Cold Creek at High Meadows Stream Channel and Floodplain Restoration Project

Second Year Post-Project Monitoring Report

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Executive Summary

Large scale restoration activities in Cold Creek at High Meadows began in July 2010 and were completed in October of 2012. Restoration actions included construction of a total of 3,600 feet of new channel on three separate tributaries, installation of in-channel long debris structures along an additional 2,200 feet, filling of 2,500 of old channel, and removal of 8 acres of dead conifers from meadow edge.

Many of the benefits of this project can be easily observed, and are further quantified by the data presented in this report, which includes two years of post- project monitoring.

- Although overbank flooding has only occurred for 3 days since the project has been completed, this is because we are currently in a period of drought. The potential for overbank flooding has increased, with a predicted frequency of occurrence during 5 of the last 12 years as compared to only one year under the pre-project condition.
- Even during the current drought period, groundwater levels have increased in July and August, in areas of the meadow located within the connected floodplain of the new channel, bringing depth to groundwater within the range needed to support riparian shrubs and wet meadow grasses for a longer period of time during this critical period.
- Geomorphic stability and habitat quality has improved as measured by bank stability ratings, entrenchment ratios, pool/riffle ratios, residual pool depths, and particle size distribution. Other metrics such as width/depth ratios, sinuosity, % fines, and % shade show neutral change.
- Visual observation and photos illustrate that the harvested sod has been highly successful in reestablishing along the new channel and adjacent floodplain surfaces. Visual observations indicate the willow staking has been less successful, largely due to deer browsing.

I. Introduction

The Forest Service acquired 1,790 acres of land in January 2003 located in the upper Cold Creek Watershed, which includes a 200-acre montane meadow complex known as High Meadows.

This landscape had been highly altered and degraded since the mid-nineteenth century, primary from 100 years of cattle grazing and associated diversion ditches. This led to down cutting and widening of the stream channel, lowered groundwater table in the meadow, leading to conversion to dry meadow species and lodge pole pine encroachment into the meadow.

Figure 1: Cold Creek in High Meadows, 2004

An Ecologic Assessment Report (EAR) contracted by the US Forest Service (Swanson Hydrology, 2007) identified the opportunity to restore degraded ecosystem condition within the High Meadows stream channels and adjacent meadow floodplain through large scale stream channel restoration.

The follow describes the restoration goals and objectives identified for stream and floodplain restoration:

- Restore properly functioning channel and floodplain configuration based on application of geomorphic principles for design of new channels, stabilization of existing channels, and floodplain reconstruction.

- Increase meadow surface flood frequency to a two/three year return interval (estimated to occur at flows >20 cfs), as well as duration of meadow flooding during spring runoff.

- Decrease pollutant loading by reducing bank erosion, and increasing frequency, duration, and extent of overbank flows onto the floodplain.

- Raise groundwater levels to increase duration and extent of plant available groundwater

- Increase diversity and complexity of in-channel, riparian, and meadow habitat

- Reverse Trend of Lodge pole pine encroachment into the meadow
    - Transition of habitat type conversion from forested to meadow along the meadow boundary.

Large scale restoration activities to reverse the trend of degradation began in July 2010 and were completed in October of 2012. Restoration actions were primarily focused on the lower and middle meadows of the meadow complex because these were the areas that showed the most extreme degradation.

Figure 2: New channel construction at Cold Creek in High Meadows (2010)

The following describes the restoration actions implemented to meet the above goals and objectives are described below:

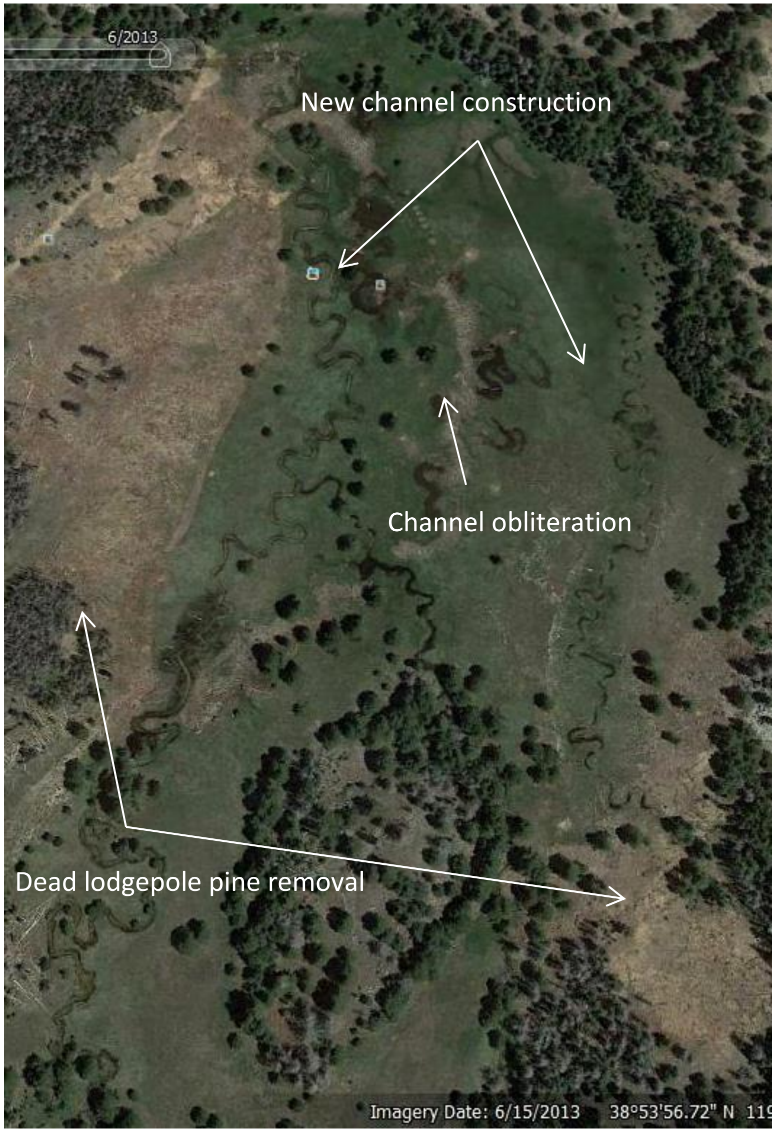
- Main stem Cold Creek - constructed 2,200 linear feet of new channel, including 5 boulder grade control weirs and 1.5 acre of inset floodplain.
- North Fork tributary – constructed 1,200 linear feet of new channel, and 4 acres of inset floodplain
- East Fork tributary – constructed 200 linear feet of new channel and installed 24 in-channel log debris structures within an additional 2,200 feet of channel.
- Abandoned channel – Filled 2,000 linear feet of old Main stem channel and 500 linear feet of old North Fork channel. Created approximately one acre of ponded water habitat areas along old Main stem fill area
- Lodge pole pine encroachment - Removal of 8 acres of dead conifers from the meadow edge.

The google earth images provided in Figure 3, from 2010 and 2013 provide a visual representation of the end result of restoration actions.

Figure 3: Google Earth Imagery of restoration actions at Cold Creek in High Meadows.

