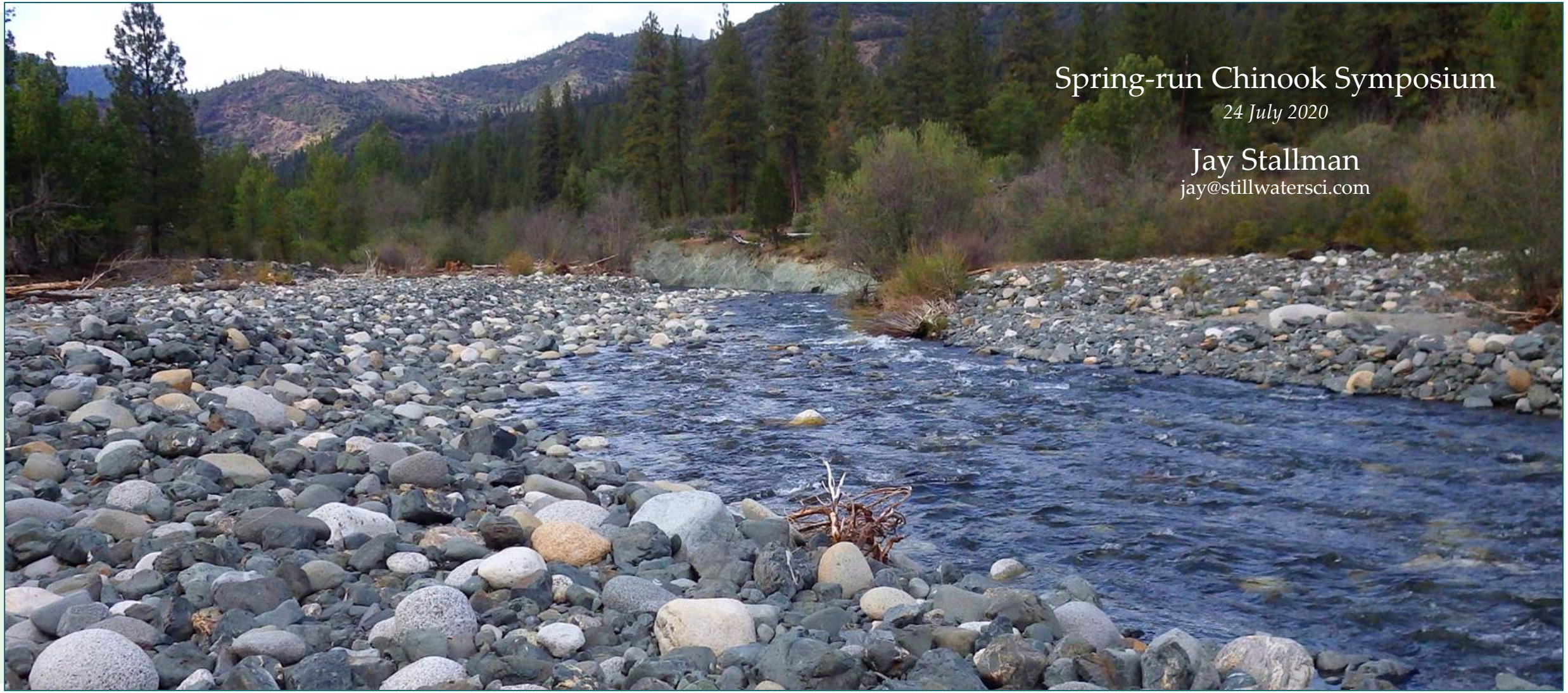
EFFORTS TO ADDRESS HABITAT IMPAIRMENTS FROM LEGACY PLACER MINING IN THE MIDDLE KLAMATH

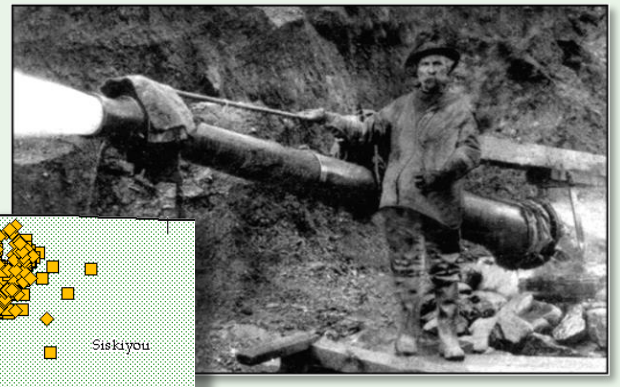


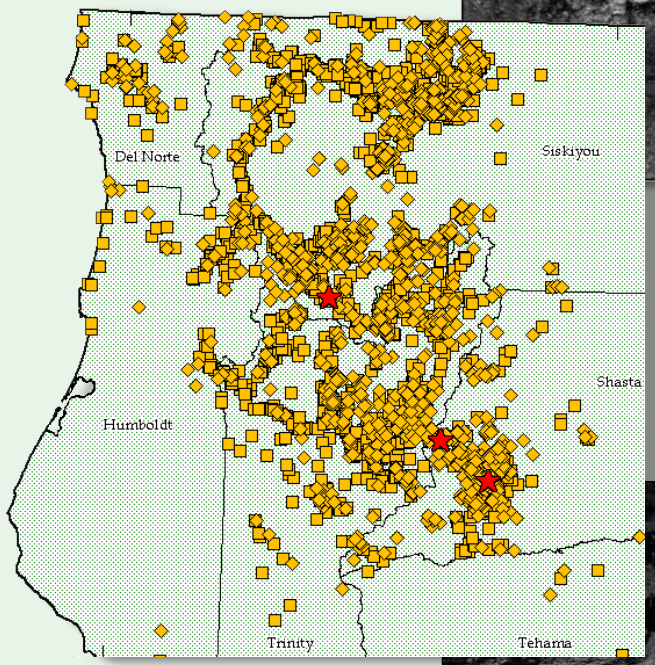
Spring-run Chinook Symposium

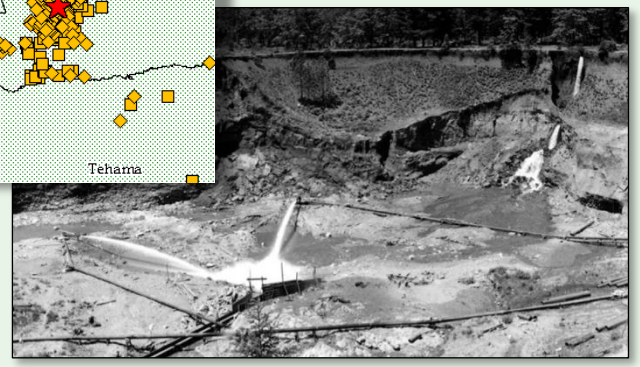
24 July 2020

Jay Stallman
jay@stillwatersci.com

PLACER MINING IN THE MID-KLAMATH BASIN







Basin	Sluice & Hydraulic	Dredge
Trinity	1860s-1900s	1887-1959
Salmon	1870s-1950s	1930s
Scott	1856	1934-1950
Sacramento	1860s	1905-1915
Sierra Nevada	1853	late 1890s

1884 Sawyer Decision in Woodruff v. North Bloomfield Mining and Gravel
Prohibited discharging hydraulic mining debris to Sierra Nevada rivers

1893 Caminetti Act
Prohibited hydraulic mining in the Sacramento River Basin

1936 Quin Bill
Prohibited hydraulic mining in the Klamath Basin July–November

1942 War Production Board Order L-208
Halted gold mining

LEGACY IMPACTS

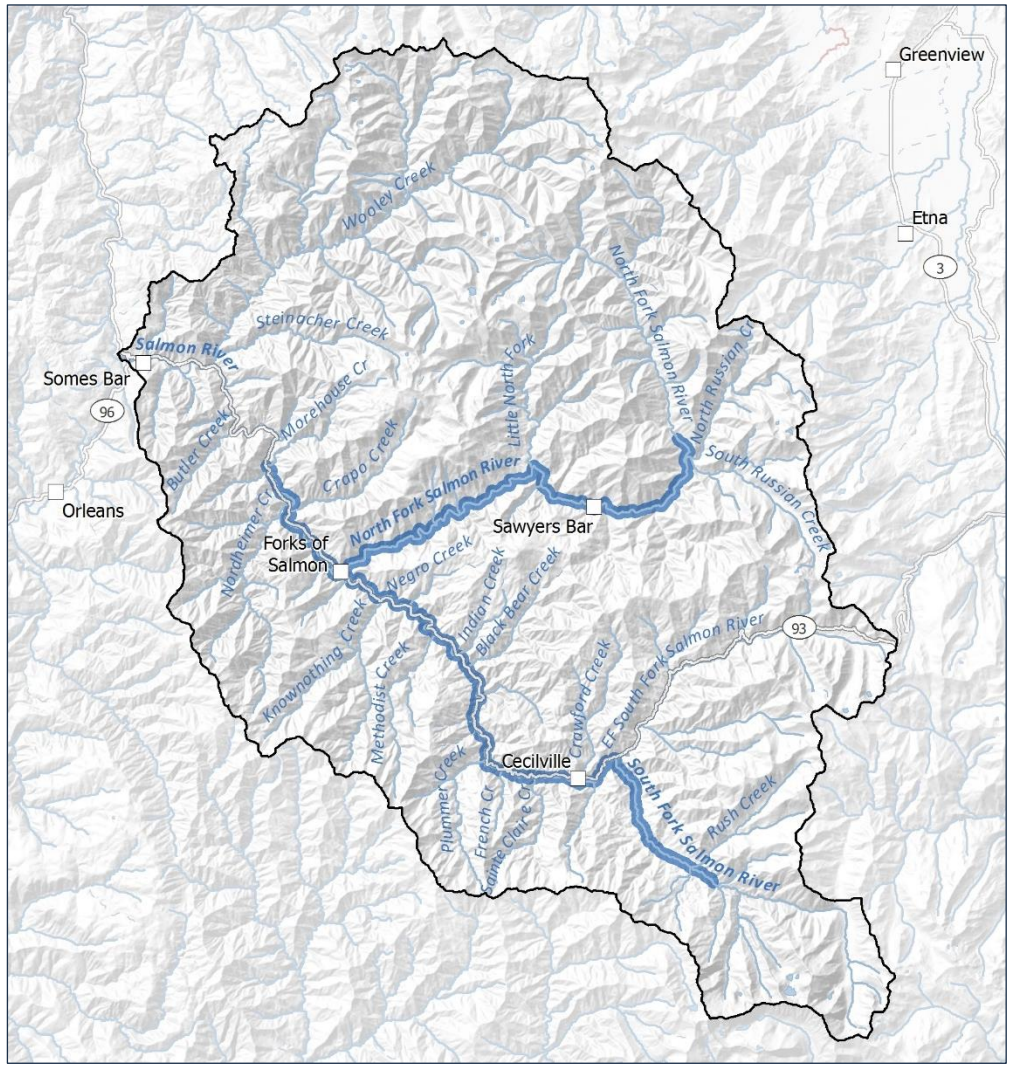
- Mining established present-day physical template
- Unique legacy in each river system
  - Methods, timing, and intensity
  - Valley and channel geometry
  - Sediment mass balance
  - Climate

- Denuded slopes and valley bottoms
- Aggraded channels and floodplains
- Reduced channel complexity
- Coarsened bed, reduced mobility
- Reduced floodplain inundation
- Elevated summer water temperatures
- Degraded riparian functions

SALMON RIVER FLOODPLAIN HABITAT ENHANCEMENT AND MINE TAILING REMEDIATION

- **SRRC initiated science-based planning process in 2014**
- **Goals:**
  - Increase long-term salmonid productivity
  - Ensure Salmon River remains refuge for cold-water dependent species
- **Objectives:**
  - Increase over-wintering, over-summering, and spawning habitat
  - Improve riparian functions
  - Improve hydrologic functions
  - Protect and enhance thermally suitable habitats

PROJECT AREA AND PHASES

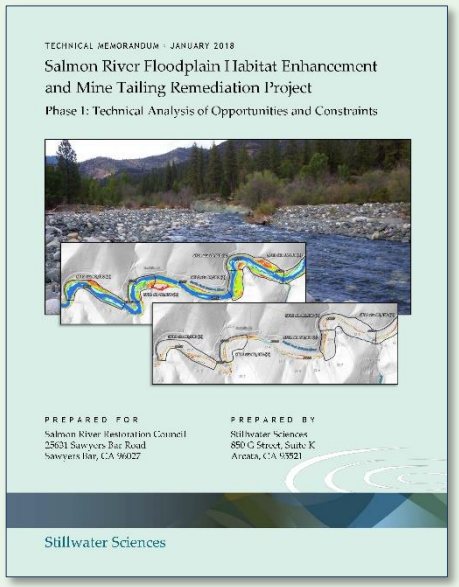


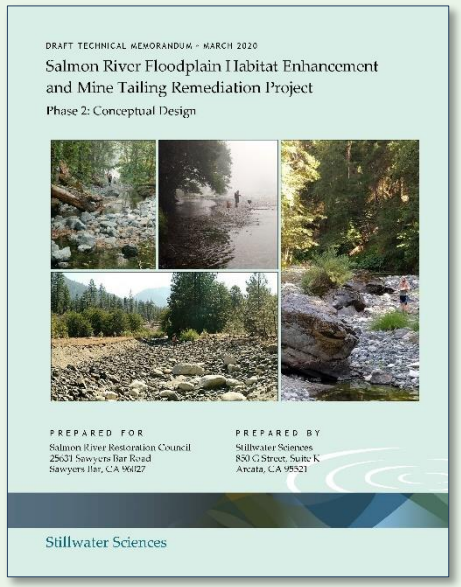
Phase 1 - Opportunities and constraints

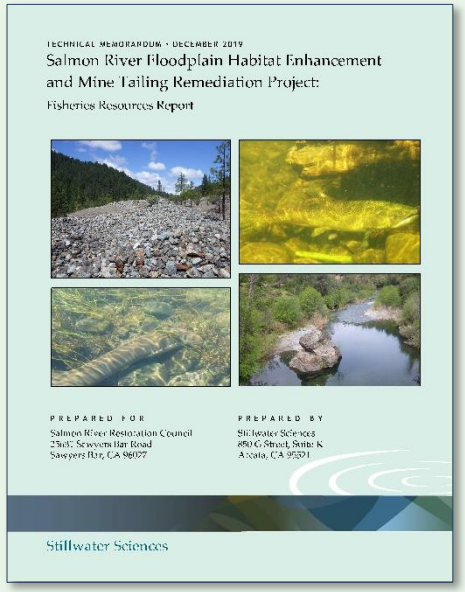
Phase 2 - Conceptual design

Phase 3 - State and Federal environmental review

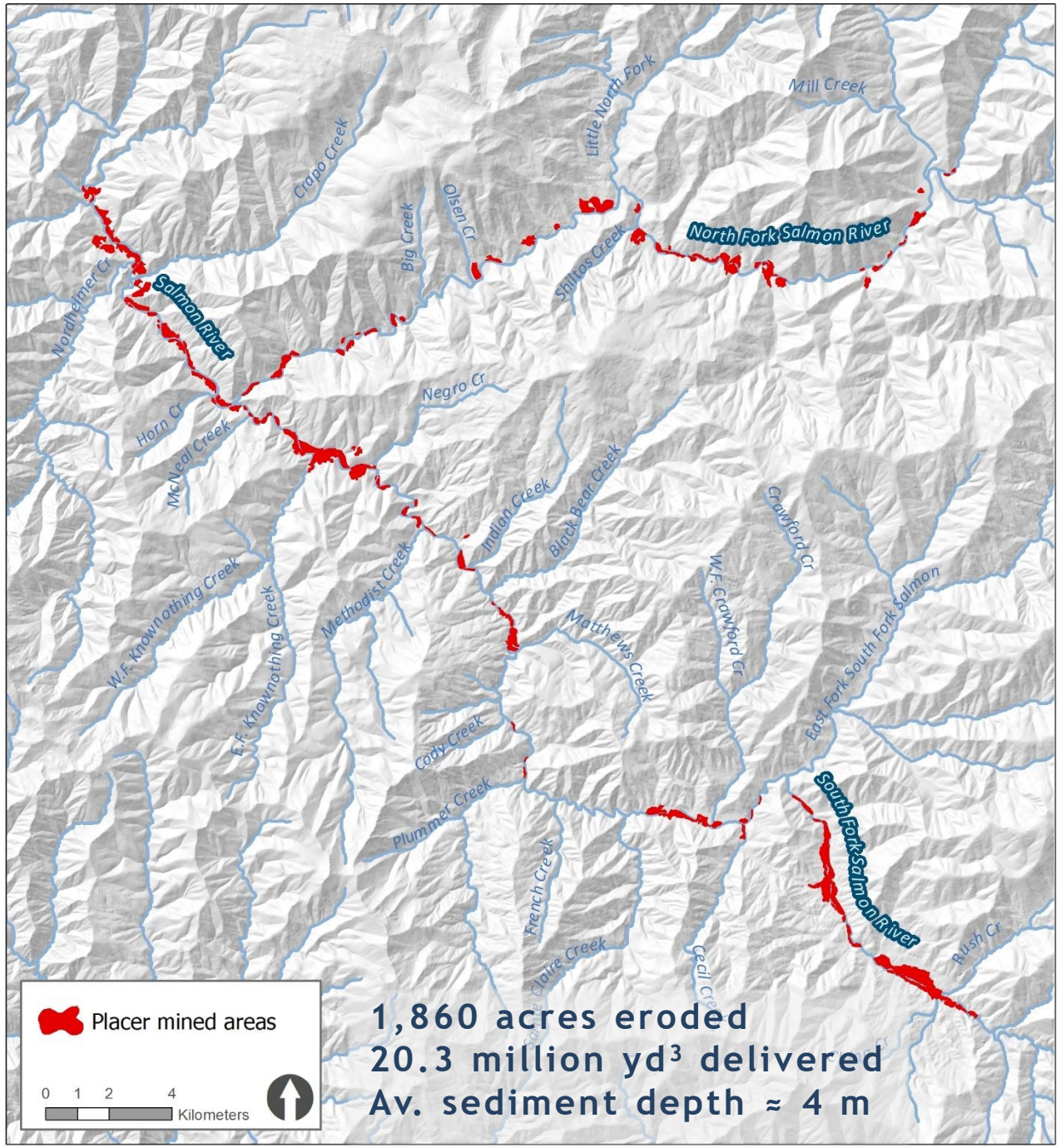
Phase 4 - Engineering design and implementation

