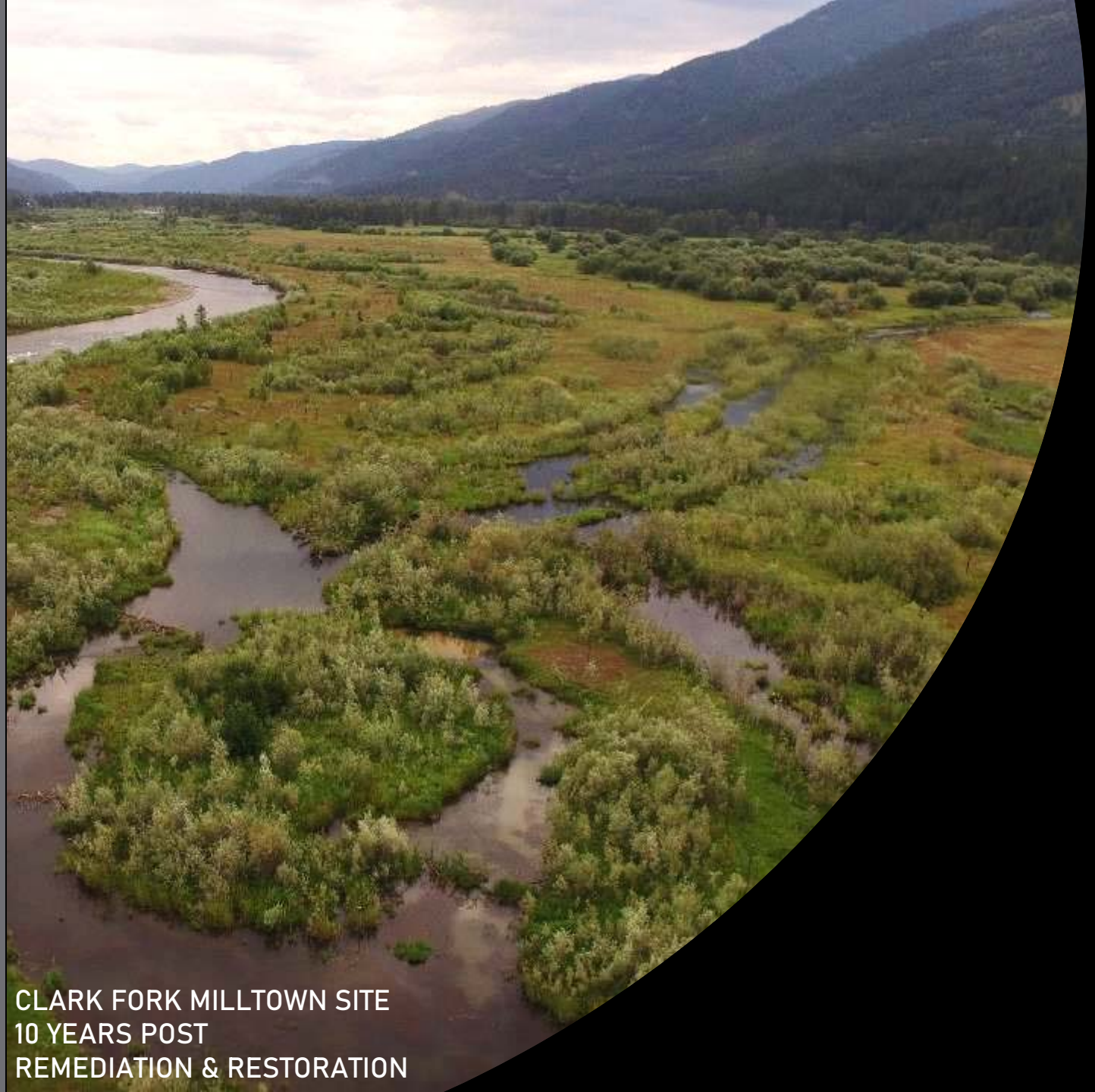


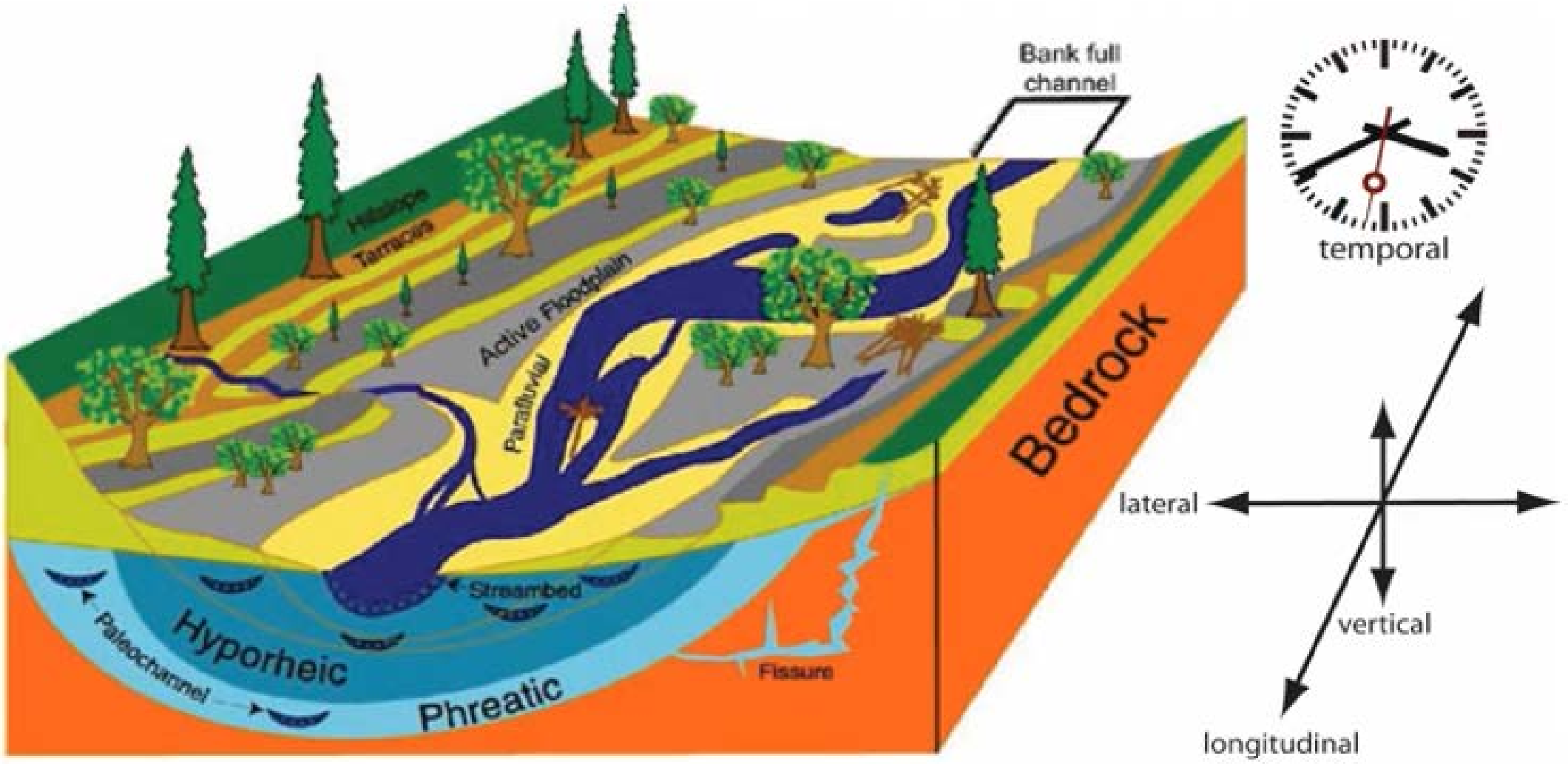
CLARK FORK MILLTOWN SITE
10 YEARS POST
REMEDIATION & RESTORATION

