Klickitat Watershed Enhancement Project (KWEP)

Yakima/Klickitat Fisheries Project (YKFP)

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I. Executive Project Summary/Abstract

This report describes restoration/enhancement activities and on-going watershed monitoring in the Klickitat River subbasin implemented by the Klickitat Watershed Enhancement Project (KWEP). The activities described were funded in part by the Bonneville Power Administration (BPA) Yakima-Klickitat Fisheries Project (YKFP). Funds provided by BPA are matched with in-kind donations from the Yakama Nation in the form of materials and supplies and cash donations awarded through the solicitation of competitive grants such as the Salmon Recovery Funding Board (SRFB) administered by the Washington State Recreation and Conservation Office. Project work emphasizes restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead (*Oncorhynchus mykiss*), spring Chinook (*O. tshawytscha*) salmon, and bull trout (*Salvelinus confluentus*).

Restoration activities conducted during 2012-2013 aimed at restoring side channel and floodplain connectivity along the mainstem Klickitat River, reconnection of headwater meadows, reduction of the severity of active channel hydraulic conditions, enhancement of the quality and quantity of salmonid rearing habitat, and the restoration of deformable banks and hillslope interaction.

The Upper Klickitat Phase 3 Project replaced an undersized culvert on a side channel of the Klickitat River at RM 72 with a steel bridge, reconnecting approximately 1,700 linear feet of side-channel. Tepee Creek Phase 2 addressed an incised reach of Tepee Creek that limited floodplain storage in the adjacent meadow. In the upstream portion of the reach (~1,000 ft) gravels were imported and riffles constructed to raise the bed elevation, in the lower half (~1,400 ft) a historic channel was reactivated. Log jams were constructed throughout the reach to encourage local scour, control lateral erosion and provide primary habitat. Wood harvested on site provided materials for construction and reduced conifer encroachment in the meadow. Additional wood was placed throughout the meadow as floodplain roughness. Phases 3 and 4 of the Haul Road Project removed approximately 3 miles of asphalt and graded the embankment to enhance riverine and floodplain function. Nearly 2,000 ft of side channel was constructed and 6 culverts were removed, 2 of which were from seasonal fish-bearing tributary.

Monitoring activities are focused on the characterization of hydrologic and geomorphic conditions within the mainstem Klickitat River and tributaries. This is accomplished through a network of stream gages, a subset of which have more focused objectives (Klickitat Delta Pilot Study and Big Muddy Creek) and the collection of topographic data (LiDAR). The purpose of these data collection activities is to inform watershed assessment, land use planning and the focus of watershed and fisheries restoration efforts. Post-project monitoring is conducted on select sites to refine future projects by documenting whether or not intended physical responses occurred. Completed projects are presented as case studies at professional meetings to facilitate discussion and the advance knowledge of restoration ecology.

II. Introduction

The Klickitat Watershed Enhancement Project (KWEP) works to restore, enhance, and protect watershed function within the Klickitat subbasin. Project work emphasizes restoration and protection in watersheds and reaches that support native salmonid stocks, particularly steelhead (*Oncorhynchus mykiss*; listed as "Threatened" within the Mid-Columbia Evolutionarily Significant Unit), spring Chinook (*O. tshawytscha*) salmon, and bull trout (*Salvelinus confluentus*; Endangered Species Act "Threatened"). Restoration activities are aimed at restoring stream processes by removing or mitigating watershed perturbances and improving habitat conditions and water quality. Watershed and habitat improvements also benefit fall Chinook (*O. tshawytscha*) and coho (*O. kisutch*) salmon, resident rainbow trout, and cutthroat trout (*O. clarki*) and enhance habitat for many terrestrial and amphibian wildlife species. Protection activities compliment restoration efforts within the subbasin by securing refugia and reducing degradation. Since 90% of the off-reservation project area is in private ownership, maximum effectiveness is accomplished via cooperation with state, federal, tribal, and private entities. KWEP addresses goals and objectives presented in the Klickitat Subbasin Plan, Klickitat Lead Entity Strategic Plan, and the 1994 Northwest Power Planning Council's Fish and Wildlife Program.

PROJECT GOALS

The overall goal of KWEP is to restore watershed processes to aid recovery of salmonid stocks in the Klickitat subbasin. There are three sub-goals:

• Assess watershed and habitat conditions to prioritize sites for restoration activities. This involves data collection, compilation, and review of existing as well as historic habitat and watershed conditions. Identification and filling of data gaps is also a component of KWEP.

• Protect, restore, and enhance priority watersheds and reaches to increase riparian, wetland, and stream habitat quality. In-situ and watershed-scale restoration activities mitigate or resolve conflicting historic, present, and/or future land-uses. Protect areas of existing high-quality habitat condition and prevent further habitat degradation. Restore areas of degraded stream channel and/or habitat condition.

• Monitor watershed conditions to assess trends and effectiveness of restoration activities. Monitoring is a critical component to evaluating project success and guiding adaptive practices. Site-specific and basin-wide spatial scales are addressed. KWEP augments the Klickitat Monitoring & Evaluation Project (BPA project #1995-06-335) by assisting data collection, providing Quality Assurance /Quality Control (QA/QC) and analysis of channel morphology, streamflow, temperature, habitat, and channel substrate.

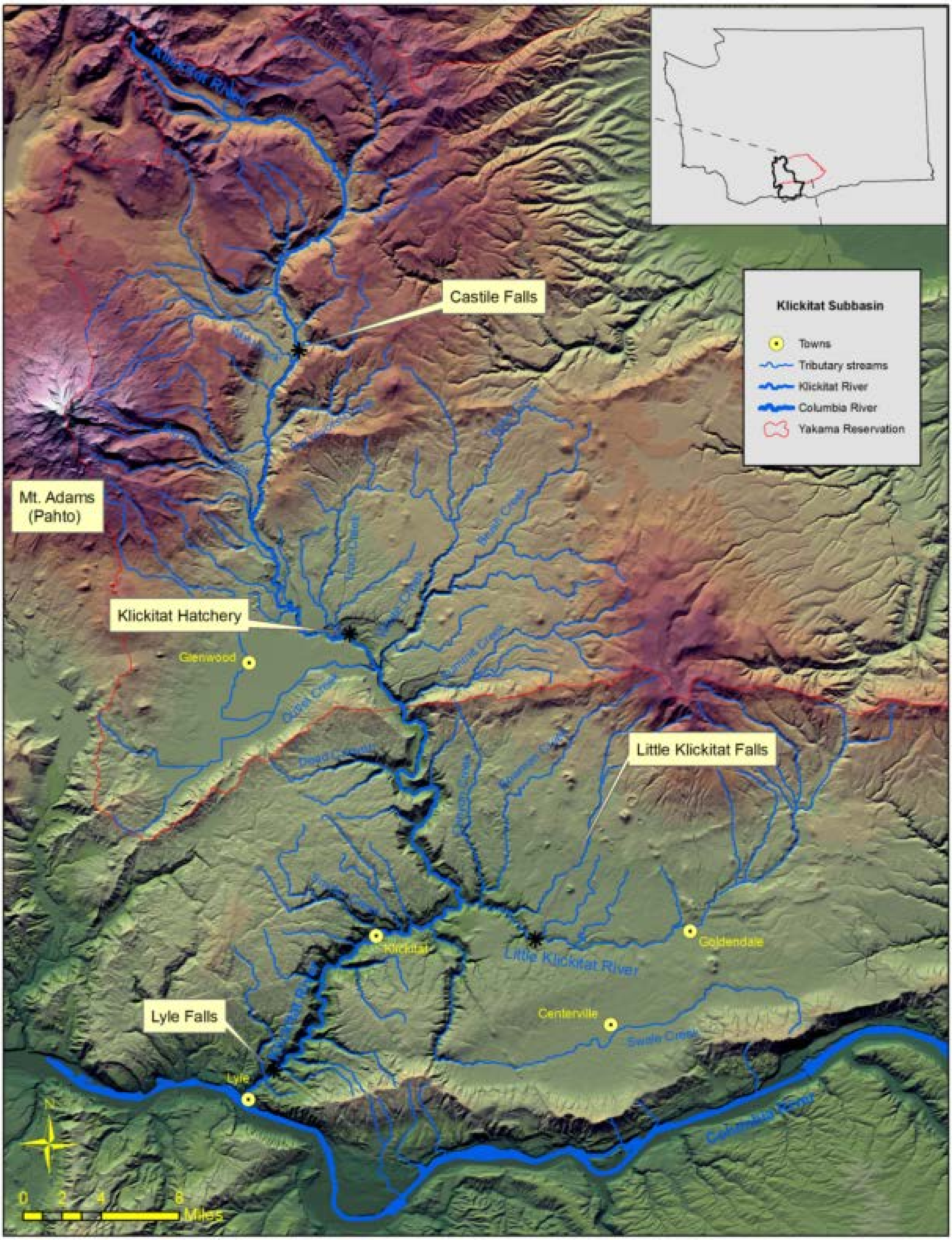


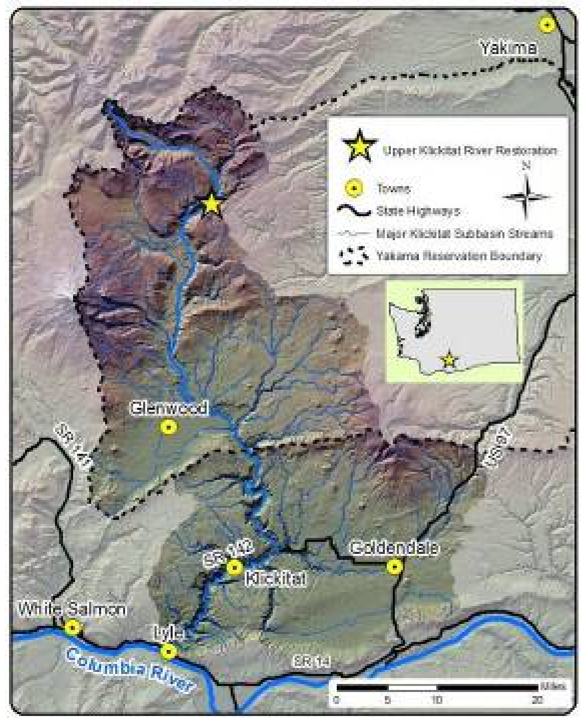
Figure 1. Klickitat River Subbasin

III. Work Elements/ Deliverables

Tributary Habitat Restoration and Protection

Upper Klickitat River In-channel and Floodplain Enhancement - Phase 3

Introduction: The project addresses limiting features (channel confinement and habitat simplification) identified for this reach by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy (KLESRS). The core Ecosystem, Diagnosis & Treatment (EDT) reach that encompasses the project sites rank third overall in the Klickitat subbasin in restoration potential for combined performance of steelhead and spring Chinook (NPCC, 2004). Project work addresses limiting factors identified for the reach between RM 70 and 74.5.



Site and Watershed Description: The project location is on a side channel of the Klickitat River in the vicinity of river mile 75.5 where a cross-valley alignment of the 255 Road interrupts floodplain connectivity. This area has the potential to provide critical spawning and rearing habitat for ESA-listed Middle Columbia River steelhead and spring Chinook. The project area consists of a ~2700 foot side channel. The side channel is located between 2950-3240' above sea level. The contributing drainage area is 89 mi^2 and is predominantly forested by Douglas fir, grand fir, ponderosa pine, and lodgepole pine. Annual precipitation ranges from 60 to 65 inches and occurs primarily as snow. Streamflows are primarily snowmelt driven, though the highest peak events on record (e.g. 1996) tend to be associated with large regional rain-on-snow events.