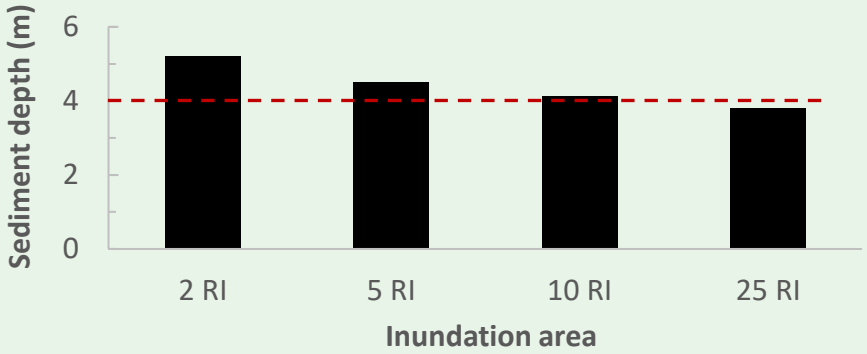


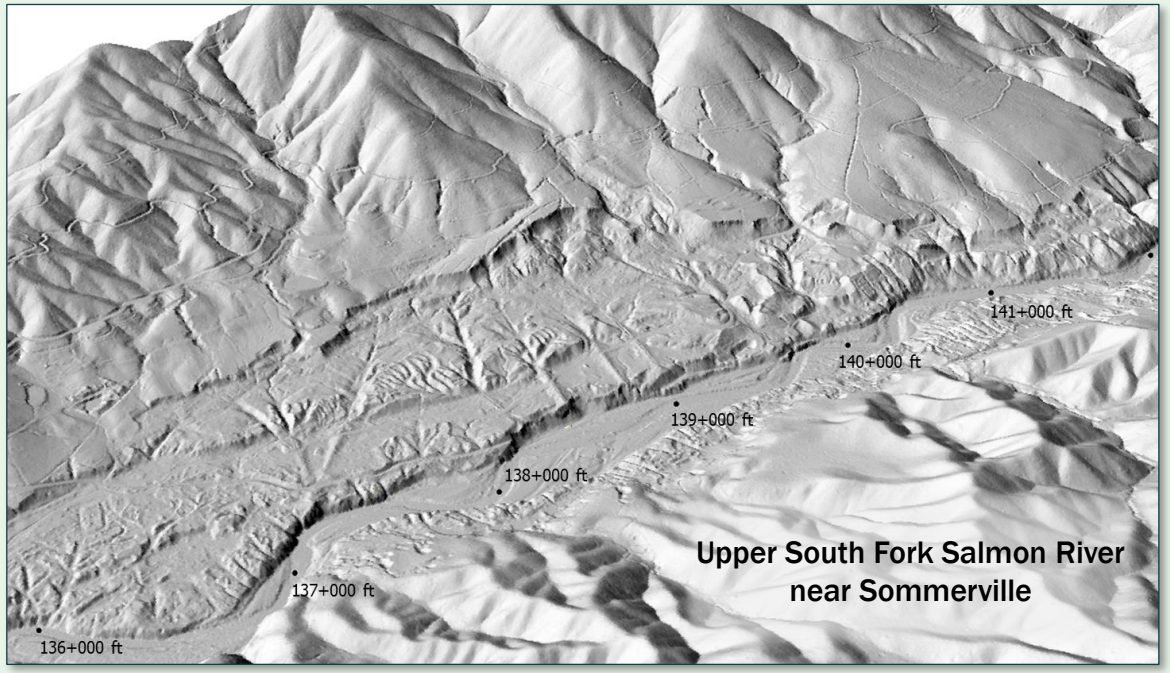


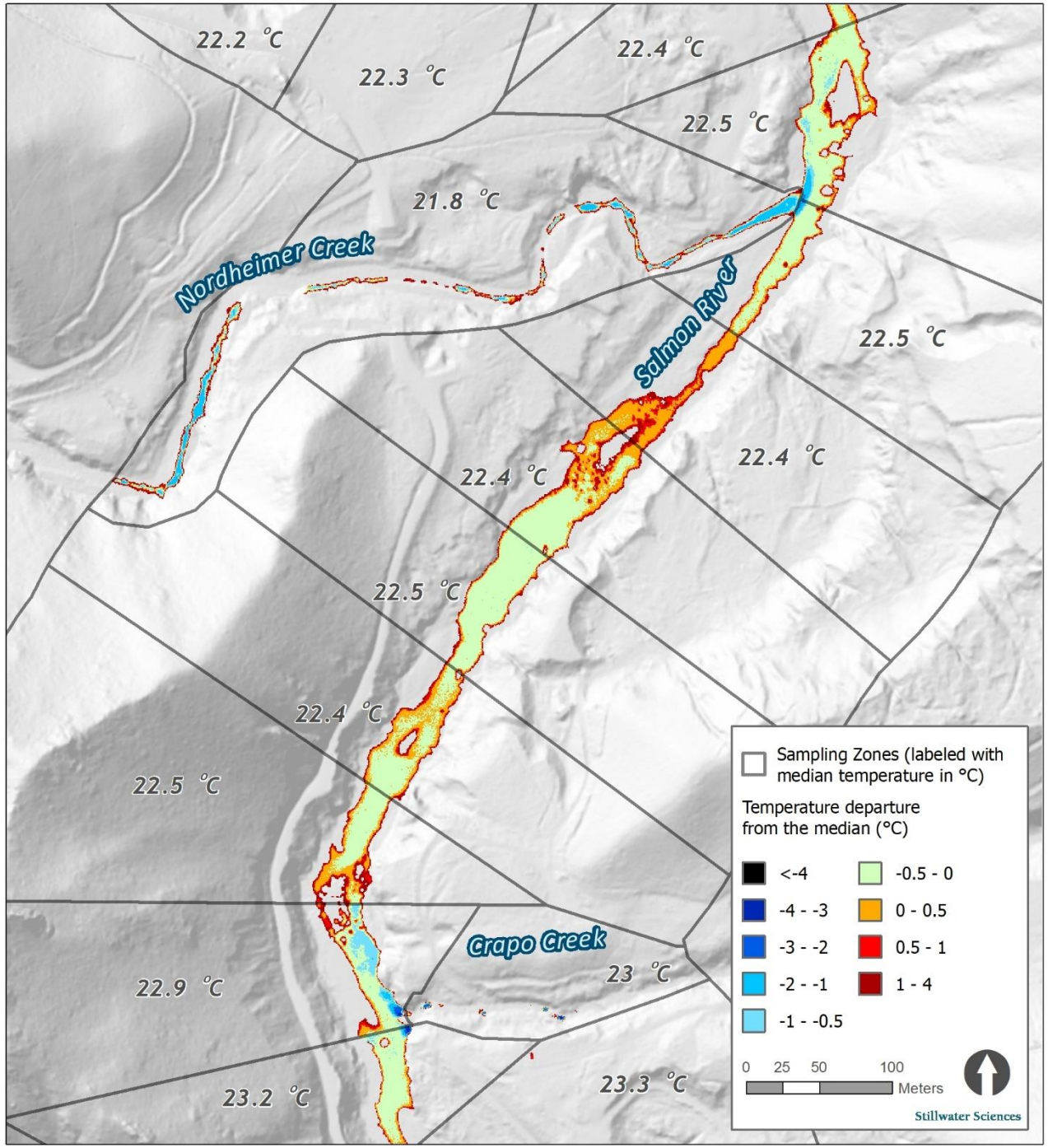


MINING DISTURBANCE









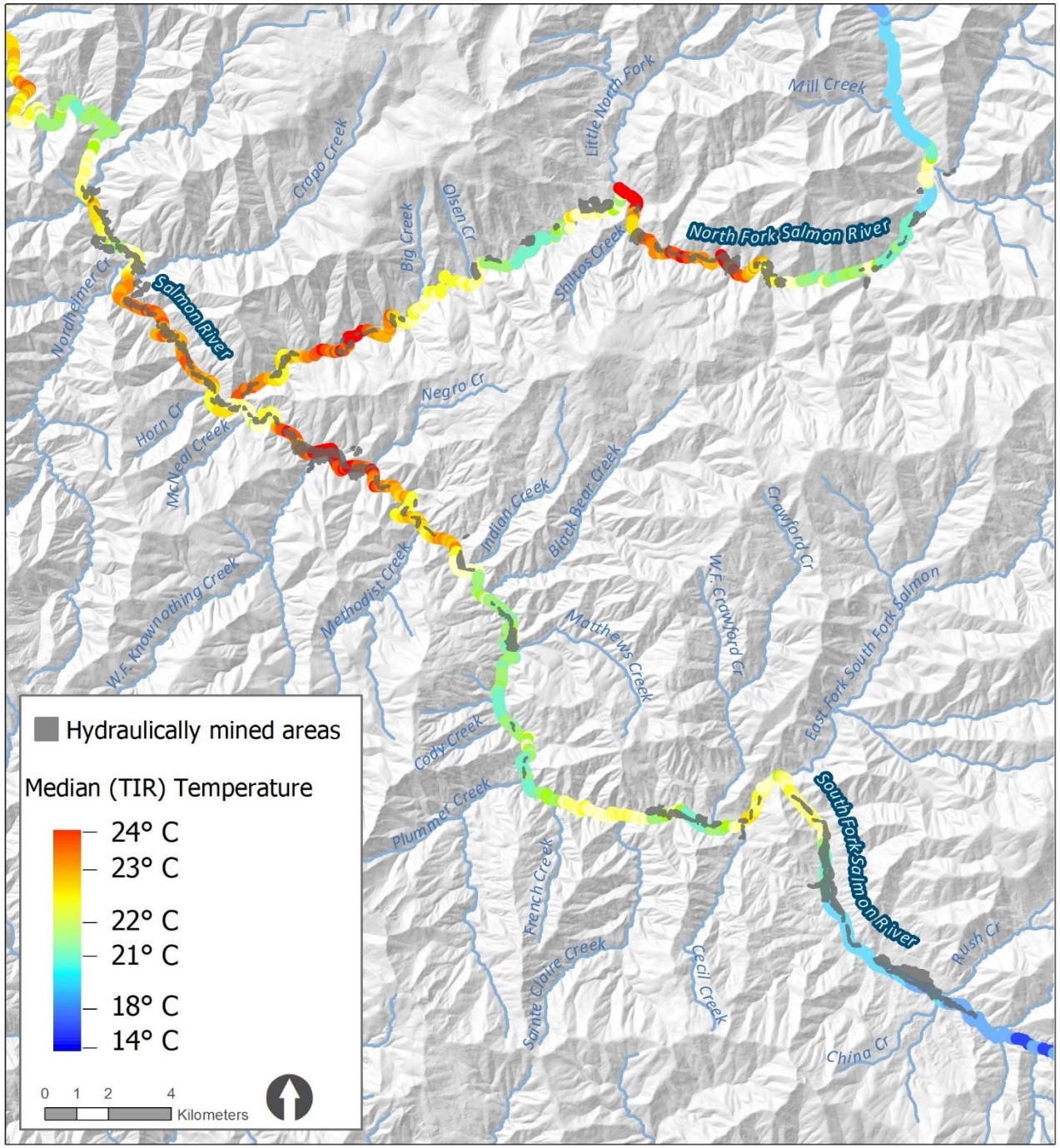
THERMALLY SUITABLE HABITAT BASED ON TIR IMAGERY

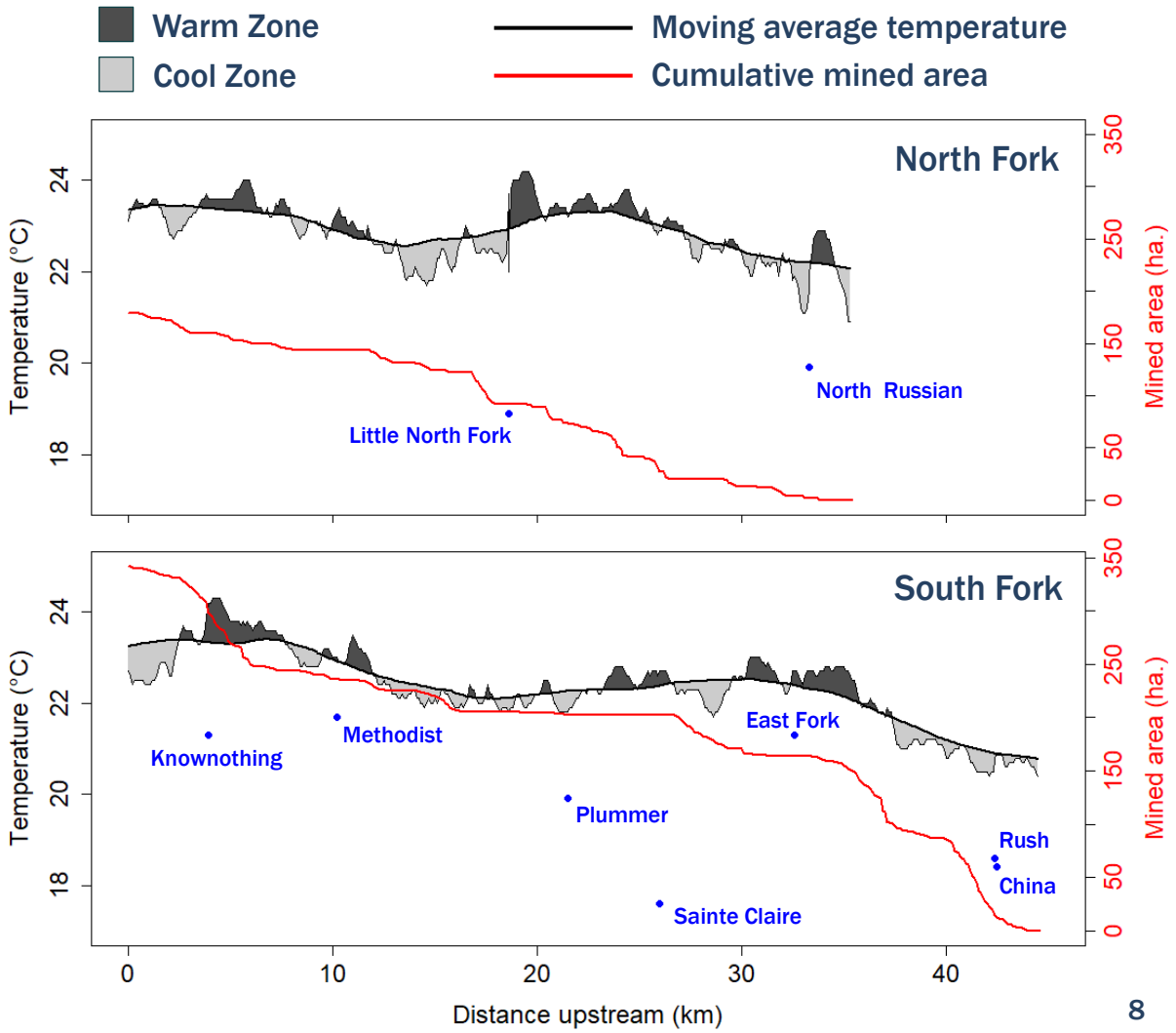
Approach:

- TIR imagery acquired for 85 mi
  July 22-23, 2009
- 100 m sampling zones
- Moving median temperatures over 500 m channel length
- Reach-scale thermal zones and thermal refuges defined by temp departures =

