increase fish access at low flows and to increase rearing capacity. There may be the potential for a groundwater-fed alcove at this location. <p>Wood placements in mainstem.</p> <ul style="list-style-type: none"> Apex jams to induce lateral channel dynamics, multi-thread channels Margin placements to enhance local cover and complexity Place whole trees (large key members) in channel at numerous apex and meander bend locations where wood would naturally accumulate in order to capture fluvially-transported wood. Alternatively, pilings could be driven at select locations to serve this same purpose. 	<p>LW numbers in this area are likely close to “adequate” (based on REI)</p> <p>Some lateral channel dynamics occurring – major channel shift between 1985 and 1994.</p>
6	16.4 – 17.2	Eagle Creek	<p>Pull existing whole trees into channel RM 17.0 – 17.1.</p> <ul style="list-style-type: none"> There are 2 very large downed trees above top of bank on the river-right bank. Pull these into channel. <p>RM 16.6 – 17.0 left bank side-channel reconnection.</p> <ul style="list-style-type: none"> Enhance connectivity to existing left-bank floodplain wetlands via select excavation. <p>Large wood placement in mainstem.</p> <ul style="list-style-type: none"> Add whole trees or pilings to encourage log jam development and lateral dynamics within the newly avulsed channel segment between RM 16.6 and 16.9. <p>RM 16.65 river-right side-channel.</p> <ul style="list-style-type: none"> Apex log jam and side channel excavation to encourage flow through a future potential avulsion path that would move the river away from the hillslope/roadway impacts. 	<p>Lateral dynamics occurring. Recent channel shift post 2012.</p> <p>New early successional channel will continue to adjust</p> <p>Some large key members are located in channel and may serve to build jams over time.</p>

Reach	Project RM	Project Name	Project Elements	Considerations
5-6	15.3 – 16.4	Scaffold Camp	<p>RM 16.2 – 16.4 right bank log jams and riparian restoration.</p> <ul style="list-style-type: none"> • Small log jams and riparian planting on river-right at eroding bank adjacent to field. Add jams for initial stability until riparian veg matures. • Riparian replanting of cleared riparian and floodplain area. <p>RM 16.2 – 16.3 left bank side-channel connection.</p> <ul style="list-style-type: none"> • Add log jam and use select excavation to activate left bank side-channels. <p>RM 16 – 16.18 right bank alcove/groundwater channels.</p> <ul style="list-style-type: none"> • One potential flow-through side-channel from RM 16.05 to near 16.18 • Reconnection of alcove/wall-based channel at RM 16. Might be good groundwater flow channel. Investigate groundwater flow potential. • Riparian restoration in cleared areas near these channels. <p>RM 15.9 – 16.1 left bank floodplain and side-channel reconnection .</p> <ul style="list-style-type: none"> • Remove levee, gabion wall, and culvert and create active side-channel within footprint of disconnected pond (re-grade). • Riparian work at cleared areas inboard of levee. <p>RM 15.8 – 15.9 right bank margin jams and riparian restoration.</p> <ul style="list-style-type: none"> • This is a cleared riparian area along the right bank with a rapidly eroding bank. Small margin log jams would provide interim stability until riparian vegetation can mature. <p>RM 15.75 – 15.9 left bank floodplain and side-channel reconnection.</p> <ul style="list-style-type: none"> • Remove all or part of levee to reconnect side-channel and floodplain. Regrade ponds as necessary to provide side-channel habitat. • Riparian restoration inboard of levee. Full levee removal may require added protection of houses downstream. <p>RM 15.53 – 15.65 left bank floodplain and side-channel reconnection.</p> <ul style="list-style-type: none"> • Remove levee to reconnect off-channel and floodplain. Apex jams to activate side-channels <p>RM 15.35 – 15.63 right bank push-up levee removal and side-channel reconnection.</p> <ul style="list-style-type: none"> • Remove push up levee near RM 15.6 and use select excavation to reconnect side channel through right bank floodplain. <p>Mainstem wood placements.</p> <ul style="list-style-type: none"> • Throughout the project area as well as in newly created off-channel habitats, place whole trees or potentially pilings to serve as key members to collect fluvially-transported wood and build log jams. 	<p>Pasture land use at upstream right bank may hinder riparian restoration</p> <p>Private property and infrastructure throughout</p> <p>Origin and use of ponds and push-up levees on left bank are unknown.</p> <p>Houses on river-left at downstream end would need risk assessment and potential protection with levee removal scenarios.</p>
5	13.9 – 15.3	Buttermilk Bends	<p>Mostly analog.</p> <p>Whole tree placement.</p> <ul style="list-style-type: none"> • Helicopter placement of a whole trees for key pieces to form log jams There is a lack of very large pieces but numerous smaller pieces that would form racking members. 	<p>Ideally would be done via helicopter placements to limit disturbance.</p>

Reach	Project RM	Project Name	Project Elements	Considerations
4-5	12.2 – 13.9	Buttermilk Fan	<p>RM 13.85 left bank side-channel or main channel shift.</p> <ul style="list-style-type: none"> • Encourage side-channel or even mainstem flow to the north (e.g. in old 1953 alignment) via select excavation and log jam placement in mainstem. The idea is to shift the mainstem away from riprap and residential development on right bank just downstream. <p>RM 13.76 and 13.84 river-right riprap modification.</p> <ul style="list-style-type: none"> • Modify/replace riprap on right bank at two locations. <p>RM 13.65 – 13.7 modify fill and bank armoring on river-right.</p> <ul style="list-style-type: none"> • To the extent possible, modify/replace bank armoring and fill at the mouth and the lower end of Buttermilk Creek to enhance this potentially highly diverse area (river-right). <p>RM 13.5 left bank levee and riprap removal.</p> <ul style="list-style-type: none"> • Remove push-up levee and a portion of the riprap on river-left just downstream of the bridge to enhance floodplain connectivity. <p>RM 13.4 river-right backwater alcove.</p> <ul style="list-style-type: none"> • Create backwater alcove (likely groundwater-fed) on river-right downstream of the bridge. <p>RM 13.28 river-left backwater alcove.</p> <ul style="list-style-type: none"> • There is an existing backwater cove at this location. Create larger backwater alcove channel that extends back into the floodplain. <p>RM 12.6 – 13.2 left bank push up levee removal.</p> <ul style="list-style-type: none"> • Remove left bank push-up levees to reconnect 100-year floodplain. In particular, removal of push-up levee at high flow channel entrance on leftbank at RM 12.85 would allow for more frequent inundation of the high flow channel extending down to RM 12.68. <p>RM 12.6 – RM 12.9 complexity wood placements.</p> <ul style="list-style-type: none"> • There is the potential for small habitat cover and complexity log jams within glides in this area. This work could extent beyond just these RMs and could occur throughout the project area. <p>RM 12.57 river-left off-channel/alcove creation.</p> <ul style="list-style-type: none"> • Excavate off-channel habitat on the left bank at road/hillslope toe at. A narrow outflow channel would be required to avoid mature cottonwoods and conifers. There is the potential to excavate large habitat beyond the stand of trees. The existing gravel cobble bar at the outflow location suggests the potential for sediment accumulation. The left bank of the outflow is the toe of the road embankment that contains riprap and bedrock. <p>RM 12.25 to 12.3 left bank riprap removal and log jams.</p> <ul style="list-style-type: none"> • Remove riprap, place meander bend log jams to achieve interim stability. • Riparian revegetation. • Potential apex jam at island at 12.25 <p>Riparian and floodplain revegetation throughout reach.</p> <ul style="list-style-type: none"> • Create a forested riparian buffer, particularly along river-left where there is pasture land and along river-right near the downstream end of the reach. 	<p>Semi-confined channel. Removal of push-up levees will not significantly increase floodplain inundation; only at very high flows.</p> <p>Private lands with potentially active grazing.</p>

