Blackwood Creek Stream Channel Restoration

Reach 1 First Year Post Project Performance Monitoring

USDA Forest Service

Lake Tahoe Basin Management Unit

December 2013

Prepared by:

Craig Oehrli, Hydrologist

Photo taken in Reach 1 of two rainbow trout on their spring migration from Lake Tahoe up Blackwood Creek. This spawning pair was observed on 10 June 2013 by LTBMU hydrologic technicians conducting project area monitoring. The fish were seen using large wood debris jam constructed the previous summer for cover. Inset photo in upper left hand corner is a record of size and species. This fish is a 24” long Lake Tahoe rainbow trout.

Overview

The Blackwood Reach 1 project was completed in October 2012. The project was designed to provide a physical structure necessary for this segment of stream to possess desirable geomorphic function and higher quality aquatic habitats in the near future. 2050 linear feet of channel were treated along both the southern (1600 feet) and northern (450 feet) forks. Project effectiveness monitoring took place along 4150 feet of the southern branch; monitoring extended 2100 feet above the upstream extent of treatments, in anticipation of channel response to raising stream bed elevation relative to the terraces along both forks.

Natural geomorphic function in terms of sediment sorting, storage, and large wood accumulation that desired supported aquatic habitats was disrupted by historic land use activities (Swanson, 2003). The primary impacts to the site were channelization associated with gravel mining in the 1960s. The Forest Service attempted to restore aquatic habitat in this area in the 1980's and 90's, but success was limited by the chronically straight incised nature of the stream in this area. Those projects did not result in recovery of pre-disturbance sediment transport and large wood debris function.

To initiate recovery of desired functions, we accomplished restoration activities as shown on the Record Drawings of the as-built survey conducted by Waterways Consulting (Appendix A). Waterways also provided a technical memorandum (Appendix B) that states the project generally conforms to the engineering drawings and meets the intent of the design.

This is a report on early post project effectiveness relative to flood hydrology, sediment deposition and scour patterns, cross section shape changes, bank stability, and stream shade.

Hydrology

Winter rain-on-snow flooding is the primary driver responsible for significant sediment deposition, scour, and large wood accumulation and spatial organization. Spring snowmelt floods tend to be quite smaller and occur more frequently and sculpt channel and floodplain forms left behind by the larger winter events.

WY 2013 discharge was evaluated using the discharge record from USGS Blackwood Creek Station #10336660 located 3 miles downstream at the Highway 89 bridge crossing. Discharge levels at that gage are then adjusted down to account for the projects' smaller contributing drainage area, based on a flow and drainage area relationship established in the Swanson 2003 study. Snowpack and precipitation patterns responsible for runoff were assumed to be similar to what occurs at NRCS Ward Creek #3 SNOTEL site # 848, located roughly 3 miles north of project area. SNOTEL data review indicates that on December 3rd precipitation was accompanied by a brief period of warmer temperatures and higher snow levels. Rain on the existing snow pack produced runoff that filled channel quickly with a peak discharge at the USGS gage of 1230 CFS (Figure 1).

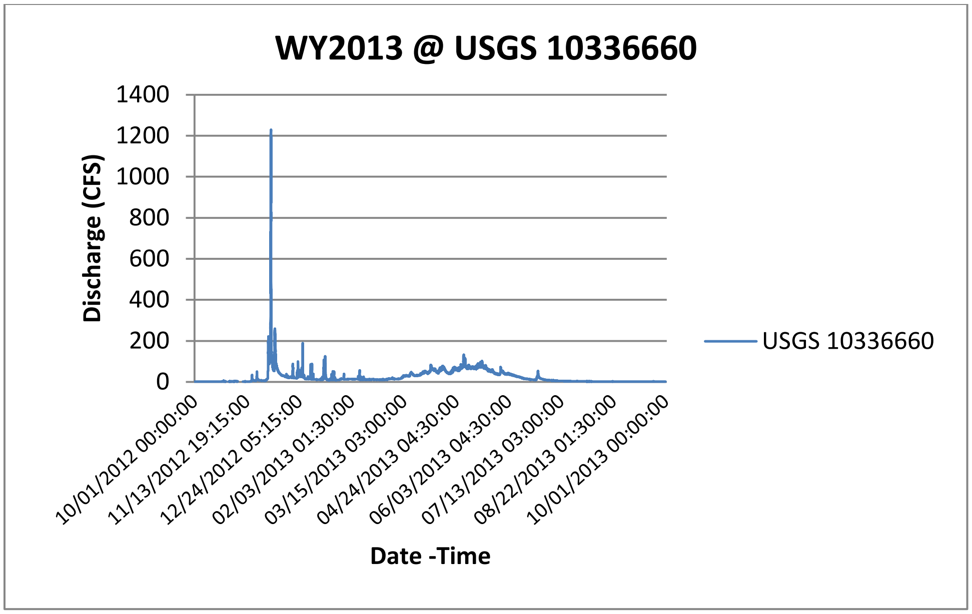


Figure 1 – WY2013 discharge at the Blackwood Creek USGS 10336660 gage

Flood evidence (flood detritus hanging off stream side vegetation identified after winter) established the flood level (Figure 2) and Swanson's flood numbers suggest the project area discharge ranged between 700 to 900 CFS, estimated to be an 8 to 10 year rain-on-snow type flood. Site inspection on December 5th suggests that flow was split between the south and north channels with the majority of flow probably going down the larger southern branch. Another minor high elevation rain storm on December 5th caused a 250 CFS flow at the USGS gage. Project area discharge was roughly 150 CFS and about 60 percent of capacity.