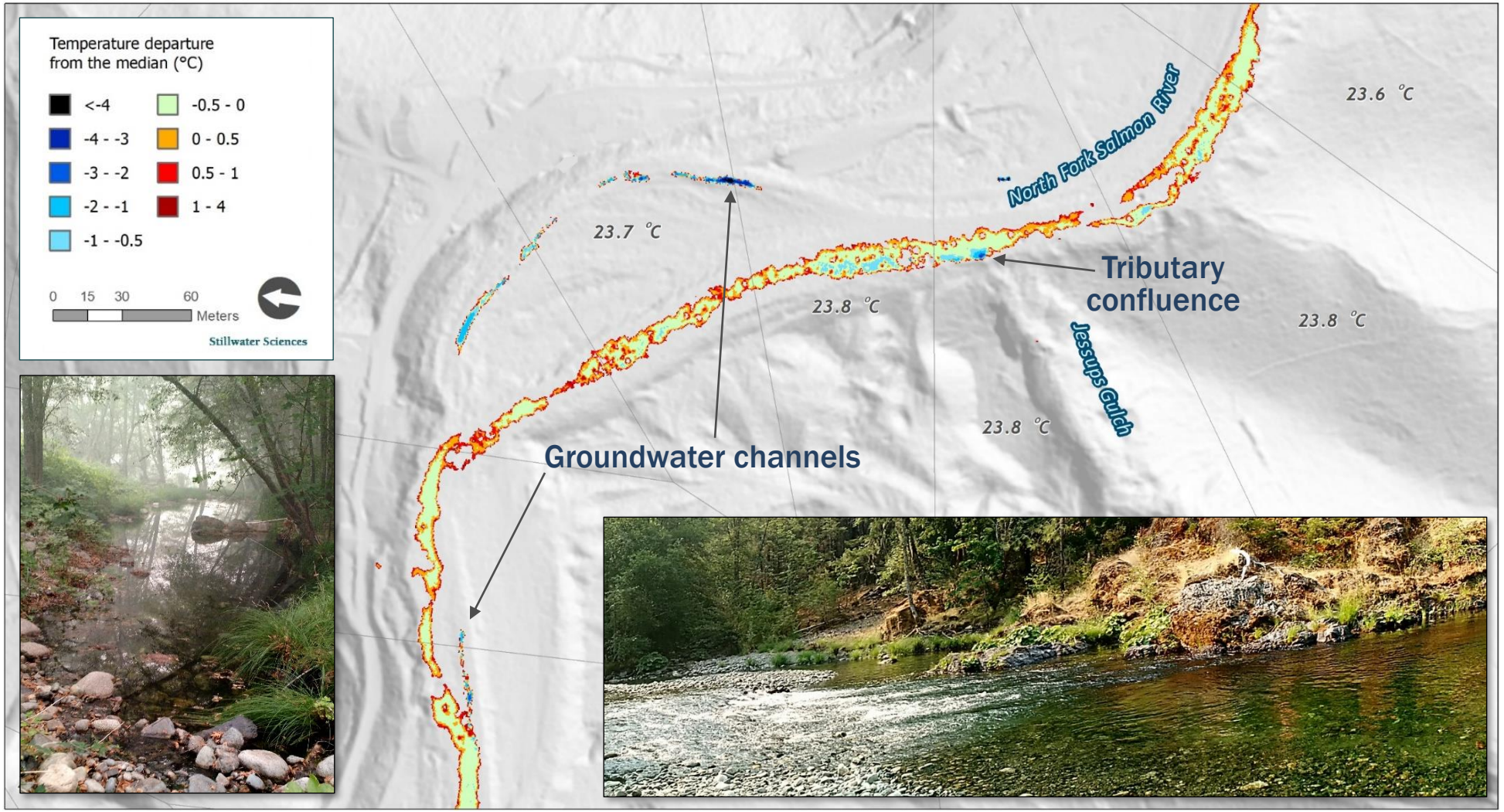
  median zone temp – observed TIR temp

REACH-SCALE THERMAL ZONES



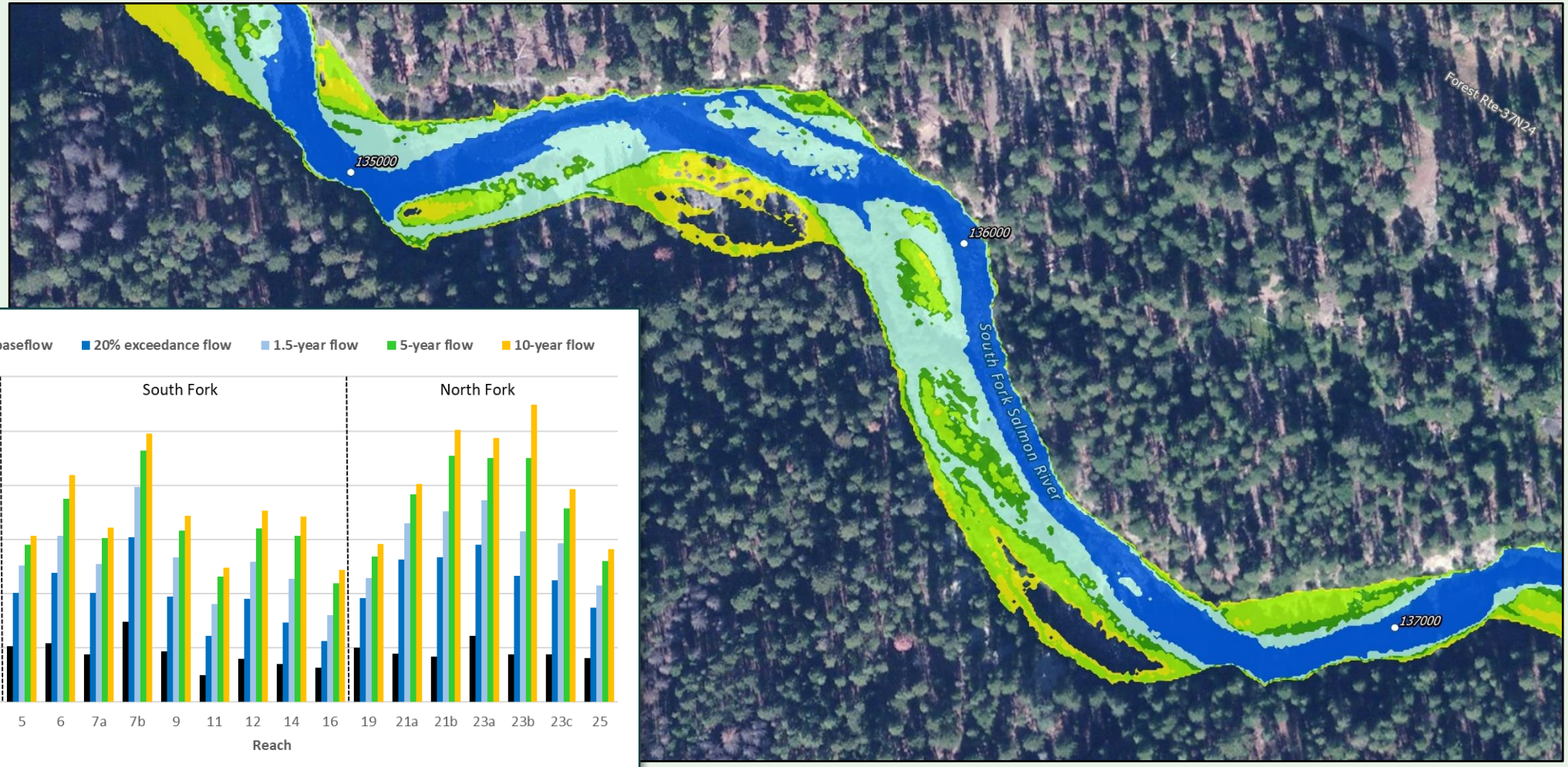


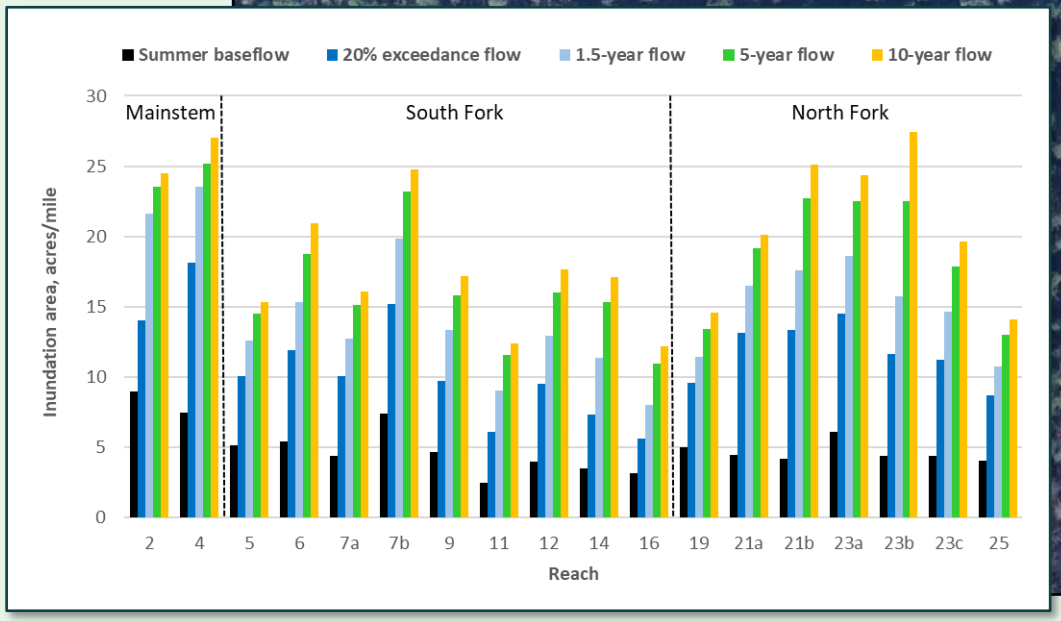
THERMAL REFUGES



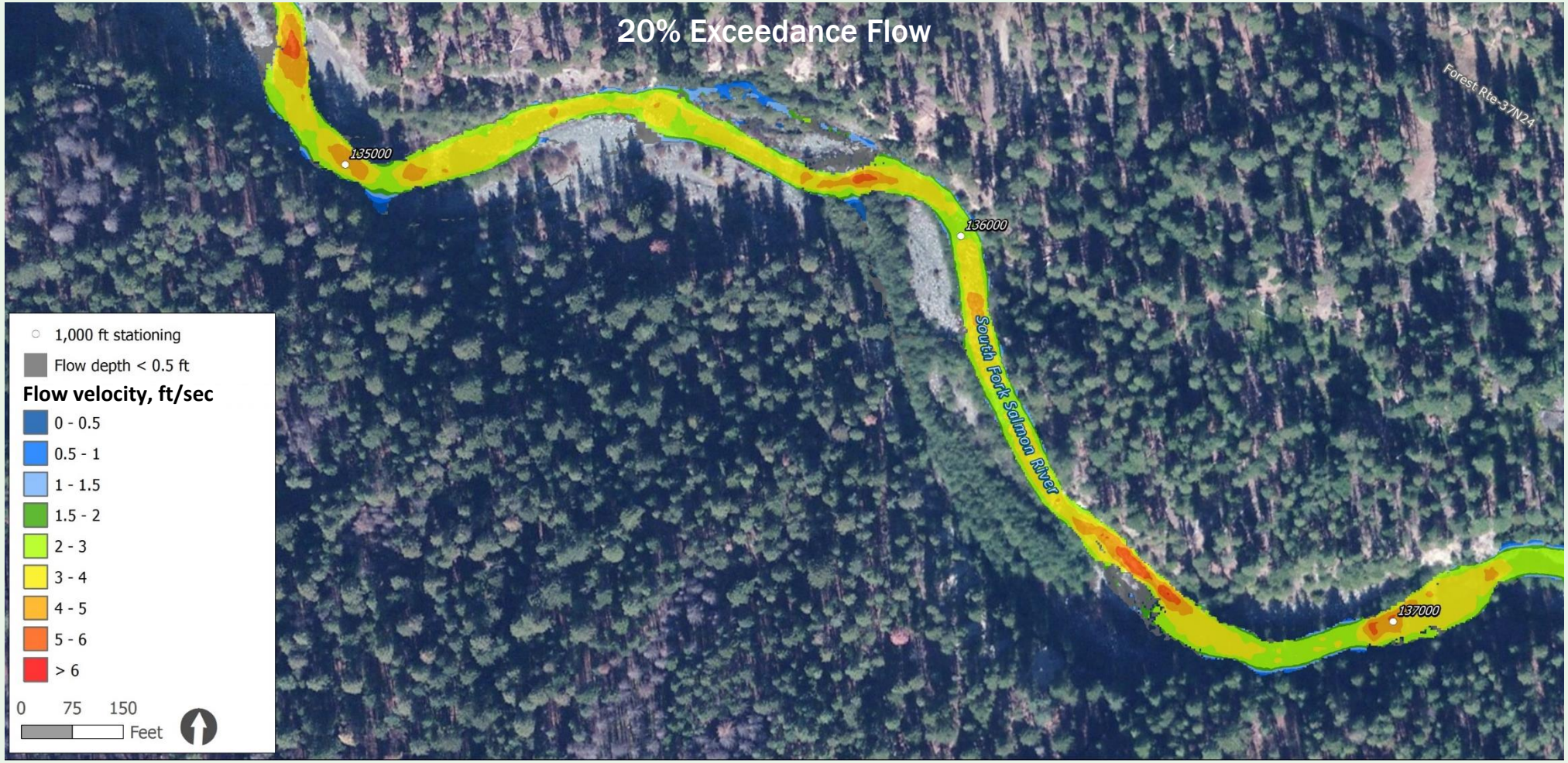
- Tributary Confluences
- Groundwater Channels
- Trailing bar edge
- Valley pinch points
- Pools

HYDRODYNAMIC MODELING: FLOW INUNDATION

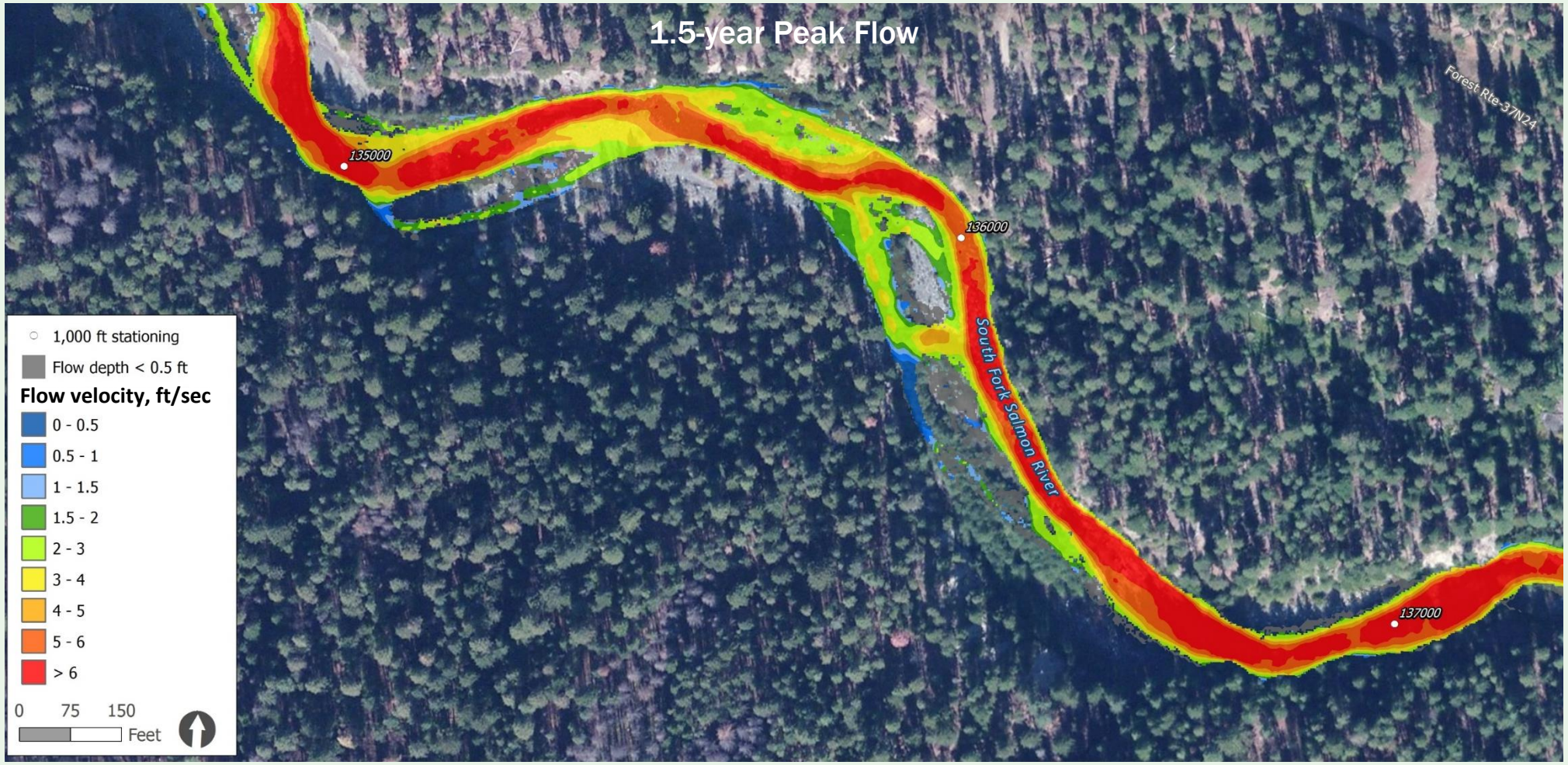




HYDRODYNAMIC MODELING: FLOW VELOCITIES

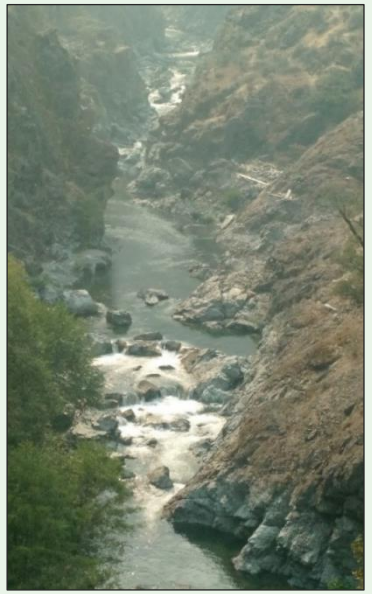


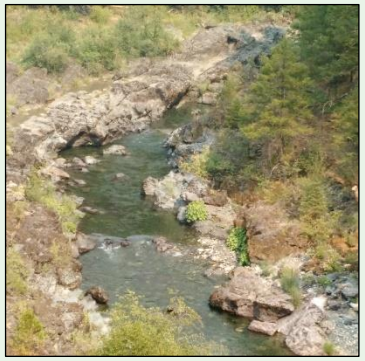
HYDRODYNAMIC MODELING: FLOW VELOCITIES

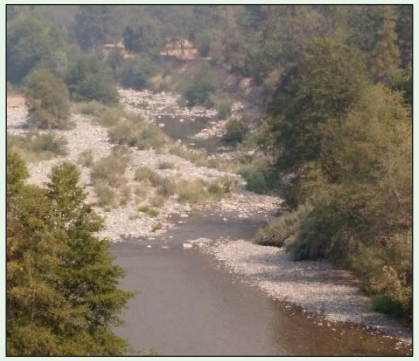


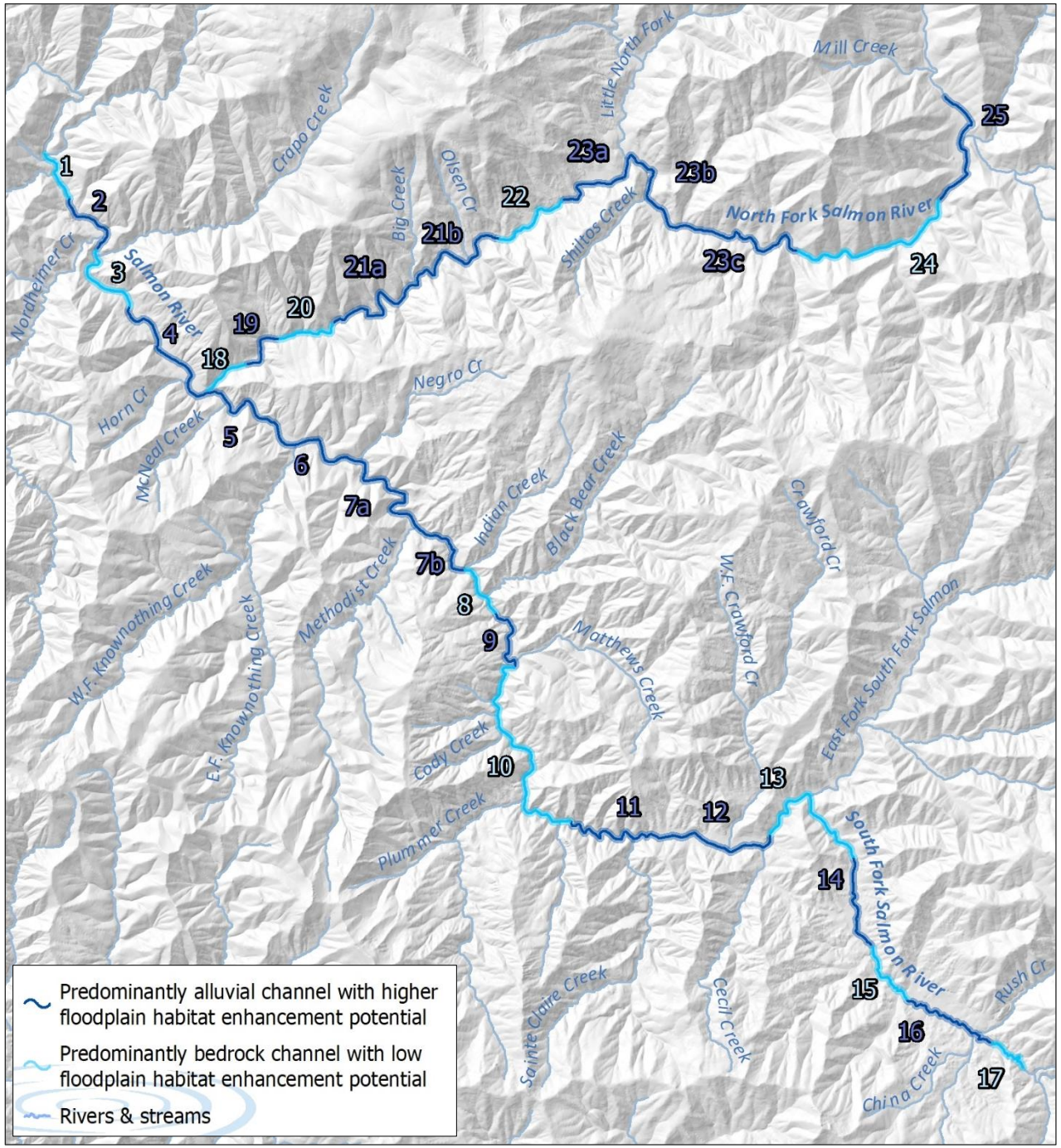
REACH MORPHOLOGY

- Channel gradient
- Valley width
- Channel confinement
- Resistant channel boundaries
- Alluvial channel features