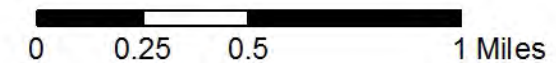
Reach	Project RM	Project Name	Project Elements	Considerations
3	11.1 – 12.2	Horseshoe Side-Channel	<p>RM 11.98 – 12.15 river-left side-channel.</p> <ul style="list-style-type: none"> Apex jam and select excavation to activate river-left side-channel. <p>RM 11.86 – 11.96 river-right side-channel.</p> <ul style="list-style-type: none"> Potential for river-right apex jam and select side-channel excavation. <p>RM 11.25 – RM 11.8 valley-left wetland and side-channel complex reconnection.</p> <ul style="list-style-type: none"> Numerous possibilities for side-channel and off-channel reconnection in the expansive abandoned oxbow wetland complex on valley-left. This would be accomplished via select excavation to connect up remnant oxbow wetlands. Removal of road crossings (fill) and artificial berms/dikes that have been built in the area. Wood cover would be added to off-channel habitat. <p>RM 11.25 – 11.6 river-left side-channels and levee removals.</p> <ul style="list-style-type: none"> Numerous possibilities for apex jams and flow-through side-channel activation via select excavation closer to the river on river-left. Numerous push-up levees throughout this area could be removed to restore natural floodplain inundation patterns. <p>RM 11.3 – 11.45 river-right side-channels.</p> <ul style="list-style-type: none"> Two possibilities for apex jams and select excavation for flow-through side-channel activation on river-right. The upstream one begins at RM 11.3 and the other one begins at RM 11.45 <p>RM 11.2 riprap and fill removal.</p> <ul style="list-style-type: none"> The riprap bank and floodplain fill at RM 11.2 on left bank is not protecting infrastructure and could be removed Place log jams for interim stability until restored riparian vegetation can become established. Reforestation of streambanks and cleared riparian area. <p>Riparian restoration.</p> <ul style="list-style-type: none"> Numerous areas with past and on-going vegetation clearing could be targeted for riparian and floodplain vegetation restoration throughout this project area. 	<p>USBR developed a preliminary suite of restoration alternatives for this site in 2006 (USBR 2006).</p> <p>Private lands with some residential uses.</p>
3	9.8 – 11.1	Newby Narrows	<p>RM 10.66 – 10.95 margin complexity.</p> <ul style="list-style-type: none"> Add margin complexity wood, primarily on river-right bank but also potentially on river-left. <p>RM 10.65 – 11.07 riparian reforestation.</p> <ul style="list-style-type: none"> Riparian reforestation on river-left from where the riparian and floodplain areas have been cleared for agriculture and residential uses. <p>RM 10.4 to 10.75 river-right old oxbow reconnection.</p> <ul style="list-style-type: none"> Old oxbow in river-right floodplain. Excavate downstream connection for fish access and to increase low flow rearing area. There is also the potential for excavation to connect as a flow-through side-channel from upstream end near RM 10.75. Groundwater-fed channels connecting to the oxbow are possible, but need further investigation. <p>RM 10.4-10.57 left-bank side-channel.</p> <ul style="list-style-type: none"> In river-left floodplain there is the potential for creation of a side-channel that would connect up to the existing low flow side-channel. Place apex jam at side-channel inlet. <p>RM 10.27 – 10.43 apex log jams.</p> <ul style="list-style-type: none"> There are two places for apex jams on existing bars to enhance split flow conditions and island development. One at RM 10.43 and one at RM 10.27. <p>RM 10.4 – 10.56 river-right margin complexity.</p> <ul style="list-style-type: none"> Place margin complexity wood on river-right bank where it has been cleared. <p>RM 10.5 – 10.6 river-right riparian restoration.</p> <ul style="list-style-type: none"> Riparian and floodplain revegetation on river-right, primarily between RM 10.5 – 10.6. <p>RM 10.2 right bank backwater alcove.</p> <ul style="list-style-type: none"> Potential excavation of backwater alcove channel that outlets on right bank near RM 10.2. <p>RM 9.96 – 10.1 apex log jams.</p> <ul style="list-style-type: none"> There is the potential for 2-3 bar apex jams in this overwidened section that has some existing bar formation. One of the apex jams could be built at RM 10.05 upon an existing car-sized mid-channel boulder. The jam would also add wood complexity to existing pool formed behind the boulder. Another jam or jams could be built downstream along the bar complex. <p>RM 9.97 to 10.08 river-left off-channel.</p> <ul style="list-style-type: none"> In the river-left floodplain, a side-channel or groundwater-fed alcove could be excavated utilizing an existing flood swale. 	<p>Groundwater flow potential needs further investigation.</p> <p>Private lands. Houses nearby in river-left floodplain.</p> <p>During field survey, saw real estate for sale sign on river-right parcel near RM 10.56 (Clingan Property?).</p>

Reach	Project RM	Project Name	Project Elements	Considerations
1-2	7.8 – 9.8	Newby to Bridge	<p>Not much opportunity due to high gradient, confinement, lots of development, the nearby roadway, and flood protection infrastructure.</p> <p>Riparian restoration</p> <ul style="list-style-type: none"> • Work with willing landowners to perform riparian reforestation where possible. <p>RM 8.3 river-left alcove habitat.</p> <ul style="list-style-type: none"> • There is the potential for creation of off-channel alcove habitat in river-left floodplain. This would be a small project but a good one with limited impacts to existing vegetation. There is very little off-channel rearing habitat in upstream or downstream areas, which means this could provide good “stepping stone” habitat to bridge the gap between other higher quality rearing areas. <p>Enhance channel margin complexity</p> <ul style="list-style-type: none"> • Where possible, enhance channel margin complexity via large wood placements. In some areas, it may be possible to enhance habitat along existing riprap banks via large wood placements for margin complexity and cover. 	<p>Private residences, development, the nearby roadway, and flood protection infrastructure will limit the ability to do work in this area.</p>



Middle Twisp Reach Assessment Restoration Overview

- Reach Breaks
- 2-year flood
- River Miles
- Middle Twisp Projects



2006 LiDAR










Middle Twisp Reach Assessment
 Project Opportunities
 War Project

These drawings should be viewed only as very preliminary concepts intended to describe the types of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.




Project Elements

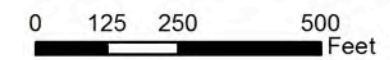
-  Bar apex jam
-  Margin jam
-  Whole tree placement

-  Side-channel (existing)
-  Side-channel reconnection

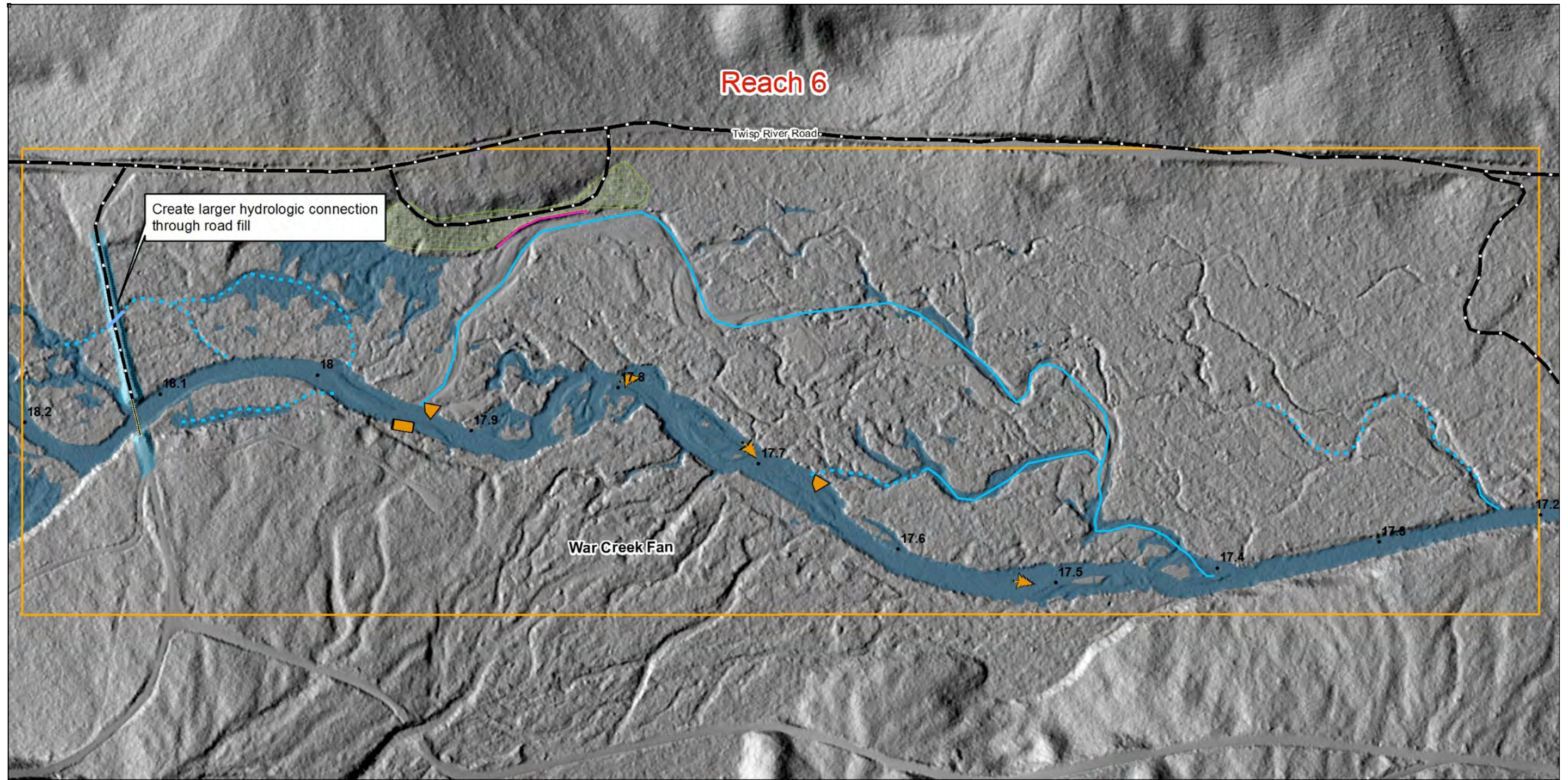
Human Features

-  Riprap
-  Road
-  Bridge
-  Culvert

-  Fill
-  Cleared and Graded
-  River Miles



2012 Aerial Photography



Middle Twisp Reach Assessment
Project Opportunities
War Project

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Project Elements

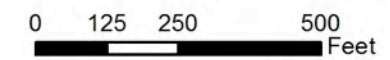
- Bar apex jam
- Margin jam
- Whole tree placement