Fisheries Significance: Castile Falls is a series of 11 waterfalls located at RM 64 of the Klickitat River (roughly 5.0 – 10.0 miles downstream of the project site). Some steelhead and some spring Chinook passage was apparently possible prior to construction of a small headworks dam above Falls 11 in the 1960's to provide grade-control for the intake of a fishway constructed by the Washington Department of Fisheries. The fishway was constructed with the intent of improving spring Chinook salmon and steelhead passage and functioned properly for several years before becoming plugged with bedload at which point the fishway became a velocity barrier. The combined effect of the dam and fishway was obstruction of upstream passage under an estimated 99% of flows for which monitoring has occurred since 1996. There are no anecdotal accounts of adult steelhead or Chinook observations in intervening years. The Yakama Nation completed modifications to the upper fishway and the fishway at Falls 4/5 in

2003 and 2004, respectively. Fisheries managers anticipate that natural straying of wild steelhead will recolonize upstream habitats including those in the vicinity of Upper Klickitat enhancement sites.

Pre-project Problem: Channel simplification is the primary problem that likely resulted from the placement of the 255 Road in the floodplain of the Klickitat River**.** The project location is on a side channel of the Klickitat River in the vicinity of river mile 75.5 where a cross-valley alignment of the 255 Road interrupts floodplain connectivity (Fig. 2). The 255 Road is the major arterial road in the upper Klickitat watershed. Prior to the project there was a single bridge crossing. Several side channels exist up-valley from the road crossing but the alignment of the largest of these channels (BFW ~20') is deflected where it contacts the fill slope from the 255 Road. Once deflected the side channel runs along the toe of the fill for approximately 300' before rejoining the mainstem Klickitat River.

In addition to the road's influence on channel morphology and habitat, it seems likely that stream cleaning occurred at some point. The Washington Department of Fisheries conducted a habitat survey between Castile Falls and McCormick Meadows in 1957 (LeMier, et al. 1957) and noted, "many log and debris jams caused by windfalls are present in the stream area ranging in size to 200 feet long, 50 feet wide, and 18 feet high." The report notes other conditions (depth and pool frequency) that were more favorable to salmonids than those observed pre-project. In particular, the reach within which the Upper Klickitat Phase 2 project occurs contained, "The largest and most serious log jams." The report went on to prescribe "…therefore, removal of these obstacles is mandatory if the [Castile] falls improvement work is undertaken." Stream cleaning was a common practice throughout the Pacific Northwest into the 1980s and the construction of the 255 Road would have made the reach much more accessible to the practice had it not occurred previously. Given the absence of jams or older relics of jams on floodplain, it seems highly likely that stream cleaning occurred in the project reach.

Project Goal: Restablish connectivity of a side channel of the upper Klickitat River. The overall goal is to provide enhanced spawning and rearing habitat for spring Chinook salmon and steelhead along roughly 2680 feet of side-channel in the vicinity of river mile 76 of the Klickitat River. The project area is located within the "Upper Klickitat Mainstem: McCreedy Creek (RM 70) to Diamond Fork" reach that is ranked in the top tier of priority geographic areas identified in the Klickitat Lead Entity Region Salmon Recovery Strategy.

Design: Perforation of the embankment and installation of 80' x 24' single span bridge will distribute flow at channel-forming discharges. This will facilitate: 1) development of the side channel and 2) reduce shear in the primary channel. As the side channel continues to develop, rearing habitat will likely increase and spawning habitat (for *O. mykiss*) should develop. LWD placed in the side channel is intended to increase the quality and hasten development of rearing habitat.

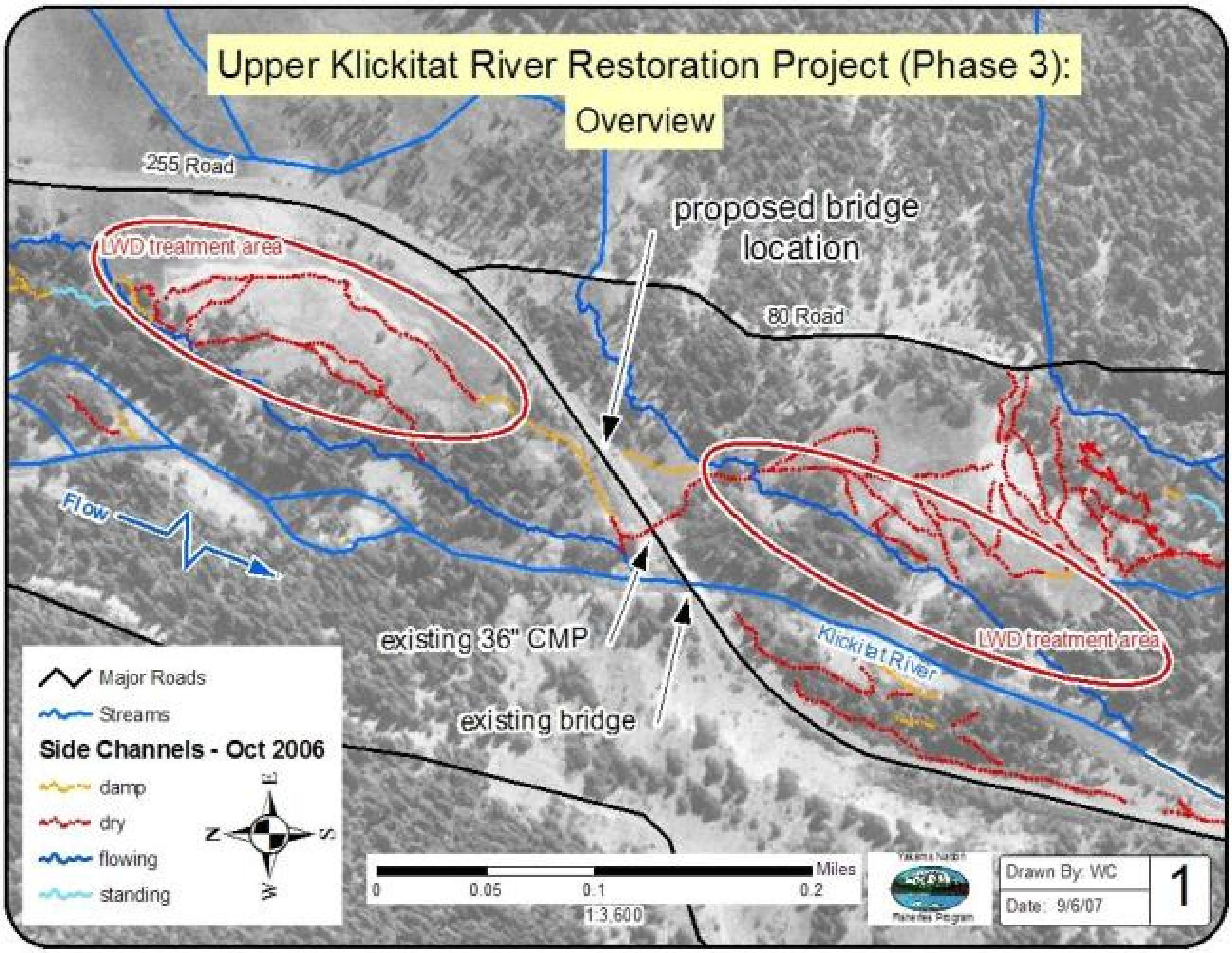


Figure 2. Side Channel Inventory (2006) and location of new bridge crossing.

<u>Construction</u>: Placement of the new bridge occurred over the course of two construction seasons (fall 2012 and spring 2013). External forces (abnormally dry late-summer/fall followed by unseasonable wet fall/early winter) in 2012 resulted in a condensed work window. The unusually dry fall led to the highest fire danger in September and early-October (IFPL level 4 = total shutdown of forest lands). Then, rain accumulation in the month of November exceeded the thirty year average. Significant progress was made in early December but ultimately the project had to be postponed until spring based upon concerns over human safety and the long term performance of the project. Work resumed in early Spring 2013.

2012-2013 Activity:

2012

- Incorporated LiDAR data with ground-based topographic datasets
- Refined hydraulic model for Phase 3
- Completed specifications, solicited bids, selected construction contractor, and awarded subcontract
- Mobilized equipment
- Dewatering and fish salvage
- Completed excavation (~2000 cu-yd)
- Completed rock hauling
- Transported 3 bridge sections to project site
- Pre-cast footings fabricated and delivered to site
- Completed channel invert (~100 l.f.) through the bridge crossing
- Completed 90% of slope armoring through bridge crossing
- Roughed-in approx. 250 l.f. of new channel downstream of crossing
- Completed the foundation (including subgrade compaction and footing placement) for the west abutment

2013

- Completed slope armoring
- Completed the foundation (including subgrade compaction and footing placement) for the east abutment
- Completed bridge installation
- Completed grading of floodplain surfaces
- Installed floodplain roughness elements (LWD)
- Installed in-stream habitat enhancement features (LWD) along channel margins of transitional areas
- Disposed of excavated material and applied erosion control (weed free straw)
- Applied native seed mix (upland and wetland) and erosion control measures (weed free straw)

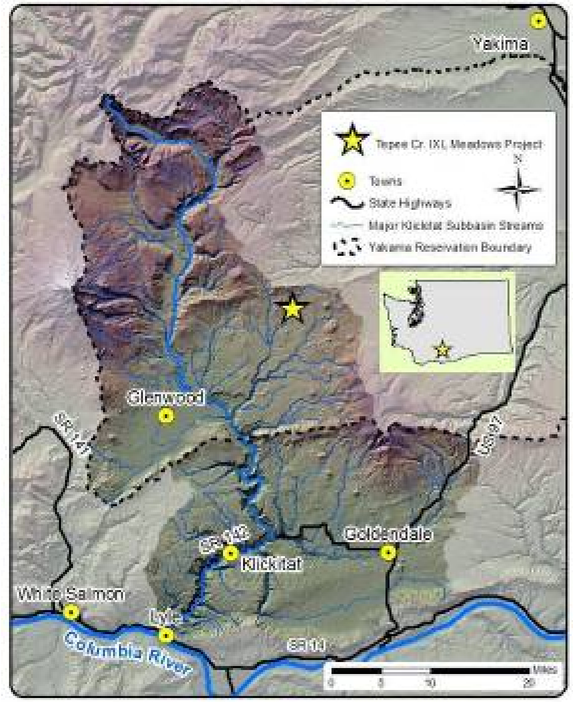
Design for bridge sizing, roughened channel, and in-stream habitat enhancement elements were conducted jointly by Yakama Nation Fisheries staff hydrologist and a Professional Engineer (PE) from Inter-Fluve Inc. of Hood River, OR. The bridge was designed and constructed by Big R Bridge of Greeley, CO to meet YN-specified performance criteria. Geotechnical and foundation design was conducted by PLSA of Yakima, WA. Wilbert Pre-cast of Yakima, WA cast the foundation. Bridge placement and other construction activities were performed by Rodarte Construction Inc. of Auburn, WA and their subcontractors.

Project Outcomes: The primary outcome of the project was the replacement of an undersized culvert (18” CMP with obstructed inlet and outlet) with an 80’ x 24’ steel bridge (Figs. 3 and 4). As a result approximately 1700 linear feet of side channel downstream of the road embankment was reconnected, bringing total side channel length to 4100 linear feet. Additional habitat elements were also constructed (floodplain roughness (LWD) and in-stream channel complexity (LWD)). A native seed mix (upland and wetland) and weed free straw mulch was applied to all surfaces disturbed during construction. Habitat elements were scaled-back slightly from original estimates due to the increased cost of the bridge and increased costs associated with snow removal and de-mobilization of equipment in 2012 resulting from construction being in-progress when a major snowfall event occurred.

Figure 3. Upper Klickitat River In-channel and Floodplain Enhancement – Phase 3 pre (left) and post bridge installation (right) looking in the downstream direction above the 255 rd-xing.

Figure 4. Upper Klickitat River In-channel and Floodplain Enhancement – Phase 3 pre (left) and post bridge installation (right) looking in the downstream direction below the 255 rd-xing.

