Progress Report 2012-2016: Hangman Creek Fisheries Enhancement Restoration Summary

BPA Project # 2001-032-00

Report covers work performed under BPA contract #(s) 57528 & 61127, 64877, 68858, and 72434

Report was completed under BPA contract # 75767

5/1/2012 - 12/31/2016

Redband trout (Oncorhynchus mykiss gairdneri)

Kinkead, B.A. and T.J. Biladeau, T. J. Coeur d'Alene Tribe, Plummer, ID 83851

May 2017

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

This report should be cited as follows: Kinkead, B. A., and T. J. Biladeau, Progress Report 2012-2016: Hangman Creek Fisheries Enhancement Restoration Summary, 5/1/2012 - 04/30/2017 Annual Report, BPA Project #2001-032-00. 36pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Table of Contents

List of Figures

List of Tables

1 Summary

Restoration for this reporting period began in 2012 in Sheep Creek as part of BPA contracts 57528 and 61127 following restoration prioritization derived from Herrera (2011). Other small-scale projects intended to provide beaver with food and dam building materials were implemented in BPA contract 64877 and continue into later contracts. Removal of a salmonid migration barrier was implemented in 2014 as part of BPA contract 64827. Large scale stream restoration and riparian enhancement activities entitled the k'wne' 'ulchiyark'wmtsut project were initiated in 2013 in the upper Hangman Creek watershed with the intention of facilitating natural stream and floodplain function. Planning, construction and riparian enhancement activities for the k'wne' 'ulchiyark'wmntsut project were carried out under BPA contracts 61127, 64877, 68858, and 72434 and conducted during the period from June 15, 2013 through December 1, 2016 in four phases of restoration. An additional project in lower Sheep Creek to improve stream and floodplain function was implemented during 2016 under BPA project 72434.

2 Site Description and Background

Hangman Creek drains 430,000 acres of northern Idaho and eastern Washington. The study area consists of the portion of the Hangman Creek watershed that lies within the Coeur d'Alene Reservation and east into the headwaters outside of the reservation. The Washington-Idaho State border, which corresponds to the border of the Coeur d'Alene Indian Reservation, marks the western boundary of the project area. The total acreage is 157,586, with 147,993 of that within the reservation. Elevations range from 754 meters in the northwest corner of the Project Area where Hangman Creek flows west into Washington to 1,505 meters at the top of Moses Mountain on the southeastern end of the Hangman/Coeur d'Alene Basin watershed divide (Figure 1). The named tributaries within the basin include Mission, Sheep, Smith, Nehchen, Indian, the SF Hangman and its' tributaries Conrad, Martin, and the upper part of Hangman Creek east of the Reservation along with its' named tributaries Parrot and Bunnel *(*Figure 1). All of these tributaries were thought to be home to trout in the 1940's (Aripa 2003).

Assessment of the fisheries populations included a broad spatial sampling of fish and habitat in order to determine distribution and limiting factors over the entire Hangman watershed within Idaho boundaries (Peters et al 2003). Fisheries assessments from 2002 - 2013 in Hangman Creek indicate distinct linkages between land management practices and the presence of salmonids. In land managed for timber production and small home sites, habitat includes medium to dense forest canopy, gravel and cobble dominated substrate, and temperatures conducive to salmonid spawning and rearing (Peters et al. 2003; Kinkead and Firehammer 2011, 2012). In valleys dominated by various agriculture practices, discharge, temperature, dissolved oxygen, excess fine sediments, and lack of canopy and instream complexity coincide with an absence of

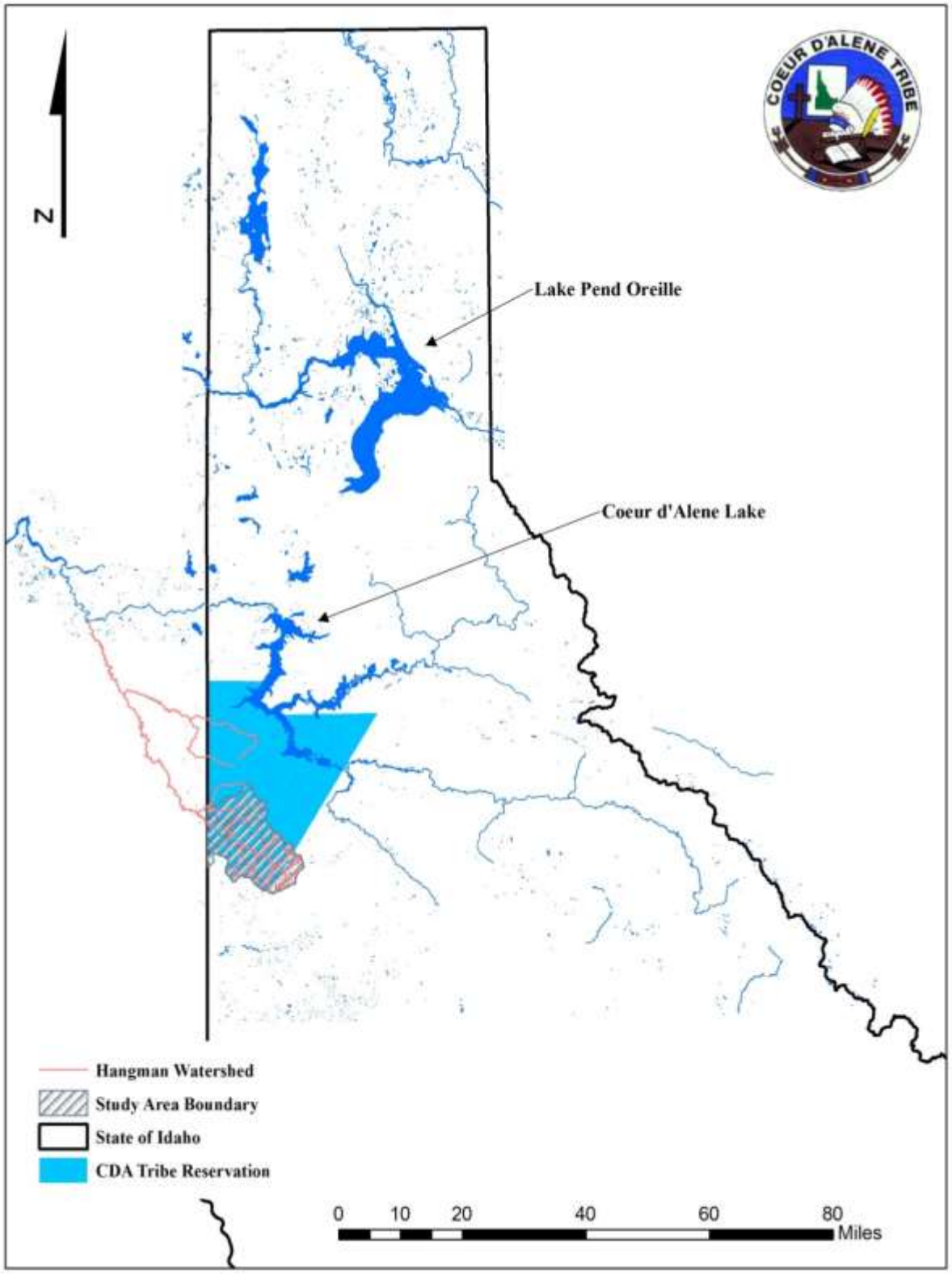


Figure 1. The Hangman Creek watershed study area, located in Idaho almost entirely within the Coeur d'Alene Reservation**.**

salmonids during summer rearing (Kinkead and Firehammer 2011 & 2012). The spatial focus of the project was further delineated to prioritize tributaries and main-stem reaches at, or above Mission Creek where salmonid distribution is at its lowest extent (Green et. al 2008) in order to connect isolated salmonid populations.

The Coeur d'Alene Tribe began transitioning from simple to more dynamic restoration approaches which rely more on hydrogeomorphic processes and away from the more traditional channel form or physical structure approach as described by Palmer et. al, (2014). Small restoration projects began with riparian enhancement on Hangman Creek in 2005, and large woody debris additions on Indian Creek in 2008 (Kinkead and Firehammer 2011 & 2012). These initial efforts show that while moderated impacted habitat can be restored with simple methods, severely impacted stream reaches need better channel/floodplain connectivity to insure riparian function. Cost constraints prompted the Coeur d'Alene Tribe to consider using beaver to restore normal channel and riparian conditions.