- Side-channel (existing)
- Side-channel reconnection

Human Features

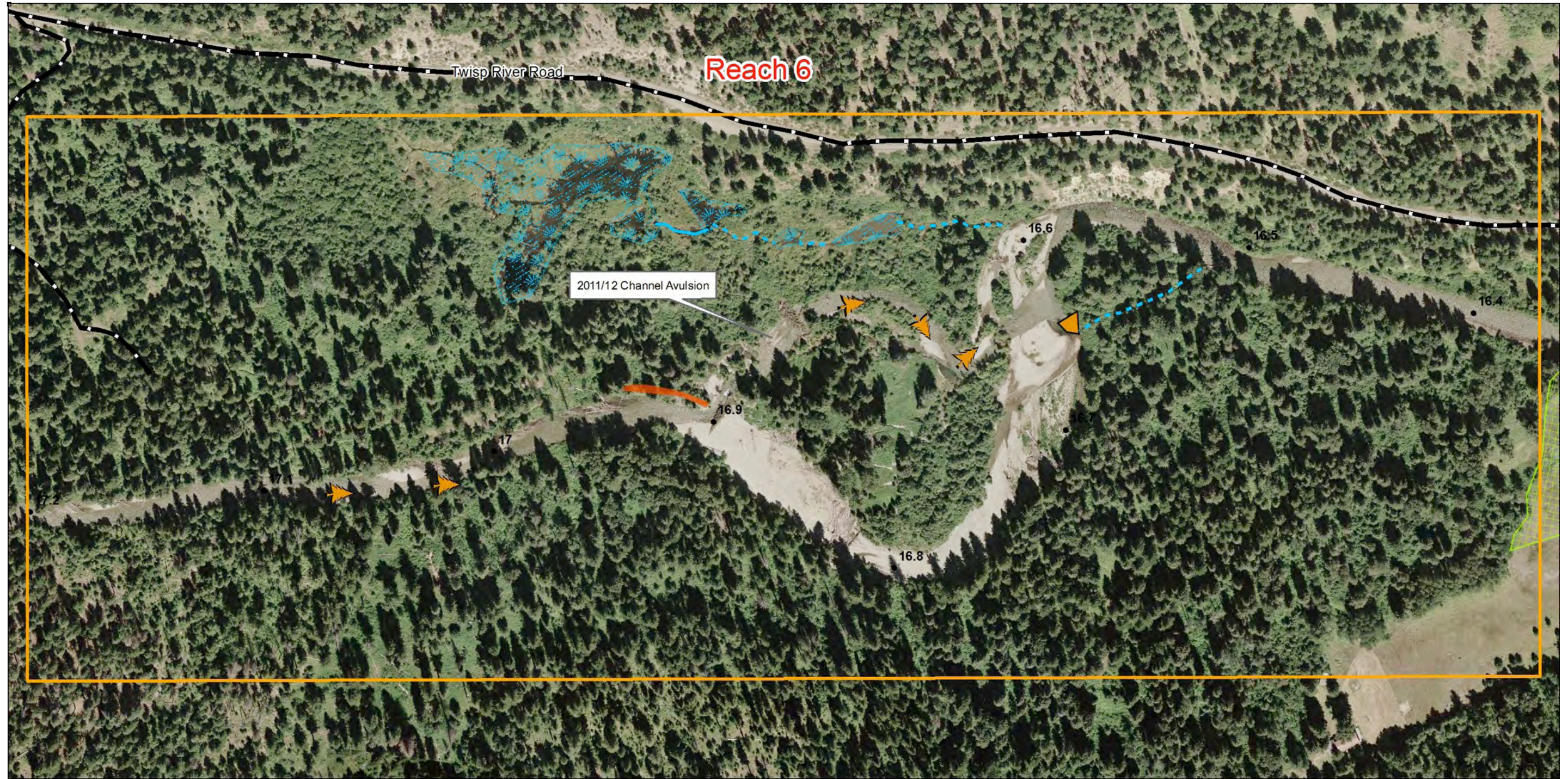
- Riprap
- Road
- Bridge
- Culvert

- Fill
- Cleared and Graded
- 2-Year Flood
- River Miles



2006 LiDAR







Middle Twisp Reach Assessment
 Project Opportunities
Eagle Project






2012 Aerial Photography

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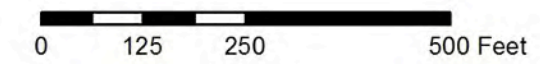
Project Elements

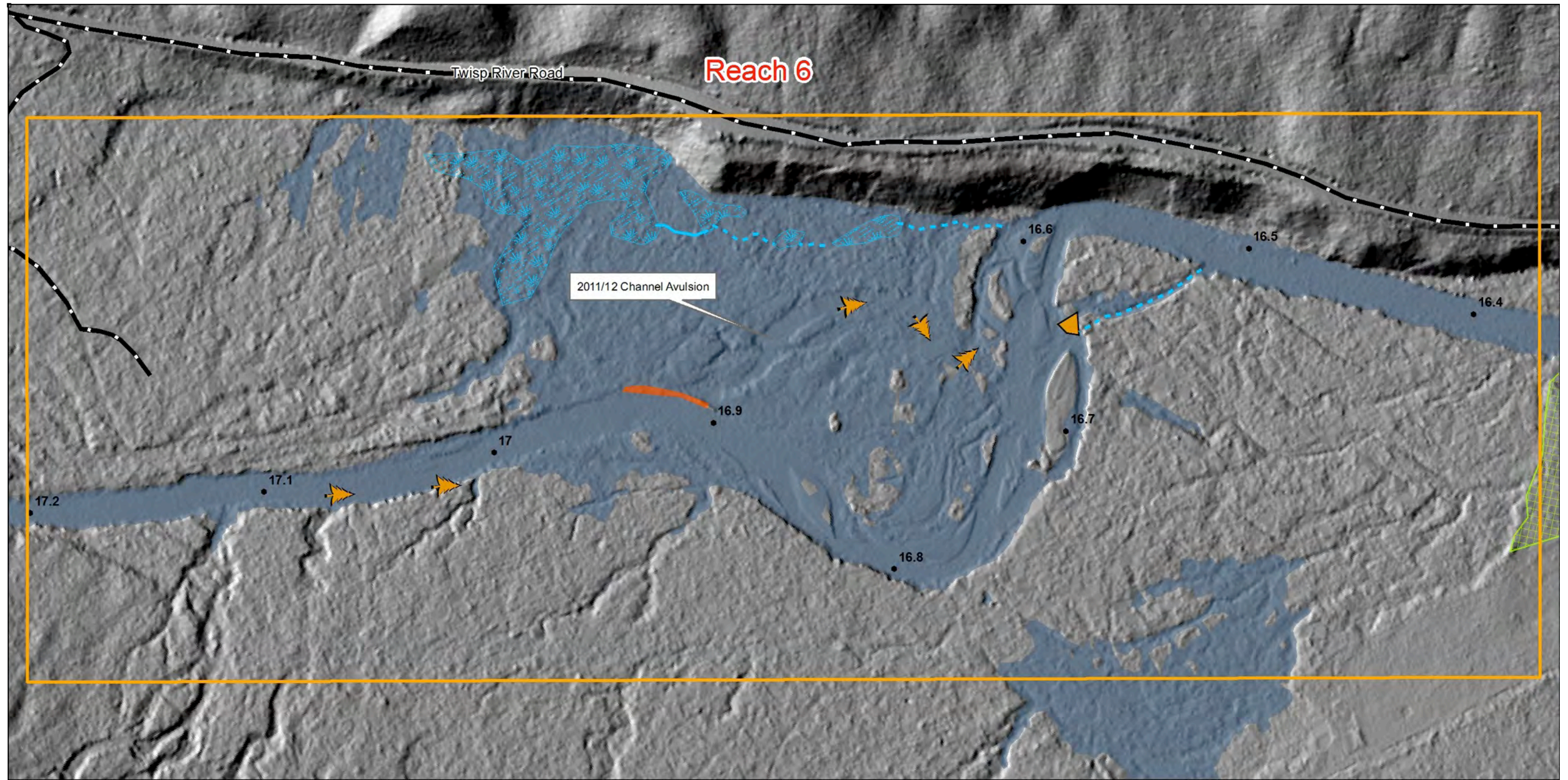
-  Bar apex jam
-  Whole tree placement

Human Features

-  Side-channel reconnection
-  Floodplain wetlands (existing)
-  Road
-  Push-Up Levee
-  Cleared and Graded

