APPENDIX E

GEOMORPHOLOGICAL MONTORING REPORT
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September 2013

Introduction

Keystone Restoration Ecology (KRE) conducted geomorphological monitoring in the Upper Gunnison Basin on stream channels where restoration techniques were implemented to enhance wetland/riparian habitats important for Gunnison Sage Grouse brood rearing. The stream channel monitoring data will establish baseline conditions at the following restoration sites:

- Redden Ranch
- Wolf Creek Ranch
- Wolf Creek BLM
- West Flat Top at Henkel Road, including the Exclosure site

Restoration treatments were designed by Bill Zeedyk to use the resource of flowing water and sediment transport to restore wetland areas, fix gullies, and reduce head cutting. Most of these treatments involved small rock structures such as Zuni bowls and one rock dams to reconnect the stream channel with its floodplain and prevent further gullying. Over time these structures will capture sediment flowing in the channel during runoff events and fill in gullies. This will re-connect the channels to their floodplains and increase the riparian area. KRE established longitudinal profiles for each restoration channel to monitor channel elevations through time.

Methods

The geomorphology monitoring was set up to monitor the effects of restoration treatments in the sites. The longitudinal profiles run "along" the channel, from upstream to downstream, and were taken after the structures were built for an "As-Built Survey". Cross sectional transects were also placed above selected structures to more closely monitor the effects of those structures. These cross sections are marked on site with 2" by 2" wooden stakes and in most cases coordinate with a restoration treatment structure number. When possible we used benchmarks taken in 2012 by Zeedyk Consulting. These are rocks in the stream channel or on the terrace marked BM in blue paint. At Wolf Creek, the lower two reaches benchmarks were established by using 2x2 wooden stakes and taken as GPS points. No existing benchmarks were found at the Flat Top site, so 2x2 wooden stakes were used as benchmarks there too.

A sub-meter, hand-held Trimble Geoexplorer Global Positioning System (GPS) unit and self-leveling laser level unit with rod and sensor were used to collect elevational data along the stream channel. A two-person crew worked in tandem to collect a GPS position for each point surveyed with the laser level. Elevational data was then merged with GPS positions to provide distance, elevation, and exact location in the stream channel. As the grade of the channel descended down valley, the laser level was repositioned and turning points created to calibrate and establish a continuous longitudinal profile.

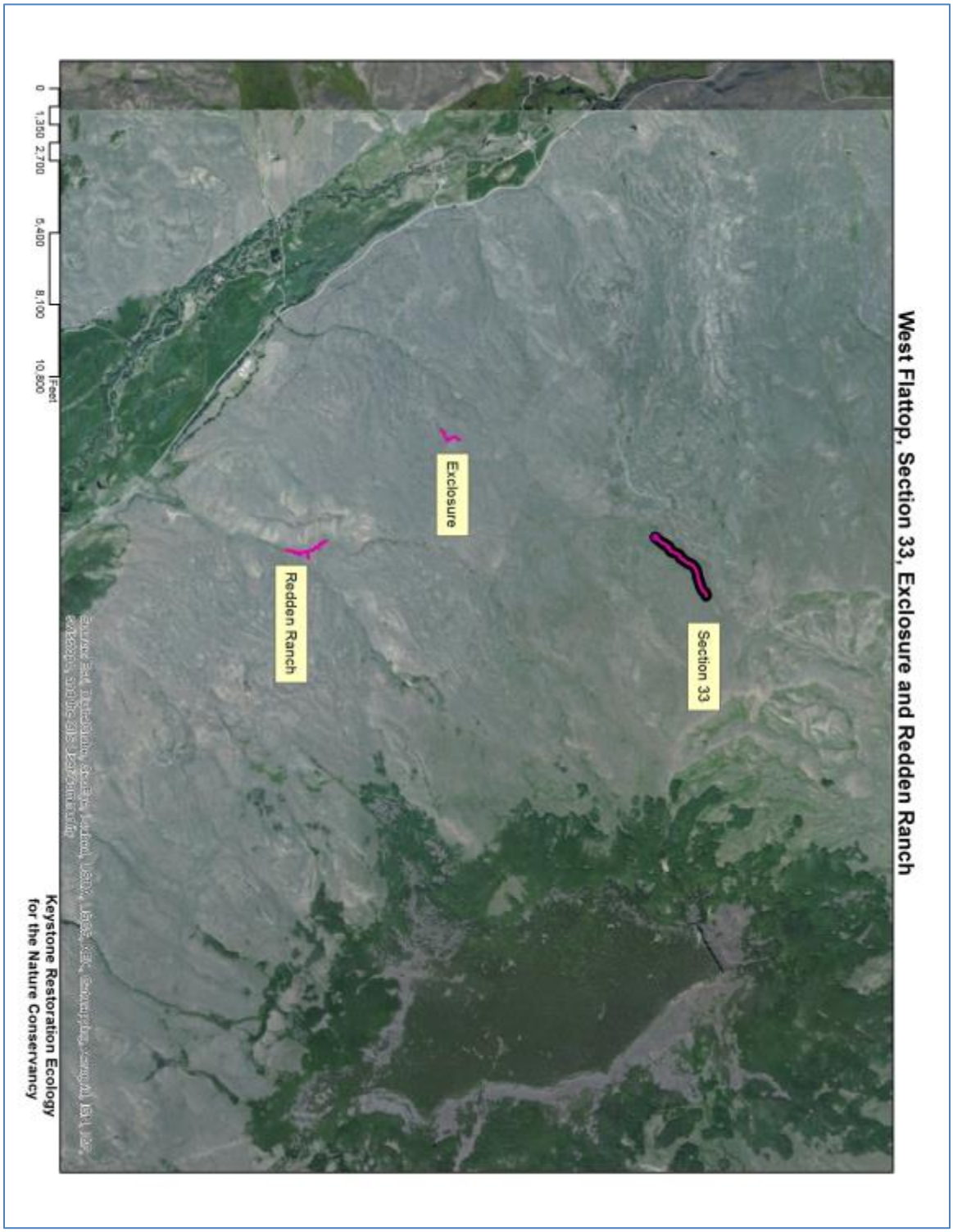
The methods used to take the geomorphology elevation data at these sites allowed Keystone Restoration Ecology to survey almost every reach that had been worked on in 2012 and 2013. The advantage to the method using the Trimble sub-meter GPS allows the survey team to not

"pull tapes" and continually replace 300 foot tapes down the channel. If 300 foot tapes were used, much less data would have been taken in the time available due to the time to move and re-lay the tapes. Perhaps only one or two sites would have been surveyed by the conventional methods.

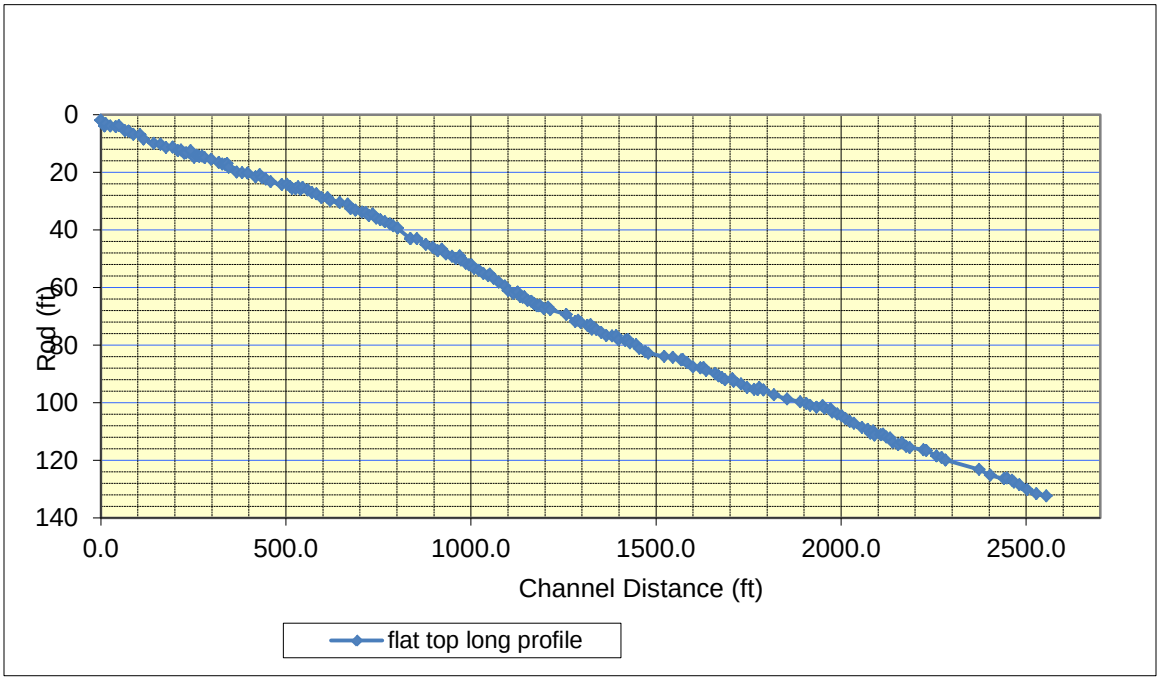
In addition, there is an accumulation of errors as a survey continues down a long channel, basically, it is impossible to lay the tapes in the same place each year. While this is not too significant, it can lead to errors in the data that do not happen when each elevational data point is "stationed" with a GPS. The data at 2000 feet down the longitudinal profile is as correct as the data at 200 feet.

