



Living shorelines, Stage 0 floodplains, and other design measures for climate adaptability

Steigerwald Floodplain Reconnection
USFWS Steigerwald National Wildlife Refuge
Washougal, WA

Curtis Loeb, PE
Amanda Jones, PE
Rowyn Cooper-Caroselli, PE

Climate resiliency and design linkage – Lower Columbia

Stressors

Increasing temperature
Droughts
Floods
Hydrograph - modification

Resiliency

Adaptable
Recoverable
Absorbing disturbance
Elasticity

Focal areas

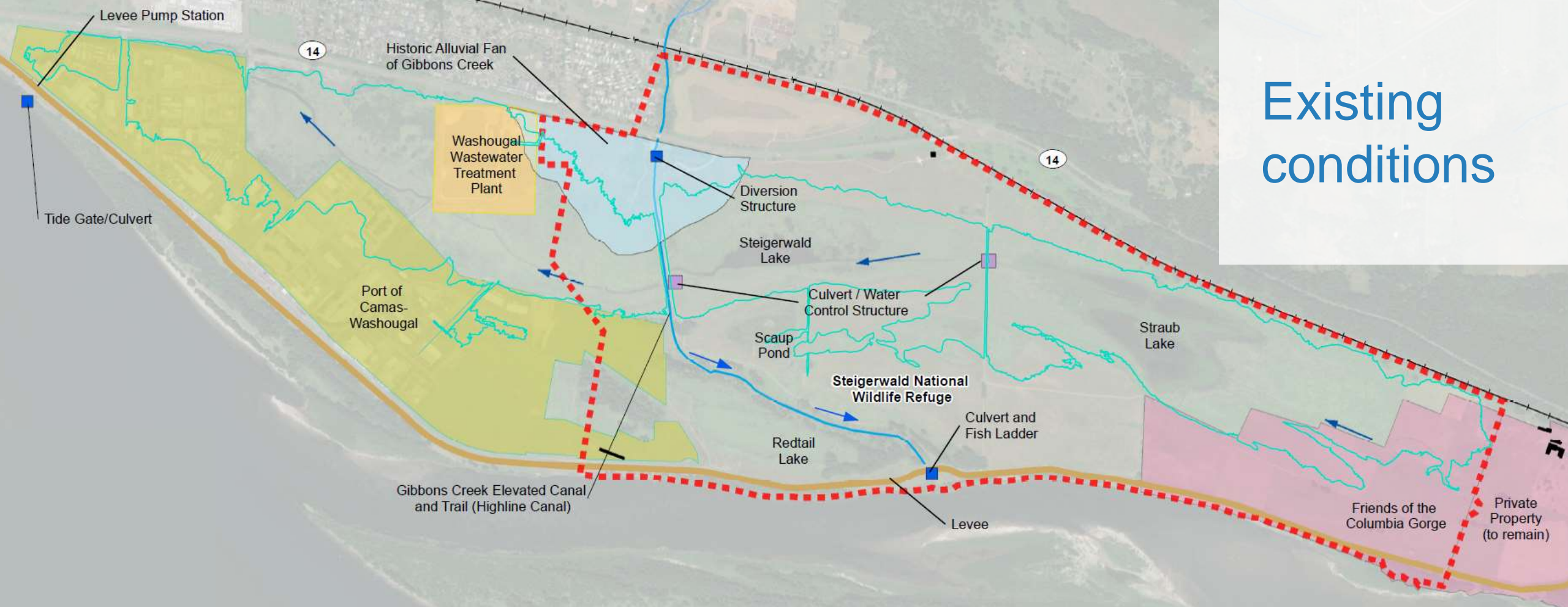
Invasives control & biological players
Sediment dynamics
Natural features
Floodplain & longitudinal connections