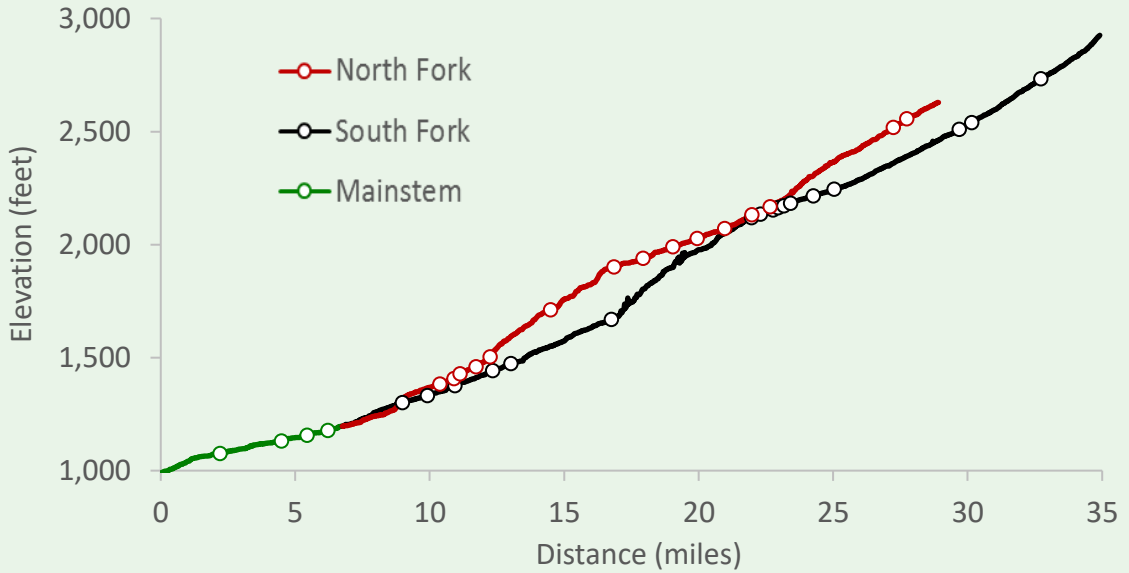


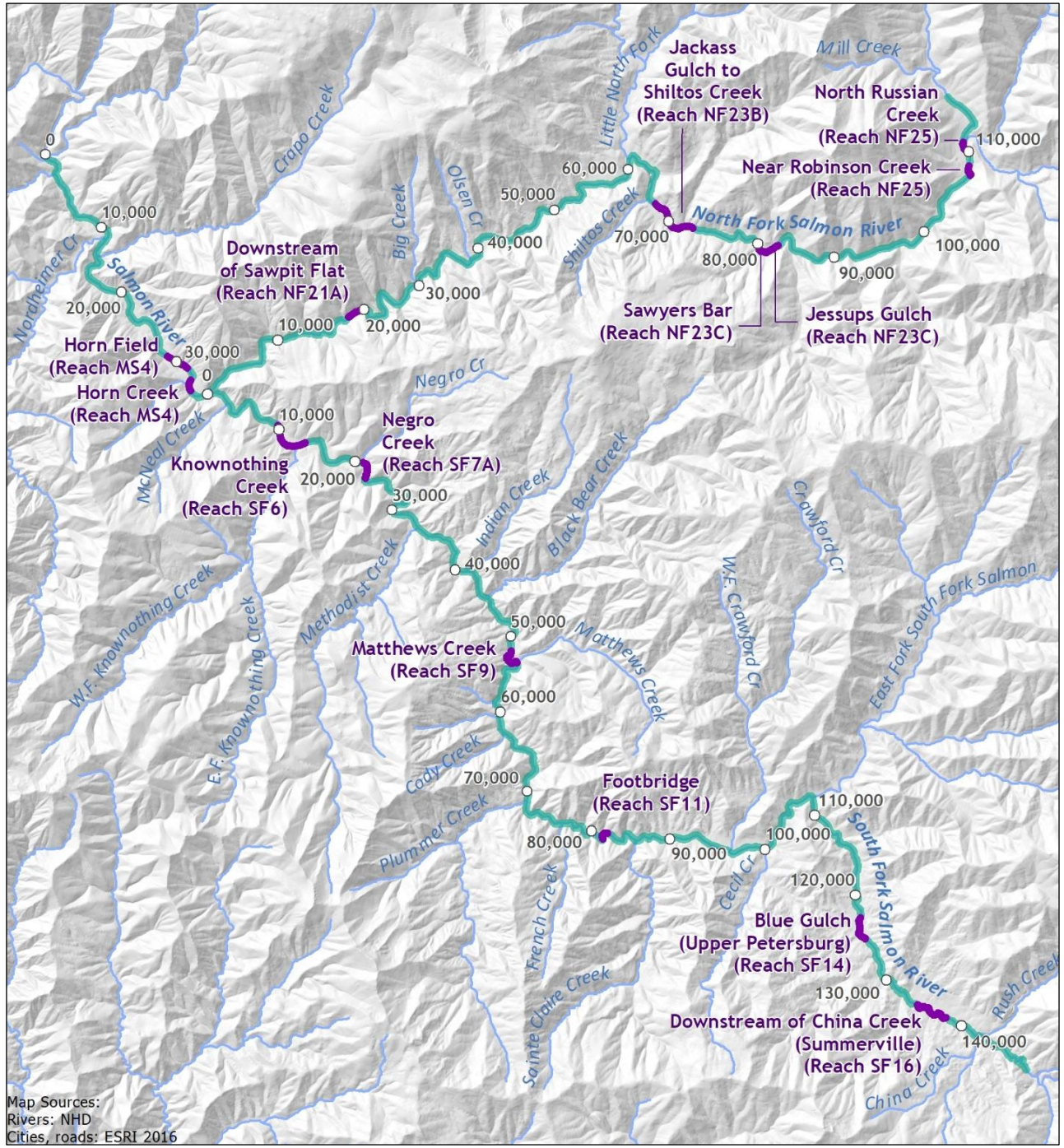




POTENTIAL ENHANCEMENT SEGMENTS

- Reach morphology
- Flow inundation
- Thermal conditions
- Riparian vegetation cover
- Spawning and rearing habitat conditions
- In-stream restoration priorities identified by TAC

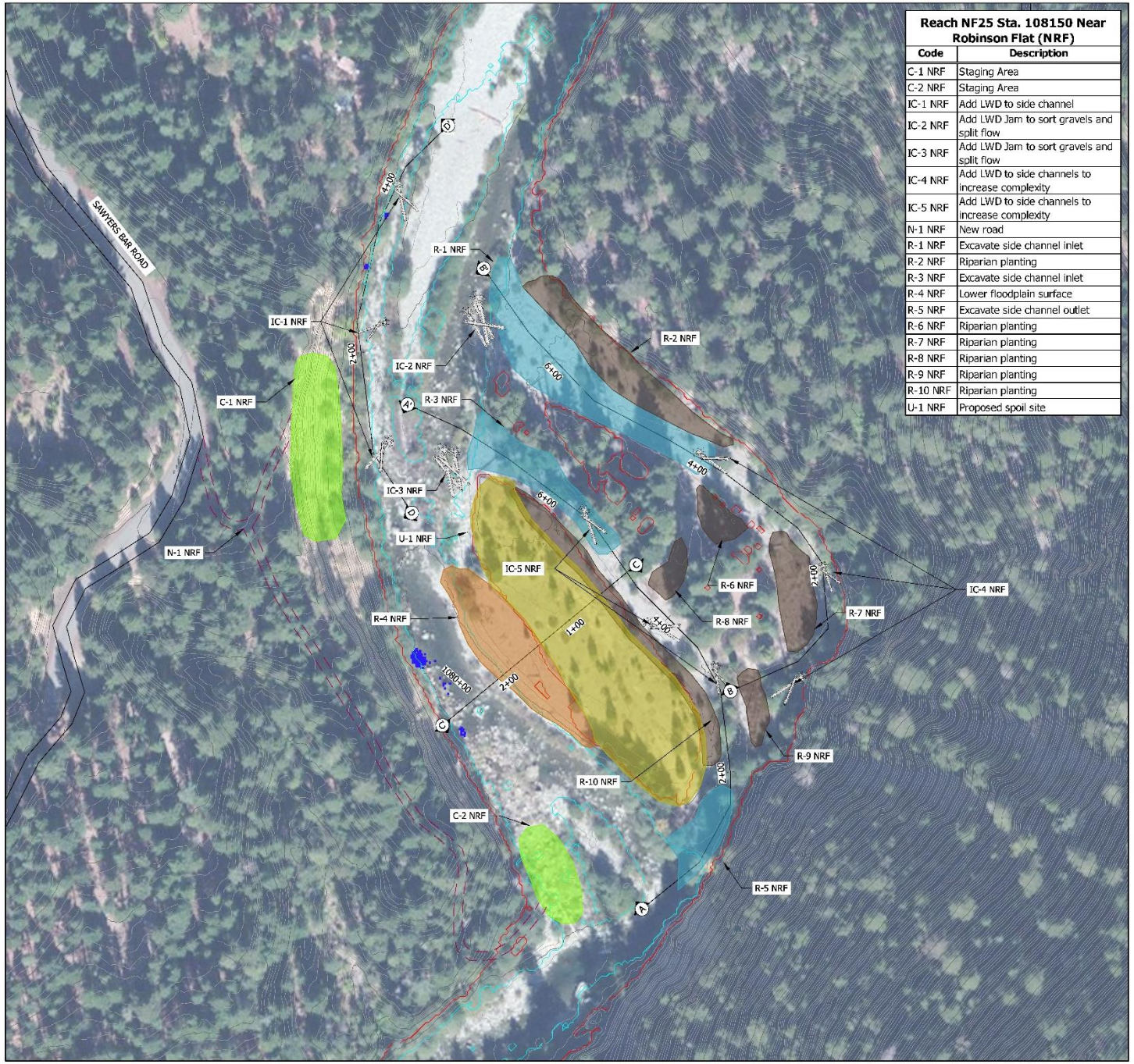




DESIGN SITES

Design site	Reach
Horn Field	Mainstem 4
Horn Creek	Mainstem 4
Knownothing Creek	South Fork 6
Matthews Creek	South Fork 9
Negro Creek	South Fork 7A
Footbridge	South Fork 11
Blue Gulch (Upper Petersburg)	South Fork 14
Downstream of China Creek (Summerville)	South Fork 16
Downstream of Sawpit Flat	North Fork 21A
Jackass Gulch to Shiltos Creek	North Fork 23B
Jessups Gulch	North Fork 23C
Sawyers Bar	North Fork 23C
Near Robinson Creek	North Fork 25
North Russian Creek	North Fork 25

CONCEPTUAL DESIGN



Reach NF25 Sta. 108150 Near Robinson Flat (NRF)	
Code	**Description**
C-1 NRF	Staging Area
C-2 NRF	Staging Area
IC-1 NRF	Add LWD to side channel
IC-2 NRF	Add LWD Jam to sort gravels and split flow
IC-3 NRF	Add LWD Jam to sort gravels and split flow
IC-4 NRF	Add LWD to side channels to increase complexity
IC-5 NRF	Add LWD to side channels to increase complexity
N-1 NRF	New road
R-1 NRF	Excavate side channel inlet
R-2 NRF	Riparian planting
R-3 NRF	Excavate side channel inlet
R-4 NRF	Lower floodplain surface
R-5 NRF	Excavate side channel outlet
R-6 NRF	Riparian planting
R-7 NRF	Riparian planting
R-8 NRF	Riparian planting
R-9 NRF	Riparian planting
R-10 NRF	Riparian planting
U-1 NRF	Proposed spoil site

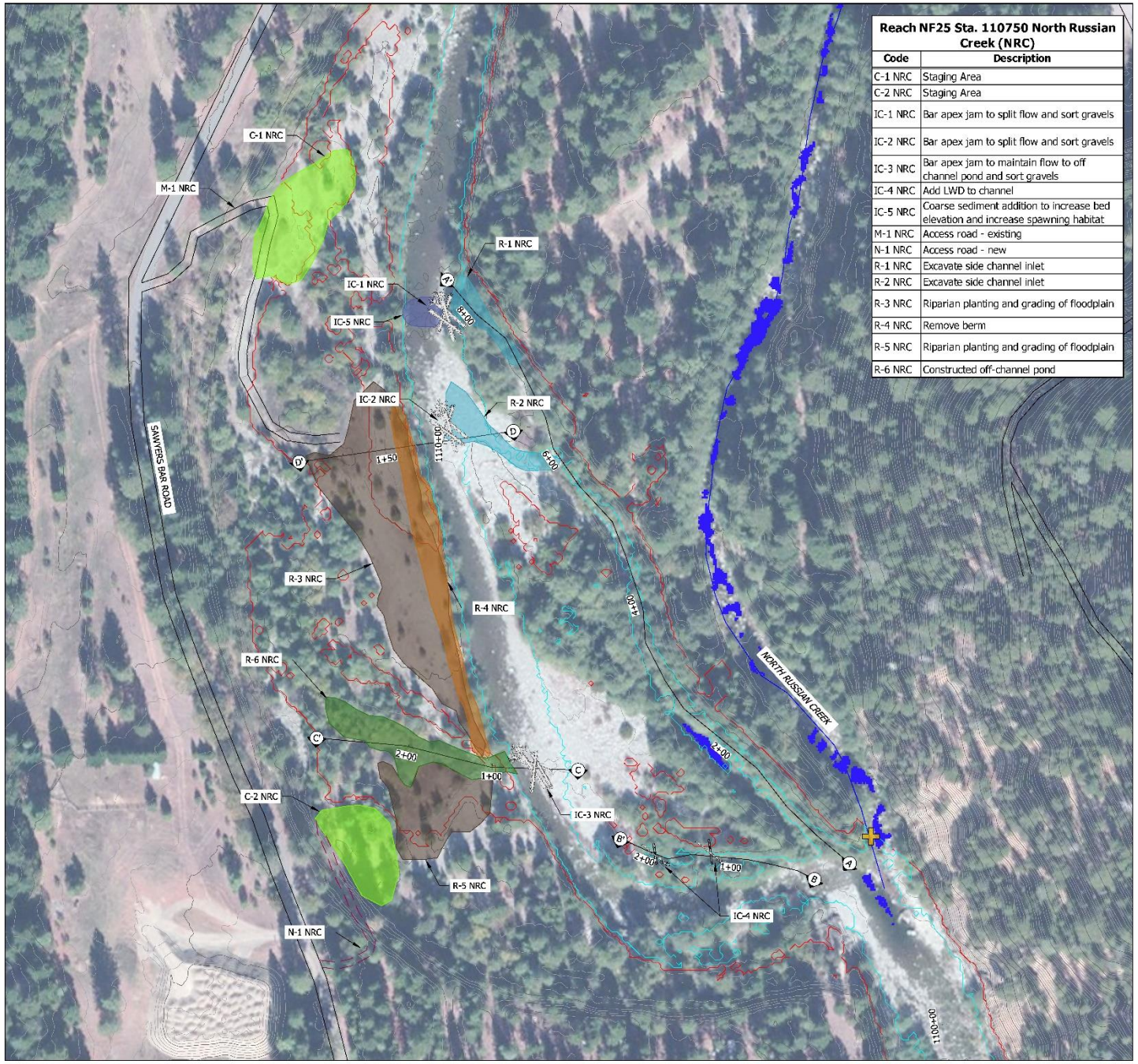
LEGEND

- XXXX+00 STATIONING IN FEET
- PROFILE LINE
- 20% EXCEEDANCE FLOW BOUNDARY (EXISTING)
- 100-YEAR FLOODPLAIN BOUNDARY
- EXISTING ROAD
- PROPOSED ACCESS ROAD
- MINE TAILING REMEDIATION
- PROPOSED STAGING AREA
- PROPOSED SPOIL SITE
- PROPOSED COARSE SEDIMENT ADDITION
- PROPOSED OFF-CHANNEL HABITAT (ALCOVE)
- PROPOSED SIDE CHANNEL ENHANCEMENT
- PROPOSED OFF-CHANNEL HABITAT (POND)
- PROPOSED CONSTRUCTED INUNDATION SURFACE
- PROPOSED RIPARIAN PLANTING
- PROPOSED LARGE WOOD PLACEMENT
- PROPOSED LARGE BOULDER PLACEMENT
- PROPOSED STREAM CROSSING
- PROPOSED CULVERT
- THERMAL REFUGES (TIR TEMP DEPARTURE >=1°C)
- POTENTIAL TRIBUTARY ENHANCEMENT

Activity Areas	
Code	**Meaning**
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

0 30 60 120 FEET
SCALE: 1" = 60'
2-FOOT CONTOUR INTERVAL

- Increase inundation frequency, improve connectivity
- Add complexity to side-channels and channel margins
- Create in-channel structures that promote sorting, depth, and cover
- Revegetate floodplains and tailings



Reach NF25 Sta. 110750 North Russian Creek (NRC)	
Code	**Description**
C-1 NRC	Staging Area
C-2 NRC	Staging Area
IC-1 NRC	Bar apex jam to split flow and sort gravels
IC-2 NRC	Bar apex jam to split flow and sort gravels
IC-3 NRC	Bar apex jam to maintain flow to off channel pond and sort gravels
IC-4 NRC	Add LWD to channel
IC-5 NRC	Coarse sediment addition to increase bed elevation and increase spawning habitat
M-1 NRC	Access road - existing
N-1 NRC	Access road - new
R-1 NRC	Excavate side channel inlet
R-2 NRC	Excavate side channel inlet
R-3 NRC	Riparian planting and grading of floodplain
R-4 NRC	Remove berm
R-5 NRC	Riparian planting and grading of floodplain
R-6 NRC	Constructed off-channel pond

LEGEND

- STATIONING IN FEET
- PROFILE LINE
- 20% EXCEEDANCE FLOW BOUNDARY (EXISTING)
- 100-YEAR FLOODPLAIN BOUNDARY
- EXISTING ROAD
- PROPOSED ACCESS ROAD
- MINE TAILING REMEDIATION
- PROPOSED STAGING AREA
- PROPOSED SPOIL SITE
- PROPOSED COARSE SEDIMENT ADDITION
- PROPOSED OFF-CHANNEL HABITAT (ALCOVE)
- PROPOSED SIDE CHANNEL ENHANCEMENT
- PROPOSED OFF-CHANNEL HABITAT (POND)
- PROPOSED CONSTRUCTED INUNDATION SURFACE
- PROPOSED RIPARIAN PLANTING
- PROPOSED LARGE WOOD PLACEMENT
- PROPOSED LARGE BOULDER PLACEMENT
- PROPOSED STREAM CROSSING
- PROPOSED CULVERT
- THERMAL REFUGES (TIR TEMP DEPARTURE >=1°C)
- POTENTIAL TRIBUTARY ENHANCEMENT