Tepee Creek Meadows Restoration - Phase 2



Introduction: Tepee Creek is a tributary to White Creek and provides important spawning and rearing habitat for ESA-listed Middle Columbia River steelhead and is a top geographic priority. The White Creek watershed as a whole is likely the most important spawning and rearing tributary watershed within the Klickitat subbasin. In recent years (2002-2013), the White Creek watershed on average accounts for 29% (11-55%) of the observed steelhead spawning in the entire Klickitat subbasin. Tepee Creek has accounted for up to 31% of the observed spawning in the Klickitat subbasin in recent years (2002-2013), however on average it accounts for 9%. Extensive reaches of Tepee Creek are incised 3-5' and are now intermittent in many places that anecdotal information suggests were once perennial. The project addresses limiting habitat features (bed degradation and pool structure) identified by the Subbasin Plan (NPPC 2004) and KLESRS (2012) along 2000 feet of Tepee Creek.

Site and Watershed Description: The project reach consists of approximately 1 mile of Tepee Creek in the vicinity of river-mile 5 (Fig. 5) and immediately downstream of the IXL Meadows Restoration Project (completed 2007; Conley 2008). The site is at 2900' elevation. Average annual precipitation is between 20 and 29 in., with roughly half falling as snow. The reach is a mix of meadow, ponderosa pine parkland and mixed conifer forest. The contributing drainage area is 8.4 square-miles in size and occurs primarily between 3000' and 4000' feet in elevation. Basal geology is the Grand Ronde Basalt of the Columbia River Basalt Group which contributes both to low to moderate topographic relief and to resistant parent materials. Surficial parent material likely originates as ash from Cascade and volcanic rocks and ash from the Simcoe Volcanic field. Faulting associated with the Yakima Fold Belt along the northern margin of the watershed has generated steeper slopes that increase weathering rates and contribute to a limited gravel supply for the watershed. Soils and banks on-site are cohesive with a prevailing clay loam texture.

Fisheries Significance: Tepee Creek provides spawning and rearing habitat for ESA-listed ("threatened") Middle Columbia River steelhead. On average, Tepee Creek accounts for 9% of the total observed spawning in the Klickitat subbasin. The project area occurs within a reach that has been identified by the Klickitat Technical Advisory Group as one of the top priority areas for salmon recovery in the Klickitat Subbasin.

Problem: In general, summer rearing habitat in the White Creek watershed is highly limited. Summer refugia, in the form of perennially-flowing stream reaches or remnant pools in otherwise dry reaches, are highly limited in Tepee Creek and are necessary for successful rearing within the watershed. Stream channel incision throughout much of the watershed limits floodplain storage. Upstream, in the IXL Project reach, pre-project hydraulic modeling indicated that most cross-sections required at least a 10-

year recurrence flood to generate overbank flow (Interfluve 2004). Where wetlands and floodplains are intact, such as in the headwaters of Tepee and in the East Fork Tepee Creek watershed perennial flows do exist. Where perennial pool habitat is present, survival appears to be good, particularly for 0+ and 1+ aged fish. Currently, downstream migrations triggered by summer freshets often fail to provide continuity to perennial habitats resulting in stranding in intermittent flow areas. Additional refugia are critical for increased survival. Anecdotal evidence, along with watershed size, elevation, and precipitation, suggest that more reaches had perennial flow historically.

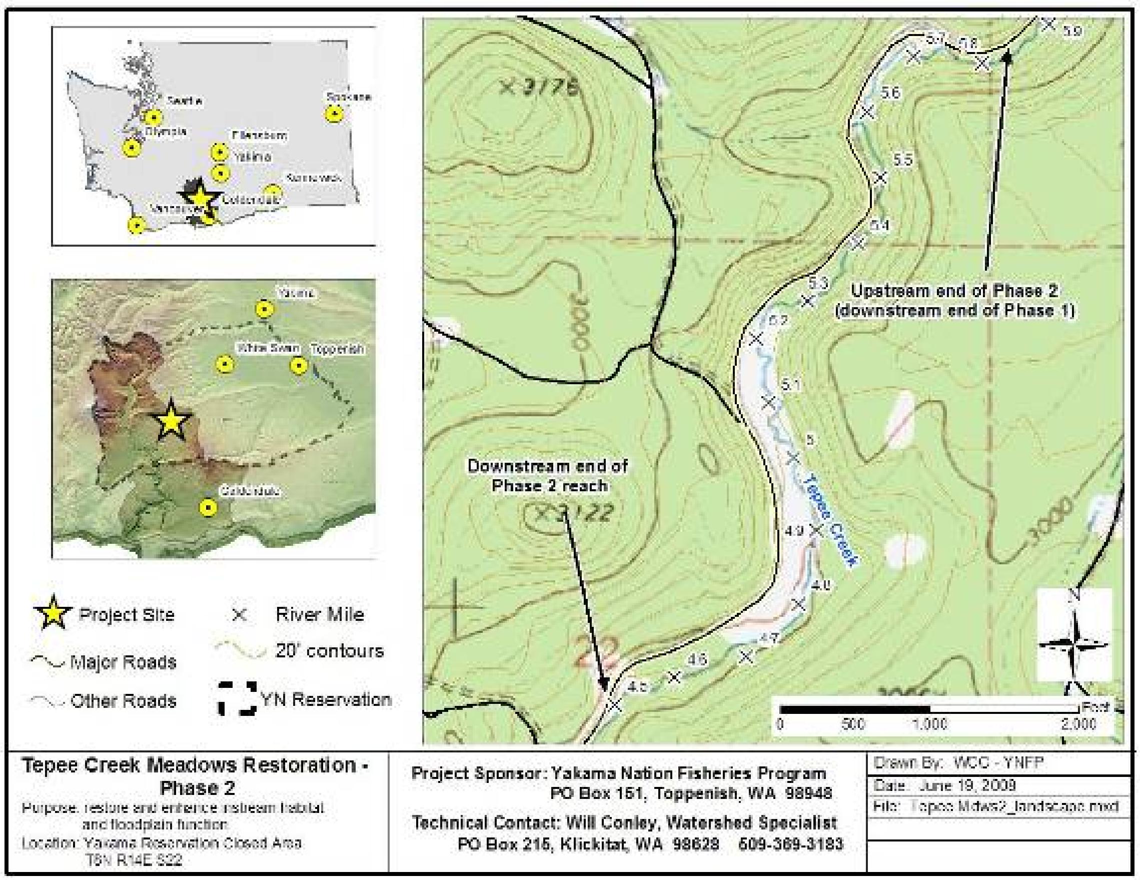


Figure 5. Map of Tepee Creek Meadows Restoration – Phase 2.

Currently, most of the incised reaches in the White Creek watershed (including the project reach) dry up from July through October. Anecdotal accounts from the 1960s suggest that at least some of these reaches were historically perennial. Many of the same reaches showing signs of bed armoring are also characterized by a simplified morphology with low pool frequencies, rectangular, canal-like cross sections, and an absence of LWD.

The trigger for incision in the Phase 2 reach appears to be largely of local origin. There is a perched, abandoned channel in the lower half of the reach possessing different channel geometry than the adjacent, active channel. The abandoned channel is much narrower and more sinuous and has remains of a low-head timber bridge near its inlet at the diversion point with the active channel.

Livestock grazing (in the form of altered riparian vegetation, bank erosion, and channel incision) may have also pre-disposed the site to channel incision. Site-based effects coupled with watershed scale management activities are the most probable causes of current conditions. Hydrologic modeling (nhc 2003) indicated increased stormflow and volume in the upper White Creek and Tepee Creek watersheds due to forest road density and drainage characteristics.

Project Goals:

- Increase floodplain storage
- Reduce severity of active channel hydraulic conditions during high flows
- Enhance quantity and quality of steelhead spawning and rearing habitat
- Potentially restore base flows to this and downstream reaches
- Restore suitability of valley bottom for medicinal and traditional food plants

Design: Conceptual design for enhancement of the Phase 2 reach raises stream bed elevation and reconnects historic channel and floodplain. This strategy provides a greater potential benefit than other alternatives (e.g. excavating new floodplain) as it maximizes wetter perimeter for discharges greater than 1.4 year return intervals and has the potential to increase water storage and extend hydroperiods across the valley width. The central design goal is to configure the channel to promote more frequent overbank flooding, which will improve primary channel hydraulic conditions for fish while promoting better wetland habitats and water storage late in the year. In-channel treatment will involve importing gravel into the existing channel in combination with channel cross-sectional area adjustments and planform modifications.

Design templates were configured such that the channel will convey the existing sediment supply, while mitigating the tendency to degrade. Planform modifications were determined by design slope and hydraulic geometry. Hydraulic geometry, including bankfull width, was refined by analysis of upstream analog cross-sections and slopes, regional hydraulic geometry relationships, and the creation of a hydraulic model for the project reach. A design hydrology that approximates actual and anticipates future conditions as much as possible was selected to guide hydraulic geometry development. Proposed channel components allow some threshold movement and deformation.

Methods/Elements:

- Constructed bedforms – The primary treatment is to raise stream bed elevation by importing gravel to construct riffles. Constructed riffle crests on an average reach gradient of 0.4%. Pools formed by default in locations where fill is not introduced. Because of the bedload-limited nature of the watershed, material is sized to be immobile at the bankfull discharge (~$Q_{1.3}$). The specification for size gradation incorporates sufficient fines to control porosity to ensure lower discharges flow over the riffle crests for as much of the flow-duration curve as possible without introducing so many fines as to destabilize imported material.

- Channel margins – Native bank materials are cohesive and moderately resistant to lateral erosion, particularly in the rooting zone. Large woody debris used on the outside of corners to encourage local scour that will help maintain pool depths and volumes, control lateral erosion, and provide primary habitat (Fig. 9). Channel edges (banks) constructed with wood will be less expensive and more erosion resistant than if fabric were used.
- Vertical control - A roughened channel, on a steepened grade (approximately 5%) was constructed at the downstream end of the reach to transition between restored bed elevations and the somewhat incised channel downstream. This feature will set the gradient for the upstream (constructed) reach and increase the stability of constructed riffles.
- Revegetation - Existing riparian vegetation was salvaged where possible. Use of sod mats salvaged from the pre-project inset-floodplain of the IXL reach was very effective and dramatically reduced recovery time. Woody and herbaceous species native to the watershed were utilized where salvaged materials were insufficient or inappropriate. Woody species were propagated primarily from dormant cuttings of local origin. Seed for herbaceous revegetation was sourced from a producer with source genetics suitable for the site. Existing riparian vegetation in localities with invasive weeds (e.g. Canada thistle) were not salvaged.
- Floodplain roughness - Large woody debris strategically placed on the reactivated floodplain to prevent avulsions and flanking of constructed riffles.

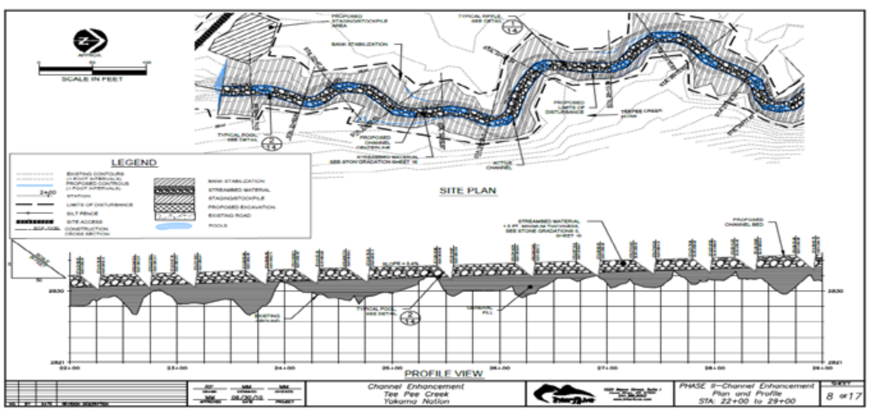


Figure 6. Site plan and profile view of the Tepee Creek Meadows Restoration (Phase 2).