Before restoration

After restoration



II. Monitoring Approach

A variety of metrics were selected for monitoring to evaluate the degree to which restoration actions are able to meet the above restoration goals. The monitoring questions these metrics were designed to answer, the metrics, and current period of record is summarized in Table 1 below. A more detailed description of the sampling protocols, monitoring locations, and schedule, is contained in the updated project monitoring plan (USFS, 2015)

Table 1: Cold Creek High Meadows Restoration Effectiveness Monitoring

Monitoring Questions	Metrics	Period of Record
Has the frequency and duration of overbank flooding increased?	Discharge	2003- 2014
Have groundwater levels increased during the plant growing season?	Piezometer Wells	2008 - 2014
Has the geomorphic stability and habitat condition of the stream channels improved?	USFS, Stream Condition Inventories (see results for more description of metrics) and photopoints	2008 and 2013
What is the response of planted vegetation in the project such as sod along the new channel, willow stakes, and willow wattles? Are dry meadow grass species and conifers in the central meadow being out-competed and replaced with desired meadow species indicative of wetter hydrologic conditions?	Wiexelman Transects, and Photopoints	2009 and 2014

III. Results

a. Floodplain Connectivity

The monitoring question to determine whether floodplain connectivity to the stream channel has been improved is: “Has the frequency and duration of overbank flooding increased? To put this analysis into context related to climate variability, water year precipitation totals are provided from Snowtel data collected within the nearby Heavenly Ski Resort (Table 2).

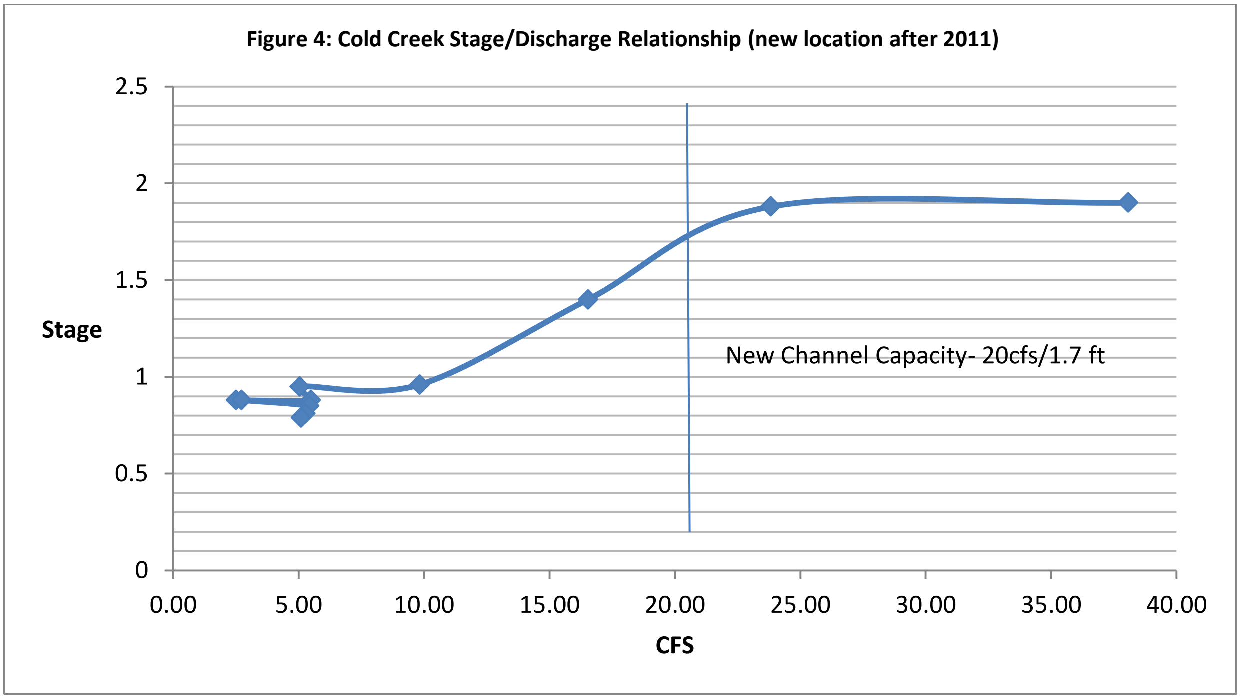
Table 2: Snowtel Precipitation Totals-Heavenly Site

Year	May	September	Measured Peak Flow
2003	27.5	31	29.4
2004	24.9	26.2	No data
2005	36.1	41.2	29.0
2006	41.8	42.5	37.0
2007	20	20.9	8.4
2008	23.2	26	No data
2009	25.3	28.4	No data
2010	31	34.4	No data
2011	50.3	56.8	2.5 ft / ? cfs*
2012	19.5	21.8	1.07 ft / 12.5 cfs
2013	23.4	28.4	1.09 ft / 12.5 cfs
2014	20.2	25.4	1.04 ft / 12.0 cfs

* *Flow cannot be estimated at this time beyond 1.9 feet in stage height.*

Pre-project years from 2003 through 2010 contain a variety of dry, average, and wet years. The two post project years 2013 and 2014 were both dry years, and were preceded by another dry year in 2012. Years 2011 and 2012 are interim years in which spring time floodplain/channel hydrology would have been partially affected by project construction.

Spring runoff flow volumes were measured manually before the project between 2003 and 2007 (except for 2004 in which only the month of April was measured). The peak flows measured during this period are provided in Table 2, and the raw data is available at the LTBMU. After the project, flow stage was measured every 30 minutes using a pressure transducer recorder. Post- project spring runoff stage data was collected in 2013 and 2014. Corresponding flow measurements (cfs) collected during the spring runoff period were utilized to develop a stage discharge relationship to calculate spring runoff flows in 2013 and 2014 (Figure 4). This stage discharge relationship is currently very weak at the higher flows since stage has been measured up to 2.5 at the pressure transducer, but the highest flow measurements measured and recorded were at 1.88 feet and 1.9 feet. If these flow measurements are accurate there is a large difference in flows between this small increase (0.02 feet) in stage height, from 24 to 38 cfs. There is too much uncertainty to predict flows above 1.9 feet in stage.



The channel capacity of the main channel pre-project and post project was calculated from cross section data on both the pre-project and post project channels, utilizing procedures contained in the Rosgen Field Guide (Rosgen, 2008). Based on these calculations the volume of flow (cfs) at which the flows exceed the channel capacity and begin to spread out onto the floodplain was 53 cfs in the old main channel, and 20 cfs in the new main channel. From an analysis of measured data, flows did not exceed channel capacity in the old channel during the period of record from 2003 through 2014, with the exception possibly of 2011. Although our rating curve is not accurate enough to confirm, it does seem likely that flows entering high meadows may have exceeded 53 cfs for a substantial period of time during this high water year. Post project, overbank flows in the new channel above 20 cfs have not occurred during the two dry years following construction, with the exception of a 3 day storm that occurred in February of 2014, in which stage was recorded up to 2.12 feet.

Although a longer period of record is needed to document frequency and magnitude of overbank events in the new channel during average and wet years, it is clear that overbank flooding will increase substantially as a result of reducing the channel capacity by 63% (53 cfs to 20 cfs). Based on data contained in Table 2, we conclude overbank flows would have occurred during water years in which May precipitation totals exceed about 27 inches (five out of the last 12 years).

b. Groundwater Availability for Plants

For the purposes of comparing pre and post project groundwater levels, comparisons were stratified by precipitation totals, looking at cumulative precipitation for May and September, as presented in Table 2 above. The pre-project year 2007 was compared to the post project year 2012 and 2014 (@ 20 inches of precipitation through May), and pre-project years 2008 and 2009 were compared to 2013 and 2014 (23 to 25 inches of precipitation through May) . The period between 2012 and 2014 reflect a drought period, considered to be below average water years. Years 2010 through 2012 are years in which the project was under construction, and also happened to include two of the wettest years for the period of record of groundwater data.

Only groundwater data collected during July and August was utilized for this analysis, because this is the time period in which plant available water from groundwater sources is most relevant. *(note: data gaps exist, due to crew error no data was collected in July of 2007 or 2014.)*

It is assumed that groundwater levels needs to be no more than 4 feet below the ground surface to be available to support riparian shrub species and three feet to support wet meadow grasses (Loheide, 2007). During construction of this and other projects, LTBMU staff have observed that the roots of meadow grasses are most dense in the 12” to 18” range, but it is not unusual to see roots extend to three feet in depth.

