Tucannon River Programmatic Habitat Annual Report

Project #: 2010-077-00

Annual Progress Report

(Reporting Period January 2018 to December 2018)

Contractor:

Snake River Salmon Recovery Board

Reporting Completed Under Contract: #78510

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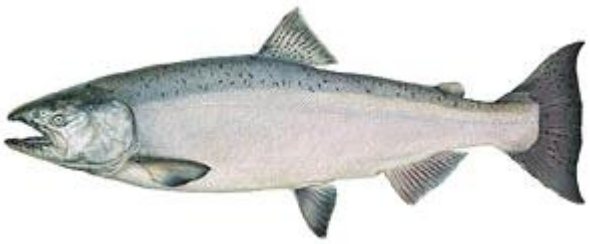

Acknowledgments:

A special thanks goes to the partners of the Tucannon Programmatic, it is through your hard work and continued support that measurable habitat improvement is achieved. Also, the landowners for having faith in a sciences based process and committing to restoring habitat and preserving valuable species for future generations.

Implementers:

Columbia Conservation District
Confederated Tribes of the Umatilla Indian Reservation
Nez Peirce Tribe
Snake River Salmon Recovery Board
US National Forest
Washington Department of Fish and Wildlife

Funders:

Bonneville Power Administration:
Salmon Recovery Funding Board:
Washington Conservation Commission:

Partners:

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Introduction:

The Tucannon River Program Habitat Project 2010-007-00 (herein referred to as the Program) is a restoration "Umbrella" project focusing on improving Snake River spring Chinook habitat in the Tucannon River, near Dayton, WA (Figure 1). The Snake River Salmon Recovery Board (SRSRB) manages the Program in conjunction with the partners: the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Columbia Conservation District (CCD), Nez Perce Tribe (NPT), U.S. National Forest (USNF) and the Washington Department of Fish and Wildlife (WDFW). The Program partners have been working as a group for 7 years in the implementation of the Conceptual Restoration Plan, Reaches 6 to 10 Tucannon River Phase II (Anchor November 2011). Collectively, the Program has funded restoration treatments on 12 of the 28 projects identified in the plan and coordinated treatments on 3 others.

The SRSRB serves as the Regional Organization and the Lead Entity for salmon recovery in the Washington State portion of the Snake River basin and the Washington State portion of the Walla Walla River basin, supporting the implementation of the Salmon Recovery Plan for SE Washington (SRSRB 2011) and guiding funding for the Salmon Recovery Funding Board (SRFB). The SRSRSB provides a broader perspective for salmon recovery than a typical one-watershed process, by participating in salmon recovery efforts and issues throughout the State of Washington working to develop and maintain partnerships in restoration but also in monitoring, and land management issues. The SRSRB also provides a sounding board for public input and involvement in salmon recovery both in projects and in approaches, building the baseline support need for large-scale restoration. The SRSRB is not a restoration implementer in its self but a supporter and regional coordinator of implementers.

The Program restoration goals were reviewed and refined in the Tucannon Geomorphic Assessment (Anchor QEA 2011, herein referred to as the Assessment) and are geared towards shifting the river back to a more natural and properly functioning condition (PFC). The Assessment identified the following primary habitat factors currently limiting spring Chinook; riparian condition (4.1), instream structural complexity (5.2), floodplain connectivity (6.1) and summer temperature (8.1) (SRSRB 2011). The Assessment identifies the importance of large woody debris and floodplain connectivity in the development and maintenance of healthy naturally functioning riparian habitats.

The Program restoration objectives (Table 1) closely align with those identified in the Sub-basin Plan and the Salmon Recovery Plan for SE WA and were directly applied to the implementation actions identified in the Conceptual Restoration Plan, reaches 6 to 10 Tucannon River Phase II, (Anchor November 2011, here in referred to as the Conceptual Restoration Plan). Based on the goals and objectives outlined in the Assessment, 28 discreet conceptual restoration projects (RM 20-50) are developed and prioritized in the Conceptual Restoration Plan, which the Program has been using like an 8 year work plan. The concepts focus on PFC as the restoration goal, the Program priorities focus on

increasing floodplain connectivity, reducing channel confinement and increasing in channel complexity at the intensity needed to reset natural process and have an impact at the watershed scale.

The restoration approach enacted by the Program and its partners has focused on restoring stream channel complexity and floodplain connectivity to the extent possible give landownership and public support. Where possible restoration actions target full reconnection of floodplain at flows >1.5 year flood. In 2017, the Program adapted some of the more widely used channel evolution models (Cluer 2013, Brierly 2005) for forested wondering gravel bed, to best fit the Tucannon River (Figure 2, Figure 3). The floodplain model illustrates the ecological process targeted for habitat restoration in the Tucannon and helps to communicate the benefits of connected floodplain to practitioners and the public. The model illustrates that as floodplain roughness is lost, the river channel devolves to a wider shallow channel traveling unabated over the floodplain as exhibited in our model stage B (Figure 2 & 3). In the Tucannon, this lead to land management activity, which have trained the river to be straighter and steeper, and in some place trapped the river behind levees illustrated in our stage C (Figure 2 & 3). Once this has occurred, channel evolution stalls leaving the channel in a relatively stable condition best described as arrested degradation (Clure, Thorne 2013), poor conditions can persist until the stream is forced from the stage. In 2018, one additional stage was added to our Tucannon model though it has not at the time of this report been illustrated which would include a transition from stage B (Figure 2&3) to an incised state which required no levees to maintain, but remains in an arrested degradation state as well through entrenchment and legacy armored river cobble. The Program approaches floodplain connectivity from three angles, the removal of river levees or gravel berms/fill that blocks overbank flow or disconnected channels from being inundated (Figure 4). In many project reaches simple removal of blockages is not, the single action required to reconnect floodplain in the Tucannon. These reaches also require the placement of LWD in some structural form, but for the purpose of reducing channel capacity and increasing streambed roughness raising flood stage (Figure 5). Wood structures placed in the Tucannon for the purpose of reconnecting incised channels, which exhibit plane bed condition and are stuck in arrested degradation (Figure 2-3 C). The third is to cut or reconnect side channels, an approach to spreading flows and proving winter refuge for juvenile Chinook (Figure 6).

Floodplain connectivity created in a previously incised reach of the Tucannon River in PA-10, during an estimated 120 cfs flow.

Purpose:

The purpose of the Program is to guide restoration funding in support of the implementation of the Sub-basin Plan, the Salmon Recovery Plan for SE WA, and the 2008 FCRPS Biological Opinion in support of improving spring Chinook habitat in the Tucannon River. In the development of the Assessment the factors habitat limiting, were identified and updated from the existing plans into the habitat restoration objectives that currently have the greatest biological benefits (Table 1). The Conceptual Restoration Plan went one-step further, identifying and prioritizing over-winter survival of juvenile Tucannon River Spring Chinook as a critical life stage limiting the recovery of this ESA threatened species. The Conceptual Restoration Plan also identified degrade channel complexity and floodplain connectivity as the two highest priority factors suppressing ecological function, and developed restoration action/objectives targeting those factors. Within the Conceptual Restoration Plan 28 discrete restoration projects located within the highest priority spring Chinook spawning and rearing range (RM20 to RM50), were prioritized by the Regional Technical Team (RTT) for implementation between 2012 & 2018. Each conceptual project identifies restoration actions, potential improvements towards restoration objectives, a description of geomorphic and biologic benefits from meeting the objectives. The Program has prioritized the 28 conceptual restoration projects outlined in Conceptual Restoration Plan, Reaches 6 to 10 Tucannon River Phase II (Anchor November 2011) and has been working with the project implementers since 2011 toward completion.

In 2018, the Program initiated an update to the Tucannon Assessment and Conceptual Restoration Plan through a CCD lead. The intention of the update is to revisit both project areas that have receive restoration treatments and ones that have not, make determinations if projects are meeting original goals. We are also assessing habitat function to determine departure from functioning. We are also updating the salmonid habitat distribution and migratory timing model used in the original prioritization to better capture the in basin life cycle as we now understand it. The outcomes of the final document (scheduled for completion in 2019) will provide a new prioritized list of projects, and a list of management actions for project where previous actions could be improved, maintained or advanced to a higher benefit for salmonids. An example of an action where a higher benefit is identified and acted on, is described for PA3 in a later section of this report (Page 15).

The Program has been in place through the development of the restoration plans and is the center for coordination and prioritizing restoration within the basin and has operated under a contract at <10% of the overall annual Program budget (BPA #78510) between 2011 and 2018. The Program works to set an annual work plan in coordination with the implementation partners, and then allocates budgets and assists in the pursuit of matching funds. The Program provides technical support to the implementation partners and coordinates outside technical design review. The Program invested its self in the update of the conceptual Restoration Plan in 2018 by providing technical and administrative support during the process.

The Program also provides a forum for the implementers to coordinate their restoration project amongst regional BPA funded projects including the CCD Columbia County Tucannon Stream & Riparian Restoration Project (1994-018-06), the CTUIR Tucannon Watershed: Protect and Restore Habitat (2008-202-00), and the WDFW Floodplain Management Plan.

Area of Primary Focus:

The Tucannon River is a Snake River tributary originating in the Blue Mountains of southeast Washington (Figure 1) and is located in Columbia and Garfield Counties. The main channel is approximately 58 miles long and drains about 503 square miles before entering the Snake River approximately 3 miles upstream of Lower Monumental Dam. Several major tributaries drain into the main stem including, Pataha Creek, Tumalum Creek, Cummins Creek, Little Tucannon, and Panjab Creek. A full description of the basin is provided in the Assessment.

In 2018, the Program began to move to a multiple species restoration approach investigating Snake River steelhead, Columbia River bull trout, lamprey and a number of non-game native species of the Tucannon basin. The details on how this will guide restoration actions is not yet agreed to by the stakeholders, but is believed to reinforce our process based restoration approach currently in place.

In 2011, the weight of evidence reviewed in the Geomorphic Assessment (Anchor 20111 April) and the Conceptual Restoration Plan (Anchor 2011 Nov) identified river mile 20 to 50 to have the greatest impact on salmonids, based on spawning distribution density. Beginning in 2013, WDFW developed a model for the Tucannon life cycle of spring Chinook and steelhead parr and smolts, within the Tucannon Basin. Salmonid parr were tagged in 2014, 2015, and 2017 with passive integrated transponder tags within their summer rearing areas, for the purpose of monitoring survival through four PITT arrays distributed downstream in the Tucannon basin. The results of this study have indicated that yearling and age zero Chinook Parr emigrate in large proportions from the upper watershed as water temperatures decline into late fall and winter. This is likely a response to reduced winter carrying capacity in the upper basin, however it has been determined that these fish are exhibiting lower than expected survival (<20% over winter) in the lower river before leaving in the spring and entering the Snake River. In 2018, the update to the Conceptual Restoration Plan and is investigating the limiting habitat factors identified for the middle and lower river and incorporate actions (projects) that can increase over winter survival within these reaches.

As part of the Conceptual Restoration Plan Reach 3-5 (Anchor 2012), nineteen additional conceptual projects are identified with actions to benefit Chinook and steelhead. These project areas were not part of the initial project prioritization and implementation, due the understanding at the time identified the reaches as passage only where we now know reach 4 and 5 are also winter rearing. The Program is working with the CCD in updating the Conceptual Restoration Plan, integrating and prioritize project

reaches 2-5 river mile 2 to 20. Prioritizing the conceptual projects in these reaches considering higher fish benefit to winter survival will increase the priority of implementing additional projects in these reaches. During the process, the Tucannon Coordination Committee (TCC) will reconvene to work with the program and partners to solicit entities who will conduct implementation in the following 3-5 year work plan.

Focal Species:

The Tucannon supports four populations of threatened species including the Snake River ESU spring Chinook, Snake River fall Chinook, Snake River ESU summer steelhead, and the Columbia River bull trout. All reaches of the Tucannon River are utilized during one or more life stage annually except fall Chinook, which only use the lower 18 miles of the river. The lower Snake River spring Chinook is currently only found in the Tucannon River, having been extirpated from Asotin Creek (Figure 1).

The Tucannon River spring Chinook is a sub-population of the Snake River spring Chinook ESU, which is listed as threatened under the Endangered Species Act since 1996, and is the primary focus of the Program restoration project. The Tucannon River is the lowest downstream tributary spring Chinook population in the Snake River.

The population was in decline throughout the 1980s, but reached a critical low in the mid-1990s when the number of wild adults dipped to as few as three naturally produced individuals. More recently, adult returns to the Tucannon have been steadily increasing as overall habitat conditions improve (Gallinat 2015). The current know distribution for spawning and rearing spring Chinook in the Tucannon is from RM 20 upstream to RM 58 based on available information (Figure 1). As river habitat conditions (primarily summer water temperatures) improve this boundary has expanded downstream. At the drafting of the Snake River Salmon Recovery Plan in 2005, spring Chinook and steelhead were not observed spawning or rearing downstream of RM 30. In more recent years improving stream temperature has supported spawning and rearing downstream to at least RM 20 and potentially further downstream to Pataha Creek (SRSRB 2011) in wetter seasons.

In 2017, two colonies of bivalves (Margaritifera spp) discovered in PA-28 and one in PA-18. The CTUIR bivalve research project visited and enumerated the colonies in PA28 during the 2018 field season identifying the site as having potential as a source population for future relocations to new suitable sites. As rare native spp observations are made the Program makes record of native species maps them into our data base, notification of interested parties to help to develop more information of their distributions as habitat improves. As we improve natural function in the Tucannon, habitats that are more diverse will support greater distribution and number of native vertebrate and invertebrate species.

To data, the Program has focused on restoration priorities targeting spring Chinook and primarily actions improving winter rearing and survival. It is widely believed that restoration actions taken to improve spring Chinook habitat (floodplain and channel connectivity and channel complexity), will also improve conditions for other native species such as steelhead, bull trout, native rainbow trout, white fish, mountain sucker, pacific lamprey, mussels and invertebrates. In our efforts to restore natural process, we anticipate positive changes in species diversity as well as abundance. In 2018, as part of the Conceptual Restoration Plan update the Program has been more inclusive in consideration of all native species in the development of restoration actions.

2018 Administrative Budget & Projects:

The Program formed in January 2011 (FY11) with the initial FTE support at 0.15 for the SRSRB Director, 0.15 FTE for a Coordinator and 0.12 FTE for a student intern to provide office and technical support. A goal of the early Program was to maintain a high ratio of implementation to administration while allowing staff to become familiar with the inner workings of BPA contracting and reporting. A detailed account of administrative history and past expenditures were outlined in the 2016 Program Summary Report (Buelow 2017).

In 2018, the Program operated with ~10% of the overall BPA budget going toward administration, personnel, and travel and outreach, 2% supporting subcontracts for effectiveness monitoring and 87% going to the project sponsors conducting project implementation (Figure 7). With the 10% or $147,000 the Program supports 1.25 FTE to administer and coordinated the Program, provide partner technical support, perform program outreach and conduct program reporting both within the program and outside the program as requested by BPA, the NW Power Council and the ISRP.

One of the primary goals of the Program is to support the project partners/implementers in the pursuit of matching funds for construction and in 2018, the Program construction budget was match at 7% (Figure 7), primarily comprised of WDFW project support and CCD SRFB grant. The Program partners have been very effective in generating funds to extent the restoration budget, generating >$3.1 million dollars in cash and materials since 2012 equaling nearly 30% of the total dollars spent in the basin of the time of the Program.

Tucannon River Programmatic Parent Contract #78510

The following sections of this report will provide a detailed description of activities conducted in support of the Program, under the work elements outlined in the scope of work (contract number 78510). When applicable, methods, results and progress on deliverables are described for January 1, 2018 through December 31, 2018.

Work Element 119, 185, 132: Manage and Administer Project, Produce Status Reports & Annual Report:

Deliverables: 2018 SOW development, property inventory, submitted in Pisces. Coordinate the Tucannon River Programmatic and identify project matching funds. Complete periodic status reports and annual report.

During the time period January 1, 2018 through December 31, 2018 the SRSRB managed the implementation of the Program through the "Parent" contract: (78510) and was the point of contact from SRSRB office at 410 B East Main Street, Dayton, Washington 99328. The SRSRB coordinated monthly RTT meetings on the 3rd Wednesday of each month for the purpose of prioritizing restoration actions, set restoration goals and objectives and reviewing restoration designs. In 2018, the Tucannon Implementers Committee (TIC), a group of project sponsors, resource experts and land managers locally involved in Tucannon River habitat restoration continued to meet on quarterly basis. The TIC is a subcommittee of the RTT with the purpose of identifying restoration activities, which best meet the restoration objectives (Table 1), and coordinating those activities over the duration of the Program. The TIC works to streamline restoration, review design, sharing information, coordinating with monitoring efforts determine the pursuit of matching grants and discussing project progression. The participants of the TIC included representation from the, USFS, CTUIR, NPT, WDFW, CCD, PCD, TSS and SRSRB.

In 2018, the Program coordinated with the implementers to conduct pre/post rapid surveys of the project areas for the purpose of measuring the project as-built condition at a reach scale following restoration. The data collected on the projects includes pre-existing wood, side channel and pools, post construction wood, and side channels as well as an extensive photo record. Metrics collected are directly comparable to those collected in past CHaMP metrics so the as-built data is applicable and comparable to past monitoring activities across the basins and used by the Program in effectiveness monitoring. The Program coordinates with the implementers to conduct status, annual and completion reporting and relies on the data collected in the rapid habitat surveys to provide date for these efforts. During the 2018 field season, surveys were completed on PA3, PA28, and PA32 as part of project implementation as-built survey development. Due to the lack of significant flow in 2017-18 water year no additional surveys were conducted, and will be delayed until significant flow occurs or are otherwise required.

The Program staff had worked closely with those conducting monitoring in the basin, but in 2018 the CHaMP had been discontinued and with the limited coverage of AEM within the basin we anticipate working with BPA in the development of future monitoring actions. In 2018, we worked with monitoring groups to identify and produce products, which would best reflect outcomes of restoration in the Tucannon and plan to continue this in 2019. In working with WDFW, we help scope and implement two studies including a Life Cycle Model and chinook and steelhead movement study. The information from these two studies is providing insight into winter migrations and survival of spring Chinook, and informing future restoration priorities.

Community Involvement and Education'

Work Element 99: Outreach and Education

Deliverable: Conduct one project tour, present program accomplishments to regional agency personnel and LE Board. Develop outreach materials.

The SRSRB and the Program conducted outreach activities in 2018 by attending public habitat restoration meetings, coordinating and hosting public tours, and posting it's completed and planned projects on the Washington State Habitat Work Schedule (http://hws.ekosystem.us/). Additionally, SRSRB staff attends local public meetings where they lead discussions on the restoration and protection of salmon habitat in the Tucannon. The SRSRB operates highly visible office in downtown Dayton that is highly accessible to the public, providing opportunity for individuals to meet with the SRSRB Director and staff.

The Program participates in a number of public forms and boards during the scoping and design of projects in the Tucannon including SRSRB, the Tucannon River Citizens Work Group and the Lead Entity SRFB review. It is through these processes restoration projects proposed under the Program are "vetted" by the landowners and stakeholders of the watershed. All projects funded through the Program in 2018, were supported by the SRSRB Lead Entity beginning in the design –process through implementation. Using this approach ensures a wide cross-section of support from landowners, agencies, tribes, Columbia County residents, and County officials providing at least a peripheral knowledge of the projects.

Program collected extensive photo and video records of implementation throughout the entire implementation season, in 2018. A number of outreach materials prepared by the SRSRB for CTUIR, WDFW and the CCD are the product of these photo records. We anticipate continuing this effort in 2019. The Program worked with CTUIR to acquire a complete aerial data set of the entire Tucannon Basin floodplain in 2018 for the dual purpose of outreach and monitoring. In addition, the Program supported CTUIR staff in the collection of pre-post aerial video and photos of the channel and floodplain of a number of 5 project areas, which will be used to show landowners and the public the changes being brought about by the restoration in the Tucannon.

The Program participated in and conducted a number of field tours during 2018, including a landowner tour in November, which was attended by 16 individuals not including supporting faculty. The SRSRB (Debbie Seney) continued the youth education program working with 4th graders in the three counties, with the priority of teaching restoration of natural systems and salmon natural history. In total, > than 500 students participated in the fall of 2018 program. This program discontinue in 2018 do to changes

in funding and available personnel, efforts will be made to provide some type of outreach to students in the future through one of the Program partners.

The Program supported CTUIR in an effort to develop a Tucannon basin website (Tucannon.com) where we will provide a public portal for outreach materials and provide access to project data and information on a broader platform. This is being completed through a partnership with the CTUIR technology group currently developing and maintain the CTUIR domain. This work is planned to be completed sometime early in 2019.

Conduct Environmental Compliance

Work Element 165: Produce Environmental Compliance Documentation

In 2018, the Program worked to initiate and assist project sponsors in the development of project permits for PA3, PA 28 and PA32. Permitting support included assisting in the development and finalization of the JARPA, SEPA, Forest Practices, 401&404, HIPP III and Cultural Resource documents. The Program also provides assistance in the development of project completion documentation for project implementers as per HIPP III requirements.

Program Progress Tracking

Project stories are develop by the Program in coordination with the implementers and the partners for the purpose of better describing site conditions and history of each project area. The stories summaries describe previous work completed at project areas, development of the project concepts and designs, project goals and objectives and a desired time line for meeting those goals. The project stories for the two projects implemented in 2018 are provided in the appendix section of this report (Appendices 1-2). The Program also collects project implementation metric for the purpose of tracking contract deliverables and change in site conditions over time. Results for implementation on all 14 projects, which have had restoration action implemented, are summarized and used in this report (Table 2). The Program collects pre/post project reach data (for the entire project length) in the form of an adapted rapid habitat survey (using CHaMP compatible metrics) focusing on setting photo points, delineating existing channels, pools and enumerating LWD key pieces (>6m long and 0.3m dia). The purpose of this effort is to help in developing clear and concise restoration goals and objectives, support restoration designs, document as-built conditions, support future effectiveness monitoring and to aid in the development of the data and maps in reporting.

2018 Implementation Actions & Budget:

The section reports on habitat restoration projects, and associated restoration support funded, partially or entirely, through the Program for the calendar year of 2018. The primary funding sources included in this report include the BPA and Washington State Salmon Recovery Funding Board (SRFB). Most projects also include at least some level of additional cost share, both in-kind and cash, not entirely included in this report. In 2018, the Program implemented two instream projects, supported a third, advance one design to near final (2019 implementation) and advanced one design to 60% for implementation 2019-2021. The Program also, approved one project previously identified in the Tucannon Conceptual Restoration Plan (Anchor 2011 Nov) as a priority for design in 2019 and implementation in 2020-21, as well as a newly emerging fish passage project not previously identified in the 2011 to be developed by the NPT.