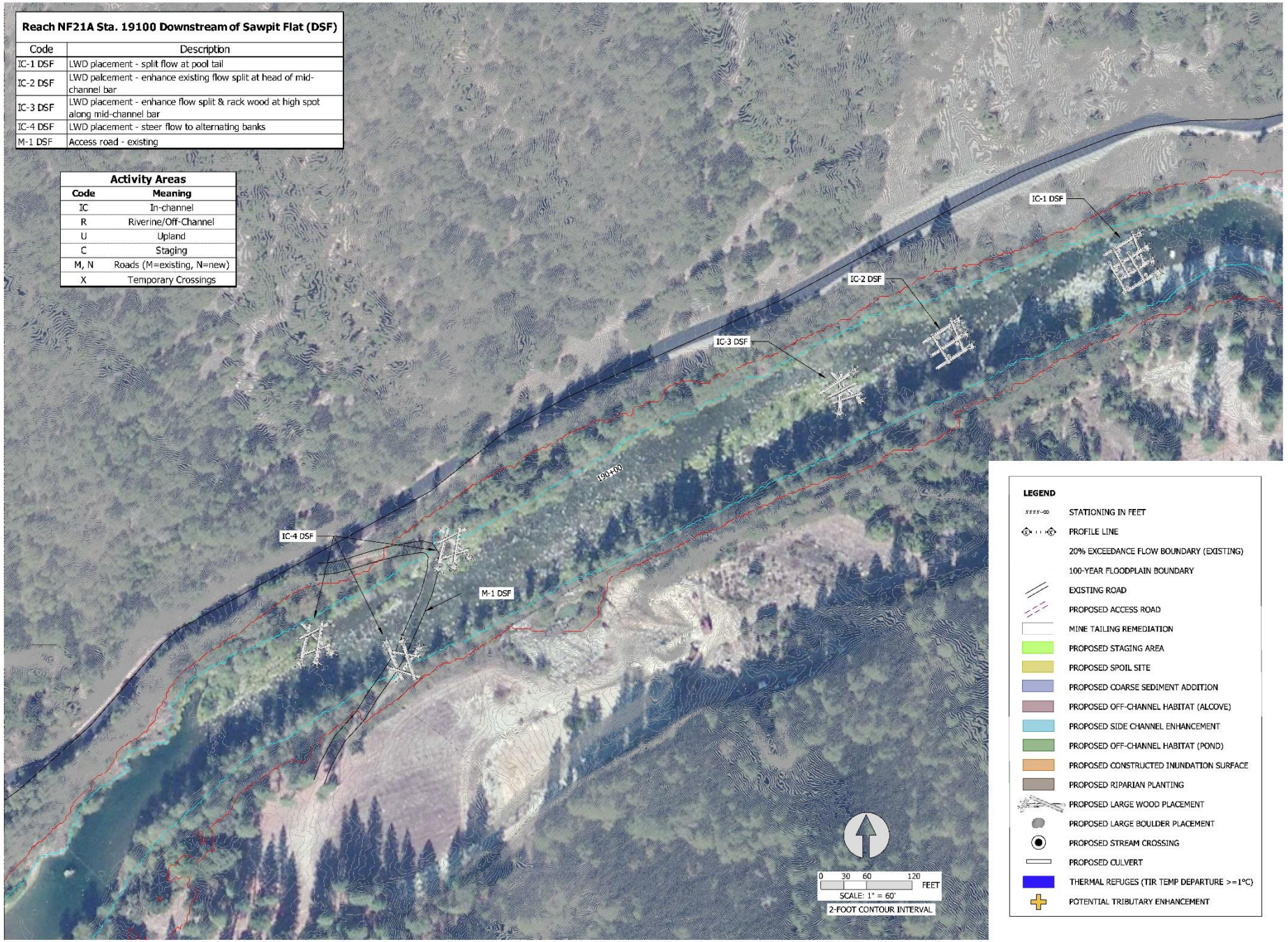
Activity Areas	
Code	**Meaning**
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

0 30 60 120 FEET
SCALE: 1" = 60'
2-FOOT CONTOUR INTERVAL

CONCEPTUAL DESIGN

- Enhance thermal refugia
- Create, enhance, and connect off-channel ponds and wetlands
- Revegetate floodplains and tailings
- Add complexity to side-channels and channel margins
- Create in-channel structures that promote sorting, depth, and cover
- Increase inundation frequency, improve connectivity

CONCEPTUAL DESIGN



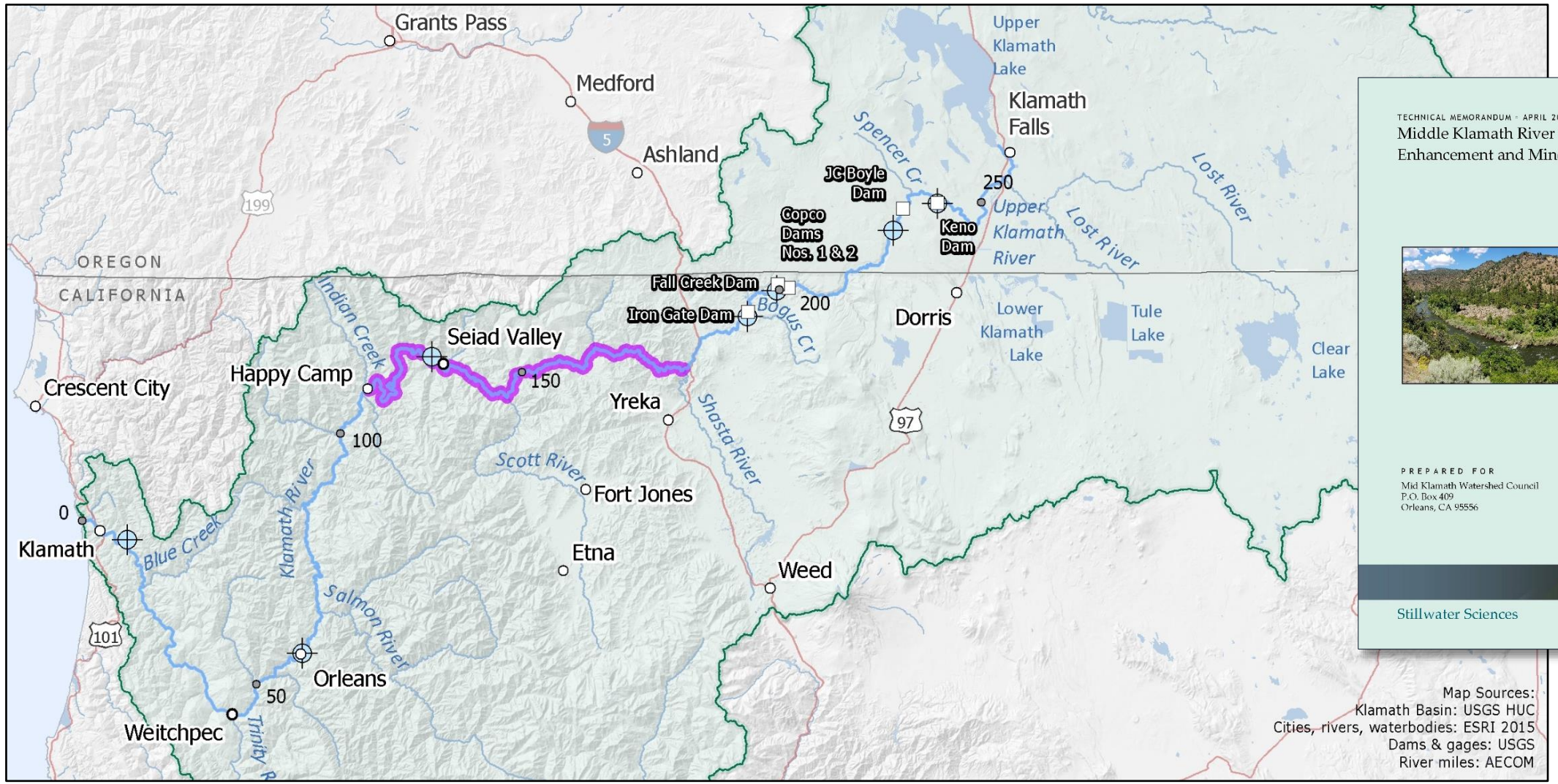
- **Create in-channel structures that promote:**
  - ✓ Channel complexity
  - ✓ Sorting
  - ✓ Depth
  - ✓ Cover

MIDDLE KLAMATH RIVER FLOODPLAIN HABITAT ENHANCEMENT AND MINE TAILING REMEDIATION

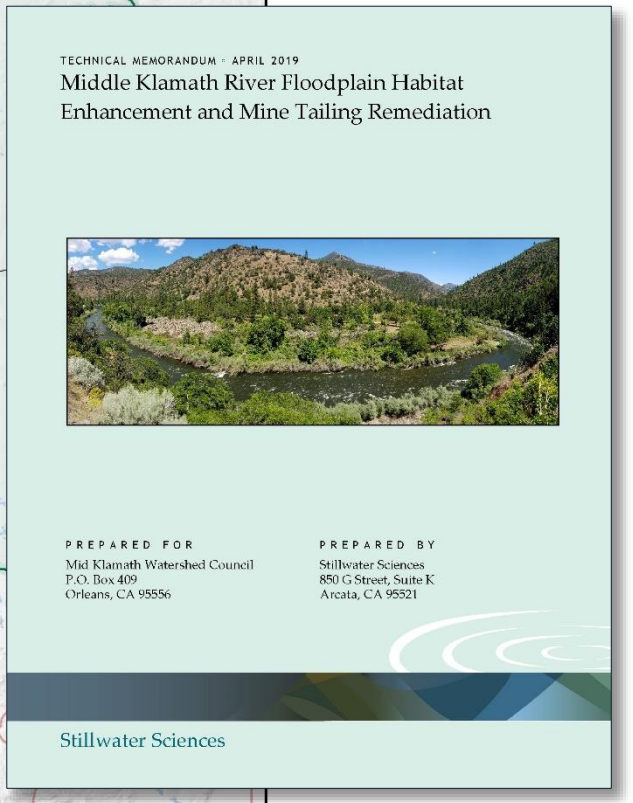
Mid Klamath Watershed Council

Stillwater Sciences

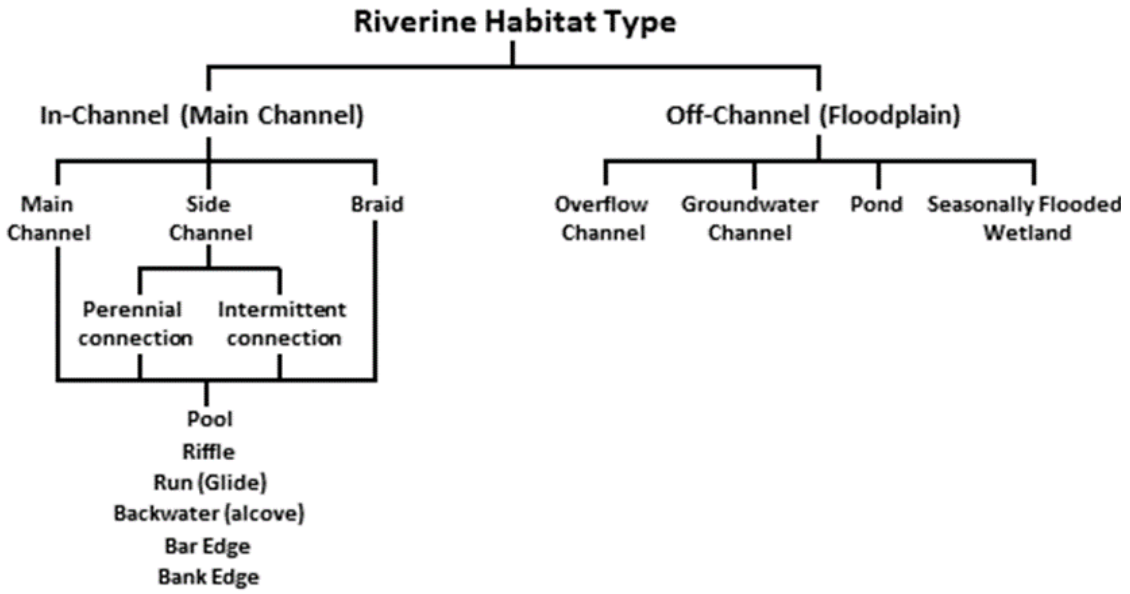
Coastal Conservancy

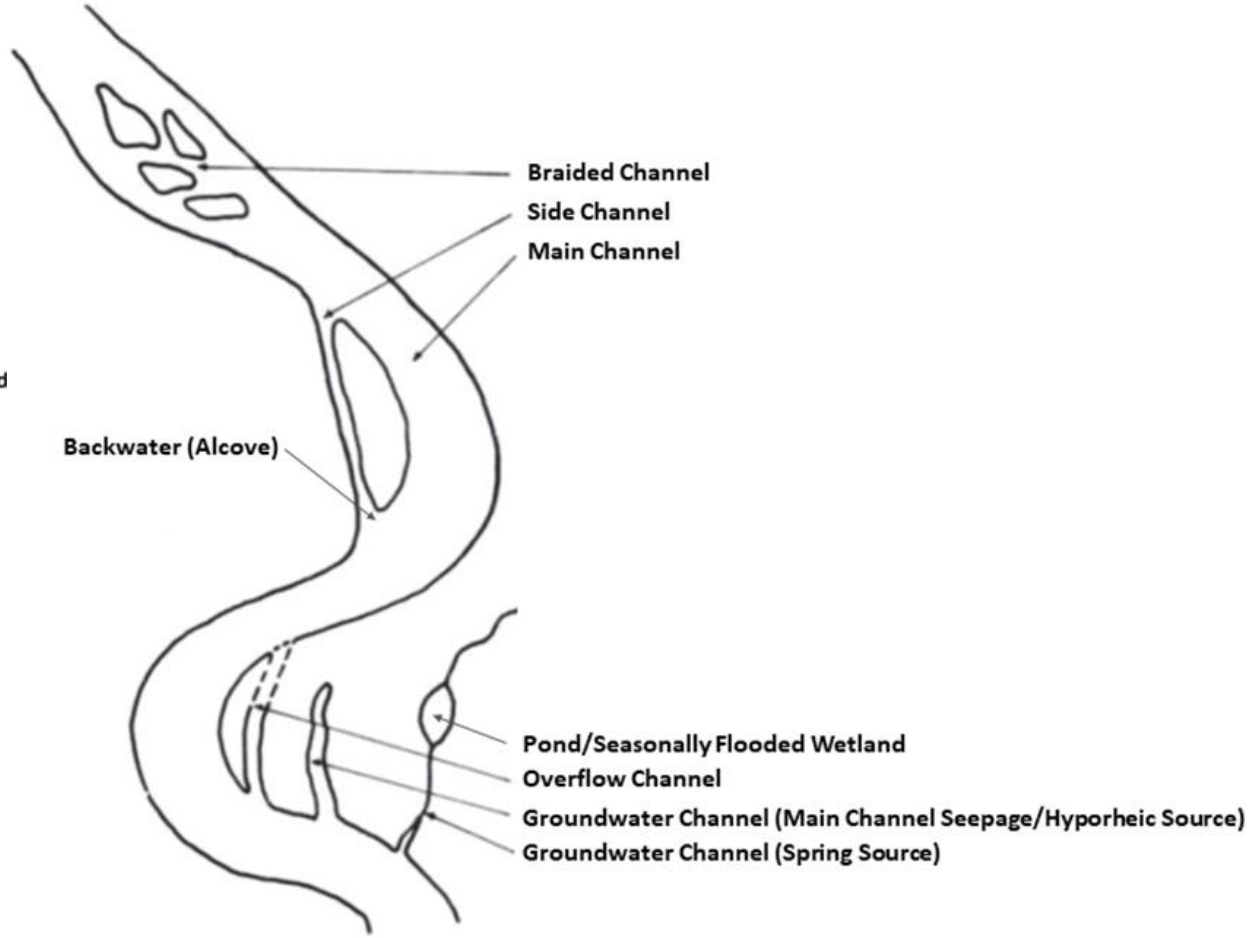


Map Sources:
Klamath Basin: USGS HUC
Cities, rivers, waterbodies: ESRI 2015
Dams & gages: USGS
River miles: AECOM