A total of 11 wells were monitored, and the locations of these wells relative to the old channel are illustrated on Figure 5. They essentially are positioned in 3 transects, transect one (wells 1 through 4) across the bottom half of the main meadow, transect 2 (wells 5, 11, 6, 7, 8) across the upper half of the main meadow, and transect 3 (wells 9 and 10) located in the bottom half of the middle meadow. Well 11 was added later than the other wells, accounting for the odd numbering sequence within transects.

Well graphs are presented in Appendix A, and observations from interpretation of these graphs are summarized below.

Transect 1, (lower portion main meadow, wells 1 through 4). All wells show a reduction in depth to groundwater, between before and after project comparisons of similar precipitation years. Groundwater levels near well 1 increased by two to 3 three feet, bringing levels close to the range needed for riparian/meadow plants. Groundwater levels in wells 2, 3 and 4 were already above the desired 4 foot level prior to restoration, but post- project groundwater levels were increased by an approximately additional 0.5 foot, perhaps benefitting species that prefer very wet conditions.

Transect 2, (upper portion of main meadow, wells 5,11,6, 7, 8). Both of the wells on the outer edges of the meadow do not indicate increased groundwater levels as a result of the project. Well 5 does not appear to be deep enough to measure depth to ground water, and indicates that groundwater levels are well below the range needed for riparian/meadow plants both before and after the project. Well 8 data indicates that for the past two years groundwater levels are lower than pre project years, probably as a result of the current extended period of drought. Wells located closer to new channel construction, 11, 6, and 7, illustrate an increase in groundwater levels post restoration ranging between 2 to 0.5 feet, bringing ground water levels up to the 4 foot level at wells 11 and 7, and up to 3 feet at well six.

Transect 3, (lower portion of middle meadow, wells 9 and 10). These wells would not be affected by the new channel construction in the main meadow, but rather were designed to reflect impacts from restoration of upper meadow legacy diversions. Again well 9 does not appear deep enough to measure depth to groundwater, and levels in August are consistently well below that available to plants, except for the very wet year in 2011. Data at Well 10 indicates that groundwater depths have increased by about one foot, bringing groundwater further out of the range available to plants. Again we conclude, precipitation during the extended current dry period (2012-2014) dominate effects on groundwater levels at these two wells, and the impacts of upper meadow legacy diversion restoration is not currently having a measurable effect on raising groundwater. Diversion restoration was not completed until June of 2014.

For the wells which did show a positive response, the depths to groundwater in the first summer period after restoration (2013) were equal our less than those measured in the wetter years of 2010 and 2011. This is particularly notable, considering the total accumulated precipitation in 2011 was 100% greater than the 2013 water year.

What these observations allow us to conclude is that in areas of the meadow in which the new channel has better hydrologic connectivity, ground water levels have been substantially increased during dry years, during times of the year, when it can have the most benefit to sustaining riparian/meadow plant species. By raising the channel bed elevation with the new channel, groundwater hydrology has been restored within the connected floodplain, and will support a conversion of meadow species from dry to wet meadow plant communities.

It is too early to tell the full extent and range of this impact. From the ground water data presented in Appendix A, a positive impact of increasing ground water levels is indicated at wells 1, 2, 3, 4, 6, and 7. Groundwater levels at wells 5, 8, 9 and 10 are likely never going to be impacted by restoration actions. In consideration of funding decreases for monitoring, it is recommended to prioritize wells 1, 2, 3, 4, 6 and 7 for future monitoring, along with continued vegetation response monitoring.

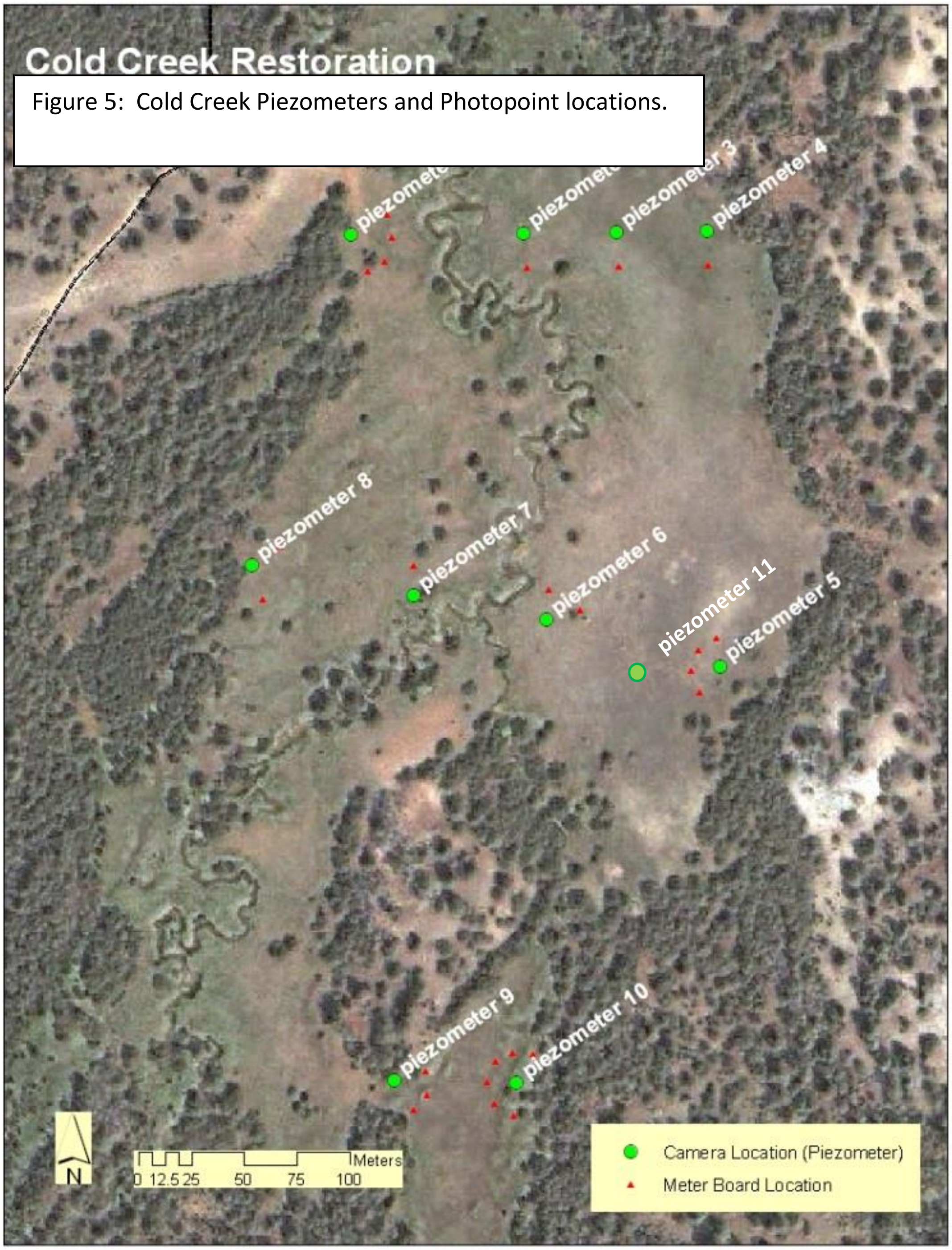


Figure 5: Cold Creek Piezometers and Photopoint locations.

a. Stream Channel Condition

A variety of data was collected to evaluate the degree to which stream channel condition has improved as it relates to channel geomorphic stability and aquatic habitat quality, utilizing USFS Region 5, Stream Condition Inventory (SCI) Protocols (USFS, 2005). The metrics collected and analyzed include bank stability ratings, sinuosity, width/depth ratios, entrenchment ratios, pool/riffle ratios, residual pool depths, and particle size distribution. In this report metrics collected in 2008 in the old channel prior to restoration, are compared to measurements collected in 2013 in the new mainstem channel. The location of the two SCI reaches is also illustrated on Figure 6. The results of stream channel condition monitoring for most metrics are summarized in Table 3 below.