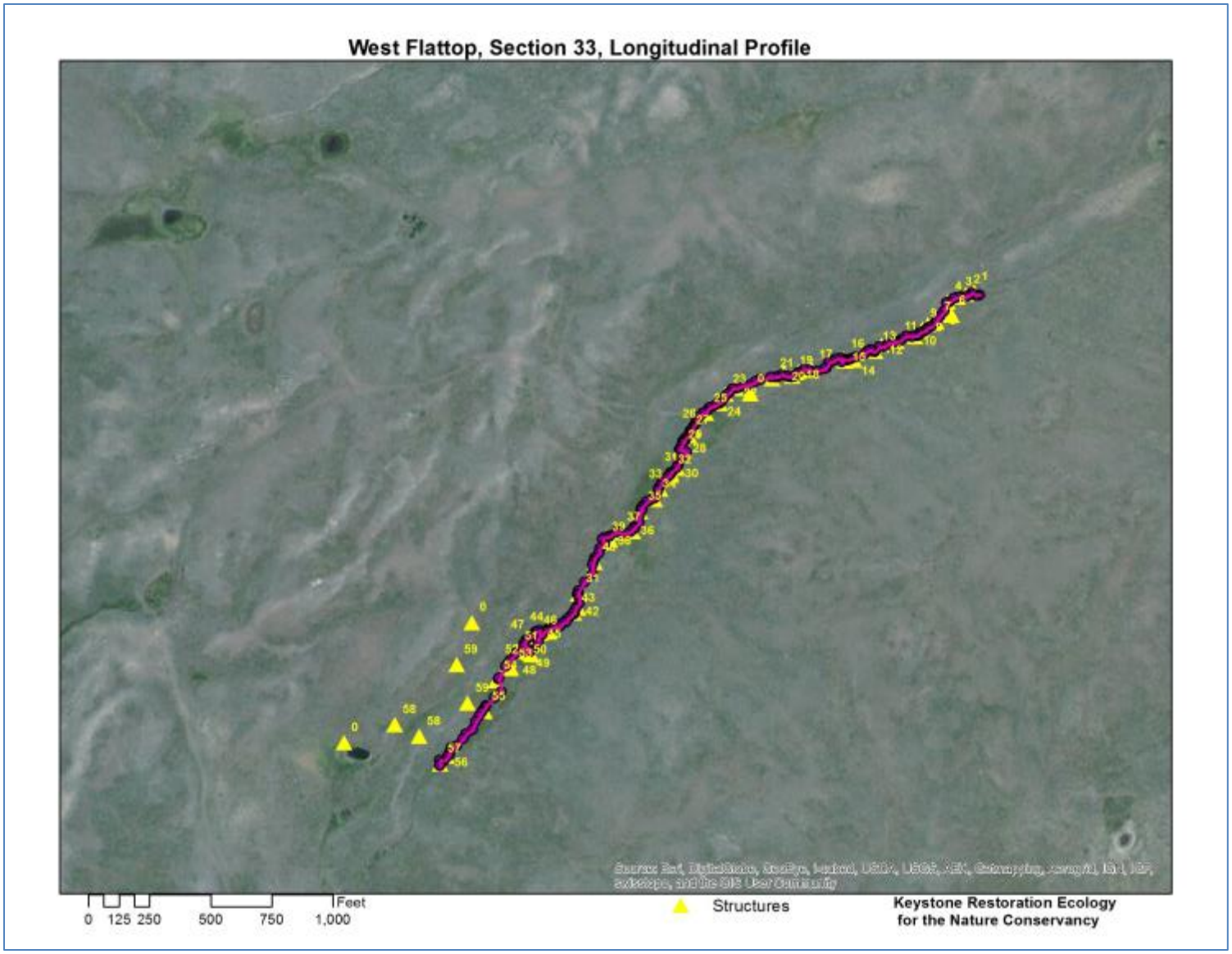
Re-taking this data requires the use of a professional grade GPS with sub-meter accuracy, which all agencies (BLM and Forest Service) have at their disposal. While re-taking the data will require some technical support, the advantages to the method allows for long reaches to be surveyed in a day. In addition, the cross sections can easily be re-surveyed with a measuring tape, not necessitating the use of a professional grade GPS.

Results: Forest Service Flat Top and Redden Ranch:
These two sites are off of Ohio Creek north of Gunnison. Flat Top Mountain dominates the area. Many small channels flow from Flat Top through sagebrush hills, the channels have intermittent springs and wet meadows in them that are used as brood-rearing habitat by Gunnison Sage Grouse.

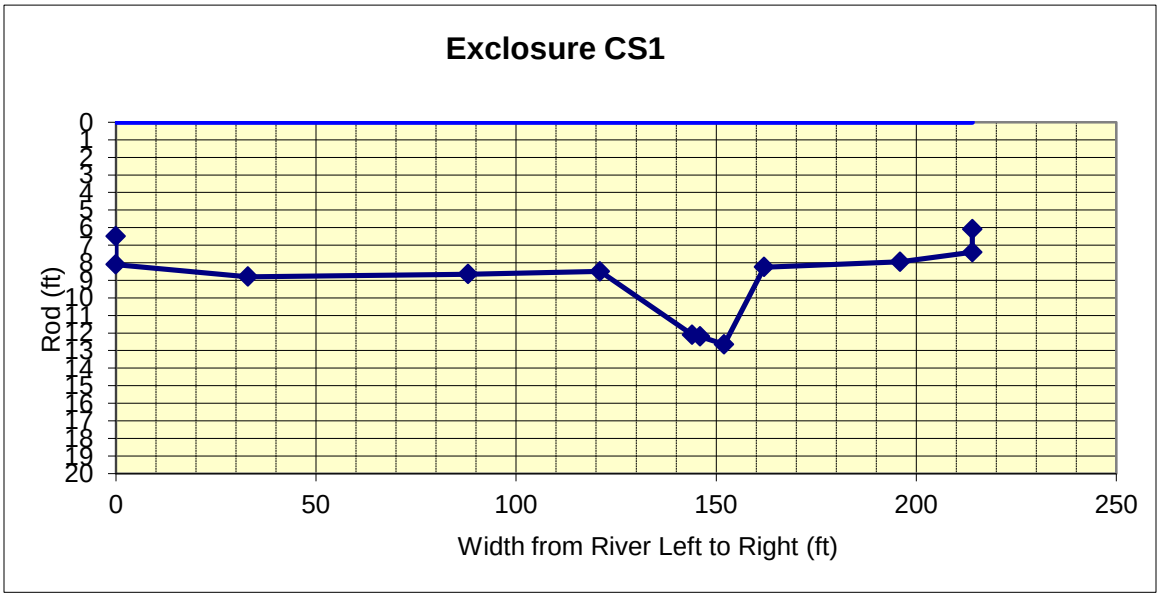


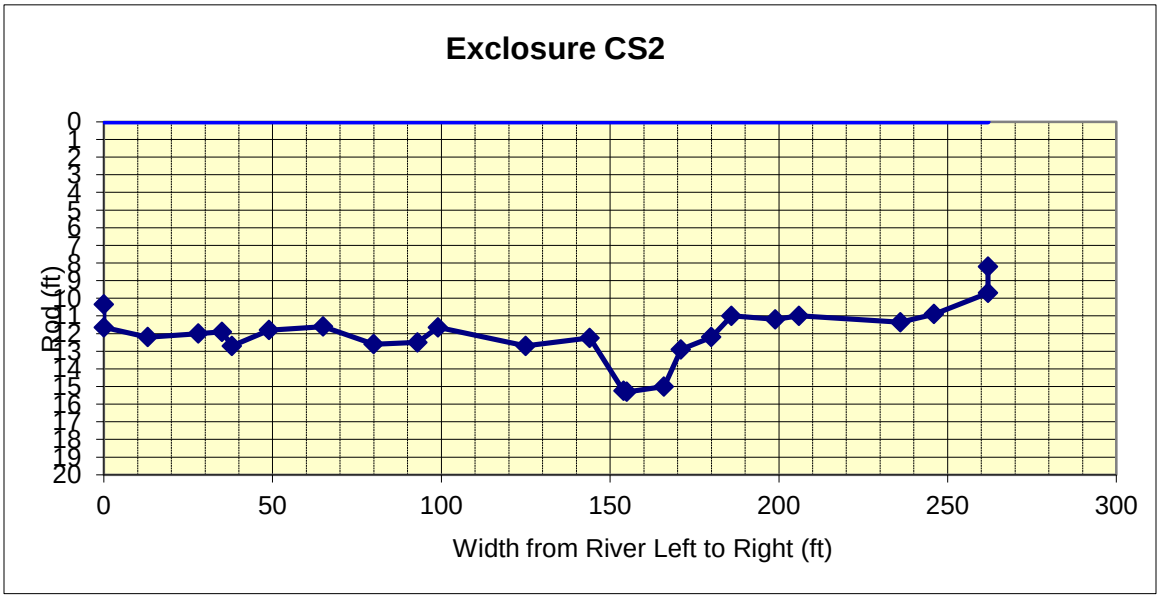
West Flat Top, Section 33: A longitudinal profile was taken of 2700 feet of the channel at the Section 33 restoration site. This small channel runs along Henkel Road, the access road to the site, and is relatively narrow and steep with a 5% slope. Structures such as one rock dams and rock rundowns were used to raise the grade of the channel and re-irrigate the narrow floodplain.