UCFWG Floodplain Session July 8, 2021

UPPER CLARK FORK RIVER FLOODPLAIN ECOLOGY & RESTORATION

Geum Environmental Consulting

Heterogenous and connected natural floodplain



(Noe 2013 *Treatise of Geomorphology*, modified from NRC 2002 Riparian Areas)

Floodplain Hydrologic Connectivity

- Flood Pulse Concept (FPC) – pulsing of river discharge drives the degree of connectivity
- Riparian and floodplain function is maximized by connectivity with the river – lateral, longitudinal, vertical and temporal
- Linked to frequency, seasonality and duration of surface flooding and groundwater and river channel water levels
- Timing of connectivity linked to life histories of some riparian plant species

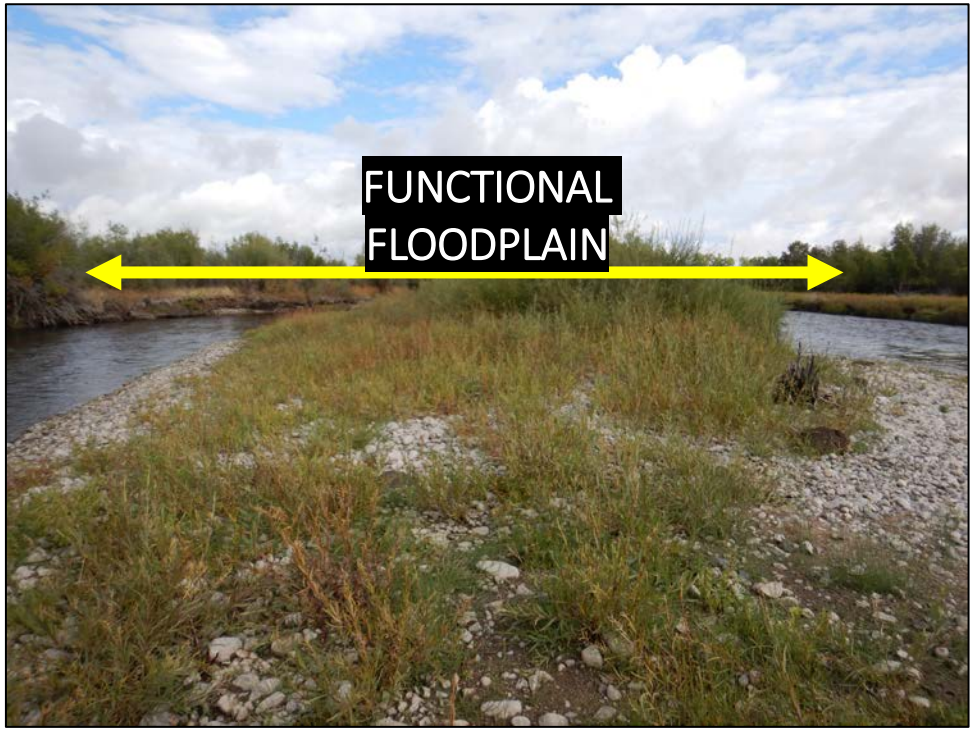
DRIVES MOST ECOLOGICAL PROCESSES AND MANY BIOLOGICAL AND BIOGEOCHEMCIAL PROCESSES

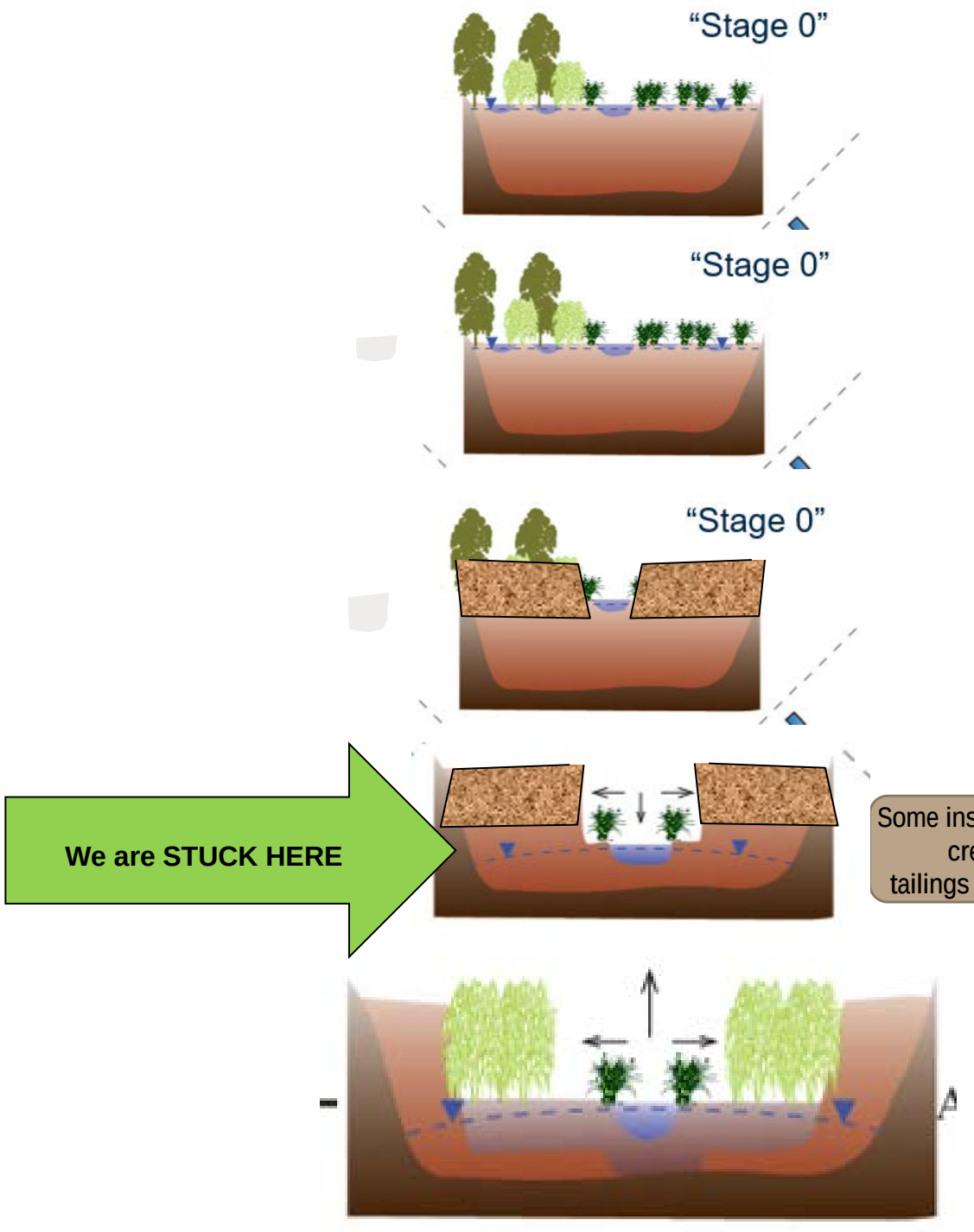
Riparian Vegetation Succession is Initiated and Driven by the Natural Disturbance Regime