Figure 6: Locations of SCI measurements, 2008 and 2013.

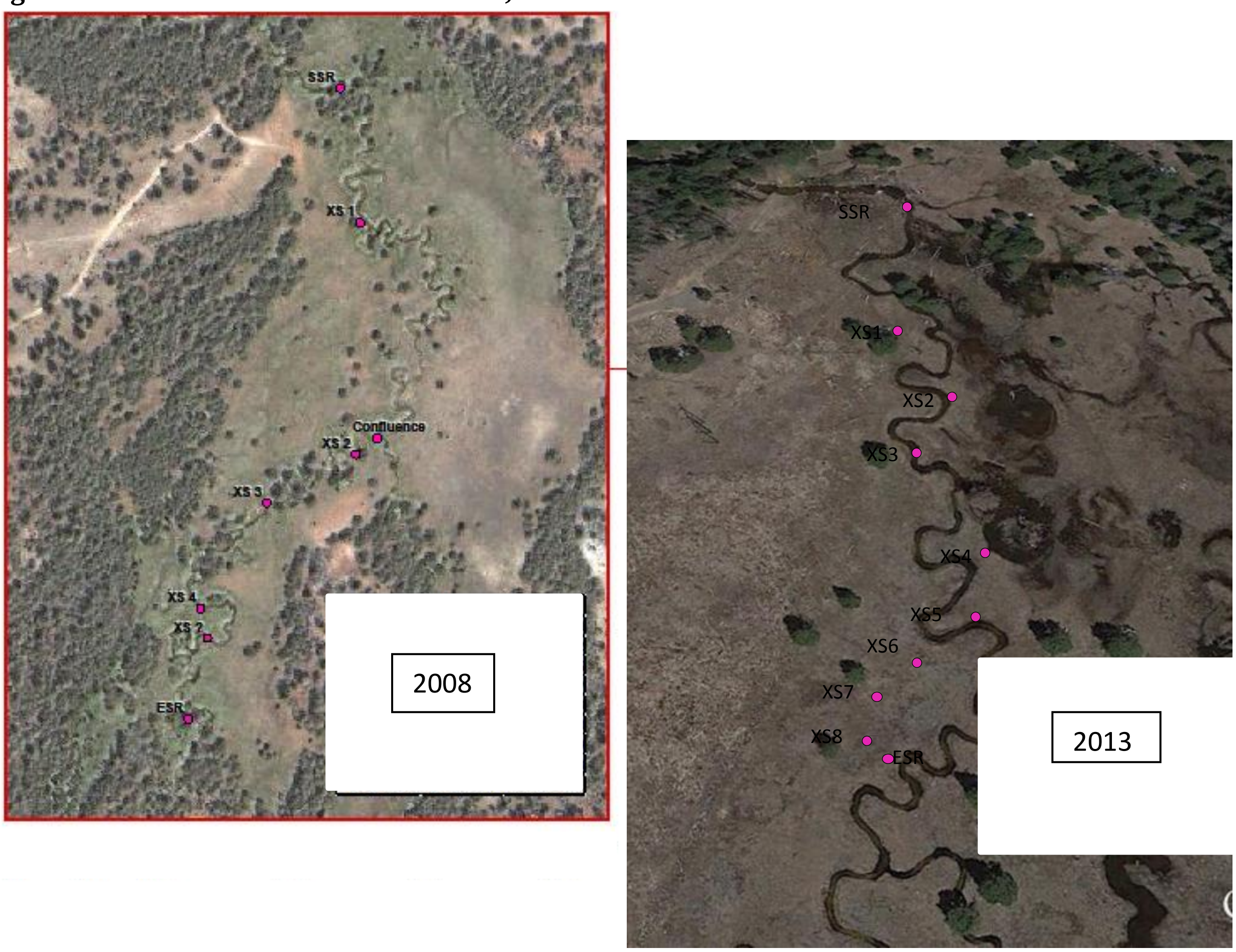


Table 3: SCI metrics in Cold Creek at High Meadows

SCI Metrics	Old Main Stem Channel	New Main Stem Channel
bank stability	20% stable, 34% vulnerable, 46% unstable	100% stable
sinuosity	2.1	1.7
width/depth ratio (median)	4.6	6.4
entrenchment ratio (median)	1.5	No entrenchment
pool riffle ratio	.59	2.5
residual pool depths (median)	0.5 ft	1.7 ft
% shade (median)	10%	5%
% fines (<2mm)	14%	16%
D50	8 to 11 mm	22.6 to 32 mm

<u>Bank Stability</u>

Channel bank stability for the entire reach was rated as stable in 2013, compared to only 20% stable prior to restoration. This was to be expected so soon after construction, given the success of sod placement in quickly establishing robust vegetation on channel banks, and that no large scale flow events have occurred to "test" the geomorphic stability of the new channel. This will be an important metric to continue to document change in 2018. The goal for a healthy channel is to maintain 80% of channel banks rated as stable.

<u>Shade</u>

Shade has decreased as a result of creating a new channel, from 10% to 5%. Shade is naturally low in open meadow channels, except as provided by riparian shrubs. It is expected to take at least 5 to 10 years before planted willow stakes mature to a point where they will start providing shade to the new channel. Visual observations indicate that planted willow stakes are being heavily browsed by deer, which will likely further inhibit the establishment of riparian shrubs.

<u>Entrenchment ratios, bankfull width/depth ratios, sinuosity</u>

Entrenchment ratio is the ratio of width of the flood prone area to the surface width of the bankfull channel. The bankfull channel is the upper level of channel forming flows, which occur at the 3 to 5 year flood interval. Bankfull width depth ratios are a measure of channel stability, in that as W/D ratio increases (i.e. channels grow wider and shallower) the hydraulic stress of against the banks also increases and bank erosion is accelerated. Sinuosity is a measure of how much the channel bends and twists, and is derived by dividing channel length by valley length for a given reach.

There were some problems with consistency in data collection. In 2008, measurements were collected at 8 riffle cross sections (4 permanent and 4 random) per the SCI protocol. However in 2013, 8 permanent cross sections were established, but included 4 cross sections within pools and glides. Cross section data within slow water habitats are not suitable for calculation of width/depth and entrenchment ratios. Therefore only the 4 riffle cross sections could be used to calculate a median for 2013, which is below the recommended statistical sample size of 8 measurements at fast water habitats. (*The monitoring plan has been updated to ensure that 8 cross sections are measured at fast water habitats in 2018*).

Based on available data, we conclude that bankfull width/depth ratio's did not change significantly (average increased from 4.6 to 6.4, but was within standard deviation). However the previous moderately entrenched main channel (1.5 entrenchment) has been replaced with a channel that is not at all entrenched. All flows that exceed bankfull will now spread out over the floodplain. Based on the analysis presented previously, channel capacity has decreased from 53 cfs to 20 cfs as a result of channel restoration. This reduces the erosive energy of flows that exceed 20 cfs, minimizing potential for channel erosion, and provides greater volume of surface flows to the adjacent meadow floodplain surfaces.

