Fish Habitat Enhancement & Recreational Development:

Confluence Recreation Area, Blue River, Colorado

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Prepared for:

Blue Valley Ranch

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FISH HABITAT ENHANCEMENT & RECREATIONAL DEVELOPMENT: CONFLUENCE RECREATION AREA, BLUE RIVER, COLORADO

This report includes a restoration design to enhance the recreational fishery of the lower Blue River near the confluence of the Colorado River. The design provides safe and convenient boat and fishing access locations with public and wheelchair accessible trails and fishing ramps. Currently there is limited public access to BLM managed lands in the area proposed for river restoration. The BLM allows a location for float boaters to take out of the river, but access is difficult given the distance to parking and the need to cross an irrigation ditch. The proposed land exchange would result in added BLM ownership of over a mile of river including both sides in the location of the proposed restoration work.

The restoration design is also intended to reduce the active streambank erosion and to improve the sediment transport capacity to help remove the fine sediment deposition in this over-wide reach of the Blue River. The reshaping of the river and installation of habitat enhancement and stream stability structures are designed to be self-sustaining. Instream and overhead cover and high and low flow refugia are provided with the design to improve aquatic habitat quality by using native materials, including logs, root wads, riparian vegetation, and native boulders. Structures are also incorporated in the design to create excellent fishing lanes along the river. Oxbow channels are also proposed to provide fishing diversity and easy access for the less experienced or physically disabled fishermen.

Specifically, the proposed design is presented to meet the following objectives:

1. Improve the natural river stability using native materials and channel shaping following a geomorphic approach to river restoration
2. Design the channel to accommodate a wide range of flows while maintaining fish habitat features
3. Re-establish a woody riparian in deficit reaches
4. Increase the fine sediment transport to prevent deposition of fines on the substrate
5. Provide for spawning habitat with adjacent cover
6. Improve fish habitat quality by providing refugia for all flows and seasons
7. Increase the useable fishing area and diversity of habitats to improve fishing experience
8. Provide wheelchair-accessible trails and ramps for recreational opportunities
9. Design fisherman and recreational access trails
10. Provide space for parking
11. Design a boat ramp facility that allows boaters to safely and conveniently remove boats regardless of river flow
12. Allow the river to be sustainable with low maintenance following major flood events

Fisheries Assessment

The lower reach of the Blue River near the confluence of the Colorado River is a low gradient, over-wide, depositional channel. Large floods on the Colorado River often create backwater at the mouth of the Blue River, thereby depositing fine sediment comprised of silt and fine sand over the gravel-bed channel. This inhibits spawning and macroinvertebrate habitat, and the fine sediment deposition decreases low flow depths and fills in the pool habitat. Overhead cover and instream cover are limiting due to lack of woody riparian vegetation and large woody debris along the stream streambanks and corridor. Streambank cover is also poor due to actively eroding streambanks and the lack of undercut banks.

Geomorphic Assessment & Stability Analysis

Due to past grazing and farming practices, the dominant riparian vegetation is a grass/forb community. The potential riparian community should be comprised of Cottonwood and willows, which would improve flow resistance and reduce streambank erosion due to the great rooting depths and high root density of this vegetation. The current streambank erosion rate is one order of magnitude higher than observed on the reference reach (stable, meandering, C4 stream type) located upstream on the Blue River. Using the BANCS model (Rosgen, 2001, 2006), the average predicted annual streambank erosion for the proposed project location is 560.8 tons/yr, corresponding to an erosion rate of 0.143 tons/yr/ft (**Figure 1**). Furthermore, fine sediment is depositing throughout the reach due to the reduced sediment transport capacity associated with the high width/depth ratio channel on the recession limb of the high flow stage of both the Colorado and the Blue Rivers.

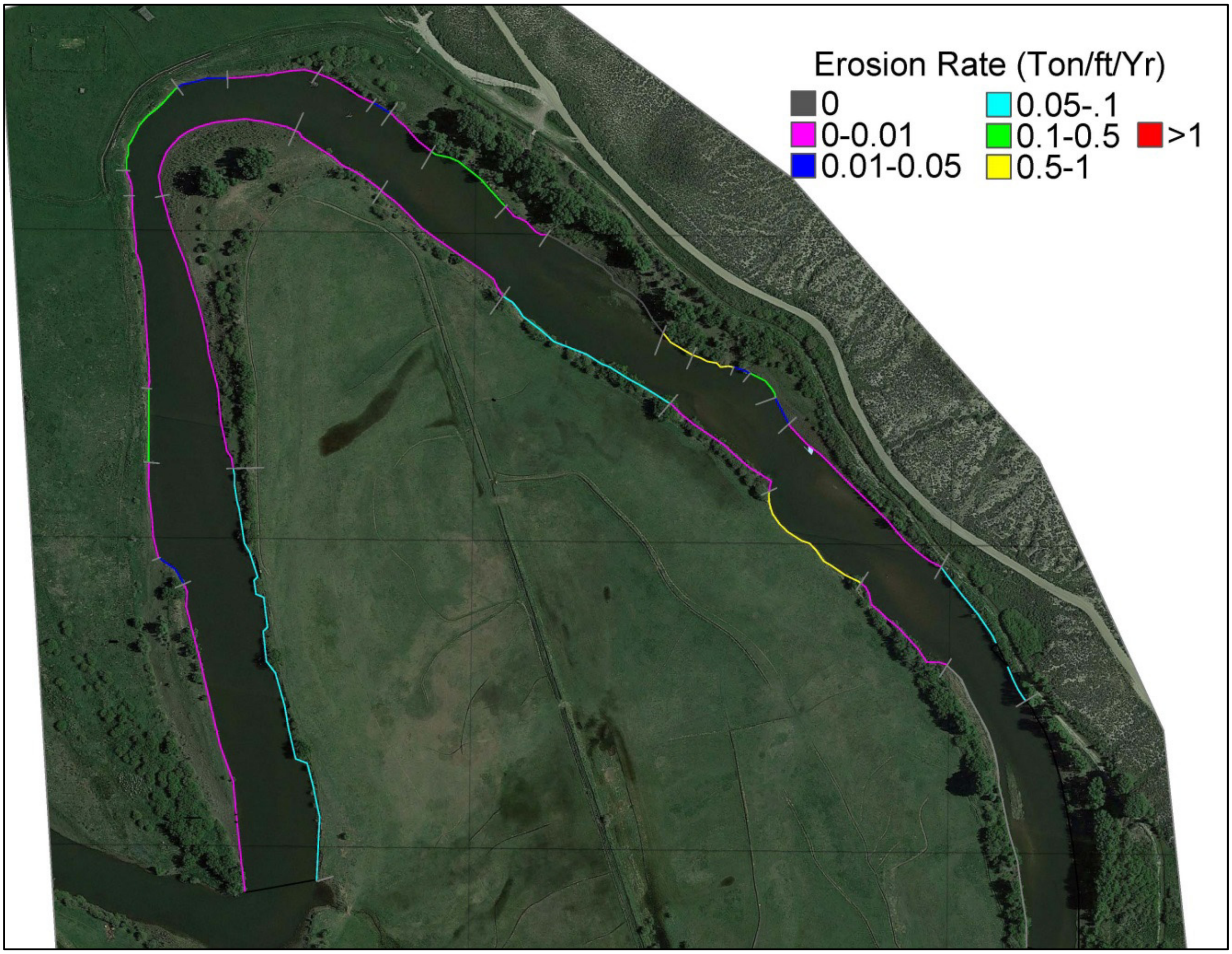

Figure 1. Streambank erosion rates in tons/yr/ft by location.

Design Concepts

The following sections provide design concepts to meet the project objectives and provide natural river stability, reduce streambank erosion, improve aquatic habitat and fishing diversity, and provide boating, fishing, and wheelchair access locations.

Natural Stability & Stream Morphology

Natural river stability will be enhanced by constructing the proper channel morphology and using native materials and vegetation to help to re-establish the physical and ecological river function. The accelerated streambank erosion contributing to the high sediment supply must also be reduced by increasing the flow resisting with the addition of native materials and by incorporating structures that decrease near-bank shear stress. A bankfull bench must be constructed along the low terrace bank locations that are prone to erosion to install toe wood and river structures. The general access trail is located on the bankfull bench adjacent to and parallel with the river. The selected structures for the design not only protect the streambanks from acceleration erosion, but also are designed to dissipate energy, increase sediment transport capacity, and enhance the aquatic habitat quality.

The sediment transport capacity of the river must be increased to eliminate the fine sediment deposition by reshaping the channel; reducing the current high width/depth ratio of 40 (or greater in places) to a width/depth ratio of 20 will increase the mean velocity, shear stress, and unit stream power. The lower width/depth ratio channel will also be necessary to maintain adequate low flow channel depths for aquatic habitat.