Design measures

Role of vegetation
Redundancy
Multi-modal hydrology
Outside-in design

Holling, C.S., 1973

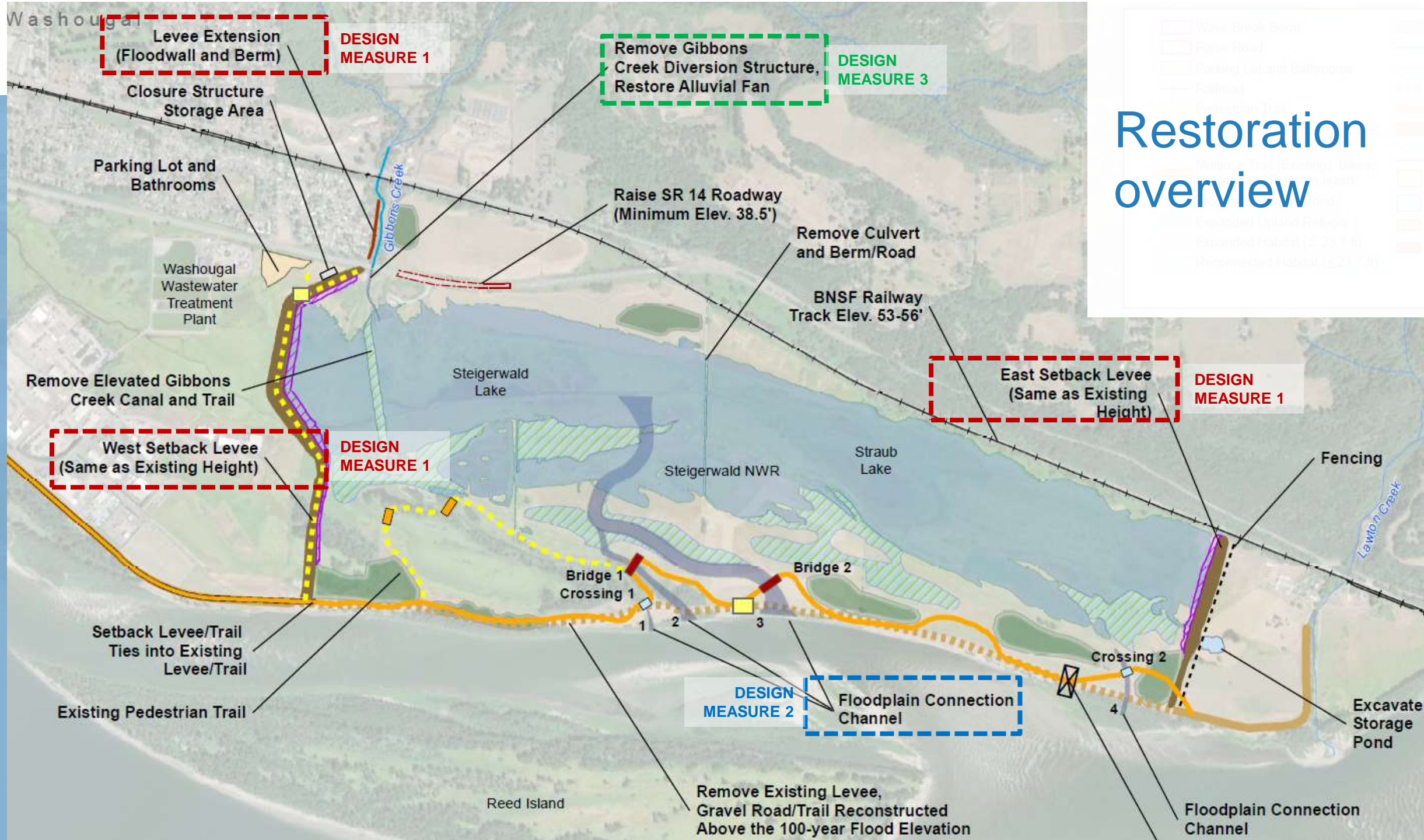
Tullos, D., D. W. Baker et al., 2021



Existing conditions



View of former river levee looking east from middle of Refuge (LCEP)



Restoration overview

- Existing Levee
- Proposed Levee
- Parking Lot and Bathrooms
- Fencing
- Existing Wetland
- Proposed Wetland
- Expanded Wetland
- Expanded Habitat
- Reconnected Habitat

Levee Extension (Floodwall and Berm)

DESIGN MEASURE 1

Remove Gibbons Creek Diversion Structure, Restore Alluvial Fan

DESIGN MEASURE 3

East Setback Levee (Same as Existing Height)

DESIGN MEASURE 1

West Setback Levee (Same as Existing Height)

DESIGN MEASURE 1

Floodplain Connection Channel

DESIGN MEASURE 2

Remove Existing Levee, Gravel Road/Trail Reconstructed Above the 100-year Flood Elevation

Floodplain Connection Channel

Excavate Storage Pond

Fencing

Bridge 2

Bridge 1 Crossing 1

Crossing 2

Closure Structure Storage Area

Parking Lot and Bathrooms

Washougal Wastewater Treatment Plant

Remove Elevated Gibbons Creek Canal and Trail

Steigerwald Lake

Steigerwald NWR

Straub Lake

Reed Island

Lawton Creek

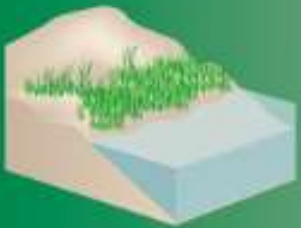
Gibbons Creek

Washougal

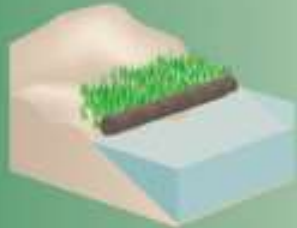
GREEN - SOFTER TECHNIQUES

GRAY - HARDER TECHNIQUES

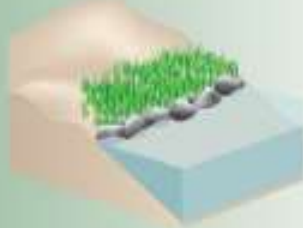
Living Shorelines



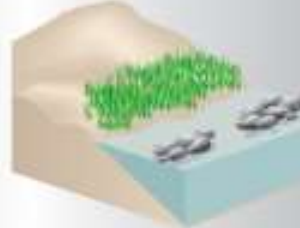
VEGETATION ONLY -
Provides a buffer to upland areas and breaks small waves. Suitable only for low wave energy environments.



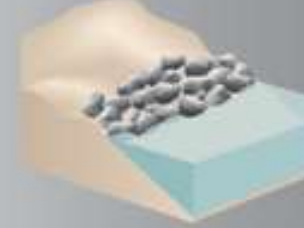
EDGING -
Added structure holds the toe of existing or vegetated slope in place.



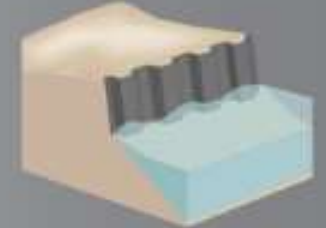
SILLS -
Parallel to existing or vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.