The Program worked with CTUIR to acquire a bathymetric LiDAR data set for the entire watershed, with the purpose of providing updated data to the Conceptual Plan update, but also the dual purpose of habitat change detection (since 2010). These data sets are also very valuable in the development of project designs and outreach materials and are displayed within the report for projects implemented in 2018 Additionally in 2018, the Program coordinated with CTUIR in the collection of pre/post project aerial video and images for current, future planned and past projects throughout the valley. These videos and images will be made available at the new Tucannon website (Tucannon.com) in 2019.

The Program has coordinated with the CCD to initiate an update to the Tucannon Conceptual Restoration Plan (Anchor 2011 Nov) for the purpose of, incorporating new information on Chinook life history, distribution, and survival. Implementation monitoring results also, will be used to update the plan, evaluate completed and future implementation, and develop a prioritized list of projects and adaptive management actions to be locally approved by the RTT. The update will review information on project effectiveness, make recommendation on additional actions that may be required to meet restoration goals in the original 28 project areas, these actions will be prioritized in a second action list with implementation being based on benefit to the goals and objectives of the project, benefit to fish and opportunity to cost share with other projects

Completed Projects 2018:

The Program and its partners have been focusing their efforts on leveraging their resources to complete the highest priority projects identified in the Conceptual Restoration Plan. To date, 13 of the 28 project identified have actions implemented on them by the Program and its partners (PA-1, 3, 6, 8, 9, 10, 11, 14, 15, 18, 24, 28 &29), and an additional three by the CCD using their own project (funding in combination with SRFB and other grant funding (PA-22, 23, 26) (Figure 8).

In 2018, the Program and partners had commitments in 6 project areas (Figure 9), implementing 3 construction projects, 2 designs and one concept development. The Program supported, CTUIR &WDFW in the implementation of PA3, an adaptive management action capitalizing on previous restoration actions to increase floodplain connectivity. WDFW in the advancement of PA13 design to a 60% level and initiation of permitting. In coordination with the program, CTUIR developed restoration concepts at PA17. Provide support to the CCD in implementing the final Phase at PA-28 (Phase III), the development of final design at PA32 and the implementation of the Little Tucannon PALs project. Our implementation process can take about 3 years from start to finish, with year 1 project development assessment, conceptual and preliminary design, year 2 design review and vetting internally (RTT, SRSRB and HIPPIII) permitting and year 3 staging, site prep and construction and year 4+ riparian restoration, stewardship and future adaptive management.

The projects completed between 2011 and 2017 are describe in detail in the 2016 & 2017 Annual Reports (Buelow 2017, 2018). Date used in the following summary was collected as part of the rapid habitat surveys conducted by the Program, which has prioritized pre-post surveys in years of construction and revisited in years following higher than average flows >2 yr return interval.

2018 ***Completed Projects Detail (Table 2, Figure 9)***
PA-3 Construction Build 2018 (CTUIR)
PA-13 Design 2018, -Build 2019-21 (WDFW)
PA-17 Design 2018-19 (CTUIR)
PA-28 Phase III Construction Build 2018 (CCD)
PA-32 Design (CCD)
Little Tucannon PALs (CCD)

Project Title: PA3 Supplement LWD & Add Complexity

Implementer: Confederated Tribes of the Umatilla Indian Reservation

BPA Programmatic Funding (2010-077-00): In 2018, $625,200 (#73982) and in 2014, $400,000 (# 62642)

Other BPA Funding (2008-202-00): In 2014, CTUIR used an estimated $140,000 on design and engineering from the (Accord Funded) Tucannon Habitat Program

Matching Funds*:* In 2018, WDFW provided $12,000 in-kind engineering, design, construction management and post project field evaluation.

Location: Tucannon River mile 46.7 to 48.25, start lat/long 46.225822, -117.722873; end lat/long 46.237480, -117.700800 (Figure 9)

Project Time Line: Initial project design implemented in 2014 (#62642) and with LWD supplementation occurring in 2018 (#73982).

Recovery Expectations: Due to the nature of placing LWD by helicopter and the goal of gaining channel length and floodplain connectivity, the project is dependent on a number of significant stream flows (>2 yr Flood). In the Tucannon basin the flood flow needed to initiate bank erosion and activate bed load, in recent times occur at a 5-10 year time scale, so this project is expected to contribute significantly over the next 10 yrs. In the short term (1-5 yrs) the project action should begin to increase localized flooding and channel connectivity causing the development of pools, gravel storage and some side channel development.

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened), Columbia River bull trout (threatened), Pacific Lamprey (SPP of Concern).

Priority Life Stages Targeted: All life stages

Potential Future Actions: Due to the restoration goal for this site of reconnecting floodplain, it may be required in upcoming years to initiate a pilot channel cut to fully achieve the side channel connectivity objective. Additional floodplain structures may also be desired once the floodplain objective is met.

2018 Project Goals and Objectives

Goal: Return a roughly 1.58 mile reach of the river located within WDFW's WT Wooten Wildlife Area closer to its historic, naturally functioning state, with complex channel form and a connected floodplain.

Objectives:

i. Short Term Obj. (1 yr): Conduct wood loading within the bankfull channel and on the floodplain to increase channel roughness, increased channel migration and floodplain connectivity.
    i. Place Log jams in 58 predetermined locations (633 of key LWD pieces > 6 m long & 0.3 m dia.) for the purpose of increasing channel roughness and habitat cover.
    ii. Place 10 floodplain structures in currently disconnected flow paths in anticipation of flood flows
    iii. Added 25 mobile LWD piles within the ordinary high watermark for the purpose of providing mobile materials

ii. Long Term Obj. (5-10yr): Strategically placed LWD jams to reconnect floodplain, disconnected side channel and off channels habitats;
    i. Connect between 1175' and 4460' of addition side channel habitat
        i. Increase River Complexity Index value from by an additional 30%.
    ii. Capture ~12 ac of disconnected floodplain at and beyond the 2 yr flow interval

2014 Project Goals and Objectives

Goal: Return a roughly 1.3 mile reach of the river located within WDFW's WT Wooten Wildlife Area property closer to its historic, naturally functioning state, and increase river complexity and floodplain connectivity.

Objectives:

I. Short Term Obj (1 yr): Conduct wood loading within the bankfull channel and on the floodplain to increase channel complexity, increased channel migration and floodplain connectivity.
   I. Add 271 LWD Key piece (>6 m long & 0.5 m dia) to increase reach LWD densities to be > 2 pieces / bank full width
   II. Place LWD in 42 strategic locations to increase channel habitat and river channel complexity
   III. Placed two structures with dual purpose of providing habitat cover and to act as a "catcher's mitt" to minimize LWD from mobilizing from the project reach.

Summary:

Back Ground: Project Areas 3 was identified in the Conceptual Restoration Plan (Anchor QEA 2011 Nov) as a project targeted for early implementation having elements that would provide immediate biological response and some requiring time to fully mature before achieving full benefits, removes important stressors from the system and had a high benefit to cost ratio. In 2012, the Tucannon Coordination Committee (TCC) requested CTUIR to initiated concept development and design for a project on PA-3 between RM 46.8 & RM 48.00 (Figure 9). The project area was located on the WDFW managed Wooten Wildlife Area, USFS and adjacent private properties. Using CTUIR Tucannon Habitat Program (BPA Accord) funding and Program technical support CTUIR completed a final design in 2013 for approximately 1.3 miles of the project reach targeting most of the public land sections leaving out about 1,000' to avoid implementation over a designated CHaMP control site. CTUIR in partnership with WDFW, USFS and the SRSRB set project goals to increase river channel complexity and localized floodplain connectivity, construction was initiated in 2014 building 42 LWD structures using 271 whole trees placed using a VERTOL 107-II helicopter (Figure 10, Figure 11).

Little historical information on the project area is available however, it was apparent that previous homesteads and agricultural use was prevalent prior to WDFW acquiring the property in 1943 as the Wooten Wildlife Area. The flood of 1996-97 lead to extensive bed and bank erosion at the site leading to degraded channel complexity and likely the reaches current state of entrenchment (Figure 5). In 1998, WDFW, CCD & USFS constructed 3 rock weir structures for the purpose of stabilizing vertical and lateral channel migration and reducing the width to depth ratio. Over the next 20 years, very little habitat improvement was observed within the reach, with the recruitment of very few logjams and the continued loss of existing channel spanning relic structures (Figure 12). The 2014, pre-project condition was best described as being in a state of arrested degradation as described in the stream evolution model developed by Clure and Thorne (2013), whereas the channel has developed into a degraded stabile state and showing no sign of recovering a higher state of complexity. This is demonstrated in the 2014 pre-

project River Complexity Index value of 7.85, a divergence from the estimated potential of >52.76. (Table 4).

Current Summary: Following 2014 implementation, the first flood of significance occurred March 2017, estimated between 1,000 cfs and 1,400 cfs (~3.5 yr event) at the WDOE Marengo stream gage. Significant mobilization of bed load and mobile LWD materials occurred at a level not observed since 2009 (prior to the initial construction of the project). Following the flow event, a rapid habitat survey was conducted to observe project integrity, habitat complexity and floodplain connectivity. The 2017 survey results were compared to the as-built survey completed in 2014 (Figure 10) indicating only minimum impacts to project reach LWD structures, relocating/combining and burying 3 of the initial structures reducing the total from 42, to a post flood value of 39. The total LWD key piece (6 m long & 0.5 m dia.) visible materials only within the ordinary high water mark (placed and natural) for the reach had declined from 389 in 2014, to 327-post flood in 2017. Some LWD observed above the high water mark or buried within gravel bars is not counted as per protocol (CHaMP) as it is not a functional piece or its measurable length can not be determined, which is a likely explanation for the final disposition for some transient LWD missing at structures. All LWD key pieces placed as part of this initial project were tagged with an individually numbered tag, allowing us to track the loss of trees from structures, however relocating these mobile trees has proven quite difficult for trees moving more than 300-400 m. To date no mobile trees moving more than 400 m have been observed in this project area, nor have any LWD key pieces been observed leaving the project area downstream.

The 2017 flow event mobilize bed load in the project area leading to localized bed aggradation (Figure 11), reducing channel entrenchment and increasing channel complexity to an extent not anticipated by the 2014 design. As a result of the floodplain expansion and reclaiming of disconnected flow paths, side channel length double, increasing from 0.34 miles in 2014 to 0.68 miles in 2017 (Figure 10). Using a method of measuring river complexity described by Brown (2002), we observed the river complexity index (RCI) values increased from RCI =8.88 (pre-project) in 2014 to a RCI = 35.09. Field observations indicated additional LWD loading may offer an opportunity to maintain and increase the reach RCI value by as much as an additional 50-100%. In 2017, the Regional Technical Team based on field investigation and an interest in maintaining and improving the existing 2017 condition, recommended a management action on PA 3 in which additional wood loading with the goals of connecting additional floodplain and increasing river complexity. CTUIR and WDFW worked to prepare a design with the primary objectives of placing 350 root wad trees in a various configurations to increase channel roughness and floodplain connectivity, to reconnect between 1,175’ to 4460’ of new side channels and high flow paths (Figure 13). Following an intermediate flow (~2 yr flow) in late winter 2018 and prior to the 2018 restoration action, a slight decline from 2017 condition, was observed in pool frequency and side channel length during the pre-construction survey (Figure 10 & 14).

The 2018 design was the product of cooperation between CTUIR, WDFW and Program staff, developed in house utilizing 45’-55’ root wad trees to be placed with a VERTOL 107 Helicopter (Figure 13 & 14),

and included the placement of mobile LWD structures and a number of boulder-ballasted structures secured with rope. This approach allowed the project to be nimble, engage and involved the landowner (WDFW) while minimizing project design cost (using the WDFW engineer). The project footprint extended upstream and downstream to include areas not treated in 2014 beginning at RM 46.75 upstream to RM 48.1. As part of the materials bid process the entire tree was requested for delivery, resulting in ~350 treetops and poles to accompany 350 root wads. The tops ranging in length from 20' to 45' were acquired at a very low cost, and were added as racking materials on structures and as mobile LWD in between structures. On July 26, 2018 the project was initiated, placing 633 LWD key pieces (>6 m long & 0.5 m dia) in 58 location not including 25 additional mobile LWD debris piles and 10 floodplain structures outside the ordinary high watermark (Figure 14).

Rapid habitat survey/implementation monitoring and reporting was conducted in coordination with CTUIR, WDFW and the Program, and is illustrated in a map showing pre 2018 and post 2018 conditions (Figure 14). Future site visits and project evaluation will be conducted by the Program, CTUIR and WDFW following significant flow events (>2 yr flow). It is anticipated this project will require a number of flows (1,500 cfs -2,500 cfs) to fully reflect the designs vision, which could require anywhere from 5-10 yrs. based on the recent flood cycles. The CHaMP/AEM treatment site embedded within the project was sampled in 2018 prior to construction; however, no post-project data was available from that survey at the time of this report.

The following data summary results are derived from pre and post project rapid habitat surveys conducted for implementation monitoring 2014-2018.

- In 2018, the entire 1.58 miles project areas LWD volume increased >900% from a pre-project (2014) average of 0.49 to a post project (2018) of 5.12 key pieces/bank full width (>6 m long & 0.3 m dia.).
- 2014-2018 pool frequency increased by 89% and pool area by 162%.
- 2014-2018 side channels increased by 44% and overall perennial length by 6%

Environmental variables are measured through a variety of projects and programs

- Improved water temperature is a long term objective of the Program and it is anticipated that the project over a 10 yr period will positively improve summer high temperatures and winter low temperatures.
- Riparian quantity and quality is being monitoring throughout the watershed using remote sensing technology in the form of available LiDAR data (2010 and 2017 data).

The Program has prepared a project story for PA3, which has more information related to the work that has been completed over the period of the program including pre-post project images and project development materials and is available at the following link on snakeriverboar.org (Appendix 1).

Project Title: PA13 Levee Removal and Channel Reconfiguration 60% Design
Implementer: Washington Department of Fish & Wildlife

BPA Programmatic Funding (2008-202-00): In FY18, $93,666 (#74314), In FY17, $58,500 (#75493), In FY16, $69,669 (#72044)

Matching Funds: WDFW has received Washington State Capitol Funding to remove levees surrounding Rainbow Lake in 2018 (est. contribution toward the project >$400,000. WDFW is anticipating a SRFB grant request at ~$400,000 in FY19

Project Time Line: Concept Development 2017, 60%-90% Design 2018, Final design funding site preparation and material sourcing 2019, Instream work Phase I start in 2020, and Phase II instream and riparian planting 2021

Location: Tucannon River mile 39 to river mile 40; Start Lat/long 46.319376 / -117.664189 End (Lat/Lon) 46.309638 / -117.657055 (Figure 9)

Project Timeline: The initial project concept development and feasibility began in 2016-17 with concept review and design development/review taking place in 2018. Due to the size and nature of the work being proposed, site preparation, material sourcing and staging will begin in 2019 with instream work beginning in 2020 and ending in 2021.

Recovery Expectations: Due to the nature of this project, levee removal and channel reconfiguration, it is anticipated that as-built conditions will be very close to the anticipated condition. Winter freshets and high flow are anticipated to redistribute and sort gravel and cobble to increase spawning habitat quality over a 2-5 yr period.

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened)

Priority Life Stages: All life stages

Potential Future Actions: Following implementation at this project efforts will be made to monitor gravel deposition, side channel connectivity and riparian health.

Project Objectives: The current goal for this project is restoring floodplain connectivity and channel complexity to the 1 mile reach between the Hatchery weir and the Hatchery Bridge.

Short Term Objectives: Increase channel roughness and structure within the one mile reach.

- Construct 31 ELJs and supplement gravel and cobble materials to raise bed elevation.

- Place LWD complexity to achieve a minimum of 2 pieces per bank full width over a 10 year average.

Short Term Objectives: Increase floodplain connectivity to the one mile reach

- Remove approximate 0.31 miles of river levee
- Reconnect > 1 mile of isolated side channels
- Reconnect >21 acres of new floodplain.

Long Term Objective:

- Improve adult holding for spring Chinook and steelhead
- Improve spring Chinook spawning habitat
- Improved spring Chinook and steelhead

Summary: Project Area 13 was identified as a high priority restoration project in the Tucannon Conceptual Restoration Plan (Anchor QEA 2011 April) and was prioritized in the plan for early implementation and approved for funding by the Regional Technical Team and the Salmon Recovery Board. The project reach is characterized as being highly confined by river levees protecting Rainbow Lake and the Tucannon Fish Hatchery infrastructure. The river through the reach had been straightened and became incised below the hatchery fish trap reducing channel complexity (Figure 15 -17). The reach is located in the center of the Tucannon spring Chinook spawning reach and while a relatively high proportion of redds are observed within the reach annually, available spawning habitat is poor and rearing habitat is limited.

In 2016, WDFW initiated the removal and set back of the Rainbow Lake dam increasing available but disconnected floodplain by >3.6 acres (Figure 15). These acres were previously lakebed (Impoundment) and remained behind ~925' of river levee until 2018 when the levee/dam was removed by WDFW (Figure 16). The 2020-21 removal of the addition 650 feet of river levee is anticipated to reconnect these acers and 18 additional acers (Figure 18).

Enhancing and restoring instream habitat in this project area will be accomplished through a variety of treatment actions in the main channel, along the banks, and within the floodplain. The treatments include; removal of river levees and rip rap (Figure 17), to reconnecting side channels and floodplain (Figure 18), the construction of a channel meander, the construction of instream habitat features such as engineered log jams to raise the river bed, and riparian planting. The principal benefits of project implementation will be restoration of historic spring Chinook spawning, rearing, and migration corridor habitats. The associated recovery of riparian areas will be supported by naturally occurring flooding over the long term.

Expected Implementation Actions (from restoration design): Reconnect >1 mile isolated side channel (~50/50 perennial-ephemeral) habitat through the removal of ~650 of river levee, and the placement of

associated log jams. The removal of levees (Figure 17) and placement of logjams will reconnect ~18.2 acers of low floodplain, in addition to the 3.6 acers previously part of Rainbow Lake impoundment footprint (Figure 18). Install ~31 ELJs and other LWD structures in the main channel to increase channel complexity over a 0.8-mile reach. Additional, unsecured mobile LWD will be placed in main channel, side channels and on the floodplain for complexity. Re-plant adjacent floodplain and riparian areas where disturbed to re-vegetate and restore disturbed construction access sites and staging areas. During planting efforts will be made to increase pines and cottonwoods throughout the reach for the purpose of future LWD key piece recruitment.

Project Title: PA17/18 Design Concept Development
Implementer: Confederated Tribes of the Umatilla Indian Reservation

BPA Programmatic Funding (2010-202-00): In 2018 - $35,700 (#73982)

Other BPA Funds (2008-202-00): In 2019 - $164,535 (#73982)

Matching Funds: No other matching funds have been identified for this project at this time, but it is anticipated that CTUIR would consider pursuing a SRFB grant as match in 2020.

Location: The project reach is located between RM 33.1 and 36.35. With a start Lat/lon46.376913 -117.693008 and end Lat/lon 46.352667 -117.684059 (Figure 9)

Project Time Line: Coordinate and outreach 2017, concept development and build landowner support 2018, 90% design 2019, construct 2020-21.

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened)

Priority Life Stages: All Life stages.

Project Objectives: The project goal will be to increase hydration of an inset floodplain through the construction of logjams, and the connection/creation of side channels. Specific project objectives will be developed during the design process in 2019.

Summary: The Project Area 17/18 floodplain and channel complexity restoration goal in 2018 was to make contacts with private landowners through a number of public meetings and events held within the basin. The result of these efforts has led to enough interest amongst the group to move forward on concept development and the development of landowner agreements. In 2019, CTUIR will work with private landowners within this high priority (Tier I) reach to identify and implement restoration

objectives that have high fish benefit while working within the comfort level of property owners. As of the winter of 2018, the majority of the 22 landowners within the ~3 mile reach have expressed interest in doing some level of restoration. CTUIR is currently working with a design engineer (using Tucannon Accord funding) to produce concepts for landowner review. It is anticipated landowner agreements will be sought based on conceptual designs and that CTUIR will complete designs within their Tucannon Accord funding (although if need outside funds may be acquired) in 2019, which would lead to a combination of Program and other grant funding to implement in 2020.

Project Title: PA28 Phase I-III: Floodplain Function & Complexity

Implementer: Columbia Conservation District

BPA Programmatic Funding (2010-077-00): In 2018 - $454,060 (#76992), and in 2016 - $210,000 (# 72405)

Other BPA Funding (1994-018-06): In 2017, CCD committed ~$220,000 (#71864) (Not a final estimate of CCD commitment from their project)

Matching Funds: In 2017 the CCD was awarded a SRFB grant for $304,775 (16-2094) and in 2016 a grant from the Conservation Commission $50,000

Location: Tucannon River mile 19.35 to 21.5 (Figure 9)

Project Time Line: Initial project Phase I implemented in 2016 (#72405 - #76992), with Phase II following in 2017 and Phase III in 2018 (#73982).

Recovery Expectations: This project is located in a dynamic section of the Tucannon River Valley, and it is expected that change in channel form and habitat complexity will occur at a relatively fast rate compared to other locations within the basin. The flow rate required to activate bed load in this reach occurs in a 2-5 year time scale, so the project is expected to contribute significantly within 5-10 yrs. Periodic site visits and rapid surveys (following high water events) will continue to follow development in side channel and floodplain connectivity.

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened), Columbia River bull trout (threatened), Pacific Lamprey (SPP of Concern).

Priority Life Stages Targeted: All life stages

Potential Future Actions: Due to the restoration goal for this site of reconnecting floodplain it may be required in upcoming years to revisited pilot channel cuts and associated LWD structures to ensure side

channel objective are being met. Additional floodplain structures may be desired on newly connected floodplain. Revisit riparian planting and health over time as floodplain landscape evolves from shrub step dominated to typical wetted Tucannon riparian forest type.

Project Goals and Objectives

Goal: Return a roughly 2.15 miles reach within project area 28 identified in the Tucannon Conceptual Restoration Plan (Anchor 2011 April) and located on a private farm, closer to its historic, naturally functioning state, increase fish habitat quality/quantity and floodplain connectivity.