Additionally, shaping this over-wide channel into a four-stage fluvial system is critical to provide the physical and biological functioning required to meet the restoration project objectives (**Figure 2**). The following are the advantages of the four-stage channel system:

- Vegetation establishment on the banks of levels 2, 3 and 4 is improved due to favorable soil moisture
- Streambank erosion rates are decreased and rooting depth and density are increased
- Near-bank stress is reduced because the flows are spread out onto the next highest level during high flow events
- During drought, or winter ice conditions, the low flow channel provides sufficient depth and refugia to hold fish
- During high flows the low flow channel influences a higher sediment transport capacity due to the lower width/depth ratio
- Increases in flood peaks can be dispersed onto floodplain and flood-prone areas
- Recreational activities and trails can be better accommodated on bankfull benches (floodplain) and low terrace areas
- Provides a more natural, visually pleasing river setting
- Improves aquatic habitat and ecological diversity

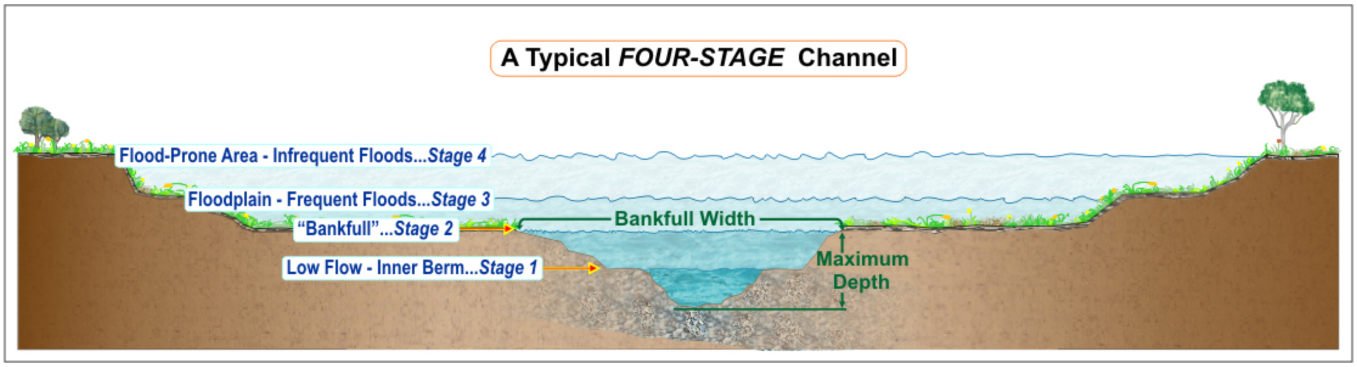

Figure 2. Diagram of the four-stage channel system including the low flow channel (Stage 1), bankfull channel (Stage 2), active floodplain (Stage 3), and flood-prone area or low terrace (Stage 4).

Habitat Improvement & Fishing Diversity

The lack of overhead and instream cover can be improved by decreasing the width/depth ratio of the river and incorporating structures comprised of native materials to meet specific habitat requirements. The channel reshaping will increase pool depths and will steepen point bar slopes to prevent the future filling of pools with fine sediment. Root wads, logs, and willow transplants (Toe Wood structure) will increase instream cover by creating undercut banks with cover. Incorporating willow transplants or cuttings will provide overhead cover and terrestrial insect habitat. The adverse slopes created below J-Hook and Cross-Vane structures will create hyporheic conditions and gravel sorting to improve potential spawning habitat. The proposed oxbows will also provide off-channel holding cover for high flow and low flow conditions and will increase the fish biomass to enhance fishing experiences. The recommended structures are designed to improve holding cover for fish and create fast/slow water seams and sufficient depths to hold fish during throughout all flows and seasons. The design also enhances the fishing diversity by defining riffle, run, pool, and glide bed features in addition to incorporating oxbow channels connected to the Blue River.

Boating, Fishing, & Wheelchair Access

The design incorporates a boating ramp for easy access and safety for all river flows. The ramp is also designed to reduce frequent maintenance. Fishing trails are also incorporated along the Blue River for easy river access and to provide multiple fishing opportunities. The trails are gentle sloping and will be surfaced with compacted gravel other than the handicap trail and fishing ramps that will be asphalt. The fishing ramp will require a curb next to the stream habitat fishing sites for safety. Rather than design a handicap platform, wheelchair access to the stream corridor with an asphalt trail and curb next to the fishing sites will provide a better opportunity for a good fishing experience for the physically-disabled. The trails paralleling the river on the bankfull bench will be compacted gravel surfacing.

Proposed Restoration Plan

The following sections describe the plan, cross-section, and profiles of the proposed restoration design.

Proposed Plan View Layout

The overall proposed plan view layout is shown in **Figure 3**, identifying the detailed plan sheet locations as shown in **Figures 4–6**. The design sheets depict structure locations, the narrowing of the Blue River, and the proposed parking and road/trail network. The proposed stream restoration length is approximately 4,043 ft.

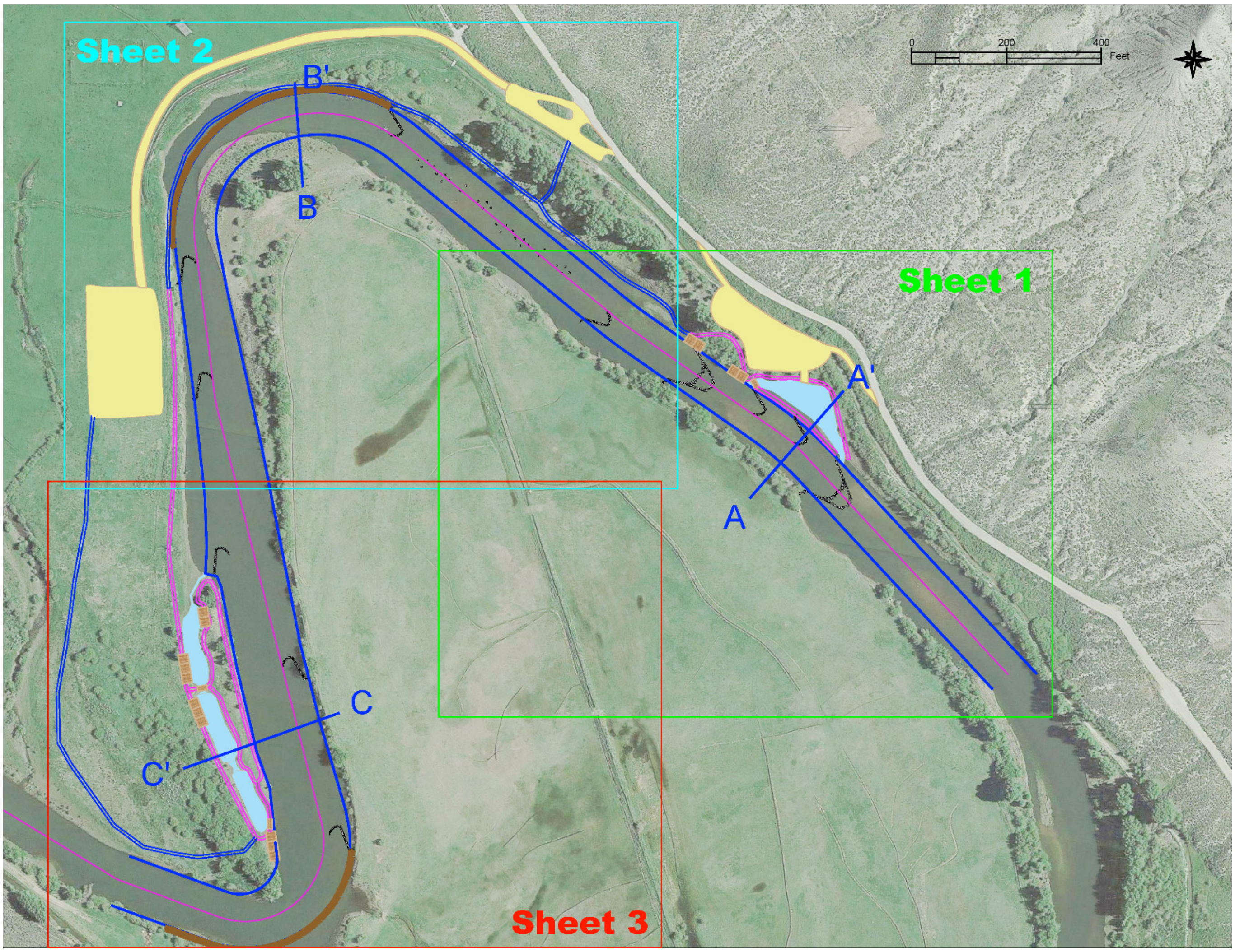

Figure 3. The overall Blue River plan view of the proposed design showing locations of Design Sheet 1 (**Figure 4**), Design Sheet 2 (**Figure 5**), Design Sheet 3 (**Figure 6**), and cross-sections A–A', B–B', and C–C'.

