Red Clover/McReynolds Restoration Project Monitoring Final Report

Feather River Coordinated Resource Management – Plumas Corporation
January 23, 2008

Background

This monitoring report accompanies the Project Final Report, which includes project goals, accomplishments, etc. The purpose of this document is to report the results of project effectiveness monitoring, as implemented according to the Project Monitoring Plan. When reading through the results, keep in mind that the project was constructed in 2006, from July through November. Most pre-project monitoring was completed in 2005. Post-project monitoring reported herein was conducted in 2007.

As mentioned in the Monitoring Plan, this project area was just downstream, and partially within, the area of a project implemented by the FR-CRM in 1985. Results of that monitoring effort, conducted by Donna Lindquist of Pacific Gas & Electric, can be found at www.feather-river-crm.org. Additionally, monitoring for this project is included within on-going watershed monitoring efforts by the Feather River CRM (FR-CRM), which helped to answer some of the monitoring questions as discussed below.

Figure 1 on the following page shows the locations of different monitoring sites for the various protocols included in the Project Monitoring Plan such as surface water temperature monitoring, discharge measurements, and monitoring groundwater levels. Figure 2 shows the proximity of the Continuous Recording Station on Red Clover Creek at Notson Bridge to the Project Location

Questions to be answered by monitoring

What is the project's effect on late season base flow?

There were two measurement efforts to answer this question. The first effort was at Notson Bridge, located nine miles downstream of the project area at the FRCRM's continuous recording station, which has been operating since 1999. Flows at this station, however, also include several tributary channels, and project effects on flow may be washed out by the time flows reach this station. Figure 3 displays pre-project base flow at this station. Figure 4 displays post-project base flow at this station. Both graphs also display precipitation. Because the 2007 data is so recent, it has not been corrected, and should not be quoted. (Although, the data are probably adequate for gross comparisons between years.) Pre-project flows were measured in 2005, with 88% of normal precipitation. Post-project flows were measured in 2007, with 76% of normal precipitation. The percent of normal figure is from the Portola station on the Calif. Data Exchange Center website.

The expectation is that the 2007 data would show an increase in base flow due to the project. However, the lack of precipitation caused a dramatic drop in base flow between these years. Comparison between these years is not valid at this time due to the extreme difference in flows and precipitation. Hopefully, the upcoming winter will provide more normal precipitation for a better comparison of pre- and post-project flow conditions at Notson Bridge.

Figure 1. Monitoring locations within the project area.

(This map is attached as a .pdf that is best printed in 11x17 Ledger format to show all monitoring sites.)

Figure 2. Location of Notson Bridge flow monitoring station.

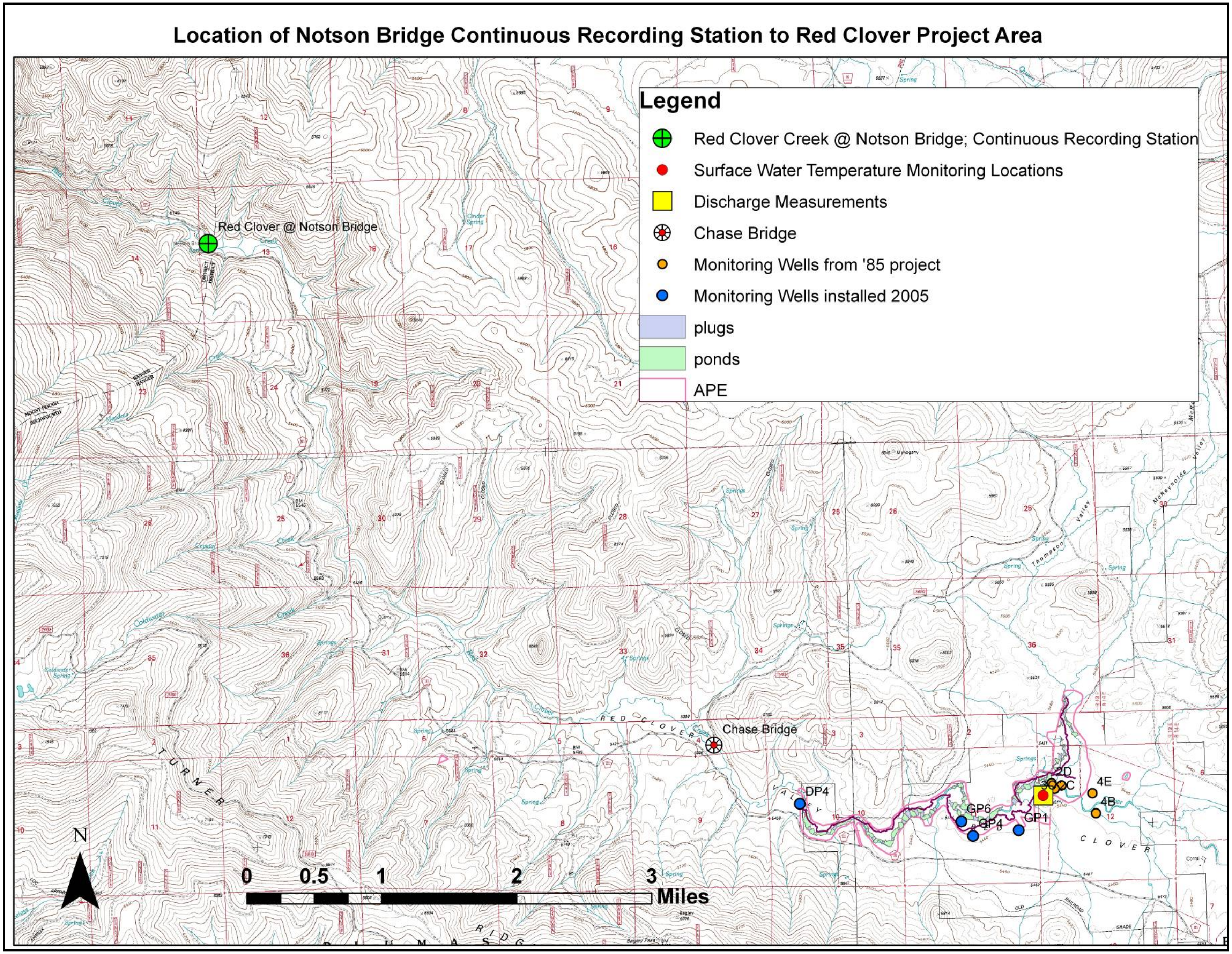


Figure 3. Pre-project base flow at Notson Bridge.

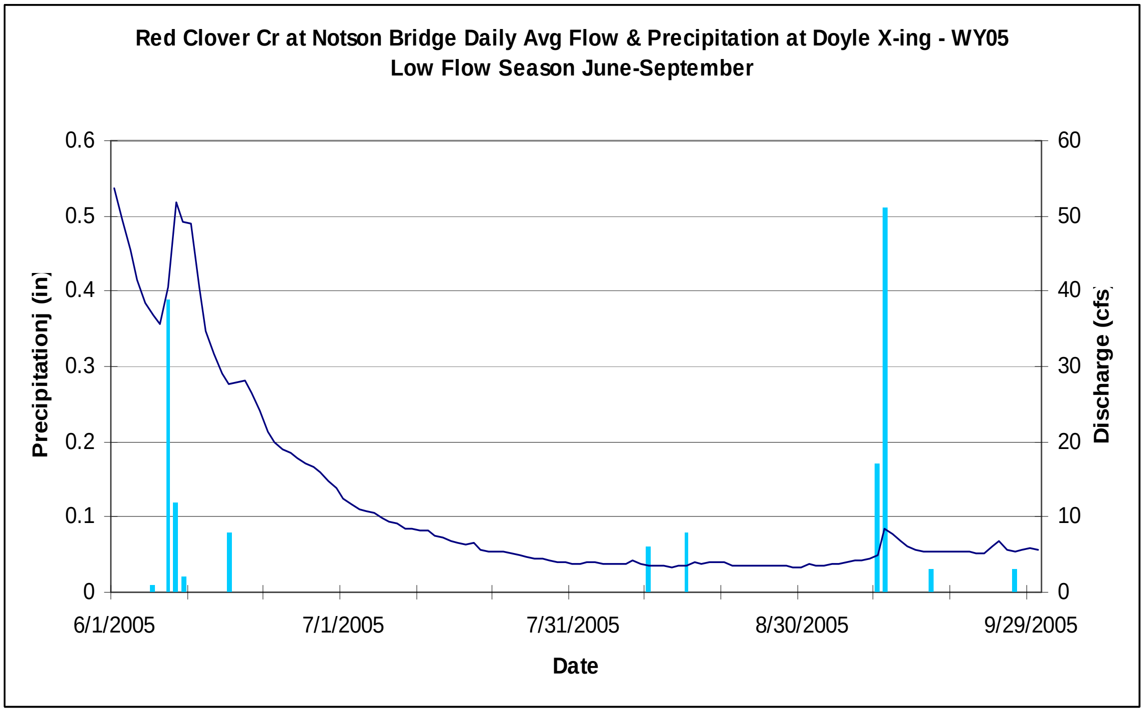
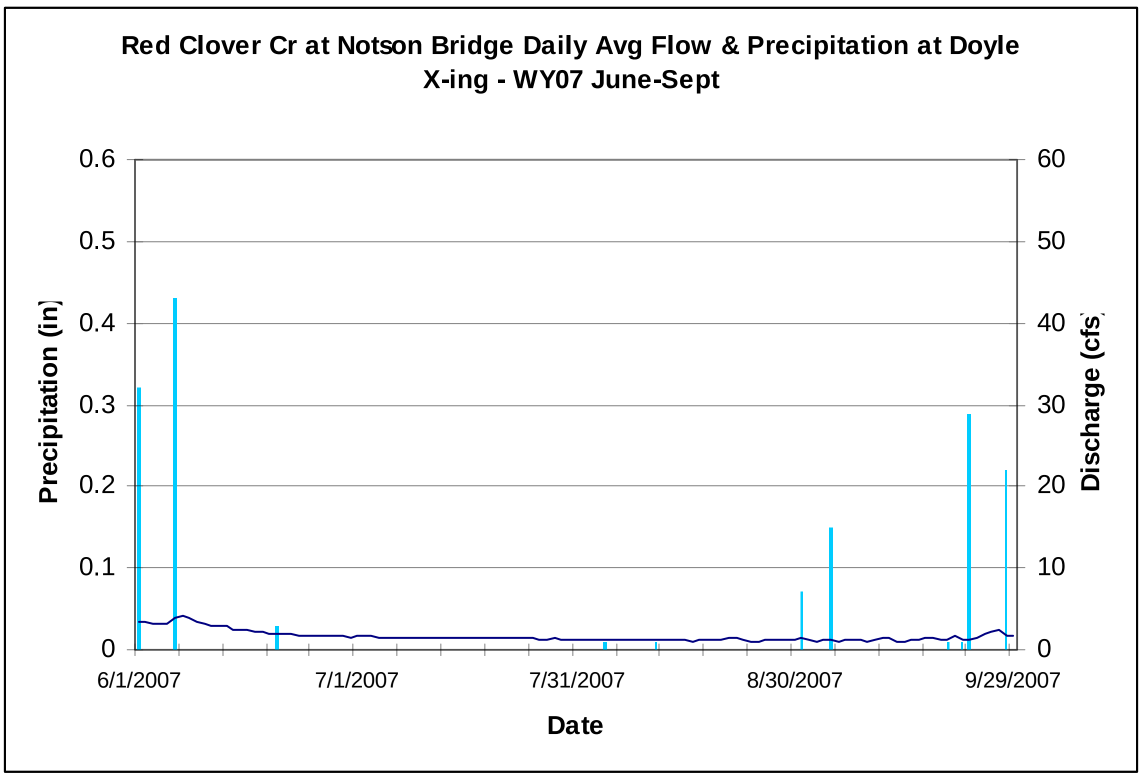


Figure 4. Post-project base flow at Notson Bridge.



