UPPER DESCHUTES WATERSHED COUNCIL
TECHNICAL REPORT

Whychus Creek Restoration Project at Camp Polk Preserve
2015 Groundwater Monitoring Report

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Project Goals

The overall goal of the Whychus Creek Restoration Project at Camp Polk Meadow is to restore the key functions and values of the historic wet meadow and associated in-stream and riparian habitat. Groundwater monitoring provides a basis for evaluating progress toward accomplishing the following project goals (Appendix A):

- Project Goal 2: Restore functioning meadow hydrology, including floodplain connectivity, an increase in the groundwater table and enhanced summer base flow.
  Objective 3: Increase the average groundwater elevation to a depth of two ft below ground surface level in the meadow during the growing season, April through October.

Groundwater data also provide information about the degree to which hydrologic conditions are sufficient to support the following additional project goals:

- Project Goal 3: Restore and enhance high quality riparian wetland habitat along the stream corridor.
  Objective 4: Establish a minimum of 35 acres of wetland and riparian plant communities.
- Project Goal 5: Decrease stream temperatures to help meet Oregon's state temperature standards.

Sufficient hydrologic conditions will allow the planted riparian community to establish and thrive; a shallow groundwater table will support surface-subsurface exchange, with the potential to contribute cooler groundwater to warm summer flows.

Background

Monitoring groundwater levels adjacent to the new and old channel as well as mid-meadow provides the data to understand groundwater trends and the range of variability in groundwater levels prior to, during, and following channel and floodplain restoration. Groundwater monitoring was initiated in 2007 and will be conducted during and following project implementation for 5 to 10 years, depending on findings (Appendix A).

In May of 2007, the UDWC installed seven monitoring wells in Camp Polk Meadow based on US Army Corp of Engineers monitoring well guidelines (Sprecher, 1993). The wells were installed in two cross sections, consisting of two and five wells (Figure 1; Appendix B). The location for the five-well cross section was selected because it is approximately centered in the middle of the meadow (upstream to downstream) and at the widest section of the meadow, is influenced by spring flows from the northwest end of the meadow, and was also anticipated to be influenced by flows from the new channel; therefore, the data collected represents the widest scope of groundwater activity in the meadow. The two-well cross section was installed slightly downstream of Duckett Pond, on the opposite side of the pond from the five-well cross section. Its location was selected to reflect Duckett Pond's influence in the meadow and to capture another dimension of the range of groundwater conditions in the meadow. The wells of the two-well cross section were installed between the new and old

channel in order to observe changes in the groundwater following diversion of the creek from the old channel to the new channel.

In June of 2009, approximately 1.5 cfs were diverted from the old channel to the then-newly constructed channel. This flow was maintained year-round pending the completion of Phase II construction and diversion of Whychus Creek into the new channel in 2012. In 2010 irrigation was installed throughout planting zones on either side of the new channel to support planted and seeded riparian vegetation. Irrigation totaled approximately 1 inch per week. Irrigation continued through the end of the growing season (October) in 2010 and was resumed for the 2011 April-October growing season. Sprinkler irrigation was removed in October 2011.

In February 2012, Whychus Creek was diverted into the restored meadow channel. The return of the creek to its historic meanders was anticipated to elevate the groundwater table in the meadow while advancing the other goals and objectives of the restoration project outlined above.

Methods

Depth to groundwater is measured at each well on a monthly basis or more frequently depending on anticipated hydrologic changes at various stages of channel construction and stream diversion. For each year, we calculate mean depth to groundwater for each well individually to evaluate the average depth of the water table at each well location over the course of the April-October growing season. We calculate the growing season mean for all wells collectively from the monthly median value of the seven well depths to illustrate trends in overall groundwater levels that impact the growth of riparian and wetland vegetation, and to show how these trends compare to baseline and objective growing season mean levels. We calculate the monthly median depth to groundwater for the seven wells collectively to show how groundwater levels change in the meadow throughout the growing season. We include March in growing season monthly median depth to groundwater to show changes in groundwater levels over each growing season relative to groundwater levels at the beginning of the growing season.