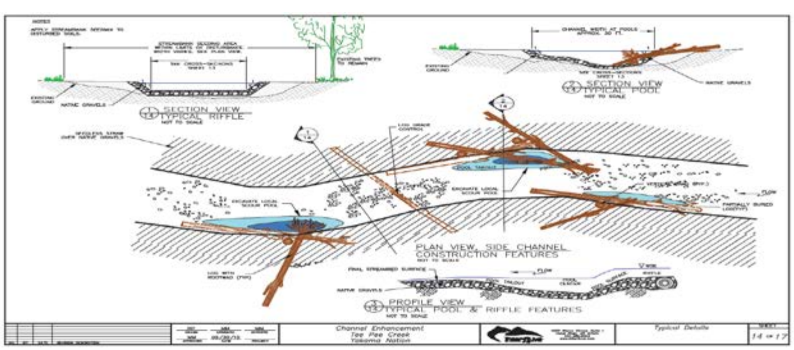


Figure 7. Plan view design of the historic channel portion of the Tepee Creek Meadows Restoration (Phase 2).

Construction: The construction of log jams, grading of riffles, and placement of floodplain roughness elements occurred over the course of two construction seasons (fall 2012 and fall 2013). External forces (abnormally dry late-summer/fall followed by unseasonable wet fall/early winter) in 2012 resulted in a condensed work window. The unusually dry fall led to the highest fire danger in September and early-October (IFPL level 4 = total shutdown of forest lands). Then, rain accumulation in the month of November exceeded the thirty year average. Significant progress was made in early November but ultimately the project had to be postponed until spring based upon concerns over the long-term performance of the project. Work resumed during the low flow period, fall 2013.

2012-2013 Activity:

2012

- Crafted specifications, solicited bids, selected contractor, and awarded subcontract for construction
- Contractor mobilized
- Completed rock production of streambed stone I and streambed stone II (materials for riffle construction)
- Large woody debris (LWD) collection – approx. 70% complete
- Construction of riffles within the upstream 1000' of project reach – 70% complete
- Reactivation of 1450 feet of historic channel
- Construction of LWD jams – approx. 60% complete
- Conducted erosion control and revegetation (native seed mix) on disturbed and constructed areas
- Finished winterizing the site and de-mobed for the season on 12/1/12

2013

- Due to performance related issues with the original subcontractor a different subcontractor was selected to finish construction
- Contractor mobilized
- Additional logging completed including removal of conifer encroachment in aspen stand
- Construction of grade control structures at downstream extent of project
- Piling of unused slash at strategic locations for burning at later date
- Finished grading riffles constructed in 2012
- Crafted specifications, bid documents, solicited bids and selected contractor for livestock exclusion fencing (to be constructed Spring 2014)
- Filled approximately 1300 feet of contemporary channel downstream of reactivated historic channel to provide grade control
- Construction of 26 LWD jams
- Finish grading of floodplain surfaces
- Placement of LWD roughness elements

Design for riffle construction and in-stream habitat enhancement elements (LWD placement) were conducted jointly by Yakama Nation Fisheries staff hydrologist and a Professional Engineer (PE) from Inter-Fluve Inc. of Hood River, OR. Rock production, logging (LWD), and other construction activities were performed by C.I. Lovell Inc. of Harrah, WA (2012) and Tom Arnold Logging Inc. of White Salmon, WA (2013).

Project Outcomes: The primary outcome of the project was the restoration of floodplain connectivity for a .7 mile reach of Tepee Creek between river miles 4.5 and 5.2. As a result floodplain storage will increase, hydraulic severity during high flow events will be reduced, and there is the potential for perennial flow within the reach (Figs. 8 and 9). Conifers have been removed from the meadow increasing the suitability of the valley bottom for native, medicinal, and traditional food plants (Fig, 10). The quality (structure, cover, and residual depth) of 26 pools has been enhanced through the addition of LWD. Project elements to address in-stream conditions had two prongs: reactivate a relic (historic) channel (~2100 ft) and raise the streambed to create riffles in the current channel (~1500 ft). Methods employed:

- LWD was placed for transitions between the imported gravel and existing valley bottom surfaces. LWD was designed to encourage local scour to maintain pool depths and volumes, control lateral erosion, and provide primary habitat (Fig. 8).
- A roughened channel, on a steepened grade (approximately 3%) is designed to provide downstream control for the reach and transition between restored bed elevations and the somewhat incised channel downstream.
- Constructed riffles consist of imported gravel that are immobile at $<Q_{1.3}$ and has sufficient fine content to control porosity (Fig. 9).
- Floodplain roughness elements (LWD) were placed to prevent avulsion around edges of the imported material or across smooth floodplain surfaces.

Figure 8. Tepee Creek Meadows Restoration – Phase 2 pre (left) and post riffle construction (right) and LWD placement, well (yellow circle) placement is consistent in both pictures although "post" picture is taken with a wider angle.

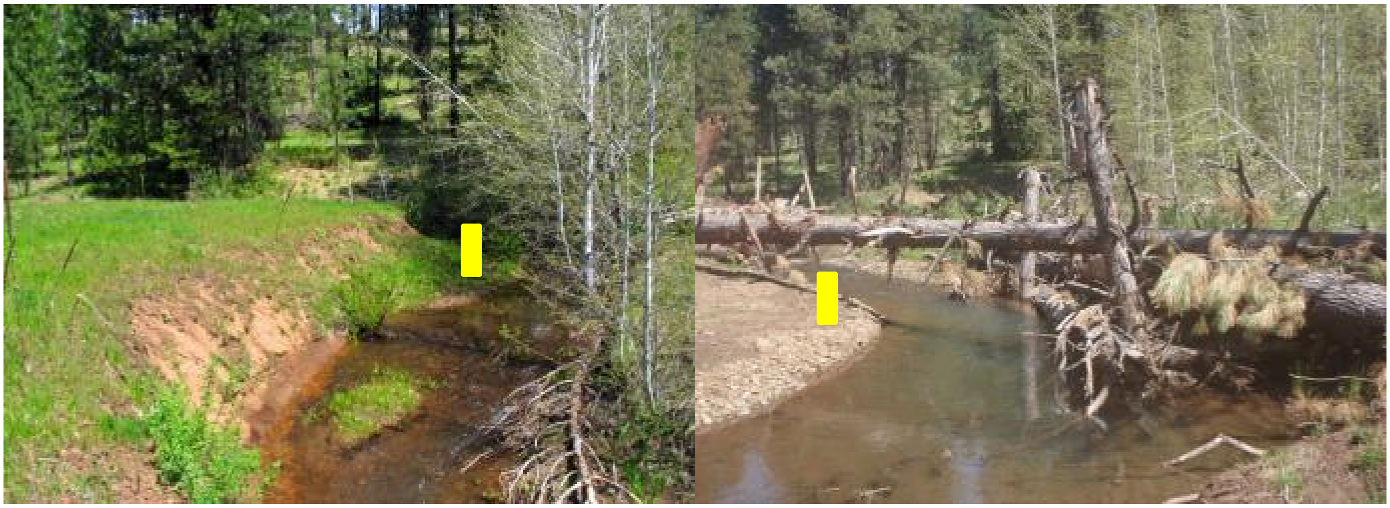
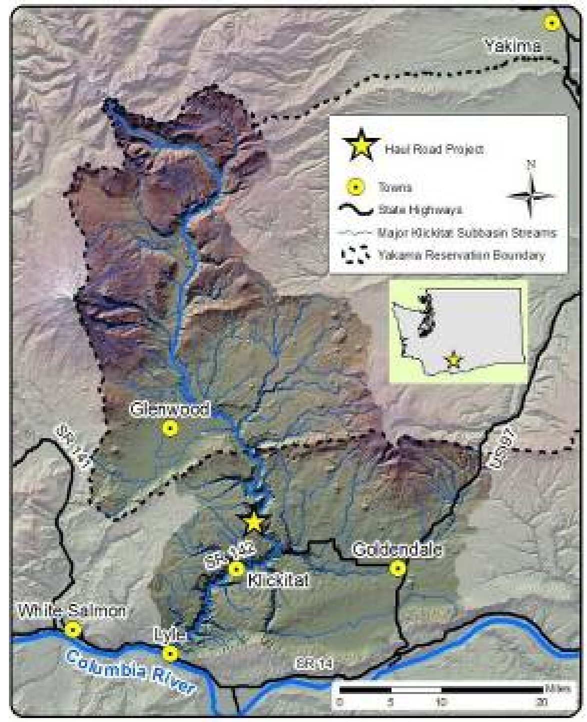


Figure 9. Tepee Creek Meadows Restoration – Phase 2 pre (left) and post riffle construction (right) and LWD placement, the yellow vertical bar indicated roughly the same location on the point bar in both pictures.

Figure 10. Tepee Creek Meadows Restoration – Phase 2 pre (left) and post (right) reduction in conifer encroachment. Pictures depict meadow conditions before and after the treatment.

Klickitat River Floodplain Conservation and Restoration (Haul Road) Project –Phase 3 & 4



Background: The Haul Road project addresses limiting features (channel confinement) identified for the Klickitat River between river miles 18.3 and 32.2 by the Klickitat Subbasin Plan and Klickitat Lead Entity Salmon Recovery Strategy. This portion of the river has the greatest habitat complexity of any reach in the lower Klickitat River and provides critical spawning, migration and rearing habitat for winter and summer steelhead (ESA-"Threatened"), Chinook salmon (spring and fall runs), and coho salmon. This reach provides a high proportion of the basinwide spawning habitat for all three species, accounting for on average 19% (2-40%), 42% (24-65%), and 15% (0-37%) of the annually observed basinwide spawning for steelhead, fall Chinook, and coho, respectively (2002-2013). Riparian and floodplain conditions have been degraded by a combination of channel encroachment and floodplain isolation by road fill as well as 1996 flood deposits. The absence of other floodplain development coupled with somewhat less-confined valley conditions affords this reach greater resiliency than downstream reaches. The project is occurring in two stages: 1) acquisition (Phase 1 funding) and 2) restoration (all subsequent phases of funding). Columbia Land Trust (CLT) acquired the property completing Phase 1 in 2007 and is the primary for SRFB grants. KWEP is the technical lead for design and construction oversight of restoration actions as well as assisting planning activities, including Road Maintenance and Abandonment Plan (RMAP) revisions.

Project Goal: The overall project goals are to prevent habitat fragmentation and restore floodplain connectivity and geomorphic processes to the valley bottom. CLT completed acquisition of the road and 480 acres of private riparian and upland in holdings within the Klickitat Wildlife Management Area in 2007 (Conley 2008). Phase 1 was completed in 2009 with removal of a cross-valley railroad embankment in Dead Canyon (tributary at upstream end of project reach). The Phase 2 grant addresses limiting features for a portion of this reach by restoring floodplain connectivity and pulling back and re-vegetating fill materials in other portions to enhance riparian vegetation. Phase 2 enhanced and restored riparian and floodplain habitat by modifying 2.1 miles (cumulative) of road to reduce channel confinement and restore floodplain access along 0.94 miles of the road. Roughly 7.5 acres of riparian and floodplain habitat will also be revegetated.

2012-2013 activity: Project planning, development and construction activities were conducted during the reporting period.