The success of initialization of the sequence in riparian vegetation succession depends on:

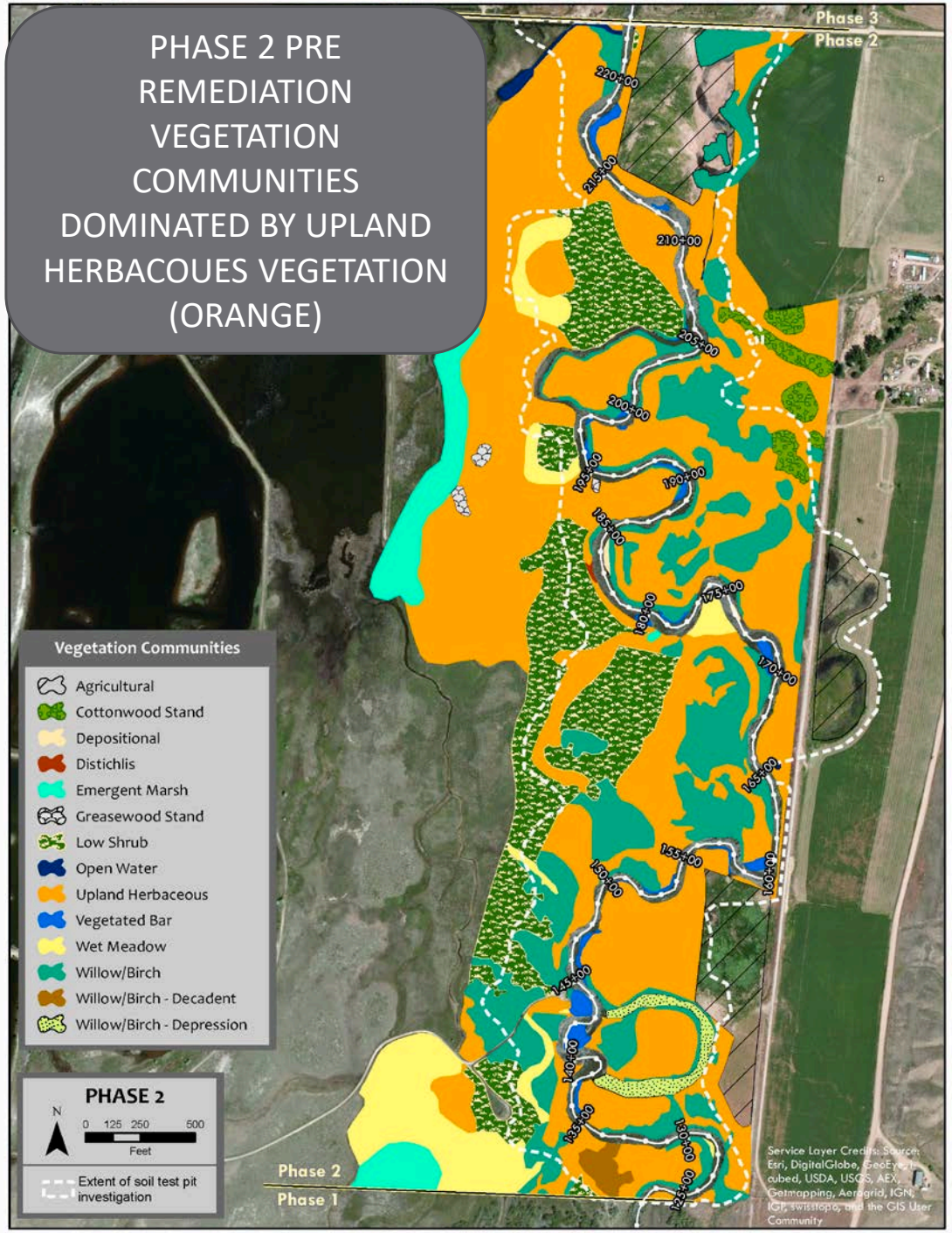
- Availability of seeds
- Availability of colonizable habitat
- Possibility of seedlings to develop enough before the next disturbance
- Resilience of the established populations to the next disturbance