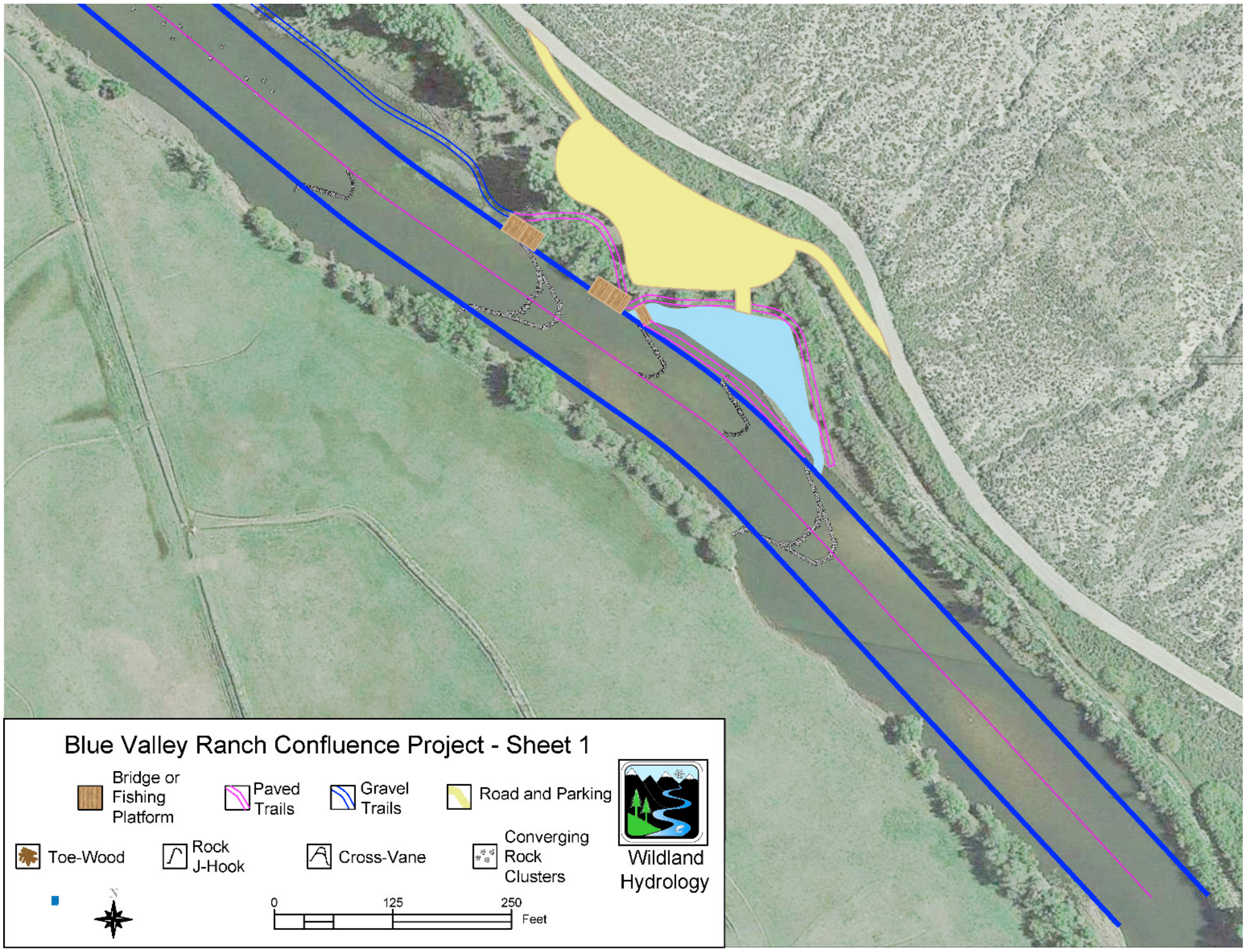

Figure 4. Design Sheet 1 showing the proposed structure locations, trail system, parking area, and boat ramp area.

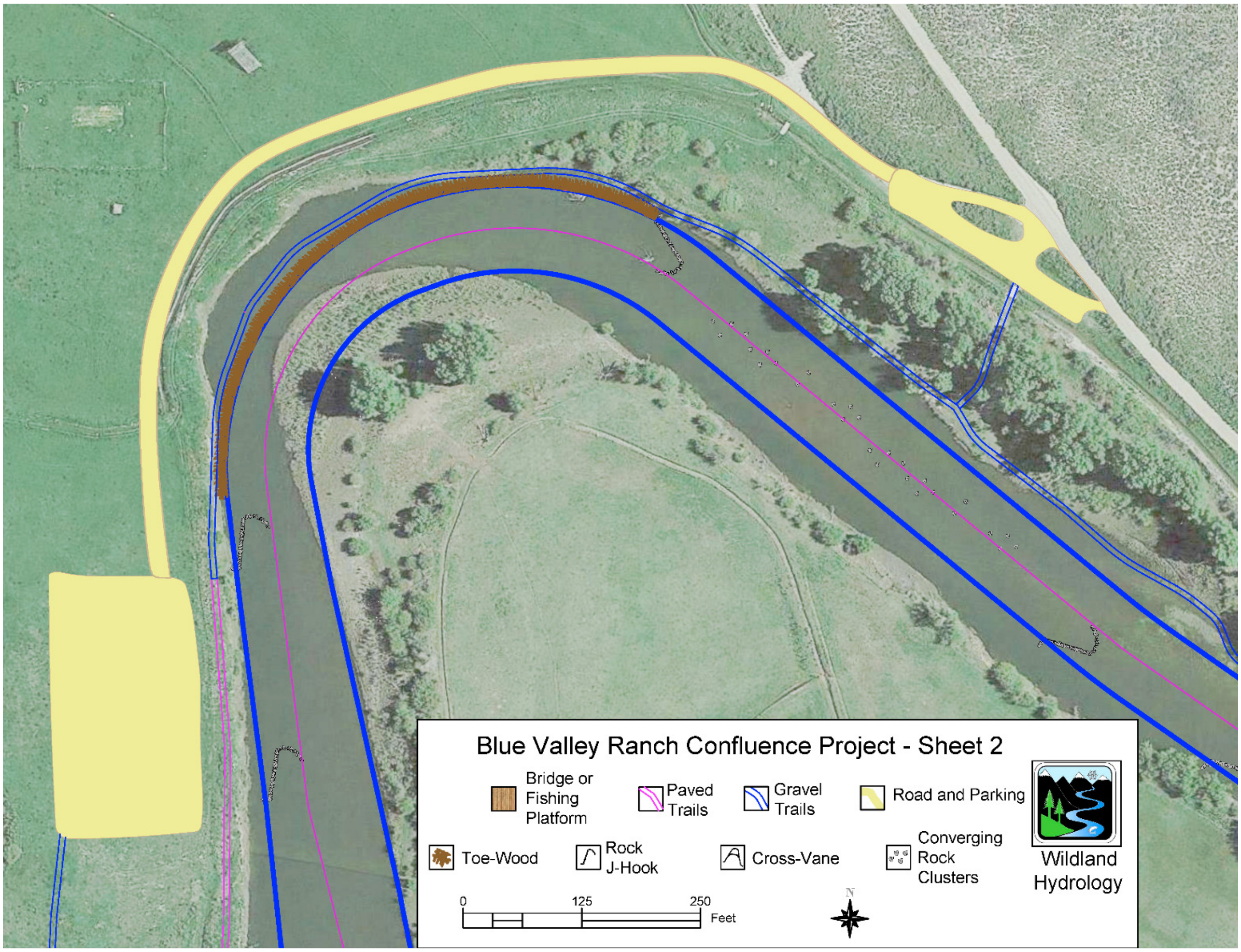

Figure 5. Design Sheet 2 showing the proposed structure locations, trail system, and parking area.

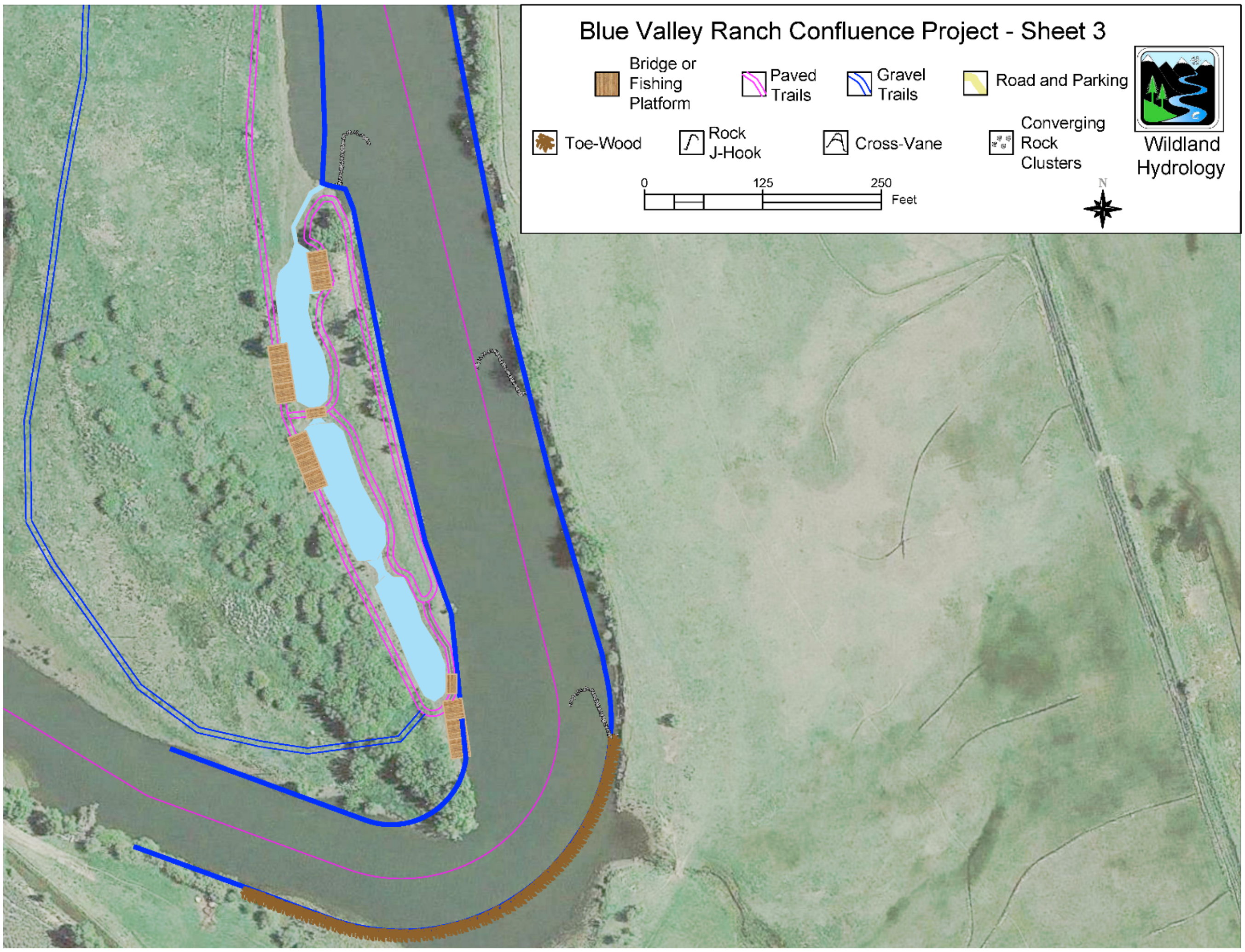

Figure 6. Design Sheet 3 showing the proposed structure locations, trail system, and oxbow channel system.

Proposed Cross-Section Views

Typical proposed cross-sections A–A', B–B', and C–C' are depicted in **Figure 7** as located on the overall plan view map (**Figure 3**). Cross-section A–A' depicts a typical riffle cross-section showing the multi-stage channel including the inner berm with a maximum bankfull depth of 8.0 ft and bankfull width of 90 ft. The excavated material from the cut will be used to fill the left side of the river to decrease the width/depth ratio. This cross-section also includes the island and boat ramp pond. Cross-section B–B' depicts a typical pool cross-section with toe wood and willow vegetation. The maximum bankfull depth of the pool is 12.0 ft with a point bar slope of 30%. The excavated material from the cut will be used to fill the left side of the river to decrease the width/depth ratio, similar to the typical riffle section A–A'. Cross-section C–C' depicts a riffle cross-section located across from a proposed oxbow channel that is 15.0 ft deep with a 2.0 ft deep and 5.0 ft wide safety shelf on the pond margin.