Objectives:

I. Short Term Obj. (3 yrs): Installing LWD structures within the bank full channel that create pool habitat, instream cover habitat, channel complexity, substrate sorting and floodplain connectivity.
   a. Place 79 log jams within the main channel for the purpose of creating channel complexity and increasing localized floodplain connectivity.
   b. Placed 4 apex jams and 5 channel grade jams in the main channel to reconnect floodplain and increases flow into side channels at < 1 yr flow.
   c. Place 66 log structure within floodplain flow paths to create complexity during winter and high flow periods
   d. Add 550 key LWD pieces (> 6 m long & 0.3 m dia.) to maintain > 2 key piece/bank full width.
   e. Increase pool frequency and volume > 50% within 3 years
   f. Excavate ~100' of pilot channel to engage 0.86 miles of disconnected side channel

II. Long Term Obj. (3-5 yrs): Increase floodplain connectivity and channel complexity.
   a. Maintain > 2 key pieces beyond 10 years
   b. Anticipated a 50% increase side channels within the first 10 yrs.
   c. Connect disconnected low floodplain (5 yr flow) ~ 28 acres

III. Planting to restore a floodplain and upland terrace forest
   a. 1,200 trees interstitially planted
   b. 1 acres of new cover trees planted

Project Summary & Back Ground

Back Ground: Project Area 28 is identified in the Tucannon Conceptual Restoration Plan (Anchor 2011, November) as long-term strategic implementation priority with a more uncertain biological response and potentially dependent on other actions to achieve full benefits. Beginning as early as 2014, degrading conditions within project area and the increased understanding in the importance of middle river floodplain connectivity and off channel/side channel habitat for juvenile spring Chinook reduced the uncertainty around a potential biological response, increasing the priority of this reach in 2015, leading to Regional Technical Team supporting implementation in 2016-18. Changing conditions at the site included the loss of LWD key pieces (red alder) through quick deterioration, and subsequent mobilization from the site leading to rapid channel migration and degradation of the channel forming processes observed in the 2010 Conceptual Restoration Plan. Reduced floodplain connectivity and

available perennial side channels also were declining from the desired anastomosing multi thread channel (Figure 19) due to loss of channel roughness and shortening channel. A 2016, rapid habitat survey identified LWD pieces to be <two pieces/bankfull at 0.51 pieces/bankfull width (Buelow 2017). Landowner sentiment had also changed in regards to the disconnected floodplain in the middle half of the project (Figure 20), allowing for much larger gains in floodplain than considered in 2011 Conceptual Restoration Plan.

In 2015, CCD initiated the development of the concepts identified in the Conceptual Restoration Plan (Anchor 2011 April), focusing on floodplain connectivity and channel complexity goals. The plan identified large woody debris, pool frequency, and floodplain connectivity as limiting within the reach, but riparian habitat was relatively intact with mature deciduous forests consisting of red alder and limited cottonwood (spp). In assessing the project-reach, it was observed that the river channel (upper 0.5 miles) was largely connected to the floodplain however lacked channel roughness and was transitioning back to a more simplified state, mostly due to the small size and short-lived nature of red alder. Within this river section structures were integrated to engage with the river and provide longer-term stability supporting channel bar deposition and riparian recruitment (cottonwood primarily). To allow for the modeled flood rise caused by increasing channel roughness features within this reach, a levee setback was incorporated into the Phase I design (Figure 20). The objective for the design was to develop an anastomosing channel (Figure 19). To conduct the "stage zero" (Clure 2013) type restoration approach on private property adjacent to agricultural fields (Figure 20) the setback levee was required so that flood risk incurred by the restoration was mitigated. Immediately following construction of Phase I in March 2017 a significant flood (~ <5 yr) occurred, connecting a significant portion of the floodplain (Figure 20 & 21). The landowner was satisfied with the outcomes from Phase I and how it performed in high water, agreed to connecting a large piece of former pasture (~24 ac) disconnected behind a gravel berm to be transitioned from sagebrush bench to low floodplain as part of the Phase III design (Figure 20).

Due to the size of the project, the number of structures to be built, and a desire to be sensitive to available annual budgets the CCD approached the project in three phase beginning in 2016 and finalized in 2018 (Figure 20). This approached allowed the project technical and design teams to adapt to changes caused by flows and react to changes or deficiencies that occurred in the short term. An example being the addition of some structures on newly connected floodplain following 2017 and an increase in structure density in the lower project area.

Summary 2018: Implementation of PA28 instream work Phase III was completed in August 2018 finalizing the three phase which were initiated in 2016 (Figure 20). The work implemented in 2018 included the construction of an additional 24 LWD structures and 10 single logs placed in the main channel (Figure 23). The removal and perforation of 448 feet of confining features including the breaching of a 360' berm/levee to connect ~28 acres of floodplain and the cutting of two pilot channels to facilitate flows into the floodplain (Figure 22). To accommodate flood flows on previously isolated areas, two floodplain structures and 41 single logs were placed in the low flow paths, where riparian trees were insufficient, to increase roughness and create complexity during high water events. In total, during Phase III 922' of perennial and 3,842' of ephemeral channels were connected and created in 2018 (Figure 24).

2016-2018 Summary: The project in total received 85 LWD structures (Figure 22) built instream serving one or more purposes including but not limited to just one: splitting flows to increase floodplain connectivity and side channel development, increase floodplain connectivity locally and development of fish habitat features (Figure 24). An additional 18 single logs were placed within the project area to increase fish habitat cover. Over the three phases 660' of confining features were removed including gravel berms and 3 channel pilot cuts were developed through high berms. On the floodplain two structures were built in association with pilot cuts and 47 single log structures were placed to supplement complexity in flow paths previously disconnected.

The following data summary results are derived from the pre/post project rapid habitat surveys conducted for implementation monitoring in 2016 - 2018.

- LWD key (>6 m long & 0.3 m dia.) piece/ bank full with increased 445% from a pre-project average of 0.56 to a post project average of 3.75 key pieces/bank full width.
- Pool frequency increased by 112% and pool area by 105%.
- Side channels increased in length by 63% and overall perennial length by 33%
- River Complexity Index increased >472%.

The upper end of the project has developed very nicely increasing side channel habitat between 2016-2018 expressing a channel form best described as "stage zero" (Clure B 2013), increasing available habitat both in quantity and quality. The increase in perennial habitat is significant when considering changes in perennial length creating 33% more habitat within the reach (pre 2.86 mi to post 4.3 mi). Preliminary investigations indicate that mean pool depth shifted within the project area from 0.5-1.0 m to 1.0-1.5 m with an increased frequency from 25 to 67 exceeding 1 m total depth in September 2018. Observations made during August 2018 identified significant densities of spring chinook parr residing within pools with residual depths > 1.0 m within the reach. This was of relative interest, as in 2017 there were no observed redds identified within the reach due to poor returns back to the entire Snake River Basin, indicating these fish may have left the upper basin redistributing into the middle river where habitat quality has improved.

Project Title: Tucannon River Habitat Restoration (PA32)

Implementer: Columbia Conservation District

BPA Programmatic Funding (210-202-00): FY18 $5,000 (#78668)

Other BPA Funds (1994-018-06): FY18 CCD $35,217 (#78668), FY19 CCD finalize design & implement $367,105 (#CR-325520)

Matching Funds: FY19 CCD $345,375 (SRFB 18-2091)

Project Time Line: 2018 Design and permit, 2019 implement Phase I and design Phase II.

Location: Start Lat/lon 46.482834/-117.953257, End Lat/lon 46.477932/-117.942397 (Figure 9)

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened)

Priority Life Stages: All life stages for all species are present at this project.

Project Goal & Objectives: Connect floodplain habitats (at 1-2 yr flood interval) through levee removal and LWD structure placement in stream and on floodplain.

a. Remove ~670' of river levee to reconnect ~26 acres of low floodplain at <2 yr flow interval.
b. Place 54 LWD structures for the purpose of increasing channel complexity/roughness and increase floodplain connectivity. Targeting a >500% increase in RCI.

Summary: The Program provided the CCD, design and technical support toward the development of PA 32 in 2018, including a pre-design rapid habitat survey and design surveys. The program supported the CCD in concept development and review as well as permitting technical support. A restoration design developed to near final in 2018 will undergo refinement as it goes through permitting and a spring 2019 post flow update.

The primary goal of this project will be to increase river channel complexity at low flood-flows (1-2 yr). This will be accomplished by increase channel roughness, increasing flood height and reconnecting ephemeral and perennial flow paths, which would lead to an increase in RCI within the reach of >500% (Figure 25, Table 4). The project will place approximately 54 structures composed of 162 key pieces (>6m long & 0.3 m dia) with root-balls attached, small to medium size "racking trees, and slash (tree limbs and other course woody debris). The design also includes multiple levels of stability to individual log structures to mimic a natural residence time to the large wood within the project reach. Structures include highly mobile wood (i.e small course debris and racking trees) and single large trees with mobility at certain flow velocities.

Implementation includes the construction of a ~4,000' offset levee (Figure 25), and removal of existing cobble dikes/levees to promote floodplain connectivity (~26 acres) and habitat function. The construction of the levee set back in this case is required to ensure the project is not affecting the production fields of the landowner.

It is the intention of this project to increase overall floodplain connection at 1 yr. and 2 yr. flood (Figure 25) and increase the RCI value from a very low 3.35 value to around 21.2 during lower typical flows. The purpose of focusing restoration outcomes on the very low end of the hydrograph is to capture the majority of flows that expected to occur. Annual peek flows within the basin have exhibited a significant decline over the period of record (Figure 26) as recorded by the USGS at the Starbuck gage

located at RM 2. The result of lower peek flows has manifested in there not having been a 5 yr flood stage since 1996-97 (Figure 26). Due to the recent hydrograph, restoration practitioners and the program have been working harder to make the most of work done by the river on an annual basis by activating the inset floodplain and make more habitat available on yearly basis.

Project Title: Little Tucannon Post Assisted Log Structures:

Project Sponsor: Columbia Conservation District

BPA Programmatic Funding (2010-202-00): In kind technical support

Other BPA Support (1994-018-06): $21,741 (#78668)

Project Matching Funds: $50,000 SRFB (15-1317)

Location: Lower mile of Little Tucannon (Figure 9)

Project Time-Line: Project was initiated in 2017 with the construction of 50 post assisted structures and was followed up in 2018 with the addition of 20 (PALS).

Priority Populations: Snake River DPS Summer Steelhead (Threatened), Columbia Basin Bull trout (Threatened).

Life Stages: Spawning and rearing.

Project Goals and Objectives: The goal of this project was to install up to 50 Post Assisted Log Structures to:

1. Increase the frequency of large wood pieces to a level similar to nearby, restored streams and
2. Increase pool frequency by 25% in the project reach, dependent upon channel forming flow events.

Summary: The CCD worked in Little Tucannon over two seasons installing 50 Post Assisted Log Structures (PALS) in 2017 and returned in 2018 to install an additional 20 PALS. The work was conducted in the mid late July and included building structure by hand using 4-5' posts and a combination of racking collected on the landscape or packed in from the road by hand (Figure 27). The Little Tucannon supports steelhead and bull trout however there is little habitat available to these fish in

the form of spawning or rearing. The Little Tucannon River is a cold-water source tributary for the Tucannon, improving condition within the Tucannon during the hot summer months

.

Structures were placed in combinations to generate gravel and cobble (bank blaster) and to trap it down stream in a variety of mid channel and bank attached bars. Using the structures in this approach will over time increase channel length and pool formation. An example structure built in 2018 is provided in Figure 27 where a new structure place in 2018 is compared to one built prior to high flow in 2017. A full as-built report has been developed for the CCD by Eco Logical Research Inc (Hill 2018).

Project Title: Conceptual Habitat Restoration Strategy: Tucannon Plan Update

BPA Programmatic Funding (2010-202-00): In 2018, $225,000 (#76992)

Other BPA Funds (1994 018-06): The sum of contribution from the CCD was not available at the drafting of this report.

Location: Tucannon Basin not including Pataha Creek

Project Time Line: 2018 fill data gaps and conduct field evaluations. In 2019 finalize assessment and supporting material and update the Conceptual Restoration Plan documents.

Priority Populations: Snake River ESU Spring/Summer Chinook (Threatened), Snake River DPS Summer Steelhead (Threatened), Columbia Basin Bull trout (Threatened). The conceptual restoration plan focuses on restoring natural function and in the Tucannon Basin, which includes all native fish species.

Priority Life Stages: All life stages.

Project Goal & Objectives: The overall goal of the Tucannon Conceptual Restoration Plan (Anchor 2011) Update is to apply what we have learned in the first 7 years of implementation in the Tucannon, to evaluate work completed, and update the plans. Then updating the Conceptual Restoration Plan for 2019-2028.

Objectives:

a. Evaluate limiting factor priorities.
b. Articulate and solidify restoration goals and define both short term and long term restoration objectives for projects.
c. Update and evaluate fish distribution and habitat use date collected for the WDFW in basin Tucannon Life Cycle Model.
d. Consideration to all priority native fish species.

e. Consideration of tributaries and connectivity throughout the Tucannon basin.
f. Evaluate project implementation and change detection information.
g. Evaluate prioritize and incorporate project reaches 2-5 in winter rearing habitats.
h. Produce a prioritized list of projects and designate implementers.
i. Identify and prioritize adaptive management actions.

Summary:

Background: In April 2011, the CCD completed work with Anchor QEA to produce the Tucannon River Geomorphic Assessment and Habitat Restoration Study (Anchor QEA 2011 April). Later that year, focusing on the high-priority areas for Tucannon spring Chinook, the CCD coordinated the development of a habitat restoration plan for the Tucannon River from RM-20 upstream to RM-50: the Conceptual Restoration Plan (Reaches 6-10), Tucannon River Phase II (Anchor QEA 2011 Nov). In coordination with the CCD, the WWCC work to complete the Conceptual Restoration Plan for reaches 2-5, completing the entire lower 50 miles of river in the Integrated Species Restoration Prioritization Tucannon River (Anchor 2012). These assessments and restorations plans were the marching orders for Program project implementation between 2011 through 2018.

Overview: At the completion of the Assessment and Conceptual Restoration Plan (Nov 2011), restoration actions focused on improving spring Chinook spawning and rearing habitat between RM-20 and RM-50 (Reaches 6-10), where all known spawning was occurring. Since the inception of the Program, restoration actions have been prioritized for implementation at 15 of the original 28 project areas identified in the Conceptual Plan. The restoration objectives for these completed projects were derived from the strategy: to improve instream complexity and floodplain connectivity, in order to promote natural function and processes that increase capacity for rearing salmonids. Through the development of the Assessment and the initial Restoration Plans, winter rearing habitat was identified as a primary habitat constraint limiting population abundance and resilience for spring Chinook in the Tucannon. The full extent of rearing was not completely understood however; and in the initial years of project development, habitat restoration within Reaches 2-5 (RM 1-RM 20) was not prioritized for implementation, although conceptualized projects existed within the Integrated Species Restoration Prioritization Tucannon River (Anchor QEA 2012). The newly developed lifecycle model (WDFW) for Tucannon origin fish has now identified higher than previously known spring Chinook use in Reach 3-5 (RM-20 to RM-2). Finding ways to increase survival of fish within these reaches is one of the goals of the plan update.

The plan update is focusing on evaluating past implementation project performance, improving habitat, developing and prioritizing a new work plan of restoration and integrating recommendations to the Program made by the NWPC and the ISRP. The process is anticipated to be completed in 2019, at which point would receive final approval by the regional technical team and be adopted by the SRSRB

for implementation. Currently, the goal is to review the plan at an interval of < 8 years to maintain focus and relevance of work implemented.

Project Action Evaluation: The Conceptual Plan update process has reviewed current conditions at the majority of projects, which had restoration actions implemented 2011-2018. Change detection evaluation is conducted using a combination of pre/post implementation (2010/2017) LiDAR derived models, including River Complexity Index, pool frequency, residual pool depth, floodplain connectivity and riparian coverage and height. The field efforts utilized rapid habitat surveys, conducted to summarize habitat units, floodplain connectivity and side channel length which is being used to qualify the remote sensing data sets where possible. A model of change in river complexity index (RCI) value for the period from 2010-2018 is being tested as it was derived from LiDAR data and will be available for the Plan update as a measure of uplift in habitat quality. An effort to use the 2017 bathymetric LiDAR dataset to develop a residual depth pool layer, has indicate some promise in developing a basin wide pool frequency and depth layer. The dataset is undergoing ground proving and will likely contribute to future change detection monitoring in the basin. Data collected is being used to determine the degree to which projects are achieving objectives and in case where management actions are identified those will be called out and prioritize in the adaptive management plan.

Project areas in some instances will have adaptive management actions identified for implementation where a project action in not meeting intended restoration objective, conditions have changed from initial design which allow expanded scope or where conditions have improved to a point where significant additional gains are possible. These actions will also be prioritized and sequenced based on their benefit to fish and natural process.

Project areas that did not received restoration actions 2011-2018 were also surveyed during field evaluations and will be incorporated into update restoration concepts and aid in the project prioritization. It is anticipated the entire list of project 44 project areas developed in 2011 and 2012 Conceptual Restoration Plans will be listed into three groups including Tiered implementation projects (I-III), Tiered adaptive management projects (I-III) and protection category where the site would have a monitoring priority (1-5 year interval) but not have restoration planned.

Project Prioritization: The Conceptual Restoration Plan update when completed will include reach-scale restoration project areas identified in the previously Conceptual Restoration Plans (Anchor QEA 2011 Nov, and Anchor QEA 2012) and will be prioritized based on expected biological response, consistency with natural geomorphic processes, and benefit-cost ratio. The geographic reaches will be prioritized, based on the most limiting life history of salmonids spawning and rearing. The priority reach is from river mile ~7 to river mile 50, which includes geomorphic reaches 5 through 10. In the plan update we are working to follow the initial prioritization approach used in 2011, with more of an emphasis focusing on the difference between existing condition and properly functioning condition. A higher priority going to projects where habitat function is estimated to between~60% and 90% of

properly functioning in 2018. The concept being that the project areas 60% -90% of full function will have a greater impact and are closer to full function making the goals more achievable in a shorter time frame providing a timely uplift measurement for the Program. The final approach taken will be outlined and reported in the 2019 Annual Program Report.

With guidance and input from the Regional Technical Team, individual reach-scale projects identified through a geomorphic assessment and conceptual restoration plan update will be developed and prioritized for inclusion into a 3-5 yr. and 5-10 yr. work plans. The RTT will review and make recommendations for approving the list of priorities in 2019, and on an annual basis, individual projects will be considered for funding approval by the SRSRB.

During the Plan update, the Program reconvened the Tucannon Coordinating Committee (TCC) to work on the update, and to solicit and select project implementers. The Tucannon basin has typically been implementer poor and has not had a funding base large enough to attract a large number of implementers to the basin. The approach taken in the Tucannon has been to invite all the parties conducting restoration in the basin and through committee identify project that were well suited to implementers restoration strengths and approaches. Outside of the Program implementation partners, no agencies have implemented projects in the basin, prior to the program or since. Which has led us to continue a focus solicitation where the projects are identified and prioritized, and the sponsors are solicited for interest and availability to implement them. Prioritizing the projects and soliciting the agencies and tribes to implement projects in committee has helped our process to be collaborative and effective over the past 8 years. A complete description of project solicitation is outlined in the 2016 annual program report (Buelow 2017).

2018 Monitoring Efforts in the Tucannon Basin:

Columbia Habitat Monitoring Protocol (CHaMP)

The Columbia Habitat Monitoring Program (CHaMP) was discontinued in the Tucannon Basin in 2018 which has left a monitoring gap not yet filled by another program. The Program has continued to use the protocol and metrics developed for CHaMP, in the collection of habitat data for project implementation/effectiveness evaluation and change detection monitoring. CHaMP began in the Tucannon watershed in 2011 and a survey design was established used control and treatment areas as strata for distributing site locations. The Tucannon CHaMP study design uses the generalized random tessellation stratified survey (GRTS; Stevens and Olsen 2004) to distribute sampling effort across the Chinook domain in the treatment and control strata identified at the beginning of the project. The Program supported the monitoring of 4 additional survey sites within the Tucannon to coordinate monitoring with restoration actions early to ensure some of the CHaMP treatments would have

implementation. This work was also discontinued in 2018 as there was not enough funding support to continue the focused surveys in the absence of the full CHaMP program in the Tucannon. Due to the gaps in CHaMP support, the Program will continue to seek opportunities to focus and streamline the monitoring protocol developed in the basin. We are also considering and exploring the monitoring opportunities offered by modeling LiDAR data collected following high flow events.

Action Effectiveness Monitoring (AEM),

Natural System Designs had been collecting action effectiveness monitoring data to detect change in both habitat and fish abundance at seven matched treatment control sites through 2017. In 2018, this effort was discontinued through the SRFB, and efforts are currently underway within the SRFB to refine and develop a new monitoring program, although it is not certain when and what that would entail.

In 2018, the Program provided coordination with Cramer Fish Sciences in the synchronizing the previously monitoring CHaMP treatment and control sites into treatment control pairs. In 2018, at least 3 treatment sites where sampled with their match control sites, but at the time of this report the Program has not received results and anticipates them in the spring of 2019.

WDFW Fish Monitoring & Life Cycle Modeling:

The WDFW Research Lab and fish program conduct fish in fish out, and basin wide spring Chinook redd surveys annually. In 2013, 14 and 17, WDFW built and tested an in basin model for juvenile spring Chinook survival. Tagging juvenile fish in the upper basin during the late summer early fall on and near the spawning areas prior to emigration from the system. Findings from this study has prompted the Program to reevaluate the fish distribution priorities identified in the 2011 Conceptual Restoration Plan in its current update. A final report is scheduled to be finalized in March 2019, and will be reported in 2019 Annual Report. We will continue to work with WDFW to interrupt what they are finding and adapt the program where necessary.

We feel that one of the best measures of effective habitat restoration will be improving returns of spring Chinook, however this is a longer term goal than often expected, by funders, the public and frankly ourselves. We all must use patients when predicting and measuring fish return as a measure in successful habitat restoration. Time will be required following restoration action before the habitat can improve (from 1-5 years) depending of flow and then fish need to respond to the habitat which will take generations to see population response. The Program has developed model to display the timeline of when projects in the Tucannon have been implemented against brood years for Chinook charting their life history and when we should expect them to return (Table 5). As part of the Conceptual Restoration Plan update, the Program is working to develop and design goals and objective, which are measurable and quantifiable. We will work with project implementers to use the project goals and objective to help us track recovery and set restoration expectations, which will aid in demonstrating positive changes in the watershed.

Climate Change

Climate change forecasts for the Blue Mountains predict increasing ambient air temperatures by 2.4-3.1 °C by 2050, with a slight increase in winter precipitation (Halofsky 2016). It is not clear if an increase in precipitation would be snow or rain, but decreasing snowpack is predicted. Decreasing snow pack will alter hydrology by decreasing winter storage and increasing runoff and potentially reducing summer base flows. Hydrology in the Tucannon Basin particularly peek flows driven by rain on snow events, producing the large peek flow floods in mid-winter. Reducing snowmelt into summer will have negative impacts on summer flows and negatively influence water temperatures. August mean water temperature in the Tucannon River priority reaches, may increase on the order of 1.4°C and 2.4°C by the years 2040 and 2080 (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

Changes in hydrology and water temperature under impaired river conditions will have a large negative impact on spring Chinook and other salmonids in the Tucannon under degraded habitat conditions. Increases in winter peek flow will increase bed scour and deposition affecting redds and over winter survival. Earlier peek flows and lower summer flows will affect migrating adults as well as impact out migrating smolts reducing survival. Lower summer base flows will also exacerbate summer high temperature affecting summer survival and could reduce carrying capacity.