Figure 2 - 5 December photo showing approximate water level of 3 December flood.

After this event snow levels fell and discharge levels receded quickly. Heavy snow accumulation occurred throughout the rest of December, with little significant snow accumulations occurring thereafter. Seasonal snow water equivalent data at Ward Creek SNOTEL indicates that the peak snowpack (usually occurring around April 1) came in at 48 percent of the April 1st median. Spring peak flow occurred in late April. Peak discharge at the USGS gage was 124 CFS on 29 April. Peak at the project area was approximately 100 CFS

Sediment deposition and scour patterns

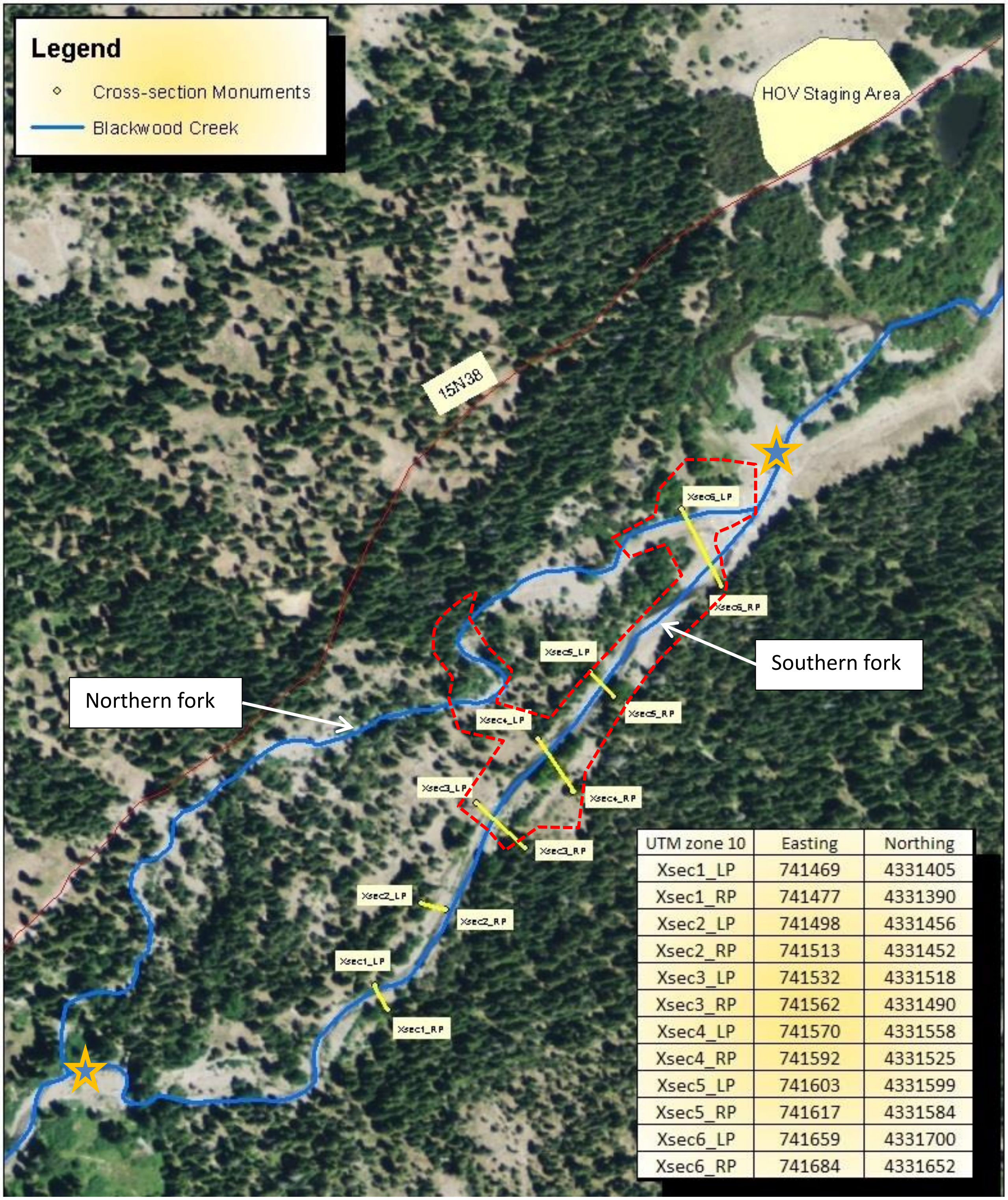
The December 3rd 2012 flood appears to have generated enough power to move sediments and cause some scour over a 12 to 18 hour period. The December 5th runoff event was much smaller and it is likely that little or no bed load sediment movement occurred, as was probably true for spring snow melt. Our conclusions are based on December 5th flood observations and June 10-11 2013 resurveys of the six permanent cross sections (Figure 3) established in November 2012.