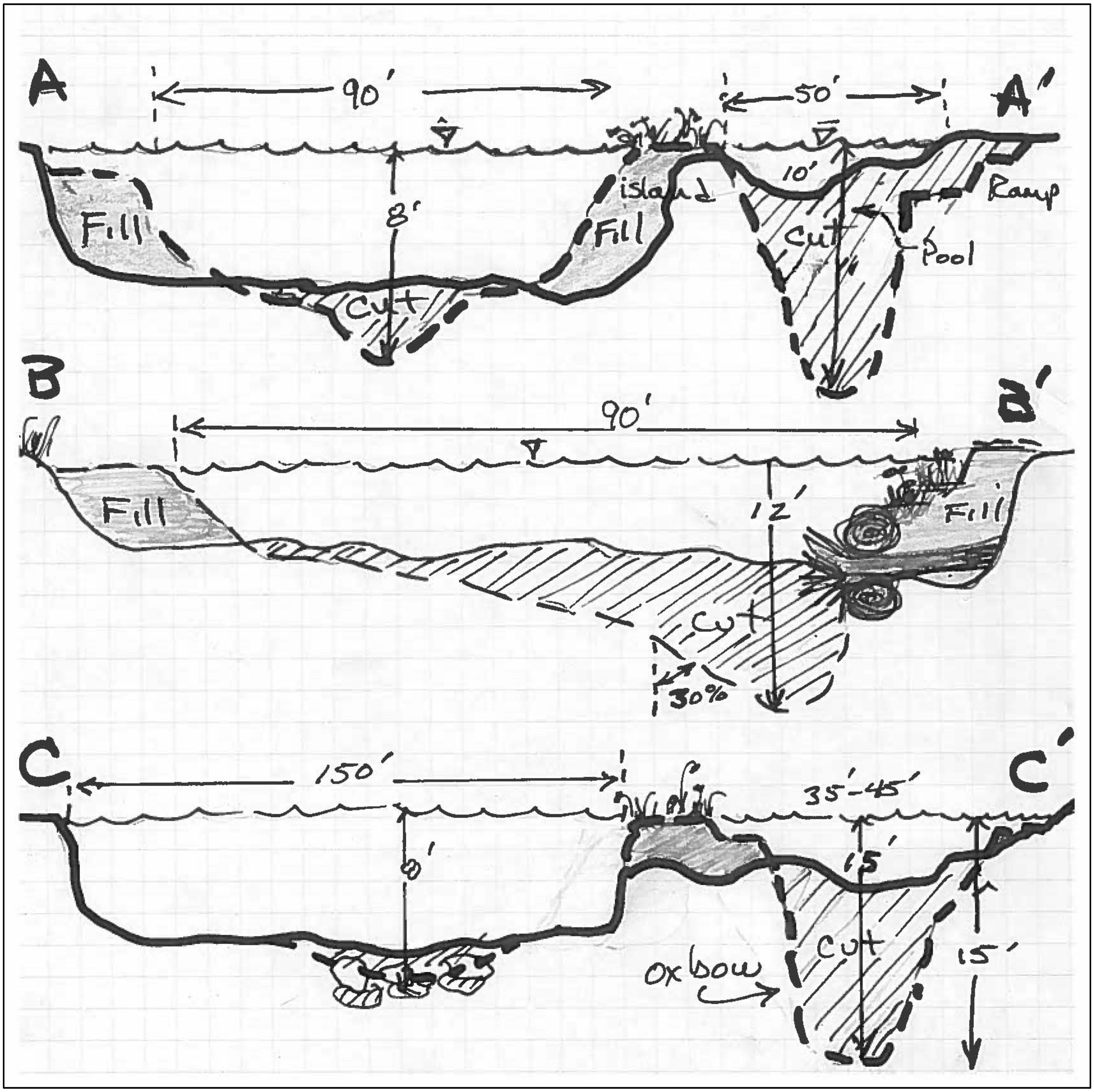

Figure 7. Typical proposed cross-section views at locations A–A', B–B' and C–C' (**Figure 3**), confluence reach, Blue River.

Proposed Longitudinal Profile

The proposed longitudinal profile is shown in **Figure 8**. The design will define the riffle, pool, glide, and run bed features.

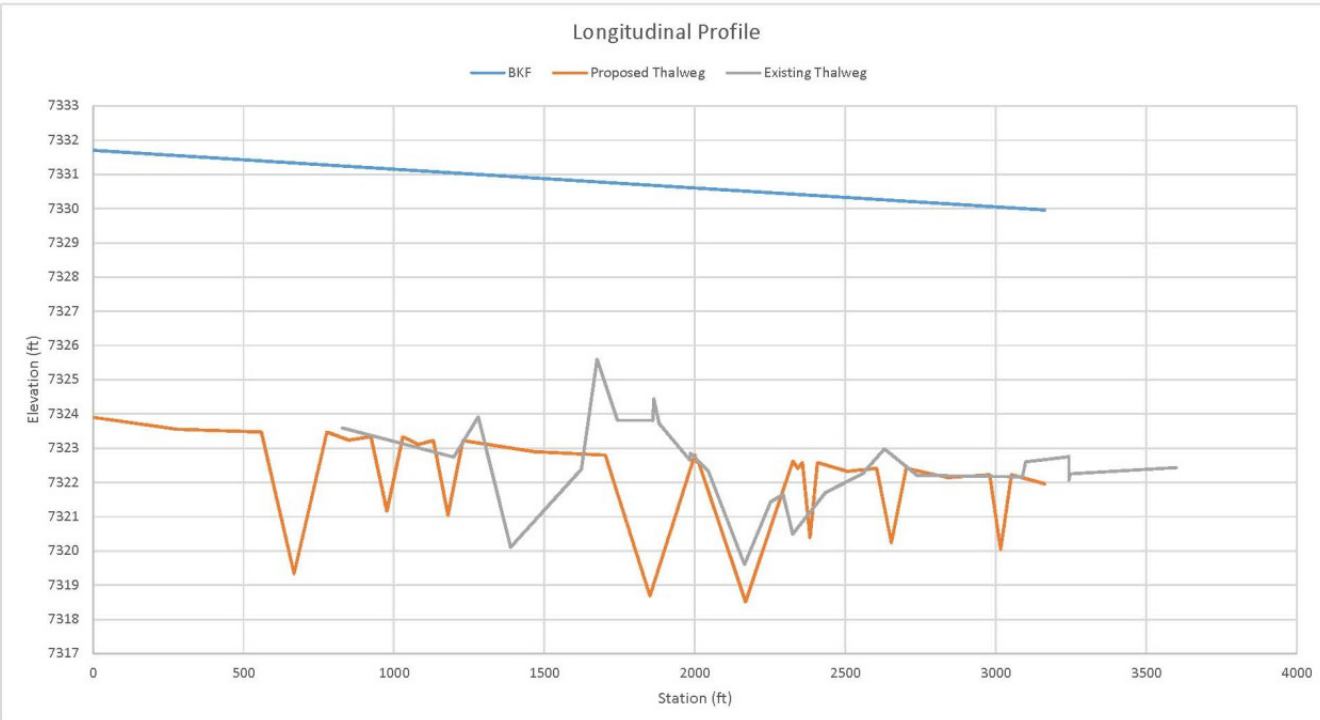

Figure 8. Proposed longitudinal profile showing existing and proposed elevations by bed features.

Boat Ramp

Figure 9 illustrates the details for the boat ramp location. The control flow at the inlet and grade control at the outlet will help reduce the velocity during high water but will have sufficient stage at mid stage levels for access to the loading ramp. The take out is designed for optimum use at flows between 500 to 1000 cfs. A foot bridge and a handicap access trail system is designed to access the island between the pond and river that will offer good fishing habitat. An option is to also provide handicap fishing access at this location, requiring a special safety curb to be placed on the bridge and trail. The trail as it enters from the parking area must meet low gradient standards for the handicap requirements.