Tabacchi et al. 1998


FUNCTIONAL
FLOODPLAIN

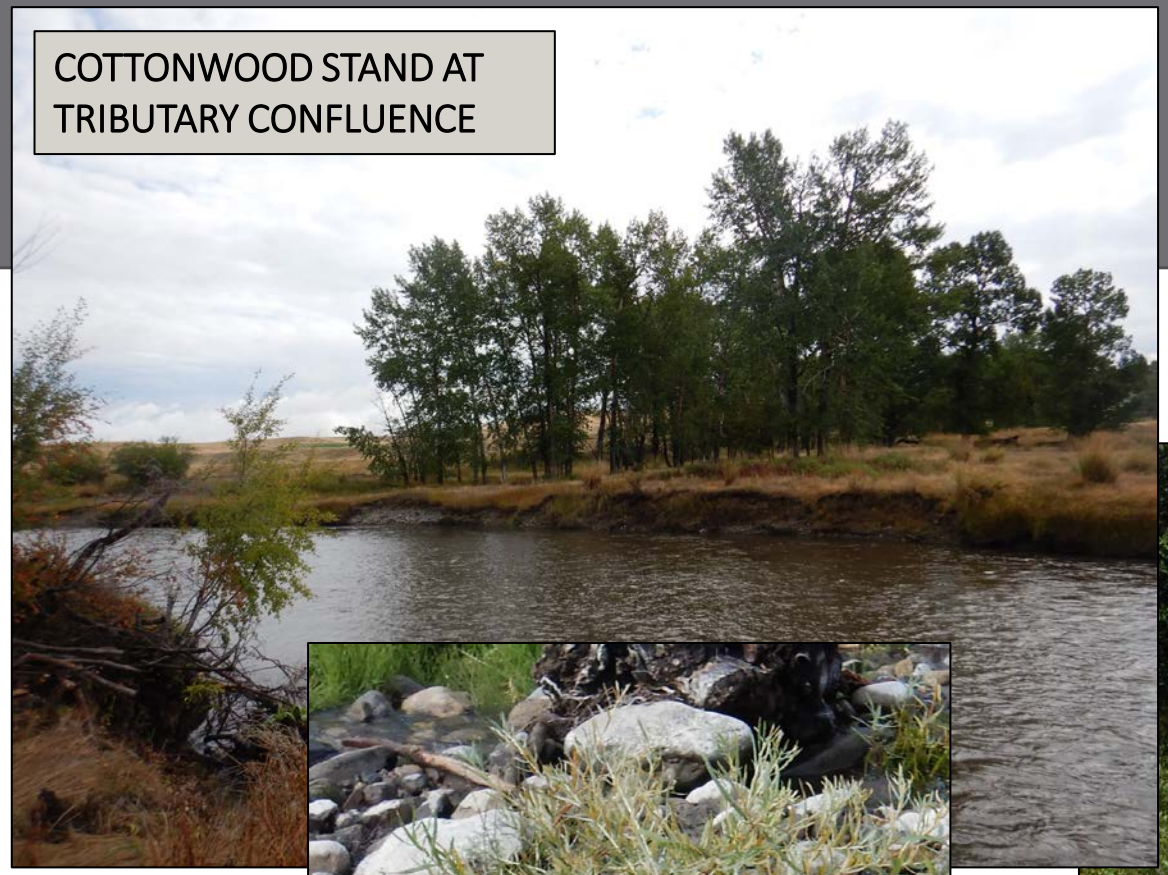

"Stage 0"
"Stage 0"
"Stage 0"
We are STUCK HERE
Some inset floodplain creation, tailings recruitment

PHASE 2 PRE REMEDIATION VEGETATION COMMUNITIES DOMINATED BY UPLAND HERBACOUES VEGETATION (ORANGE)

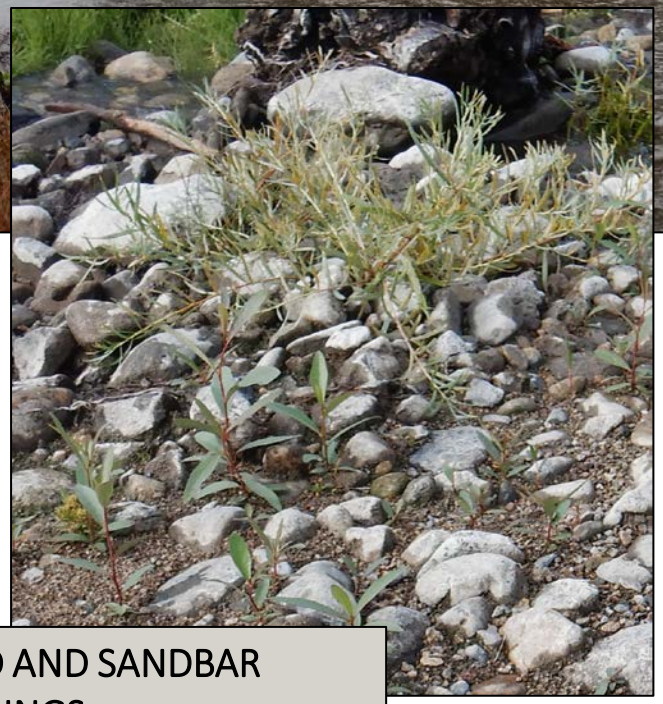


Floodplain is static and ecologically resilient and will resist shifting back to any pre-disturbance condition…