Interestingly, most of the sediment deposition and bar building did not occur in the project area, but happened along a 300' section of the southern branch just above the project. The photo and cross section (Figure 4) in this depositional zone recorded the scale of the deposition (fines, sand, and gravels) as the stream backwatered upstream of the uppermost constructed weir. The sill (boulder grade control structure) was constructed to a higher elevation than existing channel just upstream. Backwatering (expected to occur) reduced water velocity causing sediments to fall out of the water column and fill in the channel. We believe this occurred on the receding limb of 3 December flood.

Project area deposition occurred on point bars and channel margins in expected locations. Photo and cross section (Figure 5) show the largest deposit in the project area; sediment (fines, sand, and fine gravels) deposited to a depth of 0.1 to 3 feet. This deposit probably formed to due backwatering caused by a constructed sill located just downstream.

Scour did occur at one location in the project area. The photo and cross section (Figure 6) shows the pool being partially filled in by gravelly bed load sediment. The source of this material appeared to be the riffle just upstream. Scouring to a depth of a foot occurred within this roughly 30' section of the south fork. The cross section captures pool infilling. We believe the scour occurred during the December 3rd flood. The flood was of such a short duration that sediment transport within the project was localized, and with the backwatering upstream limiting the movement of replacement sediments, it resulted in this riffle scour and pool deposition pattern.

Finally, there were other areas where deposition and scour occurred but are considered minor and resulted in no notable stream bed or bank adjustments.



UTM zone 10	Easting	Northing
Xsec1_LP	741469	4331405
Xsec1_RP	741477	4331390
Xsec2_LP	741498	4331456
Xsec2_RP	741513	4331452
Xsec3_LP	741532	4331518
Xsec3_RP	741562	4331490
Xsec4_LP	741570	4331558
Xsec4_RP	741592	4331525
Xsec5_LP	741603	4331599
Xsec5_RP	741617	4331584
Xsec6_LP	741659	4331700
Xsec6_RP	741684	4331652

Figure 3 – Project Area Cross Section Monitoring Locations. Stars indicate upstream and downstream ends of the monitoring reach and the dash line is area of construction activities