Planning - KWEP and CLT staff conducted several field visits to refine treatments and geographic scope of Phase 3, 4, and 5, as well as generate a timeline for implementation of future phases. KWEP staff determined stationing for road segments delineated during assessment (Conley and Lindley 2012) and performed lay-out prior to bidding phases 3 and 4. Concurrently, the GIS database culvert layer was updated, improving the precision of location data, type, and condition. An application for Phase 4 of the Haul Road co-sponsored by CLT and the YN was submitted during the 2012 SRFB grant round. The funding decision to award the grant was received December 2012. An application for Phase 5 of the Haul Road co-sponsored by CLT and the YN was submitted during the 2013 SRFB grant round. The funding decision to award the grant was received December 2013.

Administration – During the construction process KWEP project staff supported CLT with permitting, RMAP revisions, request for proposals (by providing quantities and specifications), bidding, contract award, and contract administration process. Additionally, the YN hydrologist provided field oversight of construction activities and directed fit in-the-field implementation.

Construction

Phase 3 (fall 2012) –

- Approximately 8,900 l.f. of embankment graded to enhance riverine and floodplain function:
- ~1780' of floodplain channel constructed
- Placement of 45 pieces of wood placed to create floodplain roughness
- Restored deformability of channel margins to permit lateral channel migration and serve as long-term LWD source
- Restored hillslope interaction
- Removed asphalt from 1.7 miles of floodplain road
- Removed 6 cross drain culverts, 3 culverts from non-fish bearing tributary, and 1 culvert from a seasonal fish-bearing tributary

Figure 11. Klickitat River Floodplain Conservation and Restoration– Phase 3 pre (left) and after (right) removal of road prism, construction of channel and grading of floodplain.

Phase 4 (fall 2013) –

- Approximately 8,300 l.f. of asphalt removed
- 4,435 l.f. of fill removed
- 3,854 l.f. of fill pullback
- embankment graded to enhance riverine and floodplain function:
  - Restore deformability of channel margins to permit lateral channel migration and serve as long-term LWD source
  - Restore hillslope interaction
- Access to 9.78 acres of floodplain habitat restored
- Removed 3 culverts and restored access a to 1 seasonal fish-bearing tributary

Figure 12. Klickitat River Floodplain Conservation and Restoration– Phase 4 pre (left) and after (right) removal of road prism and exposure of bedrock outcrop.

Figure 11. Klickitat River Floodplain Conservation and Restoration – Phase 4 pre (left) and after (right) removal of road prism, construction of channel and grading of floodplain.

Vegetation Management – Invasive plant species plant were identified and removed via hand pulling (KWEP personnel) and herbicide application (spring and fall 2012 and 2013). The herbicide was applied by a license applicator from the Klickitat County Noxious Weed Board. Native seed and straw mulch were applied to disturbed surfaces by the construction subcontractor and supplemented by KWEP staff.

Containerized stock planted with either hoedad or power auger (determined by stock, species and microsite conditions):

2012

- 400 spiraea (*Spiraea douglasii*) tubelings
- 1,950 containerized plantings (14"x4" tree pots)
- Scoulers Willow (*Salix scouleriana*)
- Dogwoods (*Cornus nuttallii*)
- Cottonwood (*Populus deltoid)*
- Planted approx. 2,000 locally-sourced acorns (*Quercus garryana*)

2013

- 250 dogwood (*Cornus sericea*) tubelings
- 836 containerized plantings (14"x4" tree pots)
- Scoulers Willow (*Salix scouleriana*)
- Dogwoods (*Cornus nuttallii*)
- Cottonwood (*Populus deltoids*
- Planted approx. 1,500 locally-sourced Oaks (*Quercus garryana*)

Manage Native Nursery

In an effort to reduce the costs associated with revegetation efforts, have a supply of locally sourced plants, and generate a source of in-kind match for grant based funds, KWEP personnel constructed a small nursery at the Klickitat Field Office (KFO) in Wahkiacus, WA in 2006. The nursery consists of constructed wooden frames sized appropriately to hold treepot style containers (Stuewe & Sons Corvallis, OR). Live cuttings are harvested from native hardwoods each spring prior to leaf out, cut to size, and rooted in a planting medium in treepot containers. Plants are then irrigated 3 times weekly throughout the growing season and are typically out-planted the same year. The nursery has the capacity to grow 3,600 containerized plants within treepots with additional irrigated space to house purchased plants or holdovers from a previous growing season. In 2012-2013 approximately 3,000 plants were grown at the KFO nursery. Containerized plants are typically a mix of pine (*Pinus ponderosa*), rose (*Rosa nutkana*), dogwood (*Cornus nuttallii*), willow (*Salix scouleriana*), alder (*Alnus rubra*), cottonwood (*Populus deltoids*) and spirea (*Spiraea douglasii*).

Figure 12. Nursery at Klickitat Field Office.

Invasive plant control

Typically sites selected for restoration or enhancement projects have a history of disturbance or perturbation. As a result non-native vegetation is present to some degree and poses a potential threat to be "released" once soils are disturbed during construction activities. In order to prevent this spread and to afford native plants the opportunity to become established KWEP personnel make annual visits to project sites both pre and post treatment.

Site visits were made to eight completed project sites (34.25 acres) in 2012 and 2013 in order to control the spread of weeds. Treatments involved manual pulling of target species, primarily knapweed and non-native thistles. An initial pass was made through each site followed later by a second pass to focus removal on newly emergent plants and those that had been missed previously. On-Reservation the Yakama Nation currently has a no-spray policy thus hand removal is conducted. Off-Reservation KWEP consults Klickitat County Noxious Weed Board staff in order to develop the most effective strategy.

Tributary Habitat RM&E

Habitat Enhancement Project Monitoring

KWEP staff annually visit past project sites to photo-monitor performance of treatments implemented since 2002. Photos are taken at specific points within project areas that are typically linear. Either prominent landmarks (trees, rocks, stumps) or stations along the stream continuum are used to reorient/relocate photon points. A photo record facilitates comparisons between and among years to determine whether changes have occurred over time. Photos used throughout this document are a result of photo documentation at project sites over time.

All photos taken as part of photo-monitoring are saved digitally, filed electronically in subdirectories by their respective project name and stored on the KWEP server. Examples of photographic comparison pre and post project are presented Tributary Habitat Restoration and Protection section of this report.

Streamflow Monitoring

KWEP, cooperatively with Klickitat M&E and the YN Water Program (YNWP), monitors stream flow throughout the Klickitat sub-basin. Cooperative activity during 2012-2013 included eighty-two instantaneous discharge measurements for use in rating curve development (Table 1 and 2).

KWEP staff operated stream gages with continuous dataloggers at eleven sites during the reporting period. Two new sites were established by KWEP (Logging Camp Creek and Wheeler Creek). Site establishment entailed installation of two staff gages (for manual observation of stage elevation) and two sensor / data-loggers (to record continuous water surface elevation and water temperature). A total of ninety-seven visits were made to eleven sites with data loggers for installation, data download and field calibration (KWEP). Activities conducted at all eighteen sites are summarized in Table 1.

Table 1. Services performed by KWEP and YNWP at 16 stream gaging sites in the Klickitat subbasin during 2012-2013.

Site	Q Measure	Staff Read	Crest Read	Staff Install	Sensor Install	Download	Maint.	Repair	Survey	Total Visits
Big Muddcy Creek @ 255 x-ing		12				9	2			23
Diamond Fork @ Klickitat River	5	5	2				3			15
East Fork Tepee Creek	5	5					2			12
Klickitat River @ Cow Camp	3	3					2			8
Klickitat River @ Klickitat Hatchery					1	5	1			7
Klickitat River blw Summit Ck		10				9				19
Klickitat River @ Wahkiacus	13	22				11				46
Logging Camp Creek	8	17		1	1	6				33
Piscoe Creek nr mouth	2	1	1				2			6
Summit Creek nr mouth	3	14	3		1	9	3			33
Surveyors Creek	5	7	2	1			1			16
Swale Creek nr mouth	9	19	2			10				40
Tepee Creek abv. 175 Rd	6	20				9	3			38
Tepee Creek abv. IXL Rd	5	12			1	8	3			29
Wheeler Creek	7	17		1	1	5				31
White Creek abv. IXL	4	2					2			8
White Creek @ Cedar Valley Rd	2	3	2							7
White Creek nr mouth	5	20				11	2		1	39
Grand Total	**82**	**189**	**12**	**3**	**5**	**92**	**26**	**0**	**1**	**410**

Table 2. Data collected by YNWP personnel at sites that KWEP operates continuous dataloggers.

Site	Date	Stage	Discharge
Summit Creek nr mouth	3/7/2012	-	42.2 cfs
Summit Creek nr mouth	6/21/2012	4.80’	50.0 cfs
Summit Creek nr mouth	2/14/2013	4.72’	34.9 cfs
Summit Creek nr mouth	5/16/2013	4.88’	41.6 cfs
Swale Creek nr mouth	4/4/2012	3.84’	171.4 cfs
Swale Creek nr mouth	4/4/2012	3.85’	209.9 cfs
Swale Creek nr mouth	4/17/2012	2.88’	28.5 cfs
Swale Creek nr mouth	4/23/2012	2.72’	16.1 cfs
Swale Creek nr mouth	12/6/2012	3.44’	48.8 cfs
Swale Creek nr mouth	2/6/2013	2.85’	19.3 cfs
Swale Creek nr mouth	3/20/2013	2.74’	12.4 cfs
Swale Creek nr mouth	5/8/2013	2.20’	1.6 cfs
Tepee Creek abv. IXL Road	4/19/2012	4.44’	36.4 cfs
Tepee Creek abv. IXL Road	4/23/2013	4.12’	4.9 cfs
Tepee Creek abv. IXL Road	6/13/2013	3.98’	1.4 cfs
Tepee Creek abv. 175 Road	1/11/2012	0.70’	1.1 cfs
Tepee Creek abv. 175 Road	4/26/2012	2.14’	38.7 cfs
Tepee Creek abv. 175 Road	5/7/2012	1.39’	15.3 cfs
Tepee Creek abv. 175 Road	4/2/2013	1.23’	9.9 cfs
Tepee Creek abv. 175 Road	4/23/2013	1.03’	5.8 cfs
Tepee Creek abv. 175 Road	6/19/2013	0.69’	1.2 cfs
White Creek nr mouth	4/25/2012	3.48’	251.0 cfs
White Creek nr mouth	6/12/2012	1.78’	25.7 cfs
White Creek nr mouth	2/14/2013	1.91’	33.2 cfs
White Creek nr mouth	5/21/2013	1.58’	41.6 cfs

Figure 13. New streamflow gaging stations installed in 2012, Wheeler Creek (left) and Logging Camp Creek(right).