Reduced Cottonwood Abundance



COTTONWOOD STAND AT TRIBUTARY CONFLUENCE

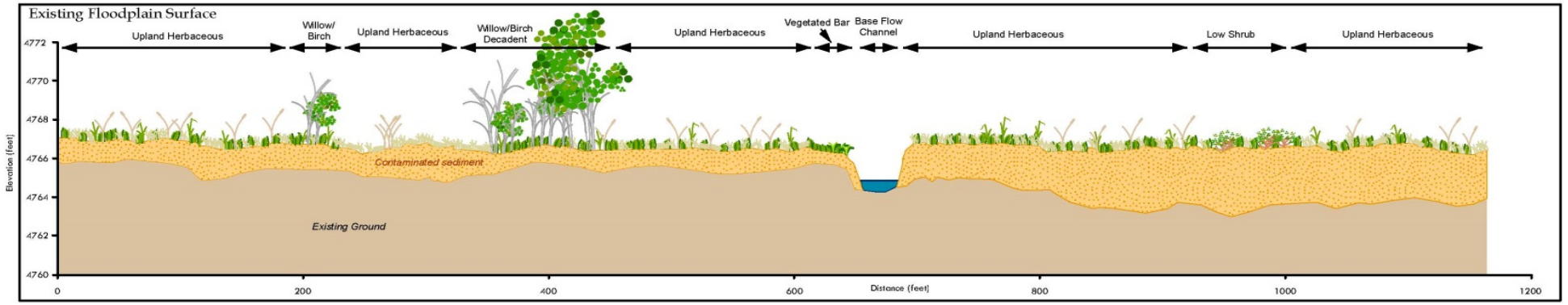


COTTONWOOD AND SANDBAR WILLOW SEEDLINGS

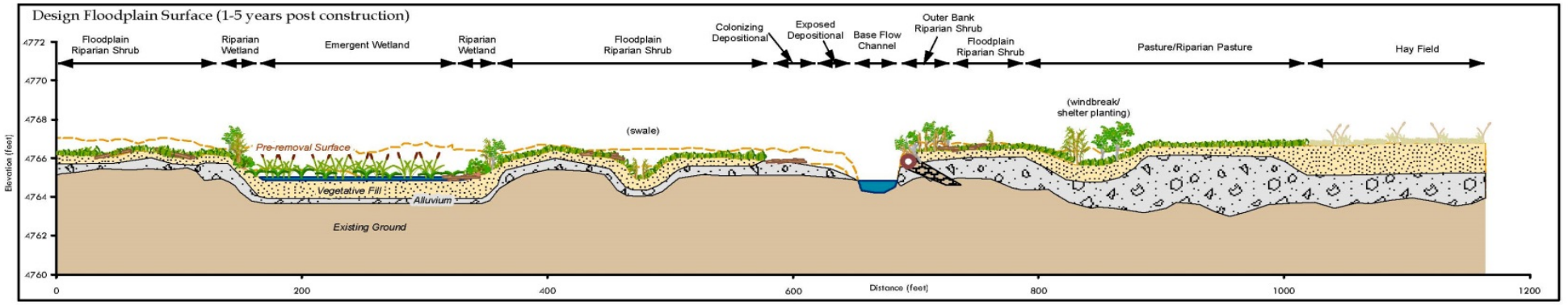
DENSE COTTONWOOD SEEDLINGS

NO COTTONWOOD SEEDLINGS

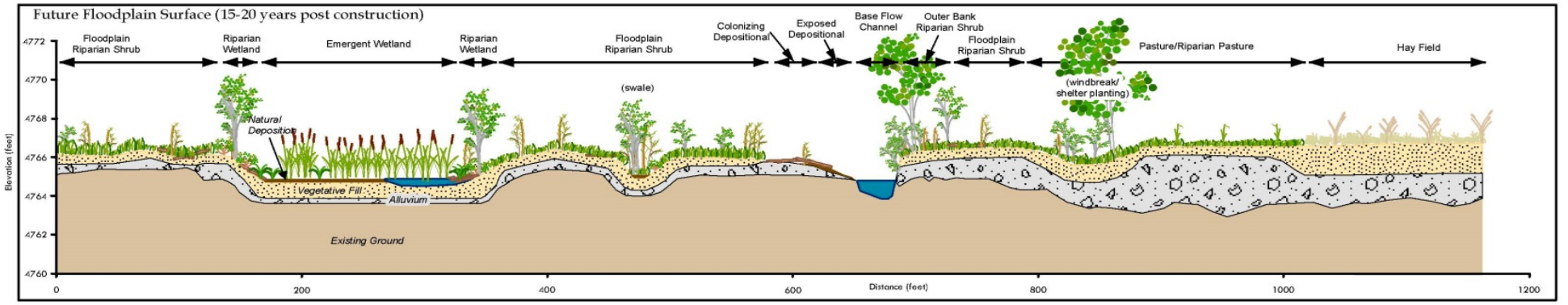
UPPER CLARK FORK SUCCESSIONAL MODEL AND POST-REMEDIATION TRAJECTORY



PRE REMEDIATION AND RESTORATION



POST REMEDIATION AND RESTORATION: SHORT-TERM



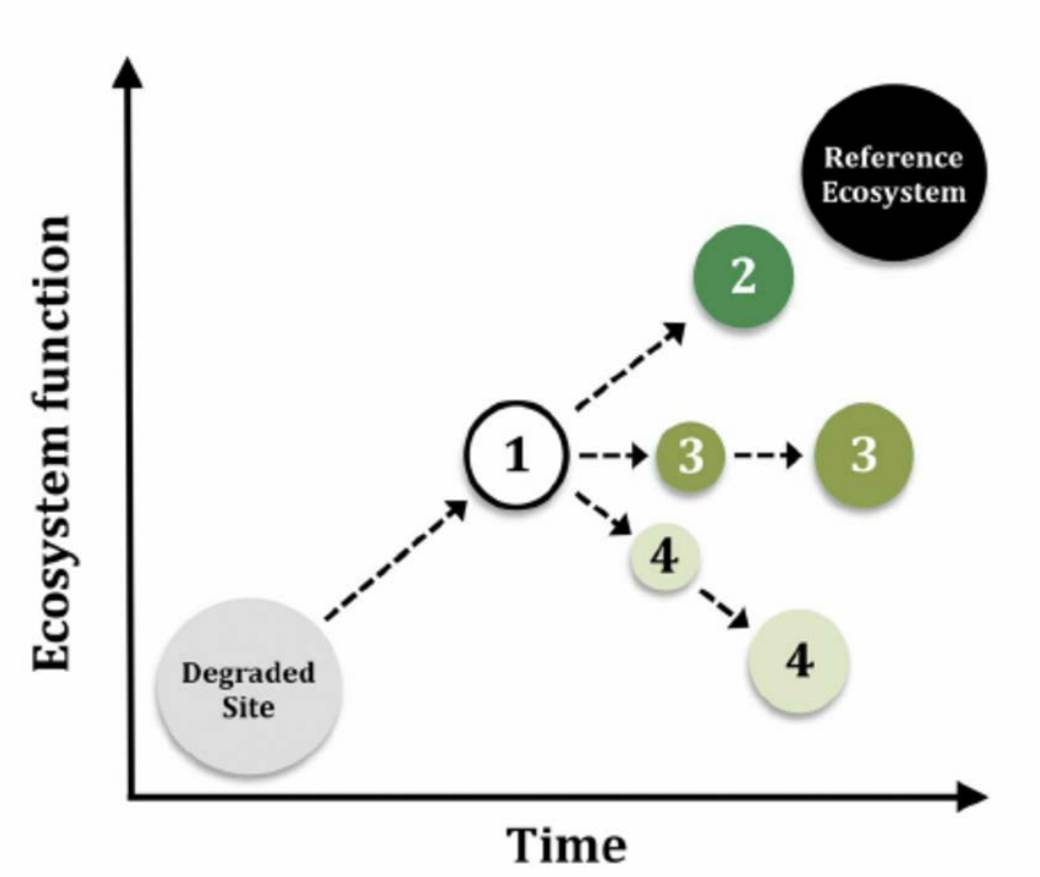
POST REMEDIATION AND RESTORATION: SHORT-TERM