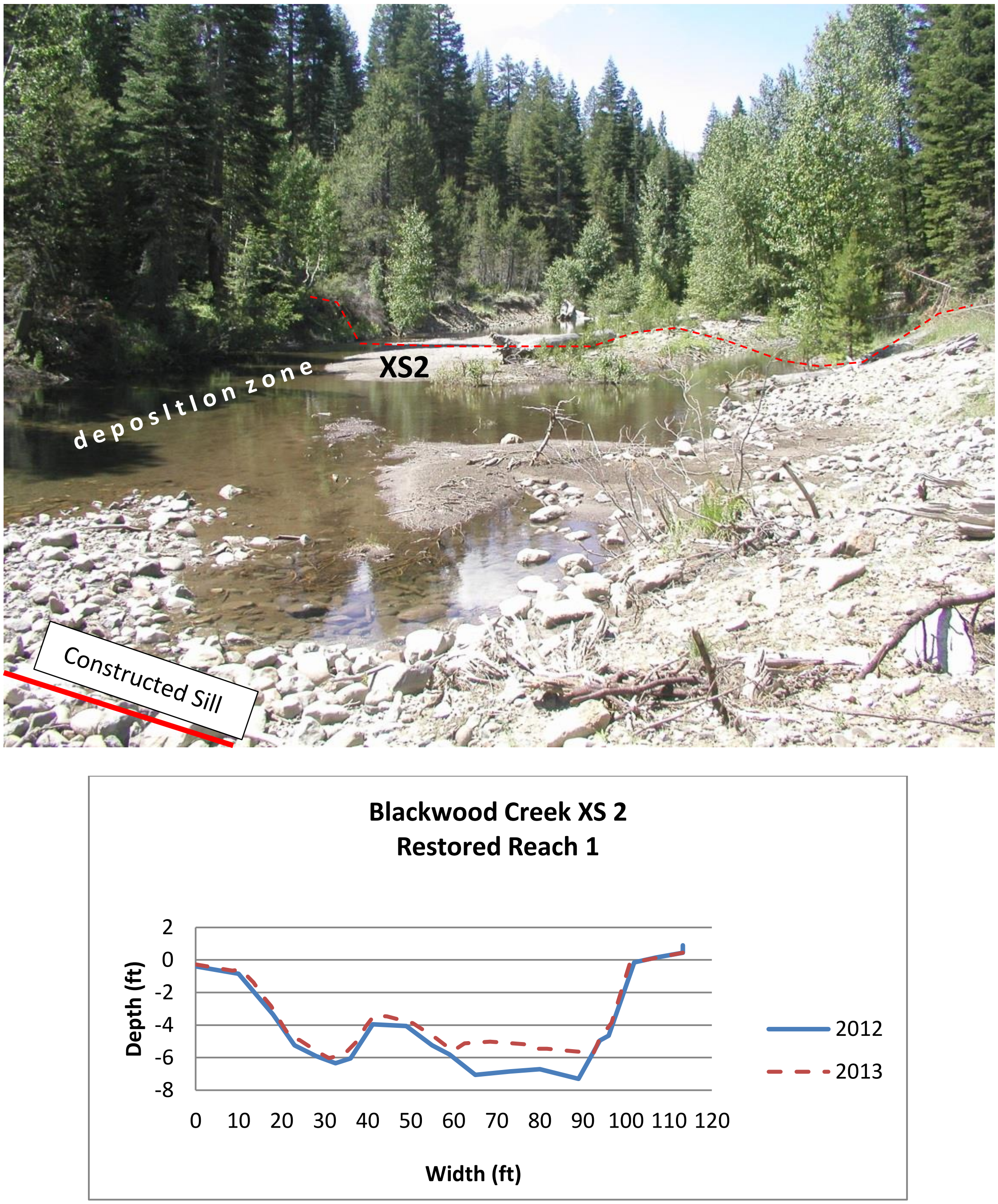
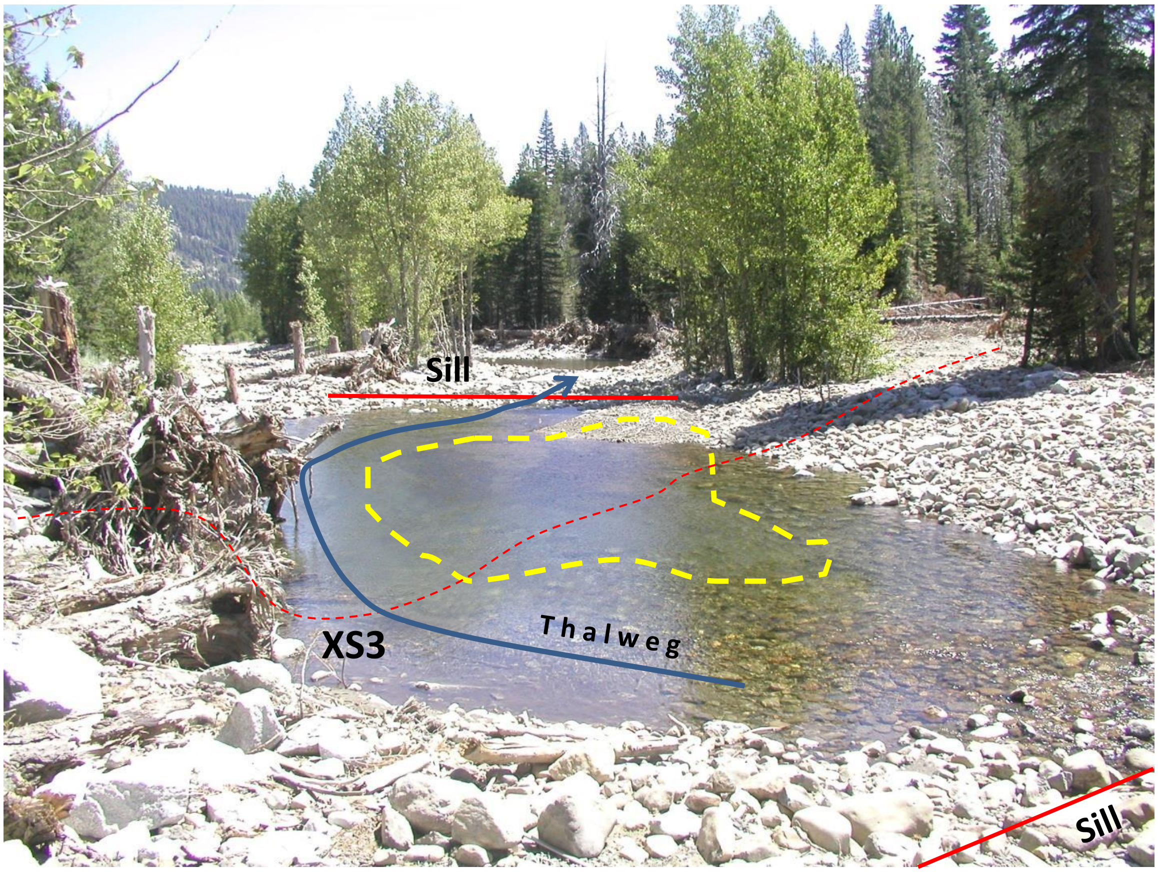


Figure 4 – July 30, 2013 photo and cross section changes in deposition zone upstream of the newly constructed stream segment on the southern fork of the creek. Photo taken near constructed sill on left bank from looking upstream at the cross section area. Cross section plot orientation is opposite of the photo.