The Coeur d'Alene Tribe contracted Herrera Environmental Consultants, Inc. to evaluate the feasibility of using beaver as a restoration tool across the entire upper watershed as a cost-effective means of restoring the hyporheic connection between incised streams and floodplains, and to replenish ground water. All of the restoration work completed from 2012 – 2016 described in this report were identified and prioritized by Herrera and summarized in Figure 2. Herrera concluded the following (Kinkead and Biladeau 2013); delay any restoration work on reaches downstream of Mission Creek identified as reach HAMF04 until significant work had occurred on upstream reaches; Sheep Creek SHMF02 is a priority for restoration using beaver because of access and suitable habitat; Hangman Creek (HAMF13) should be the initial reach restored on the mainstem of Hangman; Indian Creek (INMF02) was given a low priority for restoration using beaver due to a lack of riparian habitat containing hardwoods. Additional projects designed to improve fish passage in the priority areas were identified by Kinkead and Firehammer (2012) and completed in 2014. The lowest reach on Sheep Creek, below SHMF02, was identified as another location to gain improved stream channel to floodplain connection in conjunction with an on-going wildlife restoration project (BPA 2001-033-00), and instream work was initiated in 2016.

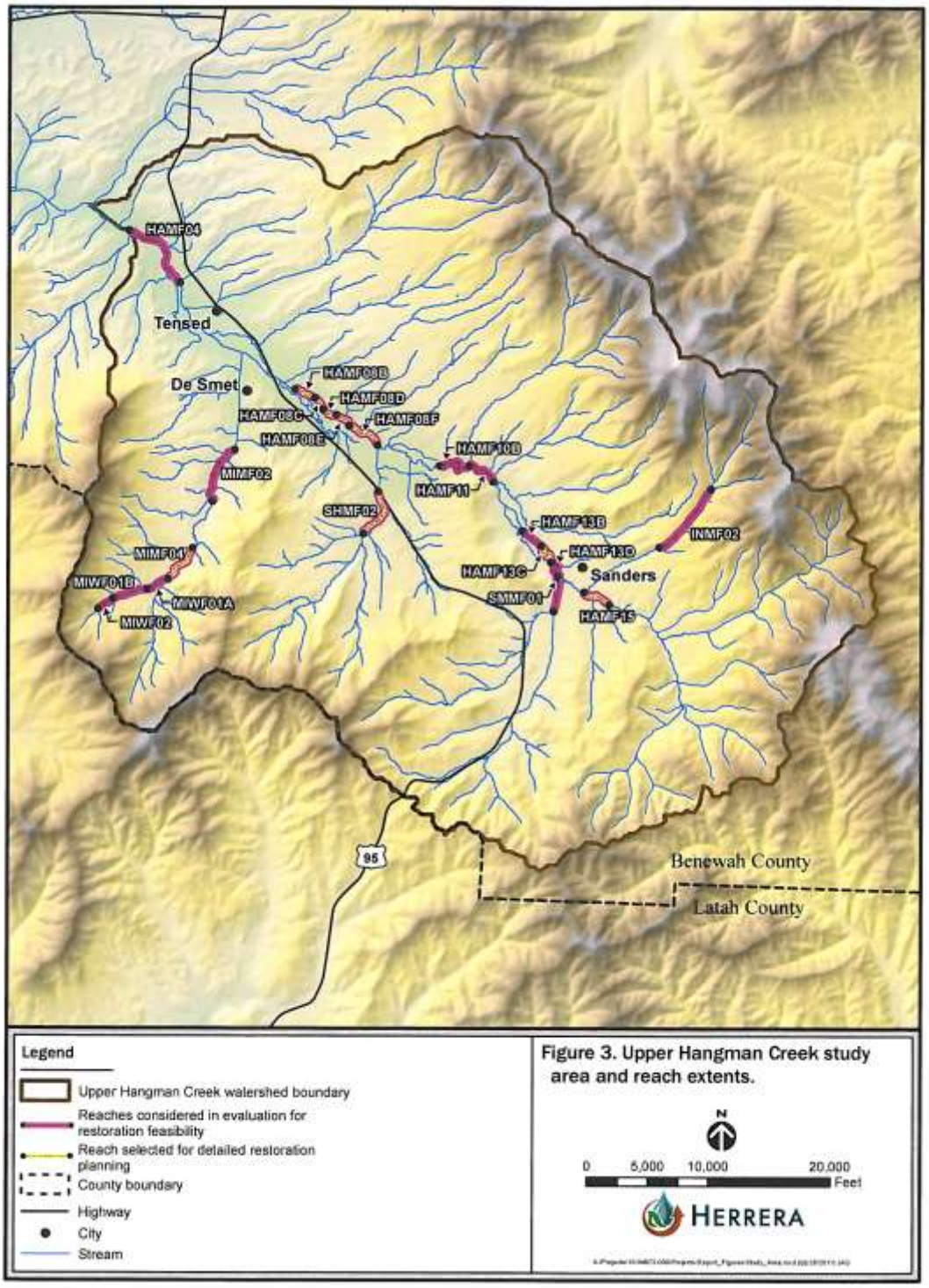


Figure 2. Map of reaches assessed and prioritized for restoration utilizing beaver (from Herrera 2011).

3 Introduction to Restoration Activities

Implementation of restoration and enhancement activities that occurred in the Hangman Creek watershed during two contract periods, May 1st 2012 – December 31st 2016, is summarized in Table 1 and Table 2. This is followed by a more detailed site characterization and summary of activities for individual treatments. In two locations, multiple treatments have been implemented to meet the objectives for the given resources. These treatments are grouped under the same project ID heading so that the interrelationship of activities is more apparent.

A brief explanation of the project ID that is used in the summary Table 1 & Table 2 and in the detailed descriptions is warranted here. The project ID is an alphanumeric code that corresponds to the location of individual treatments in relation to the river kilometer of the drainage network for the watersheds of interest. The first digit of the code signifies the watershed that the treatment is located in, using the first letter in the watershed name (e.g., HA=Hangman Creek, SH=Sheep Creek, etc.). The series of numbers that follow correspond to the river-kilometer location (in kilometers and 10ths) at the downstream end of treatment sites(s). River kilometer is tabulated in an upstream direction from mouth to headwaters and treatments that are located in tributary systems have river mile designations separated by a forward slash (/). For example, the downstream end of project IN_1.5 is located in the Indian Creek watershed 1.5 km up from the confluence with Hangman Creek. If a tributary of Indian Creek is 4.5 kilometers up the main-stem, it would be designated IN_4.5/0.5 with the 0.5 signifying that the location is 0.5 km up that particular tributary of Indian Creek. River kilometer is tabulated in an upstream direction from mouth to headwaters. In the case of Hangman Creek the 0.0 Rkm marker is at the Idaho/Washington boundary and continue upstream from that point. Site descriptions include drainage area derived from GIS methods and bankfull discharges which were obtained from USGS StreamStats. Locations of all the restoration treatments are shown in Figure 3.

Table 1. Summary of restoration/enhancement activities associated metrics completed for BPA Project 2001-032 during 2012-2013.

Project Description			Project Chronology		
Project ID	Activity	Treatments (Metrics)	Pre-2012	2012	2013
HA_20.5	Plant Vegetation	Riparian Enhancement (22.5 ha; 1.6 Km of Streambank)	Planted 8,750 conifers plugs, 2023 potted hardwoods, and 900 willow poles	.....	Installed 10 cattle Panel enclosures around existing trees
HA_20.5	Increase Instream Habitat Complexicty and Stabilization	Offer Aspen Clippings to Beaver	26 m^3 aspen (1 beaver dam)	26 m^3 aspen (1 beaver dam)	26 m^3 aspen (1 beaver dam)
SH_1.3	Plant Vegetation	Riparian Enhancement (23.9 ha; 1.73 km of Streambank)	Planted 326 potted hardwoods and 250 willow poles	Planted 3,000 herbaceous plugs, 250 willow poles.	Planted 230 willow poles, 250 (5) gal hardwood trees, 20 lbs wetland grass seed, and 50 (2)gal upland shrubs, 50 (2) gal hardwood trees. Installed 70 cattle panel enclosures for protection.
SH_1.3	Increase Instream Habitat Complexicty and Stabilization	Install Choke-Flow Structures and Beaver Dam Support Poles w/ Heavy Equipment	Choke Flow Structure Design by R2 Resource Associates	Installed 3 Choke Flow Structures, 1 Rootwad Complex, and Supported 4 Beaver Dam Locations	.....
SH_1.3	Increase Instream Habitat Complexicty and Stabilization	Install Beaver Dam Support Poles with Hydraulic Post Pounder	.....	.....	Supported 4 Beaver dams with support poles on Sheep, and 2 on Mission Creek
SH_1.3	Increase Instream Habitat Complexicty and Stabilization	Offer Aspen Clippings to Beaver (Materials for 4 Beaver Dams/year)	104 m^3 aspen	104 m^3 aspen	104 m^3 aspen
MI_6.1	Increase Instream Habitat Complexicty and Stabilization	Install Beaver Dam Support Poles with Hydraulic Post Pounder	.....	.....	Supported 3 Beaver dams with support poles
MI_6.1	Increase Instream Habitat Complexicty and Stabilization	Offer Aspen Clippings to Beaver (Materials for 4 Beaver Dams/year)	43 m^3 aspen	43 m^3 aspen	43 m^3 aspen
IN_5.1	Install Culvert	Replace Culvert with Fish Passable Culvert	.....	.....	Installed Squash Pipe below grade and 4 grade control structures
IN_5.1	Plant Vegetation	Riparian Enhancement 0.1 ha and 120 m of stream bank in disturbed ground from culvert replacement	.....	.....	Planted 50 willow poles, 25 potted hardwoods, upland and wetland grass seed, and 50 upland shrubs

Table 2. Summary of restoration/enhancement activities and associated metrics completed for BPA Project 2001-032 from 2014-2016.