• River Miles










Middle Twisp Reach Assessment
Project Opportunities
Eagle Project

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Project Elements

-  Bar apex jam
-  Whole tree placement

-  Side-channel reconnection
-  Floodplain wetlands (existing)
-  River Miles

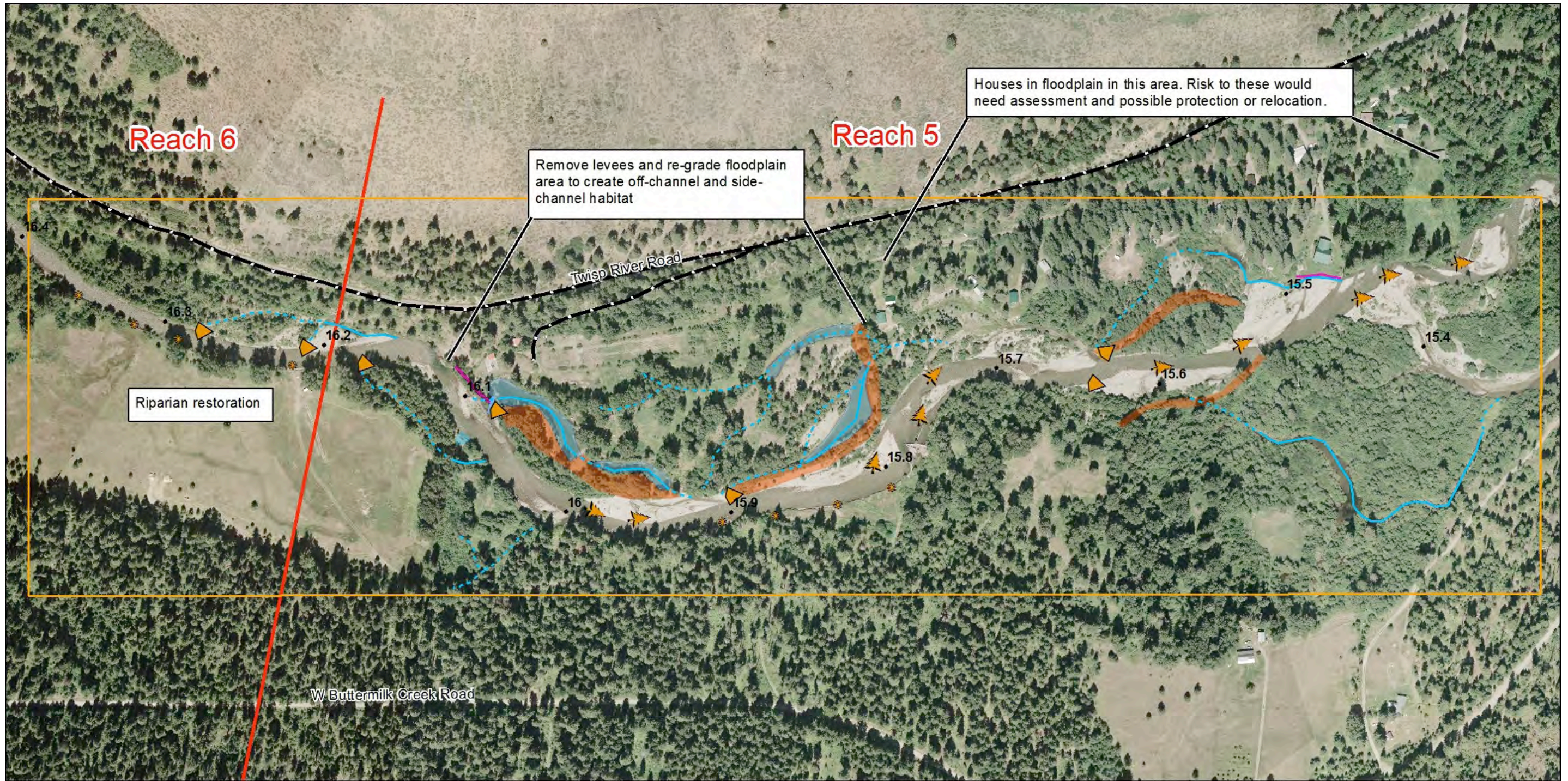
Human Features

-  Road
-  Push-Up Levee
-  Cleared and Graded
-  2-year flood



2006 LiDAR





Middle Twisp Reach Assessment
Project Opportunities
Scaffold Camp Project

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Project Elements

- Bar apex jam
- Margin complexity
- Whole tree placement
- Side-channel (existing)

Side-channel reconnection

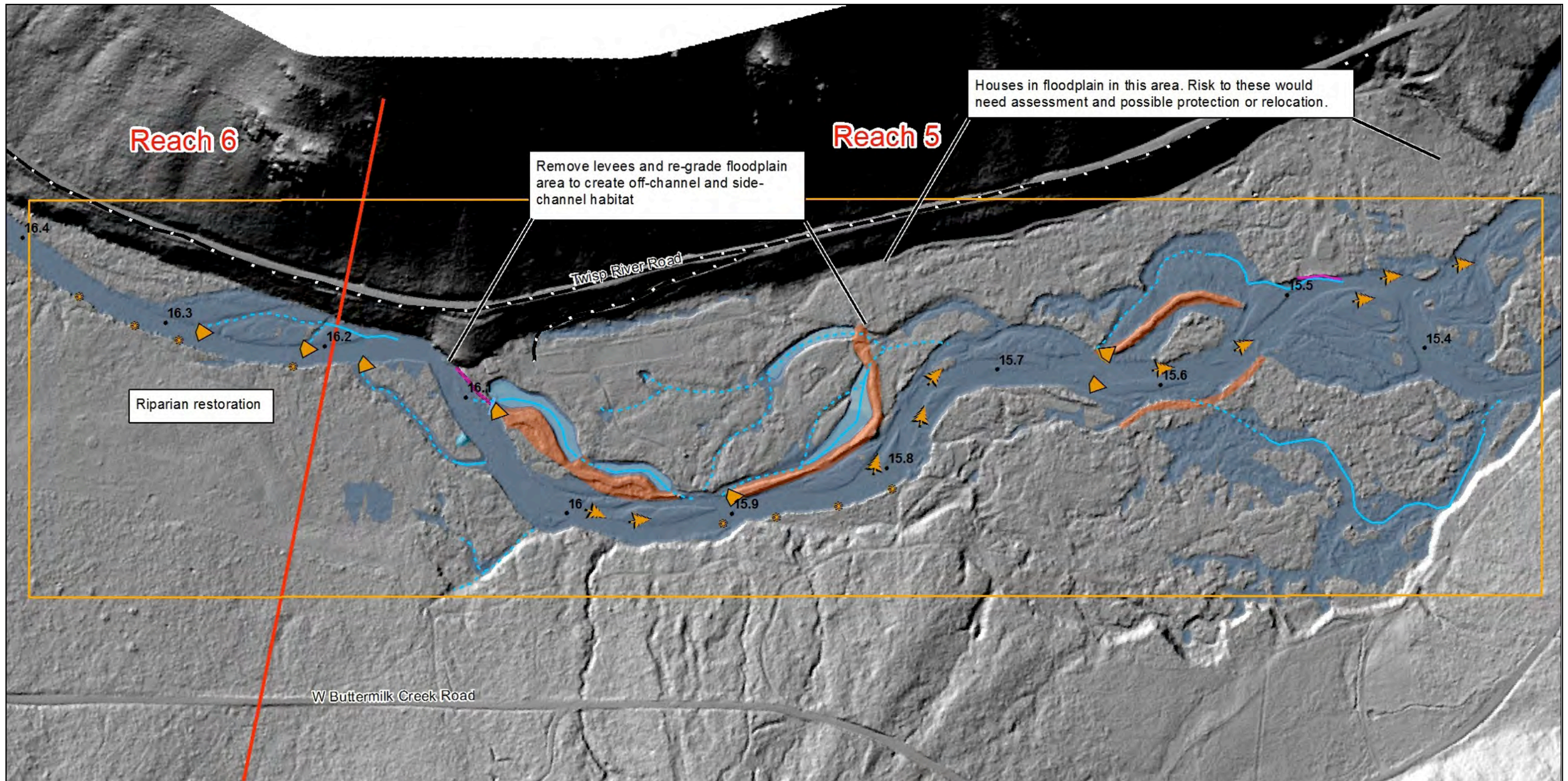
Human Features

- Riprap
- Road
- Gabion Wall

- Culvert
- Excavated Ponds
- Push-Up Levee
- Fill
- River Miles

2012 Aerial Photography

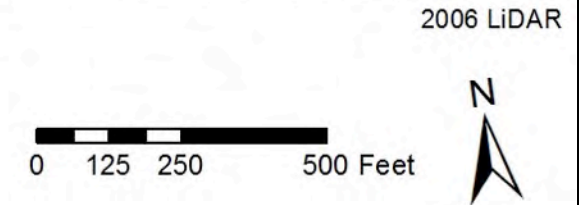




Middle Twisp Reach Assessment
Project Opportunities
Scaffold Camp Project

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|---------------------------|-----------------------|-------------------|
| Project Elements | Human Features | 2006 LiDAR |
| Bar apex jam | Riprap | Push-Up Levee |
| Margin complexity | Road | Fill |
| Whole tree placement | Gabion Wall | 2-year flood |
| Side-channel (existing) | Culvert | River Miles |
| Side-channel reconnection | Excavated Ponds | |