BREAKWATER -
(vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



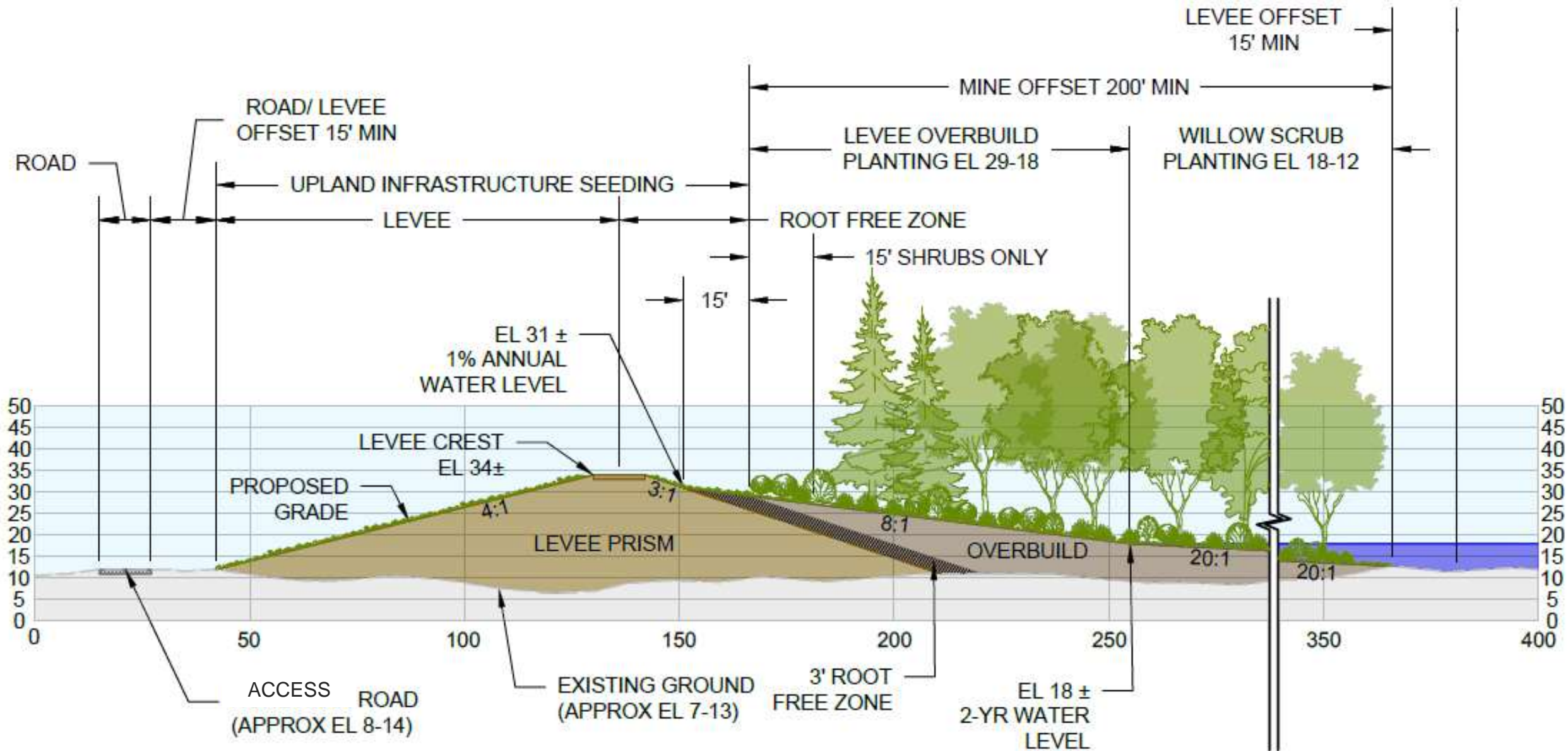
REVETMENT -
Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with pre-existing hardened shoreline structures.



BULKHEAD -
Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for areas highly vulnerable to storm surge and wave forces.