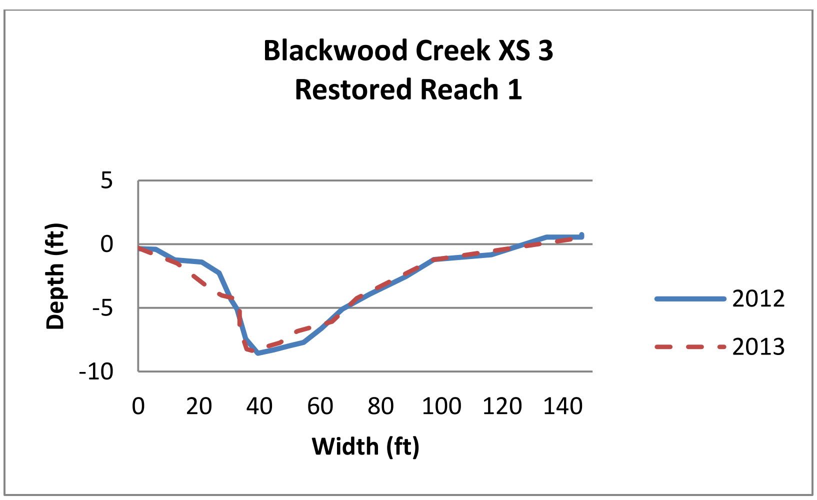
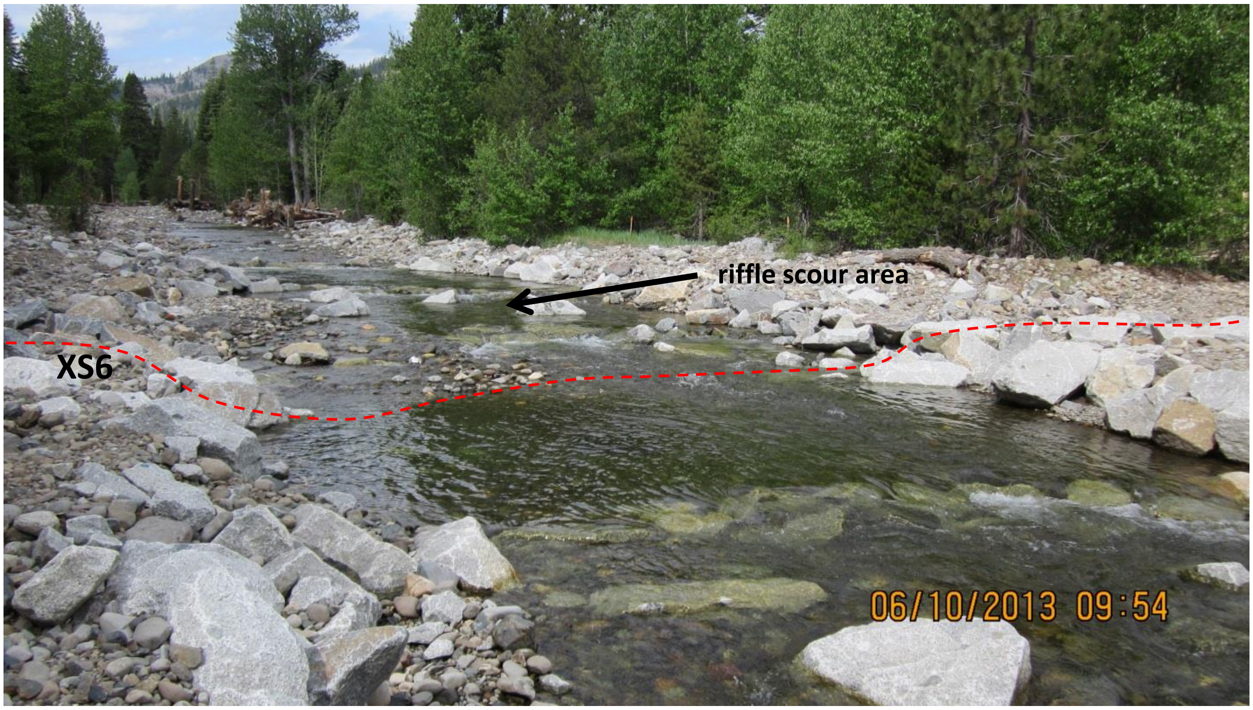


Figure 5 – July 30, 2013 Photo and cross section in deposition zone on reconstructed southern fork of the creek. Photo taken near constructed sill on left bank looking downstream cross section area and deposit; dashed polygon outlines this deposit next to the channel thalweg, the deepest part of the channel.



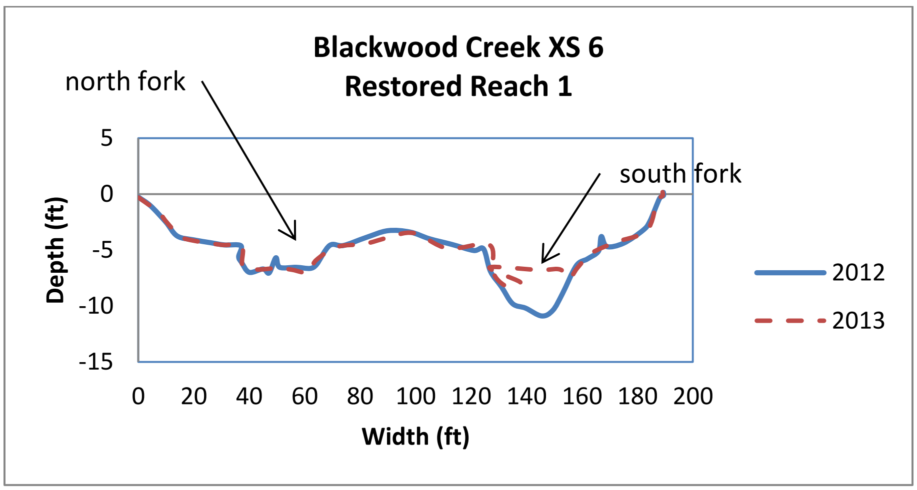


Figure 6 – June 10, 2013 photo of riffle scour and pool deposition on southern fork of the creek. Photo taken looking upstream. Cross section plot orientation is opposite of the photo.