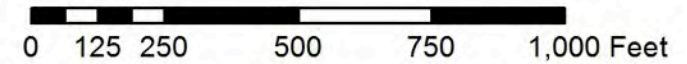


Middle Twisp Reach Assessment
Project Opportunities

Buttermilk Bends Project

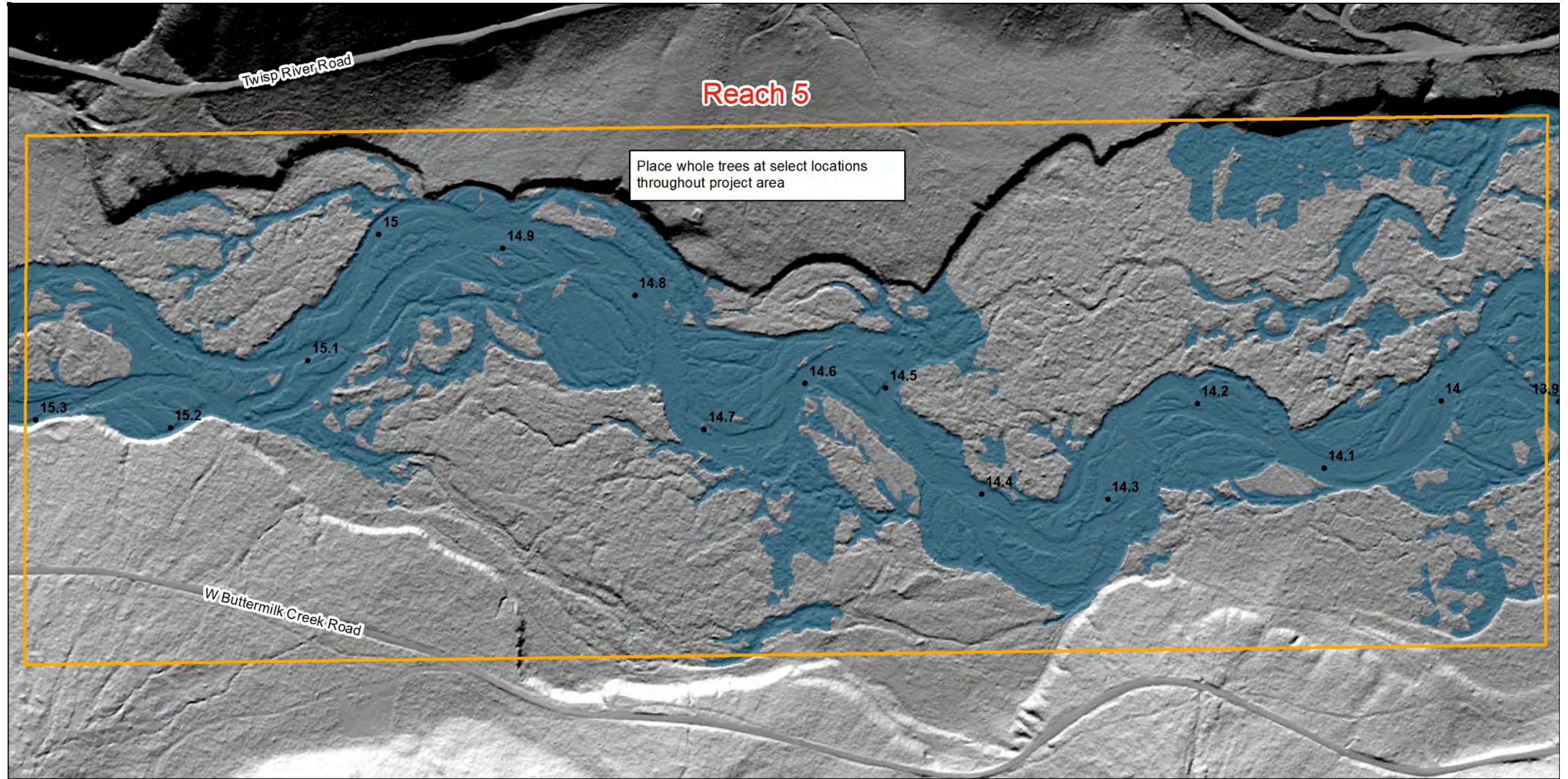
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• River Miles



2012 Aerial Photography

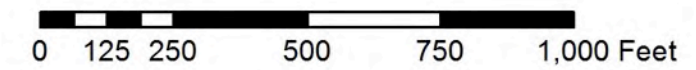




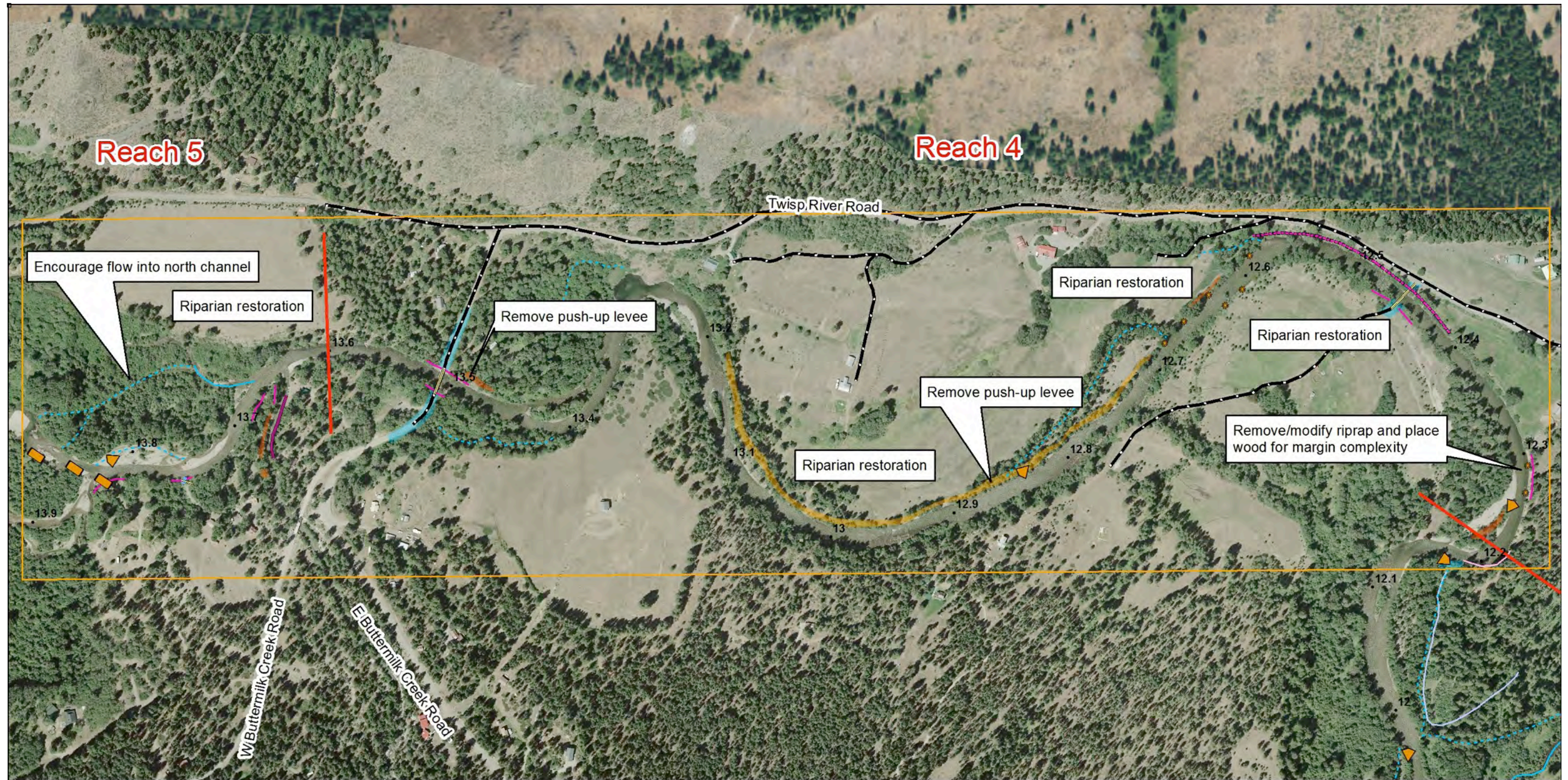
Middle Twisp Reach Assessment
Project Opportunities
Buttermilk Bends Project

2006 LiDAR

- River Miles
- 2-year flood



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Middle Twisp Reach Assessment
 Project Opportunities
Buttermilk Fan Project

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Project Elements

- Bar apex jam
- Margin complexity
- Margin jam
- Side-channel (existing)

Human Features

- Riprap/Road Embankment
- Cabled Logs and Riprap
- Riprap

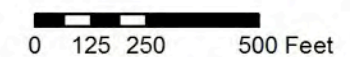
Infrastructure

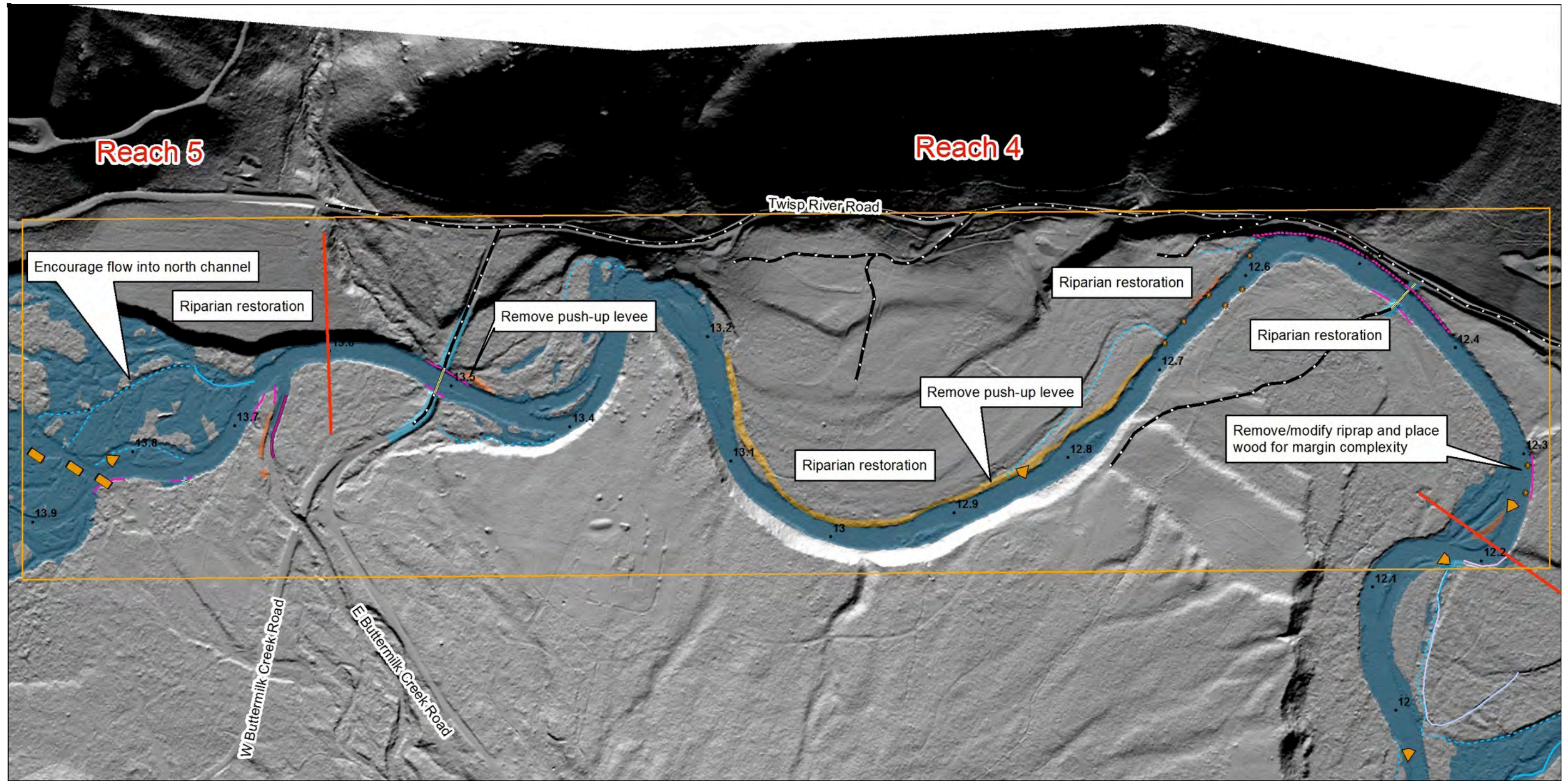
- Road
- Bridge
- Foot Bridge
- Gabion Wall
- Culvert