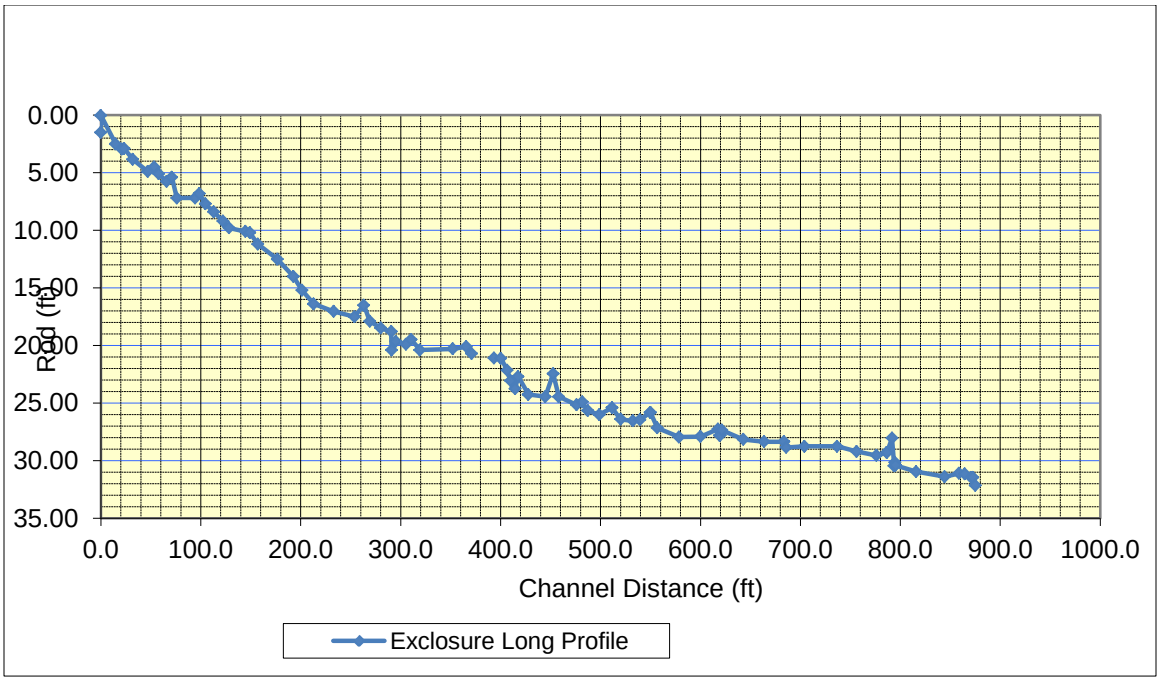



West Flattop, Section 33, Longitudinal Profile
0 125 250 500 750 1,000
Feet
Structures
Keystone Restoration Ecology
for the Nature Conservancy

Flat Top Exclosure Site:
A small exclosure fence that has been in place for decades was the location of another set of rock restoration structures. The exclosure site is deeply gullied, and because of this, two baffles were used to erode a steep bank and create floodplain at the new, gullied elevation of the channel. The cross sections show that the channel was once to the east side of the present gully, and this was a wet meadow or wetland.







The longitudinal profile of the exclosure from fence line to fence line along the channel.


Flattop Exclosure Site Geomorphic Monitoring
BM1 rebar at fence 0.3 feet
ZB
ORD
ORD
ORD
ORD
ORD
ORD
RR
Other
ORD
ZBZB
ORD
ORD
Other
ORD
Other
RR
ORD
Other
RR
ZB
ORD
ORD
CS1
cs2
0
37.5
75
150
225
300
Feet
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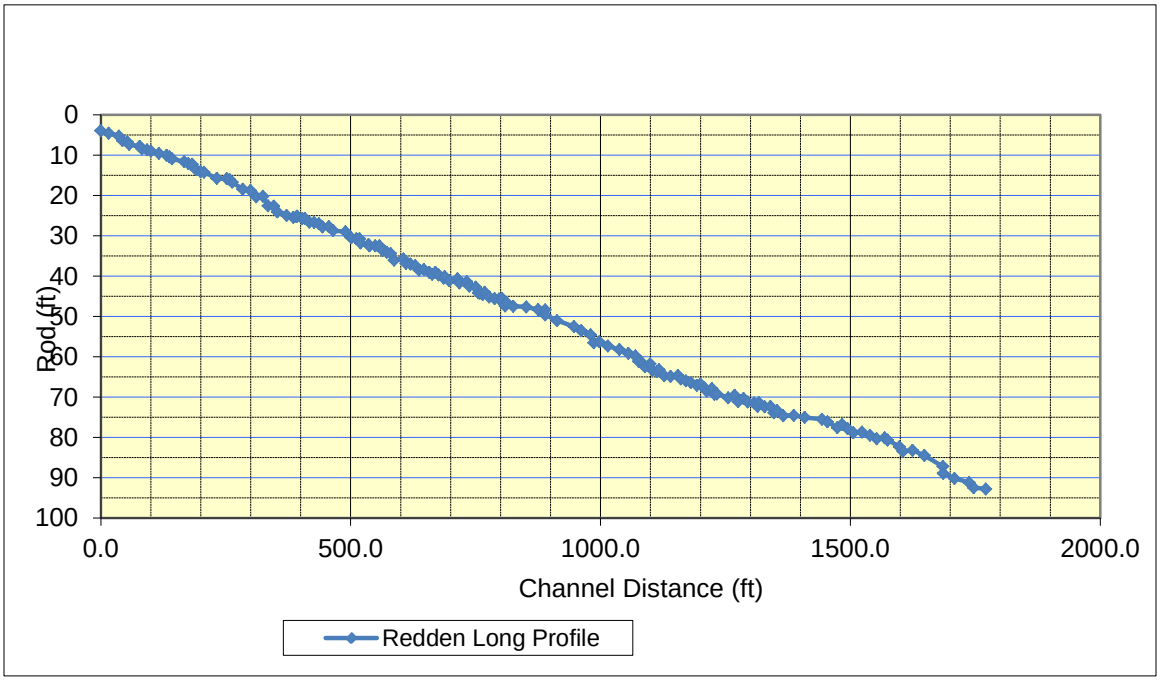
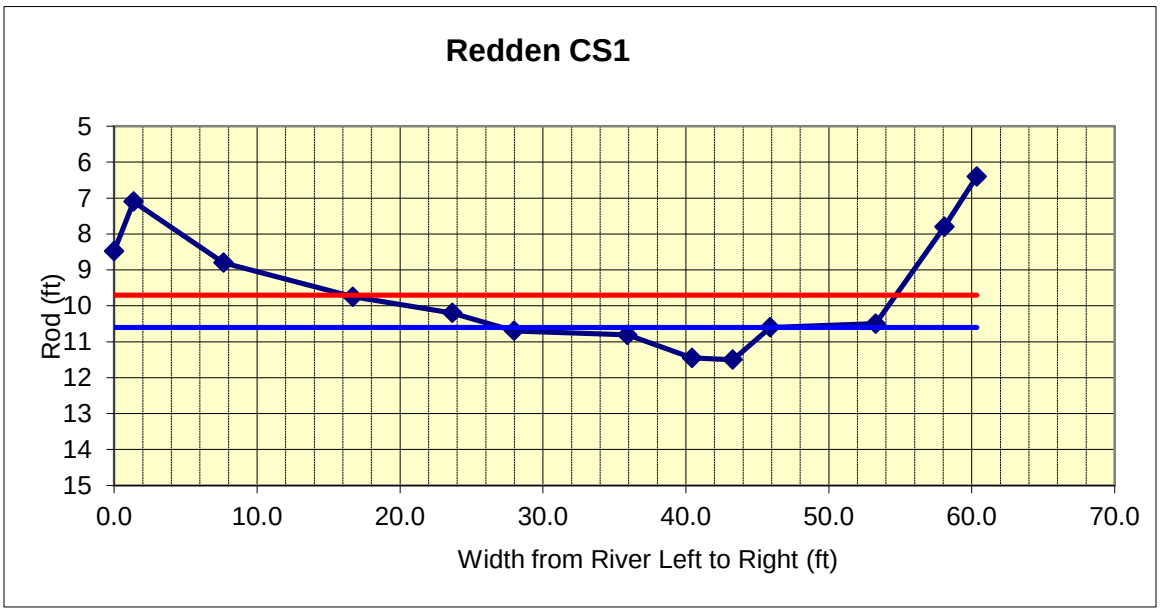
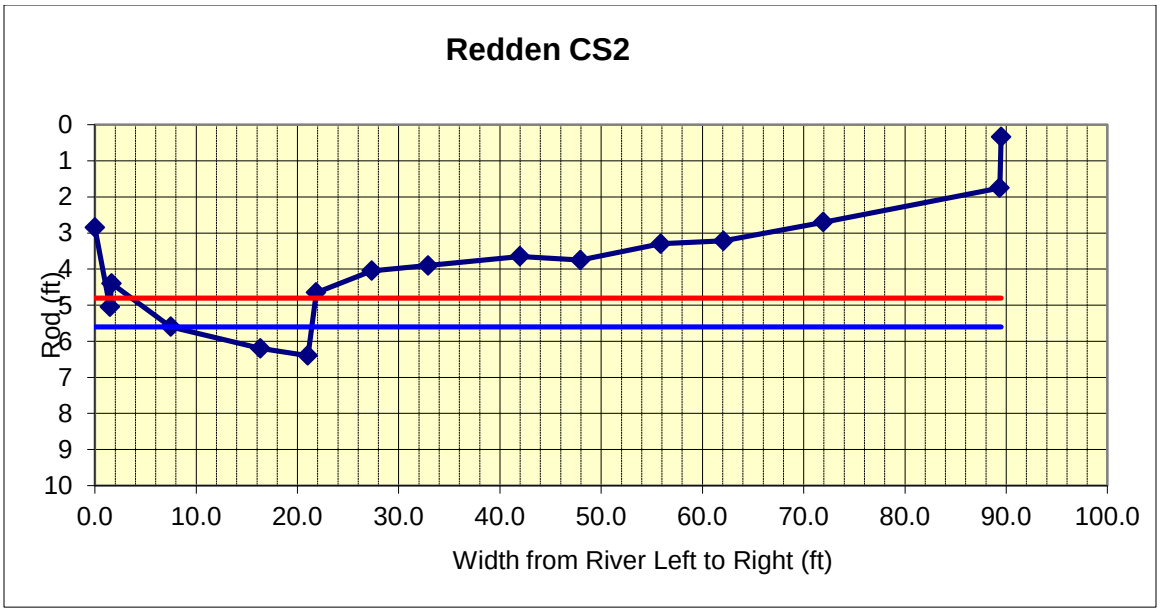
Redden Ranch

Keystone Restoration Ecology surveyed a longitudinal profile and cross sections at the Redden Ranch, below West Flat Top. The upper portion of the channel had already filled in behind the one rock dams installed in 2012 with sediment from gullied slopes uphill. This erosion, while damaging to the hill slope, is repairing a much more productive wet meadow by providing the necessary sediment to fill in the channel. The channel was surveyed by KRE for 1700 feet and has a 5.3% channel slope.