The second base flow effort was "snap-shot" monthly flow measurements from June through September at the top and bottom of project area, pre-project and post-project. Table 1 shows the results of these measurements.

Table 1. Pre- and Post- project monthly flow measurements at top of project and below project area.

Month	June		July		August		September	
	pre	post	pre	post	pre	post	pre	post
Abv McReynolds	15.3	3.8	1.4	1.2	1.4	0	1.8	0
Blw Project	17.8	2.6	1	0.1	1.1	0	1.6	0

Pre-project flows were measured in 2005, with 14.56 inches of precipitation at Doyle Crossing. Post-project flows were measured in 2007, with 11.07 inches of precipitation at Doyle Crossing. Both years used the same Marsh-McBirney flow meter, calibrated approximately every six months. The percent of normal figure is from the Doyle Crossing weather station on the Calif. Data Exchange Center website.

In pre-project conditions, the rapid decline in flow from June to July (>90% decrease) indicates the poor condition of the watershed, and lack of seasonal storage and release in the project area. It is also interesting to note that there is <u>less</u> water at the bottom of the project area than at the top in July & August in 2005. The loss may be due to evaporation, or it may be lost into bedrock. The increase of flow in September suggests that loss into bedrock may be negligible, and perhaps the loss is due at least in part to evapotranspiration.

The major decline in flows between pre- and post-project conditions is due primarily to the lack of precipitation in 2007. (Note that there is no measurable flow <u>into</u> the project area in August and September.) However, in 2007, despite the lack of precipitation, there is less of a dramatic decline in flows from June to July. And while one would expect that flows might be less below the project area as the shallow meadow groundwater re-charges, that condition also existed before the project was constructed. Because of the lack of precipitation in 2006-07, the project's full effect on late season base flow cannot be fully evaluated. Once the shallow groundwater is re-charged with precipitation, we expect to see an improvement in late season flows below the project area. In addition, beavers were very active in building dams throughout the Red Clover/McReynolds Creek Restoration Project (over twenty dams have been noted in the project area post-construction), and their intensive activity in damming up flowing water at the upper reach of the restoration project is likely to have had an effect on downstream flows.

<u>Does the project affect winter storm event flow?</u>

As with base flow, data from the Notson Bridge station can be used to answer this question, however, the problem of additional tributary flow still exists, as does the extreme difference in precipitation between the pre- and post-project years. Figures 5 & 6 display pre- and post-project spring flows. While precipitation-induced flow peaks do appear somewhat attenuated in the post-project condition, it is difficult to say whether that is due to improved infiltration in the project area, or reduced run-off from a generally unsaturated watershed.

Figure 5. Pre-project spring flows in 2005.

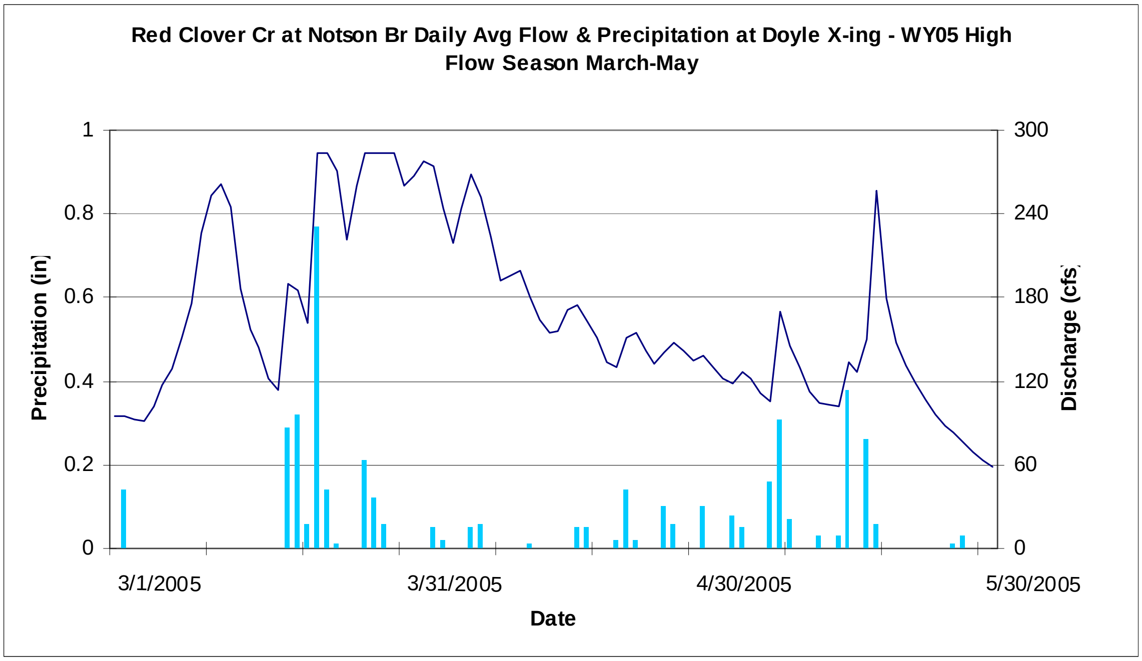
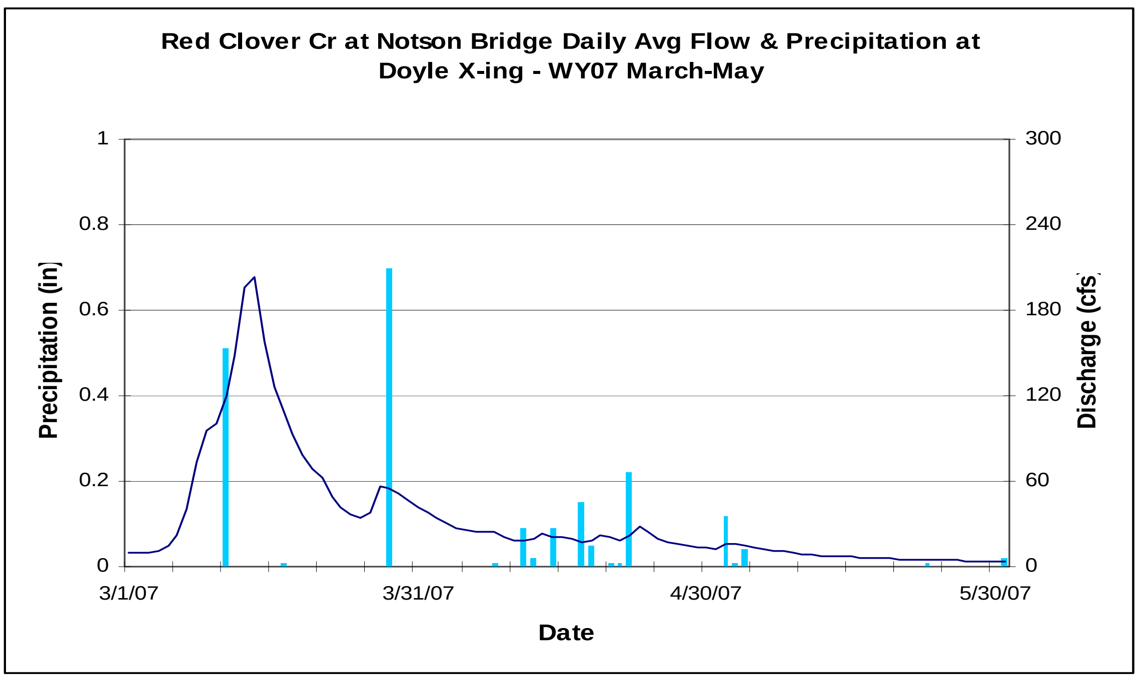


Figure 6. Post-project spring flows in 2007.



<u>What is the project's effect on water temperature?</u>

Instream hobotemps were installed near the top of the project area, and below the project area in 2005. In 2007, instream hobotemps were installed in the "new" remnant channel at the top of the project, and below the grade control at the bottom of the project. Figure 7 shows the daily average ambient air temperatures taken from the continuous recorder at Notson Bridge on Red Clover Creek during the summer of 2005 and 2007. Ambient air temperatures from mid-June to mid-August in 2005 ranged from 15 to 22 degrees C, and in 2007 from 15 to 24 degrees C.

Figure 7. Daily average air temperature at Notson Bridge in 2005 and 2007.