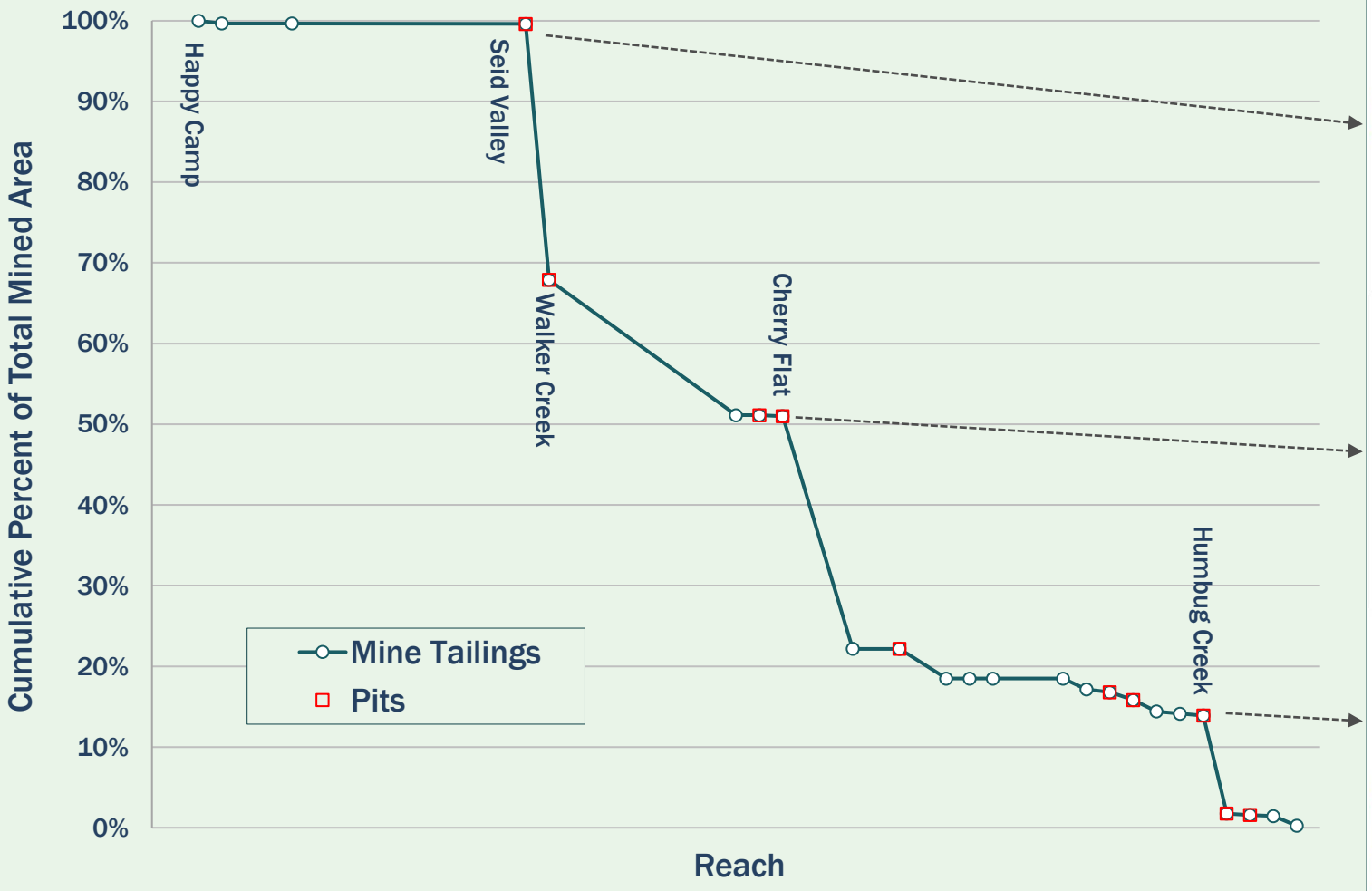
RIVERINE HABITAT TYPES

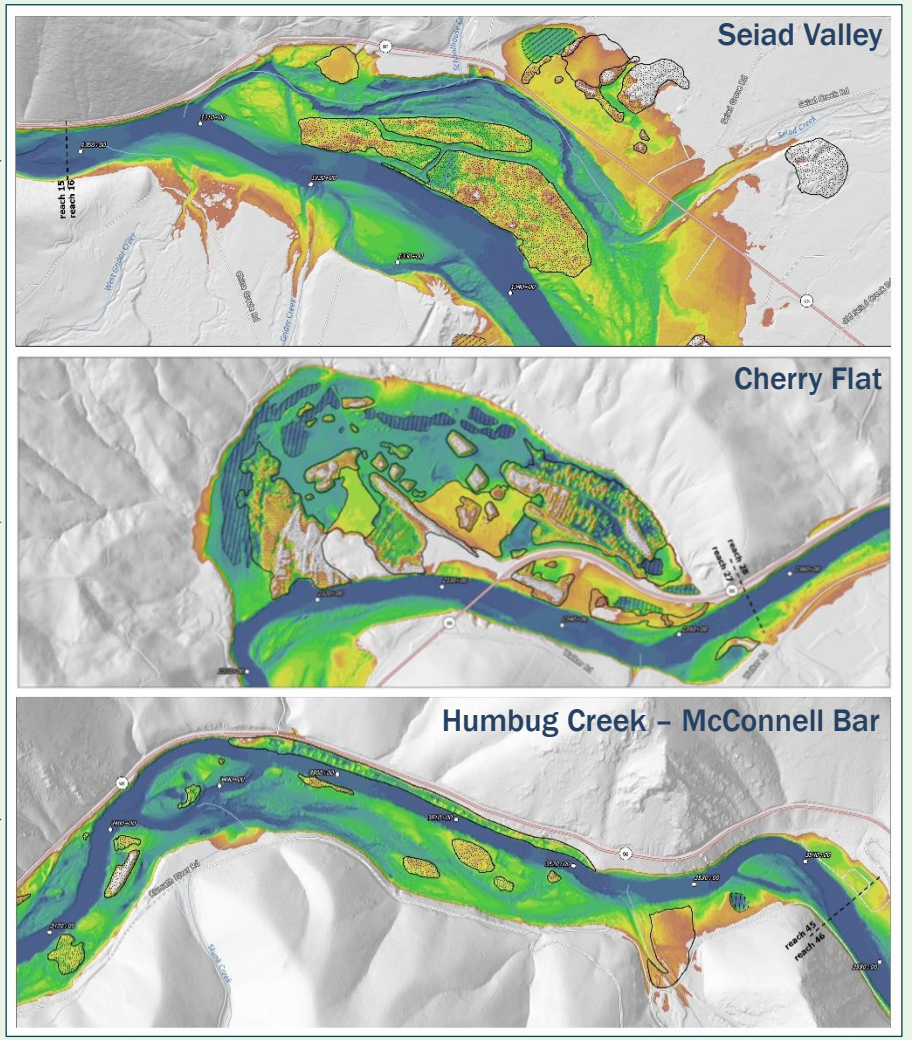




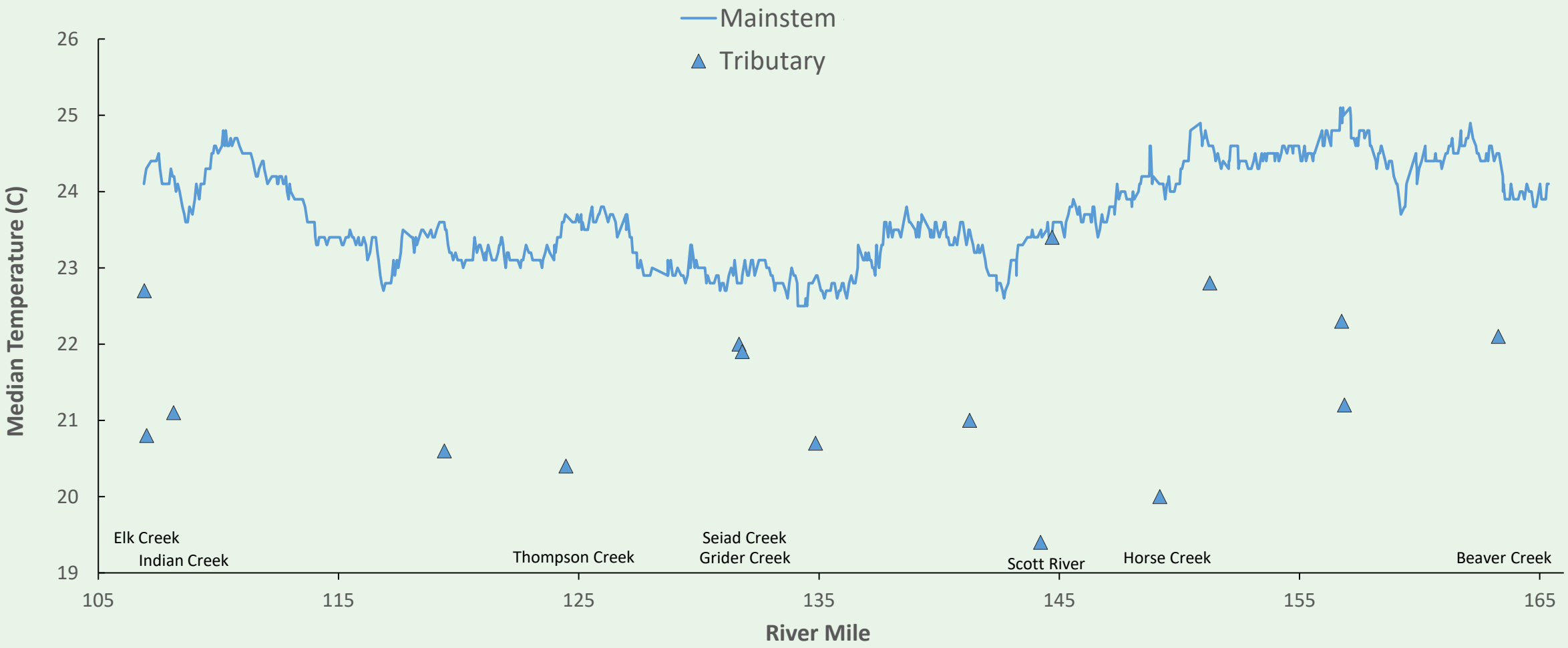
Modified from Lestelle et al. 2005

MINING DISTURBANCE

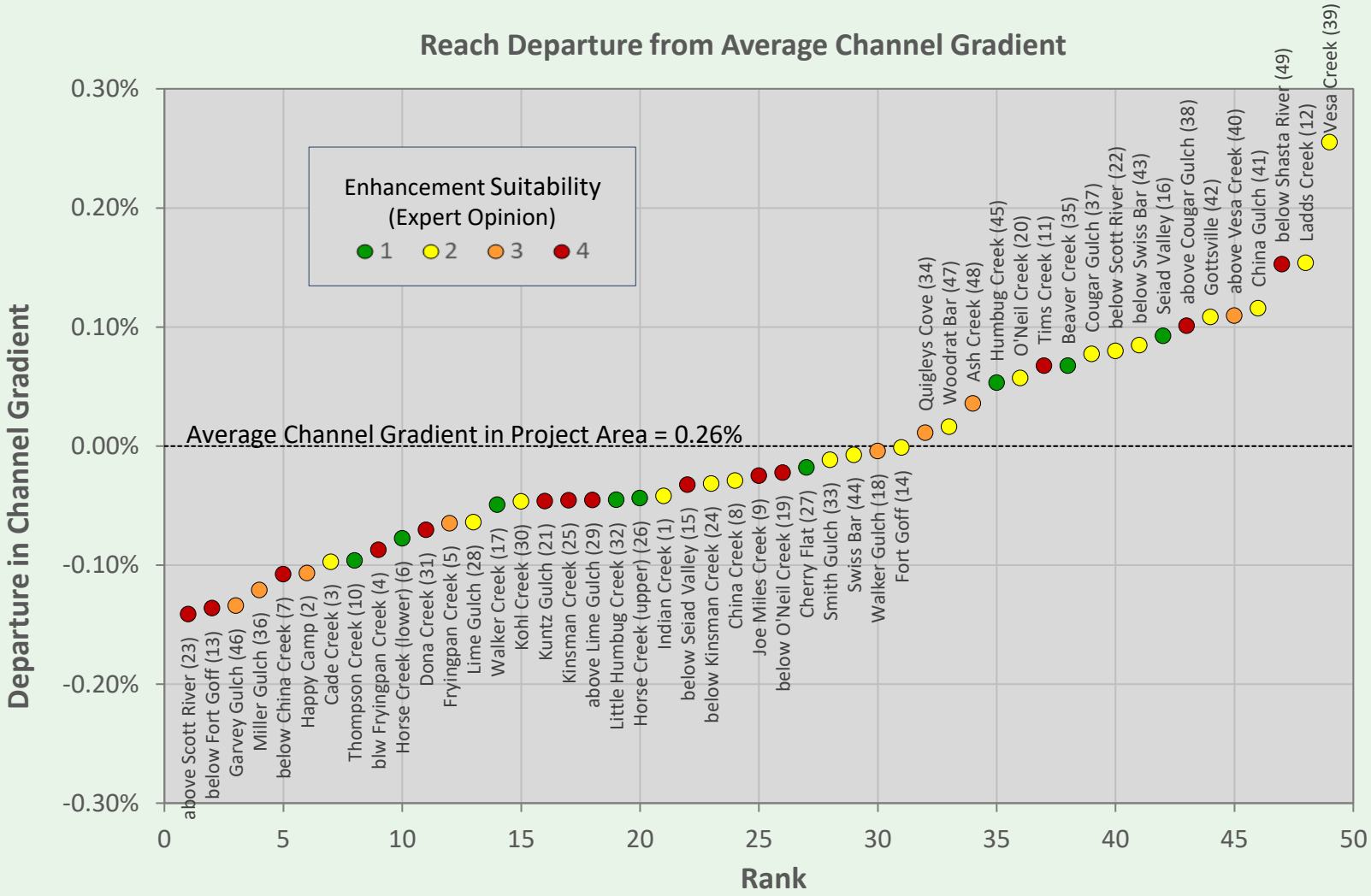


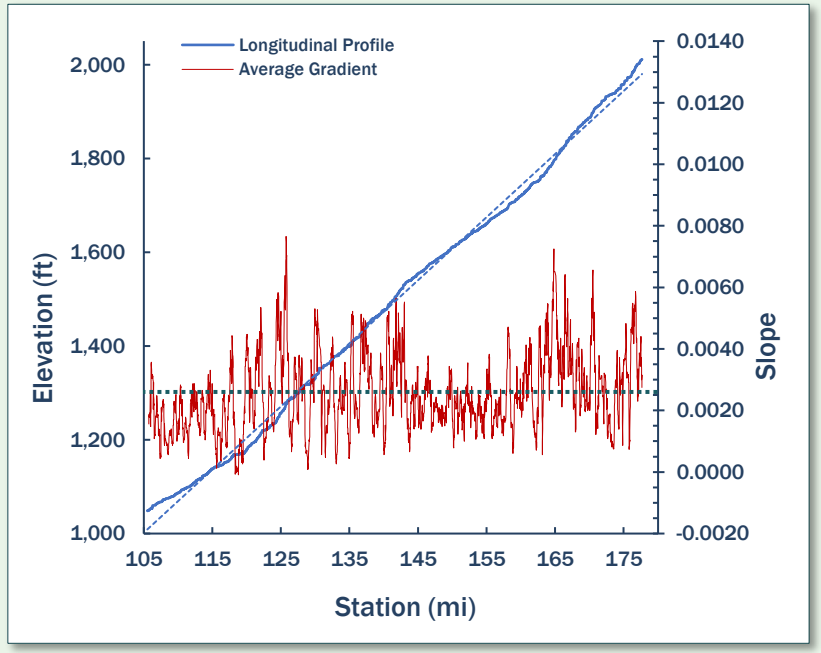


THERMAL REFUGES

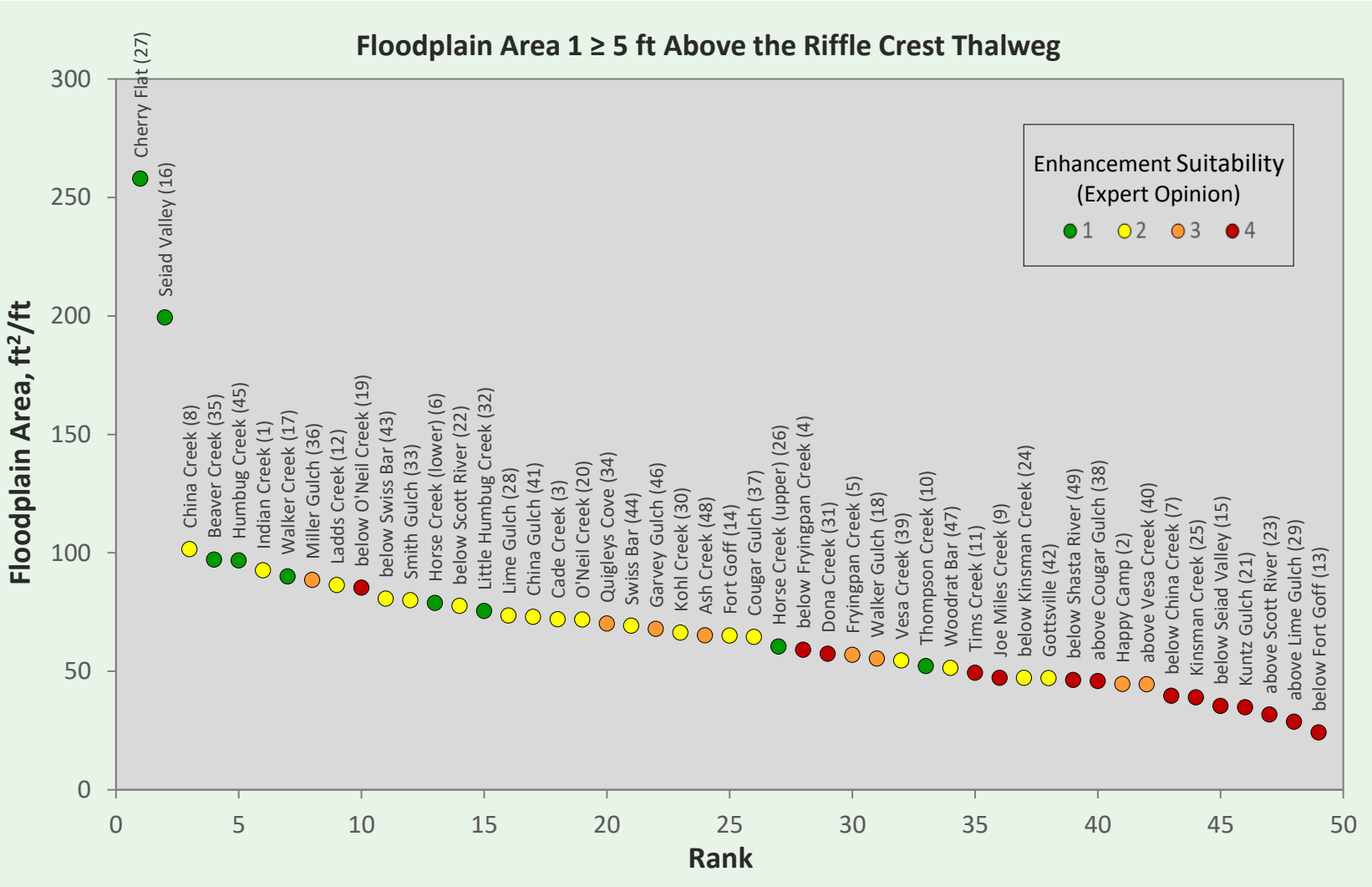


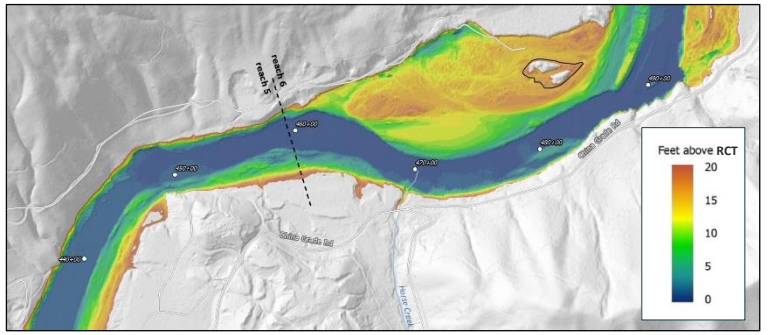
CHANNEL GRADIENT

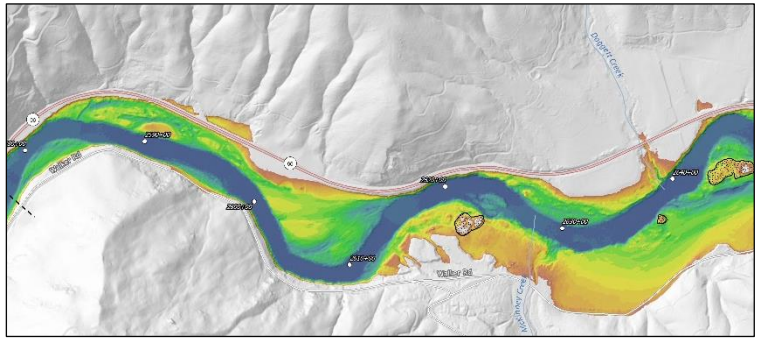


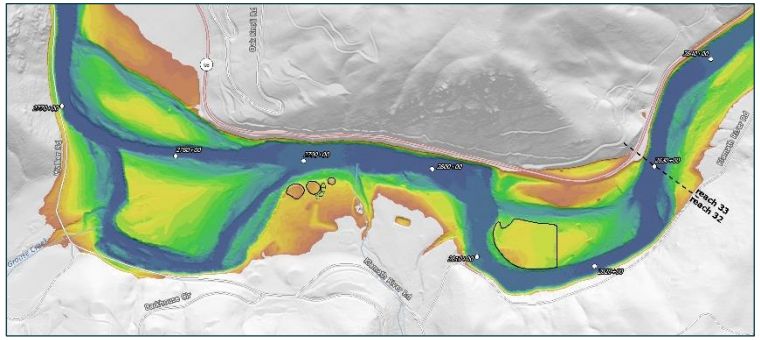


RELATIVE ELEVATION

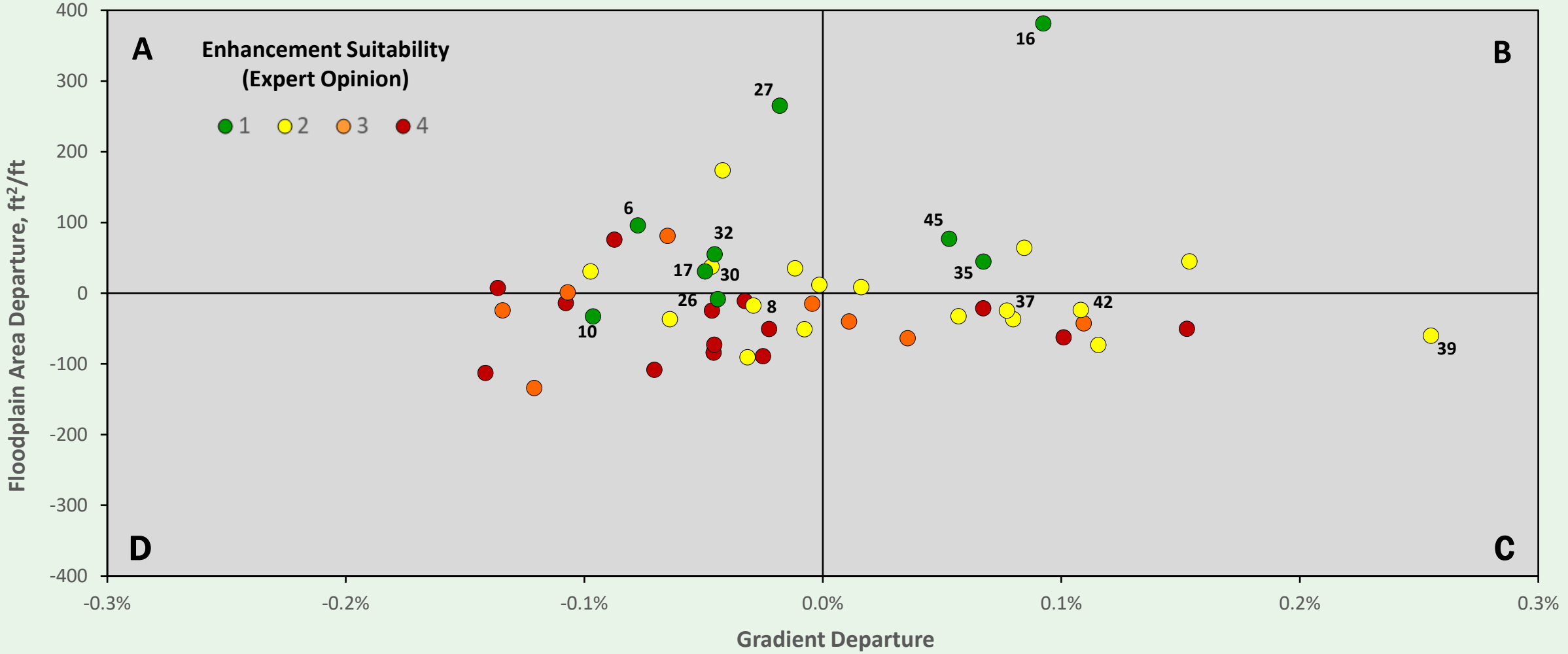








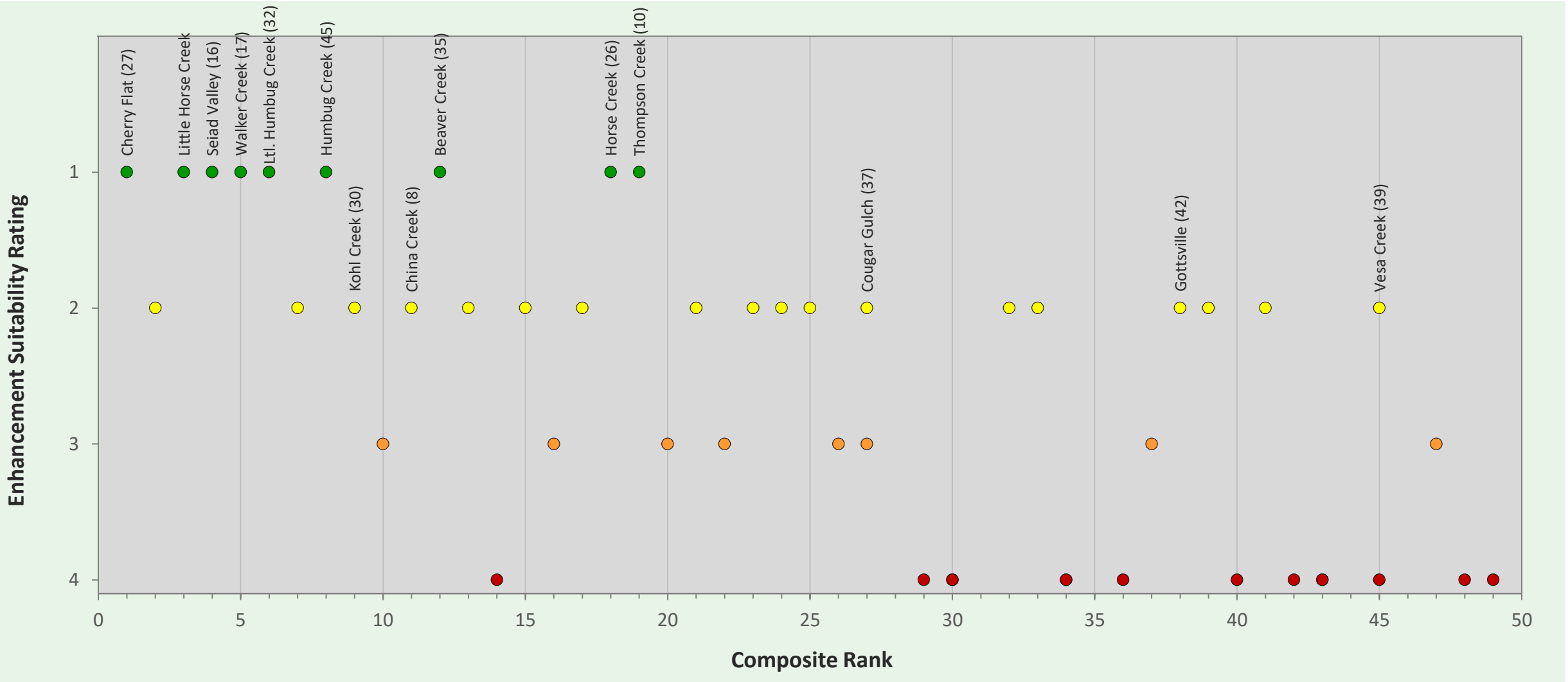
POTENTIAL ENHANCEMENT DOMAINS



COMPOSITE


Enhancement Suitability Rating
1
2
3
4
0
5
10
15
20
25
30
35
40
45
50
Composite Rank
Cherry Flat (27)
Indian Creek (1)
Horse Creek (lower) (6)
Seiad Valley (16)
Walker Creek (17)
Little Humbug Creek (32)
Cade Creek (3)
Humbug Creek (45)
Kohl Creek (30)
Fryingpan Creek (5)
China Creek (8)
Beaver Creek (35)
below Swiss Bar (43)
blw Fryingpan Creek (4)
Smith Gulch (33)
Garvey Gulch (46)
Ladds Creek (12)
Horse Creek (upper) (26)
Thompson Creek (10)
Happy Camp (2)
Lime Gulch (28)
Walker Gulch (18)
Woodrat Bar (47)
Fort Goff (14)
O'Neil Creek (20)
Quigleys Cove (34)
Miller Gulch (36)
Cougar Gulch (37)
below O'Neil Creek (19)
below China Creek (7)
below Fort Goff (13)
below Scott River (22)
Swiss Bar (44)
Tims Creek (11)
below Seiad Valley (15)
Kuntz Gulch (21)
Ash Creek (48)
Gottsville (42)
China Gulch (41)
Dona Creek (31)
below Kinsman Creek (24)
Joe Miles Creek (9)
above Scott River (23)