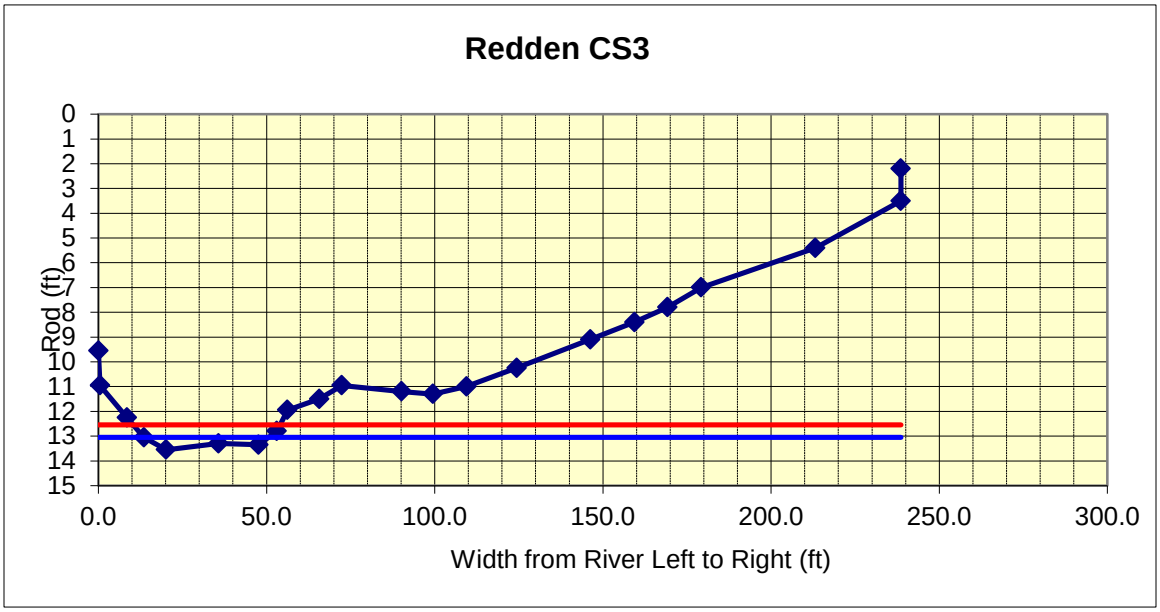




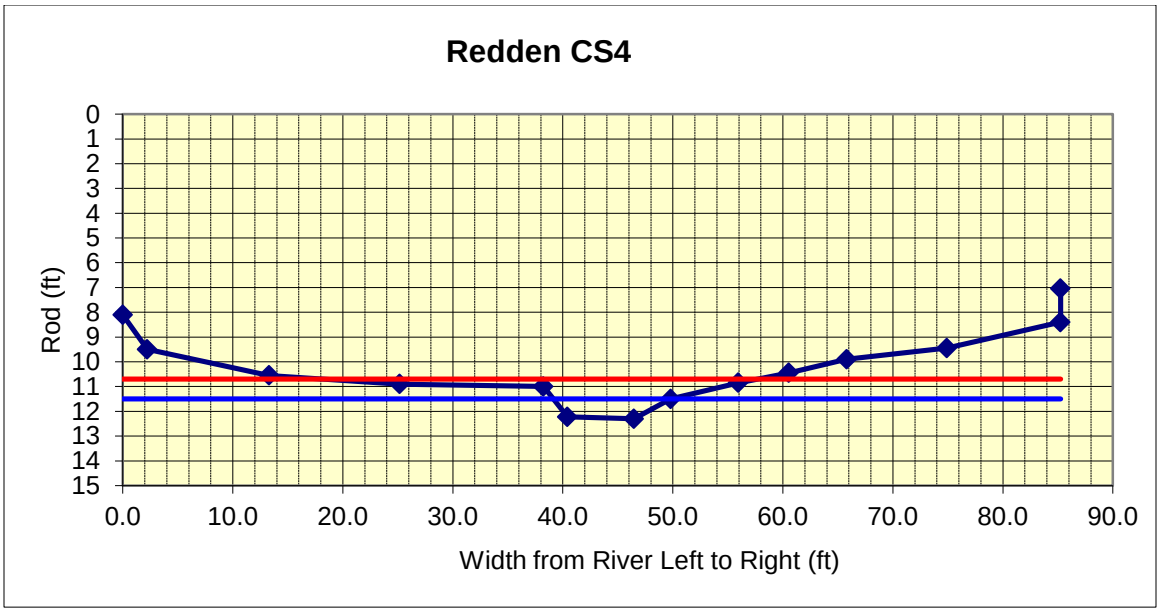
This site has filled in with sediment, and has a healthy channel shape with a floodplain.



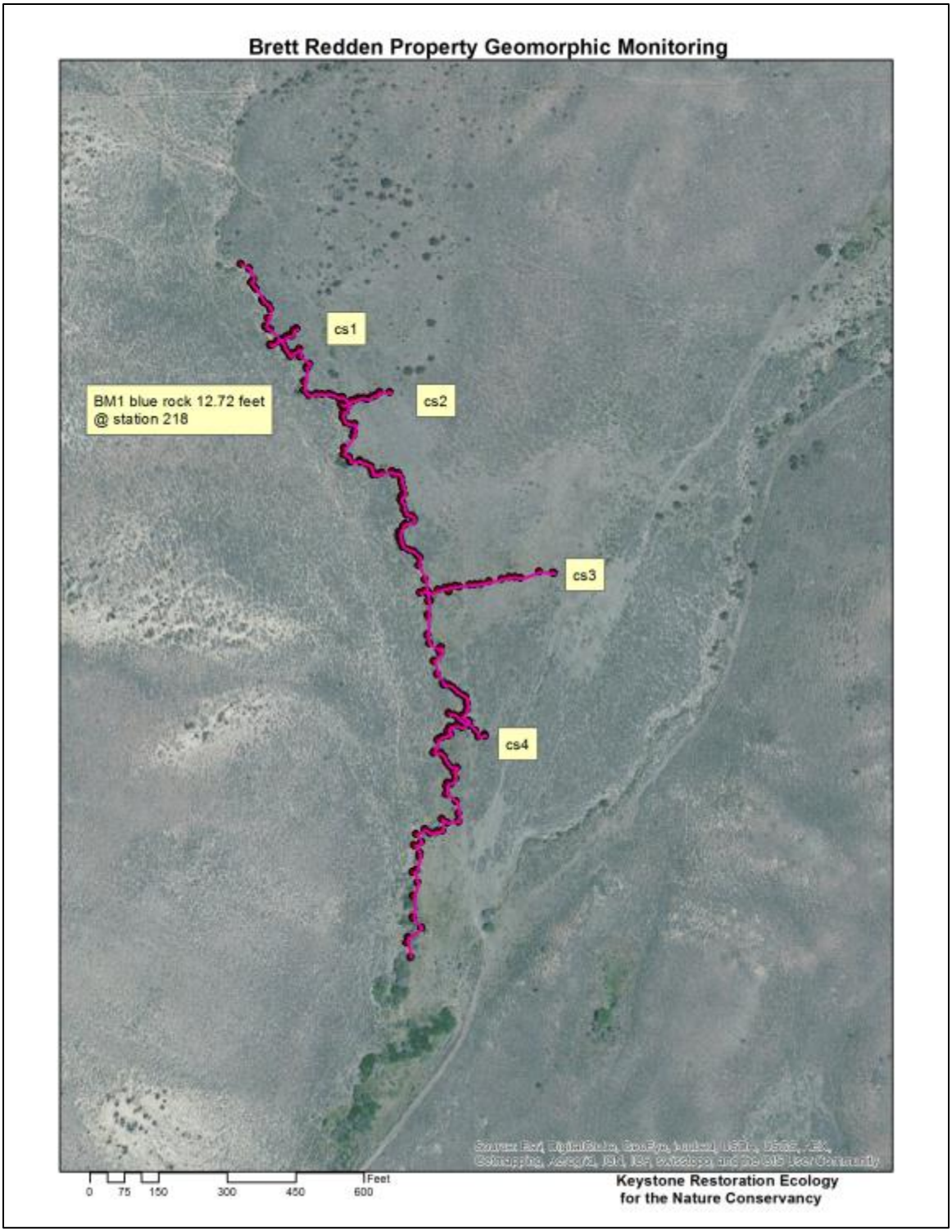
This site is still gullied, blue line is bankfull, red line "flood-prone width", an estimated 20 year storm, which could not overflow the banks of the gully at present.



Notice a swale at station 100 that was a former channel before the gullying, when the site was a wet meadow.



This cross section was taken low in the watershed at a point where the channel begins to braid around some willows. Raising the grade at this point could irrigate much of the former wet meadow between stations 10 and 40 on the cross section.