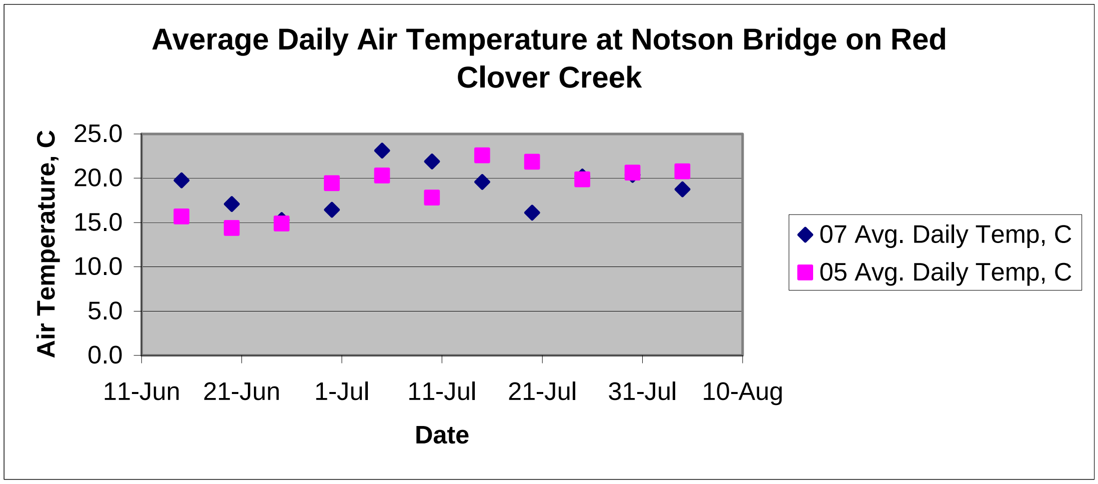


Figure 8 displays the difference in water temperature from the top of the project area to the bottom of the project area in 2005 under pre-project conditions. The average increase in daily maximum temperature was 6.3 F from the top of the project area to the bottom. The 2007 average increase in daily maximum temperature was 4.6 F from the top of the project area to the bottom.

Figure 8. Increase in daily maximum water temperatures from top of project area to bottom of project area in 2005.

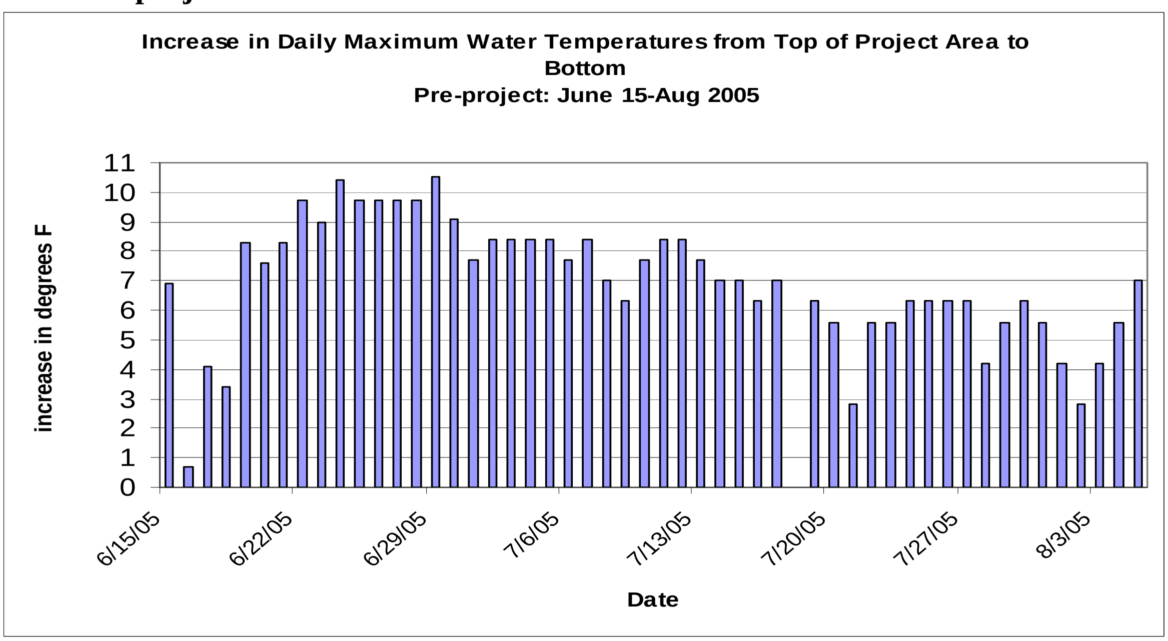
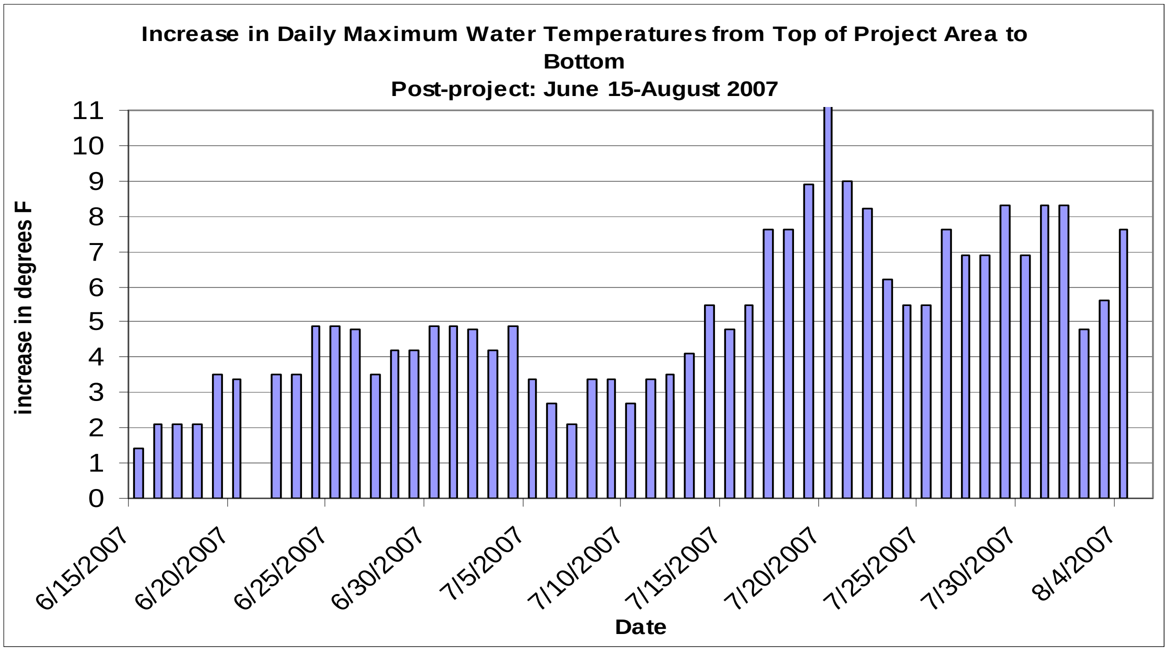


Figure 9. Increase in daily maximum water temperatures from top of project area to bottom of project area in 2007.



It should be noted that the spike in temperatures post-project in late July reflects the fact that surface water flows had ceased during this time period with no flow into the project area.

The largest change between pre- and post-project temperatures was seen at the beginning of the summer, from June 15 to July 12 where the average increase in daily maximum temperature was 2.9 F post-project versus a 7.9 F increase during the same time period before the project was constructed in 2006. Figures 10 & 11 show a more focused look at the increase in daily maximum temperature from the top of the project area to the bottom in pre-project 2005 and post-project 2007 conditions during the time period of June 15 – July 12.

Figure 10. Increase in daily maximum water temperatures from top of project area to bottom of project area from June 15-July 12, 2005.

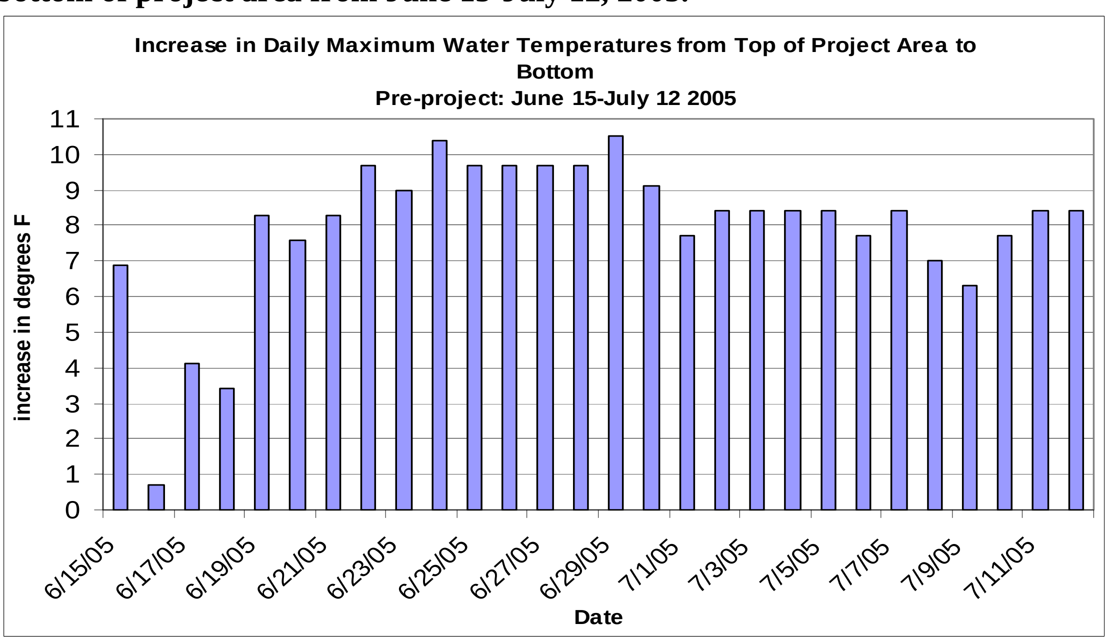
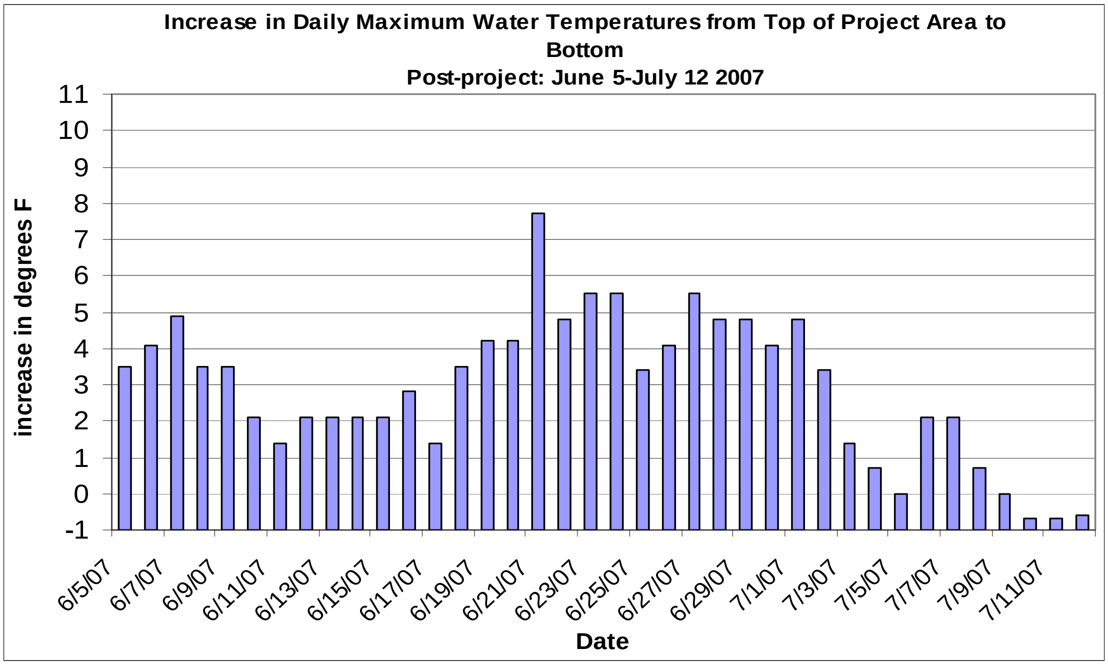