Kinsman Creek (25)
above Lime Gulch (29)
Vesa Creek (39)
above Vesa Creek (40)
below Shasta River (49)
above Cougar Gulch (38)

DESIGN SITES



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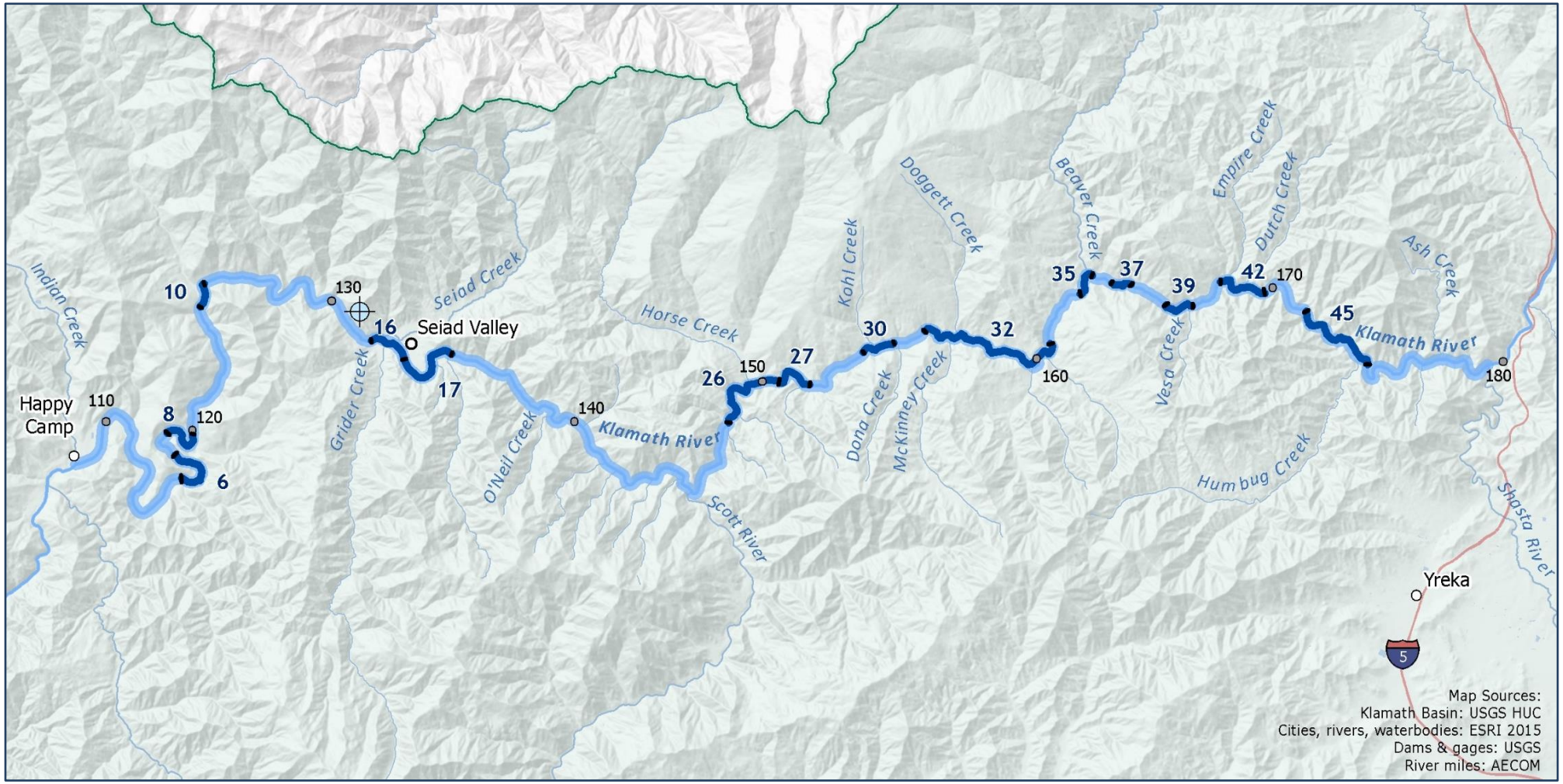
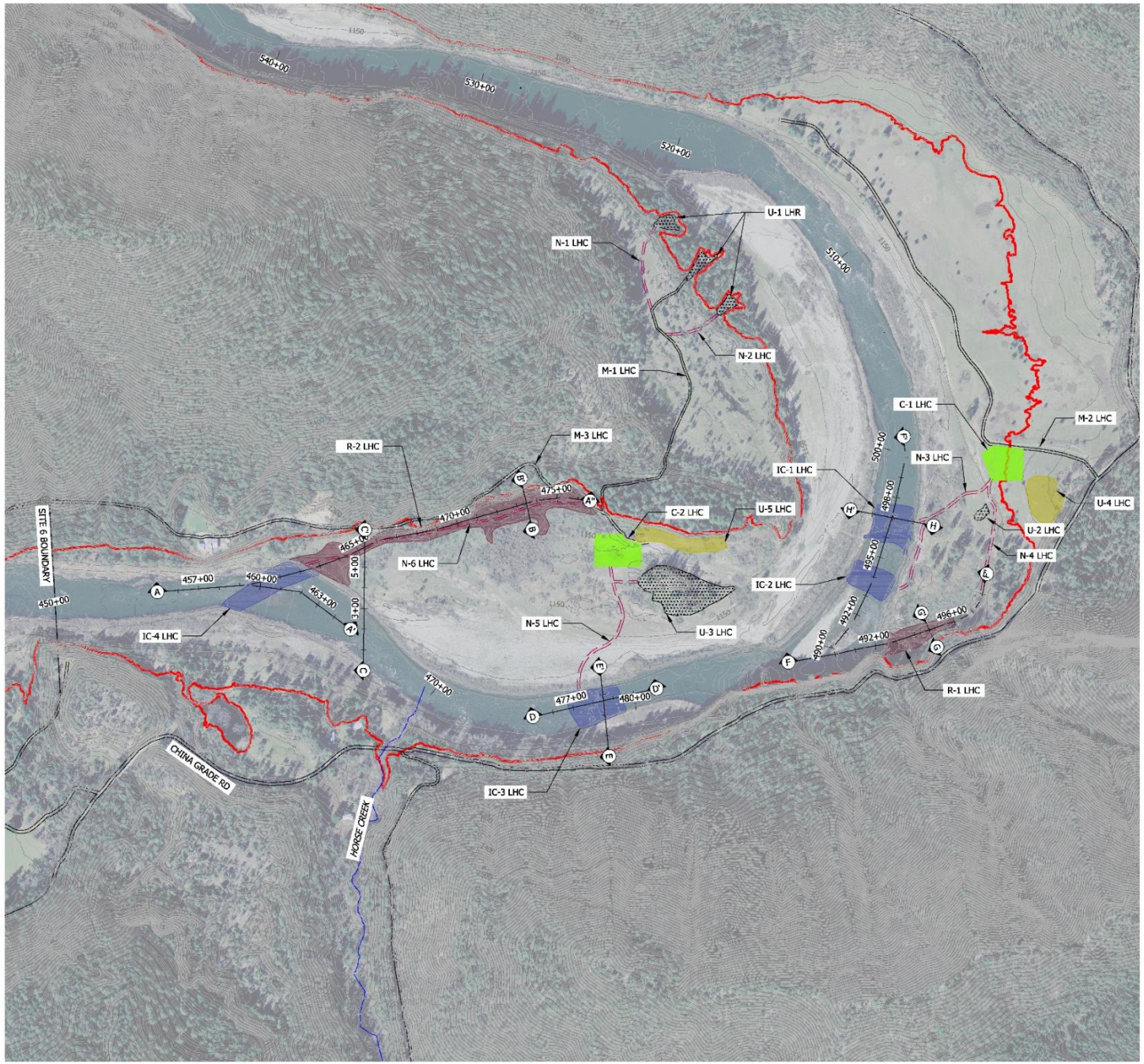


Reach No	Reach Name
6	Little Horse Creek
8	China Creek
10	Thompson Creek
16	Seiad Valley
17	Walker Creek
26	Horse Creek (upper)
27	Cherry Flat
30	Kohl Creek
32	Little Humbug Creek
35	Beaver Creek
37	Cougar Gulch
39	Vesa Creek
42	Gottsville
45	Humbug Creek

CONCEPTUAL DESIGN



LEGEND

- STATIONING IN FEET
- PROFILE LINE
- 100-YEAR FLOODPLAIN BOUNDARY
- EXISTING ROAD
- EXISTING MINE TAILINGS
- PROPOSED ACCESS ROAD
- PROPOSED STAGING AREA
- PROPOSED SPOIL PILES
- PROPOSED COARSE SEDIMENT ADDITION
- PROPOSED OFF-CHANNEL HABITAT (ALCOVE)

Site 6 Little Horse Creek (LHC)

Code	Description
IC-1 LHC	Coarse sediment addition
IC-2 LHC	Coarse sediment addition
IC-3 LHC	Coarse sediment addition
IC-4 LHC	Coarse sediment addition
R-1 LHC	Expansion of alcove/backwater
R-2 LHC	Constructed alcove/backwater
U-1 LHC	Stockpile - existing tailings
U-2 LHC	Stockpile - existing tailings
U-3 LHC	Stockpile - existing tailings
U-4 LHC	Proposed spoil pile
U-5 LHC	Proposed spoil pile
C-1 LHC	Staging area
C-2 LHC	Staging area
M-1 LHC	Access road - existing
M-2 LHC	Access road - existing
M-3 LHC	Access road - existing
N-1 LHC	Access road - new
N-2 LHC	Access road - new
N-3 LHC	Access road - new
N-4 LHC	Access road - new
N-5 LHC	Access road - new
N-6 LHC	Access road - new