The projects and restoration actions outlined in the Conceptual Restoration Plan (Anchor 2011 April) are focused on channel complexity and floodplain connectivity actions that buffer against the impacts of climate change. The Tucannon may have a head start in buffering against climate change, brought about by increased wood loading in the headwaters following forest fires in 2005 & 2006, increasing natural storage. In fact, it would appear that the watershed is responding to changes brought on by natural process, leading the program and partners to mimic natural wood loading in project designs. A review of precipitation, stream flow, water and ambient air temperatures was prepared in 2017 as part of the Programs Annual Report (Buelow 2018) which indicates base stream flow increasing while precipitation is remaining constant. Summer water temperature has also declined since the early 1990s and continues to be remain lower than it was in the 90's when salmonids were being listed under ESA. The SRSRB plans to continue to monitor this trend as conditions change in the basin.

The Program partners share restoration objectives and implement restoration actions that lead to increasing channel complexity and floodplain connectivity, including removing confining features, increasing channel complexity and floodplain connectivity. Future projects implemented in the watershed will continue to increase connectivity of channel and floodplains, increase side channels and floodplain storage by reducing incision and increasing riparian vegetation.

Adaptive Management;

The Program and the partners have been working to formalize a practical approach to evaluate completed projects so that lessons learned are incorporated into project designs in real-time. The Program has been doing this during design review within the TIC and RTT to date but is working to formalize this into the Conceptual Plan update as part of the adaptive management approach, in 2019. Most of the projects implemented to date have objectives we can measure such as LWD volumes, pool densities and floodplain connectivity, the Program has been working with implementers in the development standardized goals and objectives which can be measured and compared spatially and temporally. We have been utilizing rapid habitat surveys to observe and document increasing channel complexity (RCI), floodplain connectivity, pool frequency and LWD densities as a way to evaluate changes within projects from pre-project to post project and following high flow events. This approach allows us to observe change and evaluate rate of change to determine the appropriateness of additional actions within project areas. Using this approach, we have identified a need for project maintenance opportunities that would greatly improve processes set into motion by the initial project, with PA3 in 2017-18 being a good example.

We plan to incorporate into our Conceptual Restoration Plan update a chapter to formalize and set guidelines for evaluation and prioritizing corrective or additive actions going forward. We don't anticipate strictly adhering to the formal adaptive management model, as funds continue to decline for monitoring, but will utilize a more rapid habitat and remote sensing approaches to our existing monitoring approach.

Lessons Learned:

Over the past few years the Program has been trying to collectively compile lessons learned in conducting large scale implementation projects. The following section lists a number of them.

1. In setting up a large scale, restoration program the Geomorphic Assessment and Conceptual Restoration plan used in the Tucannon has been very effective.
2. From the time the Assessment starts, you will need 2-3 years minimum before the first project implementation.
3. A project that requires engineered design may take up to 3 years to complete. One year to conceptualize, and develop preliminary design, one year to permit and finalize design, stage and build and one year to close out and plant.
4. Free wood is not free! Make sure the materials you are receiving meet the specification of your needs and are of quality that will last in the environment.
5. A number of strategically placed stabile structures may help maintain and even distribution following flood events.

6. The placement of over stabile structures that are intended to rack materials before leaving a project area can be very effective.
7. During flood events visit your projects and meet with landowners to show them you are interested and there to help if things come unraveled.
8. Expectations for projects need to be set at a level that is achievable and plan on multiple treatments in some tough areas. It took 150 years to pull a lot of these areas apart its going to take a while to fix them.
9. Fish can respond slowly. Chinook have a long life history and it will take a couple of their generations to see effect at the population level.
10. Restoring river channel function and proving adequate floodplain is an effective way to restore Chinook habitat, improving riparian habitat, flow and temperature.
11. It is very helpful to develop cartoon models for some of your most important restoration objectives; an example is floodplain in the Tucannon. This will help you and the project stakeholders understand and visualize the restoration objectives.

NWPCC Staff Recommendations

The SRSRB, in coordination with BPA, began work in 2017 to address the NWPCC staff recommendations made in the June Decision Memo to the NWPCC. We continued in 2018 to be committed to making positives changes in our umbrella project in response to ISRP's review and NWPCC staff recommendations. The Program and its partners initiated an update to the Tucannon Conceptual Restoration Plan and within plans to incorporate staff recommendation. The following summarize progress toward addressing the recommendations:

#2 Measurable Objectives-The SRSRB developed recovery and restoration goals and objectives in the Salmon Recovery Plan for SE Washington (2005), and further refined them in the Tucannon Conceptual Restoration Plan (2011) and is currently exploring ways to make them more measurable at both the project and program level in the plan update. While the Program can generate short-term objectives (3-5 years) based on the current portfolio of projects identified and their expected outcomes (2011 Conceptual Restoration Plan), long-term objectives (5-10 years) will be based on the outcomes of the Conceptual Restoration Plan update 2019. The Conceptual Restoration Plan long-term objectives beyond 2019 will be based on all the following considerations -FCRPS BiOp process, resulting BPA mitigation commitments, regional prioritization of projects (also conducted within the plan), and funding coordination.

Short-term objectives: At the project scale, we have worked with sponsors and partners to identify project-specific objectives during project development and design phases. Currently these objectives are

based on habitat outcomes for species and life stages. We are currently looking at ways to roll these project-scale objectives up in a meaningful way as part of the Conceptual Restoration Plan update Long-term objectives: The most useful type of objectives would be those that help the Program and BPA make decisions about project prioritization, funding, and design. The Conceptual Restoration Plan update will result in a comprehensive, prioritized regional project list with associated project outcomes related to fish, habitat, and population productivity and viability (expected early 2019). Based on the needs identified in the updated Conceptual Restoration Plan, BPA mitigation commitments, funding coordination, and expected BPA funding it may be possible to select the set of Program projects and layout meaningful objectives beyond 2026. This would allow the Program and BPA to forecast potential habitat or fish-related outcomes further into the future.

The SRSRB and Program hope to be able to track progress toward meeting objectives through the reforms to the M&E programs in the basin, but currently there is little monitoring effort aimed at measuring fish and habitat outcomes at project sites or project reaches. BPA's AEM program is helping evaluate outcomes at some sites (e.g. PA3) where measurable objectives have been developed. One particularly interesting outcome will be habitat suitability modeling before (during design) and after (during AEM monitoring) project implementation. This type of modeling may allow us to develop and track changes in habitat fish capacity. Another approach the Program is investigating in the Conceptual Restoration Plan update is using basin wide bathymetric LiDAR (2017 Data set) and GIS Analysist to develop a River Complexity Index (RCI) (Beechie etal.. 2017, Brown 2002) to measure change from incised and confined channels to more connected river and floodplain. Collectively, the Program and partners are developing a monitoring plan in 2019, which will focus on a subset of limiting factors we find most effective for capturing Tucannon priorities. The goal would then be to use as much remote sensing information and approaches that are animated (reproducible) to reduce the effort and subjectivity of larger more complicated efforts.

#3 Use of Data and Information-The Program and our partners continue to rely on existing literature and the Tucannon Assessment and Conceptual Restoration Plan to inform our review of the biological benefits of proposed habitat actions. The current Restoration Plan update is focusing on integrating new date where it is available both locally and in literature.

#4 RM&E-The SRSBB is involved in the NWPCC effort to develop an M&E Strategy and is open to any guidance that could improve data and information available for project selection, design, implementation, and evaluation if and when it is developed.

#5 Screening Criteria-The Program and BPA, through coordination with the SRSRB Regional Technical Team, continue to consider and incorporate information on climate and are developing priorities based on future predicted changes. We currently have very little information on contaminants within the basin beyond the TMDL (WDOE 2010) for temperature. Human population growth within

the Tucannon basin in relation to real estate development has been relatively stable over the last decade with few new homes constructed. There is some information regarding demands on natural resources identified in a WDFW studies conducted on public resource use on the Wooten Wildlife Area.

#6 Information Gathering-The Program and partners continue to gather implementation and effectiveness monitoring data when it is available and summarize those data in annual and 3-year reports to the ISRP and NWPCC. Projects in partnership with CTUIR generally have implementation monitoring conducted pre and post construction but very few have effectiveness monitoring. Without dedicated funding for either type of monitoring for Program projects the information is limited and often inconsistent. Beginning in 2018 the Program has coordinated the development of a website and GIS supported database with the CTUIR, which will be available for release in 2019 at the domain Tucannon.com.

#7 Monitoring Sites-The monitoring projects directly associated with the Program are input into monitoringresrouces.org but to this point the restoration project data is stored at hws.paladinpanoramic.com and Snakeriverboard.org. An effort to load project data into to cbfish.org will be undertaken in 2019.

#8 Two-Year Contracts-The SRSRB encourages the NWPCC to coordinate directly with BPA on the potential for two-year contracts for the umbrella projects. The Tucannon Programmatic would benefit from such a change.

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Figures
Tucannon River Programmatic Summary Report

Project #: 2010-077-00

Annual Summary Report

(Reporting Period January 2018 to December 2018)

Contract: # 78510

Figures 1 – 27

PA-1 2017 High Flow

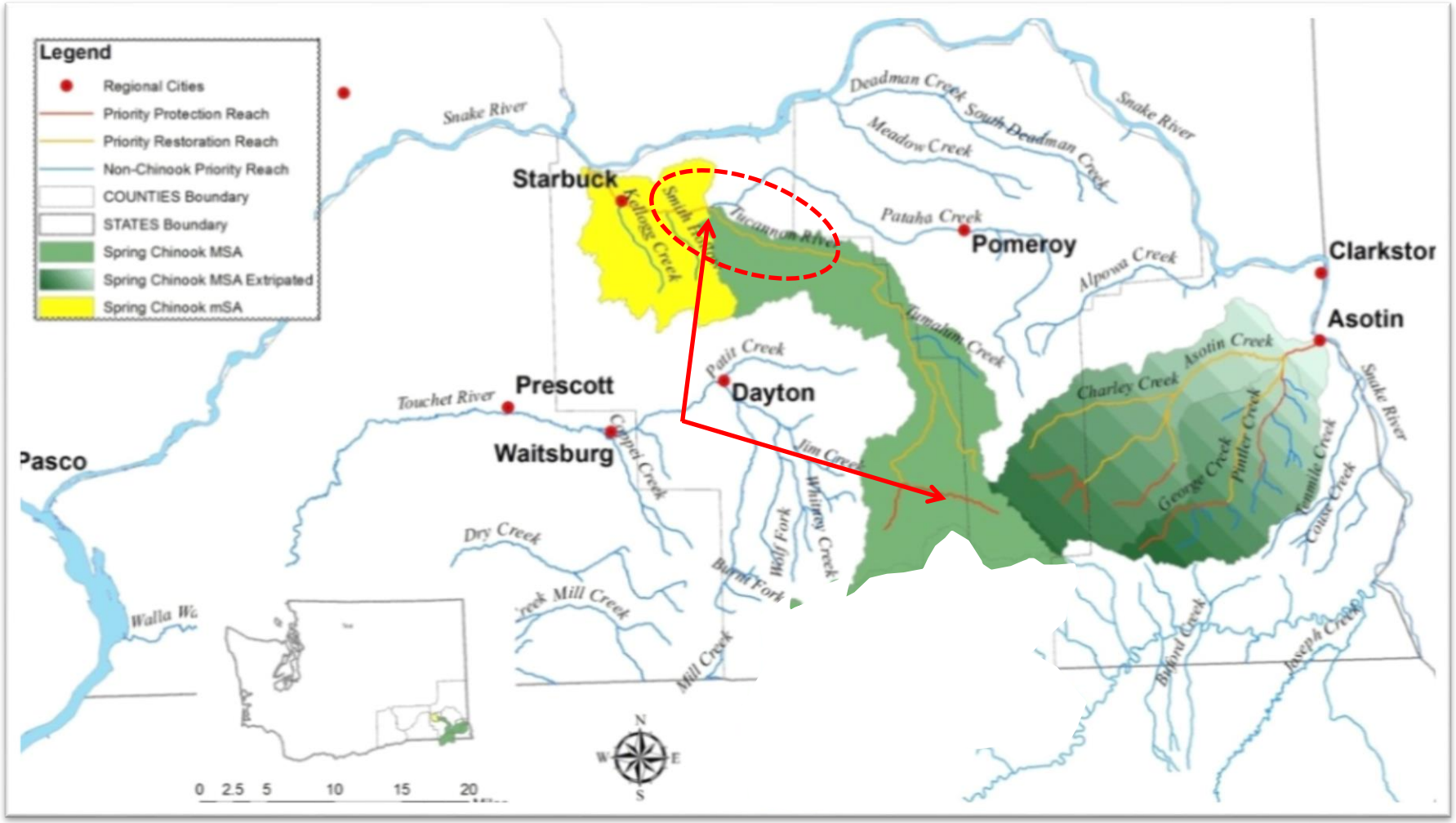

Figure 1: The Tucannon River Watershed located in southeast Washington, is the downstream most tributary of the Snake River and makes up ~2% of the remaining anadromous zone in the Snake Basin. The Snake River Salmon Recovery Plan (2011) priority areas for Snake River ESU spring Chinook and steelhead are highlighted in green (major spawning area) and yellow (minor spawning area) polygons, including the Tucannon, and Asotin River basins. The Asotin spring Chinook population is believe to be functionally extirpated, however the tributary remains a wild steelhead sanctuary. The two red arrows indicate the approximate upstream/downstream boundaries for the Tucannon Programmatic spawning and rearing habitat restoration priority reach. In 2018, the programmatic initiated consideration of priority actions in reach 3-5 indicated by the dashed red oval.

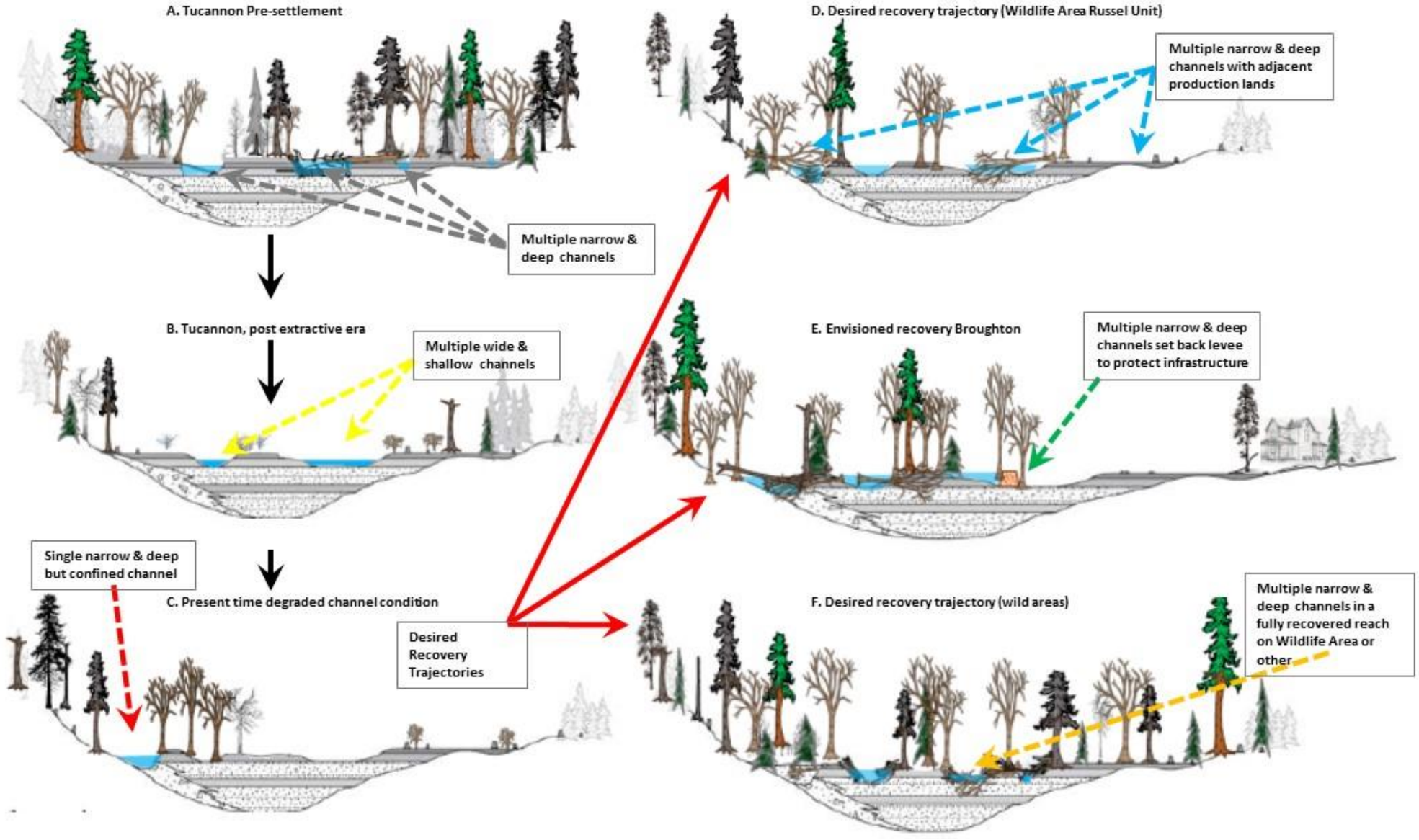

Figure 2: Tucannon conceptual stream channel model developed for forested wandering gravel bed sections of the river. This model illustrates an idealized cross section of the Tucannon River floodplain and riparian forests over time since pre-settlement. Section A through B illustrate changes from pristine through a period of degradation leading to wide shallow river channels, to a modified condition with single narrow channel however confined (section C) and recovering riparian habitat. Section D-F illustrate desired recovery trajectories for three different land types that all benefit salmon and steelhead. Section D, illustrates working landscape where occasional flooding is acceptable. Section E, illustrates working lands with infrastructure protection needs and setback levee, and Section F a full wild land restoration. All three approaches benefit salmon and using this approach has enabled us to extend restoration into private production lands.

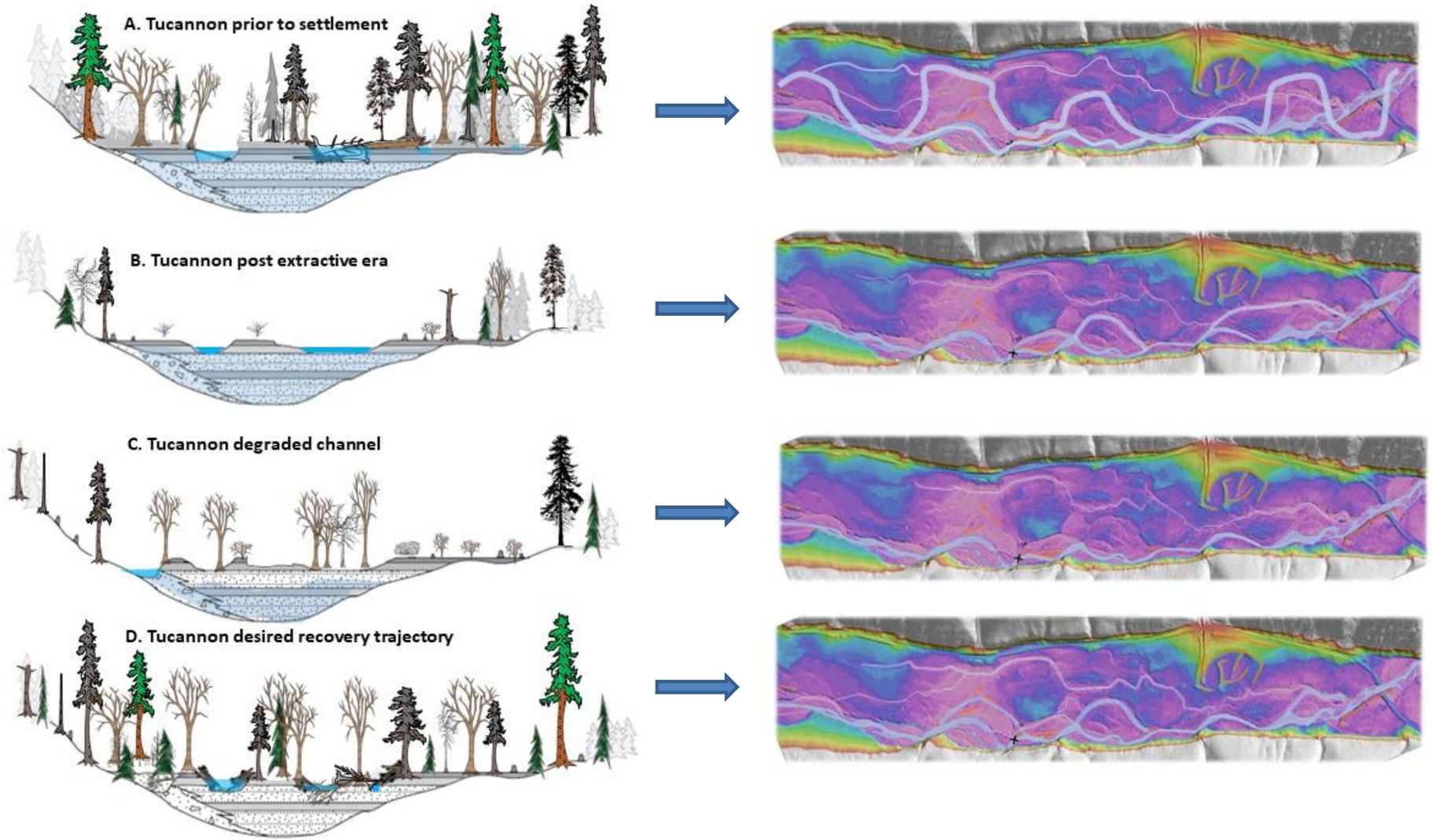

Figure 3: The upper left illustrates the Tucannon Rivers forested wandering gravel bed channel type and the evolution it has undergone from historic through present times to desired restored state. The maintenance of the forested wandering gravel bed is dependent on the floodplain forests and the large wood debris to provide equilibrium. In the absence of trees to stabilize lateral channel migration the channel will have a tendency to become wide and shallow (section B). In the Tucannon the progression was the removal of trees, loss of soils during floods and then modification of the channel (levees and berms) pushing it to the valley walls trapping it there with levee, riprap and channel incision. The illustrations on the right represent an example relative elevation model for floodplain and channel patterns corresponding to the sections to the left. The light blue lines illustrate the wet channel extent through the channel evolution, trending from high channel length to less as degradation progress. Our focus as a program is to work in these areas to recover channel extant where possible.