1 Early successional

2 Successional trend maintained

3 Alternate stable state

4 Retrogressive succession



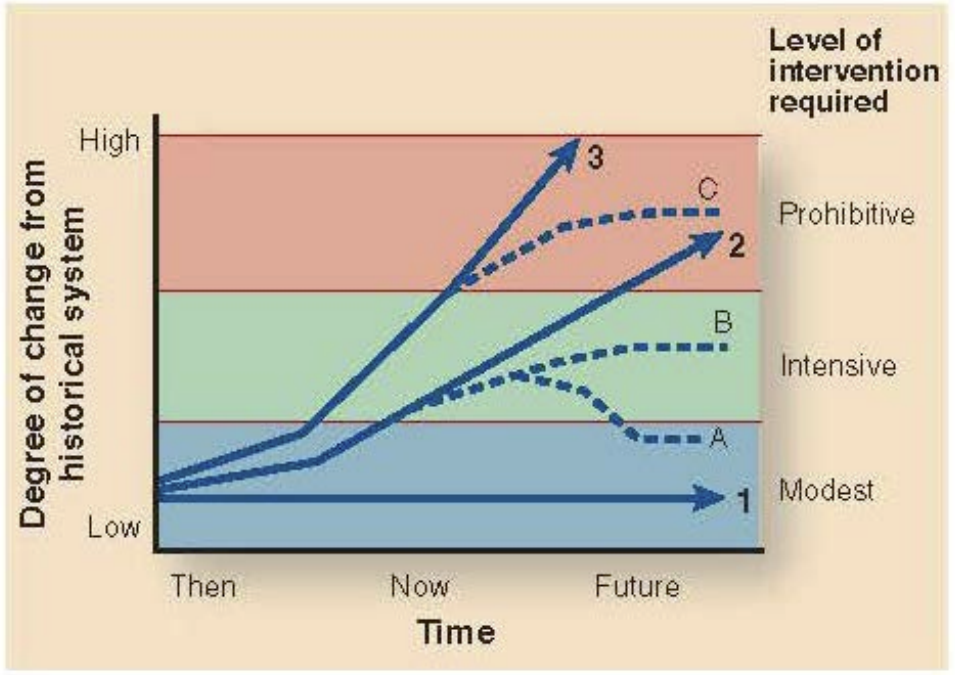
Post-Restoration Trajectories

Garbin, 2015

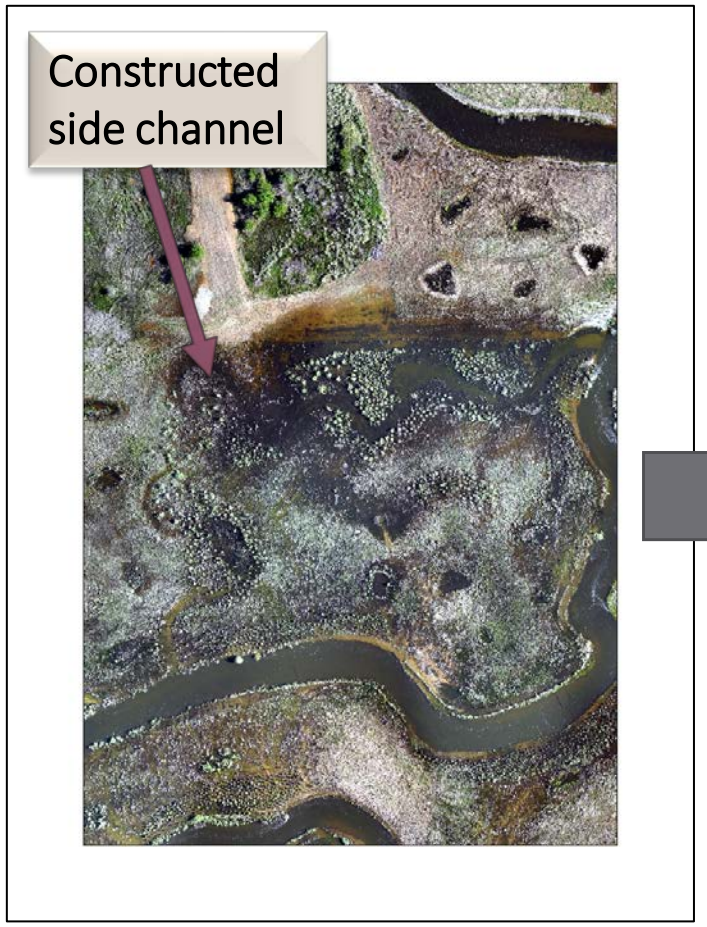
Is the historic condition a viable target?

- Climate Change
- Invasive Species
- Ecological Legacies of Human Actions

Restoration should work with current natural processes and aim to restore ecological function



Floodplain high flow surface connectivity = rapid woody pioneer vegetation expansion