DESIGN MEASURE 1

Living shoreline – vegetated overbuilds



DESIGN MEASURE 1

Living shoreline – vegetated overbuilds

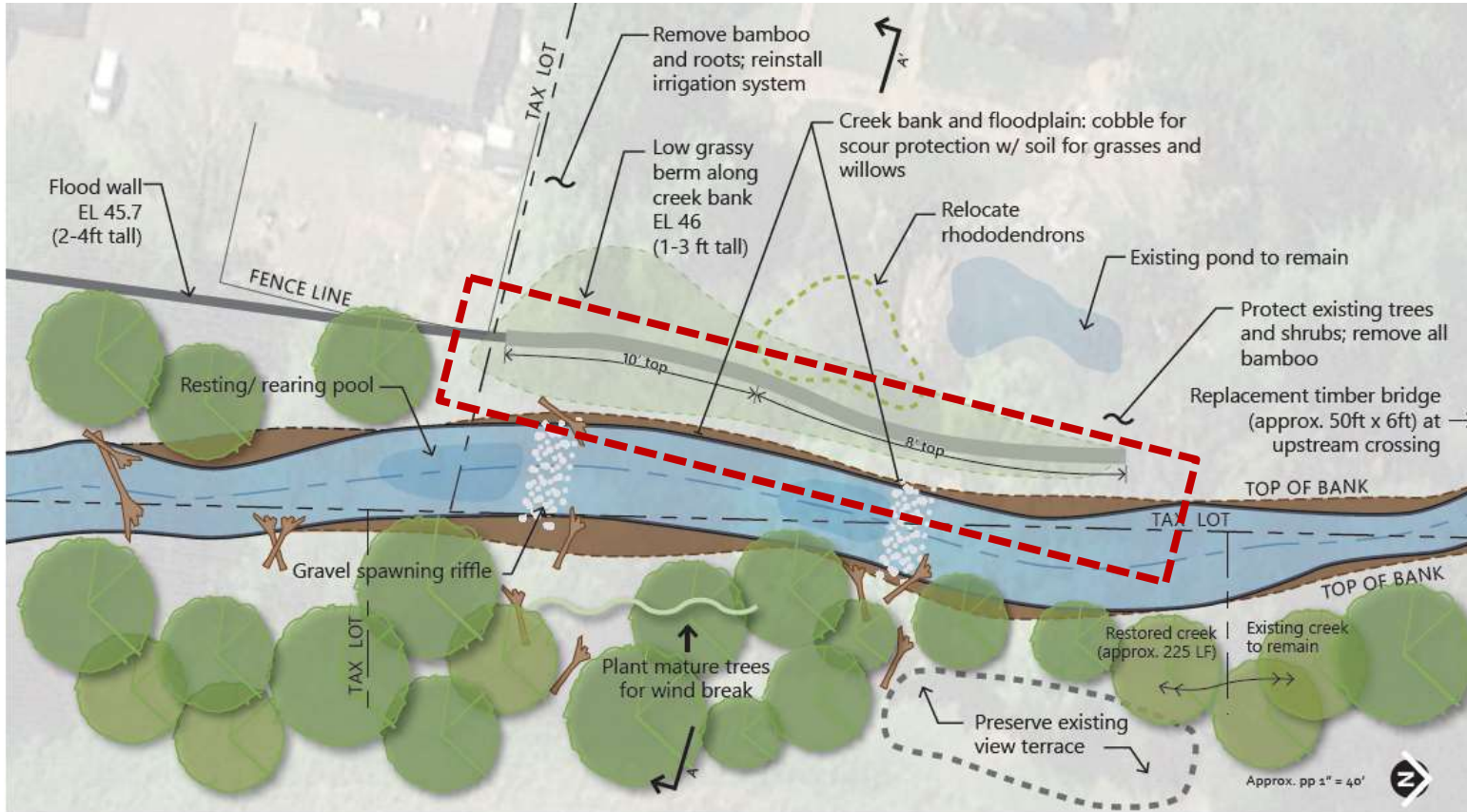
Year 1 (June 2022)
East levee overbuild



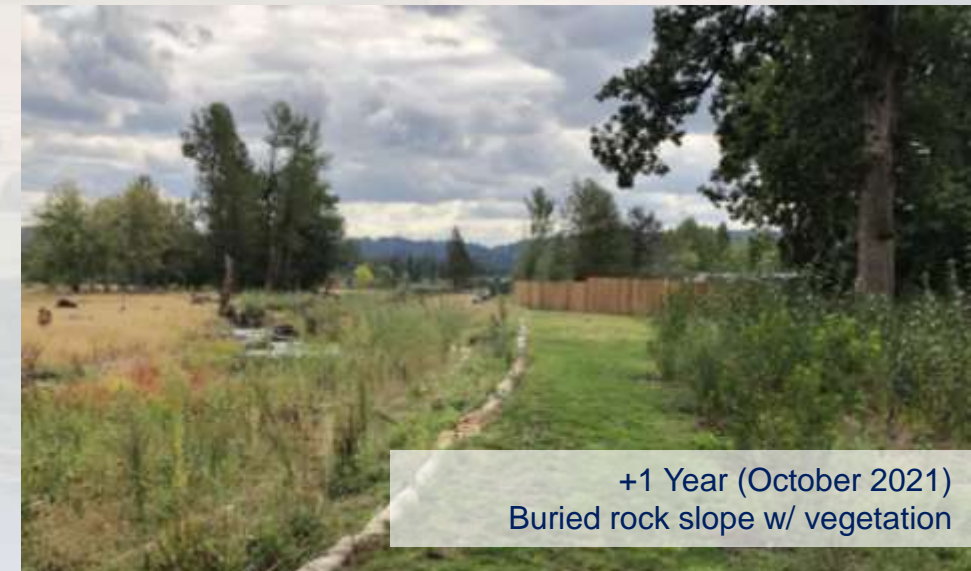
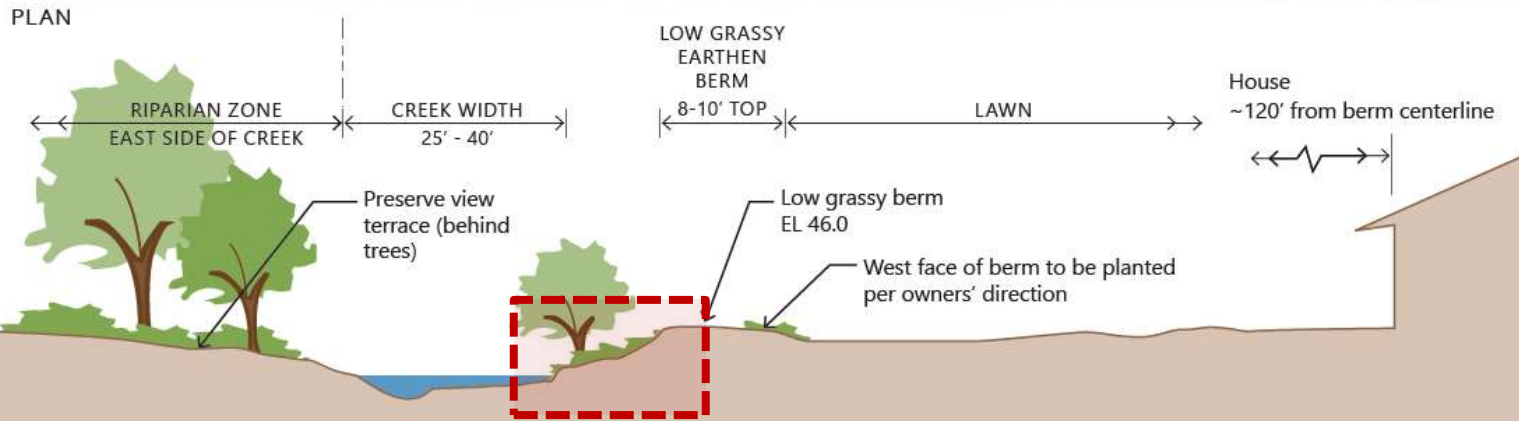
Year 2 (May 2023)
West levee overbuild