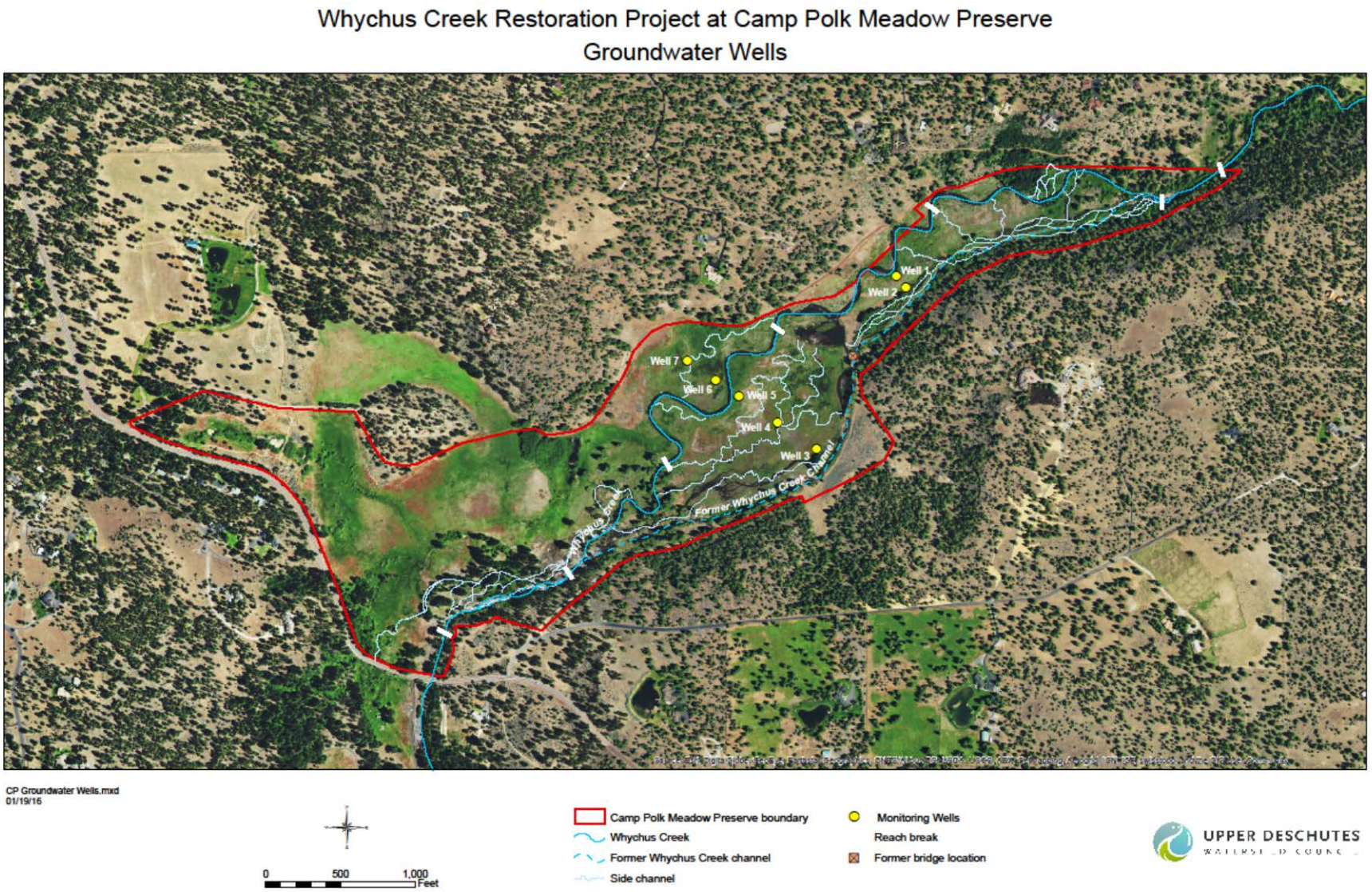


Figure 1. Seven Camp Polk groundwater monitoring wells, in two transects: the northeastern, downstream transect including wells 1 & 2, the southwestern, upstream transect including wells 3-7.

Protocol

Groundwater monitoring for Wells 1 through 7:

1. Record the date, time and your name on the data sheet.
2. Remove the monument cap by loosening bolts using a 9/16” wrench.
3. Remove the orange cap located on the PVC pipe (well casing).
4. Turn on water level measurement instrument and set sensitivity to the highest (loudest) setting.
5. Place probe at the end of the water level measurement tape into the well.
6. Insert until it beeps and then slightly move tape up and down until loudest reading.
7. Place your fingers on tape and line up with top of casing.
8. Record the water level to the nearest hundredth (tape reads in tenths of a ft, not inches).
9. Replace orange cap and screw in the monument cap.

Determining average groundwater depths:

1. To convert the recorded water level to the actual depth to groundwater for each well, calculate the difference between the surface elevation and the casing elevation. Add this number to the recorded water level.

2. Find the median groundwater depth for each month during the growing season, April through October.

3. Calculate the mean depth to groundwater during the growing season (growing season mean) as the average of growing season median depths.