Stream Bank Stability and Shading

Tracking stream bank stability and stream shading will be important metrics for long term monitoring, since they both can be a reflection of high aquatic habitat quality. Though pre - project data was not collected for these metrics, stream bank stability and shading were measured on June 10 -11 2013. We used USFS Region 5 Stream Condition Inventory method (USFS, 2005). Using this method bank stability is rated on both banks on the end points of 50 evenly spaced transects throughout the monitoring reach (Figure 3 earlier) allowing for similar sized segments of stream (restored VS. untreated) that exist in a similar geomorphic setting; 24 transects lie in 2000 feet of restored channel (including the earlier fish ladder project) and 26 transects were measured on 2100 feet upstream of the area of active restoration. Results indicate that 98% of project area banks rate as stable one year after project completion. Upstream measurements showed that about 80% of banks are stable. Overall bank stability in Reach 1 is 89% currently. This could change during the next large flood particularly in untreated areas upstream of the project that have less bank protection or grade structures in place; however, we feel that threat of instability at this time, is minimized by the backwatering effect created by raising the channel up three feet on the southern fork of the main stem stream.

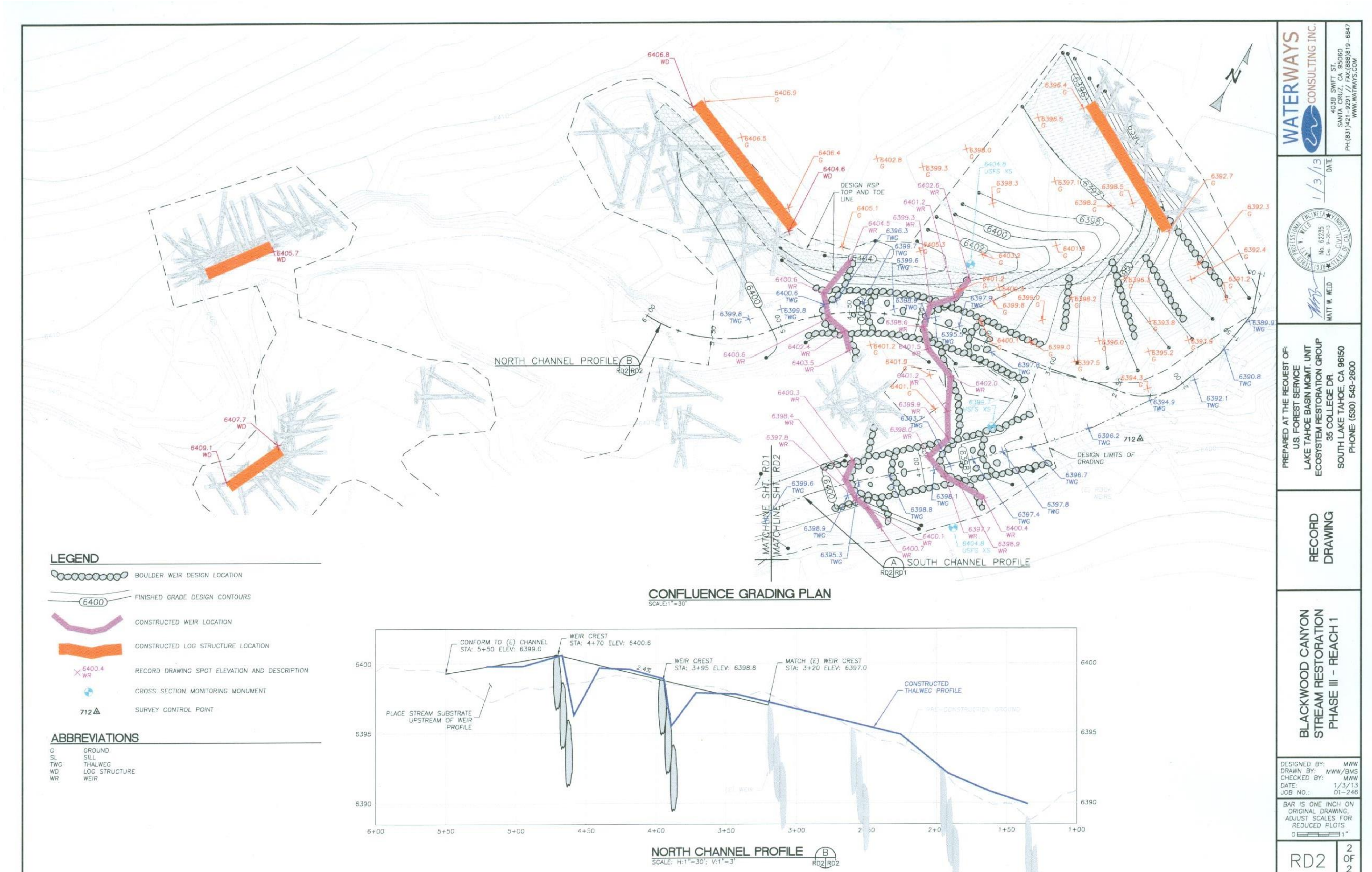
Stream shade measurements were taken in the center of the channel at the same 50 transects. Results indicate that stream shade is at 26% currently. We consider this value to be lower than desired and expect this value to increase over time. We expect shade to increase as more riparian vegetation near the channel becomes established, particularly within the project area as finer grained sediments, with higher water holding capacity and greater riparian plant colonization potential, are retained due to the increase in sinuosity and reduction in channel slope.