Other Features

- Ditch
- Intermittent Push-Up Levee
- Push-Up Levee
- Fill
- River Miles

2012 Aerial Photography





Middle Twisp Reach Assessment
Project Opportunities
Buttermilk Fan Project

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Project Elements

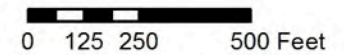
- Bar apex jam
- Margin complexity
- Margin jam
- Side-channel (existing)
- Side-channel reconnection

Human Features

- Riprap/Road Embankment
- Cabled Logs and Riprap
- Riprap
- Road
- Bridge

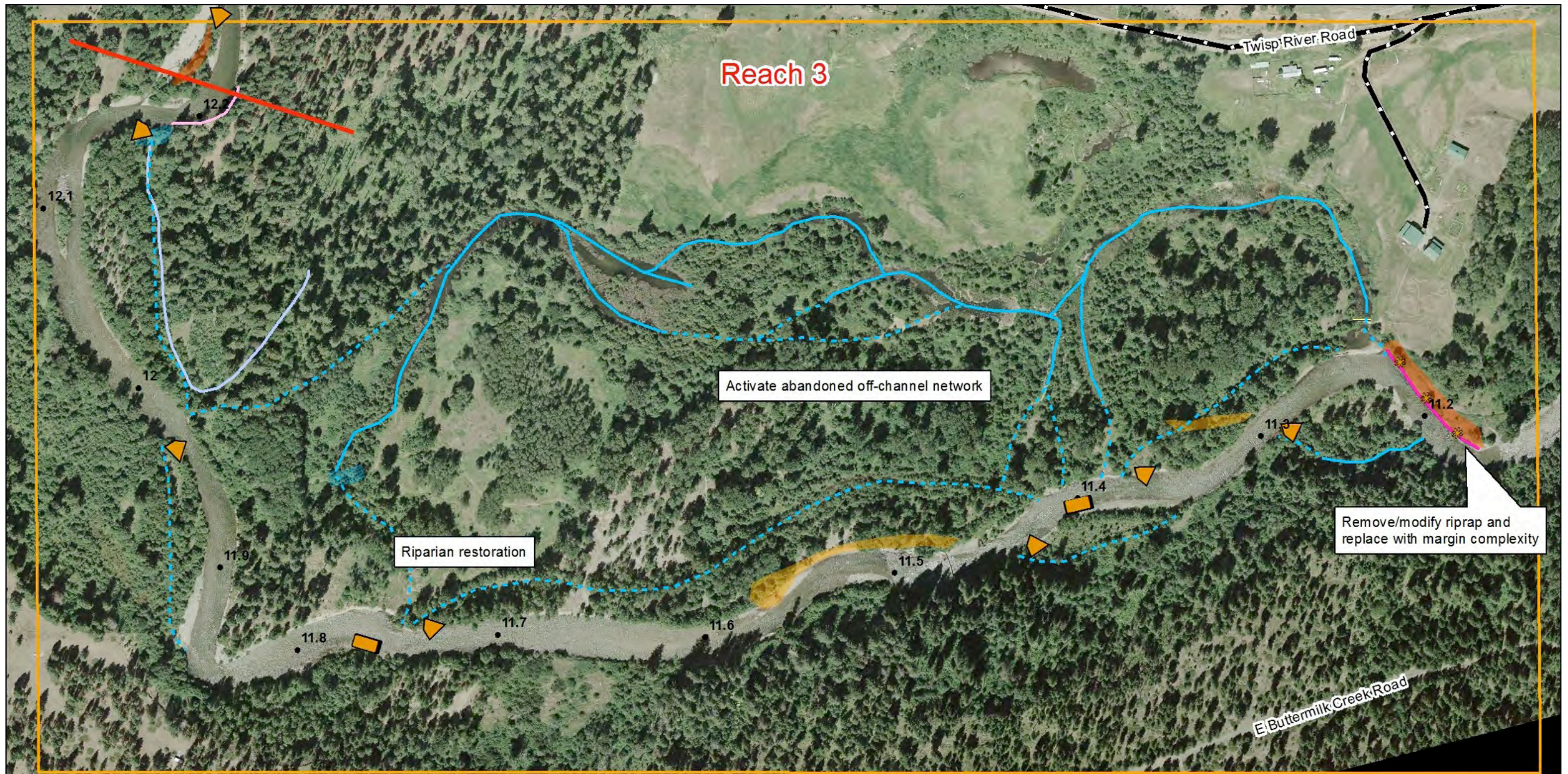
- Foot Bridge
- Gabion Wall
- Culvert
- Ditch
- Intermittent Push-Up Levee
- Push-Up Levee

- Fill
- 2-year flood
- Reach Breaks
- River Miles



2006 LiDAR

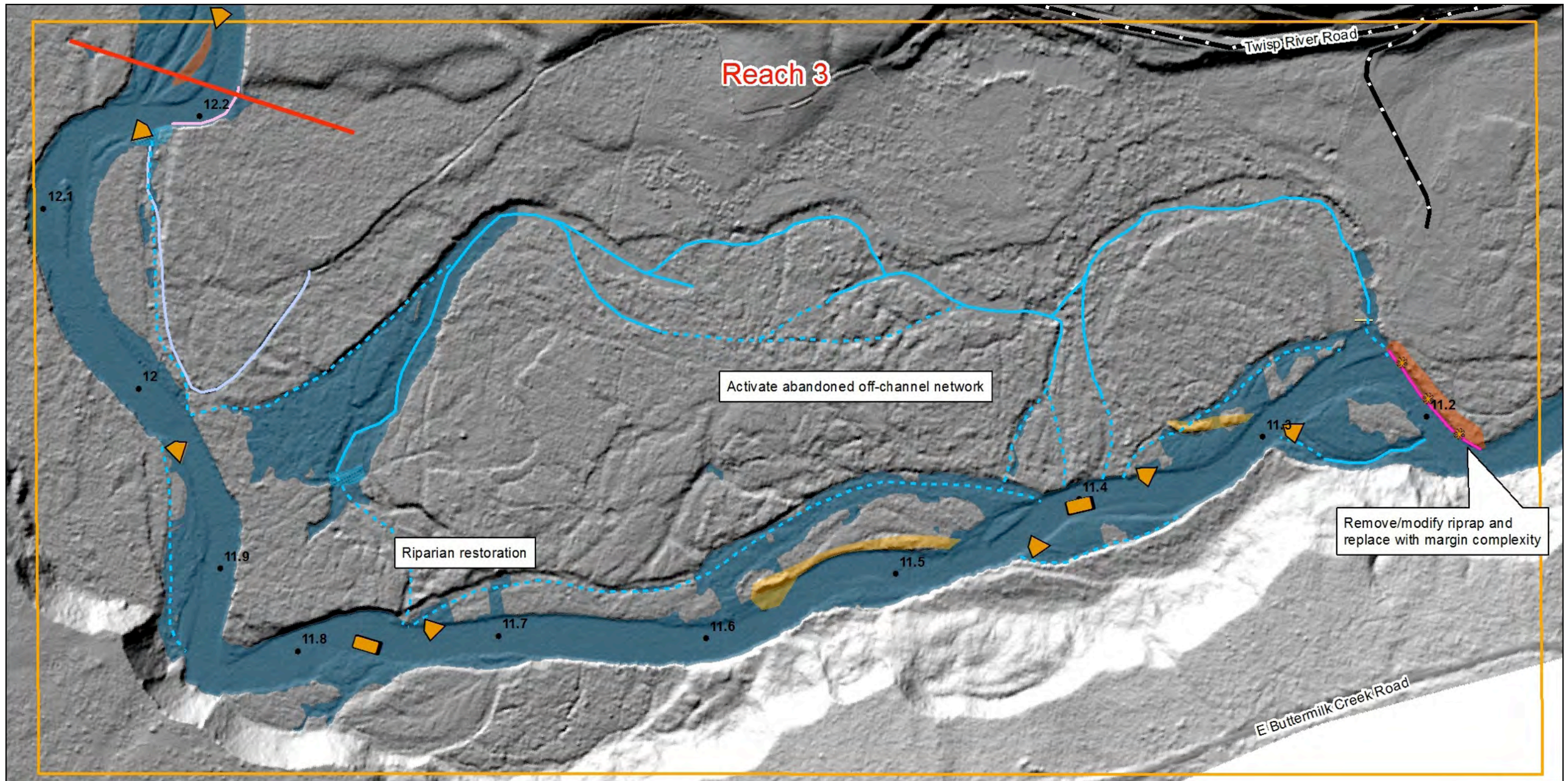




Middle Twisp Reach Assessment
Project Opportunities
Horseshoe Side-Channel Project