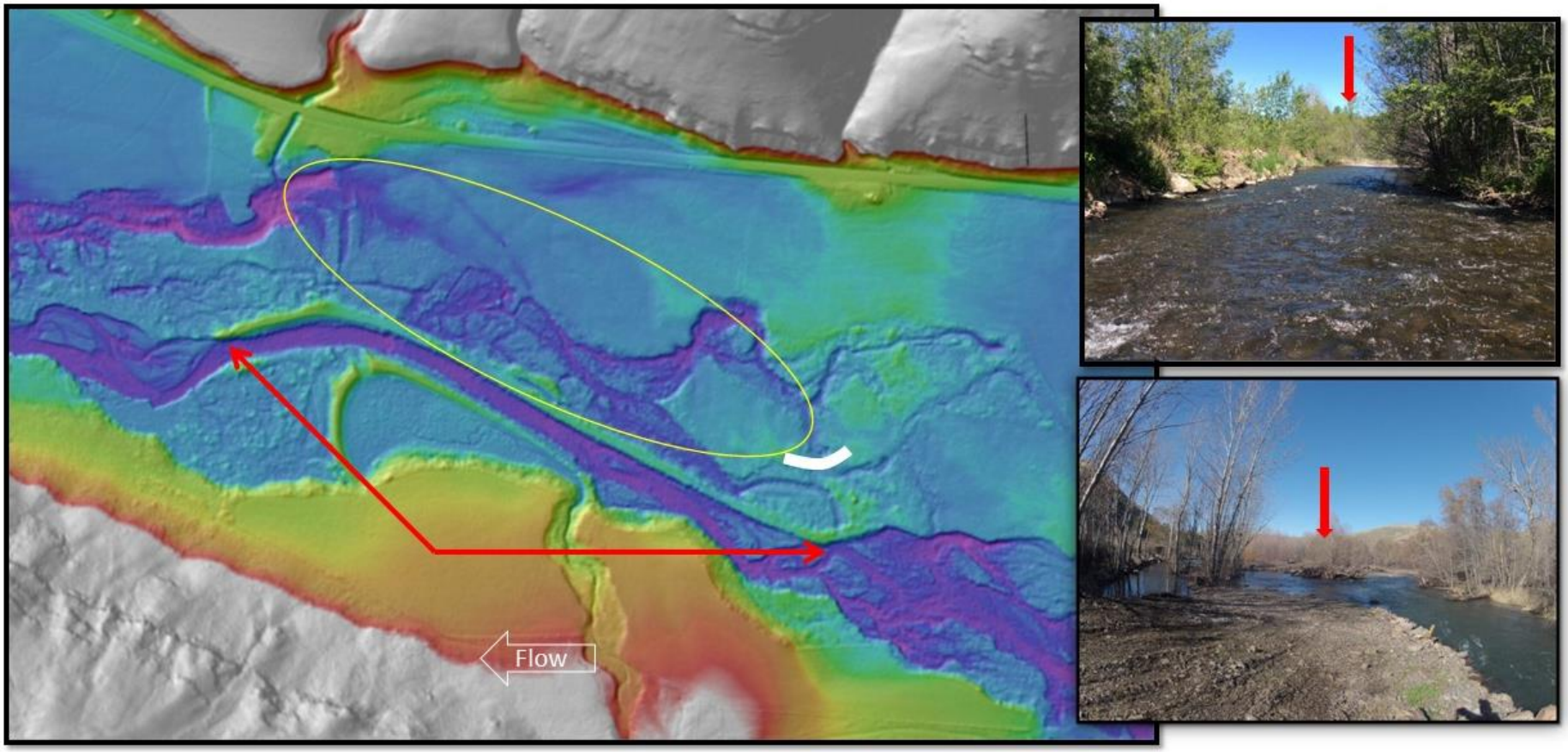

Figure 4: Floodplain connectivity through structure removal in the Tucannon occurs in two primary forms. One involves the removal of river levees placed on the riverbank for the purpose of containing flood flows and channel migration. The relative elevation model (left) illustrates the low-lying floodplain (dark blue-purple indicating lowest ground) cut off from the river by levee indicated by red arrows. Floodplain in the Tucannon is also disconnected by gravel berms placed in flow paths to prevent flooding into them (example indicated by the white arc). Following levee removal it is often necessary to remove these berms or cut pilot channels to initiate flows into areas like the one highlighted by the yellow oval. Right images show a before after image of a levee breach constructed in 2015 on private property.

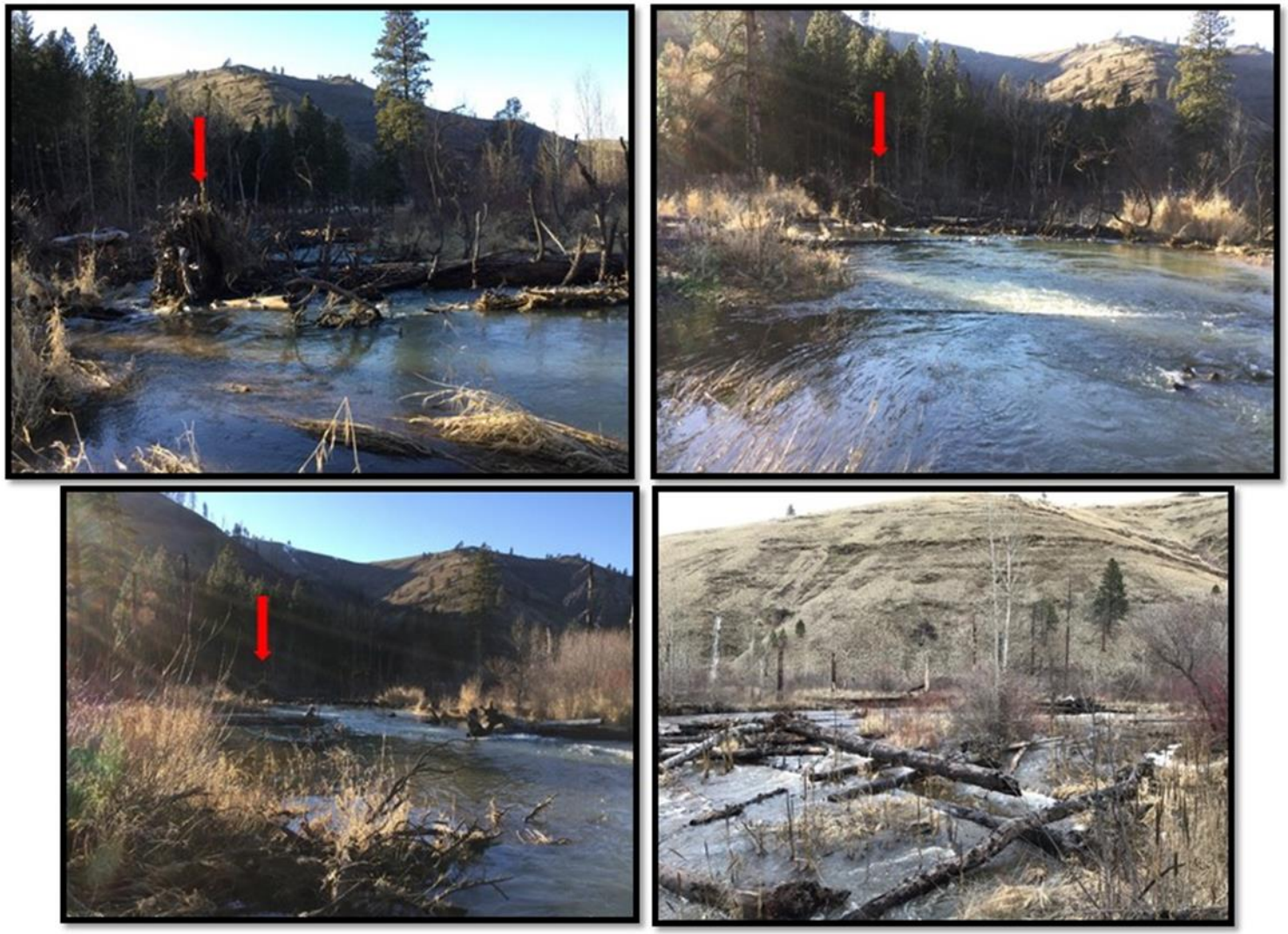

Figure 5: A LWD channel spanning structure build in the Tucannon to reverse the effects of channel entrenchment, through encouraging bed load deposition and channel migration. This type of structure is used in the Tucannon to engage new or disconnected flood paths or inundate greater areas of floodplain at lower flood stage.

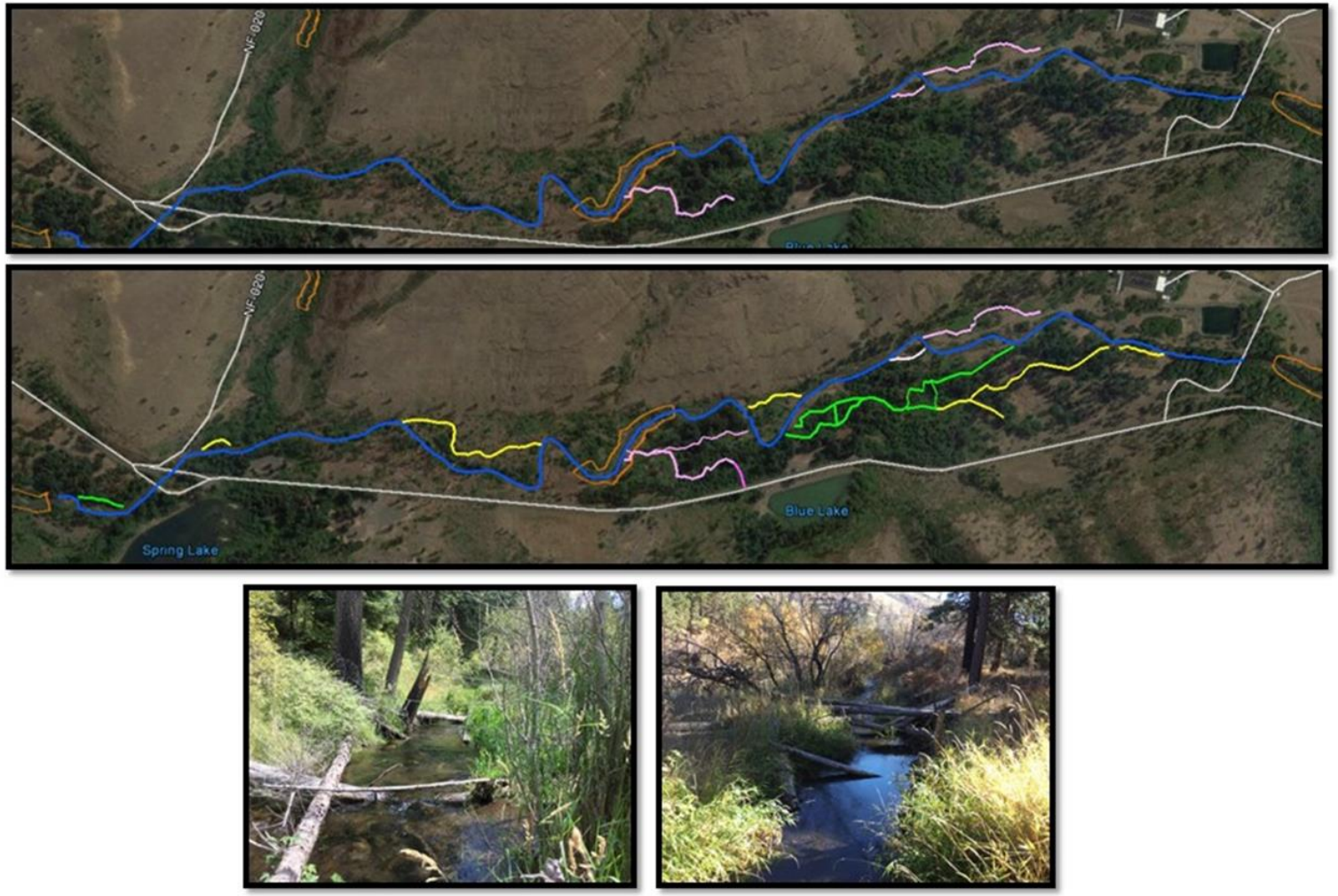

Figure 6: The program partners within the Tucannon have used side channel re-connection actions to reconnect floodplain and increase River Complexity. The upper map illustrates side channel reconnection in one project reach in the Tucannon (upper pre-project and lower post project, with the green lines being perennial, yellow being ephemeral and pink being reconnected tributaries. The lower pictures illustrate channel conditions within reconnected side channel reaches.

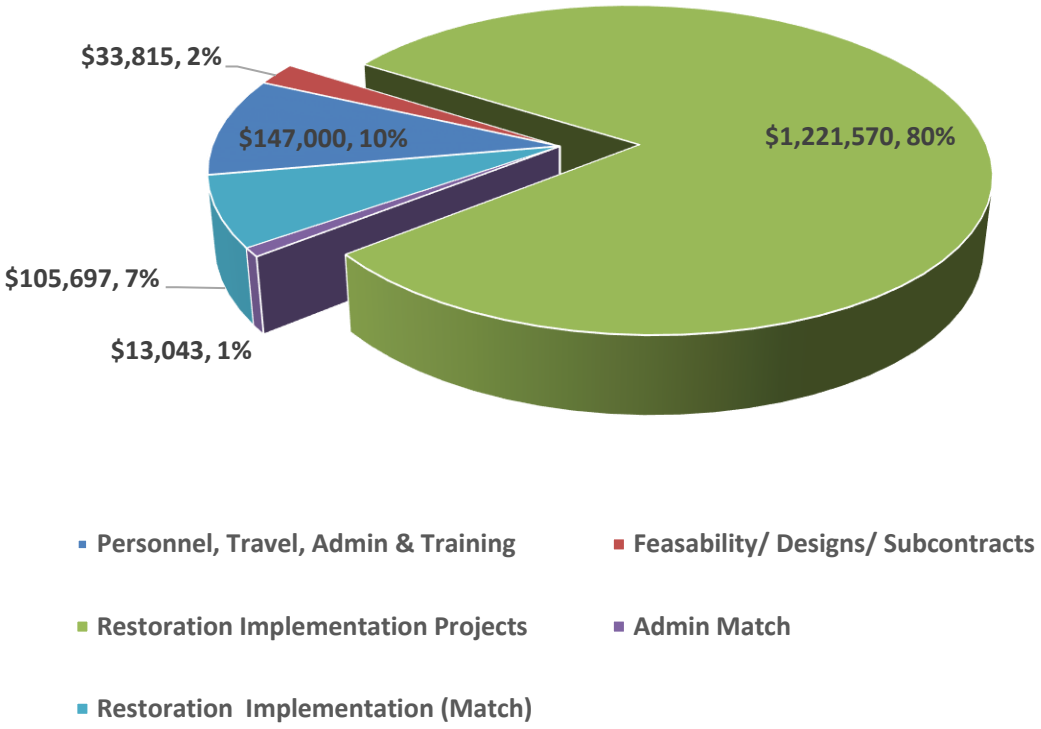

Figure 7: The FY18 Programmatic implementation budget including BPA funds and acquired match. In 2018, program match accounted for ~8% of the overall budget in the Tucannon. Matching funds were mainly in the form of WDFW in-kind project engineering and SRFB grants acquired by CCD. In 2018, ~87% of the program was used to implement projects with only ~13% going to administration, outreach, project designs and project effectiveness monitoring. In 2018, WDFW initiated a levee removal and floodplain connectivity project at PA 13 with will be matched to the PA13 project in 2019.

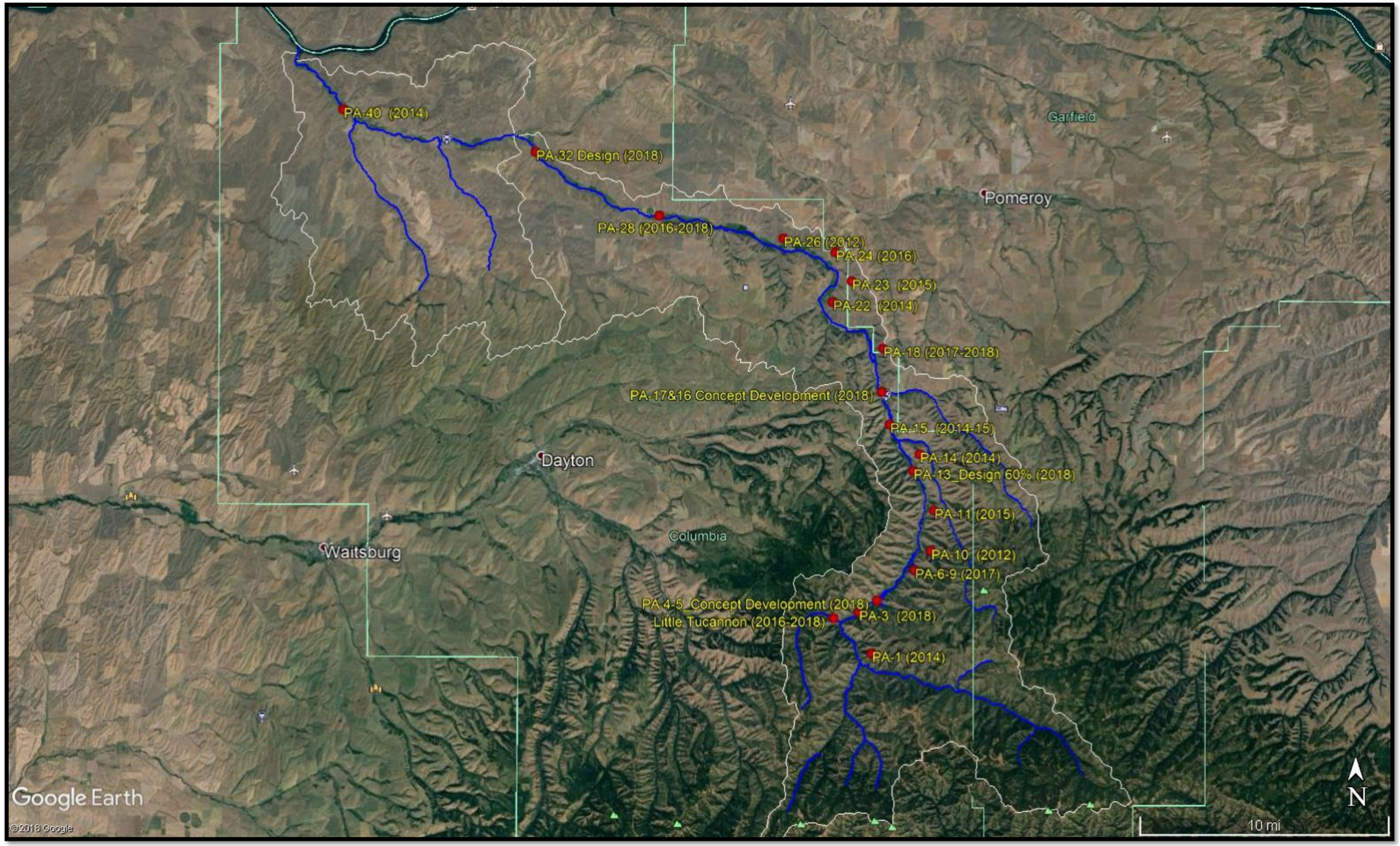

Figure 8: The map above identifies the approximate locations of projects that have had restoration actions designed or implemented, as part of the Tucannon Habitat Programmatic between 2011 and 2018. In total, 19 project areas have had restoration actions implemented over the past 8 years between 2011 and 2018.

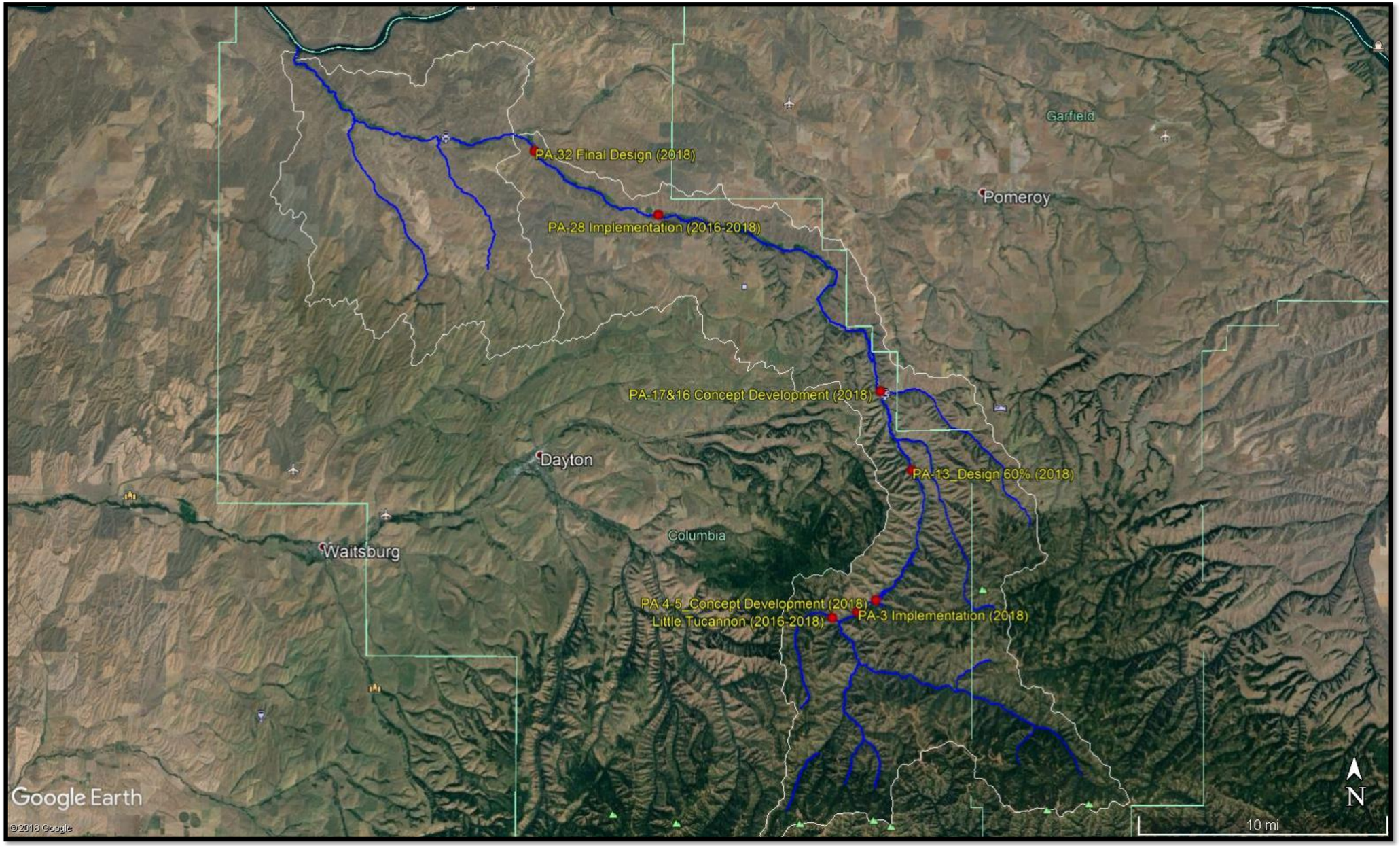

Figure 9: Google Map of the Tucannon basin, from the headwaters in the Blue Mts (lower) downstream to the Snake River (upper) located in SE Washington east of the City of Dayton. The red dots indicate the approximate locations of the three Programmatic supported projects, the two design projects and the two project concepts implemented in 2018.