Brett Redden Property Geomorphic Monitoring
cs1
cs2
cs3
cs4
BM1 blue rock 12.72 feet
@ station 218
0
75
150
300
450
600
Feet
Keystone Restoration Ecology
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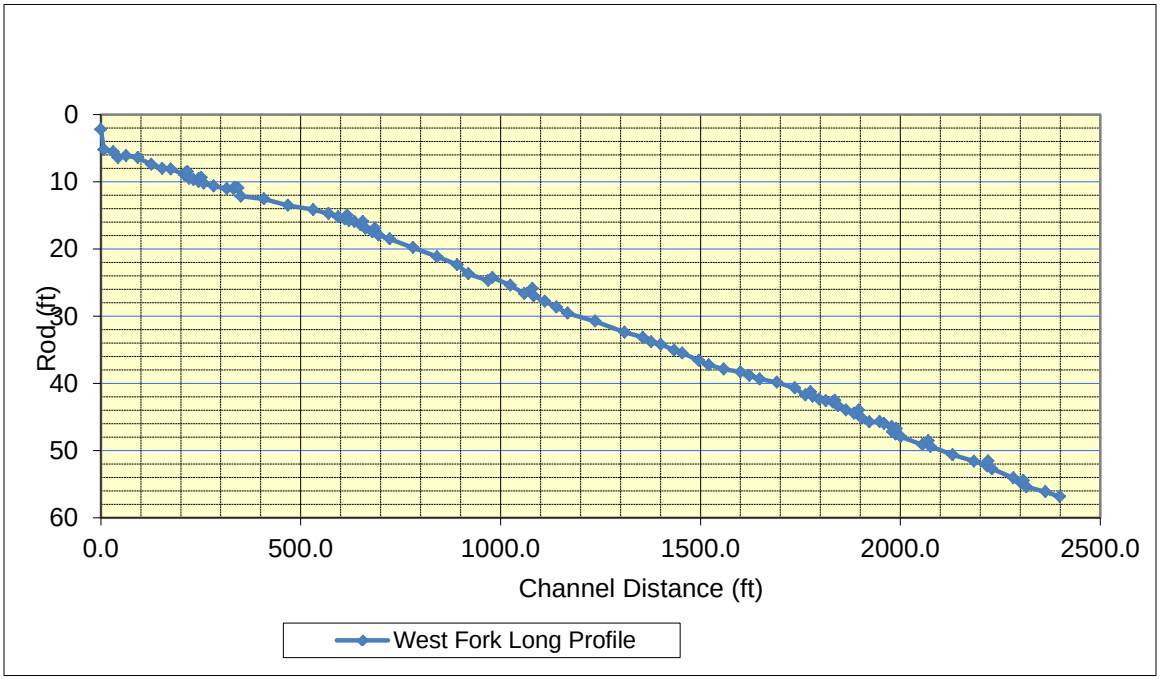
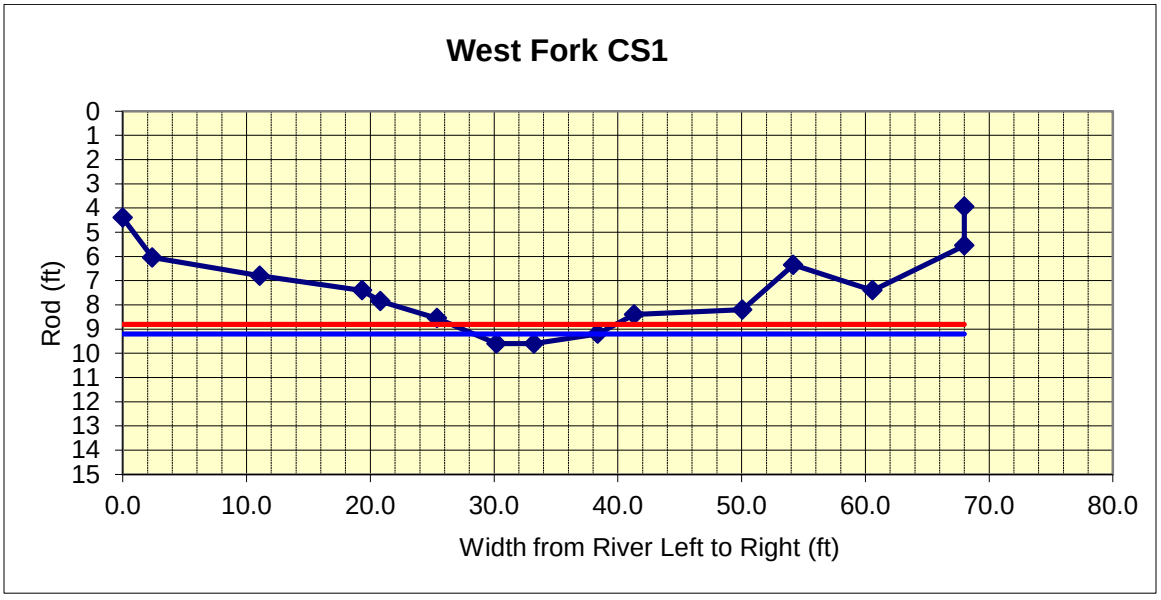
Wolf Creek Sites: Wolf Creek Ranch and Bureau of Land Management Properties:
These sites are south of Gunnison in rolling hills of sagebrush. There is a healthy spring that arises in the East Fork reach and flows into Upper and Lower Wolf Creek reaches. Three longitudinal profiles were taken, one on Wolf Creek Ranch, one on the East Fork and one on the Middle Fork Reach. A number of cross sections were taken as well. Gunnison Sage-grouse were seen during most site visits to this site.

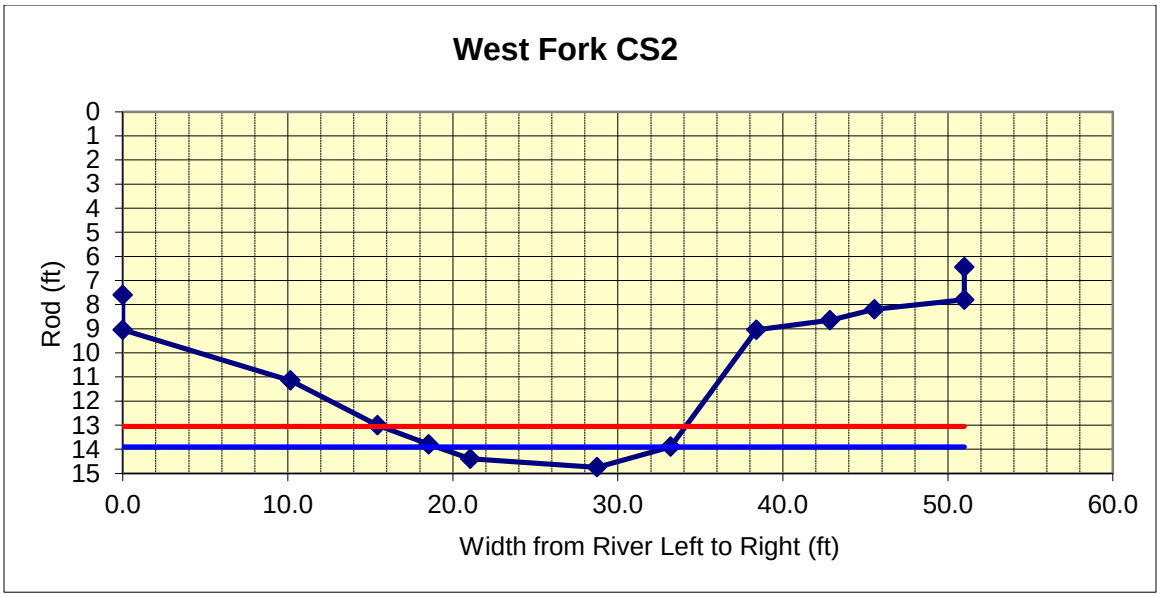
West Fork Site:



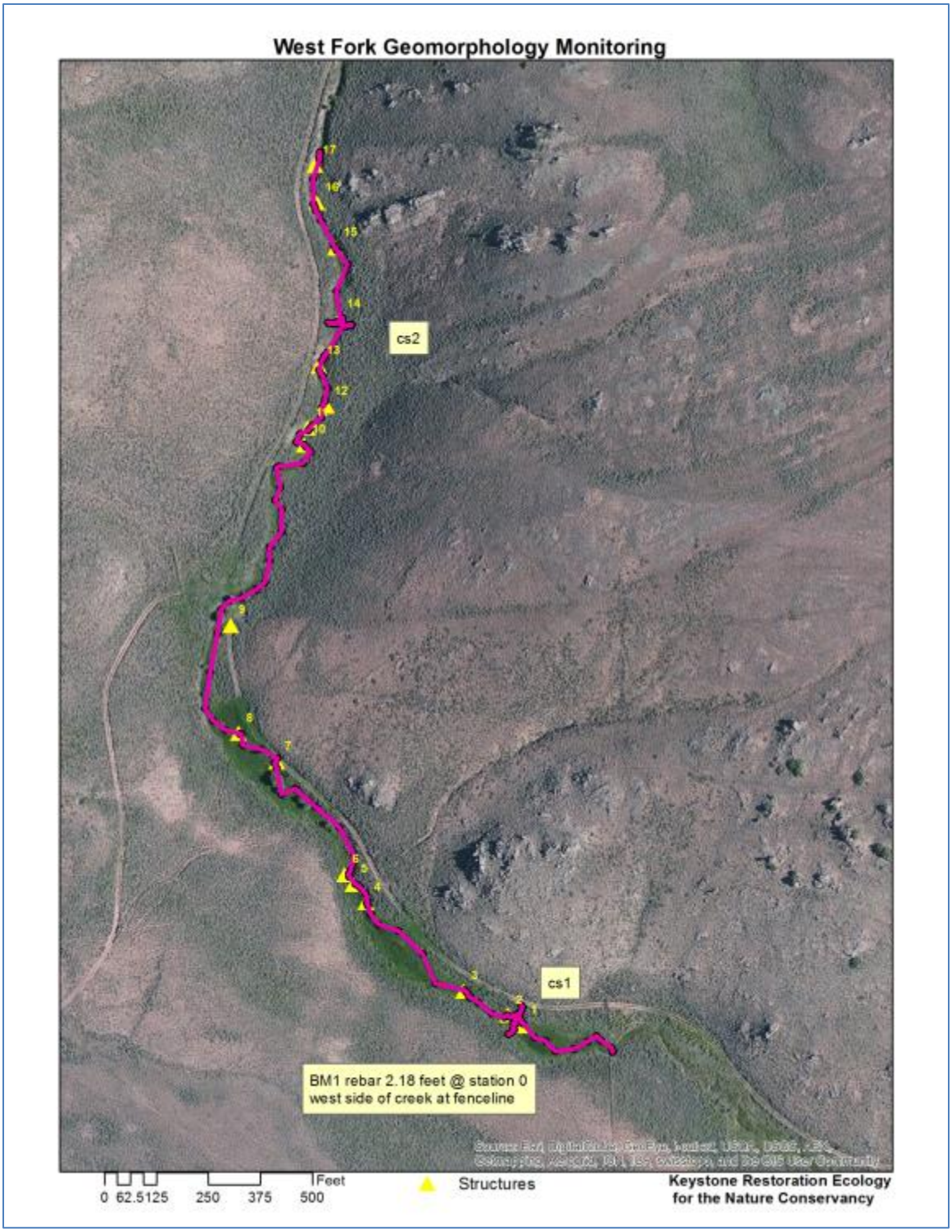
This longitudinal profile has an average 2.3% slope, the upper portion is a small channel through wet meadows. Due to the geology of the area, the lower portion runs through a natural gully between steep colluvial slopes.