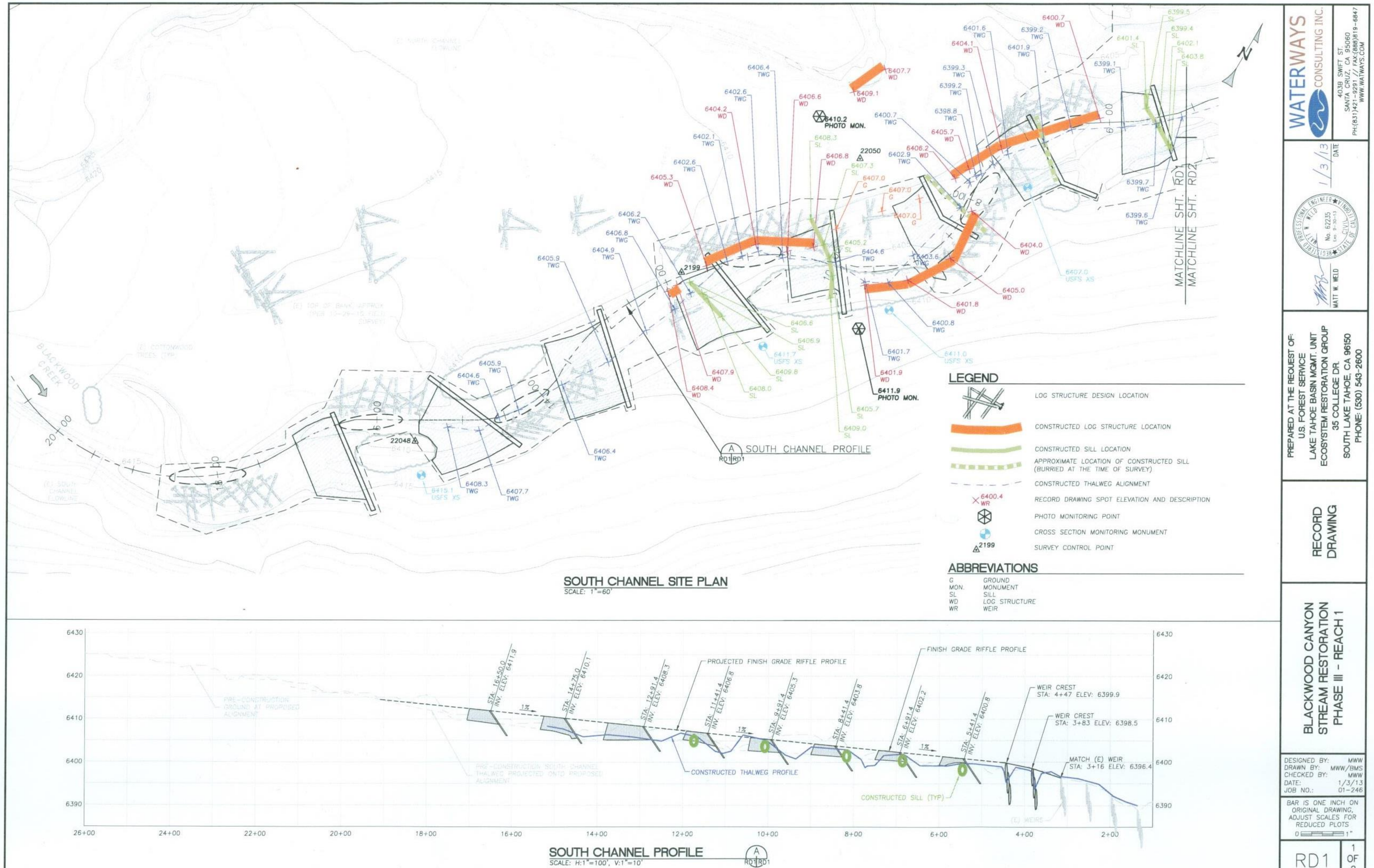
References

Stream Condition Inventory (SCI) Technical Guide. 2005. U.S. Department of Agriculture, Forest Service, Pacific Southwest Region: 111 pp.

Swanson et al., 2003. Blackwood Creek Stream Restoration Project Final Design Report. For: U.S. Department of Agriculture, Forest Service, Lake Tahoe Basin Management Unit.

APPENDIX A – RECORD DRAWINGS




SOUTH CHANNEL SITE PLAN
SCALE: 1"=60'
LEGEND
LOG STRUCTURE DESIGN LOCATION
CONSTRUCTED LOG STRUCTURE LOCATION
CONSTRUCTED SILL LOCATION
APPROXIMATE LOCATION OF CONSTRUCTED SILL (BURRIED AT THE TIME OF SURVEY)
CONSTRUCTED THALWEG ALIGNMENT
RECORD DRAWING SPOT ELEVATION AND DESCRIPTION
PHOTO MONITORING POINT
CROSS SECTION MONITORING MONUMENT
SURVEY CONTROL POINT
ABBREVIATIONS
G GROUND
MON. MONUMENT
SL SILL
WD LOG STRUCTURE
WR WEIR
MATCHLINE SHT. RD1
MATCHLINE SHT. RD2
6410.2 PHOTO MON.
6411.9 PHOTO MON.
SOUTH CHANNEL PROFILE
SOUTH CHANNEL PROFILE
SCALE: H:1"=100', V:1"=10'
PROJECTED FINISH GRADE RIFFLE PROFILE
FINISH GRADE RIFFLE PROFILE
CONSTRUCTED THALWEG PROFILE
CONSTRUCTED SILL (TYP)
WEIR CREST STA: 4+47 ELEV: 6399.9
WEIR CREST STA: 3+83 ELEV: 6398.5
MATCH (E) WEIR STA: 3+16 ELEV: 6396.4
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1/3/13
DATE
MATT W. WELD
PREPARED AT THE REQUEST OF:
U.S. FOREST SERVICE
LAKE TAHOE BASIN MGMT. UNIT
ECOSYSTEM RESTORATION GROUP
35 COLLEGE DR.
SOUTH LAKE TAHOE, CA 96150
PHONE: (530) 543-2600
RECORD DRAWING
BLACKWOOD CANYON STREAM RESTORATION PHASE III - REACH 1
DESIGNED BY: MWW
DRAWN BY: MWW/BMS
CHECKED BY: MWW
DATE: 1/3/13
JOB NO.: 01-246
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
RD1
1 OF 2