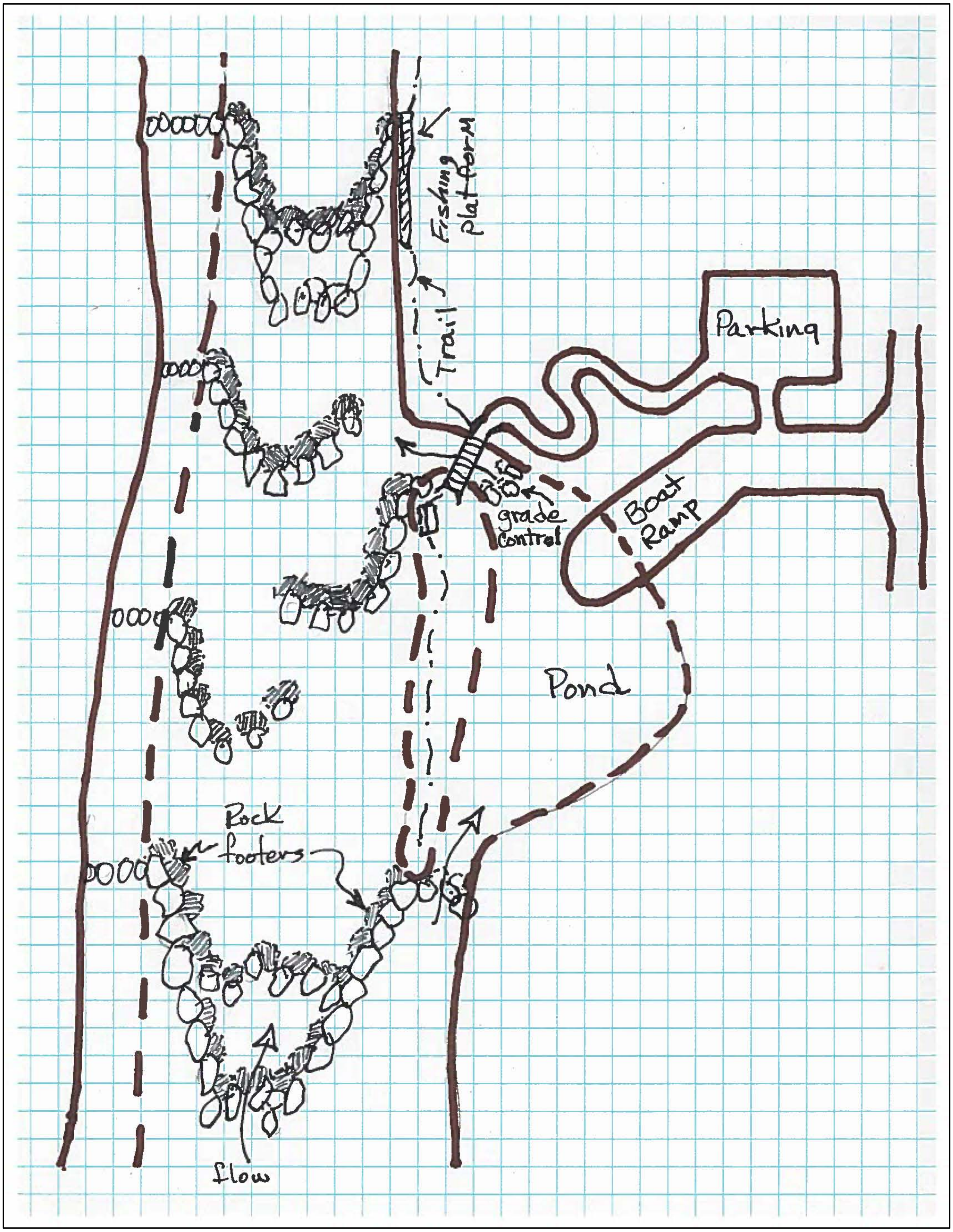

Figure 9. Design sketch of the boat ramp location and river structures.

Handicap Fishing Platform with Curb

Figure 10 depicts the proposed trail system, handicap fishing platform, and curb as placed on the lower oxbow channel. The trail can be surfaced with asphalt; the handicap ramp is comprised of treated wood with a slip-resistant spray coating. A foot bridge is incorporated on the downstream end of the oxbow to provide fisherman access to the river and the oxbow.

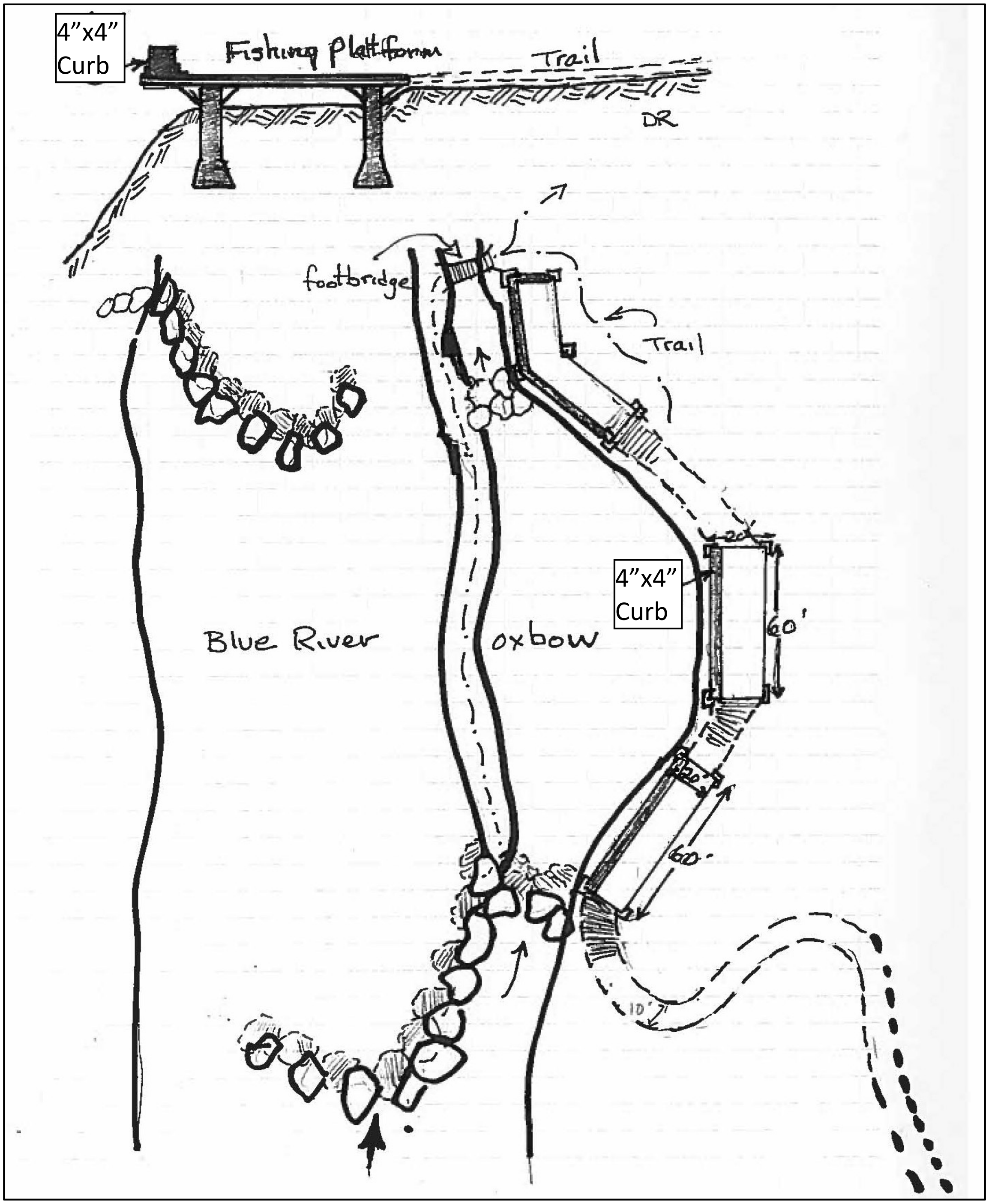

Figure 10. Design of the handicap fishing platform with safety curb and trail system along oxbow.

Restoration Structures

The Toe Wood, Rock J-Hook Vane, Cross-Vane, and Converging Rock Cluster structures are incorporated into the restoration design to meet multiple objectives as discussed in the following sections.

Toe Wood

The Toe Wood design is shown in **Figure 11**; note that the maximum depth of the pools for the Blue River design is 12.0 ft rather than the 8.0 ft shown in the design illustration. Toe Wood incorporates native woody material into a submerged, undercut bank to replicate natural stable streambanks, add flow resistance for streambank protection, and increase instream and overhead holding cover for fish during high flow and low flow stages. The toe material is comprised of root wads that are cantilevered over foundation logs to provide an undercut bank for instream and overhead cover for aquatic habitat. Woody materials are placed over and between the toe logs, consisting of filler logs, tops, limbs and brush. Approximately 10–20% of the log and debris lengths are exposed to flow forces; the remaining lengths are buried deep and counter-buttressed with fill and vegetation to avoid the buoyancy factor ensuring that the wood will remain intact throughout all flows, including floods. A face log is placed over the root wads in front of sod mats, willow transplants, and cuttings to prevent erosion. An additional layer of vegetation is placed over the face log layer, comprised of a coir-wrapped hay bale with cuttings, sod mats and willow transplants. Toe Wood also allows time for the riparian vegetation on the upper one-third of the structure to become established and provide shade, cover, and detritus to help the biological function. The structure also provides improved macroinvertebrate habitat and terrestrial insect availability for the salmonids.

Figure 12 depicts Toe Wood installed on the Blue River upstream of the proposed design location. **Figure 13** shows the use of coir-wrapped hay bales in the Toe Wood design to assist in the stabilization and revegetation on the Bitterroot River, Montana. **Figure 14** shows Toe Wood implemented on an actively eroding high terrace bank on the Bitterroot River in Montana to stop the accelerated streambank erosion and protect homes. A bankfull bench was constructed at this location and the structure experienced four years of major flooding with no lost logs while providing excellent fish habitat.