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<p>Project Elements</p> <ul style="list-style-type: none"> Bar apex jam Margin complexity Margin jam Side-channel (existing) Side-channel reconnection 	<p>Human Features</p> <ul style="list-style-type: none"> Cabled Logs and Riprap Riprap Road Foot Bridge Ditch 	<ul style="list-style-type: none"> Intermittent Push-Up Levee Push-Up Levee Fill Reach Breaks River Miles 	<p>2012 Aerial Photography</p> <p>0 125 250 500 Feet</p>
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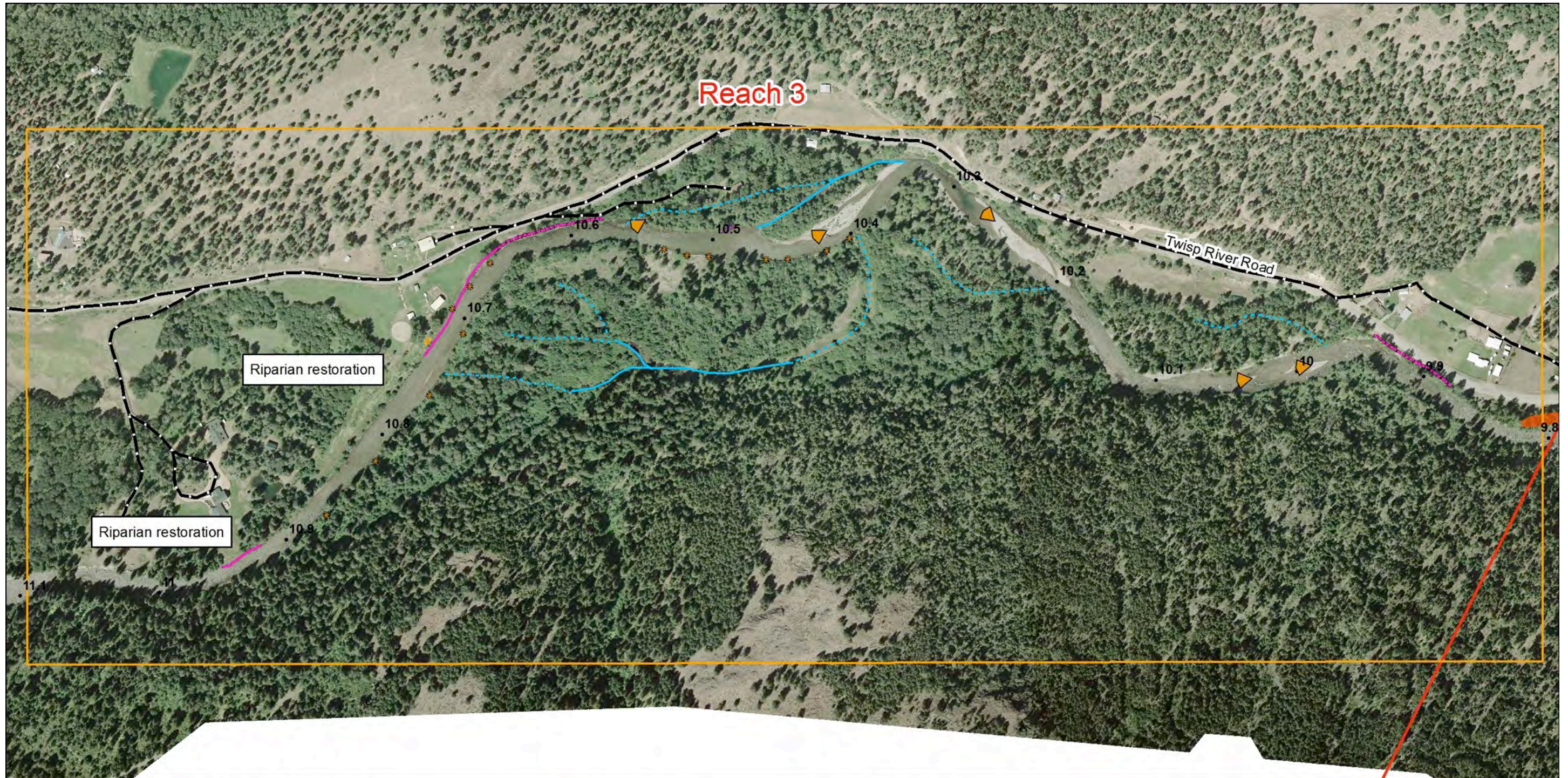
Middle Twisp Reach Assessment
Project Opportunities
Horseshoe Side-Channel Project

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Project Elements	Human Features	2006 LiDAR
<ul style="list-style-type: none"> Bar apex jam Margin complexity Margin jam Side-channel (existing) Side-channel reconnection 	<ul style="list-style-type: none"> Cabled Logs and Riprap Riprap Road Foot Bridge Ditch 	<ul style="list-style-type: none"> Intermittent Push-Up Levee Push-Up Levee Fill 2-year flood Reach Breaks River Miles

Scale: 0 125 250 500 Feet

North Arrow



Middle Twisp Reach Assessment
Project Opportunities
Newby Narrows Project

These drawings should be viewed only as very preliminary concepts intended to describe the types of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

Project Elements

- Bar apex jam
- Margin complexity
- Side-channel (existing)
- Side-channel reconnection

Human Features

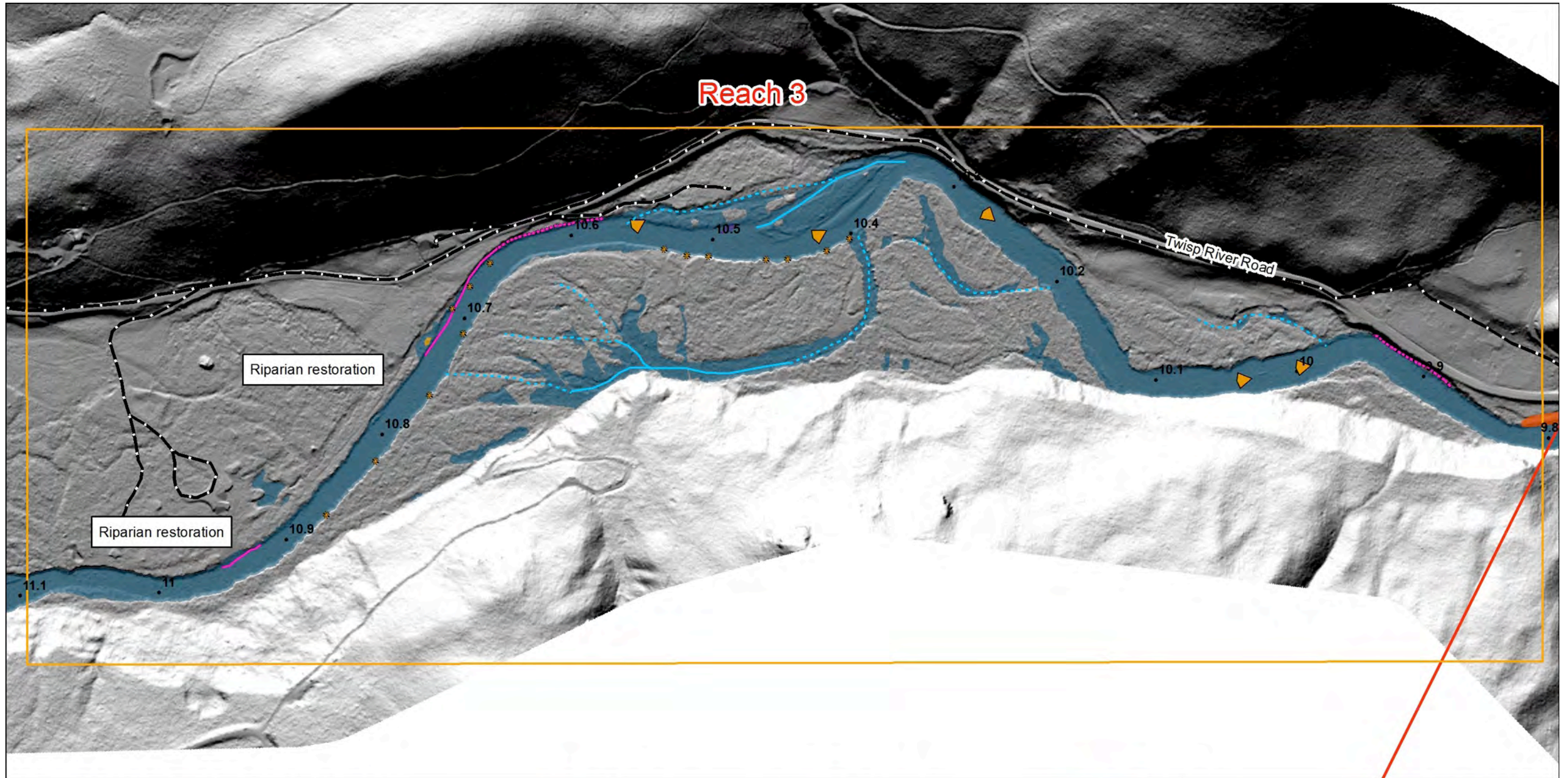
- Riprap/Road Embankment
- Riprap
- Road
- Intermittent Push-Up Levee