WATERWAYS CONSULTING

Ecological Restoration Design ~ Civil Engineering ~ Natural Resource Management

TECHNICAL MEMORANDUM

To: Craig Oehrli, *US Forest Service - Lake Tahoe Basin Mgt. Unit*

From: Waterways Consulting, Inc.

Date: February 23, 2013

Re: Record Drawing of Blackwood Canyon Stream Restoration, Reach 1

Introduction

Waterways Consulting Inc. (Waterways) and River Run Consulting provided final design drawings, construction staking, and as-built surveying services for the Blackwood Canyon Stream Restoration Project, Reach 1. Final drawings were dated 4-18-12.

The project was originally designed by Swanson Hydrology and Geomorphology as part of the phased implementation of four projects that were recommended in the Blackwood Creek Stream Restoration Project Final Design Report (Swanson, 2003). The original Swanson design concept for Reach 1 envisioned large engineered wood and rock riffles, placed to protect the eroding terraces and raise the profile grade to provide improved floodplain connectivity. In addition, the plan called for modifications to a profile transition reach previously constructed to replace a concrete fish ladder. The proposed modifications included widening the constructed cross section (which consisted of a boulder step-pool channel flanked by earth levee on river left and native slope on river right) and extending the transition reach further upstream to raise profile grade and backwater the proposed riffle placements.

Designs were modified by Waterways and River Run in 2012 to reduce the amount of fill placed within the channel upstream of the grade transition area. This was accomplished by slightly lowering the original design profile grade and shortening the riffles. Log jams were placed on outer bends to further reduce erosion potential. These modifications allowed for a more selective use of existing materials. By reducing the specified volume of imported materials, the design allowed for a significant fraction of the fines to be removed by screening, thereby reducing potential water quality impacts.

As-Built Survey Methods

The As-Built Survey field work was performed in November of 2012. The Record Drawing (Attachment A) was completed and signed on January 3rd, 2013. The work was performed with an electronic total station and data collector. The goal of the mapping was to document the constructed features, and to determine the degree to which they conformed to the Drawings. To accomplish this goal, survey data was collected as follows:

- Field ties were made to the original project survey control points.
- Flowline elevations were recorded at riffle (sill) crests and weir crests;
- Profile shots were recorded at grade breaks along the flowline;
- Upstream and downstream limits of wood placements were located, and

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- Spot elevations were recorded at areas of interest, such as the constructed floodplain adjacent to the weirs.

The Record Survey consists of two pages. The constructed features were overlain on the Design Drawings, in both plan and profile view. The as-built thalweg and profile are shown in blue, to facilitate comparison with the design Drawings. The downstream edges of the sills are approximated with a green line, connecting all data points. Weirs are shown in magenta and log jams are shown in orange. Each of the data points is displayed with the associated as-built elevation, which may be compared to the design contours or profile grades to determine conformance with the Drawings.

Results

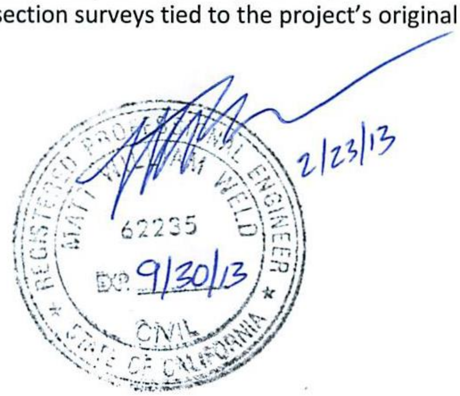
As can be seen from the Attachment A, the constructed work generally conforms to the drawings and meets the intent of the design.

Due to schedule constraints, the upstream end of the work was left incomplete, with the three most upstream weirs omitted from the work. However, the constructed portions of the project will be unaffected by this omission.

The measured profiles indicate that some of the riffle crests were constructed below design grade. The construction of the sills was guided by a sufficient amount of staking points, therefore, the discrepancy between measured and design grades is most likely the result of data points recorded at low points on the cross section (e.g., between large boulders), and may not be representative of the average sill elevation or hydraulic performance.

Recommendations

The work should be closely monitored for the first five years following construction and inspected immediately after large storm events (5-year or greater recurrence interval) to evaluate success and adaptively manage to optimize performance. Monitoring efforts should, at a minimum, include cross section surveys tied to the project's original datum to evaluate trends in bed level evolution.



2/23/13