Sinuosity was calculated using google earth imagery, and is a measure of the degree to which channels meander across the valley floor, derived by dividing channel length by valley length. The google earth images used for measurements are displayed on Figure 3. For stable meadow channels, desired sinuosity is anything greater than 1.5. Measures sinuosity decreased from 2.1 to 1.7 when comparing the old main channel to the new main channel, but the new channel sinuosity is still within the desired range of greater 1.5.

The historic main channel did not fit exactly into any of the Rosgen stream channel types (based on W/D ratio, entrenchment, sinuosity, and slope), but was heading towards a G4 channel classification if entrenchment had continued to decrease from 1.5 to less than 1.4. G4 channels are considered to be an unstable channel type because of channel entrenchment, and are vulnerable to disturbance and tend to make significant adverse channel adjustments in responses to changes in flows and sediment supply from the watershed. Because the new channel is not entrenched, it is currently rated as a Rosgen E4 channel type, which is considered a hydraulically efficient stable channel form (Rosgen, 1996)

Pool/Riffle Ratios and Residual pool depths

The frequency and depth of pools has increased dramatically as a result of restoration. Pool riffle ratios have increased from .6 to 2.5 and average residual pool depths have increased from .5 to 1.6 feet. This means there is much more pool habitat to maintain water temperatures and refugia for aquatic species during base flow periods.

Particle Data

In 2008 (pre-project) the crew measured % fines as each pool tail crest, as well as particle size distributions at the first four riffles. In 2013, only particle size distribution counts at the first four riffles were collected. At this time comparisons can only be made between the particle size distribution data measured within the first four riffles. (*Again the monitoring plan has been updated to ensure both protocols are implemented in the future since the data obtained serves different purposes for analyses. The % fines measured at each pool tail crest are a much more robust measurement of this metric throughout the reach).*

From these results we cannot conclude there has been any real change in % fines in riffles. However n looking at the particle size distribution presented in Table 4, there has been a shift in the D50, which is the particle size in which 50% of the material is less than or equal to that size, and 50% of the material is greater than that size. The D50 increased from 8 to 11 mm/medium gravel to 22.6-32 mm/large gravel. This result is not unexpected as larger sized gravels was used to construct riffles in the new channel, and is expected to provide greater riffle bed stability.

Table 4: Change in Particle Size Distributions in Cold Creek at High Meadows.

		% Particle Size Distribution	
Particle Size		**2008**	**2013**
Fines	<2 mm	14	16
small gravel	2-2.8 mm	17	20
	2.8-4 mm	20	24
	4-5.6 mm	26	29
medium gravel	5.6-8 mm	39	33
	8-11 mm	**52**	37
	11-16 mm	71	40
	16-22.6 mm	80	43
large gravel	22.6-32 mm	86	**50**
	32-45 mm	90	63
	45-64 mm	93	81
small cobble	64-90 mm	96	90
medium cobble	90-128 mm	100	97
	128-180 mm		99
large cobble	180-256 mm		100

It will be important to ensure that future SCI monitoring includes both % fines at pool tail crests as well as particle size distributions at the first four riffles, so that a more useful comparison between pre and post project, as well as change over time can be made. The monitoring plan has been updated help ensure better consistency in future monitoring efforts.

c. Vegetation Response

The photo below is representative of the condition of the main channel banks, illustrating the success of sod harvesting in quickly establishing stable vegetative cover.

Figure 7: Cold Creek in High Meadows, new main channel, 2013.

Photopoints presented in Appendix B, visually illustrate the change in vegetation within the connected floodplain of the new channels. From the photopoints in Appendix B, there is visual evidence of more robust meadow grasses, at photopoints around wells that also experienced increases in groundwater elevations as a result of the project. This is most dramatically illustrated in the panorama at Well 1, and single photos at Wells 2, 4, 6, and 7. This is especially encouraging given that WY 2012 through WY14 experienced below average precipitation. Photopoints at wells 5, 8 and 10 do not reflect visible change, which is not unexpected given that groundwater elevations did not improve at these locations either. Photo comparison at well 3 and 9 were not provided because of crew error, which resulted in photos at these locations not matching up between the two time periods.

Vegetation transect data was collected in 2008 and 2014 however analysis of this data is not planned until late in 2015. When this analysis does become available it will provide a clearer picture of how changes in hydrology, both in terms of increased overbank flooding and decreased groundwater levels, has supported changes in the composition and density of meadow vegetation.

IV. Conclusions

Many of the benefits of this project can be easily observed, and are further quantified by the data presented in this report. Results for each of the restoration monitoring questions are summarized below:

1) Has the frequency and duration of overbank flooding increased?

Although overbank flooding has only occurred for 3 days since the project has been completed, this is because we are currently in a drought. The potential for overbank flooding has increased, with a predicted frequency of occurrence during 5 of the last 12 years as compared to only one year under the pre-project condition.

2) Have groundwater levels increased during the plant growing season?

Groundwater levels have increased in July and August, in areas of the meadow located within the connected floodplain of the new channel, bringing depth to groundwater within the range needed to support riparian shrubs and grasses for a longer period of time during the growing season.

3) Has the geomorphic stability and habitat condition of the stream channels improved?

Geomorphic stability and habitat quality has improved as measured by bank stability ratings, entrenchment ratios, pool/riffle ratios, residual pool depths, and particle size distribution. Other metrics such as width/depth ratios, sinuosity, % fines, and % shade show neutral change.

4) What is the response of planted vegetation in the project such as sod along the new channel, willow stakes, and willow wattles? Are dry meadow grass species and conifers in the central meadow being out-competed and replaced with desired meadow species indicative of wetter hydrologic conditions?

Visual observation and photos illustrate that the harvested sod has been highly successful in reestablishing along the new channel and adjacent floodplain surfaces. Visual observations indicate the willow staking has been less successful, largely due to browsing by deer.

Photopoints provide visual indication of meadow plant conversion to wetter site species, but this has yet to be confirmed, until vegetation transect data is analyzed.

Continued monitoring of this project will provide valuable quantitative information about the long term effectiveness of the restoration approach employed at the High Meadows complex. Long Term monitoring will include stream condition inventories (SCI) metrics, groundwater well depth, and stream flow monitoring, photo points and vegetation transect monitoring through 2018. Manual flow measurements will also be collected to improve the stage/discharge relationship curve, at time periods when stage is expected to exceed 1.5 feet in height. Monitoring beyond 2018 will depend on the results at that time, and future funding availability.