Gibbons Cr – living berm (segment of west levee)



Post-construction (Dec 2020)
Buried rock slope



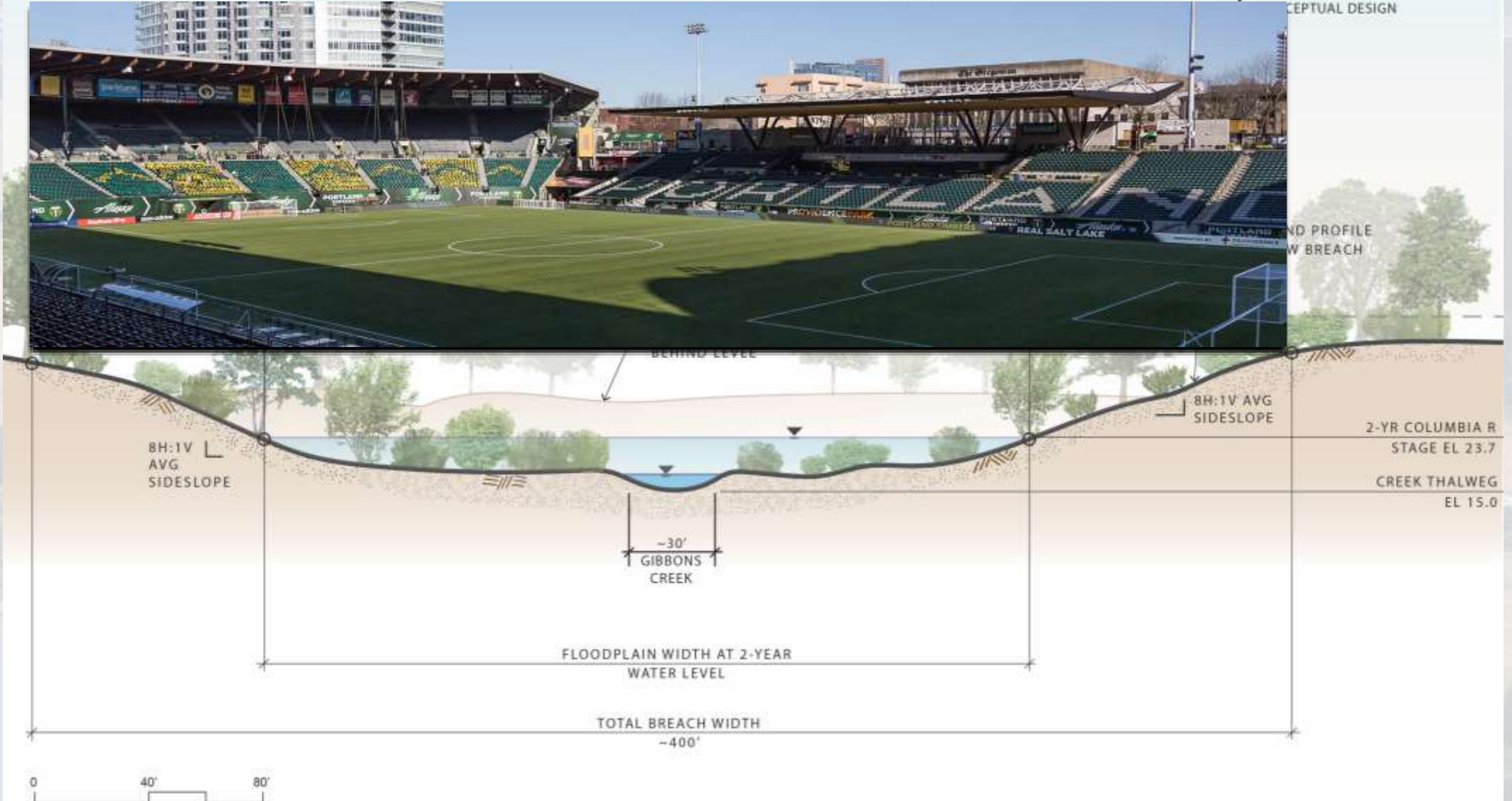
+1 Year (October 2021)
Buried rock slope w/ vegetation