Project Description			Project Chronology			
Project ID	Activity	Treatments (Metrics)	Pre-2014	2014	2015	2016
HA_21.0 Phase 1	Increase Instream Habitat Complexicty and Stabilization	Fill Man-made channel (425m) & activate relict channel (1.6 m)	----------	Filled 900 ft of existing channel and re-activated XXX ft of relict channel	Filled remaining 500 ft of man made channel	----------
HA_21.0 Phase 1	Plant Vegetation	Riparian Enhancement (17.5 ha; 2.6km of Streambank)	----------	Planted 1,000 willow poles, 1,000 herbaceous plugs, and 18 lbs of wetland seed and	Planted 80 (5) gal deciduous potted trees, 200 willow poles, 2,820 hebaceous plugs, and 60 lbs of upland seed, and installed 20 cattle panel enclosures	Planted 125 (5) gal deciduous trees, 700 (2) gal alders , 50 (2) gal willow shrubs, 2,420 herbaceous plugs, 250 cottonwood poles, and 2,450 willow poles
HA_21.0 Phase 1	Increase Instream Habitat Complexicty and Stabilization	Offer Aspen Clippings to Beaver 26 m^3 supports one ave size dam	----------	26 m^3 aspen (1 beaver dam)	78 m^3 aspen	104 m^3 aspen (4 beaver dam)
HA_24.3 Phase 2	Increase Instream Habitat Complexicty and Stabilization	Install Choke-Flow Structures w/ Heavy Equipment	----------	----------	Installed 2 Choke Flow Structures using root wads	----------
HA_24.3 Phase 2	Plant Vegetation	Riparian Enhancement (23 ha; 1.8 km of Streambank)	----------	----------	Planted 1,460 (2) gal alder	Planted 5,150 willow poles, 400 Cottonwood poles, 125 (5) gal hardwood trees, 270 (2) gal deciduous trees, 600 (2) gal upland shrubs, 20 lbs wetland grass, seed, and 50 (2) gal upland shrubs, and 1,782 herbaceous plugs. Installed 1,700 feet of wildlife exclusion fencing.
HA_22.0 Phase 3	Increase Instream Habitat Complexicty and Stabilization	Fill Man-made channel (450 m) & activate relict channel (2.3 km). Constructed 225 m of overflow relief channel	----------	----------	----------	----------
HA_22.0 Phase 3	Plant Vegetation	Riparian Enhancement (76 ha; 1.2 km of Streambank)	----------	----------	----------	Planted 600 (2) gal alders, 100 (2) gal upland shrubs, 300 conifers, and 20 lbs upland seed, and 20 lbs of wetland seed
HA_25.7 Phase 4	Plant Vegetation	Riparian Enhancement 2.0 ha and 515 m of stream bank	----------	----------	----------	Planted 483 willow poles, 100 potted (5) gal deciduous trees, 100 (2) gal upland shrubs, and 200 (2) gal aspen trees, and installed 1,000 ft of 8 ft tall exclusion fencing
SH_1.3	Increase Instream Habitat Complexicty and Stabilization	Offer Aspen Clippings to Beaver (Materials for 4 Beaver Dams/year)	312 m^3 aspen	104 m^3 aspen	26 m^3 aspen	26 m^3 aspen
IN_4.5/0.5	Remove Migration Barrier	Remove culvert on NF Indian Creek	----------	1 culvert removed on deactivated road	----------	----------
SH_0.8	Increase Instream Habitat Complexicty and Stabilization	Construct Choke Flow Structure on Sheep Creek	----------	----------	----------	Installed 2 Choke Flow Structures using root wads

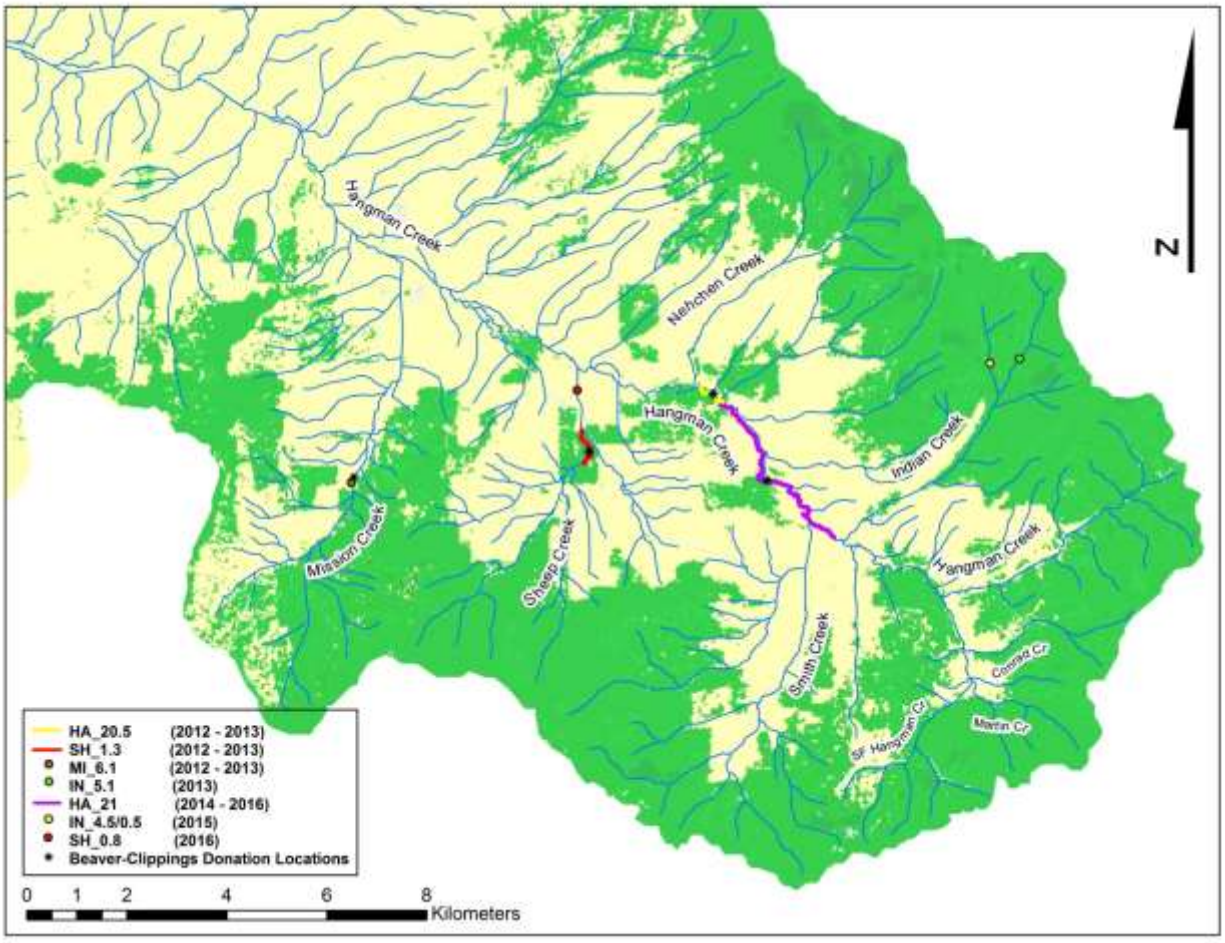


Figure 3. Locations of individual restoration projects initiated from 2012 - 2016.

4 Individual Restoration Projects

4.1 SH_1.3: Large Woody Debris Additions and Riparian Enhancement

Project Location:

Sub-Watershed: Sheep Creek	Legal: T44N, R4W, Sec 36
River Kilometer: 1.3	Begin: Lat 47.11345°N Long -116.77966°W

Site Characteristics:

Slope/Valley gradient: 0.8%	Aspect: S	Elevation: 2,706 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 80.6	Drainage Area: (7.2mi²)	

Other: *This 2nd reach of Sheep (SH2) begins above the bridge at HWY 95 and continues until the culvert on the Benewah County road. Reach passes thru CDA Tribal Allotment A336/340.*

Problem Description:

Historically, the Sheep Creek valley was likely a mosaic of open stands of conifers, wet meadows and stream corridor riparian forest. Forest composition and structure would have been maintained by frequent fires. A compositionally diverse, deciduous/coniferous forest was likely distributed along complex gradients of elevation, aspect and site water balance. Forest and riparian tree species likely included: ponderosa pine, western white pine, western larch, Douglas fir, lodgepole pine, grand fir, aspen, and black cottonwood (DeVries and Featherstone 2012). Salmonids were found in a wide distribution in the watershed as recently as 1970 (Kinkead and Aripa 2005, unpublished).