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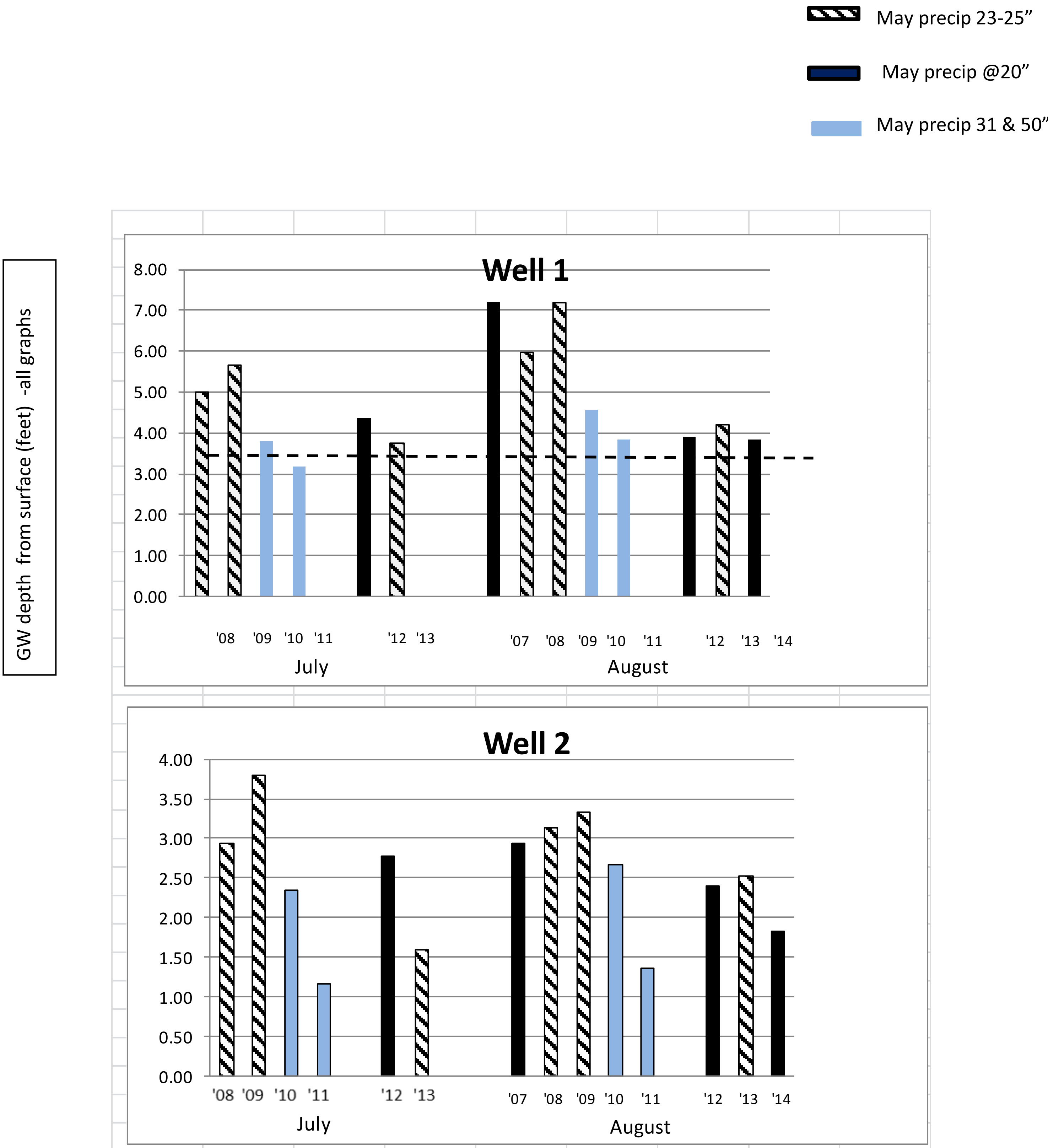
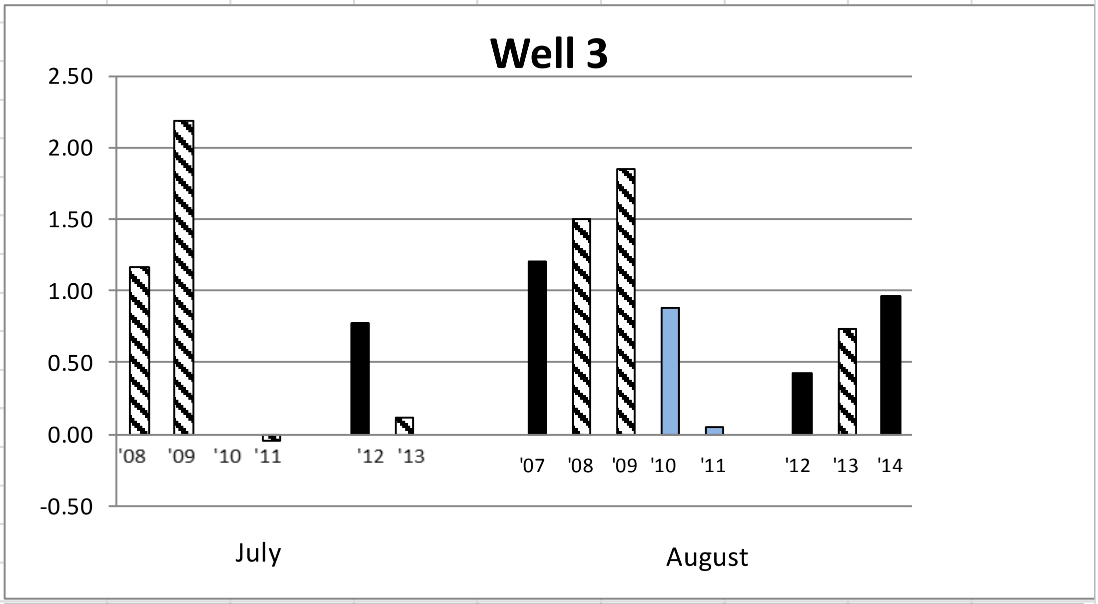
Appendix A: Transect 1- wells 1,2,3, and 4, Transect 2 – wells 5, 11, 6, 7 ,8, Transect 3 – wells 9 and 10, at Cold Creek in High meadows