Figure 11. Increase in daily maximum water temperatures from top of project area to bottom of project area from June 15 – July 12, 2007.



The monitoring plan included aerial infrared photography. Pre-project flights were conducted in 2005 in conjunction with a Stanford study. Funds are not included in this grant for a post-project flight. As mentioned in the monitoring plan, if funds are available, a post-project flight will be conducted in 2008 (or possibly later).

<u>What is the project's effects on fisheries?</u>

Three 100 meter sampling stations were established within the project area; an upper, middle and lower station. A control sampling station was also electrofished at Chase Bridge (about a mile downstream of the project area) in 2003 and 2005. Sampling areas were electrofished with a backpack SmithRoot electrofisher and two netters. Pre-project fish sampling was conducted in 2004 and 2005, and one post-project effort in 2007. At the control site, one trout was captured in 2003, and none in 2005. At all of the treatment sites combined, one trout was captured in 2004, and nine in 2005. Mountain suckers, Sacramento suckers and speckled dace were also captured.

While trout populations were very low in pre-project samples, none were captured in the 2007 post-project effort. However, the lack of trout in the post-project effort was most likely due to the sampling technique than it was due to an actual lack of trout. Pre-project pool lengths in the project area were 17% of the sampling stations. Those exact stations could not be exactly sampled after project construction because the pond and plug treatment completely removes the pre-project channel, and re-establishes the channel in another location. The size and depth of pools in the post-project channel made backpack electrofishing an inappropriate sampling tool. However, that was unknown until the sampling day arrived. The sampling crew located the post-project sampling stations as close as possible to the pre-project stations, and also used stations that were accessible to a backpack electrofisher. However, the accessible channels in those areas were connected to large, deep pools that were not accessible. Those pools were the best habitat for trout. Trout were not likely to be where we could access with the shocker. We plan to try another post-project sampling effort in 2008, probably using volunteer flyfishers. That type of sampling won't give us an accurate population estimate, but will give us an idea of the presence of trout, which could be compared to the low pre-project capture numbers.

What is the project's effects on wildlife?

As a project partner, the Calif. Dept of Water Resources is conducting the wildlife surveys and analysis for this project. One year of pre-project sampling for birds (April through November) and small mammals (November) was completed in 2004. In addition, reptile and amphibian use was documented. Post-project survey work was completed in October of 2007. Preliminary results showed increases in bird species diversity and waterfowl production. Eighty bird species were detected during pre-project sampling and 96 species were found post-project. Three species detected only after project completion are closely associated with wetland, riparian habitat: marsh wren (*Cistothorus palustris*), Wilson's phalarope (*Phalaropus tricolor)*, and pied-billed grebe (*Podilymbus podiceps*). Nine waterfowl species were found pre-project, with only three observed breeding. Post-project eighteen waterfowl species were detected, with eight observed breeding in 2007 (Figure 12).

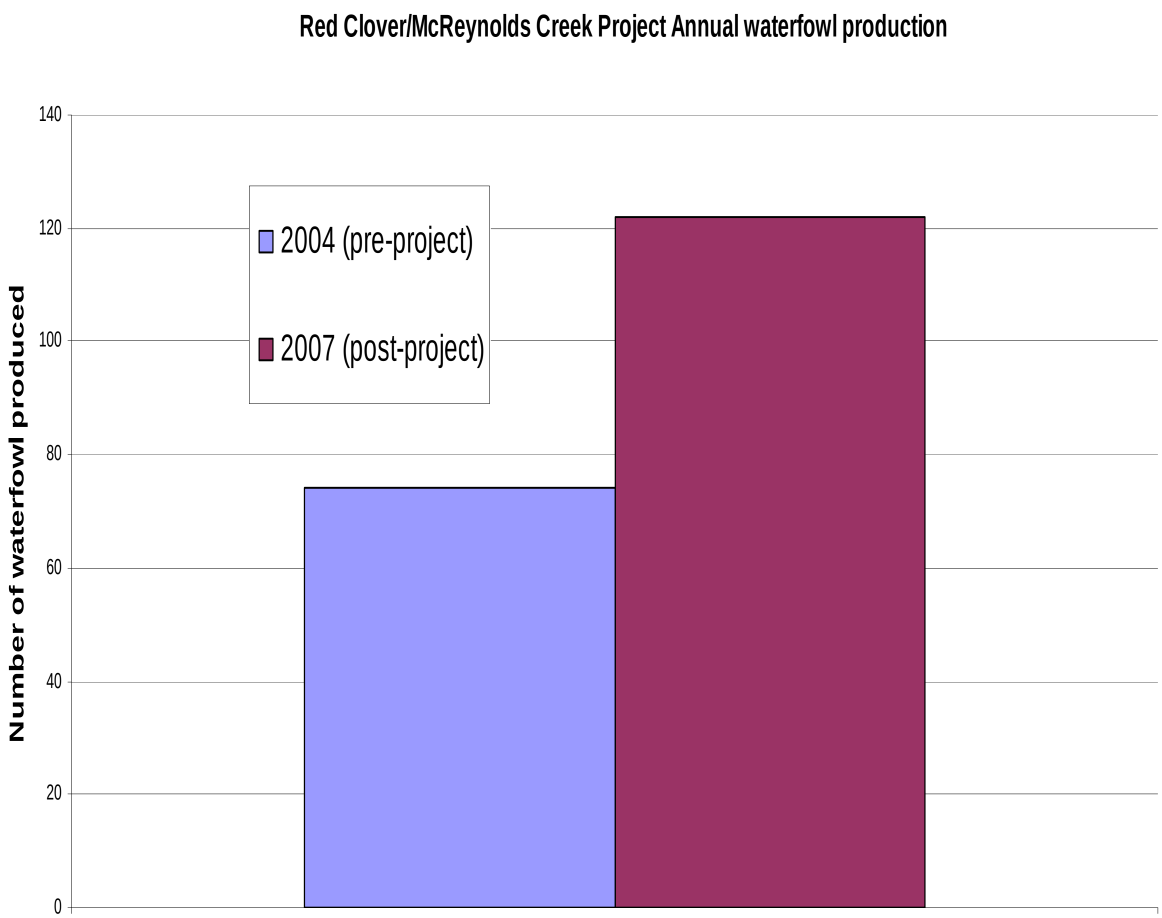
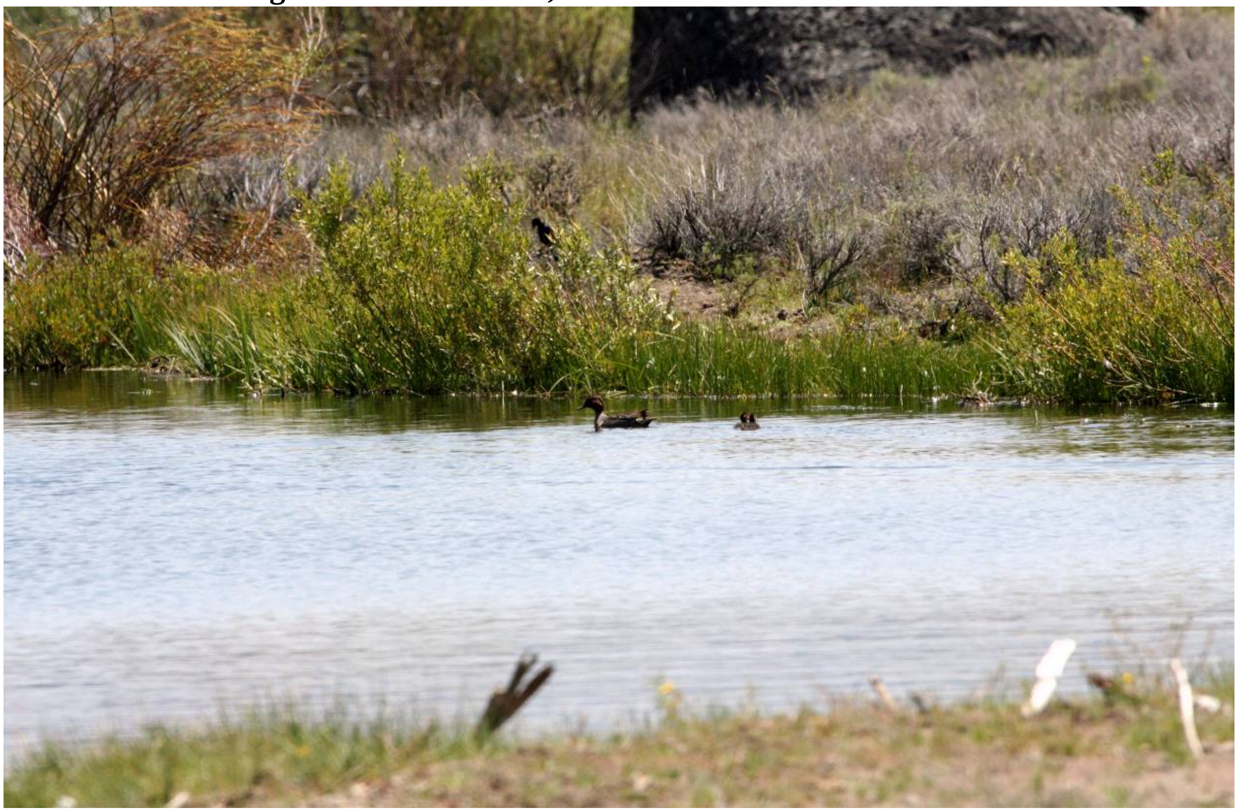


Figure 12. In 2004, 74 young were produced versus post-project in 2007 122 young were produced.