Anthropogenic impacts have greatly altered the Sheep Creek watershed since the 1940's. Dryland farming with an extensive drainage tile system, grazing within the riparian areas and silvicultural activities throughout the watershed have altered channel morphology and riparian composition, resulting in impaired fish habitat. Cattle have been excluded from the study reach for over ten years and restoration to the reach below began with removal of drainage tiles in 2008, and a design to reconnect the stream and its floodplain as part of BPA Project 2001-032-00 (Interfluve 2008).

Site inspection by DeVries and Featherstone of R2 Resource Consultants, Inc. (2012) found the forest floodplain relatively intact in the sub-reach above Sheep Creek Road and only required conventional restoration techniques such as introduction of root wads to facilitate aggradation and pool forming processes. Downstream of the culvert on Sheep Creek, they stated "the riparian zone is less intact, and key needs and opportunities for floodplain restoration are found within this reach. The Sheep Creek channel appears to be entrenched with a width/depth ratio narrower than would be expected from a more classic alluvial channel (Picture 1A & 1B). The entrenched state is inferred to have been the result of the aforementioned land use practices". Relict floodplain channels are evident in the LiDAR data mostly in the lower half of the reach. R2 corroborated with Hardin-Davis (2005) and Herrera (2011) to determine that floodplain inundation was restricted to flows higher than estimated for a representative alluvial channel. R2 described the substrate; "Spawning gravels are available for redband rainbow trout throughout the reach and upstream. However, gravel was observed upstream of all beaver dams, and appears to be within the appropriate size range for spawning. Cleaning of fine sediments associated with redd construction would render all gravels suitable for spawning throughout the reach."

Present riparian conditions were described by R2; "Although riparian forests throughout the lower Sheep Creek drainage are all degraded or absent to a significant degree relative to historic conditions with reed canary grass dominating, existing remaining riparian vegetation can be used as a reference system upon which to base the vegetation composition of the restoration design. Currently, the Sheep Creek riparian corridor supports forest fragments of Ponderosa pine, western white pine, black cottonwood, gray alder, Douglas fir, black hawthorn, lodgepole pine,

aspen, and grand fir. Shrub species include snowberry, Pacific ninebark, ocean spray, spirea, red osier dogwood, mountain alder, and willows. Wetland herbaceous species include slender sedge, lenticular sedge, small-winged sedge, Nebraska sedge, beaked sedge, Baltic rush, common rush, daggerleaf rush, slender rush, and small-fruited bulrush.

Picture 1A & 1B. Sheep Creek, tributary of Hangman Creek. Channel and riparian conditions prior to restoration.

Description of Treatment

A total of eight large woody debris structures consisting of three types were constructed in 2012 using designs by R2 Resource Associates (2012). Three flow choke structures were designed to reactivate floodplain swales at or above bankfull flows in order to optimize additional riparian habitat and decrease velocities in the main channel during high flow events (Picture 2A & 2B) (Picture 3A & 3B). Placement of these structures was made adjacent to nearby relic channels. The second type of LWD addition was Beaver-Assisting Vertical Posts, installed at four locations (Picture 4A &4B). These were designed to support existing beaver dams surveyed in 2011. Again, placement of these structures was made at strategic locations to push flood waters into adjacent floodplain channels. The third type of treatment was "Beaver-Assisting Logs" consisting of several large key pieces of wood that would attract dam construction and promote stream habitat complexity.


Picture 2A & 2B. Initial step for choke structure installation is placing a scour log and surveying in a sill log as shown here, along with completed structure.


Picture 3A & 3B. Completed choke structure in Sheep Creek where beaver have maintained a dam post-construction.


Picture 4A & 4B. Supported beaver dams incorporating upright 4" diameter poles and 12" diameter logs.

Relationship to Scope of Work

The project fulfills the Program commitments for Work Elements D & F in the 2012 Scope of Work and Budget Request (Contract# 57528) and Work Elements E, G, and H in the 2013 SoW and Budget Request (Contract# 61127) for the contract periods dating May 1, 2012 through April 30, 2014.

4.2 IN_5.1: Culvert Replacement in MF Indian Creek

Project Location:

Sub-Watershed: MF Indian Creek	Legal: T44, R 3W, Sect 33
River Kilometer: 5.1	Begin: Lat: 47.113073°N Long: -116.725478 °W

Site Characteristics:

Slope/Valley gradient: 6.0%	Aspect: SW	Elevation: 3,312 ft.
Valley/Channel type: B4	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 40	Drainage Area: (0.5mi²)	

Problem Description:

The culvert on the MF Indian Creek was suspected of being a fish barrier due to the differences of fish sampled above and below the culvert. Analysis identified it as a fish passage barrier for juveniles as well as adults by Kinkead and Firehammer (2012). Measurements were taken and analyzed using methods described by Hendrickson et. al (2008). The width/depth ratio of the culvert and channel did not match, as well as an outlet drop with a lack of water depth below limiting fish passage for both juveniles and adults (Picture 5).

Picture 5. Culvert prior to replacement: Slope 3.6%, Diameter 54", Outlet Drop 1.1ft,

Description of Treatment

The problems outlined above led to a partnership by the Coeur d'Alene Tribe and Stimson Lumber Products. Stimson agreed to pay for the purchase and transport of a new culvert, and the CDA Tribe would supply heavy equipment, rock and labor, as well as plant materials needed to revegetate the disturbed areas.

A relief ditch for a temporary pipe was constructed to take all the flow away from construction prior to removal of the existing culvert. The existing 54" pipe was replaced with a 60 ft. 71" X 47" arched-pipe at 3% gradient to improve fish passage (Picture 6A & 6B). The culvert was countersunk to allow natural substrate to accumulate within the culvert. Installation of 4 rock and LWD grade control structures were constructed to stabilize the entrance and exit of water from the new culvert (Picture 7A, 7B, & 7C).


Picture 6A &6B. Construction activities and Installation of new culvert in Indian Creek, 2014.



Picture 7A, 7B, & 7C. Indian Creek culvert after installation using a 60' arch-pipe and incorporating rock grade-control directly upstream and downstream. Lower-right photo shows planted riparian vegetation the following spring.

Relationship to Scope of Work

This project fulfills the Program commitments for Work Element D in the 2013 Scope of Work and Budget Request (Contract# 61127) for the contracting period dating May 1, 2013 through April 30, 2014.

4.3 Hardwood Clippings Provided to Beaver (Multiple Locations)

Project Location:

Sub-Watershed: Mission Creek	Legal: T44, R 5W, Sect 26 SW ¼ - NE ¼
River Kilometer: 6.1	Lat: 47.103236°N Long: -116.940031°W

Site Characteristics:

Slope/Valley gradient: 1.3%	Aspect: S	Elevation: 2,715 ft.
Valley/Channel type: C5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): unknown	Drainage Area: (4.9mi²)	

Other: *This 4th reach of Mission (MI04) begins above crossing with King Valley Road and passes thru CDA Tribal Allotment A632.Planned treatments include support poles for beaver dams and riparian enhancement, along with aspen cuttings as described in this contract period.*

Project Location:

Sub-Watershed: Sheep Creek	Legal: T44N, R4W, Sec 36
River Kilometer: 1.3	Begin: Lat 47.11345°N Long -116.77966°W

Site Characteristics:

Slope/Valley gradient: 0.8%	Aspect: S	Elevation: 2,706 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 80.6	Drainage Area: (7.2mi²)	

Other: *This 2nd reach of Sheep (SH2) begins above the bridge at HWY 95 and continues until the culvert on the Benewah County road. Reach passes thru CDA Tribal Allotment A336/340.*

Project Location:

Watershed: Hangman Creek	Legal: T44N, R4W, Sec 28 NW ¼
River Kilometer: 20.5	Lat: 47.130289°N Long: -116.834803 °W

Site Characteristics:

Slope/Valley gradient: 0.5%	Aspect: NW	Elevation: 2,605 ft.
Valley/Channel type: C5	Proximity to Water: Riparian	
Bkf Discharge (cfs): 423	Drainage Area: (39.9mi²)	

Other: *Hangman Reach 11 (HA11).Reach lies within CDA Tribal Trust land 1030 and commonly referred to the "Sweatlodge Area". Riparian enhancement was initiated in 2005 and has been ongoing with different treatments and plant protection methods.*

Problem Description:
All three locations have active beaver populations which do not have access to adequate hardwoods in order to build stable dams. Beaver surveys summarized in this report indicate that mud, grass, and hawthorn are often used for building materials without incorporating any large materials as a foundation. The first stable dams found in the watershed were in the spring of 2010 in Sheep Creek. Reed canary grass dominates the riparian area with a minimal amount of alder. Aspen and cottonwood are nonexistent prior to riparian enhancement associated with the restoration project. Hangman Creek (HA11) has deeply an incised channel with little connection between the stream and riparian area. Sheep Creek (SH02) has moderately incised channels where peak flows occasionally spill out into the floodplain. Mission Creek (MI04) lies within an extensive beaver dam complex with a wide floodplain filled with side channels caused by beaver activity. However, it has been noted by Herrera (2011) that inadequate supplies of hardwood and willow exist.