DESIGN MEASURE 2

Hydrologic variability

STEIGERWALD NWR RESTORATION
GIBBONS CREEK CONFLUENCE

CONCEPTUAL DESIGN

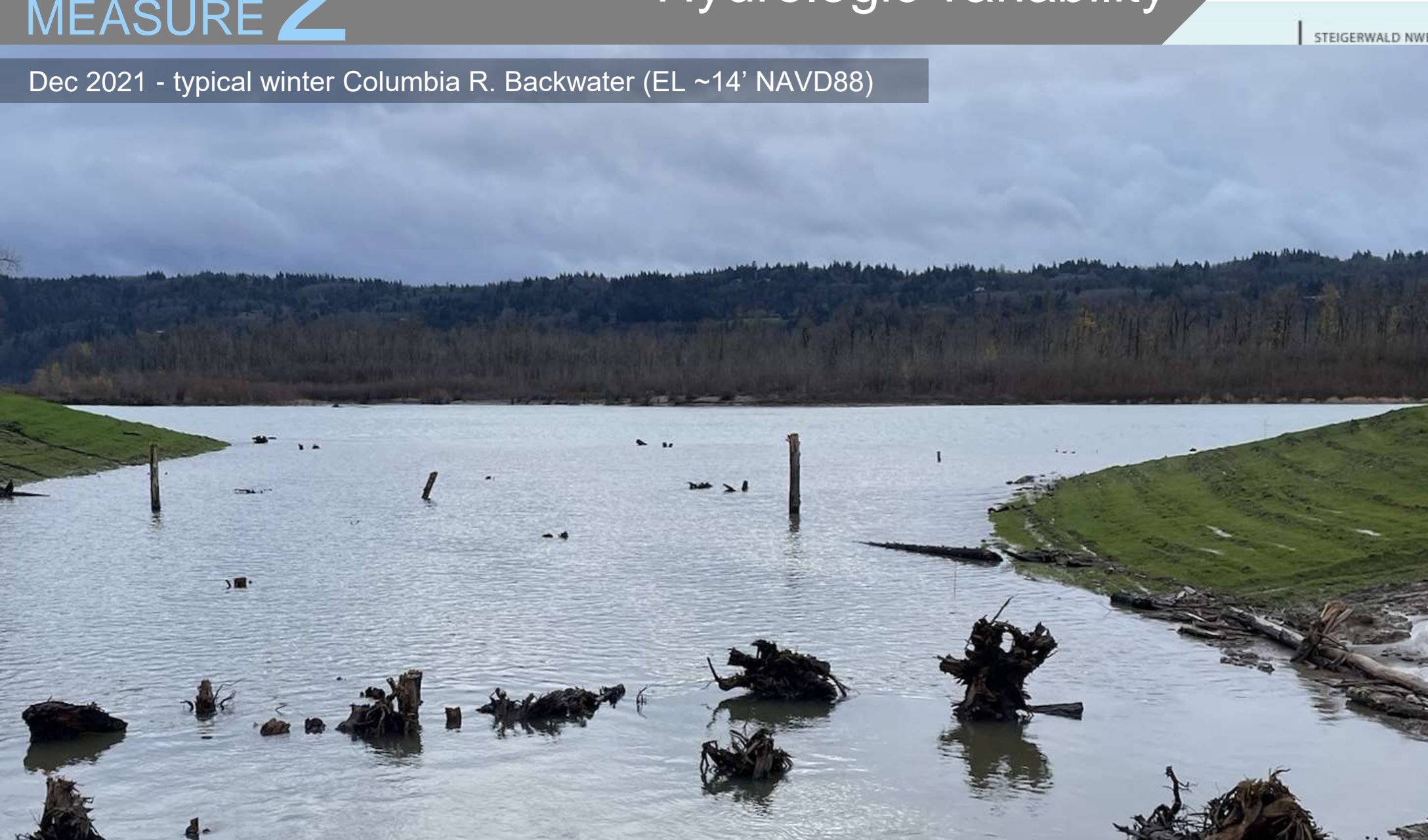


END PROFILE
W BREACH

DESIGN MEASURE 2

Hydrologic variability

Dec 2021 - typical winter Columbia R. Backwater (EL ~14' NAVD88)