Photo 1. Green-winged Teal with chicks, 2007

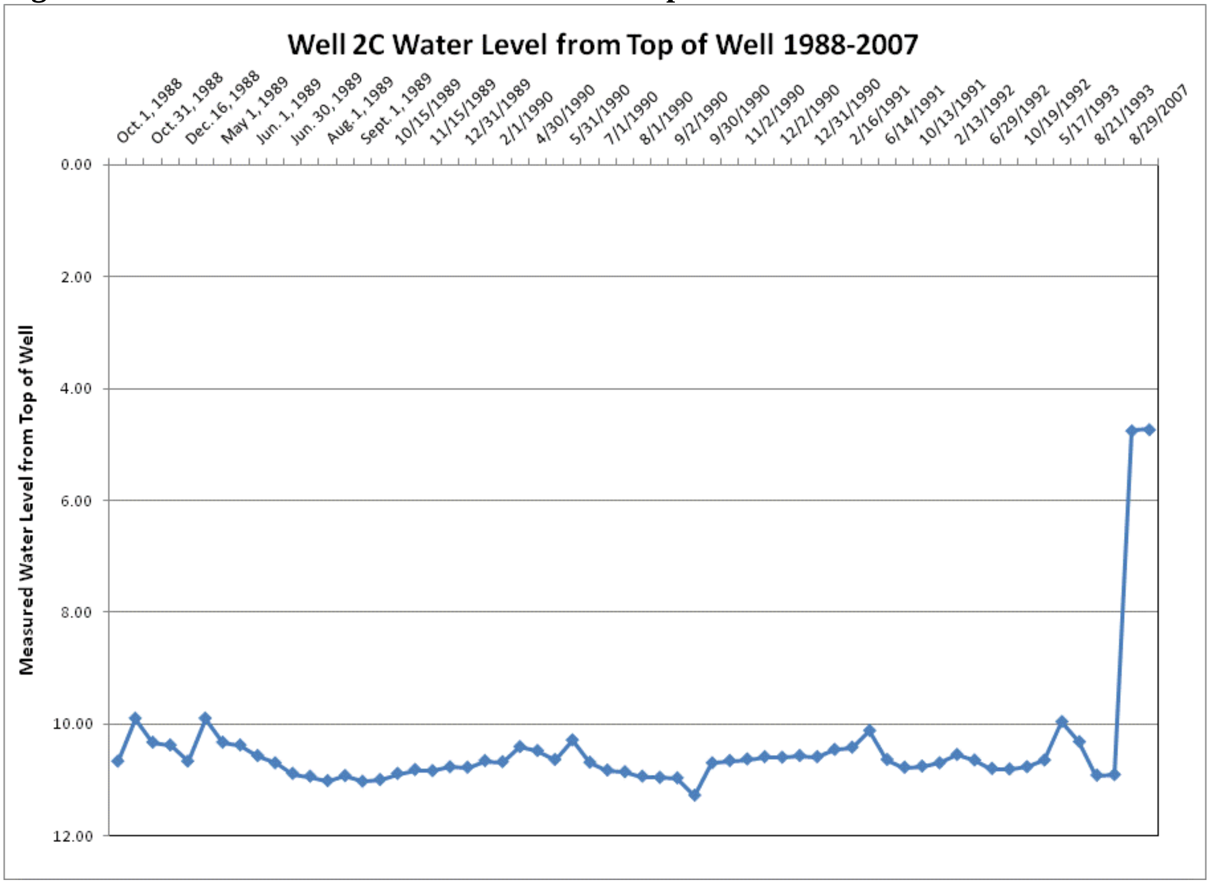


<u>What is the project's effects on groundwater levels?</u>

Plumas Geohydrology received a grant from the Plumas Water Forum to monitor groundwater sources using isotope analysis from several 3" wells, which were installed in the project area in September 2006. The isotope signature can be used to identify sources of groundwater, as it stays within the ground (from the wells), and as it emerges (from surface water samples). The final report on this project is expected in early 2008.

In August 2007 monitoring wells installed in 1985 were re-sampled to see how the groundwater level had changed due to the Red Clover/McReynolds Creek Restoration Project (see Figure 1 Monitoring Map). Five functioning monitoring wells were located at the top of the project, near the bottom and below the 1985 Red Clover Restoration Project. In October 2007 the 1985 functioning wells were sampled again for groundwater levels. Comparing the two data points from August and October 2007 to groundwater level data collected from 1988 to 1993 showed a dramatic increase in average groundwater levels from pre-restoration (1988-93) to post-restoration (2007).

Figure 13. Groundwater level measured from top of well 2C from 1988-2007



At Well 2C, immediately upstream of the Red Clover/McReynolds Creek Restoration Project, groundwater levels measured from the top of the monitoring well increased from 10.91 feet on 10/20/1993 to 4.73 feet from the top of the well on 10/26/2007 (see Figure 13). The two other wells located above the Red Clover/McReynolds project upstream of the quarry, wells 2D and 3C, experienced a 5 foot and 3 foot rise in groundwater levels, respectively, from October 1993 to October 2007 (see Figures 14 & 15). The two functioning wells farther upstream of the Red Clover/McReynolds Creek Restoration Project (4E and 4B), near the top check dam from the 1985 restoration project, did not show appreciable changes in groundwater level from the 1988-93 period to 2007.

As expected, re-sampling groundwater levels from monitoring wells installed in 1985 (and monitored from 1988-93) showed that restoring the floodplain through a pond-and-plug technique has a significant effect on groundwater levels. Though the uppermost wells were outside of the affected area, the results from the cluster of wells at the top of the project area show dramatic increases in groundwater levels.

Figure 14. Groundwater level measured from top of well 2D from 1988-2007

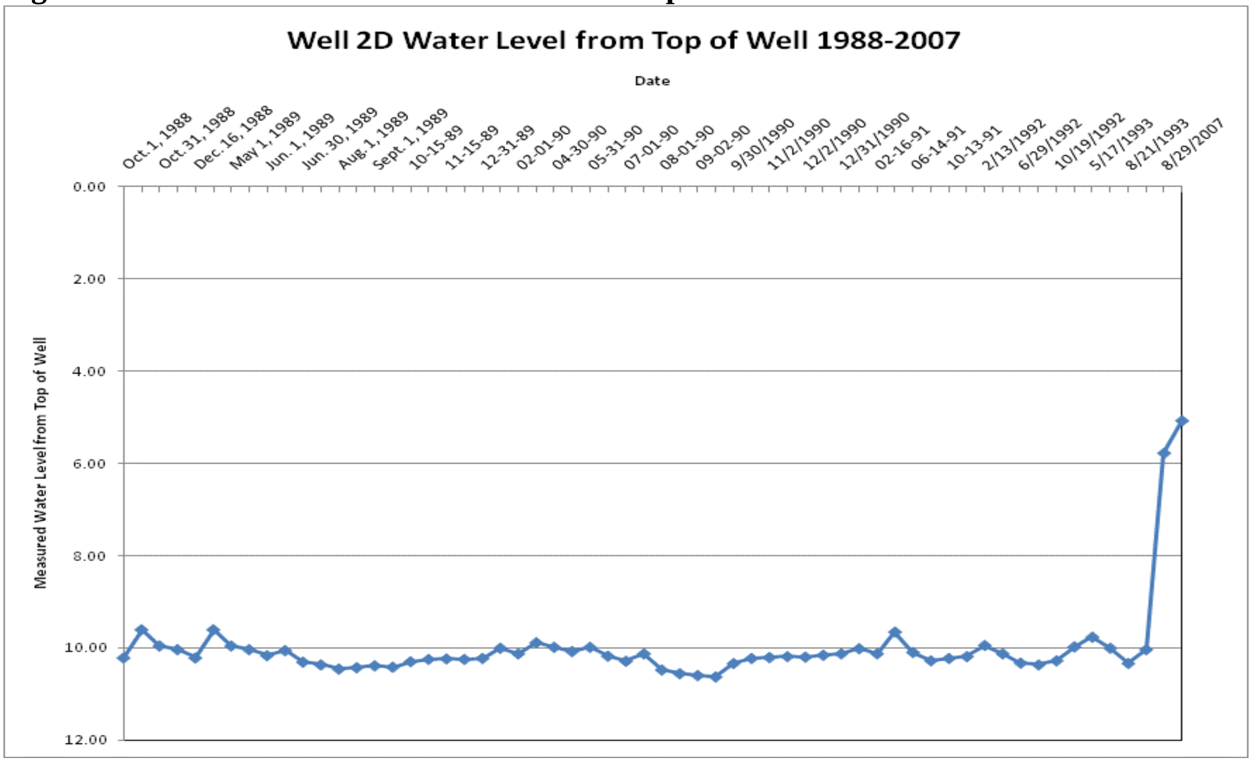
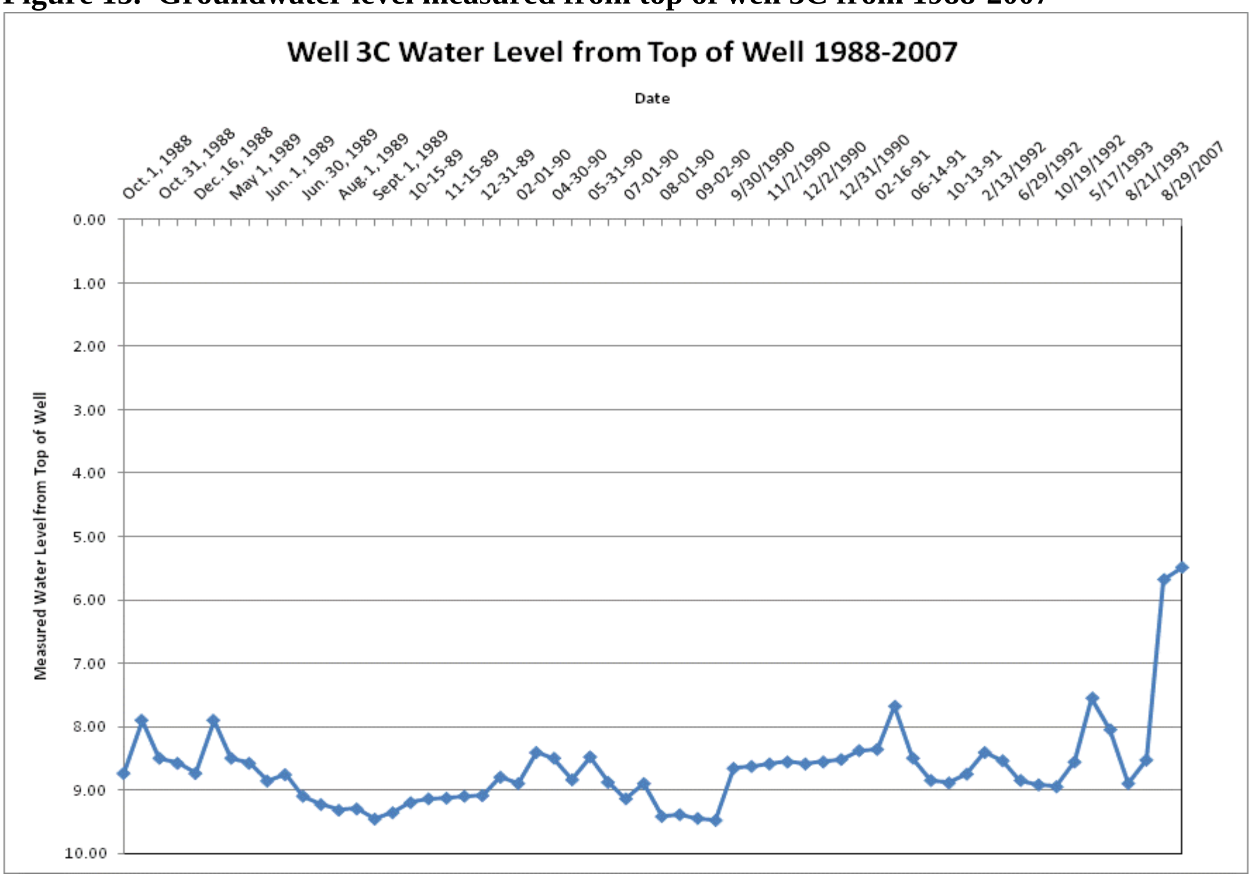