Description of Treatment
Hardwood clippings consisting of mostly aspen along with some cottonwood and alder were cut and placed at existing beaver dams in 2011 to supplement food and building supplies. A total of 6,100 ft^3 of dam building materials were provided in 3 general locations, with 3 specific dam locations on each stream reach. This amounts to an equivalent of 1,151 pieces of 2 inch diameter by 10 feet long hardwood pieces, roughly enough materials to build twenty dams four feet high, ten feet long, and fifteen feet wide. Materials were offered on Mission Creek R4, Sheep Creek R2, and Hangman Creek R11. Brush offerings were made in May, July and September of 2011. The initial offering disappeared the first night on Mission and Sheep Creek with all sizes utilized. A six foot tall dam was repaired on Sheep Creek within 24 hours of the offering of aspen cuttings (Pictures 8A and 8B). Utilization of brush by beavers in July and September were more selective with all pieces <2" diameter taken within 48 hours, while the larger pieces 2 – 4" diameter were picked up within 2 week.


Picture 8A & 8B. Aspen cuttings have been cut and a dropped off in areas of high beaver activity for use in dams and for supplementing food.

Relationship to Scope of Work
These projects fulfills the Program Commitments for Work Elements E, G, G, J, and H in the 2012, 2013, 2014, 2015, and 2016 Scopes of Work and Budget Requests, respectively (Contract# 57528, 61127, 64877, 68858, and 72434) for the contract periods dating May 1, 2012 through April 30, 2016.

4.4 SH_1.3 & MI_6.1: Beaver Dam Support Poles

Project Location:

Sub-Watershed: Sheep Creek	Legal: T44N, R4W, Sec 36
River Kilometer: 1.3	Begin: Lat 47.11345°N Long -116.77966°W

Site Characteristics:

Slope/Valley gradient: 0.8%	Aspect: S	Elevation: 2,706 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 80.6	Drainage Area: (7.2mi²)	

Other: *This 2nd reach of Sheep (SH2) begins above the bridge at HWY 95 and continues until the culvert on the Benewah County road. Reach passes thru CDA Tribal Allotment A336/340.*

Project Location:

Sub-Watershed: Mission Creek	Legal: T44, R 5W, Sect 26 SW ¼ - NE ¼
River Kilometer: 6.1	Lat: 47.103236°N Long: -116.940031°W

Site Characteristics:

Slope/Valley gradient: 1.3%	Aspect: S	Elevation: 2,715 ft.
Valley/Channel type: C5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): unknown	Drainage Area: (4.9mi²)	

Other: *This 4th reach of Mission (MI04) begins above crossing with King Valley Road and passes thru CDA Tribal Allotment A632.Planned treatments include support poles for beaver dams and riparian enhancement, along with aspen cuttings as described in this contract period.*

Problem Description:
All three locations have active beaver populations who do not have access to adequate hardwoods in order to build stable dams. Beaver surveys indicate that mud, grass, and hawthorn are often used for building materials without incorporating any large materials as a foundation. The first stable dams found in the watershed were in the spring of 2010 in Sheep Creek. Reed canary grass dominates the riparian area with a minimal amount of alder. Aspen and cottonwood are nonexistent prior to riparian enhancement associated with the restoration project. Hangman Creek (HA11) has deeply an incised channel with little connection between the stream and riparian area. Sheep Creek (SH02) has moderately incised channels where peak flows occasionally spill out into the floodplain. Mission Creek (MI04) lies within an extensive beaver dam complex with a wide floodplain filled with side channels caused by beaver activity.

However, it has been noted by Herrera (2011) that inadequate supplies of hardwood and willow exist.

Description of Treatment

Existing beaver dams were reinforced with 4 inch diameter poles driven into dams using a hydraulic post pounder along the entire bankfull profile. Six total dams were reinforced with 4 on Sheep Creek and 2 on Mission. Monitoring indicates that 2 were destroyed by high flows, 2 were slightly damaged, and two were intact after one year (Picture 9A & 9B).


Picture 9A & 10B. Beaver dam support poles installed in Sheep and Mission Creeks, 2013.

Relationship to Scope of Work

This project fulfills the Program commitments for Work Elements F in the 2013 Scope of Work and Budget Request, (Contract# 61127), with the contract period dating May 1, 2013 through April 30, 2014 but began outside of plans as shown in Work Elements in the previous contract (Contract 57528).

4.5 HA-21.0: k'wne' 'ulchiyark'wmtsut "Make it crooked again" Relict Channel Reactivation and Floodplain Connection Phases 1 – 4

Project Location:

Sub-Watershed: Hangman Creek	Legal: T44N, R4W, Sec 34
River Kilometer: 21.0 – 25.7	Begin: Lat 47.11226°N Long -116.81862°W

Site Characteristics:

Slope/Valley gradient: 0.05%	Aspect: NW	Elevation: 2,600 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 400	Drainage Area: (37.6mi²)	

Problem Description:
During the late 1940's and early 1950's, approximately 4.3 kilometers of Hangman Creek, a perennial stream, was abandoned and replaced by 1.9 kilometers of excavated channel to promote agricultural practices and the use of a railway for transporting timber products. The newly excavated channel resulted in a higher gradient stream with little to no sinuosity. This in turn increased stream velocity and promoted head-cutting and stream bank erosion within the new channel and upstream. The adjacent floodplain became disconnected from the stream, changing the valley bottom from predominantly mixed forest wetland habitat to a combination of forested wetland/scrub-shrub/upland forest habitat. Furthermore, large amounts overstory canopy were removed from the floodplain, adjacent riparian habitats, and along the stream channel to promote dryland agriculture and ranching practices in this area.

Description of Treatment
The dynamic approach to restoration relies more on hydrogeomorphic processes and away from the more traditional channel form or physical structure approach (Palmer et al, 2014). The restoration concept in Hangman Creek, although does incorporate the addition of physical structures, is intended to facilitate natural channel and riparian forest developmental processes in the project reach, leading to a more dynamic and resilient riverine and wetland ecosystem. Beechie et al (2010) describes process-based restoration actions as a way to reestablish normative rates and magnitudes of processes that create and/or sustain stream and floodplain ecosystems. This restoration design is intended to do just that, which in turn will lead to improvements in salmonid and wildlife habitat quality through the reconnection of the channel and floodplain over a large portion of the valley bottom while maintaining connectivity to the groundwater and providing additional habitat structure and depth. The design will further facilitate restoration of a riparian corridor composed of a mosaic of floodplain emergent, scrub-shrub and forested wetlands, and adjacent riparian forest. This is especially important as an increasingly dynamic and diverse riparian/floodplain ecosystem is essential for its ability to respond to future perturbations both physically and biologically, enabling it to evolve and continue to function in response to shifting system drivers such as climate change (Beechie et. al 2010).

Along with the development of a diverse and dynamic ecosystem, the Coeur d'Alene Tribal Fisheries Program also hopes to achieve a number of short-term objectives (<10 years) through this restoration project incorporating four phases (Figure 4).