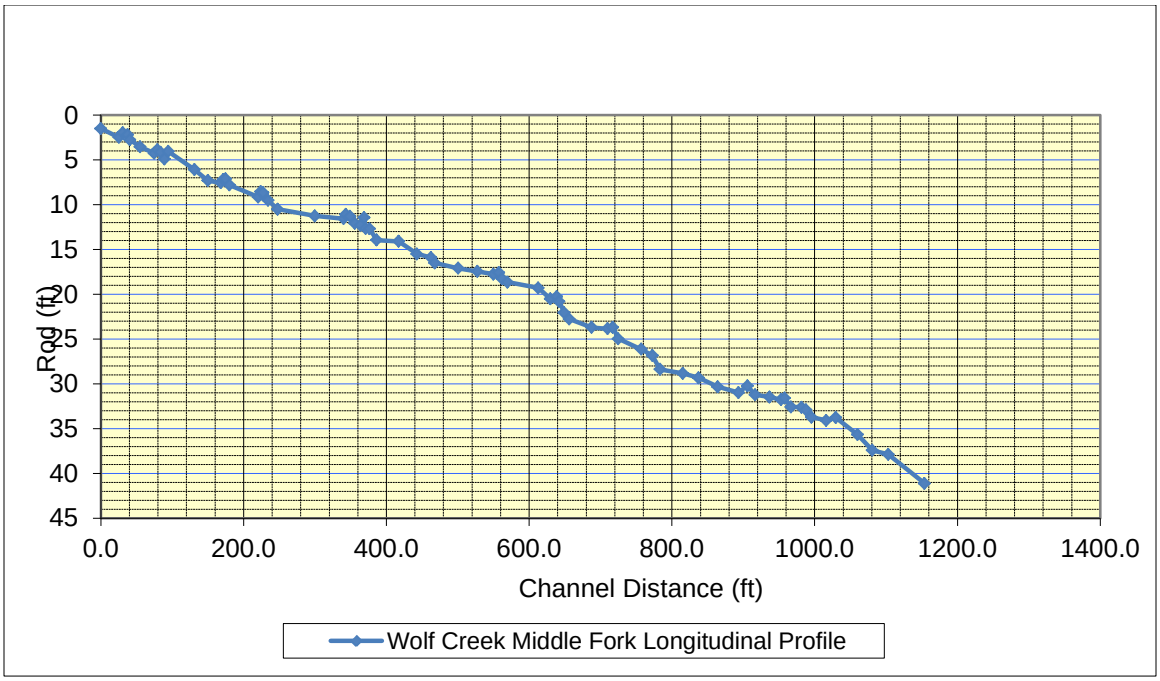
This cross section was placed in a location where we expected a large amount of sediment to fill in between several one rock dams.



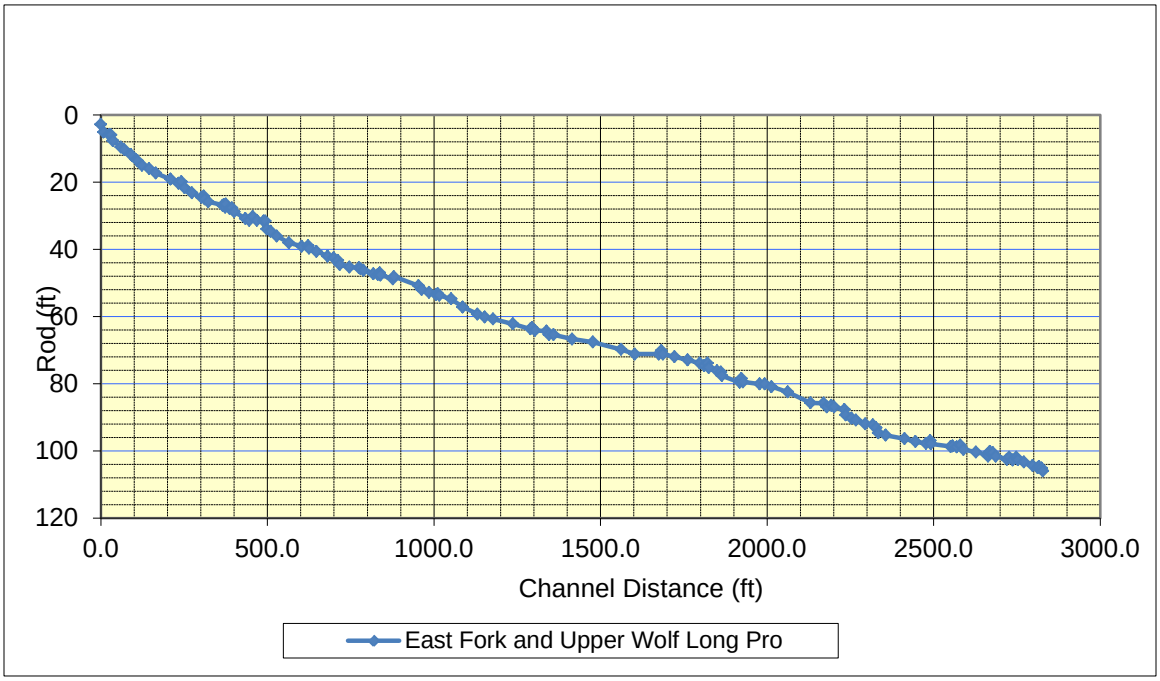
This cross section was in the lower, gullied portion of the site between steep hills on either side. This channel will fill in with sediment captured behind the one rock dam structures. This wet sediment will grow in with wetland vegetation and the defined channel will disappear (the area under the blue bankfull line should be filled in).



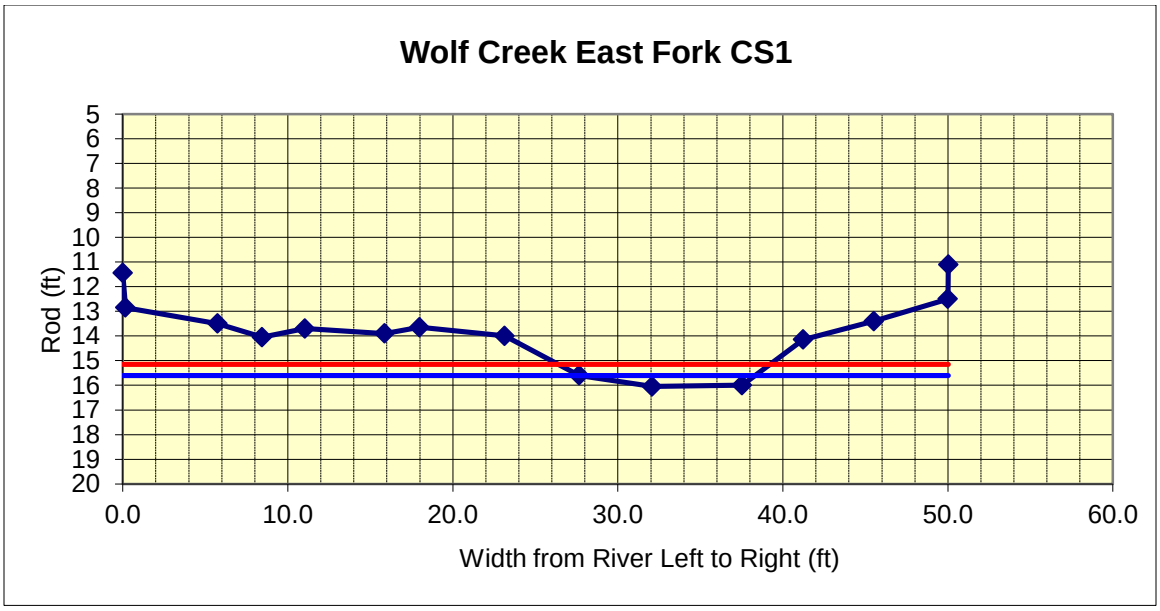
Wolf Creek: Middle Fork, East Fork and Upper Wolf:
This site is on Bureau of Land Management Property. Longitudinal profile 1 was surveyed in the Middle Fork Reach. Longitudinal profile 2 started at the spring (East Fork) and continued through the culverted road crossing to encompass the Upper Wolf Creek Reach.