Willow expansion 2 years post flood activation of side channel

Streambank Treatment Response - willow expansion

SUBSTRATE THAT ENCOURAGES WILLOW EXPANSION PLACED 10’ BEHIND TREATMENT

PHASE 1
7 YEARS POST RESTORAION

AVERAGE WIDTH OF WILLOW EXPANSION BEHIND BANK 15’
*MUCH LESS IF DENSE COVER BY SEEDED GRASSES ESTABLISHES FIRST

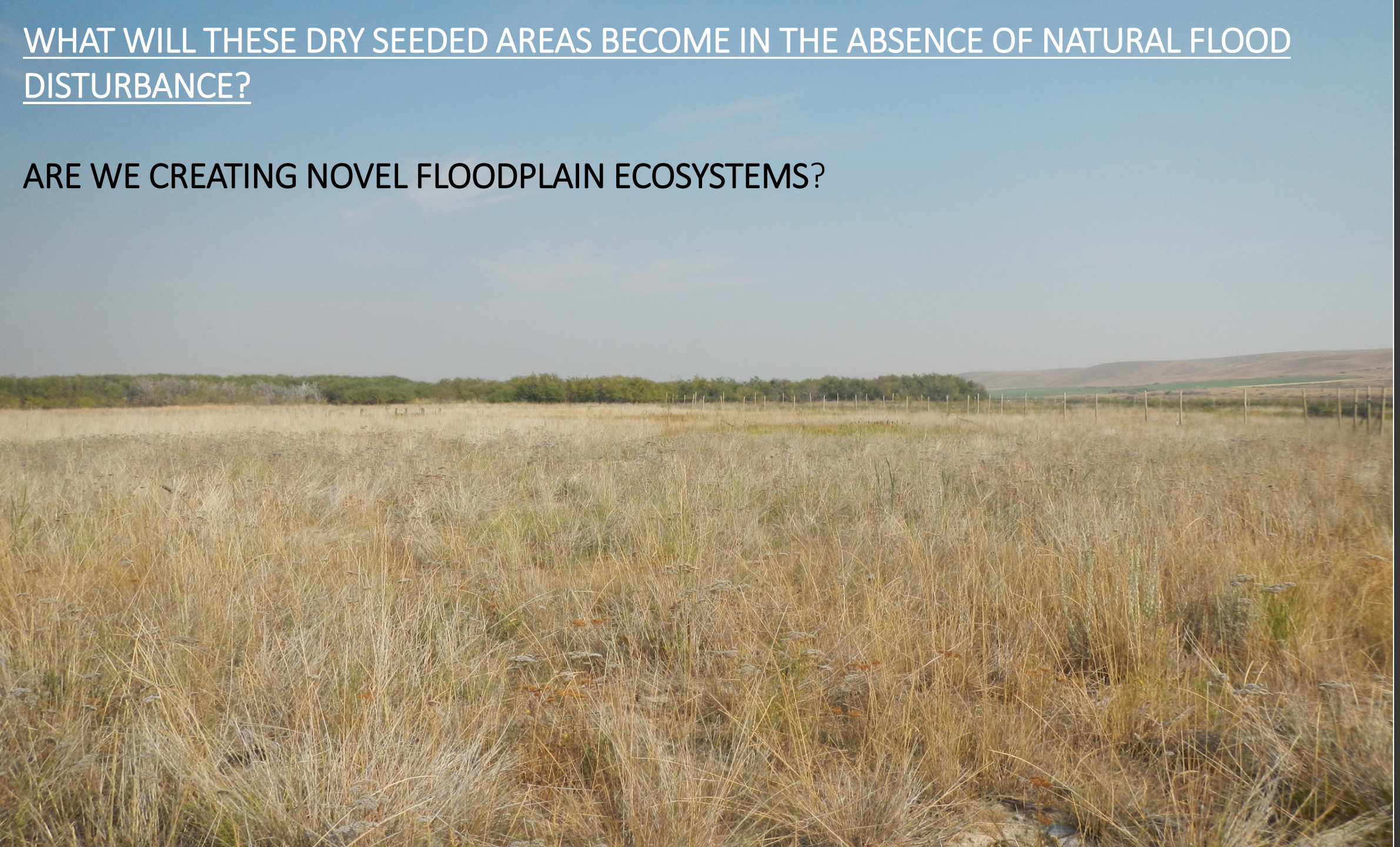
Streambank Treatment Response - Heterogeneity

Site Response - point bar building and early succession initiation (colonization)

CONSTRUCTED POINT BARS HELP BUILD FLOODPLAINS…

Close contact with late season groundwater speeds up recovery time

PHASE 1 WETLAND 3 YEARS POST ACTION



WHAT WILL THESE DRY SEEDED AREAS BECOME IN THE ABSENCE OF NATURAL FLOOD DISTURBANCE?

ARE WE CREATING NOVEL FLOODPLAIN ECOSYSTEMS?

RESTORED CONDITION = IMPORTED SOIL PLACED 12-18” DEEP OVER IMPORTED GRAVEL/SAND/COBBLE (FLOODPLAIN ALLUVIUM) WITH COMPOST (1.5%) MIXED INTO SURFACE


UPLAND SOIL BORROW SOURCE

DRY

- <1 CM) O-HORIZON DEVELOPMENT
- NO OTHER CHANGE

Capillary Barrier?

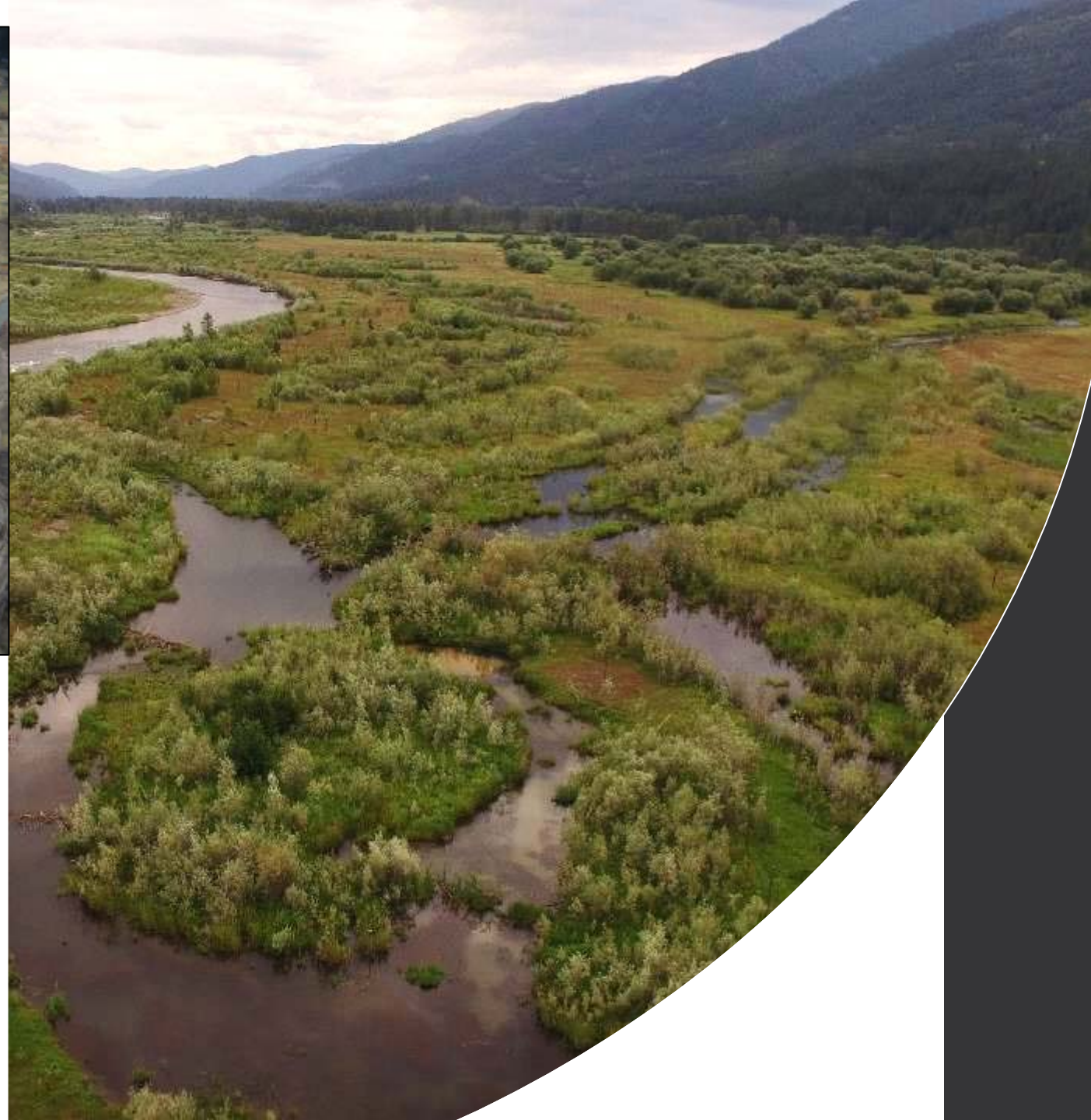
WET

- >1 CM O-HORIZON DEVELOPMENT
- REDOXIMORPHIC FEATURES FORMING >12” DEEP SOIL PROFILE
- ORGANIC MATTER DEEPER IN SOIL PROFILE