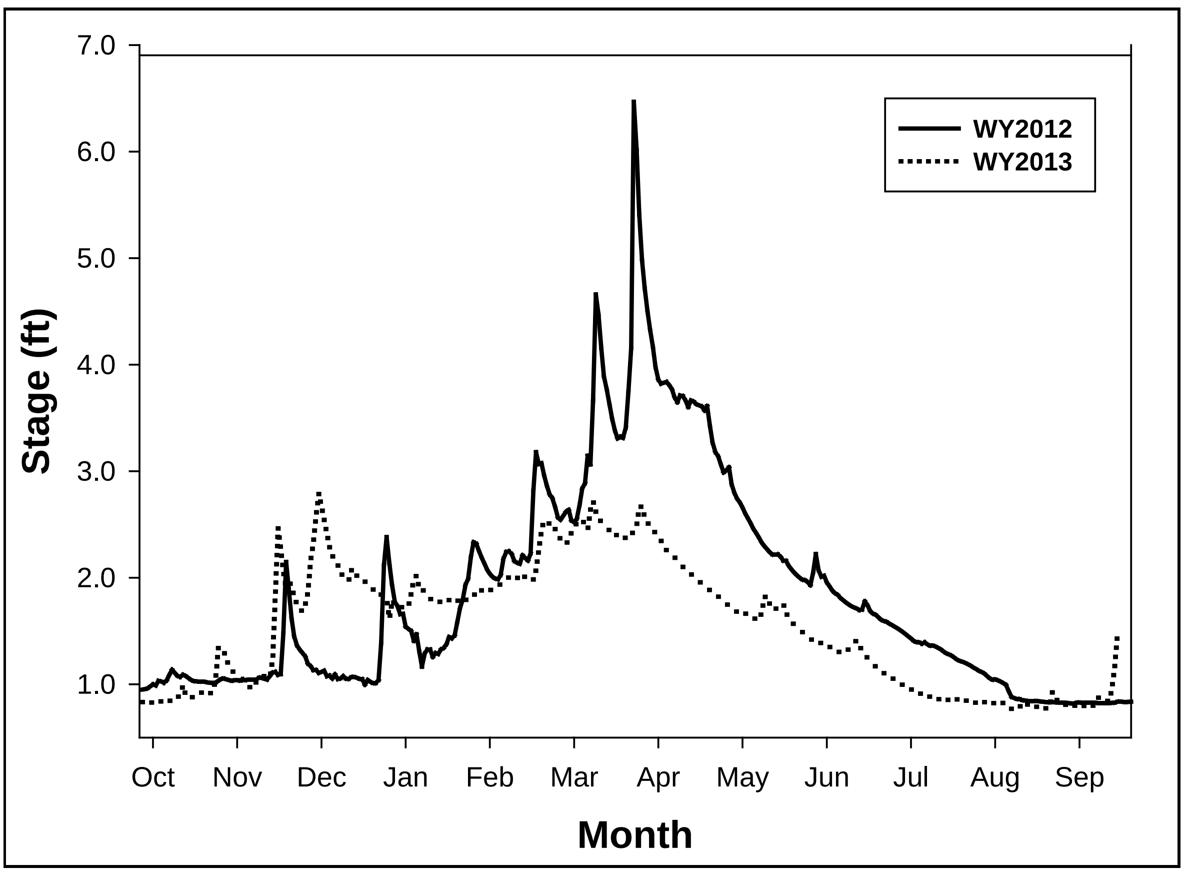


Figure 14. Provisional White Ck stage data from the gaging site near the confluence with the Klickitat River, Water Year 2012 and 2013.

Conduct Food Web Study on Tepee and White Creeks (Effectiveness Monitoring)

The objective of the study is to examine how instream restoration efforts along a 0.7-mile section of Tepee Creek affect aquatic and terrestrially derived invertebrate prey sources and diet of residualized *Oncorhynchus mykiss* and juvenile steelhead. Sampling has occurred and will continue on four treatment sites in Tepee Creek and four control sites in White Creek. Specific objectives of the study include the following:

- Quantify riparian habitat conditions in treatment and control reach sample sections.
- Compare invertebrate abundance, biomass and composition from benthic, drift, and allochthonous sources among treatment and control reach sample sections.
- Compare fish diet (abundance, biomass and composition) among treatment and control reach sample sections.
- Evaluate seasonal variation in prey availability and diet of residualized *Oncorhynchus mykiss* and juvenile steelhead trout in sub reach sample sections.

<u>Methods</u>

Study Area

Tepee Creek, a tributary to White Creek, is one of the major tributaries supporting natural production of steelhead in the Klickitat subbasin. The White Creek watershed is 138 square miles in area. Elevations range from 1140 to 5100 ft.; most of the watershed lies between 2500 and 3300 ft. in elevation. Average annual precipitation is between 20 and 29 in., with roughly half falling as snow. Current habitat conditions in Tepee Creek and White Creek reflect past riparian timber harvest and road construction throughout the drainage. Instream large woody debris (LWD) levels are low in some reaches and base flows are very low to non-existent in many reaches. Changes in channel morphology are attributable to numerous landscape level activities such as livestock grazing, road interactions, up-slope timber harvest, and in some locations, historic removal of instream LWD.

Study reaches are located on Tepee Creek (treatment) and White Creek (control). There are four sample sections within each reach. The control and treatment study reaches have similar drainage areas and channel morphology. Sample section lengths ranged from 61-101 m in Tepee Creek and 80-107 m in White Creek. Bankfull widths ranged from 10.7-26.1 m and 16.3-28.8 m in Tepee Creek and White Creek, respectively. Pool-riffle sequences characterize sample sections.

Riparian habitat survey

Riparian canopy cover and composition is measured along 50-m transects perpendicular to stream flow at one-quarter, one-half, and three-quarter length of each sample section. Canopy cover is measured with a densitometer at 15 sample points (wetted center, wetted edge, bankfull, and at 5-m intervals for a distance of 25-m from each bank; Romero et al. 2005). Riparian understory is characterized by quantifying shrub cover along the same transect described above. At each of the 15 sample points described above, the line-intercept method is utilized to quantify shrubs (percent understory cover and species composition) along a 10-m transect perpendicular to the 50-m canopy transect (Knight 1994).

Abiotic variables are measured in each sample section during each sample event include air temperature, water temperature, and stream flow. A temperature data logger (Hobo, Onset Computer Corporation) placed in each stream measures water and air temperatures at hourly intervals. Stream discharge ($m^{-3} \bullet s^{-1}$) estimates are generated based on velocity, width, and depth measurements obtained at each sub sample reach section during each sample period with a flow meter (Marsh McBirney Model 2000) by methods described in McMahon et al. (1996).

Invertebrate prey availability

To compare invertebrate prey availability between pre-and-post treatment conditions, estimates of invertebrate abundance, biomass, and composition from benthic, drift, and allochthonous sources are obtained seasonally during the study in treatment and control sub reach sample sections. Benthic invertebrates are collected with a 500-µm net Surber sampler (0.09 m^2 area) at 3 random locations in riffle habitat in each sub reach sample section. Invertebrate drift are estimated by placing a 500-µm drift net (0.45 m x 0.20 m) in the thalweg of riffle habitat at the upstream and downstream end of each sub reach sample section. Drift nets will be set for 20 minute intervals at dawn and afternoon. Drift nets are positioned to intercept the total water column to ensure capture of invertebrates floating on the surface. Surber and drift samples aremsieved (500-µm), large organic material removed, and organisms preserved in a 95% ethanol alcohol solution prior to processing.

During each sampling event, allochthonous invertebrate inputs are estimated from samples collected in pan traps (0.071 m^2) for 7 days. Nine pan traps are suspended 1 m above the water surface from rebar in each sub sample reach section. Pan traps are filled with approximately 3 cm of water with 2-3 drops of soap surfactant to help retain captured invertebrates. The wetted width is divided longitudinally into three subsections (left, center, and right) and three pan traps are randomly placed in each subsection. During each sampling event, the random placement of pan traps is repeated in each sub reach sample section. Pan traps are sieved (500-µm) at the end of each 7-day sample period and preserved in a 95% ethanol alcohol solution prior to processing.

Resident rainbow trout and juvenile steelhead diet

During each sampling period, resident rainbow trout and juvenile steelhead are collected in each sub reach section to sample for stomach contents. Fish are collected 24 h after instream invertebrate sampling to allow fish to return to natural foraging behavior. A variable waveform backpack electroshocker (Smith Root Inc., Vancouver, Washington) is used to collect fish. Electroshocking is conducted from the downstream end of each sub reach sample section to the upstream. Every effort is made to collect a minimum of 20 fish (≥ 70 mm FL). Captured fish are placed in 5 gallon buckets with aerators. Sampling occurs between 10:00 and 16:00 to include stomach contents of prey from aquatic and terrestrial derived sources.

Captured fish are anesthetized in a solution of water and MS-222. Stomach contents are removed by a flushing procedure using a narrow pipetted bottle, strained into coffee filters, and placed into small plastic bags with 95% ethanol alcohol (Meehan and Miller 1978). For each fish, time and date of capture, length (nearest mm FL), and weight (to the nearest 0.1 g) are recorded. Each sampled fish receives a 12 mm Passive Interrogator Tag (Destron Fearing, South St. Paul, Minnesota). All fish are returned to their original location after fully recovering from anesthesia.

Invertebrate Identification

Invertebrates collected from the benthos, drift, pan traps, and fish stomachs are sorted under a dissecting microscope, taxonomically identified (primarily to the family level), enumerated, and measured to the nearest 0.5 mm using an eyepiece micrometer. Organisms are categorized as either aquatically or terrestrially derived based on the larval residence time (Wipfli 1997). Macroinvertebrate biomass (dry mass mg•m^{-2}) is estimated using publish taxon-specific length-mass regression equations. Lengths of partially digested organisms are estimated from intact individuals of the same taxon that appear to be of similar size (Wipfli 1997).

The sampling of additional physical and biological attributes was initiated in 2009 to document and assess pre-project baseline conditions. Elements include: groundwater, low-flow refugia mapping, habitat survey/mapping, vegetation inventory, juvenile *Onchorhynkus mykiss* (Steelhead/Rainbow trout) abundance estimation, and a food web study.

Fish abundance

In partnership with M&E staff, juvenile *O. mykiss* (Steelhead/Rainbow trout) populations are estimated using a multiple-pass electroshocking technique. In each sampling event a multiple-pass electrofishing survey is conducted in each of the four Tepee (treatment) and White Creek (control) reaches. All juvenile steelhead and rainbow trout greater than or equal to 60 mm in length are tagged with a Passive Integrated Transmitter (PIT) tag and have length and weight measurements taken. A fixed PIT tag detection array installed by the M&E project at the mouth of White Creek will facilitate survival and migration timing analysis on those fish tagged within the project reach.

Groundwater

Twelve shallow (~6.5' deep) wells were installed to characterize existing groundwater conditions. They will be used for post-project effectiveness monitoring if future funding permits. Two wells are located outside of the project reach as controls (one upstream and one downstream). The remaining ten wells are dispersed strategically throughout the project reach to characterize local geohydrology (Fig. 17). Six wells (including both controls) have sensors that measure and record water level once every hour; data are downloaded several times per year using a field computer. KWEP staff take manual measurements of water level with an e-tape at the remaining six wells approximately once per month (on average). Data from four wells with continuous sampling are presented in Figure 12. In-stream construction was initiated in October 2012 and completed in November 2013. Continuous groundwater elevation data from 2013 in Wells 1, 5, and 6 reveal a prolonged period of raised ground water elevations (approx. 8

months). While similar periods in 2010-2012 show brief periods of elevated groundwater followed shortly by a receding limb.