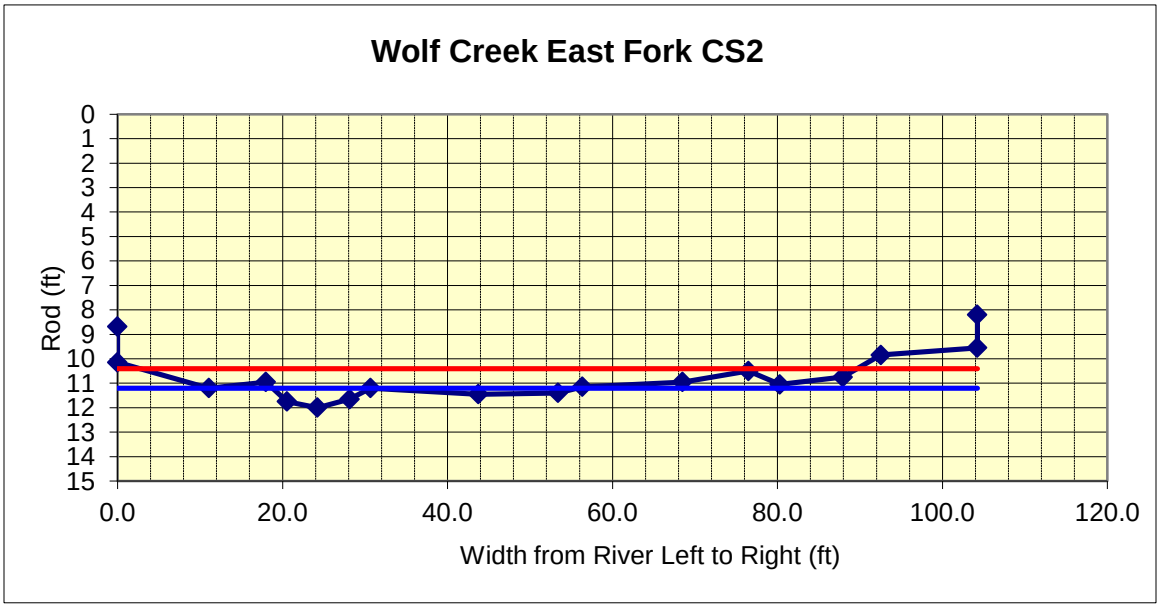
This profile shows the locations of many of the structures as "high points" in the profile. This profile is the tributary channel beginning at the road and running downstream to wide valley with the spring, where the Middle Fork begins.



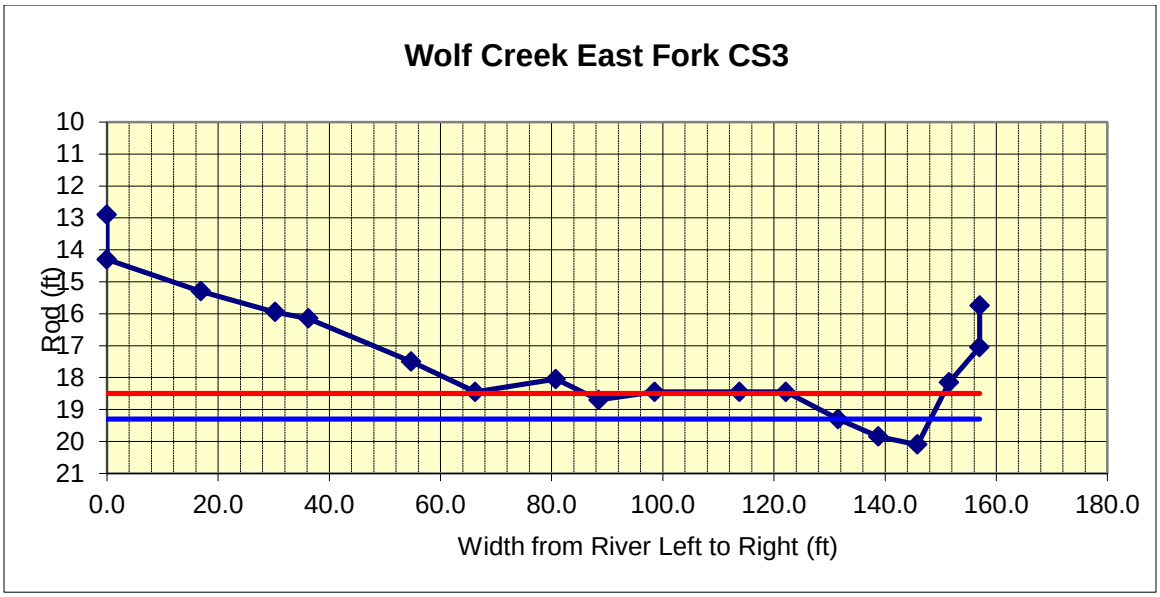
This profile starts at the spring at station 0, the wetland at the confluence runs from about 1000 to 1300. The culverted crossing is at 1350, where the Upper Wolf Reach begins, and runs downstream to the beginning of Lower Wolf Reach.



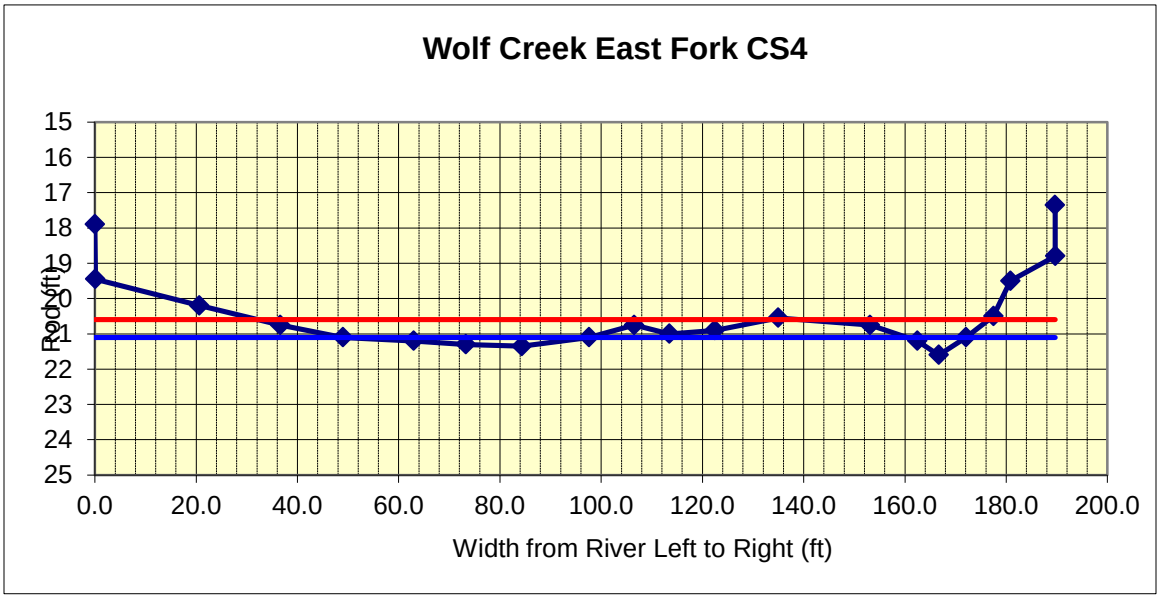
This cross section was taken in a narrow portion of the channel, upstream from the spring. However, the form of the channel may indicate that this area was once a slope wetland without defined channel through it (old channel to left at station 8 feet).



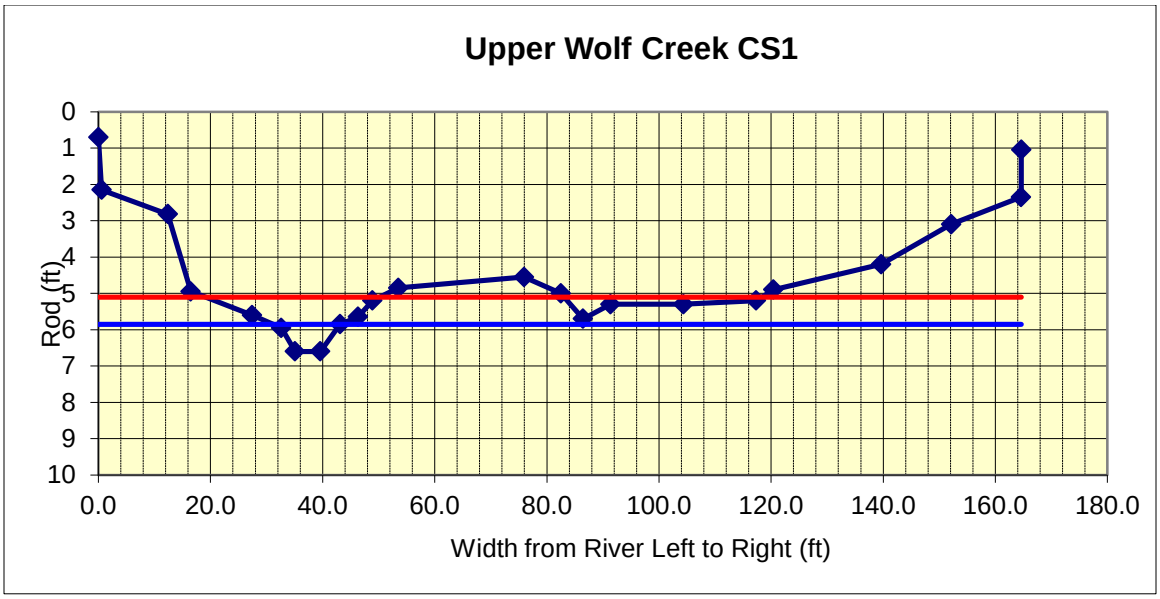
This cross section was taken where the channel enters the wide valley with the spring; this cross section runs across an alluvial fan feature with multiple channels in it. This cross section should continue to "aggrade" or gain elevation due to the braiding of the channel and accumulation of sediment from the growth of the alluvial fan.