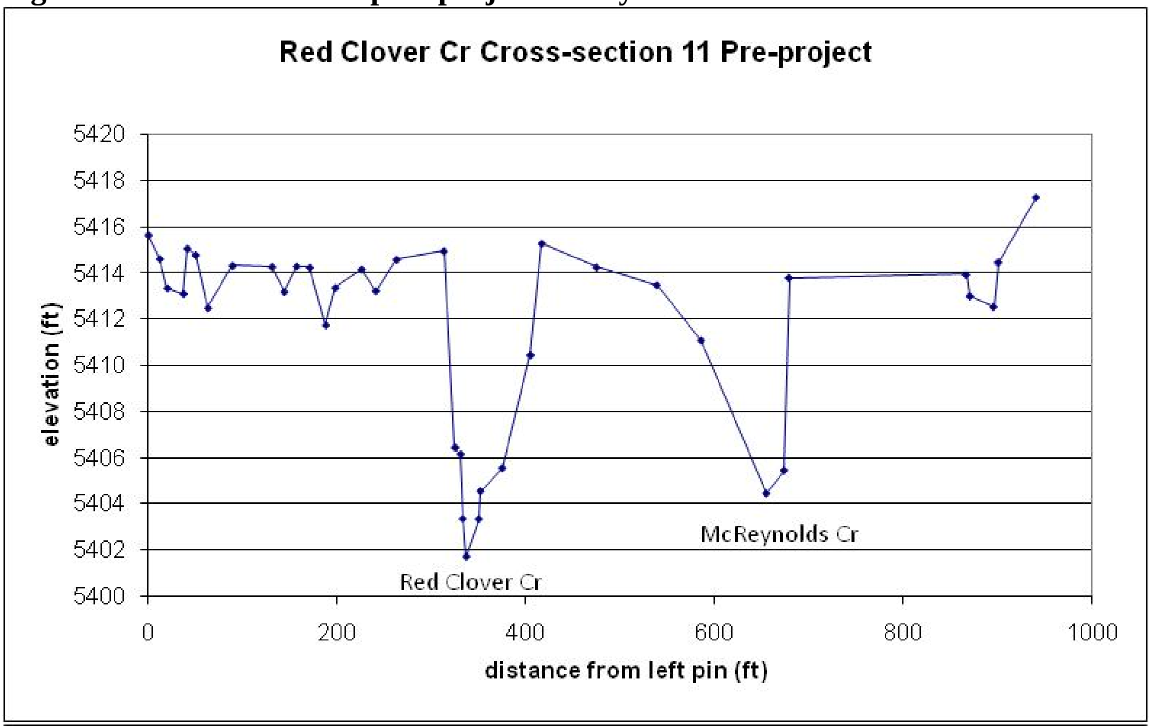
Figure 15. Groundwater level measured from top of well 3C from 1988-2007

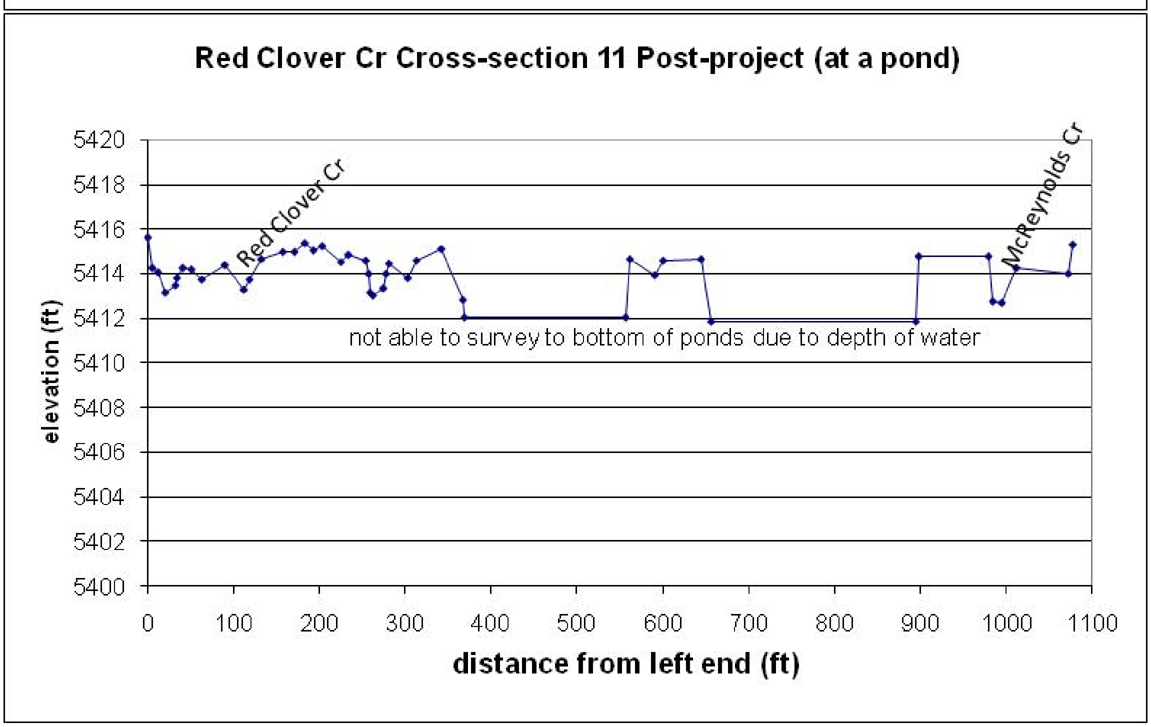


How has the project affected channel morphometry?

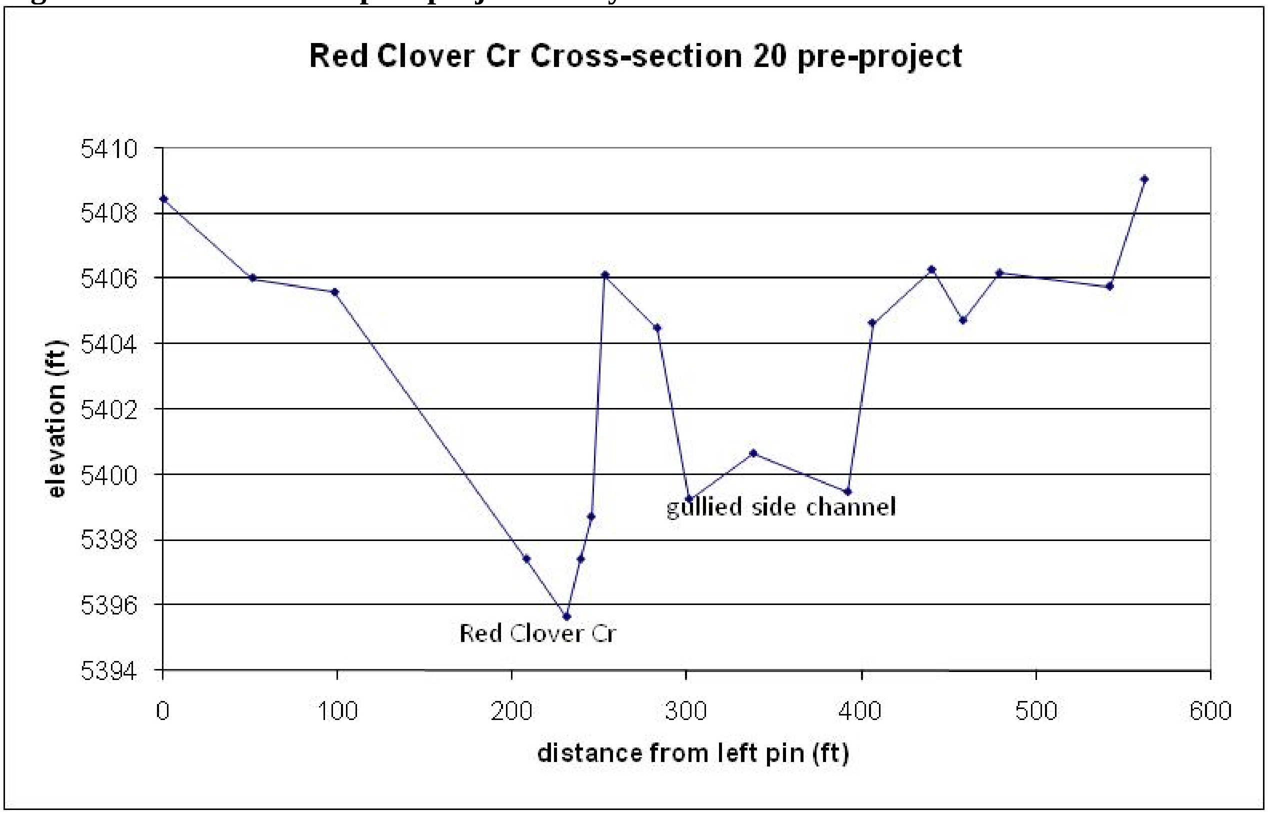
Figures 16 through 21 show pre- and post-project channels. The main channel changed from a large entrenched gully to a small channel on the surface of the meadow. Actual post-project survey data is only on cross-section 11, due to difficulty in finding end pins on the other cross-sections, however, the post-project cross-section is an accurate depiction of the post-project condition.