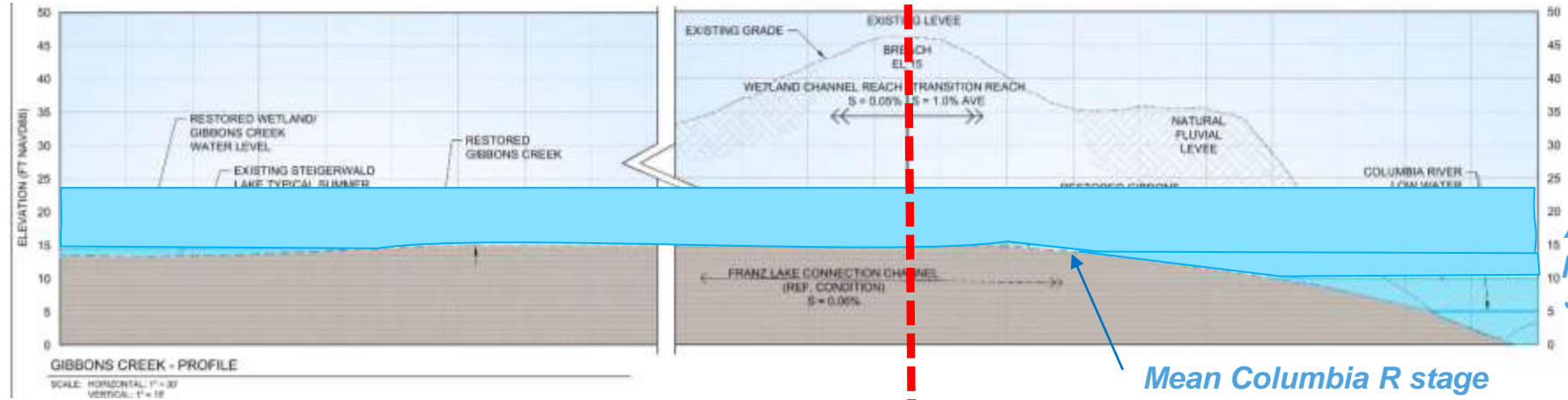
STEIGERWALD NWR RESTORATION

INFLUENCE
GN

YR COLUMBIA R
STAGE EL 23.7
CREEK THALWEG
EL 15.0

DESIGN MEASURE 2

Hydrologic variability

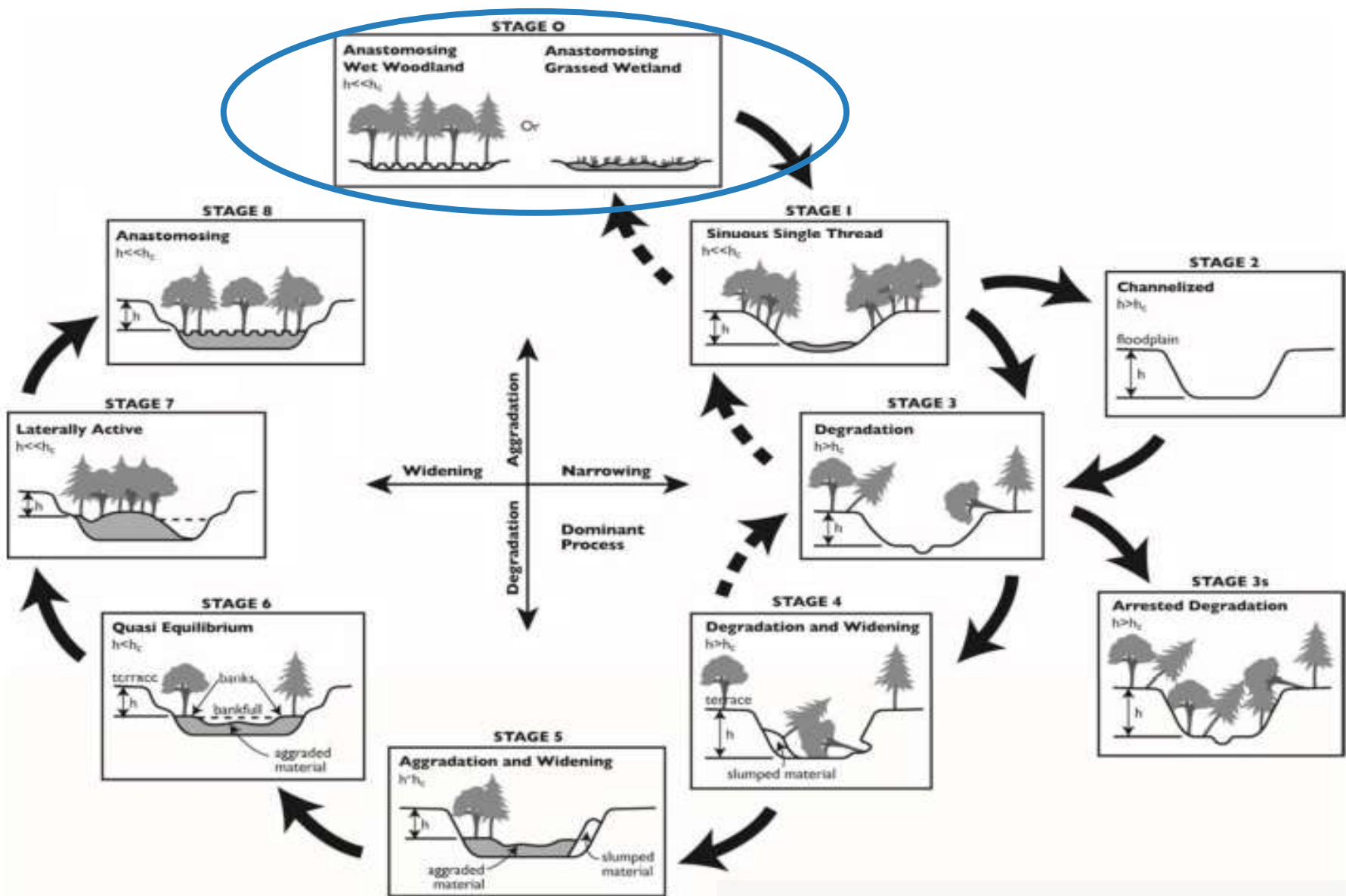


*Apr-Jul
Nov - Mar
Jul - Oct*

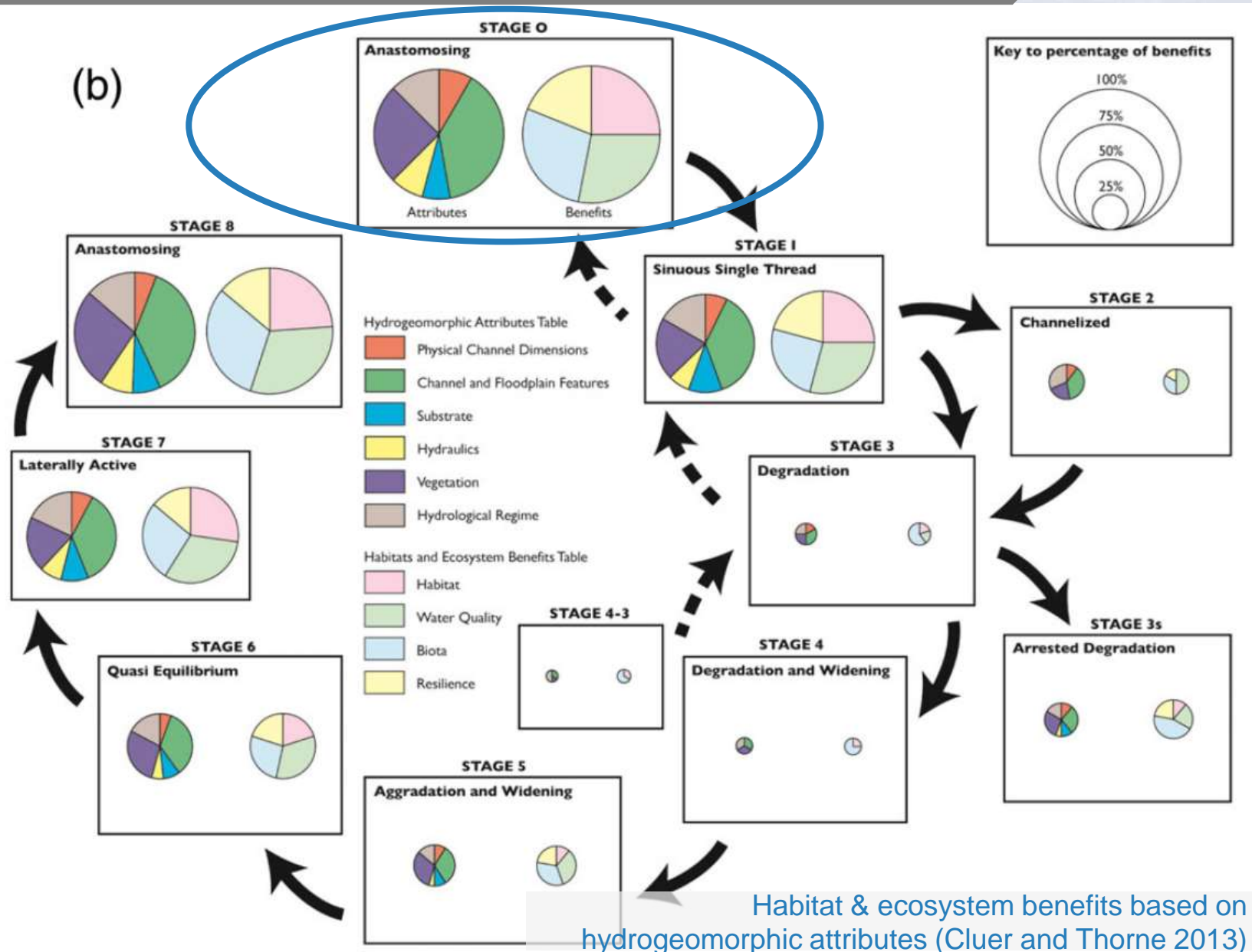
*Mean Columbia R stage
Nov - Mar is 6" below
floodplain invert*

DESIGN MEASURE 3

Full floodplain connectivity



Stream evolution model (Cluer and Thorne 2013)



DESIGN MEASURE 3