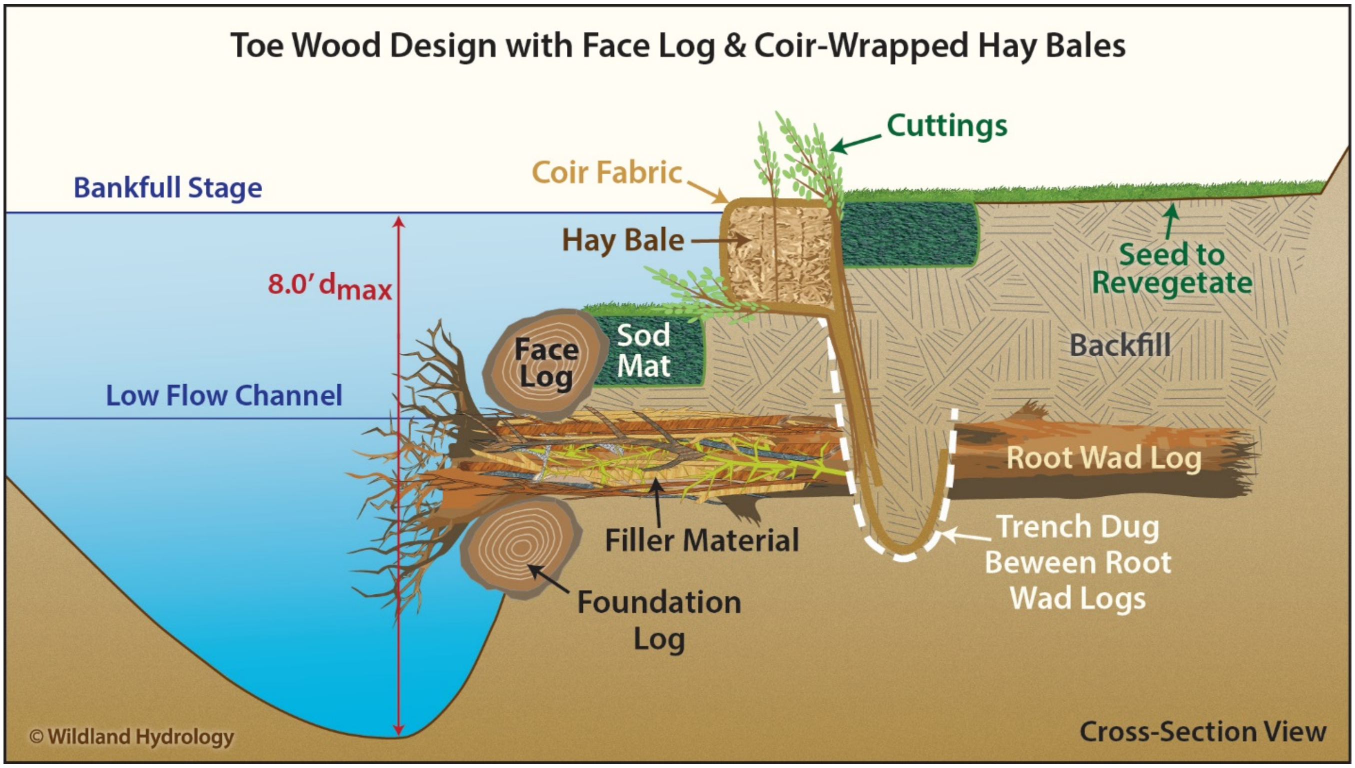

Figure 11. Cross-section view of the Toe Wood design. Note that the sod mats can be replaced with woody transplants, and the coir-wrapped hay bales can be replaced with soil lifts.

Figure 12. Toe wood below a J-Hook Vane on the main Blue River on the Blue Valley Ranch that was installed to provide a natural appearing structure, reduce streambank erosion, and provide holding cover for fish.

Figure 13. The use of hay bales and willow cuttings on the upper one-third of a Toe Wood bank on the Bitterroot River, Montana. The bankfull stage maximum pool depth is 18 ft at this location.

Figure 14. Toe Wood and a constructed bankfull bench against a high eroding terrace bank, Bitterroot River, Montana. The maximum pool depth is 20 ft along this meander bend. The submerged wood has stayed in place throughout four extreme flood events occurring since implementation.

J-Hook Vane

The J-Hook Vane design is shown in **Figure 15**. J-Hook vanes create seams that hold fish and serve as feeding lanes, provide holding cover by creating and maintaining deep pools, maintain bed features including glides that are important for spawning, and redistribute velocity vectors thereby reducing near-bank shear stress and streambank erosion. The riparian plantings on the adjacent banks also provide shade, overhead cover, and terrestrial insect habitat. The vane arm can be constructed of rocks or logs and protects nearly three times its length of streambank.

J-Hook Vanes have been successfully installed for nearly 20 years and represent a low risk for failure. Numerous J-Hook Vanes have been installed on the upper Blue River and have experienced major floods yet continue to maintain excellent habitat. Pre-restoration versus post-restoration photographs are shown in **Figure 16** and **Figure 17**. **Figure 16** depicts the unstable bank and poor riparian vegetation on the Blue River streambanks in 1990 prior to the implementation of a J-Hook Vane, whereas **Figure 17** documents the installation of a J-Hook Vane downstream of the location shown in **Figure 16**. A series of J-hook Vanes along with a bankfull bench were installed at a different location on the Blue River as shown in **Figures 18–20**. The J-Hook Vanes at this location continue to reduce streambank erosion, allow time for riparian vegetation to reestablish, and improve fish habitat.

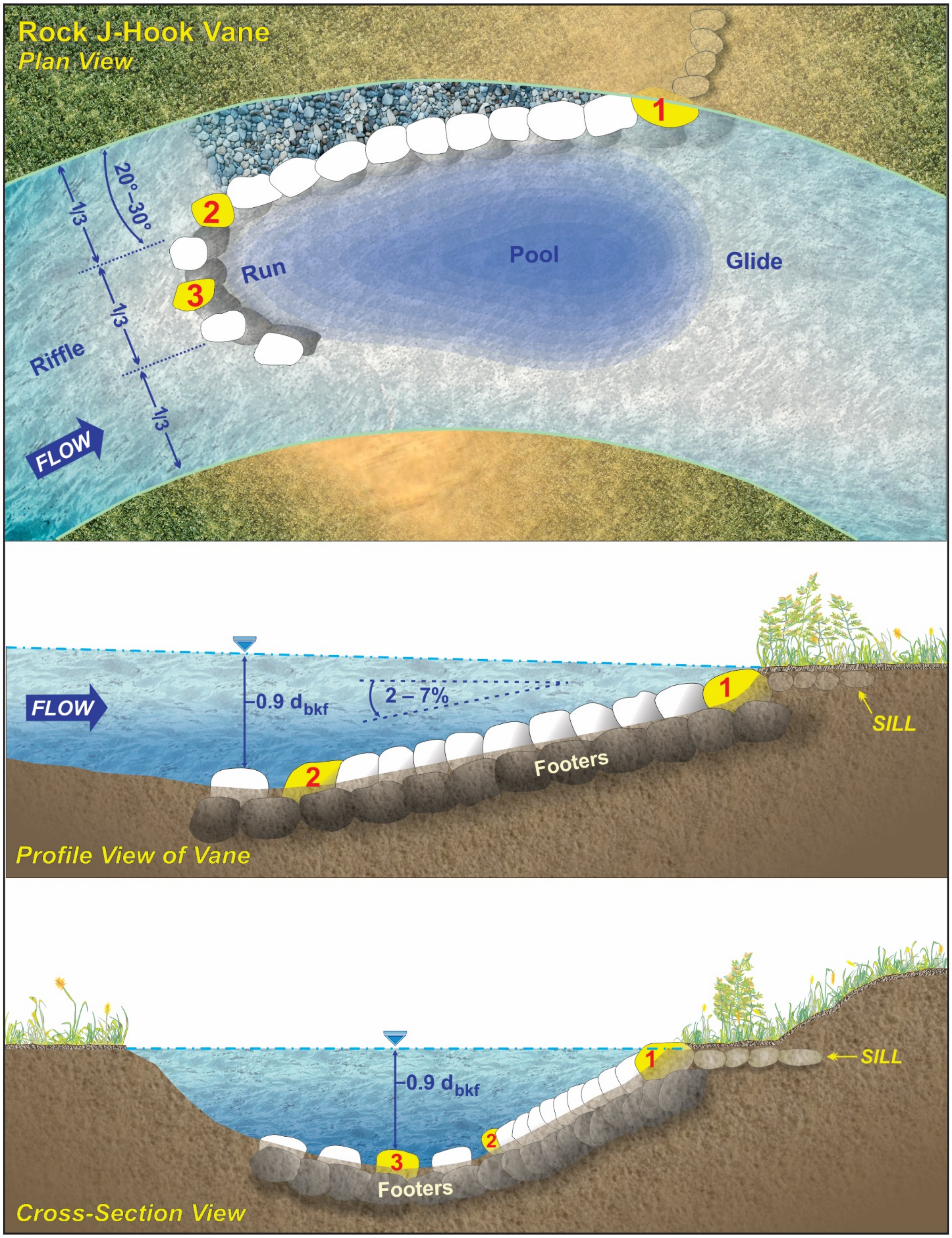

Figure 15. Design details of the rock J-Hook Vane structure.

Figure 16. Pre-restoration photograph of an eroding bank on the Blue River, 1990. Note the cottonwood gallery; view is looking downstream prior to installing a J-Hook Vane.

Figure 17. Post-restoration view of a J-Hook Vane installed on the Blue River near same location as **Figure 16** on the Blue Valley Ranch (note same cottonwood gallery). The right bank with abundant willows was previously an actively eroding bank without vegetation; photo taken looking upstream.

Figure 18. A J-Hook Vane and a bankfull bench shown immediately following construction on the Blue River. Willow or cottonwood transplants were not placed on the bench as the decision was made to let the river do it.

Figure 19. Same location as in **Figure 18** one year post-construction and following a flood that deposited fine sediment and cottonwood seedlings on the bankfull bench.

Figure 20. Same location as **Figure 18** five years post-construction, showing the establishment of a new cottonwood gallery and a functioning bankfull bench.

Cross-Vane Structure

The Cross-Vane design is shown in **Figure 21** and **Figure 22**. Cross-Vanes are used to control the grade, stabilize streambanks, route sediment, provide fish habit, and enhance recreational boating. Examples of Cross-Vanes are shown in **Figure 23** and **Figure 24**.