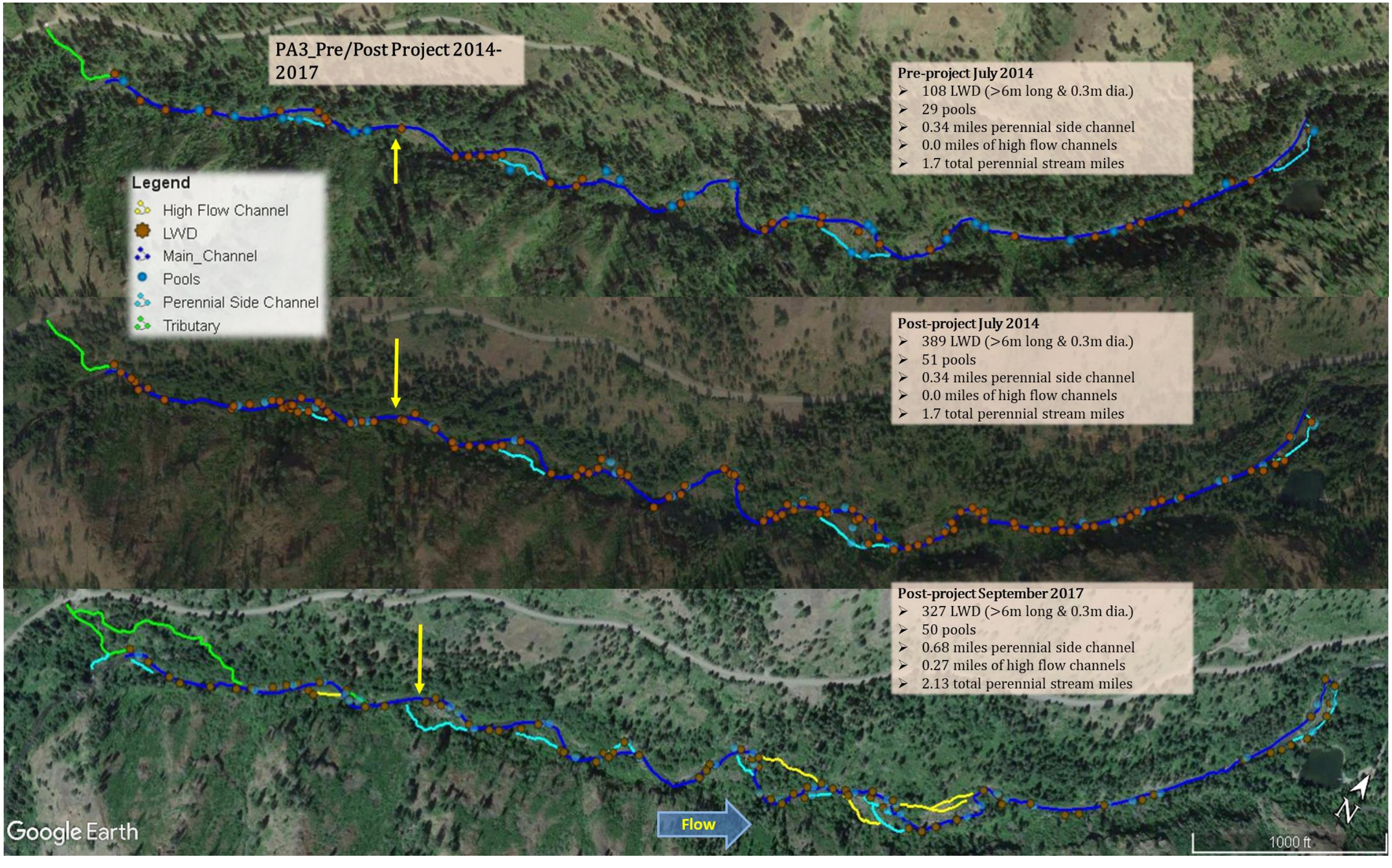

Figure 10: Project Area 3 restoration actions and outcomes between 2014 and 2017, illustrating the position and frequency of log jams, pools and side channels. The three separate maps represent the time line from pre-project in 2014, post-project 2014 and post project 2017, shown respectively from top to bottom. Project metric data, was collected using rapid habitat approach as part of project implementation/effectiveness monitoring, is provided within the map tables for each time interval. The yellow arrow indicates the approximate location of the CHaMP/AEM monitoring treatment site located within the reach.

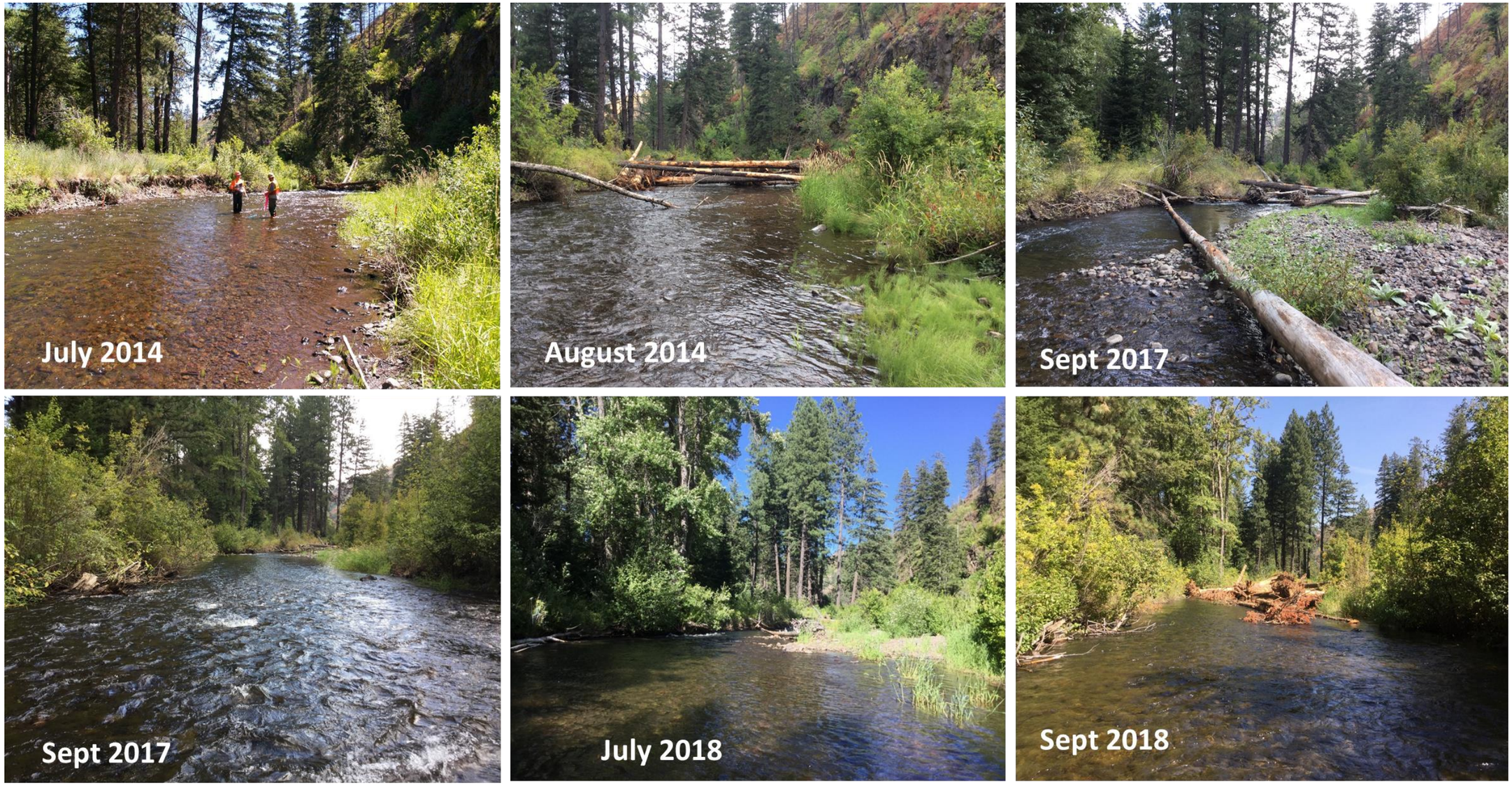

Figure 11: PA3 photo time series illustrating changes in entrenchment and channel shape preceding 2014 restoration treatment, through four winter freshets with one of them being a significant bed load mobilizing event~1,400 cfs (March 2017). The upper left image shows the pre-treatment plain bed channel, and to its right the 2014 treatment. The upper right and lower left images show a change in channel shape and some aggradation of the river bed. The lower middle and lower right images illustrate the 2018 restoration treatment designed to maintain and increase river bed aggradation occurring at this location, with the long term goal of capturing the left bank floodplain significantly increasing habitat river complexity within the reach.

Figure 12: Natural channel spanning log jam located on the Tucannon River within Project Area 3. A channel spanning log jam has persisted at this location for >20 yrs (USFS personnel communication) and has been sustained by a number of very large ponderosa pines and Douglas fir trees estimated to be >30" in diameter. The trees have been buried in river cobble and are maintaining grade preserved in a wet environment. The log jam has been used as model for reference condition incorporated into the design of projects throughout the Tucannon (Upper right). The left image illustrates remains of a natural spanning jam which failed due to the failure of the main key piece in 2010, which can still be seen in the left side of the right image. The loss of the jam reduced habitat complexity and increased entrenchment within the reach.

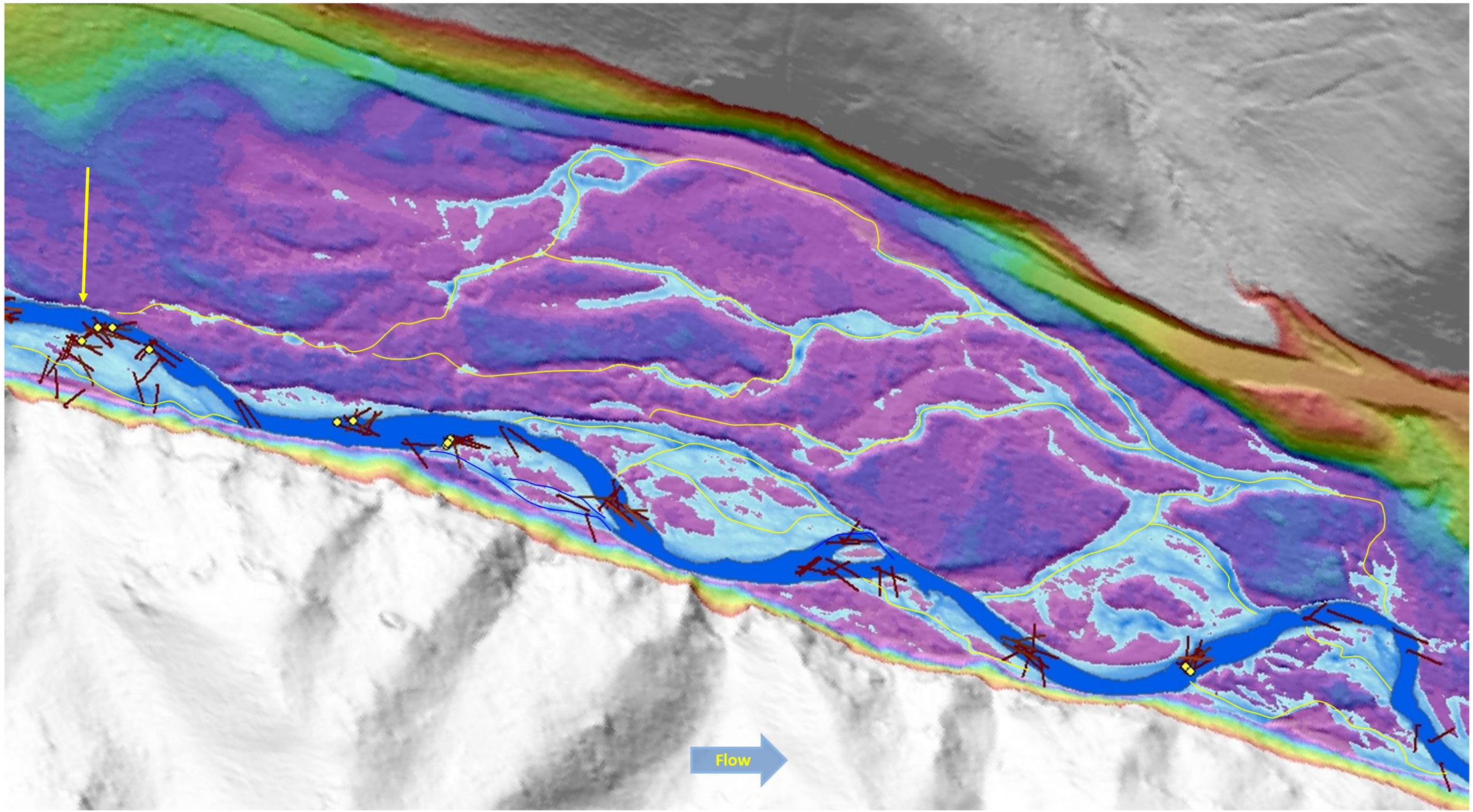

Figure 13: The map above illustrates the middle third of Project Area 3, 2018 design. As it was built in 2018. The map is a relative elevation model generated from a November 2017 bathymetric LiDAR survey, with the water surface layer (at 130 cfs) in dark blue and the 2 yr flood in light blue. The brown symbols (lines) represent as –built log structures with each line a separate log, while the yellow dots indicating a ballast rock (~3 ton rock) placed in 2018, by helicopter. The yellow lines trace the anticipated high water flow paths, connected beyond a 2 yr flow interval. The yellow arrow indicates the approximate location of the log jam illustrated in the photo time series in Figure 11, which was designed to increase inundation of the left bank flow paths during a two years flow event.

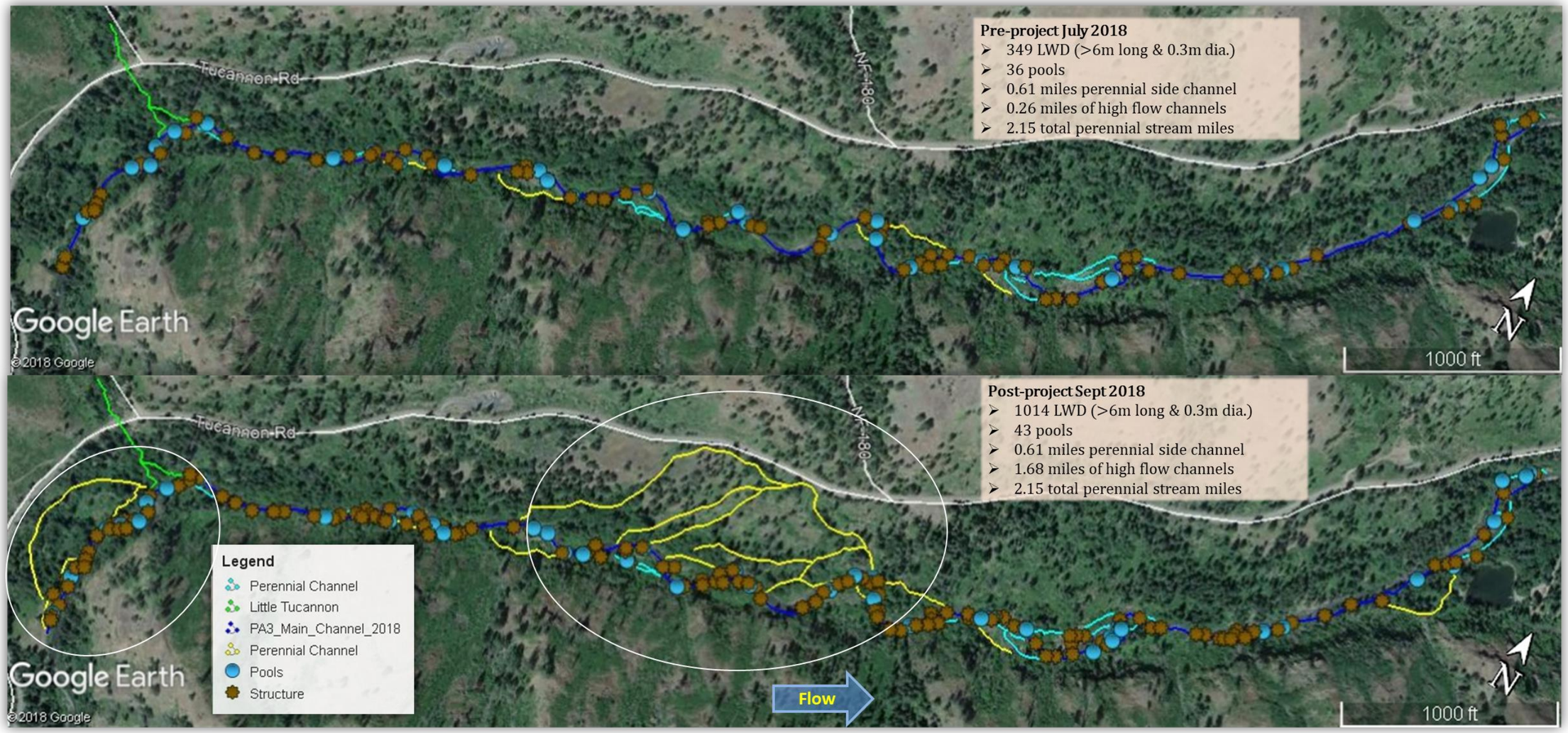

Figure 14: Project Area 3 restoration actions and outcomes for wood loading implementation in 2018, illustrating the position and frequency of log jams, pools and side channels. The upper maps represent the time frame from pre-project in July 2018, post-project September 2018 shown on the bottom. Project metric data, collect using rapid habitat data collected as part of project implementation/effectiveness monitoring, is provided within the map tables for each time interval. The two white ovals indicate areas of the floodplain targeted with LWD structures specifically to reconnect disconnected flow paths. It is anticipated during a higher flow some of the new flow paths would become perennial. To accommodate new perennial flow floodplain LWD was placed in these channel to create as roughness.

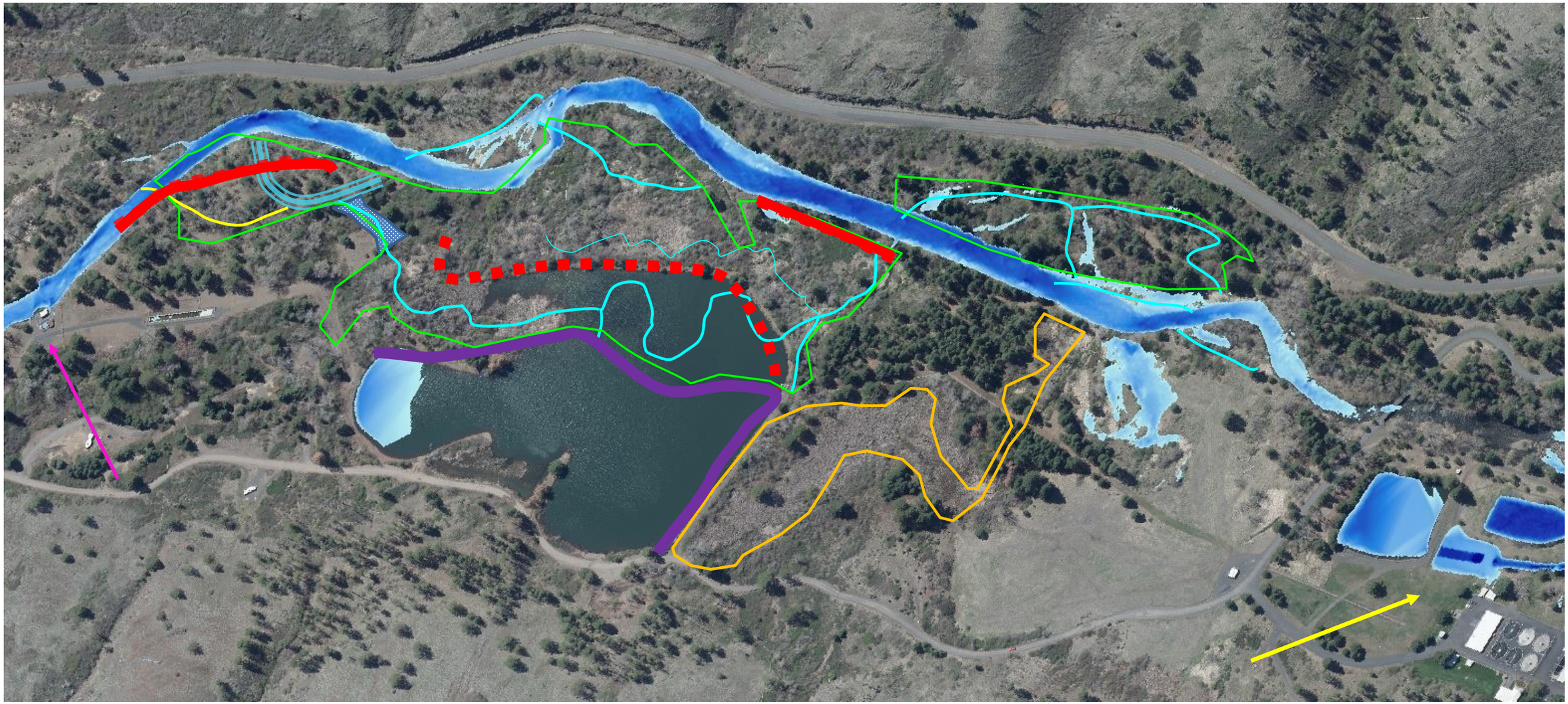

Figure 15: Project Area 13 is located just upstream from the Tucannon River Fish Hatchery (indicated by yellow arrow) and downstream from the fish hatchery trap (pink arrow). The image was taken in early April 2018 before Rainbow Lake was drained and reconfigured in July 2018 by WDFW. The heavy dashed red line indicates the lake levee that was removed as part of the WDFW Floodplain Management Plan, and was relocated to the position of the heavy purple line. The river reach is both leveed and incised as a result of past management and manipulations, which has significantly reduced connectivity to the floodplain. The blue color ramp is indicating the current 5 yr. floodplain, which leads to the transport of river bed material through the reach. With the reconfiguration of the lake and the removal of the 3 levee sections (~650' highlighted in red line & 925' in red dashed line) and the placement of ~31 associated ELJ structures (See 60% design attached to contract #72044) it is anticipated that ~21.8 acres of floodplain would be reconnected at the 1 yr. flood interval (area indicated by green polygons). The area enclosed in the orange polygon indicated an area of wet land which will be connected to flood flows and fish access following the completion of PA 13.