- Increase floodplain connectivity
- Reduce in-stream temperatures to levels acceptable for redband trout *Oncorhynchus mykiss gairdneri* spawning and rearing
- Increase the rate of redband trout dispersal between subpopulations
- Increase rearing habitat for redband trout
- Reduce erosion rates within the stream channel
- Provide higher rates of mean base flow while blunting the peak(s) in the hydrograph
- Increase streambed elevation to natural conditions
- Promote colonization and persistence of beaver *Castor canadensis*

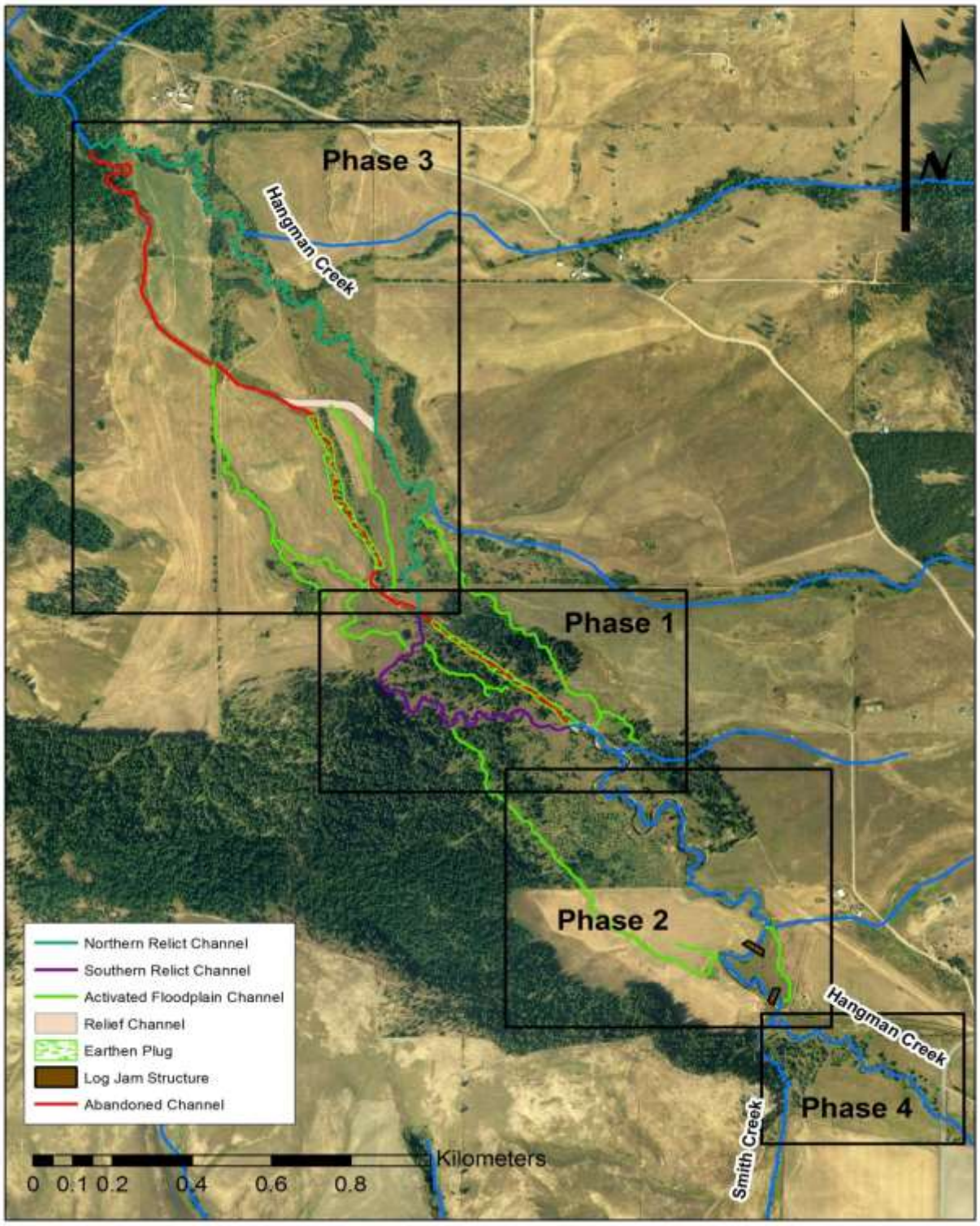


Figure 4: Project area highlighting the 4 phases of construction and the restoration design elements.

4.5.1 Relict Channel Reactivation:

The southern and northern relict channels, although grown-in with significant amounts of vegetation, were intact and did not appear to show any signs of erosion (Picture 10A & 10B). Cross-sectional measurements throughout the channel(s) exhibit a carrying capacity that is consistent to an estimated bankfull flow (1.5 year interval). Bed elevation corresponded to the underlying cobble-gravel layer evident sporadically throughout the valley bottom. Channel preparation was limited to minor amounts of vegetative "grubbing" within the channel. A 100 meter long reach of channel required excavation to connect with the southern relict channel and the active ditch **(**Picture 11A & 11B**,** Picture 12**)** in 2014. A temporary rock riffle was constructed at the outflow of the southern relict channel to maintain connection to the channelized ditch prior to the activation of the northern relict channel during phase 3. The relict channel in Phase 3 was activated in summer 2016 (Picture 13)

Picture 10A &10B: Portions of the relict channel in Phase 1 prior to reactivation in 2015.

Picture 11A & 11B. Construction and activation of the engineered connection channel, 2014.

Picture 12: Engineered channel post-activation for connecting the southern relict channel to the channelized ditch.

Picture 13. Activated channel in Phase 3 during spring 2017.

In both phases 1 & 3 of reactivation, the channelized ditch immediately downstream of the relict stream was filled with borrow material excavated from the adjacent uplands. Over the last 7 decades, high rates of incision and lateral erosion have created a profound difference in streambed elevation and cross-sectional area between the channelized ditch and the relict channel (14A & 14B).

Pictures 14A & 14B. Portion of the channelized ditch which have since been filled and abandoned.

This resulted in large ponded areas of stream directly upstream of the earthen plugs (Pictures 15A & 15B and 16). These areas will likely serve as sediment basins into the future until a consistent gradient and channel aspect ratio is naturally formed.

Picture 15A &15B. Ponded area between Phase 1 and Phase 3 relict channels creating additional wetlands.

Picture 16: Aerial photo facing downstream post-relict channel reactivation (Phase 1 & 3). Ponded areas are shown immediately upstream of the earthen plugs used to divert water back into the relict channels.

4.5.2 Engineered Log Jams:

Picture 17: Engineered log jam structure during construction showing sill logs across the stream bottom and one-half of the logs/root wads incorporated into the bank.

The project element portion of phase 2 allows for more frequent and extensive floodplain connection during annual runoff, and is a natural analog alternative to large scale riffle construction that helps maintains connectivity with cooler groundwater during summer months. Engineered log jams such as these are incorporated into the stream bank (Picture and result in a "choke" of stream flow, where only a pre-designed amount of runoff is allowed to pass through the opening (Pictures 18A & 18B)**Error! Reference source not found.** This type of rehabilitation approach also creates a mosaic of water velocities throughout the matrix of multiple structures. This in turn can lead to sediment retention and sorting, as well as protection from mass wasting of stream banks within an incised channel (Shields et al 2001). Locations have been selected strategically to facilitate connection of floodplain swales during high flows (Picture 19). The structures would be porous such that low flows would not be backed up to the extent that groundwater flow would be reduced due to head differences between the water table and the stream channel. This element is also designed to be an adaptive application, where the backwatering control needs at some locations can be adjusted through removal or additions of large wood to modify the cross-sectional area, and therefore the transport capacity, of the structures as needed to meet the restoration objectives for the larger reach.

Picture 18A. Newly completed engineered log jam structure, Picture 18B during runoff. Structure is allowing flows equivalent to a 1.5 year interval to pass through.

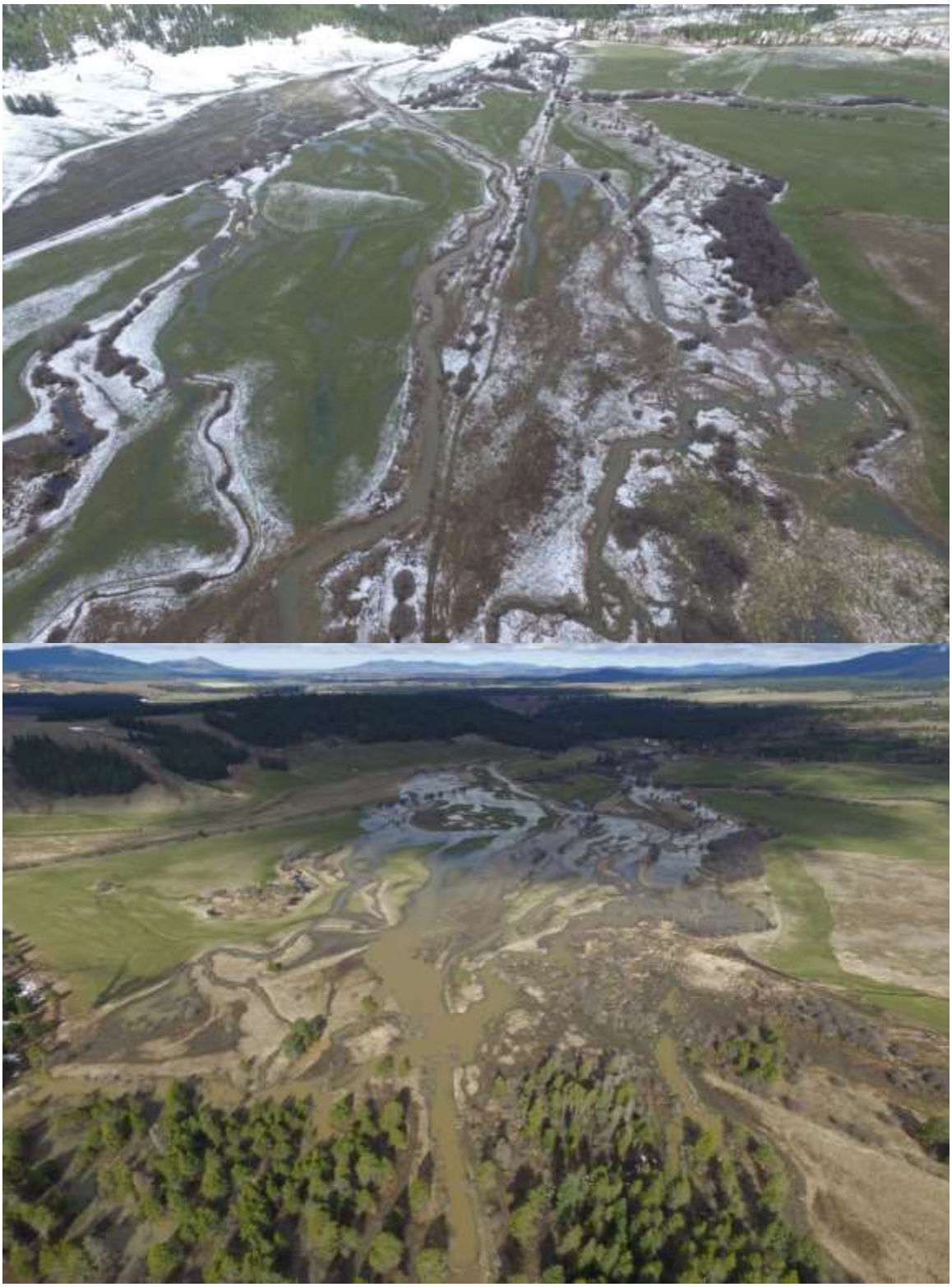
Picture 19: The 2 engineered log jams (red circles) diverting flows out of the incised stream channel during runoff (blue arrows).