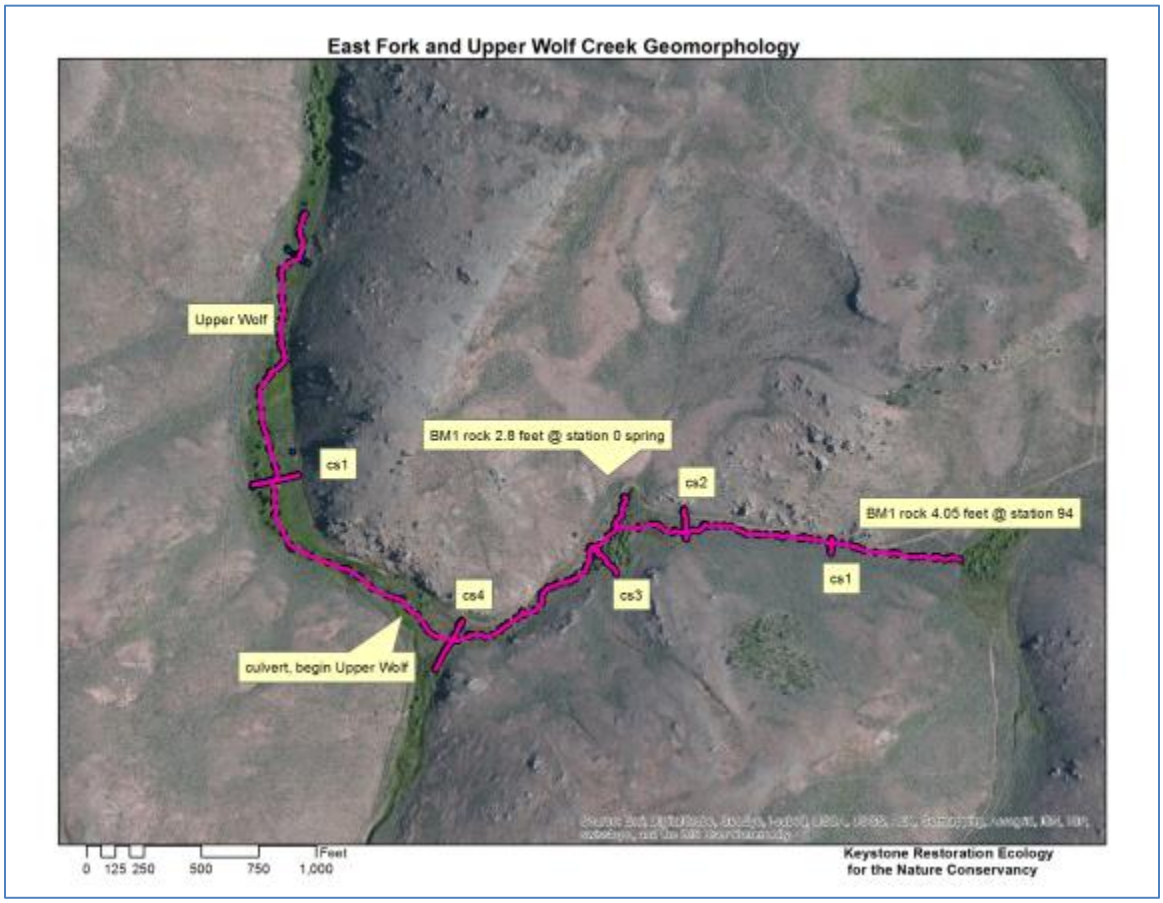
This cross section was taken at the end of the "spring valley", showing several channels which could contain the flow from the spring. Presently, the spring is flowing at station 150 on the cross section, in the lowest elevation channel.



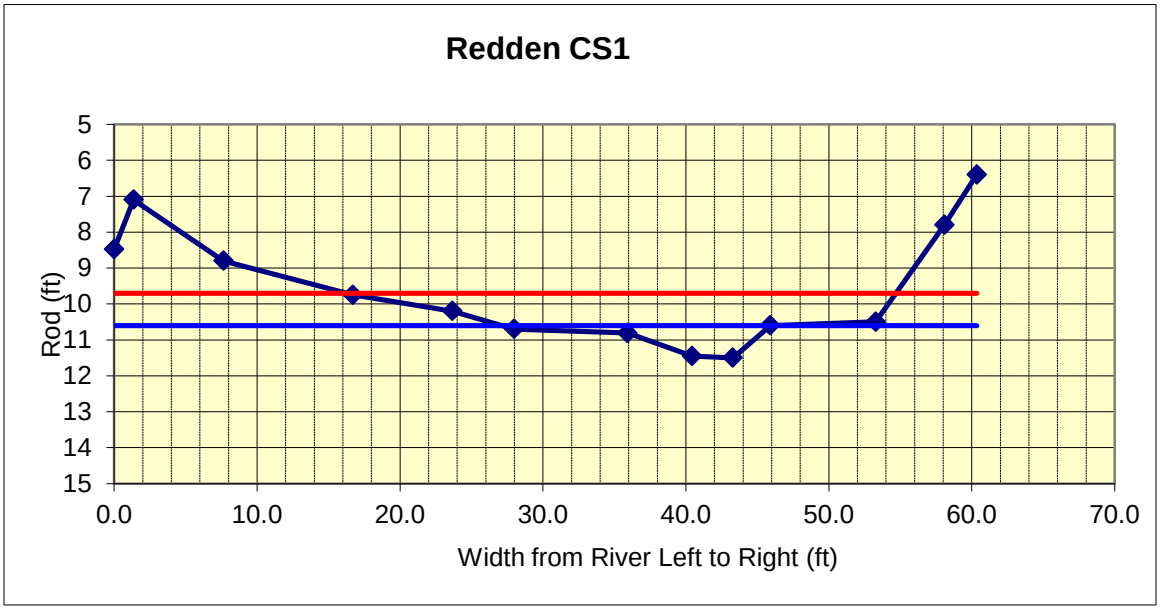
This cross section was taken near the confluence with Upper Wolf Creek, where the water spreads across the wetland. The water has spread throughout this cross section after the work was done in 2012. There is water in channels from station 60 to station 170.

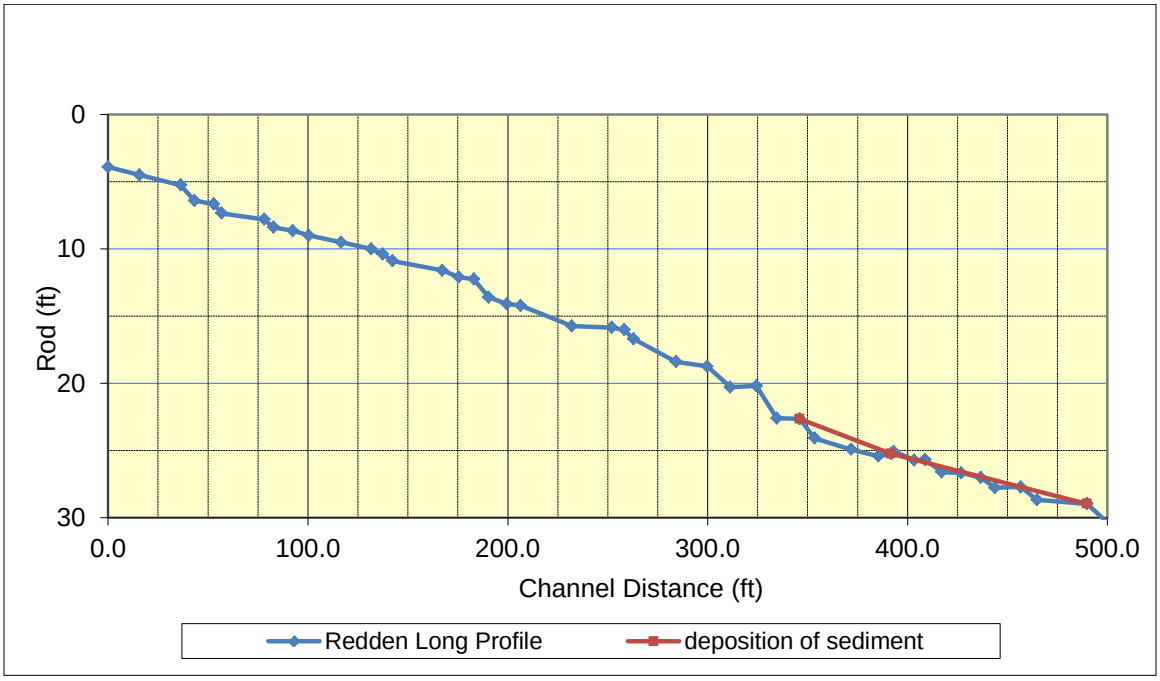


This cross section was taken above the first large "Media Luna" structure in the main channel of Wolf Creek, several hundred feet below the culvert. The water has already been spread across the valley and is not flowing in the lowest channel at station 40. The Media Luna runs from about 85 to 115 on the cross section.



Conclusions:
The geomorphic monitoring taken was performed as an "as-built" survey with data taken just after construction. This allowed for one monitoring event to capture both the "pre-treatment" elevation of the channels and the location and height of each structure.
The purpose of many of these structures is to capture sediments such as gravel and soil during flood events and to re-fill the gullied channel. Some of this sediment capture was seen on the Redden Ranch (built in 2012) at the upper end, the channel form has changed from a gullied channel to a channel with a floodplain.





The upper portion of this profile has filled in and "smoothed", as this sediment works downstream, it will fill in the area under the "deposition of sediment" line.

The two graphs shown above for the Redden Ranch show the effects of the restoration structures after one year of channel flooding and deposition. The cross section shows a channel that is un-gullied and has an active floodplain. The longitudinal profile shown has filled in with sediment and the structures are actually obscured under fresh sand and silt. This deposition will proceed from upstream (the sediment source) downstream through the longitudinal profile (the sediment sink).

Future Work:
Comparing this year's "as-built" data with surveys taken in the following years will show this deposition of sediment moving downstream through each treatment area. As the structures fill with sediment, additional layers of rock can be added onto the one rock dams to raise the grade even further and eliminate the channels. This will create slope wetlands out of formerly gullied channels.

In addition, the growth of wetland or wet-meadow vegetation, as being monitored by Renee Rondeau, will assist in capturing even more sediment. The fine roots and leaves of wetland vegetation will create a "comb effect" and remove finer sediment than can be caught in the spaces between the rocks of the restoration structures.

Other effects of the structures include the buffering of flood force leading to reduced erosion, growth of vegetation in and around the structure, raising of the water table and irrigation of the banks, and spreading floodwaters across a wide floodplain, which allows the floodwaters to irrigate a large area and soak into the groundwater.

A re-survey of this geomorphic monitoring by the US Forest Service and BLM in several years may show many of these changes. In a dry climate such as Gunnison, flood events are rare, and snowmelt events may not move as much sediment as brief, intense summer rainfall events. If another good "monsoon" season is seen, sediments should be transported downstream and captured behind the structures, beginning the processes of channel re-filling, water table increase and wetland plant growth. These changes will improve the important brood-rearing habitat of the Gunnison Sage-grouse in a number of ways such as improved cover, food sources, and watering places.