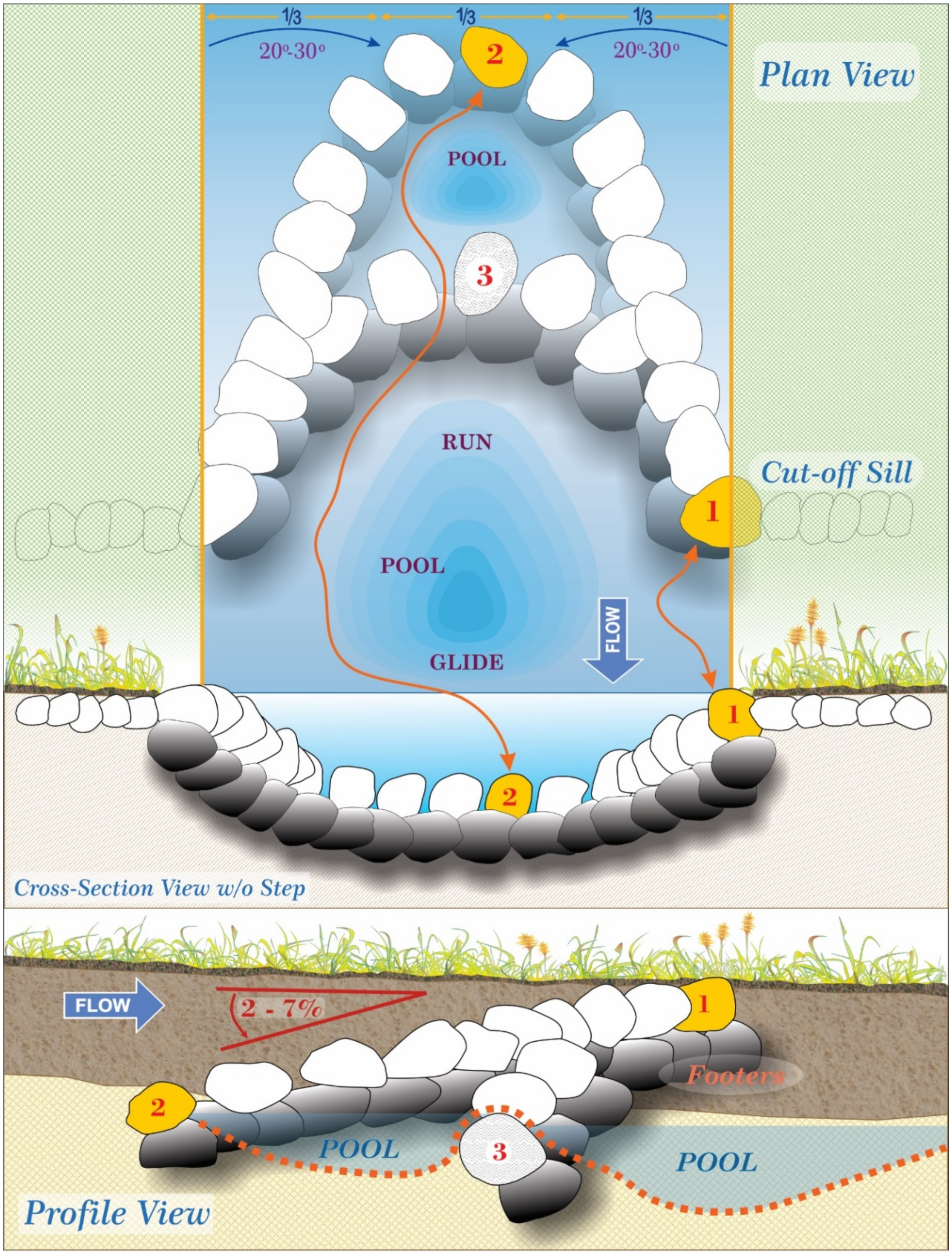

Figure 21. Plan, profile, and section views of the Cross-Vane design.

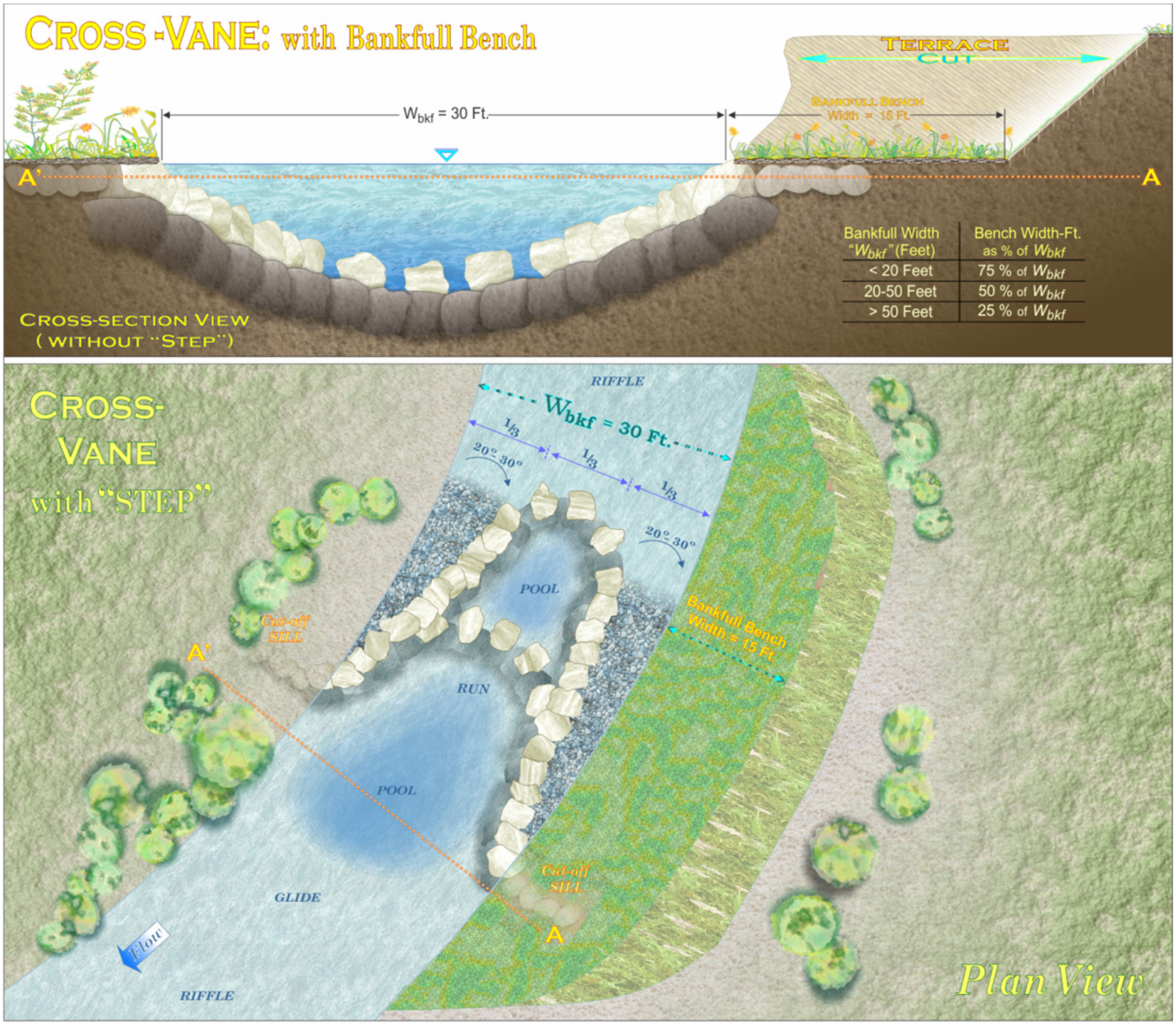

Figure 22. Plan and section views of the Cross-Vane structure with recommended widths for a bankfull bench.

Figure 23. A Cross-Vane structure used for a flow diversion on the Blue River shown during a high flow period. This structure is proposed for the boating ramp location because of the lower velocity and higher stage upstream of the vane arm.

Figure 24. A Cross-Vane structure constructed on the Blue River. Note the low gradient and low velocity stage of the river upstream of vane arm.

Converging Rock Clusters

The Converging Rock Clusters design is shown in **Figure 25**. This structure dissipates energy and provides grade control at the head of riffles to keep the facet slopes of the glide and pool flat and the riffle or rapid steep. Converging Rock Clusters also create pocket water pool habitat for cover in riffle and run reaches. The rocks must be submerged below half of the bankfull stage. **Figure 26** and **Figure 27** depict Converging Rock Clusters installed on Crystal Creek and the Laramie River.

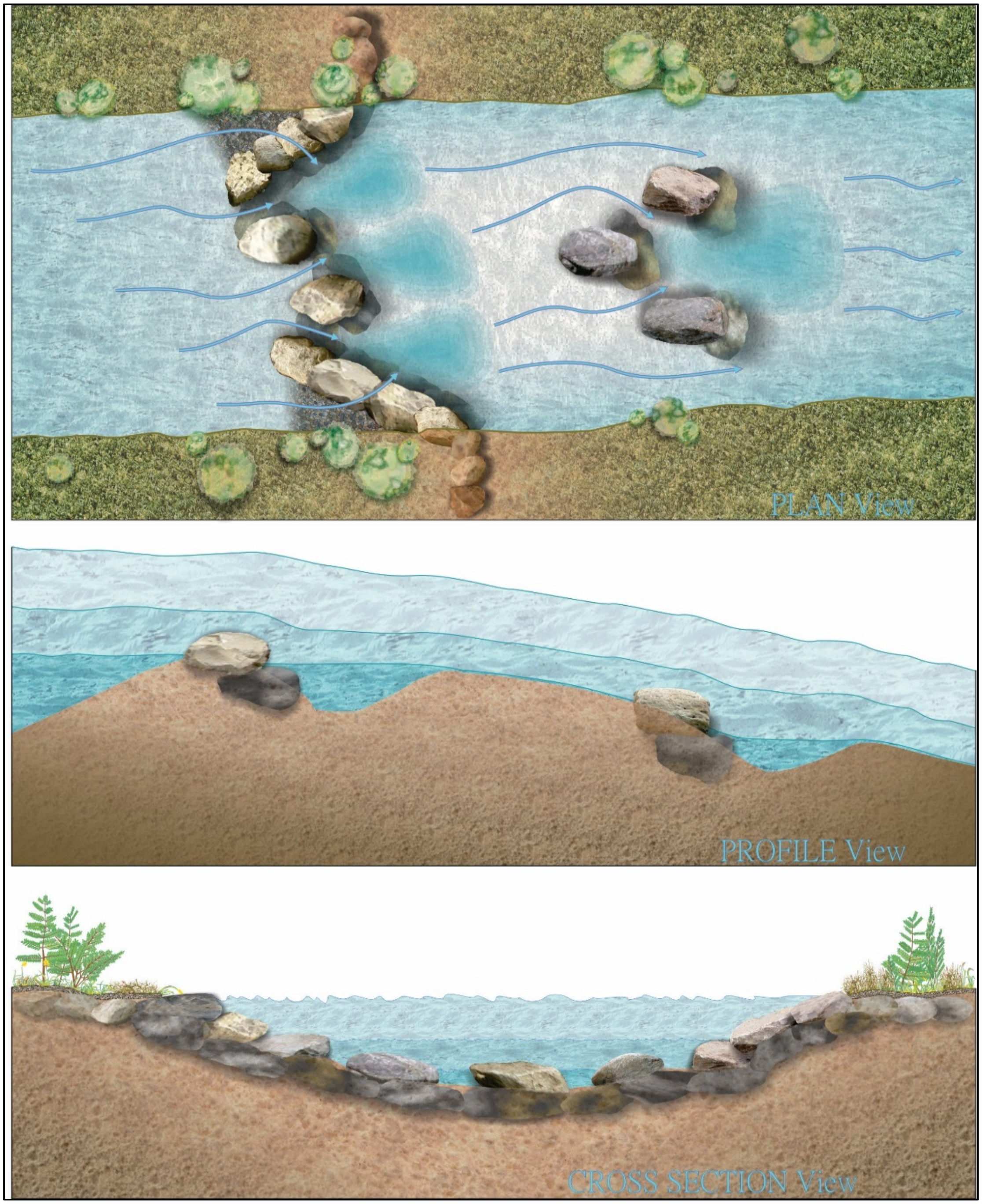

Figure 25. Plan, profile, and cross-section views of the Converging Rock Cluster design.