Activity Areas

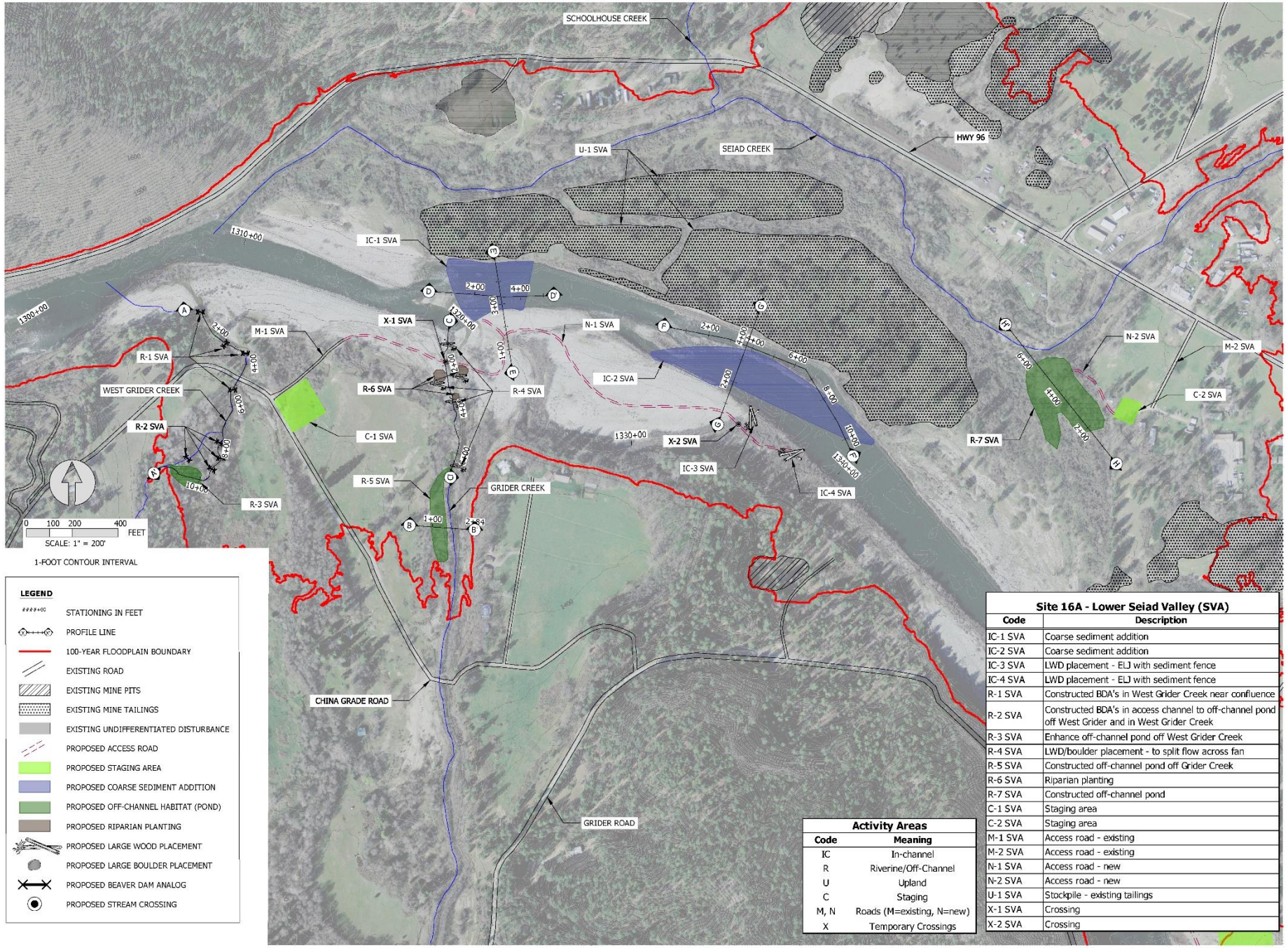
Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

0 125 250 500 FEET

SCALE: 1" = 250'

1-FOOT CONTOUR INTERVAL

CONCEPTUAL DESIGN



LEGEND

- STATIONING IN FEET
- PROFILE LINE
- 100-YEAR FLOODPLAIN BOUNDARY
- EXISTING ROAD
- EXISTING MINE PITS
- EXISTING MINE TAILINGS
- EXISTING UNDIFFERENTIATED DISTURBANCE
- PROPOSED ACCESS ROAD
- PROPOSED STAGING AREA
- PROPOSED COARSE SEDIMENT ADDITION
- PROPOSED OFF-CHANNEL HABITAT (POND)
- PROPOSED RIPARIAN PLANTING
- PROPOSED LARGE WOOD PLACEMENT
- PROPOSED LARGE BOULDER PLACEMENT
- PROPOSED BEAVER DAM ANALOG
- PROPOSED STREAM CROSSING

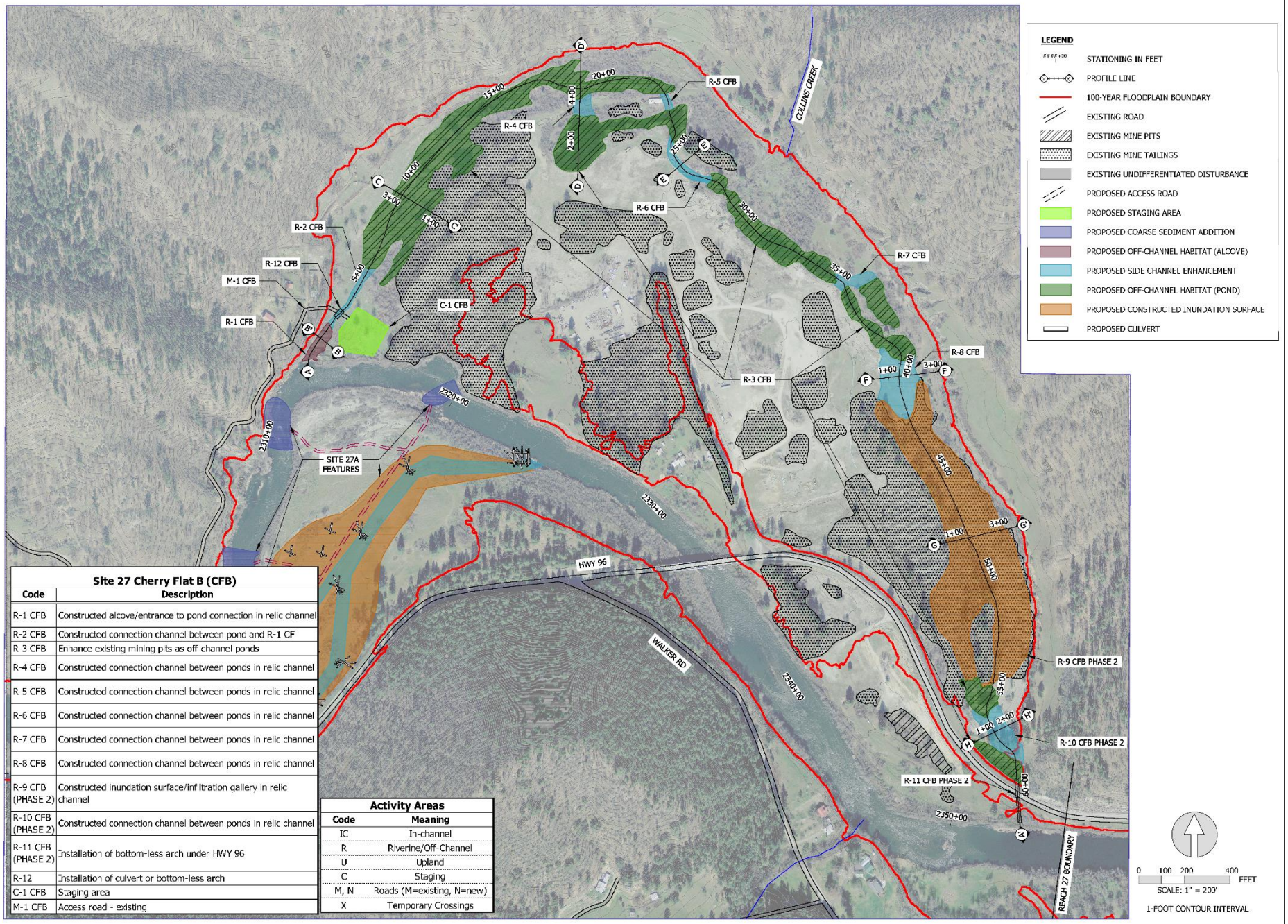
Activity Areas

Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

Site 16A - Lower Seiad Valley (SVA)

Code	Description
IC-1 SVA	Coarse sediment addition
IC-2 SVA	Coarse sediment addition
IC-3 SVA	LWD placement - ELJ with sediment fence
IC-4 SVA	LWD placement - ELJ with sediment fence
R-1 SVA	Constructed BDA's in West Grider Creek near confluence
R-2 SVA	Constructed BDA's in access channel to off-channel pond off West Grider and in West Grider Creek
R-3 SVA	Enhance off-channel pond off West Grider Creek
R-4 SVA	LWD/boulder placement - to split flow across fan
R-5 SVA	Constructed off-channel pond off Grider Creek
R-6 SVA	Riparian planting
R-7 SVA	Constructed off-channel pond
C-1 SVA	Staging area
C-2 SVA	Staging area
M-1 SVA	Access road - existing
M-2 SVA	Access road - existing
N-1 SVA	Access road - new
N-2 SVA	Access road - new
U-1 SVA	Stockpile - existing tailings
X-1 SVA	Crossing
X-2 SVA	Crossing

CONCEPTUAL DESIGN



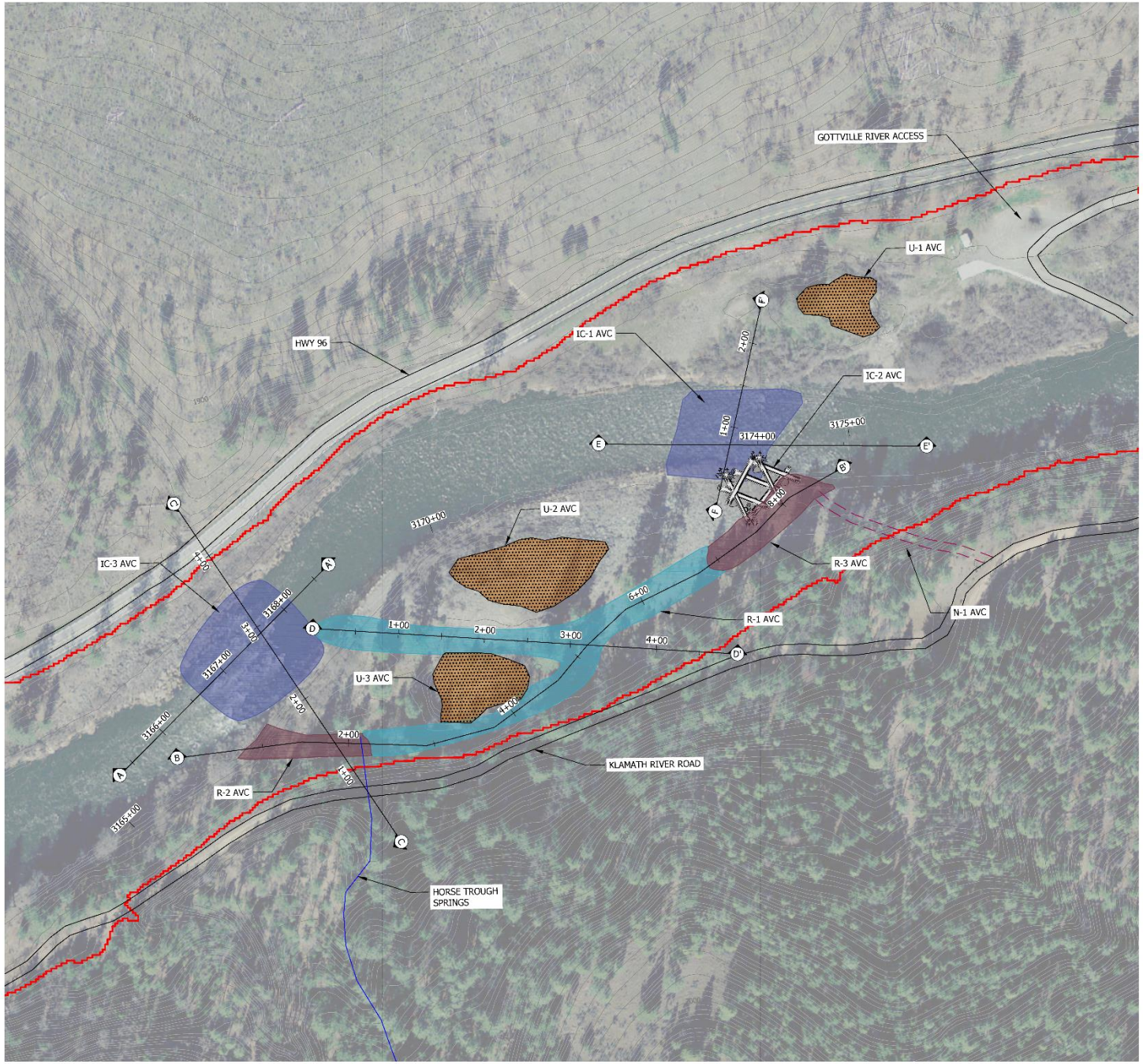
Site 27 Cherry Flat B (CFB)

Code	Description
R-1 CFB	Constructed alcove/entrance to pond connection in relic channel
R-2 CFB	Constructed connection channel between pond and R-1 CF
R-3 CFB	Enhance existing mining pits as off-channel ponds
R-4 CFB	Constructed connection channel between ponds in relic channel
R-5 CFB	Constructed connection channel between ponds in relic channel
R-6 CFB	Constructed connection channel between ponds in relic channel
R-7 CFB	Constructed connection channel between ponds in relic channel
R-8 CFB	Constructed connection channel between ponds in relic channel
R-9 CFB (PHASE 2)	Constructed inundation surface/infiltration gallery in relic channel
R-10 CFB (PHASE 2)	Constructed connection channel between ponds in relic channel
R-11 CFB (PHASE 2)	Installation of bottom-less arch under HWY 96
R-12	Installation of culvert or bottom-less arch
C-1 CFB	Staging area
M-1 CFB	Access road - existing

Activity Areas

Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

CONCEPTUAL DESIGN



LEGEND

- STATIONING IN FEET
- PROFILE LINE
- 100-YEAR FLOODPLAIN BOUNDARY
- EXISTING ROAD
- EXISTING MINE TAILINGS
- PROPOSED ACCESS ROAD
- PROPOSED COARSE SEDIMENT ADDITION
- PROPOSED OFF-CHANNEL (ALCOVE)
- PROPOSED SIDE CHANNEL ENHANCEMENT
- PROPOSED CONSTRUCTED INUNDATION SURFACE
- PROPOSED LARGE WOOD PLACEMENT
- PROPOSED LARGE BOULDER PLACEMENT

Site 40 Above Vesa Creek (AVC)

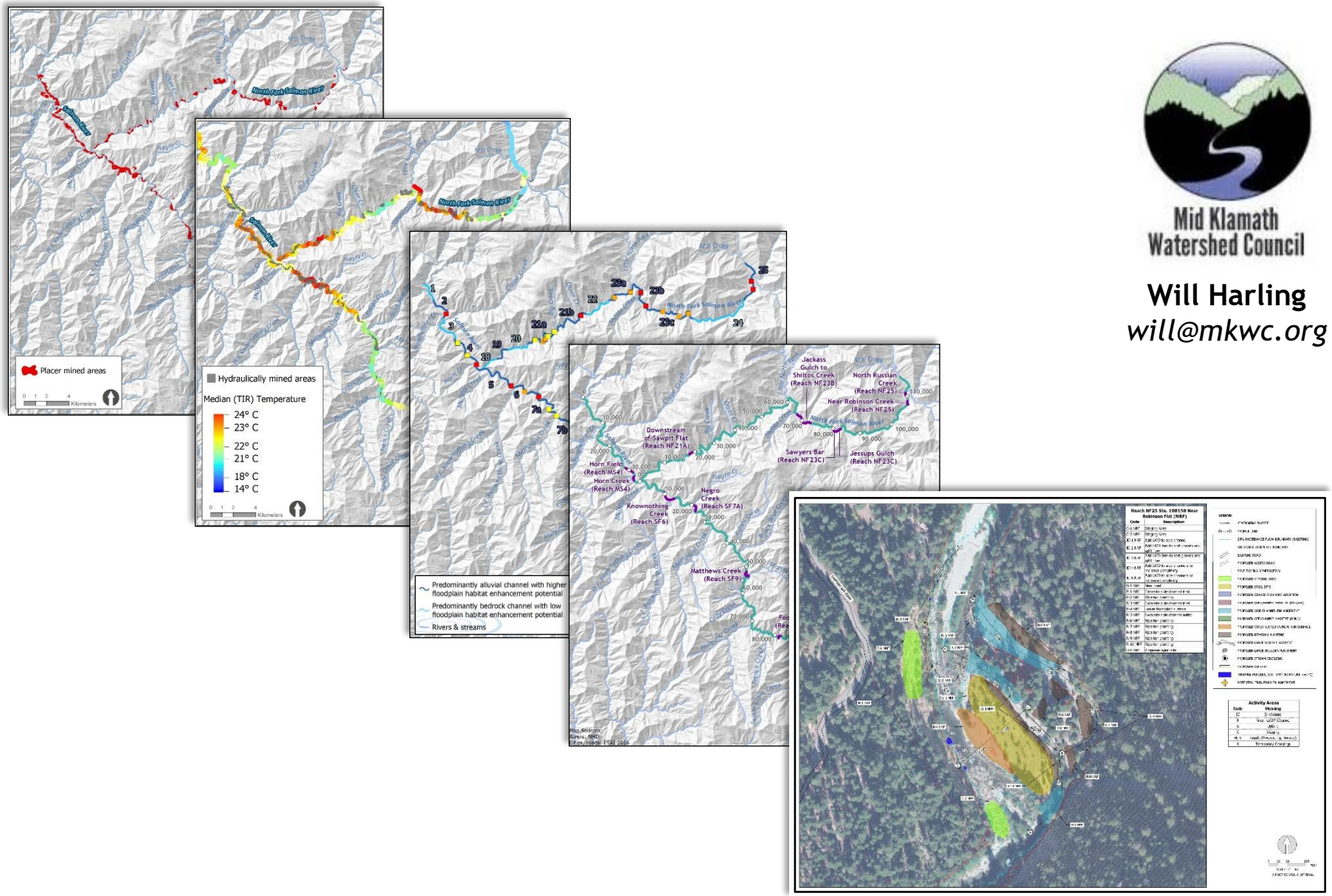
Code	Description
IC-1 AVC	Coarse sediment addition
IC-2 AVC	LWD placement - ELJ with sediment fence
IC-3 AVC	Coarse sediment addition
R-1 AVC	Constructed side channel
R-2 AVC	Constructed alcove
R-3 AVC	Constructed alcove
N-1 AVC	Access road - new
U-1 AVC	Mine tailing removal/graded floodplain
U-2 AVC	Mine tailing removal/graded floodplain
U-3 AVC	Mine tailing removal/graded floodplain

Activity Areas

Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

0 30 60 120 FEET
SCALE: 1" = 60'

1-FOOT CONTOUR INTERVAL



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