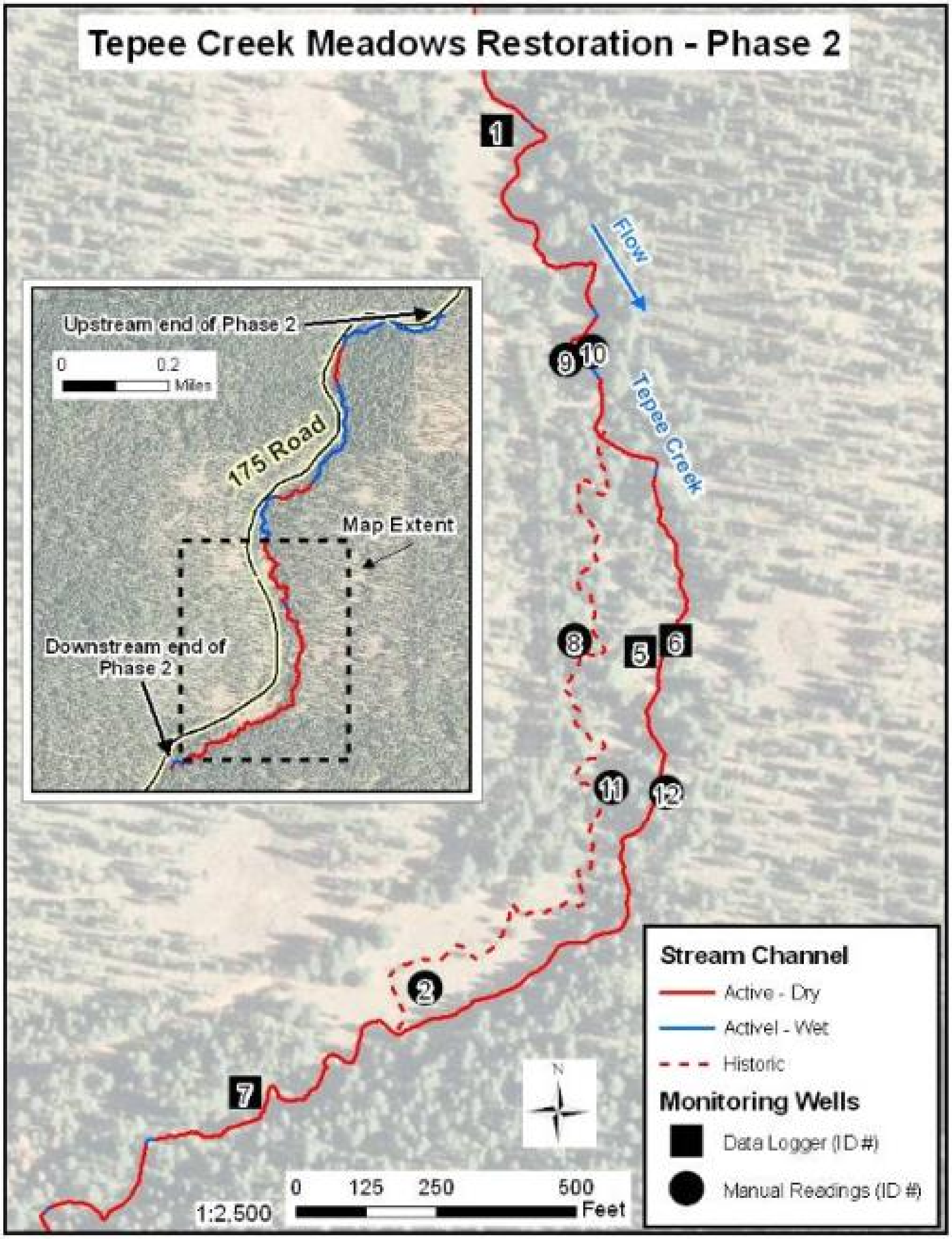


Figure 15. Distribution of monitoring wells and the portions of Tepee Creek with perennial water as observed on September 21, 2009.

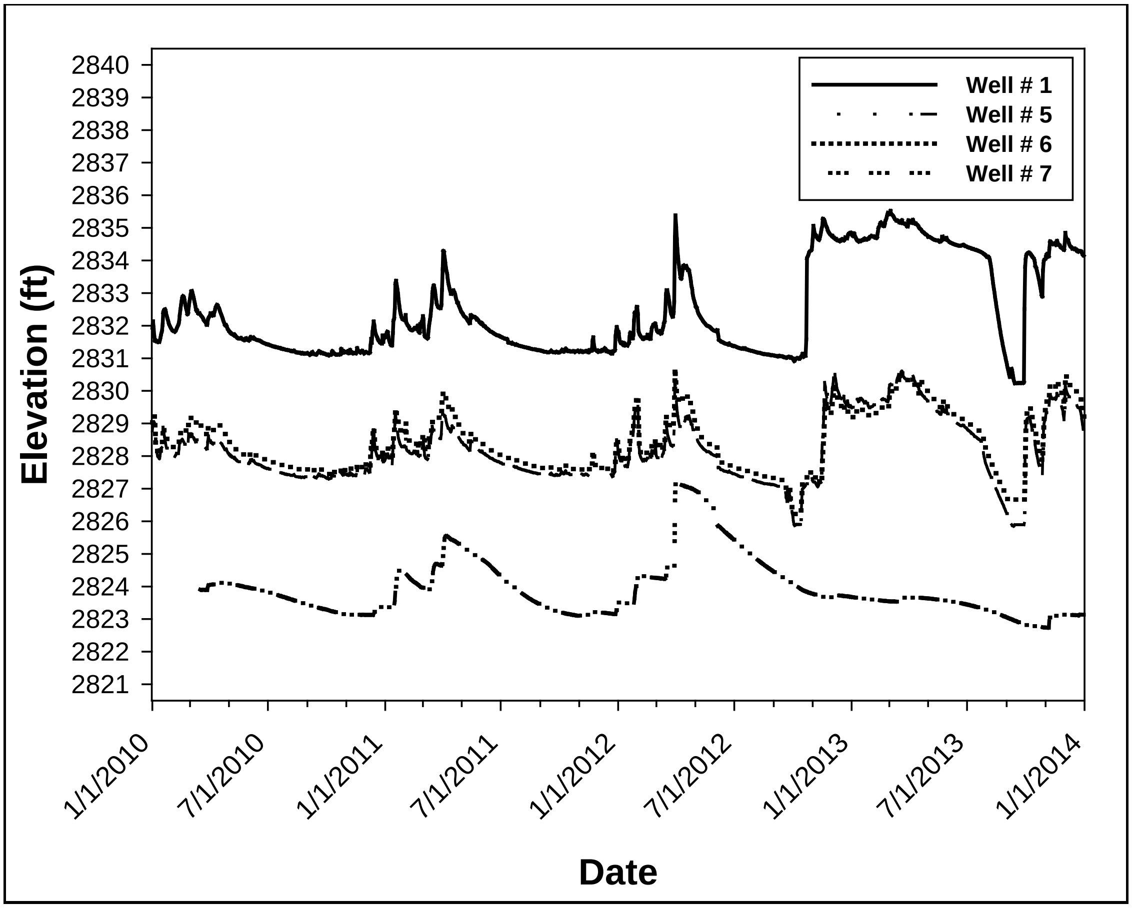


Figure 16. Groundwater surface elevations by date for wells 1, 5, 6, and 7.

Habitat Assessment

In late 2009, KWEP and M&E began a review of the aquatic habitat protocol (TFW) utilized by M&E in the Klickitat subbasin to determine if it met current needs. Established aquatic habitat assessment needs are:

- Determine the effectiveness of habitat enhancement projects by quantifying differences between pre-and-post project aquatic habitat conditions.
- Expand the spatial extent of known baseline conditions within the anadromous bearing portion of the Klickitat subbasin.
- Identification of stream sections that warrant further investigation as sites with potential for enhancement via intervention.

The objectives for the stream habitat assessment protocol are to provide a single approach for effectiveness monitoring, status and trend monitoring, and to inform need, location, type, and project development.

A variety of existing stream habitat protocols were reviewed and compared to determine if they fulfilled the defined management objectives. While there are numerous stream habitat assessments currently utilized in the Pacific Northwest, they vary in their performance, compatibility, and repeatability (Roper et. al. 2010). Based on this review, a new protocol was subsequently developed that combined two widely used Pacific Northwest stream classification systems, TFW (Pleus et al. 1999, and Schuett-Hames et al. 1999) and the Aquatic Inventory Project (Moore et al. 2010). Data collected in the future to characterize large woody-debris will be backward compatible with the historic TFW data. The new protocol is the Rapid Aquatic Habitat Assessment Protocol (RAHAP) (Romero and Lindley 2012). The RAHAP approach is: 1) spatially continuous, 2) relatively fast (per unit of collection), and 3) collects paired physical and fisheries data.

RAHAP utilizes field crews comprised of two people to delineate reaches, habitat units, spawning patches, wood pieces, and wood jams. Surveys are conducted in the upstream direction by defining and sequentially numbering each geomorphic habitat unit. The following metrics are collected for each habitat unit: habitat type (pool, riffle, or glide), wetted width, maximum and residual pool depth, percent undercut banks, and bankfull width. Delineated habitat units are geo-referenced and photo documented. Surveys to quantify LWD (jams and individual pieces) are conducted concurrently with the habitat surveys and spatially linked to the defined habitat units. Following the completion of the habitat inventories fish abundance surveys are conducted. Single-pass fish surveys (by electrofishing or snorkeling) are conducted to spatially quantify fish distribution, composition, and relative abundance.

In the spring of 2012, one Klickitat River Tributary, Beeks Canyon was surveyed via the RAHAP methodology. The survey was limited to the anadromous bearing portion of the watershed. Beeks Canyon was selected due to the loss of vehicular access that occurred with the implementation of Phase 3 of the Haul Road Project and the relatively small size of the drainage area. The drainage size afforded a fairly short stream reach to continue the refinement of the survey protocol.

In comparison to the four tributaries surveyed in 2011 (Dillacort, Logging Camp, Snyder, and Wheeler Creeks) pool frequency was considerably higher (Lindley and Conley 2013). This is likely due to the upstream most sampled section of Beeks Canyon that had a higher gradient and a step-pool channel type. Overall Beeks Canyon was comparable to Logging Camp Creek in regards to average bankfull with, average habitat unit with, average habitat unit area, and average residual pool depth (Lindley and Conley 2012). LWD jams were non-existent and the number of LWD pieces per kilometer was the lowest of any Klickitat River tributary surveyed to date.

Table 3. Summary of aquatic habitat inventory data collected May 2012. Parentheses denote side channel values.

Purpose	Survey Date	Stream	Discharge	Total Survey Length (m)	Total Survey Area (m^2)	Avg. Bankfull Width (m)	Avg. Habitat Unit Width (m)	Avg. Habitat Unit Area (m^2)	Pool Frequency (pools/km)	Avg. Residual Pool Depth (m)
Anadromous Portion - Beeks Canyon Creek	**5/1-2/2012**	**Beeks Canyon**	**0.18, 0.49 cfs***	**1,145.8 (88.9)**	**3,413.7 (62.4)**	**6.0 (1.9)**	**2.9 (1.2)**	**35.2 (12.5)**	**29.7 (0)**	**0.34 (0)**

*****Instantaneous discharge measurements taken during sampling period.

Table 4. Summary of Large Woody Debris (LWD) and LWD Jam inventory data collected May 2012.

Purpose	Survey Date	Stream	Total Survey Length (m)	Total Survey Area (m^2)	# LWD Pieces (pieces/km)	# LWD Jams (jams/km)	# Jam Pieces (pieces/km)
Anadromous Portion – Beeks Canyon Creek	**5/1-2/2012**	**Beeks Canyon**	**1,145.8 (88.9)**	**3,413.7 (62.4)**	**13.1 (0)**	**0 (0)**	**0 (0)**

Collect water surface elevation data - Klickitat/Columbia River Confluence (Klickitat Delta Pilot Assessment)

YKFP fisheries biologists have expressed concern about adult fish passage at the mouth of the Klickitat River. KWEP staff initiated sampling water surface data (August 2009) to provide data for evaluation of depth-frequency. Data will document inundation frequency of landforms in the vicinity of the delta and be used to evaluate potential factors limiting salmonid production. The initial phase of the project consists of: 1) collection of water level data at four locations in the vicinity of the delta fan and 2) compilation of historic information. Data are anticipated for use in subsequent assessments such as evaluation of water temperature, growth of aquatic vegetation, juvenile and/or adult fish passage, and/or predation. Funding for the pilot assessment is being cost-shared by a grant received from Columbia River Intertribal Fish Commission (CRTIFC).

During the reporting period the sensor array installed in August of 2009 was operated continuously (Fig. 19). Primarily data collection was monitored via an ftp site KWEP staff can access from the Klickitat Field Office. KWEP staff from time to time observed discrepancies, errors, data gaps, or non-reporting dictated site visits for troubleshooting purposes. Additional site visits were conducted to collect staff gage observations during a range of stages (Fig. 20) to establish stage reference points. These reference points are utilized to quality control data collected by deployed sensors.