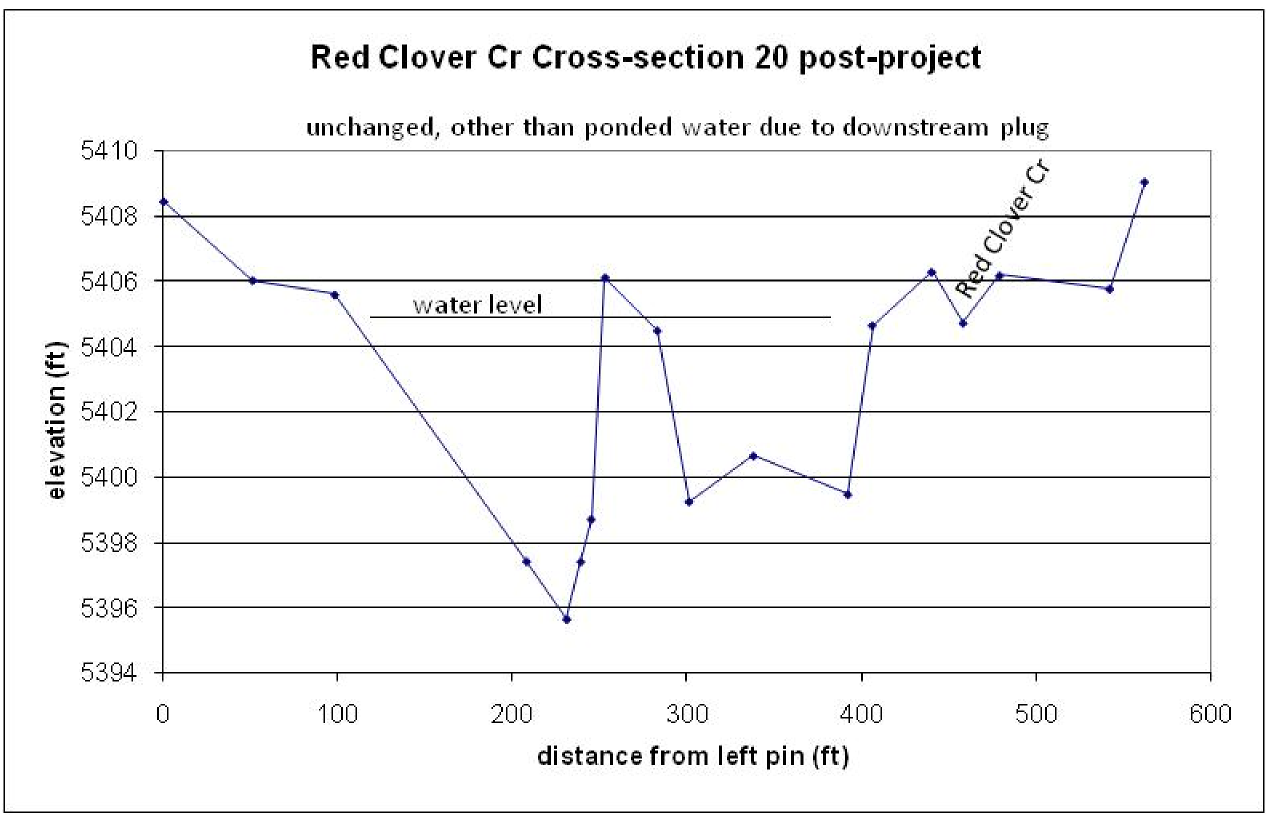
Figures 16 & 17. Pre- and post-project surveys of cross-section 11.



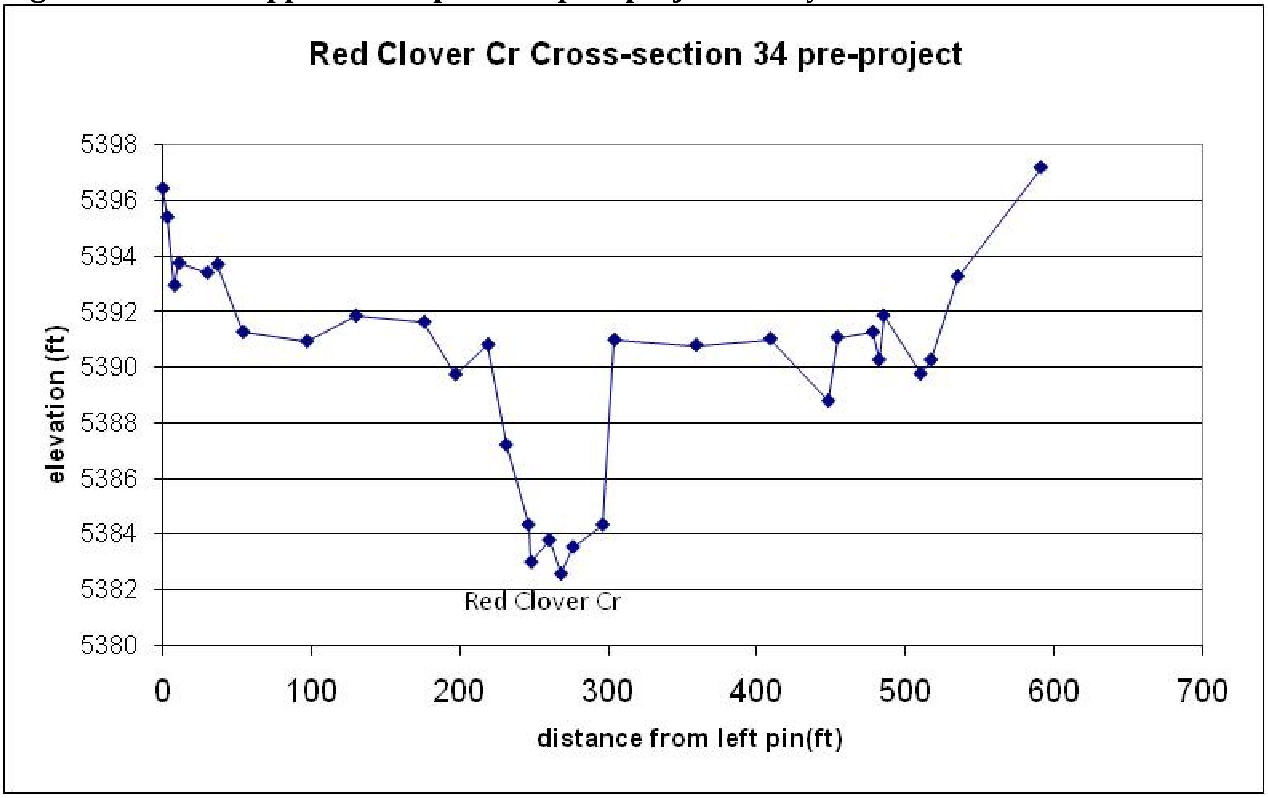


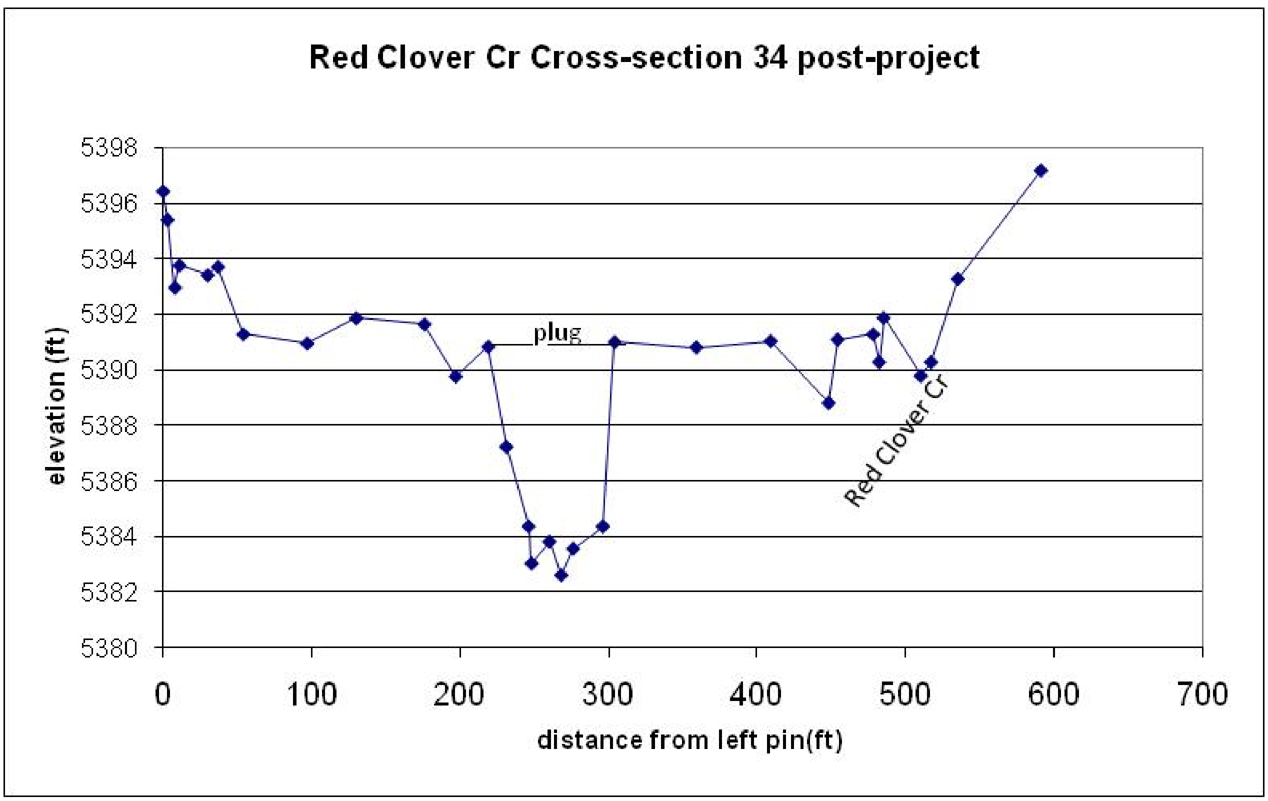
Figures 18 & 19. Pre and post-project surveys at cross-section 20.