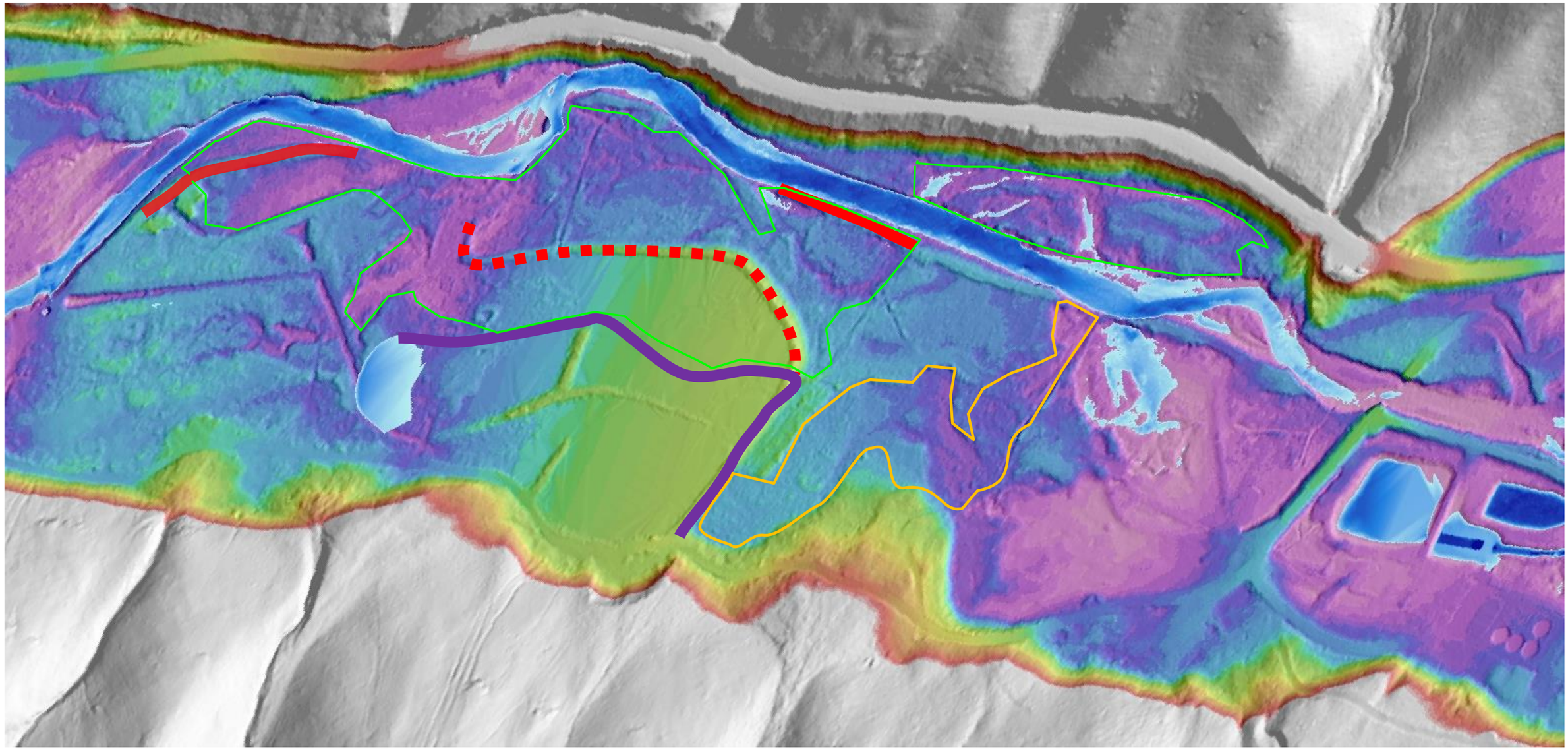

Figure 16: Project Area 13 relative elevation model developed from the 2017 LiDAR data set. The image was taken in early April 2018 before Rainbow Lake was drained and reconfigured in July 2018 by WDFW. The red dashed line indicates the lake levee that was removed as part of the WDFW Floodplain Management Plan, and was relocated to the position of the purple line. The river reach is both leveed and incised as a result of past management and manipulations, which has significantly reduced connectivity to the floodplain. The blue color ramp is indicating the current 5 yr. floodplain, which leads to the transport of river bed material through the reach. With the reconfiguration of the lake and the removal of the 3 levee sections (~650' highlighted in red & 925' in red dashed line) and the placement of ~31 associated ELJ structures (See 60% design attached to contract #72044) it is anticipated that ~21.8 acres of floodplain would be reconnected at the 1 yr. flood interval (area indicated by green polygons). The reconnected wet lands are highlighted by the orange polygon. Proposed and anticipated flow paths are highlighted on the previous figure (15).

Figure 17: Tucannon River Project Area 13 pre-project conditions in 2018. The upper left image is the Tucannon Fish Hatchery weir and fish trap located at the upper most end of the project area. The project reach is described as a combination of plain bed riffle and rapids (lower left and right images) caused and maintained by river levees and riprap. The lower left image shows one of the river levees being removed (yellow arrow) in 2020 as part of the restoration project design for this reach.

Figure 18: The upper left image was taken in March 2019 and illustrates the upstream extent of the Rainbow Lake dam removal that took place in 2018 as part of the WDFW lead Floodplain Management Plan. The yellow arrow indicates the previous position of the dam/levee that was removed. Following the removal of the dam the area that was previously lake bed was roughened with LWD and will be planted with wetland plants in the spring 2019. A flow path was developed through the previously inundated area (upper right) however this area remains disconnected from the river by levees which will be addressed during the implantation of PA13 in 2020. The lower right image shows the downstream end of the treated area.

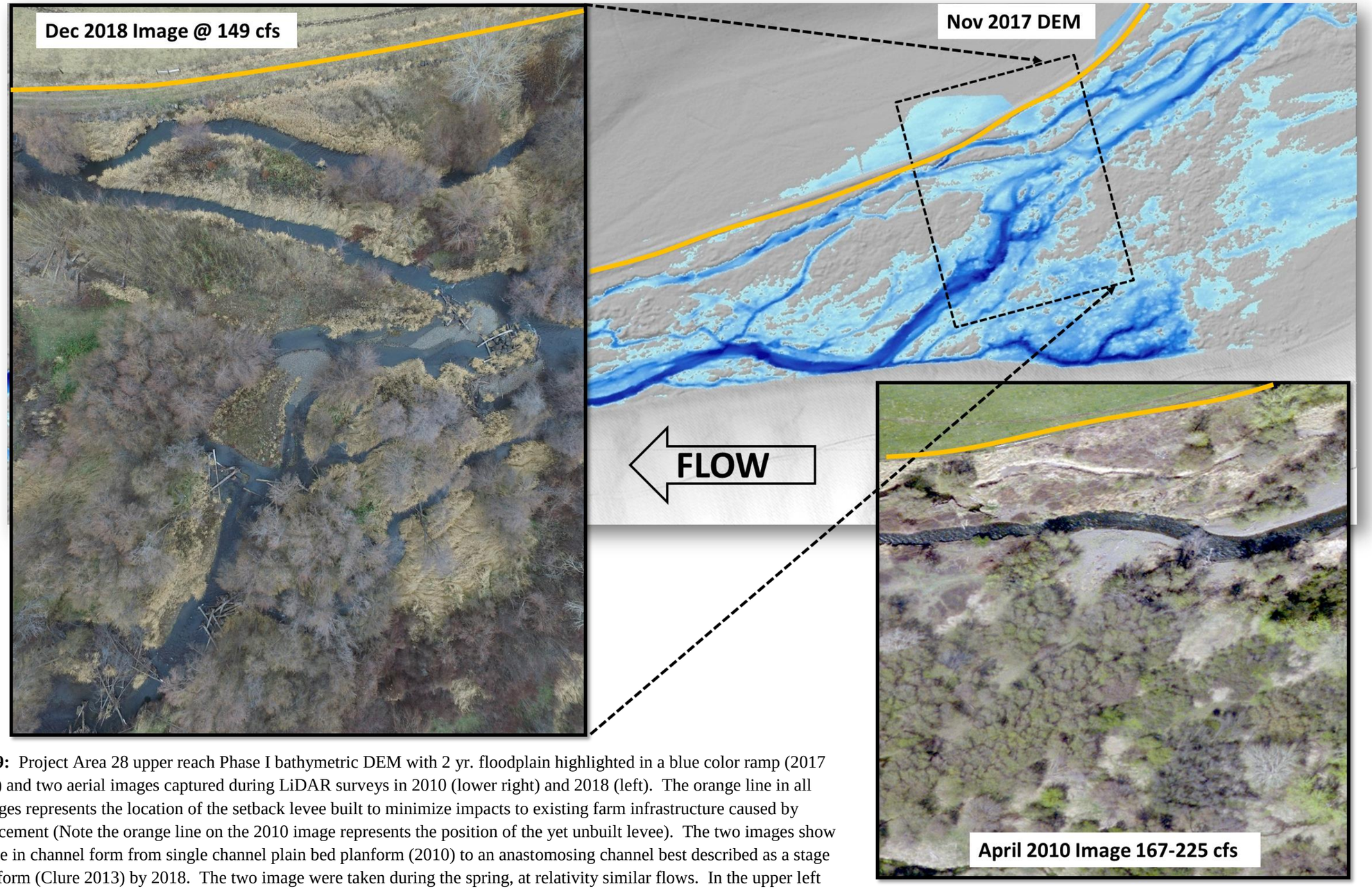

Figure 19: Project Area 28 upper reach Phase I bathymetric DEM with 2 yr. floodplain highlighted in a blue color ramp (2017 Nov data) and two aerial images captured during LiDAR surveys in 2010 (lower right) and 2018 (left). The orange line in all three images represents the location of the setback levee built to minimize impacts to existing farm infrastructure caused by LWD placement (Note the orange line on the 2010 image represents the position of the yet unbuilt levee). The two images show the change in channel form from single channel plain bed planform (2010) to an anastomosing channel best described as a stage zero bed form (Clure 2013) by 2018. The two image were taken during the spring, at relativity similar flows. In the upper left post project image some of the Phase I LWD structures responsible for developing and supporting the high degree of channel complexity are visible.

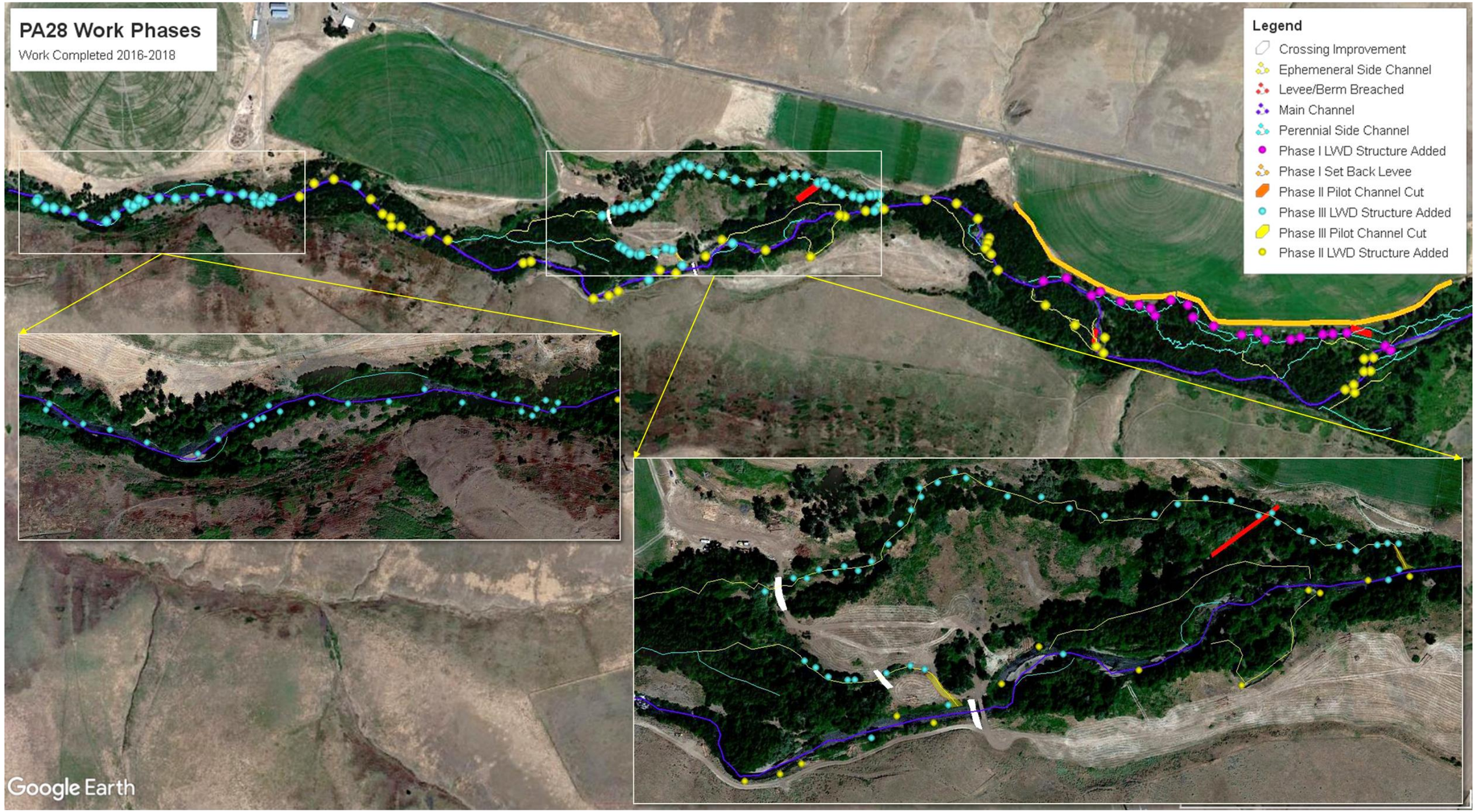

Figure 20: PA-28 was subdivided into three consecutive work windows (phases I-III) for the purpose of fitting into past funding cycles between 2016 and 2018. The map illustration above shows the break out for the each phases. The purple dots indicate Phase I LWD structures that were palace in 2016 (22 LWD structure & 4 single logs). The yellow dots indicate Phase II (2017) LWD (47 structures & 4 single logs) and the blue dots indicating main channel and floodplain structures (24 Structures, 10 single logs, 2 Floodplain structures & 41 floodplain logs), Phase III in 2018. The two expansion boxes magnify the work completed in 2018, including the improved crossings (white polygons), levee berms breached (red line) and side channel pilot cuts (yellow polygons).

Figure 21: Phase I side channel pre project (upper left) immediate post project (upper right) and post high flow 2017 (lower left). The lower left photo shows the level of the flow in March 2017 and ~1,100 cfs. Flows during the flood extended across the entire floodplain and exhibited relatively shallow depth and low velocities. Flowing the flood very little scour was observed on the floodplain, however some areas had >2" of fine sediment deposition and residual pools depths within the channel exceed 1.5 m in some areas. The yellow arrow indicates the same general location through the time series.

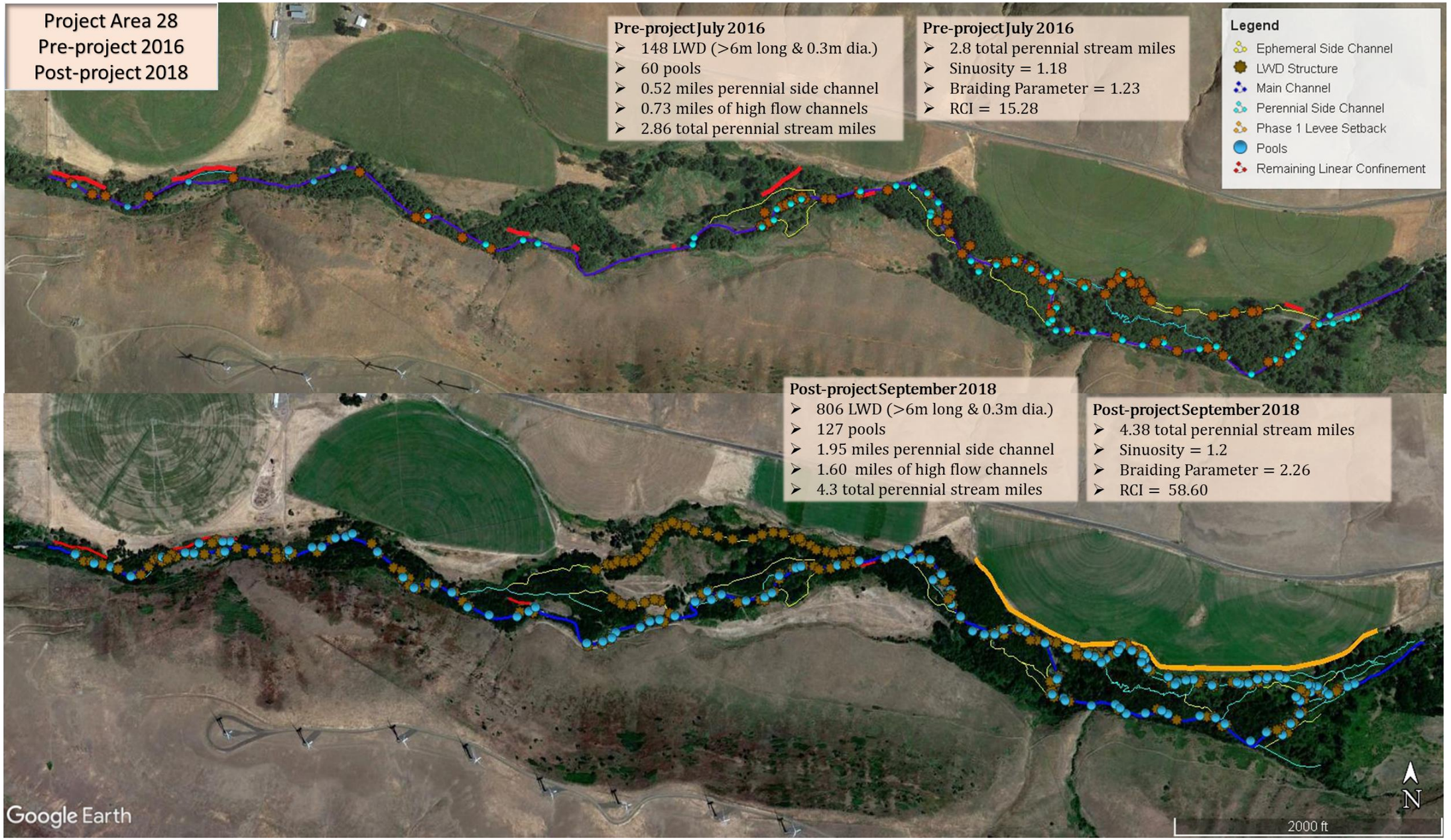

Figure 22: Project Area 28 Phase I through Phase III channel and floodplain complexity actions. Pre-project condition showing LWD structures, pools and side channels in 2016 (upper). The post project condition following LWD placements and side channel connection actions in Phase I - Phase III (lower). The red lines in the upper map are the gravel berms and or rip rap present in the project area before and after the project. The orange line is the setback levee placed in 2016. An estimate for river complexity index (RCI) was generated to monitor change in channel complexity between 2016 and 2018 and into the future. The two yellow arrows indicate reconnected high flow paths connected by pilot channels and had LWD single logs placed in them.

Figure 23: Project area 28 work completed in 2018 before after construction images, the left image showing a structure built for channel complexity and fish cover, the center channel complexity and cover and the right a floodplain connectivity structure design to split flows and develop in channel islands. The upper images are taken in July 2018 at ~125cfs and the lower images in September at ~70cfs. or a low base flow.

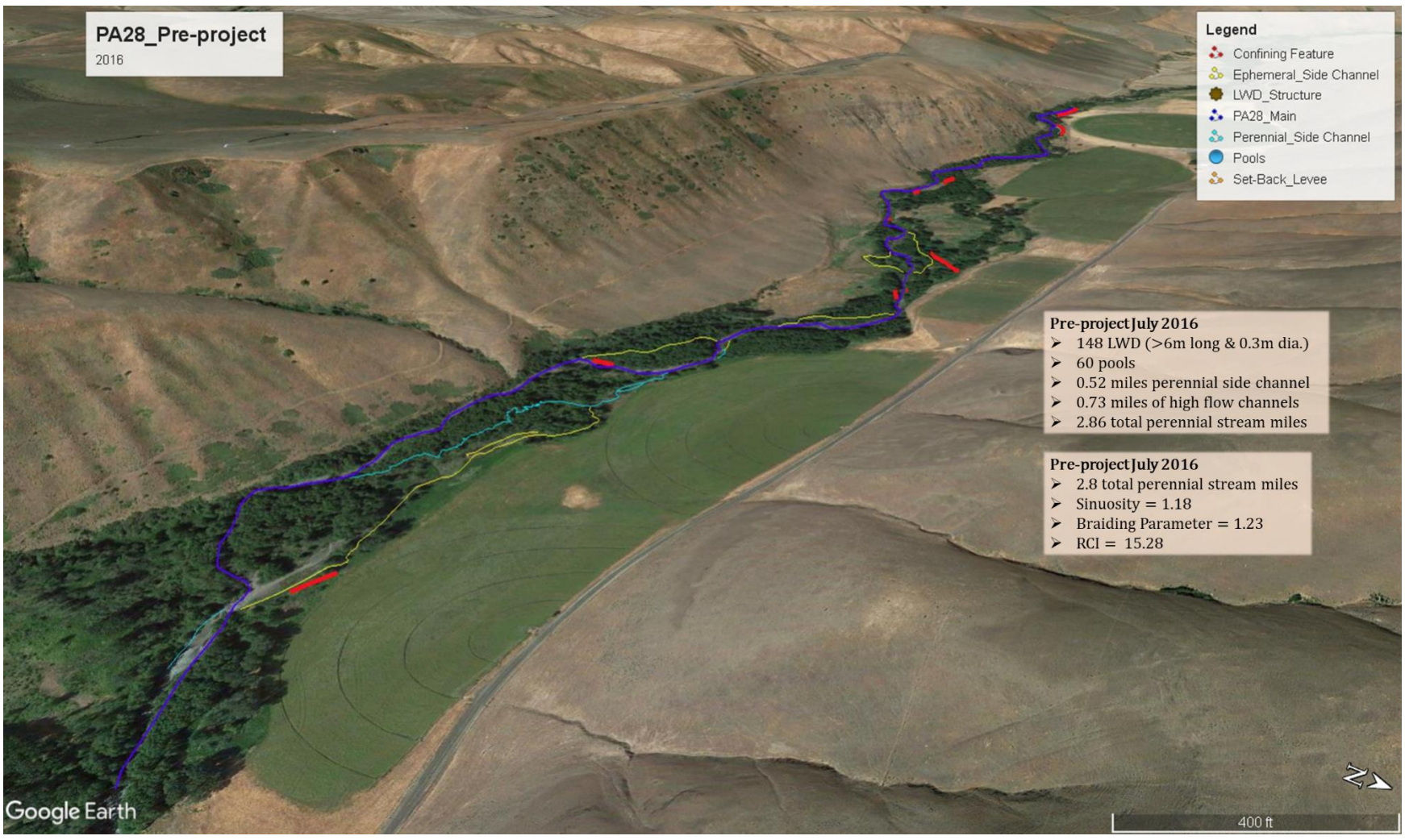

Figure 24: Project Area 28 floodplain connectivity in 2018 following 3 consecutive years of implementation. LWD structures were placed at a strategic location in relatively high density throughout the project to increase channel complexity and floodplain connectivity. The upper map illustrates the floodplain connectivity and channel complexity in the 2016 pre-project condition. The lower map illustrates the post project condition with significant higher channel connectivity at winter flow (100 cfs). The orange line indicated the position of a setback levee built to preserve agricultural infrastructure. It is anticipated that the lower reach (indicated by the yellow arrow) will be captured during successive high flows leading to further increases in river complexity and floodplain connectivity.