Push-Up Levee

- Push-Up Levee
- Rock Barb
- Reach Breaks
- River Miles

2012 Aerial Photography





Middle Twisp Reach Assessment

Project Opportunities

Newby Narrows Project

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Project Elements

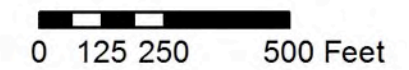
- Bar apex jam
- Margin complexity
- Side-channel (existing)
- Side-channel reconnection

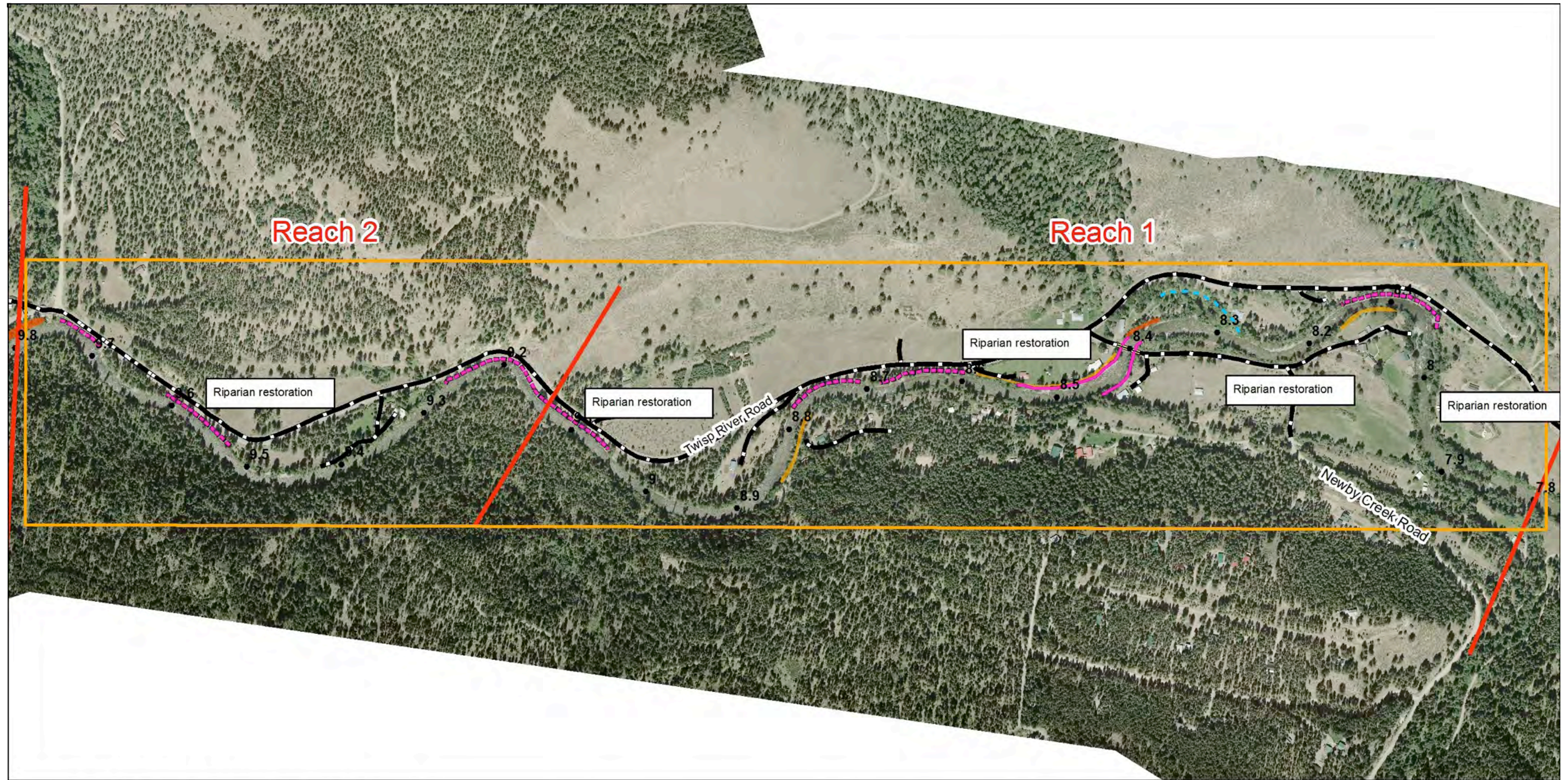
Human Features

- Riprap/Road Embankment
- Riprap
- Road
- Intermittent Push-Up Levee

- Push-Up Levee
- Rock Barb
- 2-year flood
- Reach Breaks
- River Miles

2006 LiDAR





2012 Aerial Photography

Middle Twisp Reach Assessment
Project Opportunities
Newby to Bridge Project

These drawings should be viewed only as very preliminary concepts intended to describe the types of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

Project Elements

--- Side channel reconnection

Human Features

--- Riprap/Road Embankment

--- Riprap

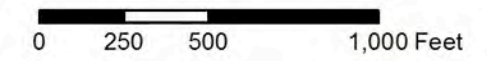
--- Road

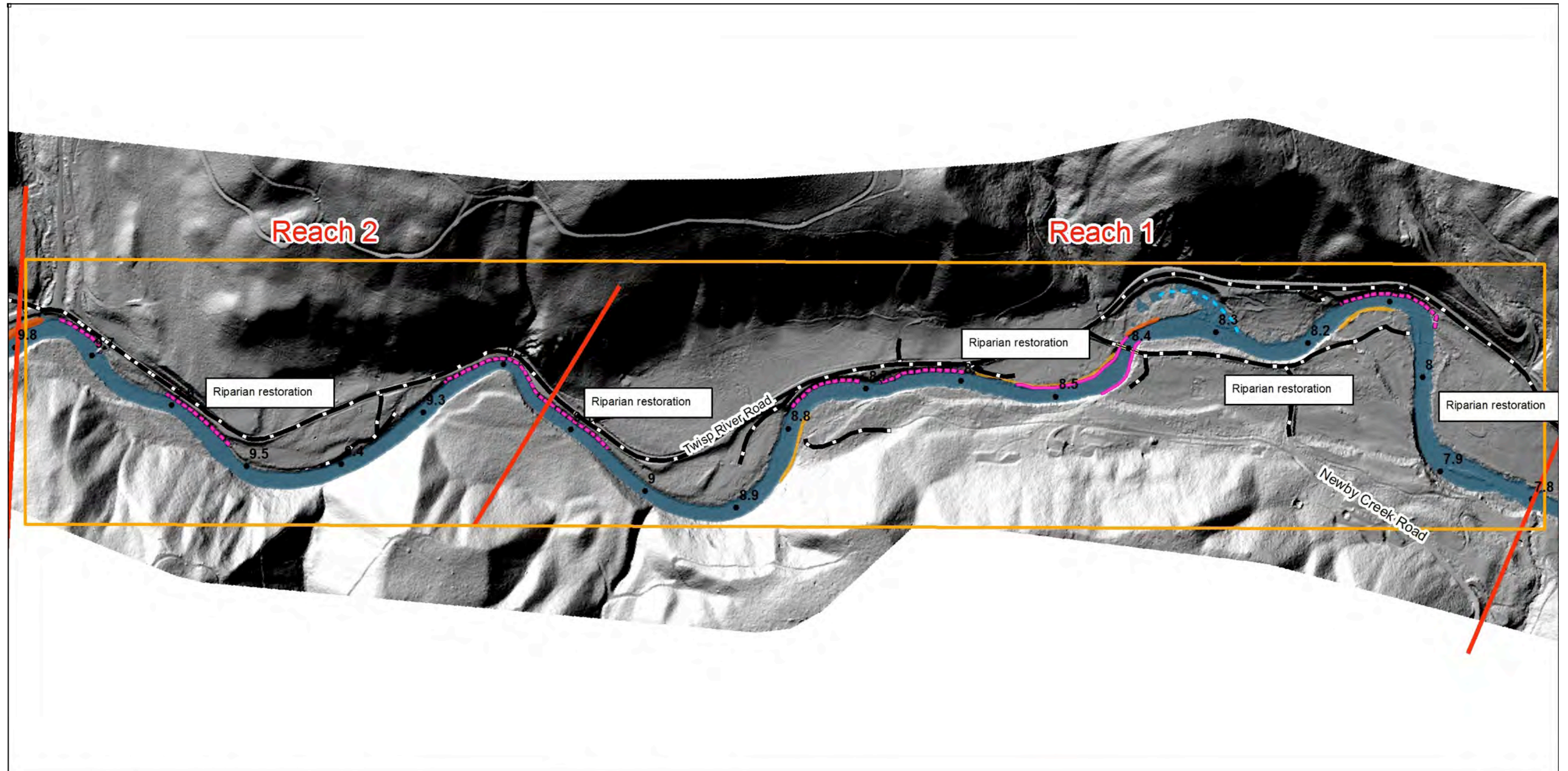
--- Bridge

--- Intermittent Push-Up Levee

--- Push-Up Levee

• River Miles





Middle Twisp Reach Assessment

Project Opportunities

Newby to Bridge Project

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Project Elements

--- Side channel reconnection

Human Features

--- Riprap/Road Embankment

--- Riprap

--- Road

--- Bridge

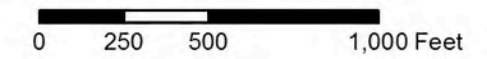
--- Intermittent Push-Up Levee

--- Push-Up Levee

--- 2-year flood

--- Reach Breaks

• River Miles



2006 LiDAR