Figures 20 & 21. Approximate pre- and post-project surveys at cross-section 34.





The following photo points show changes in the channel due to the project:

Photo 2. McReynolds Creek gully pre-project 2004.

Photo 3. McReynolds Creek remnant channel post-project 2007.


Photo 4. Red Clover Creek gully at photo point cross-section 19 pre-project June 2006.


Photo 5. Red Clover Creek remnant at photo point cross-section 19 post-project June 2007.

How has the project affected erosion rates?

Meadowbrook Conservation surveyed three sets of three cross-sections (1985, 86, 90, 96) in conjunction with the Red Clover Demo project. The cross-sections are above the demo project area, below the demo project area, and a control at the Chase Bridge. We were unable to relocate these cross-sections before the project was constructed. However, the volume of the void in the gully that was filled was approximately 600,000 cubic years, with the most rapid degradation since the 1950's. Over 56 years, that is an average of over 10,000 cubic years of sediment eroded from the project area each year. The project has re-established the depositional function in the project area, and so erosion is expected to be near zero. This was demonstrated through turbidity samples taken during high water events in 2007 at the top of the project area above the confluence with McReynolds Creek and just below the bottom of the project. Turbidity entering the project during an event on February 10-13, 2007 had respective readings of 71 and 77 NTUs. Turbidity readings leaving the project during the same event were 30 and 52 NTUs, respectively. An additional sample taken on April 18th during spring snowmelt showed turbidity entering the project at 6 NTUs , with 2.7 NTUs leaving the project.

What is the project's effects on vegetation?

The project area was flown before construction in 2005 using aerial infrared photography. The project has not yet been flown after construction. Once funding becomes available for this task, the project area will be flown, and the aerial extent of cooler (moist) vegetation will be compared under pre- and post- project conditions.

The following photo points show changes in vegetation:

Photo 6. Red Clover Quarry Veg Transect, pre-project May 16, 2006

Photo 7. Red Clover Quarry Veg Transect, post-project May 31, 2007

Photo 8. Red Clover McReynolds Veg Transect, pre-project June 8, 2006

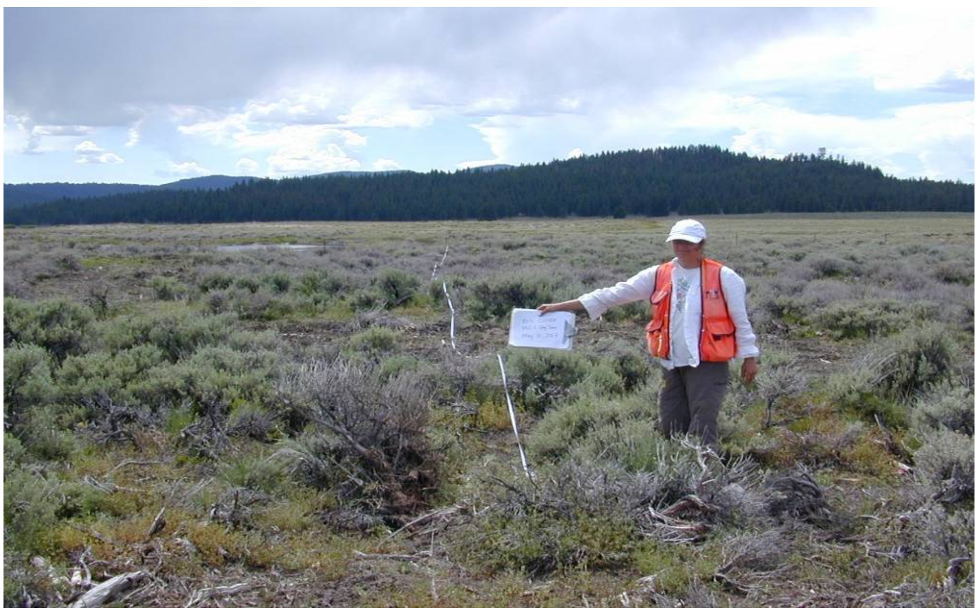


Photo 9. Red Clover McReynolds Veg Transect, post-project May 31, 2007

What is the project's effects on forage production for cattle?

Total annual production, including woody material, was estimated using USDA- NRCS plant production protocols as outlined in the *NRCS Quick Start Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems.* Sampling was conducted between mid-May and early-June pre-project (2006) and post-project (2007) on four transects, three within the project area and one control transect outside the project area. Total plant production increased on all transects in 2007, with a decrease in sage within the project area. Sage increased on the control transect downstream of the project area. Overall species composition increased at all sites, with an overall increase in the diversity of grasses and forbs on each transect. The greatest change in composition was seen along the Quarry Transect at the top of the project area along Red Clover Creek where three times as many species were noted in 2007 than in 2006. As the hydrological changes continue to influence the plant communities within the project area, it is expected that more mesic, palatable meadow species will dominate the sites, as the less desirable xeric species decline in abundance.

Figures 22. Total Plant Production Pre- and Post-Project.

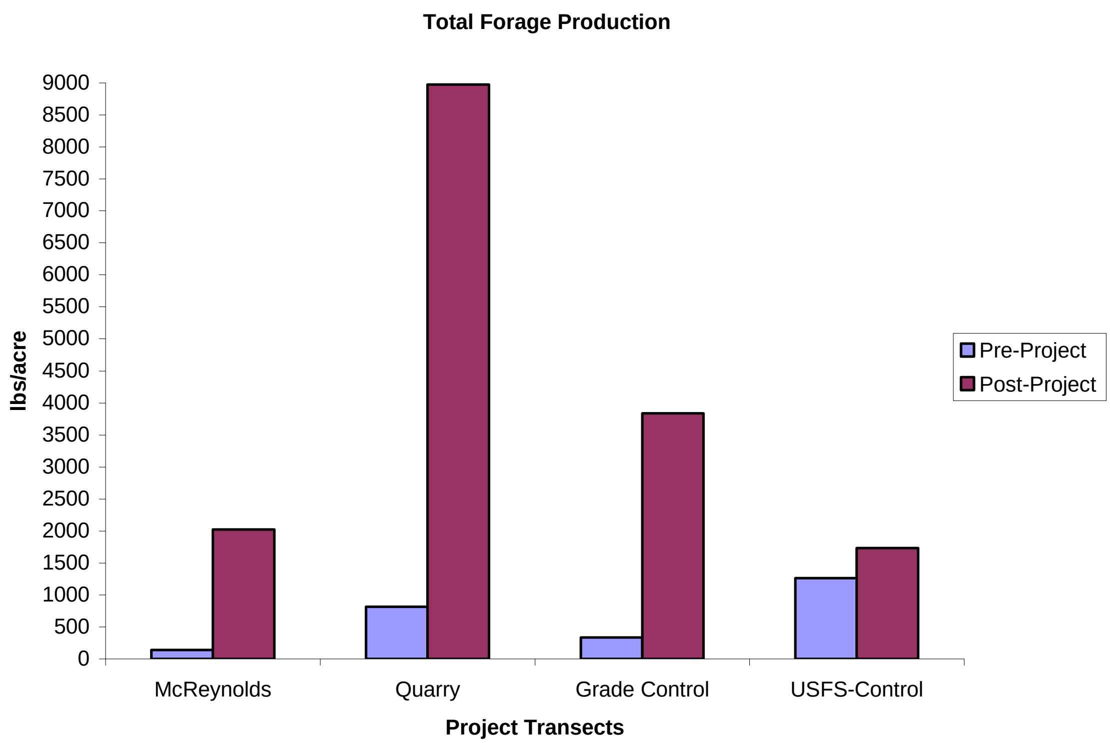


Table 1. Plant Species Percent Composition by Transect.

Species	**Percent Composition by Transect Pre-Project (2006) and Post-Project (2007)**			
	RC Quarry	RC Grade Control	McReynolds	Control-USFS
Sage spp.	**32** / **20**	**48** / **28**	**26** / **8**	**2** / **9**
Poa spp. (bulbosa)	**43** / **61** (**23** / **6**)	**29** / **0** (no bulbosa)	**20** / **0** (no bulbosa)	
Juncus spp.	**12** / **2**		**12** / **3**	**3** / **11**
Dandelion	**0** / **TR**		**6** / **0**	**0** / **2**
Red clover	**1** / **1**	**0** / **1**	**TR** / **0**	
Lupine spp.		**0** / **TR**	**4** / **0**	
Wild Onion			**20** / **0**	
Buttercup	**5** / **0**	**0** / **6**		
Equisetum	**0** / **TR**	**2** / **0**		
Rabbit brush		**2** / **0**		**0** / **4**
Yarrow	**0** / **1**			**6** / **5**
Pussypaw		**4** / **0**		
Sedge spp.			**0** / **TR**	**4** / **17**
Larkspur spp.		**12** / **7**		
Unknown forbs	**6** / **6**	**2** / **19**	**11** / **89**	**61** / **17**
Unknown grasses	**0** / **8**	**0** / **38**	**1** / **TR**	**23** / **35**

TR=Trace amount, <1% of total composition.

Is the project contributing to noxious weed proliferation?

The pre-project plant surveys found no noxious weeds within the project area. Annual walking surveys of disturbed areas in the project area will be conducted prior to seed production for three years after project construction. Any noxious weeds found will be counted and removed. The first year post-project all disturbed sites (i.e. plugs) were checked for noxious weeds. No weeds were found in 2007.