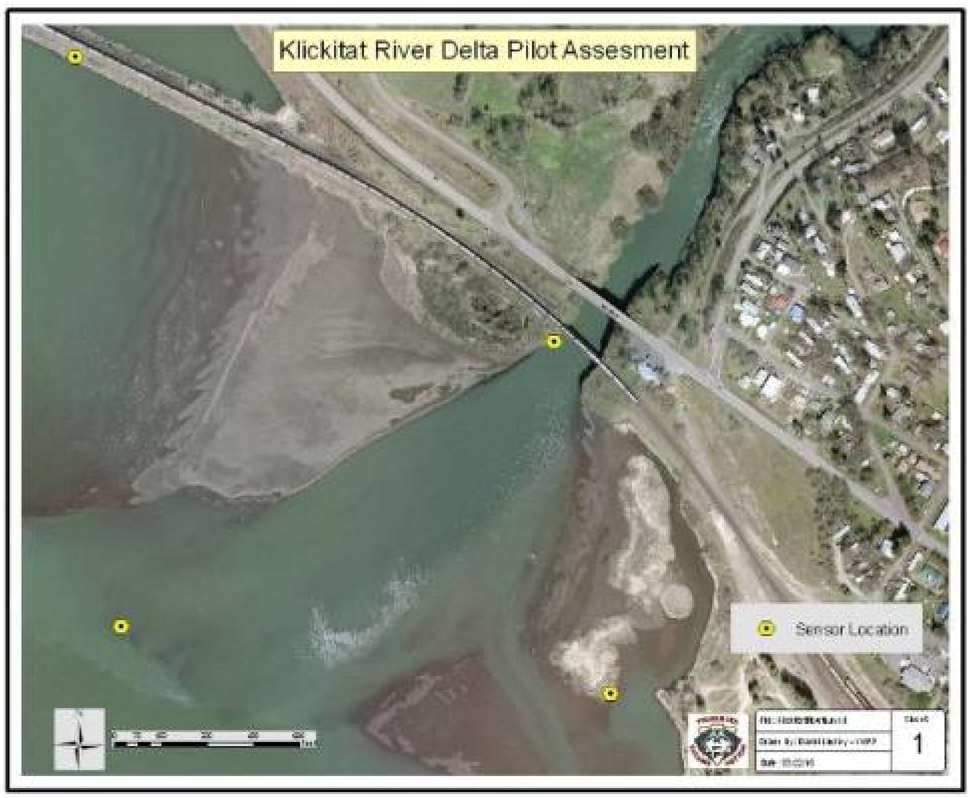


Figure 17. Sampling locations for the Klickitat River delta.

Examples of visits conducted for maintenance, repair or refinements:

- May 23, 2012 – visit conducted to both the Basalt Cliff and East Delta sites to survey high Bonneville Pool stage water surface elevations. At the East Delta site three temporary bench marks (TBM) established previously were relocated. At the Basalt Cliff site three TBM were established for future reference.
- June 1, 2012 – visit conducted to East Delta to repair site from damage incurred by boat or vandalism. The mast that the antennae, solar panel, and communication box is mounted to was bent at a 90 degree angle to the east. Temporarily fixed issue and accessed repair needs for future site visit.
- August 20, 2012 – Site visit to East Delta site to reinstall low staff gage and install a high staff gage. The installation of a high staff gage facilitates a range of 0-6.66 feet of depth for which physical observations can be made. PT12 sensor was reinstalled in a more secure sensor housing (1.5" IMC) and the terminal end was secured to the base of the t-post holding the staff gage.
- January 10, 2013 visit conducted to Basalt Cliff to investigate null values for stage as observed via remote monitoring of data at KFO. It was initially thought that the water surface was currently at a level below the location of the sensor. Upon field investigation it was determined the sensor was below the current water surface and should be obtaining stage values. Further sleuthing revealed that due to the difference between the depth the sensor reads and the staff gage the obtained values are offset to, the current water surface elevation results in a negative stage value. The computer program running the sensor sampling does not allow negative values thus they are reported as null. The sensor offset was changed to avoid this issue in the future.
- March 29, 2013 visit conducted to West Delta site to perform maintenance and to conduct survey of staff gage and high stage reference points observed in 2011. Maintenance tasks preformed included the remounting of the bracket securing the sensor housing.
- November 12, 2013 – Visited site and installed replacement modem. Reoccurring communication issues were diagnosed to be a faulty cell phone modem. Once the replacement modem was installed communications resumed and data that had not been previously transmitted the past few weeks was transmitted.

Figure 18. Klickitat River delta at low (left) and high Bonneville Pool and Klickitat River stage (right). Photos of stage levels were taken on February 20, 2012 and March 31, 2012 respectively.

Measure turbidity timing and duration associated with Big Muddy Creek

Big Muddy Creek is a Klickitat River tributary that originates on the south-eastern flank of Mt. Adams and is a known source of debris flows. In the past, debris flows have contributed to salmonid mortality observed in the mainstem Klickitat River. In 2011, a data collection effort was initiated to document patterns associated with runoff production and sediment generation. Data will be utilized to inform decision making regarding location and type of enhancement projects to be implemented. Dependent upon the duration of the data collection effort longer term trends regarding the timing, duration and frequency of turbidity events may be characterized. In the future, as time and budget permits, suspended sediment may be measured to develop a rating curve between observed turbidity and suspended sediment loads.

KWEP staff installed telemetry equipment at two existing sites to facilitate remote data transmission (Big Muddy Ck @ 255 rd x-ing and Klickitat River ds of Summit Ck). Due to the remoteness of the sites and critical nature of having functioning equipment during these episodes of increase turbidity, communication via the GOES satellite network was established (Fig. 21). The hardware and software were purchased through YSI Incorporated. Programming of sensors, communication, and hardware installation was performed by KWEP staff (Fig. 22). Data are accessed via the Web multiple times a week to ensure the station is functioning properly.

Figure 191. Panoramic picture of Big Muddy Creek depicting canyon nature of site and challenges inherent in gaging operation.

Figure 20. Telemetry communication equipment, Klickitat River DS of Summit Ck (upper left) and Big Muddy Ck @ 255 rd x-ing (upper right).

Collect LiDAR Derived Topographic Data for Klickitat River Valley Bottom (~ 20 miles)

In March of 2013 the Yakama Nation Fisheries Program (KWEP) contracted with Watershed Sciences, Inc. to collect Light Detection and Ranging (LiDAR) data and high resolution digital imagery. The data collection took place during snow free and leaf-off conditions in the spring of 2013 for multiple discrete valley bottom reaches throughout the Klickitat Basin (Table 5 and 6). The primary purpose of the data acquisition was to aid in the assessment of topographic and geophysical landscape properties to support the development of fisheries habitat restoration projects (Figs. 23 and 24).

Table 5. Acquisition dates, acreages and data types collected for the Klickitat Basin.

Project Site	Contracted Acres	Buffered Acres	Acquisition Dates	Data Type
Klickitat Basin AOI	8,542	14,242	4/16/2013 4/18-20/2013 4/22/2013 6/15/2013	LiDAR
			6/14-15/2013	3 band (RGB) Digital Imagery

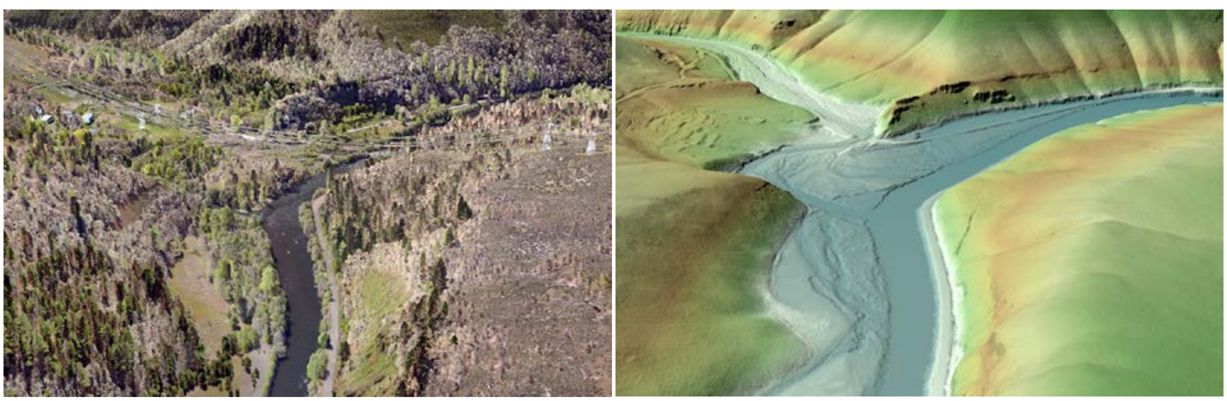


Figure 21. Views looking south at the confluence of the Little Klickitat and the Klickitat River.

Figure 22. Views looking south at Canyon Creek a tributary to the Little Klickitat River.

Table 6. LiDAR products delivered to YN Fisheries from Watershed Sciences, Inc. for the Klickitat AOI.

Klickitat Basin LiDAR Products Projection: Washington State Plane South FIPS 4602 Horizontal Datum: NAD83 (CORS 96) Vertical Datum: NAVD88 (GEOID03) Units: US Survey Feet	
LAS Files	LAS v 1.2 All Returns Ground Returns Model Keypoints ASCII Model Key Points
Rasters	ESRI Grids (3.0 foot) Bare Earth Model Hyrdoflattened Bare Earth Highest Hit Model Geo Tiffs (1.5 foot) Intensity Images
Vectors	Shapefiles (*.shp) Site Boundary LiDAR LAS Index DEM/DSM Index 3D Hydrolines Smooth Best Estimate Trajectory (SBETs)
Digital Imagery	Orthoimagery Index (*.shp) 6-inch 3-band Image Mosaics (RGB GeoTiffs)

Education and Project Outreach

Though education and outreach constitutes a minor portion of overall KWEP staff time allocation, it is a critical component of the project. KWEP staff conducted several public presentations from 2012-2013. These activities are oriented toward helping the public understand what we do, why we do it and communicating lessons-learned to improve overall practice of watershed and stream restoration.

Public presentations: KWEP staff authored/co-authored 4 presentations delivered at two professional meetings during 2012 and 2013, including:

- River Restoration Northwest's 11th Annual Northwest Stream Restoration Symposium (2012): KWEP staff co-authored a peer-reviewed presentation delivered by Nicolas Romero (Klickitat M&E) entitled "Effectiveness Monitoring at Multiple Temporal and Spatial Scales to Quantify Biotic and Abiotic Responses to Stream Enhancement ". The presentation described effectiveness monitoring of the Tepee IXL project (Romero, Lindley and Conley 2012a).

- River Restoration Northwest's 11th Annual Northwest Stream Restoration Symposium (2012): KWEP staff presented a peer-reviewed poster providing an overview of Rapid Aquatic Habitat Assessment Protocol (RAHAP) developed cooperatively with Klickitat M&E within the Klickitat Subbasin (Lindley, Romero and Conley 2012). The poster session was a designated hour and a half segment of the Symposium that facilitated the one-on-one interaction of participants with KWEP staff.

- River Restoration Northwest's 11th Annual Northwest Stream Restoration Symposium (2012): KWEP staff presented a peer-reviewed presentation entitled "Design Consideration for IN-stream Wood and Boater Safety". The presentation offered vantage points from a whitewater enthusiasts and restoration practitioner (Conley 2012).

- 2012 Klickitat and White Salmon Rivers Fisheries and Watershed Science Conference: Klickitat M&E staff were invited to give an oral presentation on habitat related activities in the Klickitat Subbasin. Nicolas Romero presented a similar talk to the one he gave the month before at the RRNW symposium, "Effectiveness Monitoring at Multiple Temporal and Spatial Scales to Quantify Biotic and Abiotic Responses to Stream Enhancement". The presentation summarized effectiveness monitoring of the Tepee IXL project and touched on ongoing research on the Tepee Phase 2 Project (Romero, Lindley and Conley 2012b).

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