Planted Fall 2013
Individual browse protectors (good herbivory protection)
Non drought year
High flows out of banks
= >90% survival + willow expansion

Planted Fall 2014
4-ft wire fences (poor herbivory protection)
Drought year
High flows not out of banks
= <20% survival + no willow expansion

10 Years and 8 high flow events, timed closely with seed release and sustained hydrologic conditions needed to create this

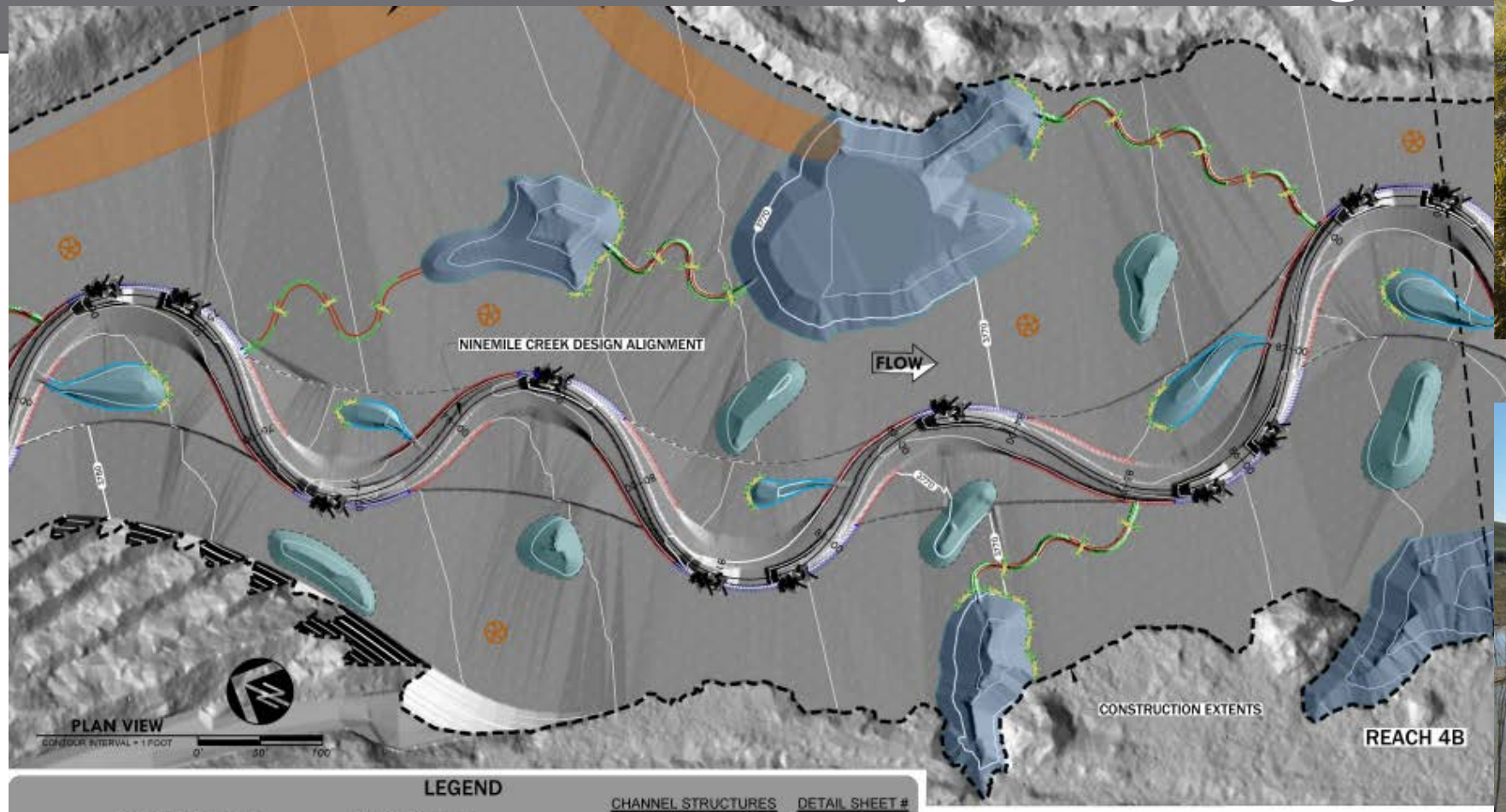


MILLTOWN SITE 10 years post Remediation and Restoration –

Areas of concern are areas that 1) lack connectivity with flood surface waters and late season groundwater; or 2) have residual metals present

What can we do to enhance floodplain function and process in restoration?

Maximize Flood Connectivity and Routing



What can we do to enhance floodplain function and process in restoration?

Maximize Diversity

MACRO SCALE – wetlands, swales, large depressions, side channels, oxbows, etc.

MICRO SCALE – extend wood below ground to increase below ground diversity and break potential barriers

What can we do to enhance floodplain function and process in restoration?

Mimic Vegetation Recruitment Processes

SEEDING OF WILLOWS & COTTONWOODS TIMED WITH HIGH FLOW RECESSION

USE OF SAND AND GRAVELS ON POINT BARS AND BANKS TO ENCOURAGE WOODY PIONEER SPECIES COLONIZATION AND EXPANSION & INPUT FLOODPLAIN BUILDING SUBSTRATES INTO SYSTEM

RESTORATION TAKES TIME AND SHOULD BE THOUGHT OF AS AN ADAPTIVE MANAGEMENT EXPERIMENT…

- Monitoring and research are integral to improving floodplain restoration
- Creating resiliency through restoration is critical in these areas, particularly in the light of climate change
- There is a need to develop clear ideas of where we want to go and trajectory paths that reflect that – meeting performance targets along do not always tell us if we are creating resilient ecosystems
- There is a need for further research to better understand floodplain processes and functions specific to the Upper Clark Fork and which of those are critical for remediation/restoration success