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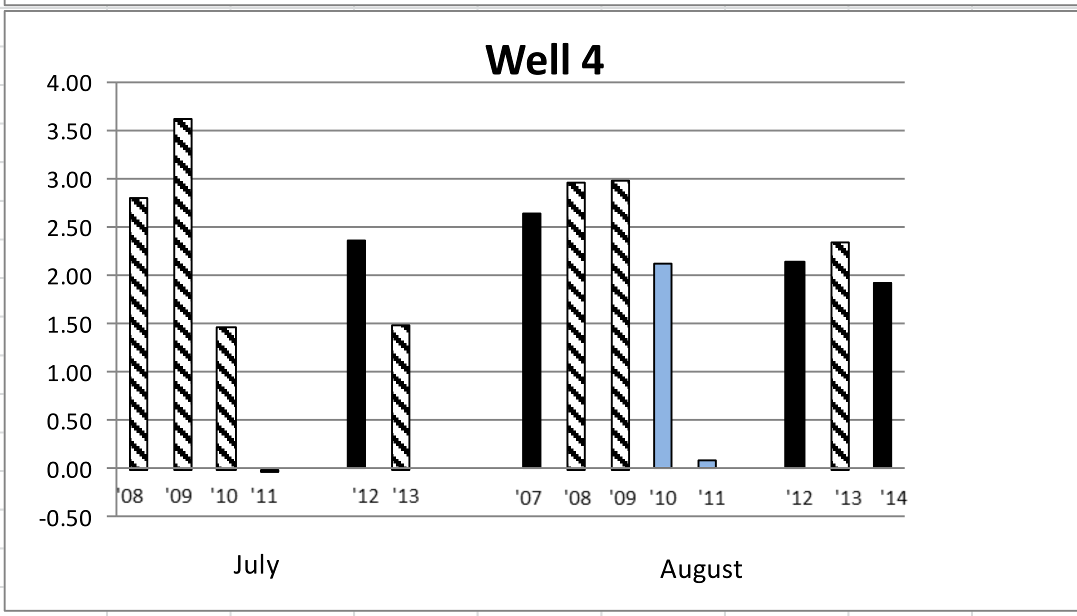
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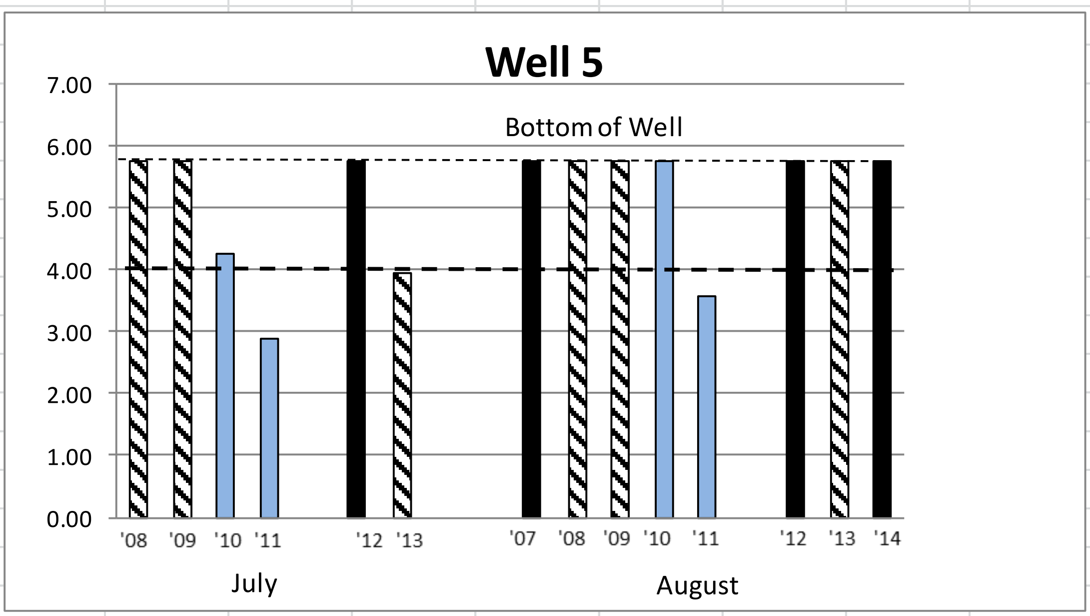
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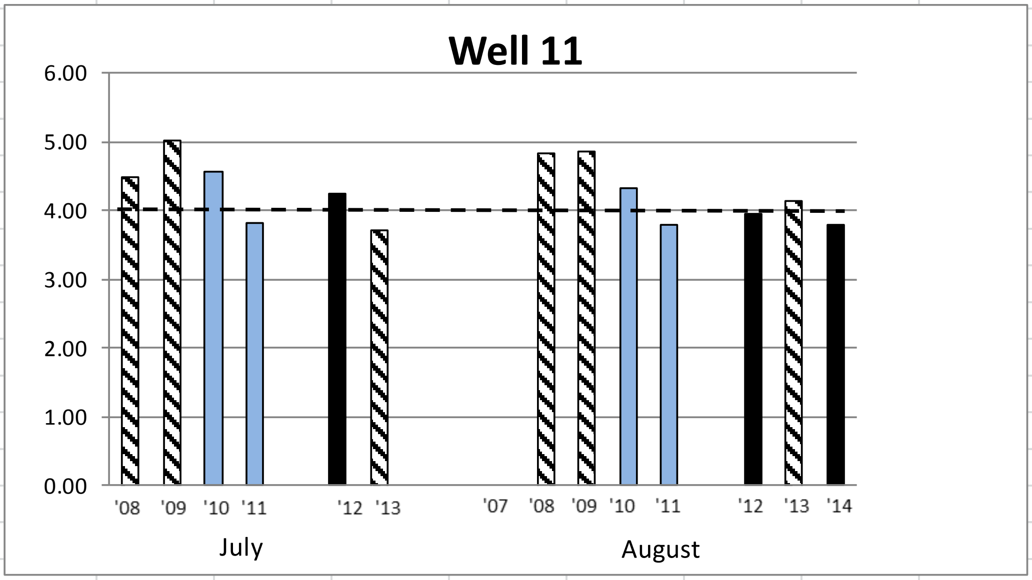
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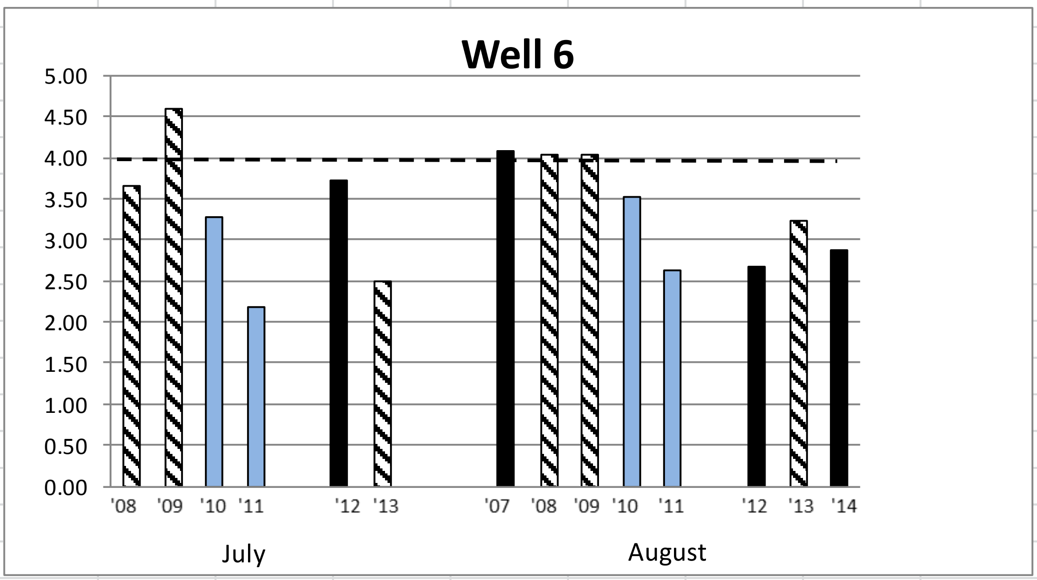
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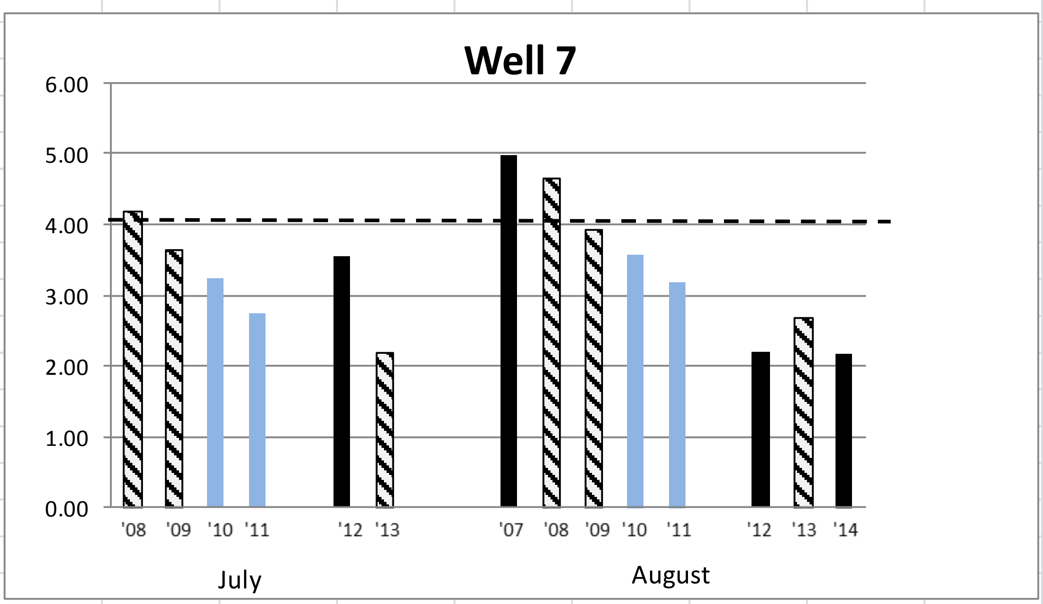
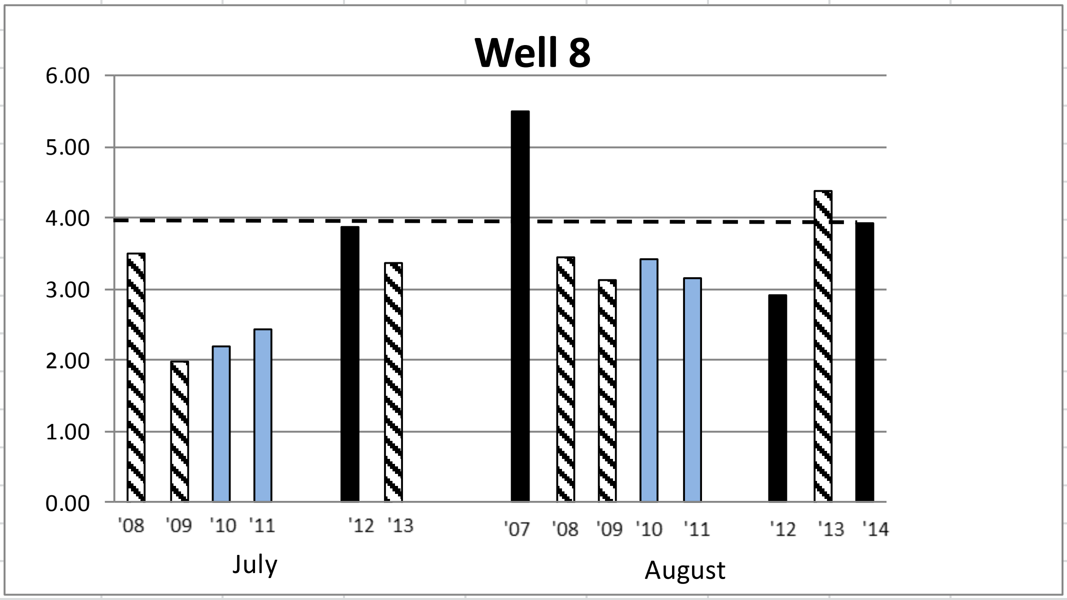
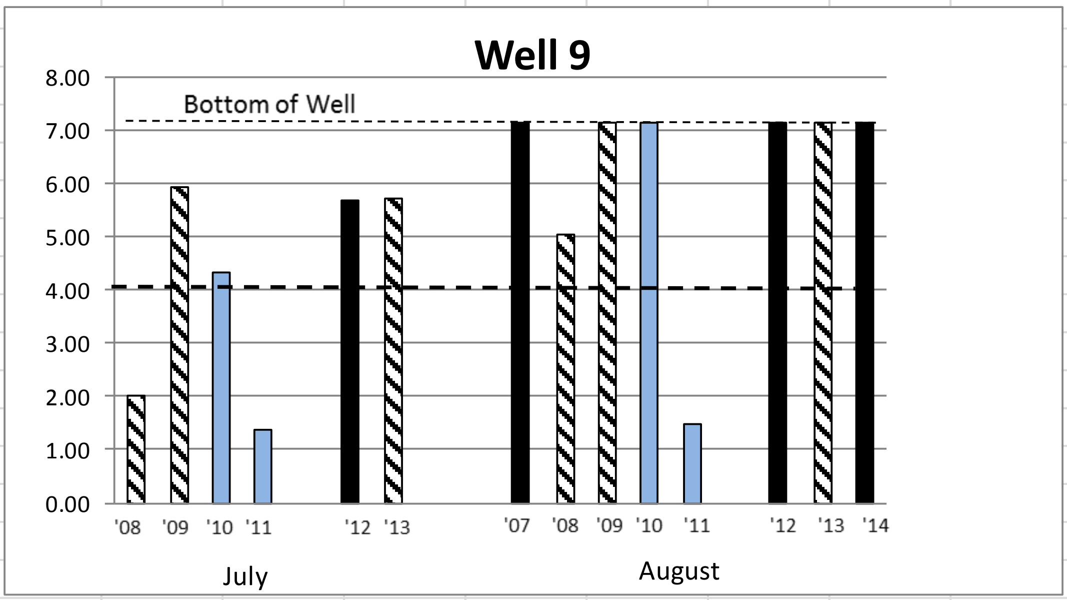
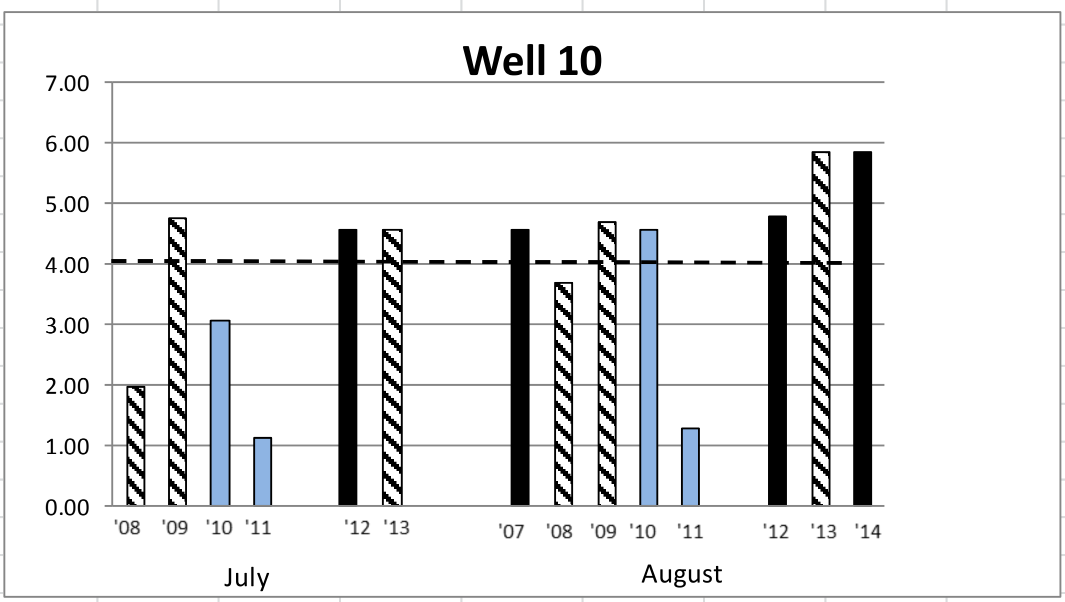
July
August