Stage 0 – Gibbons Creek



DESIGN MEASURE 3

Stage 0 – Gibbons Creek



Keys

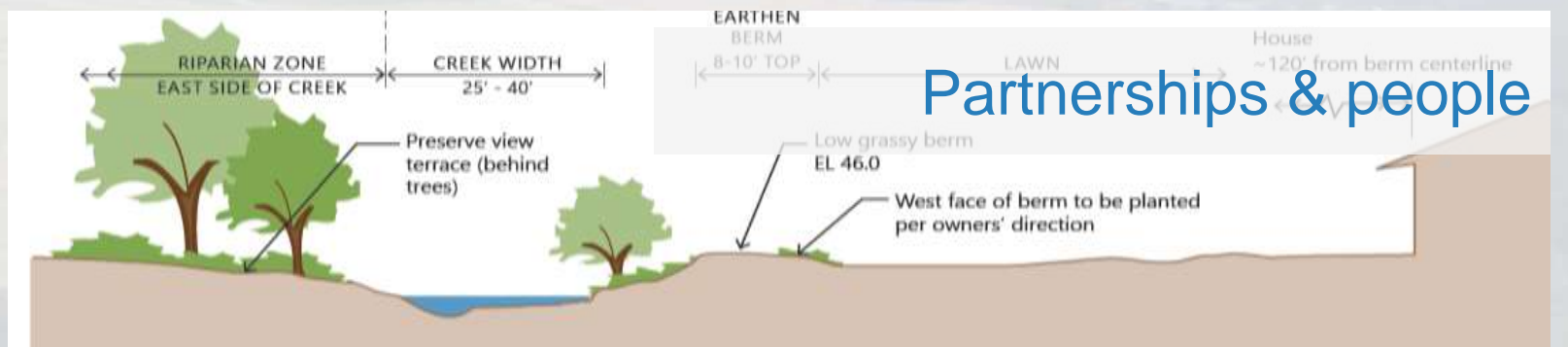
to

climate

resiliency:



Space & scale



Partnerships & people



Redundancy &...redundancy

Questions?

With gratitude to the team!

Partners



Design team



*Laura Herbon
Landscape Architect, LLC*



DESIGN MEASURE 3

Hydro-geomorphic sensitivity

How much space is enough?

Hydraulics & sediment competence response to changes in channel geometry?