4.5.3 Floodplain Flow Paths:

The upstream end of several floodplain channels were excavated and re-contoured to an inlet elevation that begins to flow at the 1.5 year return interval flood. The wetland swales will be used as a nursery area for propagation of black cottonwood and willow whips and live stakes for riparian zone restoration throughout the reach. Significant differences in overbank flow occurred over the winter 2016/7 (Picture 20).

4.5.4 Relief Channel:

A relief channel designed to carry flows in excess of 450cfs was constructed within phase 3 of the project area (Picture 21). This was built to provide flood relief for the adjacent landowner's infrastructure directly downstream of the project area. During periods of runoff, flow is metered out of the northern relict channel, through the relief channel, and back into the channelized ditch downstream of the earthen plug. The excess flow returns to Hangman Creek directly downstream of the project area and the landowner's property.



Picture 20: Before and after aerial photos of the floodplain within phase 3 of the project area. Both photos are during runoff events with equivalent flows.


Picture 21. Construction of relief channel in 2016, and high flows in spring 2017.

4.5.5 *Riparian Restoration throughout Project Reach*

The riparian enhancement design has several components that seek to re-create the historic mosaic of wetland/floodplain flora that once was found in Hangman Creek, with a different emphasis in each of the four phases of k'wne' 'ulchiyark'wmt. 1) Supply beaver with the necessary food and building materials to create a self-sustaining ecosystem with natural connections of stream and floodplain. Beaver favor black cottonwood *(Populus tricarpa)* and aspen *(Populus tremuloides)*, and various willow *(Salix spp)* that may be stored over the winter for food, and herbaceous sedges *(Carex spp)* and rushes *(Juncas)* that are only utilized for summer food. Black cottonwood in particular was identified as a species that could quickly "flip an ecosystem" based on its quick growth and superior shade factor. 2) Additional species that currently are successful in the watershed such as thinleaf alder *(Alnus incana)* and pacific ninebark *(Physocarpus capitatus)* should also be utilized if they can provide shade and streambank cohesion. It is not a coincidence that these two species are not as palatable to aquatic and terrestrial grazers. 3) Plant a wide variety of wetland and upland seed, live willow poles, potted riparian shrubs and trees, and upland shrubs/trees in locations where heavy equipment disturbed native vegetation in multiple dense applications. 4) Use adaptive management to make changes in plant protection methods and species composition to address a heavy utilization of the project area from a large herd of elk and other terrestrial grazers, as well as a firmly established beaver population. Intense flooding and ice flows are part of the watershed and also need to be addressed in designing plant protection measures. At the close of the reporting period multiply layers of protection were being implemented as a direct response to heavy damage from grazing. These included 8 foot tall wildlife exclusion fencing in Phases 2 and 4 (Picture 22).

Picture 22: Wildlife exclusion fencing on Phase 4 of k'wne' 'ulchiyark'wmtsut.

Phase 1 of the project emphasized a complete riparian treatment of all plant types to a new channel dug for 400 feet to connect with an existing relic channel. The remaining relict channel was planted with willow poles, alder, aspen and black cottonwood.

Herbaceous plants were used exclusively in barren areas after heavy equipment use (Picture 23).

Picture 23: Short-beaked sedge (Carex brevior) in Phase 1 restoration.

Within weeks of activating the Phase 1 relict channel beaver built 3 dams in fall 2014, and have and maintained a total of 4 dams through 2016.

Picture 24: Beaver dam established in Phase 1.

Phase 2 was the biggest challenge of the four phases for a variety of reasons. The channel is still degraded below the floodplain and vegetation planted received heavy damage from high flows in the spring of 2017 connected to a majority of the floodplain.

The choke flow structures have been successful in getting water out onto the floodplain with high success of willow and herbaceous in the exiting swales (Picture 25). Upland plants that have had good survival is hawthorn *(Crataegus douglasii)* and serviceberry *(Amelanchier alnifolia)* planted at the top of the raw banks

Picture 25: Creeping spikerush (Eleocharis palustris) and other herbaceous plants and willows doing well in activated swales

Floodplain benches were trenched down to wet gravely soil layers, and willow poles were installed and backfilled (Picture 26). Cattle panels were built around the enclosure for protection because of the difficulty getting willow established with heavy beaver grazing at other locations. Extensive work is planned in the future in this reach that was devoid of any native vegetation prior to 2015.

Picture 26. Willows installed by trenching and backfilling with cattle panel enclosures.

Phase 3 riparian enhancements were just getting started in 2016 with upland plants an emphasis, along with some test treatments until the new channel fully forms and better surveying of water levels can be accomplished to match species and soil moisture content. Wildlife exclusion fencing will preclude the majority of riparian enhancement to maximize plant survival.

Phase 4 was the only area that did not need stream channel work prior to riparian enhancement. A wide variety of hardwood shrubs and trees were planted, and enclosed by 2,000 feet of eight foot tall wildlife exclusion fencing (Picture 22).

*Overall impression of survival rates and robustness of growth***.**
All vegetation has been planted at designed water level elevations to match soil moisture needs. Plant protection measures were designed to deter beaver and undulant. Vegetation planted in the activated relic channel has the highest overall survival rates where water level is consistent. Survival rates of vegetation planted prior to summer of 2015 show significant losses of herbaceous plants and willow poles from the drought of 2015. However poles and sedges planted in fall of 2015 have done significantly better, especially in areas impounded by beaver keeping the water level consistent. Willow poles have been historically difficult to get established and several methods have been used. The best has shown to trench down to a gravel layer at the ground water level. Robust growth occurred within 2 months. Alders are generally doing better than cottonwood and aspen if left unprotected by fencing and cattle panels. Elk, deer and beaver are favoring cottonwood, aspen, and willows and these plants are under intense pressure, and the need for even more plant protection than originally designed has become necessary. Eight foot tall fencing has been installed and has proven to be a good deterrent if maintenance needs are closely monitored. Cattle panels have proven effective against deer and elk but beaver have made it necessary to hang chicken wire on the bottom of the cattle panels and across adjacent

ground to prevent burrowing into the enclosure. The least amount of grazing pressure is in the swales created by the choke-flow structure. Beaver have not discovered the potted trees, sedges, and willows planted in the high flow swales.

Relationship to Scope of Work
This project fulfills the Program commitments for Work Element I in the 2013 Scope of Work and Budget Request (Contract# 61127), Work Elements F and H in the 2014 SoW and Budget Request (Contract #64877), Work Elements F and K in the 2015 SoW and Budget Request (Contract #68858), and Work Elements E, I, J, and K in the 2016 SoW and Budget Request (Contract #72434) for the contract periods dating May 1, 2013 through April 30, 2017.