Well 7
6.00
5.00
4.00
3.00
2.00
1.00
0.00
'08 '09 '10 '11 '12 '13 '07 '08 '09 '10 '11 '12 '13 '14
July
August


Well 8
6.00
5.00
4.00
3.00
2.00
1.00
0.00
'08 '09 '10 '11 '12 '13 '07 '08 '09 '10 '11 '12 '13 '14
July
August


Well 9
Bottom of Well
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
'08 '09 '10 '11 '12 '13 '07 '08 '09 '10 '11 '12 '13 '14
July
August


Well 10
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
'08 '09 '10 '11 '12 '13 '07 '08 '09 '10 '11 '12 '13 '14
July
August

Appendix B: Cold Creek High Meadows Photopoint Comparisons - August 2008 and September 2014

Well 1- Panorama 1, August 2008

Well 1- Panorama 1, September 2014

Well 5-Panorama 5, August 2008

Well 5 -Panorama 5, September 2014

Well 10-Panorama 10, August 2008

Well 10- Panorama 10, September 2014

Well 2- photopoint 2a, August 2008

Well 2- photopoint 2a, September 2014

Well 4-photopoint 4a, August2008

Well 4-photopoint 4a, September 2014

Well 6-photopoint 6b, August 2008

Well 6-photopoint 6b, September 2014

Well 7-photopoint 7a, August 2008

Well 7 -photopoint 7a, September 2014

Well 8-photopoint 8a,   August 2008

Well 8-photopoint 8a, September 2014