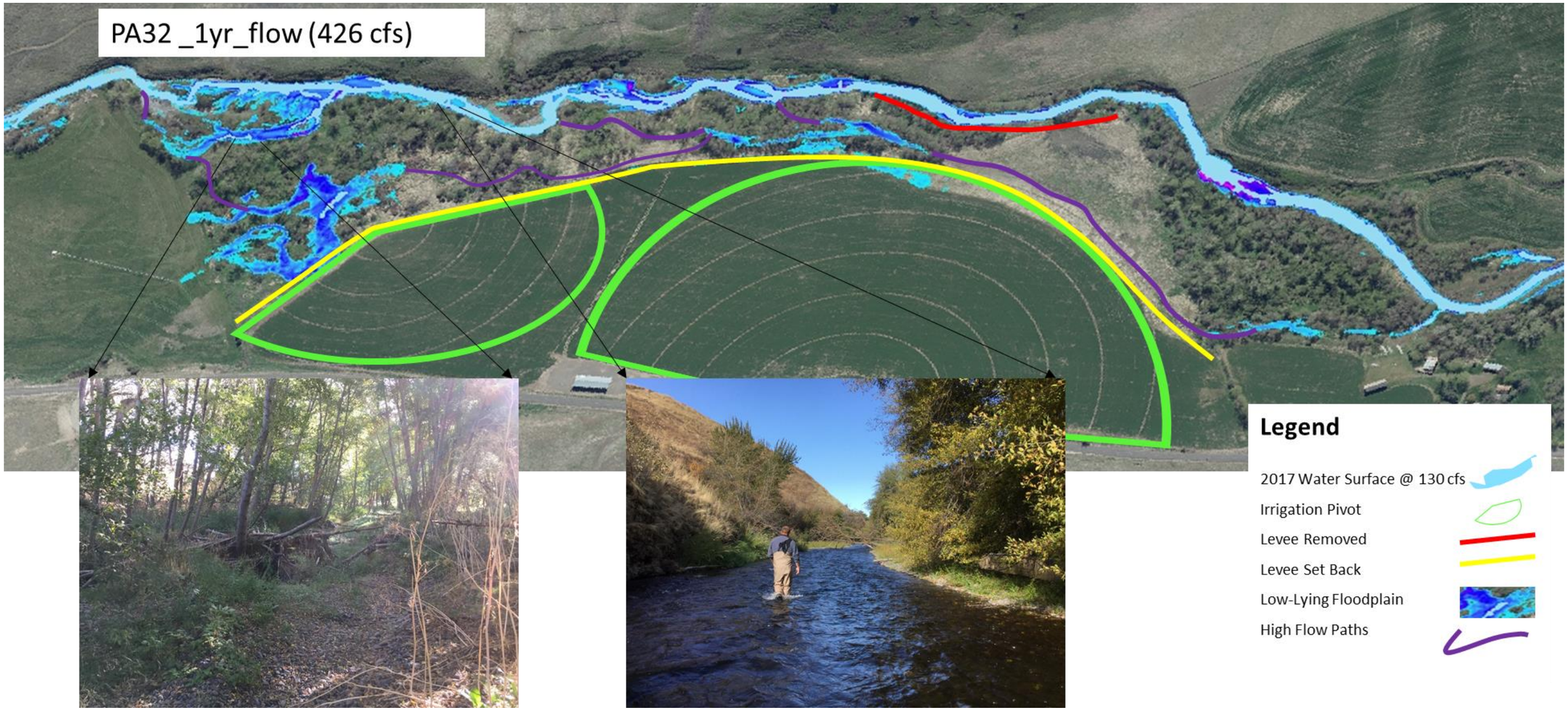

Figure 25: Project Area 32 is located in an entrenched and disconnected reach but has opportunities to reconnect floodplain at <2 yr interval while maintaining existing agriculture. The map illustrates the 1yr flood elevation in the blue color ramp. The purple curves indicate the anticipated flow paths to be connected between the 1-2 yr flow events following LWD structure placement. The red line indicated the position of a river levee that would be removed and the yellow line a setback levee built to minimize impacts to the agricultural field. The two images indicate the position of the pre-project photos collected in 2018, with the left one showing disconnected flow path and the right a part of the plain bed channel prevalent throughout the reach.

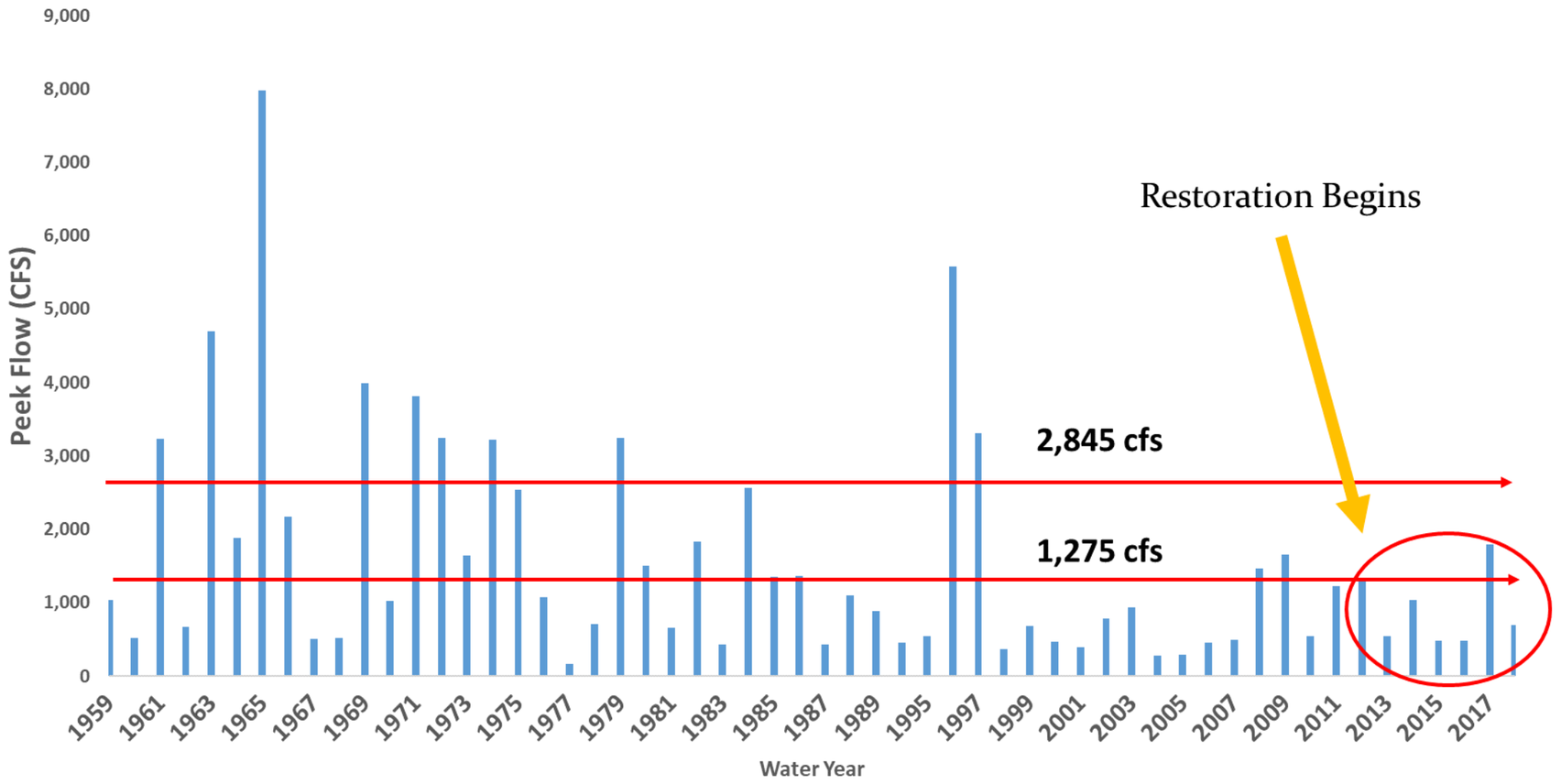

Figure 26: Annual peek flows for the Tucannon River for the time period 1959-2018 measured at the USGS gage in Starbuck WA. The lower red line indicate the approximate 2 yr flood event which is estimated to be 1,275 cfs, and the upper the 5 yr event estimated to be 2,845 cfs (Anchor QEA 2011 Nov). The red oval indicated by the orange arrow highlights the time period in which the Tucannon Habitat Program has been conduction restoration within the Tucannon Basin.

Figure 27: In 2018, the CCD conducted a Post Assisted Log Structure project on the Little Tucannon River for the purpose of generating bed load and storing it. The upper image is a post project photo before high flow and the lower image is a structure following flow and grave deposition around the structure.

Tables
Tucannon River Programmatic Report
Project #: 2010-077-00

Annual Report
(Reporting Period January 2018 to December 2018)

Contract: # 78510

Tables 1-5

PA-14 2017 Winter Flows

Table 1: Tucannon Programmatic Habitat (2010-077-00) Objectives 2018 as defined in the 2010 project proposal in cbfish.org (https://www.cbfish.org/Proposal.mvc/Summary/GEOREV-2010-077-00)

Reduce channel confinement/increase floodplain connectivity so that no more than 30% river length is unnaturally confined. (OBJ-4)	The desired outcome of this objective is improved channel function, increase stream length and side channel habitat, restored hyporheic conditions and riparian survival.
Increase pool frequency to 15% of stream area (OBJ-3)	The desired outcome of this objective is to increase stream depth, habitat complexity, substrate sorting, and promote stable pool-out habitat for spawning.
Increase large woody debris to 2 or more pieces per channel width (OBJ-2)	Add LWD to increase pool quantity and quality, promote development of side channel and backwater habitat and streambed aggradation to increase floodplain connectivity.
Increase riparian function to 75% of maximum (OBJ-1)	Restore and protect riparian species composition and density to improve canopy cover, riparian area (acreage) and riparian structure.
Reduce maximum daily water temperature so that it does not exceed 72F at confluence of Pataha Creek (RM 11.8) (OBJ-5)	The outcome of this objective is to improve water temperature, increase useable habitat, and expand the geographic range of spring Chinook.
Decrease substrate embeddedness to 20% in all reaches above confluence of Pataha Creek (RM 11.8). (OBJ-6)	The outcome of this objective is to increase egg survival, improve invertebrate species diversity and abundance, and increase interstitial spaces.

Table 2: Tucannon Programmatic habitat restoration action accomplishments 2011-2018 measured using rapid habitat survey methods, including the project completed by Columbia Conservation District that the Programmatic was a technical partner. Key for symbols in table; bb - # of Key LWD Pieces >6m long & > 30cm dia, cc - # of multiple log structure added, ccc - # of multiple log structures present in recent survey, dd - total number of post project wood in reach >6m long & >30cm dia, ee - # of medium LWD >6m long & 15-30cm dia, * Miles of main channel treated based on Anchor QEA 2011 Nov Conceptual Report reported project lengths, ** Miles of LWD Key Piece placed including main and side channel, *** Only placed wood counted during survey and visible, **** This includes the natural wood survey from 2014 plus the 10 natural key pieces in Phase II 2015, ~ This includes the natural wood survey from 2014 plus the 10 natural key pieces in Phase II 2015, ~~ Estimated in CHaMP Table Sheet Summary Piece Per BF-Width. The project column also indicates the primary funding source for the project with blue indication the Programmatic, green indicating the Columbia Conservation District and yellow the proposed project to be completed 2016-18.

Tucannon Habitat Programmatic 2012-2018

Project Area	Year Implemented	Tier	River Miles Identified			River Mile Treated		Main Channel Treated (mile) *	Pre-project LWD Key Pieces (bb)	Placed LWD As-built (mile) **	LWD Key Pieces added (bb) ***	Placed wood Visible in Survey (bb) ****	Med LWD Debris Added (ee)	# Structures added (cc)	# of Floodplain Structures Added	# of Existing Structures (ccc)	# of single logs added (bb)	Natural Key Pieces Visible in Survey (bb)**	Natural Medium (ee)	Rapid Hab/Post Survey Visible (#of key pieces) (dd)	Pre-Current # of key piece/width(BF)	Post Project Current # of key piece/width(BF)
			from	to	Miles	From	To															
1	2014	2	50.10	49.10	1.00	50.10	49.45	0.65	44	0.81	231	231	37	38	0	0	13	17	9	248	0.60	3.42
3	2014	2	48.65	46.8	1.85	48.10	46.80	1.30	108	1.38	271	271	21	42	0	0	4	118	50	389	0.6	2.31
3	2018	2	48.65	46.8	1.85	48.20	46.80	1.40	330	1.56	608	960	82	58	12	40	10	77	31	981	2.31	5.54
4	2018-19	2	46.80	46.40	0.40	46.80	46.70	0.10	19	0.10	25	28	2	5	0	3	0	10	3	33		
6	2017	3	45.95	45.30	0.65	45.85	45.30	0.55	38	0.55	255	278	53	40	0	0	0	23	13	278	0.52	3.79
8	2017	2	44.85	44.40	0.45	44.95	44.40	0.55	74	0.71	153	186	23	26	0	0	0	33	5	186	1.40	3.61
9	2017	3	44.40	44.00	0.40	44.40	43.70	0.70	38	0.70	252	276	47	50	0	0	0	24	11	276	0.85	6.14
10	2012	1	44.00	42.40	1.60	44.00	42.40	1.60	99	1.94	300	445	312	69	0	87	13	23	8	468	0.55	2.61
11	2015	1	42.40	40.70	1.70	42.30	40.70	1.60	61	2.35	709	709	255	74	23	48	20	75	30	770	0.34	4.29
14	2014	1	39.20	37.15	2.05	39.20	37.70	1.50	64	1.64	712	647	65	71			17	50	28	697	0.36	3.96
15	2014	1	37.15	36.35	0.80	36.95	36.35	0.60	55	0.89	597	417	79	46	0	0	37	55	18	472	0.81	6.98
18a	2017	2	34.30	32.10	2.20	34.25	33.13	1.12	55	1.12	549	549	123	49	29	25	41	28	145	577	0.49	5.12
22	2014	1	30.30	29.30	1.00	30.00	29.40	0.60	10	0.63	36	36	0	8	0	0	0	10	42	46	0.16	0.71
23	2015	1	29.30	28.25	1.05	29.05	28.40	0.65	35	0.75	51			12				35	35	86	0.46	1.14
24	2015	1	28.25	27.50	0.75	28.25	27.50	0.75	43	0.99	498	354	32	28	0	0	33	23	53	377	0.5	4.36
26	2011	1	26.90	23.60	3.30	26.90	23.65	3.25		0.30	78	84	19	17		2		7	33	91		1.02
26	2013	1	26.90	23.60	3.30	26.85	24.85	2.00		0.75	78	84	19	17	4	5	1	7	33	91		1.02
28b	2016-18	3	21.50	20.00	1.50	21.50	20.00	1.50	139	3.29	463	463	141	62	66	2	1	103	99	566	0.56	3.75
29	2018	3	20.00	18.60	1.40	20.00	19.35	0.65	9	0.65	129	129	81	25	0	0	17	4	3	133	0.15	2.16

bb	# of Key LWD Pieces >6m long & > 30cm dia
cc	# of multiple log structure added
ccc	# of multiple log structures present in recent survey
dd	total number of post prject wood in reach >6m long & >30cm dia
ee	# of medium LWD >6m long & 15-30cm dia

^	Projects supported by Programmatic but not with funding
*	Miles of main channel treated based on Conceptual Report Design RM lengths (Anchor QEA 2011 Nov).
**	Miles of LWD Key Piece placed including main and side channel.
***	LWD key piece used in the as built condition including that which is not above grade
****	LWD key pieces counted during rapid habitat survey (above grade)
~	Pre-construction estimate

Project Implemented
Project Partially Implemented
Planned 2017 Implementation
Planned 2017-18 Design

Table 3: Changes in habitat reported below were captured in 2017 for change between the time of implementation and 201 including the following project areas; 1, 3, 6, 8, 9, 15, 18a, and 28. The remaining projects areas reflect change from pre-to post project only. LWD key pieces are > 6 m long and 0.3 m dia, pool areas is estimated in the field and channels and side channels were delineated during rapid habitat surveys.

Project Area	# of Key Pieces			# of Pools			Pool Area M^2			Miles of Side Channel			Increase in Perenial Reach Length (Miles)		
	Pre Project	Post Project Current	% Increase	Pre Project #	Post Project	% Increase	Pre Project	Post Project	% Increase	Pre Project	Post Project	% Increase	Pre Project	Post Project	% Increase
1	44	221	402%	14	30	114%	535	644	20%	0.15	0.91	84%	0.77	1.26	39%
3	108	327	203%	29	50	72%	652	1419	118%	0.34	0.95	64%	1.72	2.06	17%
6	38	278	632%	10	13	30%	227	294	30%	0.24	0.51	53%	0.76	0.83	8%
8	74	186	151%	12	16	33%	180	604	236%	0	0.30	100%	0.71	0.92	23%
9	38	276	626%	8	29	263%	120	1143	853%	0.18	0.62	71%	0.76	1.29	41%
10	99	468	373%	N/A	N/A	N/A	N/A	N/A	N/A	0.23	2.20	90%	1.53	2.55	40%
11	61	770	1162%	23	85	270%	293	1927	558%	1.47	2.30	36%	3.14	3.72	16%
14	64	697	989%	30	43	43%	757	1236	63%	0.1	2.29	96%	1.66	3.01	45%
15	55	525	855%	18	49	172%	1036	1722	66%	0.14	1.55	91%	0.67	1.07	37%
18a	55	577	949%	28	53	89%	950	2487	162%	1.51	2.70	44%	2.20	2.33	6%
22	10	46	360%	14	14	0%	N/A	N/A	N/A	0	0.00	0%	0.63	0.63	0%
23	35	86	146%	N/A	N/A	N/A	0	0	N/A	0	0.00	0%	0.75	0.75	0%
24	43	377	777%	13	30	131%	142	486	242%	0.15	0.54	72%	0.92	1.22	25%
26	N/A	N/A	N/A	N/A	0	N/A	N/A	851	N/A	0	0.00	N/A	0.00	0.00	N/A
28a	162	564	248%	57	107	88%	1897	2812	48%	1.25	2.47	49%	1.89	3.66	48%

Table 4: The table below is generated from pre/post Rapid Habitat Surveys (Brown 2002) conducted in the years of implementation for PA 3 and PA28. A pre-project survey was used in combination with the design report for PA32. River Complexity Index is a measure of stream channel length and the number of side channel supported in the floodplain. A straight channel with low sinuosity (close to one) and no side channels would have a RCI of 1.

Project Area & Phase	Reach Length (L_R) (ft)	Side Channel Length (L_{SCH}) (ft)	Thaweg Length(L_{CH}) (ft)	No. Side Channels	No. Junctions	Total Channel Length (L_T)= Thalweg + side channels	S = L_{Ch}/L_R	Braiding Parameter =(L_T)/(L_{CH})	RCI = S(1+J)	RCI/Mile = [S(1+J)]/reach length	% Increase RCI/mile
PA3 Pre-project 2014	6400	935.78	7180	3	6	8115.78	1.12	1.13	7.85	6.48	
PA3 Post-project (2019)	6400	3446	7180	28	56	10626	1.12	1.48	63.95	52.76	**714%**
PA28 Pre-project	10243	2744	12038	6	12	14782	1.18	1.23	15.28	7.88	
PA28 Post-project (2018)	10243	18890	12266	36	72	31156	1.20	2.54	87.42	45.06	**472%**
PA32 Pre-project	3139	632	3503	1	2	4135	1.12	1.18	3.35	5.63	
PA32 Post-project (2020 est.)	3139	16236	3503	9	18	19739	1.12	5.63	21.20	35.67	**533%**

Table 5: Tucannon River stream and floodplain restoration action in relation the life-cycle of spawning spring chinook 2011 into the future. Restoration projects are listed in the left column, beginning in 2011 (through 2021). The columns to the right indicate the years that will pass as chinook brood years through time from September spawning, a winter-spring summer and 2nd winter of rearing and spring smolting. In the Tucannon spring Chinook begin to return as 3-yr old sub-adults up to 5-yr old adult. The take home messages is that the first fish to experience a restored reach are spawning adults the September following the July-August restoration work-window. Due to flow timing, and the type of restoration actions we employ in the Tucannon, positive impacts from restoration may not be realized until the flowing spring flood flows. The five project years highlighted red in the far left column are projects that were constructed prior to the significant flow volume in 2017 – the first flow to approach a stage large enough to activate river processes, with a significant volume of restoration actions in place. The rows highlighted blue indicate the life stages impacted by the flow event. Note: it is plausible the flood flow in 2013/14 (which occurred before most restoration actions had been implemented) had a negative impact on fish, due to redd scour – a symptom our restoration action hope to alleviate. The orange rows highlight life stages impacted by the drought and extreme temperatures that occurred in 2014-15.

			Seasonal Condiiotns		Production Year (September)																
Major Restoration in Spawning Areas			Winter Flood	Drought	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
PA-26 Levee	Spawn Year (September)	2011			**Spawn**	Rear	Smolt	3yr	4yr	5yr											
PA-10		2012				**Spawn**	Rear	Smolt	3yr	4yr	5yr										
PA-26 LWD		2013	1,390cfs				**Spawn**	Rear	Smolt	3yr	4yr	5yr									
PA 1, 3, 14. 22, 40		2014		Drought				**Spawn**	Rear	Smolt	3yr	4yr	5yr								
PA - 15 11, 24, 23		2015		Drought					***Spawn****	Rear	Smolt	3yr	4yr	5yr							
PA-28 Phase I, Little Tucannon		2016	1,400cfs							***Spawn****	Rear	Smolt	3yr	4yr	5yr						
PA - 6, 8, 9, 18, 28 Phase II		2017									***Spawn****	Rear	Smolt	3yr	4yr	5yr					
PA-28 Phase III, Little Tucannon		2018										**Spawn**	Rear	Smolt	3yr	4yr	5yr				
PA32 Phase I		2019											**Spawn**	Rear	Smolt	3yr	4yr	5yr			
PA-13 Phase I, PA17, PA26,		2020												**Spawn**	Rear	Smolt	3yr	4yr	5yr		
PA13 Phase II		2021													**Spawn**	Rear	Smolt	3yr	4yr	5yr	
		2022														**Spawn**	Rear	Smolt	3yr	4yr	5yr
		2023															**Spawn**	Rear	Smolt	3yr	4yr

Time Laps for Channel Shapping Flow