4.6 IN_4.5/0.5: North Fork Indian Creek Culvert Removal

Project Location:

Sub-Watershed: Indian Creek	Legal: T44N, R4W, Sec 30
River Kilometer: 5.0	Begin: Lat 47.1348°N Long -116.7658°W

Site Characteristics:

Slope/Valley gradient: 0.3%	Aspect: S	Elevation: 3,280 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 10	Drainage Area: (0.9mi²)	

Summary
During the summer of 2014, an undersized culvert was discovered in the headwaters of Indian Creek. The Coeur d'Alene Tribe notified Bennett Lumber Products, Inc. (BLP), the landowner, and expressed our desire to improve passage through this culvert. BLP recommended to fully remove this culvert as the stream crossing would no longer be used for timber harvest activities. In July of 2015, Coeur d'Alene Tribe Fisheries staff removed the culvert on the North Fork of Indian and reshaped the streambank to match existing stream cross-sections up and downstream.

Problem Description:
Indian Creek is a major fish-bearing tributary in the upper Hangman Creek watershed. The stream supports a significantly stable and large population of redband trout and is therefore of great importance to the Coeur d'Alene Tribe Fisheries Program. The headwaters of Indian Creek provide important spawning and rearing habitat for resident and fluvial redband trout. The NF Indian Creek is especially important as it consistently provides cool water throughout the summer and is relatively devoid of fine sediment.

Spawning ground assessments conducted in 2014 found 561 ft^2 of potential spawning habitat in NF Indian Creek throughout 1.6 km of stream. However, an undersized culvert located 1.0 kilometers from the mouth was likely blocking access to 245.5 ft^2 (44%) of potential spawning habitat. Due to the lack of capacity through the culvert, it was also evident that runoff flows were over-topping the road and producing a source of sediment input to the stream (Picture 27).

Picture 27. Undersized culvert prior to removal in NF Indian Creek.

Description of Treatment

This project will restore access to 0.6 km of spawning and rearing habitat in NF Indian Creek by removing a barrier to fish passage. This project will also reduce fine sediment input to the stream which impacts spawning habitat quality downstream. Prior to conducting culvert removal, a Memorandum of Agreement MOA was entered into between the Coeur d'Alene Tribe and BLP for removal of the culvert.

Relationship to Scope of Work

This project fulfills the Program commitments for Work Element I in the 2015 Scope of Work and Budget Request (Contract# 68858) for the contract period dating May 1, 2014 through April 30, 2015.

4.7 SH_0.8: Lower Sheep Creek Engineered Log Jam

Project Location:

Sub-Watershed: Sheep Creek	Legal: T44N, R4W, Sec 30
River Kilometer: 0.8	Begin: Lat 47.1289°N Long -116.8747°W

Site Characteristics:

Slope/Valley gradient: 0.08%	Aspect: X	Elevation: 2,540 ft.
Valley/Channel type: F5	Proximity to Water: In channel and riparian	
Bkf Discharge (cfs): 84	Drainage Area: (10.5mi²)	

Summary
In July of 2016, the Coeur d'Alene Tribe Fisheries Program constructed an instream engineered log jam in order to promote overland flow during runoff events and reduce runoff energy within the channel. The structure was built 0.8 km upstream of the current mouth of Sheep Creek in a portion of the channel that has had a history of channelization. This structure is also designed to relieve runoff pressure to a relict stream channel which is projected to be (re)activated in 2018.

Problem Description:
Much like many areas throughout the Palouse, portions of Sheep Creek, a major tributary in upper Hangman Creek, were channelized in order to move water off the landscape for the benefit of dryland agriculture practices. In turn, the natural stream channels were abandoned and in this particular case, are still relatively intact.

In 2007, the Coeur d'Alene Tribe Natural Resources Program initiated a project near the mouth of Sheep Creek to reroute the stream through a 3.8 km reach of relict channel. This will result in a new location of the mouth of Sheep Creek; entering Hangman Creek approximately 3.5 kilometers downstream of the current location. However, an engineered channel 550 m in length was necessary to complete the reactivation project. In order to help maintain this channel, a portion of runoff stream flow will be diverted across the floodplain; relieving pressure due to runoff energy within this channel. The portion of stream above and beyond bankfull capacity will be diverted using an engineered log jam constructed 310 meters upstream of the excavated channel.

Description of Treatment
The engineered log jam is designed to pass flows equivalent to a bankfull, or 1.5 year interval flow (Picture 28). The remaining flow will be diverted across the floodplain and throughout a mature wetland/forest community. Along with the reactivated relict channel, this will result in the reconnection of 162 ha of floodplain and wetland ecosystem. The engineered log jam is composed of logs, root wads, and rocks with a trapezoidal opening and a sill that will functionally increase the streambed elevation by 2.2 feet. The log jam will function independently for 2 years, after which the relict channel immediately downstream will be reactivated and it will then function as added roughness within the inundated area upstream of an earthen plug.

Picture 28: Choke flow structure in winter 2016/7.

Relationship to Scope of Work

This project fulfills the Program commitments for Work Element F in the 2016 Scope of Work and Budget Request (Contract# 72434) for the contract period dating May 1, 2014 through April 30, 2015.

5. Future Restoration Outlook

The Hangman Creek Fisheries Program will continue to focus on restoring natural processes associated with a diverse and resilient stream/floodplain ecosystem. Potential for large-scale restoration projects such as the k'wne' 'ulchiyark'wntsut project exist throughout the upper Hangman watershed; in both lower tributary and mainstem stream reaches. These areas typically contain low gradient streams within large valley bottoms, capable of supporting diverse ecosystems and promoting the hydrogeomorphic processes that once dominated the landscape. These types of restoration actions are thought to have the most impact toward recovering the fragmented fish and wildlife populations that currently reside in the upper Hangman watershed. There will be a continuation of restoration prioritization that seeks to connect isolated fish populations in tributaries that include, and are upstream, of Mission Creek. Undoubtedly, beaver support and proliferation will continue to be the centerpiece of our restoration efforts, as they are instrumental in promoting and maintaining a healthy ecosystem. The choke flow structures using root wad construction has been a huge success and opportunities to repeat this method to generate addition floodplain connection will be sought out in scoping out new locations for restoration.

We will also continue to pursue small-scale restoration projects such as removing migration barriers and increasing stream habitat complexity. These types of projects are shown to have immediate beneficial results for redband trout populations, and the opportunity to implement projects such as these are present throughout the project area.

6. Acknowledgements

We wish to thank the Coeur d'Alene Tribe for the support given to this project, and to the Power Planning Council, United Columbia Tribes (UCUT), Bonneville Power Administration, Western Native Trout Initiative, Environmental Protection Agency, and Trout Unlimited for funding and technical guidance. The following were instrumental as partners and sources of data: Idaho Department of Environmental Quality, Idaho Dept. of Lands, Benewah County Conservation District, Spokane County Conservation District, and to internal staff that provided technical assistance and data gathering; Glen Lambert, Todd Johnson, Jon Firehammer, Gerald Green, Dan Jolibois, Stephanie Hallock, Angelo Vitale, Berne Jackson, Jason Sholtz, George Aripa, Jeff Jordan, and finally to tribal elder, Felix Aripa, who continues to support and inspire all of us.

7. *References*

Aripa, F. 2003. Personal communication with tribal elder.

Biladeau, T. J., and B.A. Kinkead. 2014. Progress Report 2012-2013: Implement Fisheries Enhancement on the Coeur d'Alene Indian Reservation: Hangman Creek. RM&E Summary. BPA Project #2001-032-00. 68pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Green, G.I., B. Kinkead, and D. Callery. 2008. Prioritization Area Selection within the Hangman Watershed of the Coeur d'Alene Reservation. 28pp. Coeur d'Alene Tribe. Plummer, ID

Herrera Environmental Consultants. 2011 Recommendations for Beaver Habitat Restoration in the Upper Hangman Watershed. 128pp. Technical Report prepared for the Coeur d'Alene Tribe.

Kinkead, B.A., and J.A. Firehammer. 2011. Progress Report: 2004-2007 Hangman Creek Fisheries Restoration . BPA Project #2001-032-00. 263pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Kinkead, B.A., and J.A. Firehammer. 2012. Final Progress Report: 2008-2009: Hangman Creek Fisheries Restoration. BPA Project #2001-032-00. 113pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Kinkead, B.A., and T. J. Biladeau. 2013. Progress Report 2010-2011: Hangman Creek Fisheries Restoration, BPA Project# 2001-032-00, RM&E and Restoration Summaries. 134pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Peters R., B.A. Kinkead, and M. Stanger. 2003. Year-End Report: 2001-2002 Implement Fisheries Enhancement on the Coeur d'Alene Indian Reservation: Hangman Creek. BPA Project # 2001-032-00. 189 pp. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Shields, F. D., N. Morin, and R. A. Kuhnle. (2001) Effect of large woody debris structures on stream hydraulics: From Proceedings of the conference on Wetland Engineering and River Restoration. Reno, Nevada, August 27-31, 2001.

United States Geological Survey. 2017, February. StreamStats. https://water.usgs.gov/osw/streamstats/