Figure 26. Converging Rock Clusters installed on Crystal Creek, Heartrock Ranch, Idaho.

Figure 27. Converging Rock Clusters installed on the Laramie River, Colorado.

Oxbow Channels

Deep, low gradient oxbow channels, as shown in **Figure 28**, are proposed to be constructed adjacent to the Blue River. Oxbow channels provide excellent fishing opportunities, especially for those with physical disabilities or with beginner- or intermediate-level fishing abilities. Oxbow channels also increase the usable area for trout and fish well during high flow periods due to the reduced velocities and lower gradients. The oxbows also provide great depths throughout the year, providing low flow, high flow, and winter refugia for trout.

A series of oxbow channels are proposed to be located near the end of the project as shown on the plan view design sheet 3 (**Figure 6**). Typical profile and cross-section views of the oxbows and step-pool structure are shown in **Figure 29**. The step-pool structure is installed at the downstream end of the oxbow to keep the slope flatter than the valley slope and to provide an adequate water stage at the upstream location of the oxbow (**Figure 30**).

Figure 28. Oxbow channel as constructed on the Blue Valley Ranch upstream of the proposed confluence project.

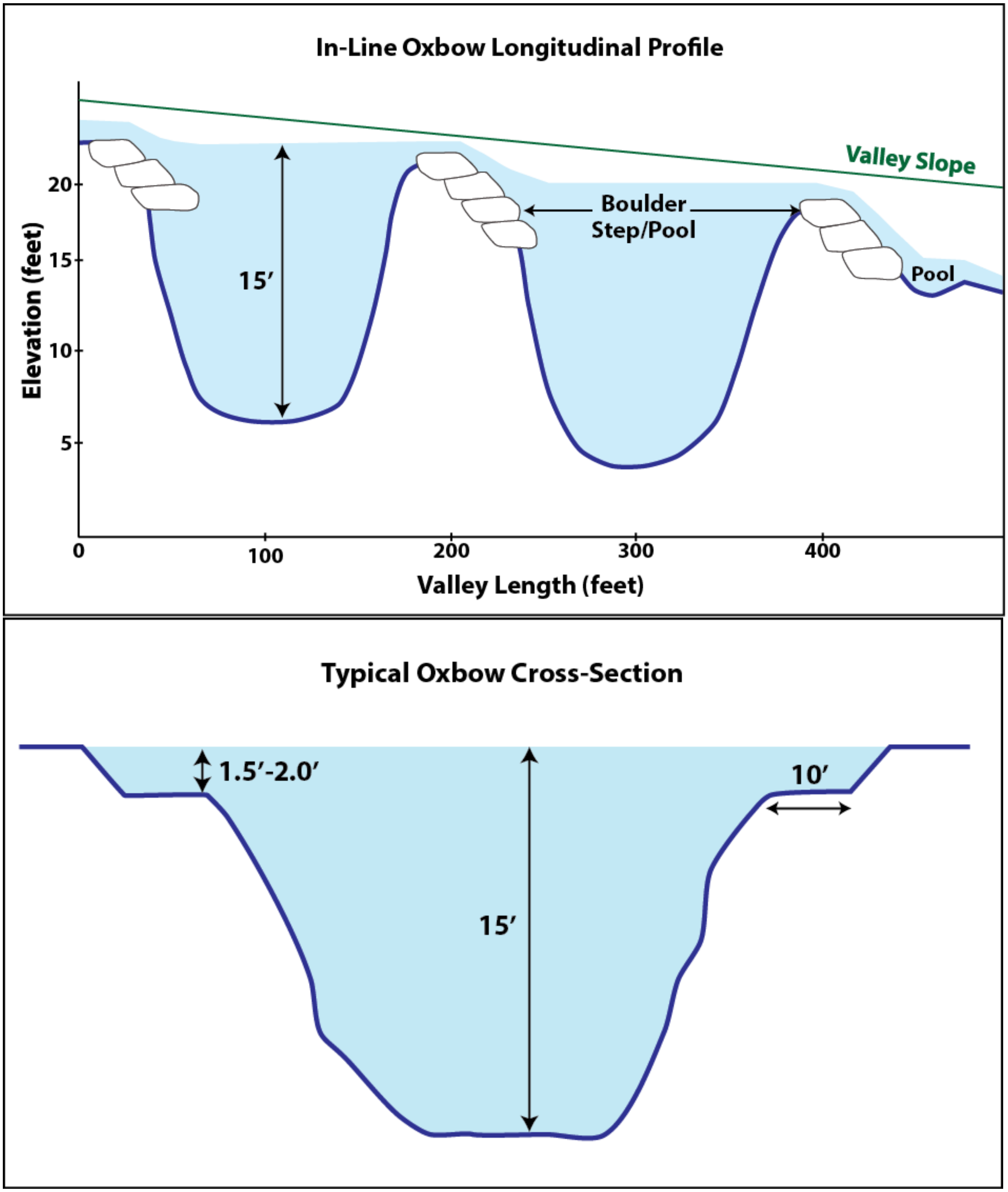

Figure 29. Schematic detail of the oxbows with step-pool structures showing the shallow safety shelf bench and the deep oxbow depths.

Figure 30. Oxbow with step-pool outlet, showing the flat slope of the oxbow channel above the step-pool outlet.

Summary of Restoration Objectives Addressed with the Proposed Design

The following summarizes the 12 specific objectives and how these objectives are addressed with the proposed design.

Objectives 1–4:

1. Improve the natural river stability using native materials and channel shaping following a geomorphic approach to river restoration
2. Design the channel to accommodate a wide range of flows while maintaining fish habitat features
3. Re-establish a woody riparian in deficit reaches
4. Increase the fine sediment transport to prevent deposition of fines on the substrate

To meet these objectives, the design:

a) Creates a four-stage channel system
b) Reshapes the channel to narrow the bankfull channel and decrease the width/depth ratio
c) Increases the bankfull shear stress and mean velocity
d) Incorporates near-bank stress reduction structures for bank stabilization and habitat
e) Increases flow resistance on streambanks by adding Toe Wood
f) Establishes a woody riparian vegetation corridor by transplanting

The four stage channel system includes:

Stage 1: A low flow, defined thalweg channel to decrease the current high width/depth ratio and create bed features rather than the flat-bottomed channel that presently exists

Stage 2: A bankfull channel with a corresponding narrower width, greater depth, and constructed bankfull bench against the high terrace bank

Stage 3: An active floodplain surface constructed at the incipient point of flooding to establish floodplain function and provide a fishing trail adjacent to the streambank and associated habitat

Stage 4: A flood-prone area comprising of the low terrace that presently borders the channel. This stage includes riparian vegetation comprised of cottonwood and willows to be transplanted from disturbed areas (boat ramp and parking areas) to streambanks with structures and a bankfull bench

Objectives 5–7:

5. Provide for spawning habitat with adjacent cover
6. Improve fish habitat quality by providing refugia for all flows and seasons
7. Increase the useable fishing area and diversity of habitats to improve fishing experience

These objectives are met with the application of instream structures, deepening of pools and the low flow channel, construction of side channel oxbows, and installing Toe Wood that will create a substantial increase in useable fish habitat and diversity. The instream cover provided with this design provides a great range of refugia habitat throughout all seasons and flow periods. The riparian woody vegetation established will also help provide shade, detritus, and terrestrial insects while adding to streambank stability. Spawning habitat will be increased by providing adverse slopes in the pool tail-out or glide reaches below Cross-Vanes and J-Hook Vane structures. Converging Rock Cluster will provide holding cover in riffles and in potential spawning habitat.

Objectives 8–9:

8. Provide wheelchair-accessible trails and ramps for recreational opportunities
9. Design fisherman and recreational access trails

These objectives are met by the construction of fishing trails planned along the stream on bankfull benches, new floodplain levels, and partially on the low terrace. The trails will also accommodate wheelchairs to access handicap fishing sites. Handicap access ramps and fishing platforms with safety curbs are located near the boat ramp as well as on the various oxbow channels constructed along the river corridor. The proposed trail will direct fisherman to habitat amenities while controlling foot and ATV traffic to prevent damage to the riparian habitat, yet allowing for easy, safe, and rapid access to a wide range of fishing sites.

Objectives 10–11:

10. Provide space for parking
11. Design a boat ramp facility that allows boaters to safely and conveniently remove boats regardless of river flow

To meet these objectives, a boat ramp area is planned with adjacent parking. The structure used in conjunction with the side channel ramp area and outflow channel is designed to maintain a useable depth for boat access regardless of flow stage in the river.

Objective 12:

12. Allow the river to be sustainable with low maintenance following major flood events

This objective is met by replicating similar structures and functions implemented on the Blue Valley Ranch and monitored with successful results over a twenty-year evaluation period.

References

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