Monitoring Summary

2007

Groundwater monitoring began in June of 2007 and was conducted monthly during the first week of each month. The preliminary data helped determine what riparian plant species to plant and in which areas. It also confirmed the need for seasonal irrigation during the Phase I plant establishment period (Fall 2009 to Spring 2010).

2008

Monitoring was suspended during January 2008 because the wells were inaccessible due to snowpack. However, monitoring resumed in February and continued monthly for the remainder of the year. The growing season data for 2008 represent baseline groundwater data for Camp Polk groundwater monitoring.

2009

During January through March 2009, monitoring was conducted monthly. In June, UDWC started running less than 1.5 cfs of water down the new channel to support planted vegetation. Initial data for the month of June showed a noteworthy change in groundwater elevation. As a result, UDWC increased monitoring to once a week during the growing season, April through October, to allow a better understanding of how the flows in the channel were affecting the meadow. As the growing season slowed during September and October UDWC shifted to monitoring biweekly, and in November and December, during the dormant season, resumed monitoring once a month.

2010

UDWC continued monitoring groundwater wells monthly from January through December 2010. In June of 2010, the US Forest Service (USFS) installed seven semi-permanent staff gages near water surfaces throughout the meadow as part of a groundwater study for a USFS resource management course (Figure 1). Two staff gages were added to each well cross section, one in the new channel and another in the old channel. A third cross section was created with the remaining three staff gages. One staff gage was installed in Duckett Pond, while the other two completed the cross section via the new and old channel. Staff gages allowed for more frequent monitoring during months when changes to the new channel were anticipated to influence groundwater levels. The staff gages were removed from the meadow in summer 2010 following completion of the study.

2011

Groundwater monitoring was conducted on or around the 15th of every month throughout 2011.

2012

Each of the groundwater wells was sampled once in January, then once during each week of February to more closely track groundwater trends preceding diversion of Whychus Creek into the restored meadow channel. Wells were monitored several times per week for three weeks in March following diversion of the creek into the

restored channel. Wells were subsequently sampled around the 15th of every month throughout the growing season (April through October).

2013

In 2013, UDWC monitored wells at Camp Polk Meadow during the growing season, March through October (Appendix A) around the 15th of each month, eliminating groundwater well monitoring from November through February. The rationale for this revision is: a) plants are dormant and have minimal water demands during the colder months, thus depth to groundwater during the winter is not important for riparian plant success; and b) the groundwater table freezes during the winter, reducing or eliminating the surface water-groundwater exchange that otherwise drives increases and fluctuations in the water table.

2014

Groundwater was monitored on a monthly basis during the 2014 growing season at Camp Polk Meadow. Monitoring was conducted between the 13th and 17th (i.e. within two days of the 15th) of each month. As in 2013, groundwater monitoring was conducted during the growing season only. In 2014, the casing of Well 1 was exposed due to the headcutting process of a small, nearby channel. The functionality of the well was evaluated and it was deemed functional, however, no data was collected at Well 1 for April.

2015

During 2015, monthly monitoring of Camp Polk Meadow groundwater levels was conducted from March through October; monitoring occurred around the 15th of each month. Monitoring of Well 1 was discontinued as of March 2015 after a side channel head-cut back to the well, connecting surface and groundwater at the well site and calling into question the integrity of the well casing and function of the well. We recalculated monthly median values for March through October 2008-2015, the 2008 baseline mean growing season depth to groundwater, and the overall mean for each growing season 2009-2015, excluding values from Well 1 to allow comparison between years prior and subsequent to the 2015 failure of Well 1.

Results and discussion

2007

Since groundwater monitoring began in June of 2007, after the growing season had already started, the results could not be used as a baseline for future results. However, 2007 data established that the depth at which the wells were installed was adequate. During the planning process, test-pits were dug in order to assess groundwater depths throughout the meadow. These tests suggested that groundwater levels ranged between five and seven ft below the ground surface. Accordingly, the wells were installed approximately 10 ft below the ground surface. The deepest depth recorded at an individual well in 2007 was 9.38 ft below ground surface, which confirmed that the wells were installed at adequate depths to express a range of depths including the deeper groundwater levels encountered. The results also confirmed that groundwater levels throughout the meadow would need to increase by approximately three to five ft in order to accomplish the two-ft depth to groundwater objective (Figure 1a).

2008

Data collected during the 2008 growing season were selected as the baseline groundwater data for the project due to 2008 being the first year that data were collected throughout the growing season. The mean growing season depth to groundwater for wells 2-7 was 4.98 ft, showing that groundwater levels needed to rise approximately three ft in the meadow in order to meet the objective (Figure 1a). For wells 1-7 the mean growing season depth to groundwater was 5.30 ft. This information was considered in the design for the new channel.

2009

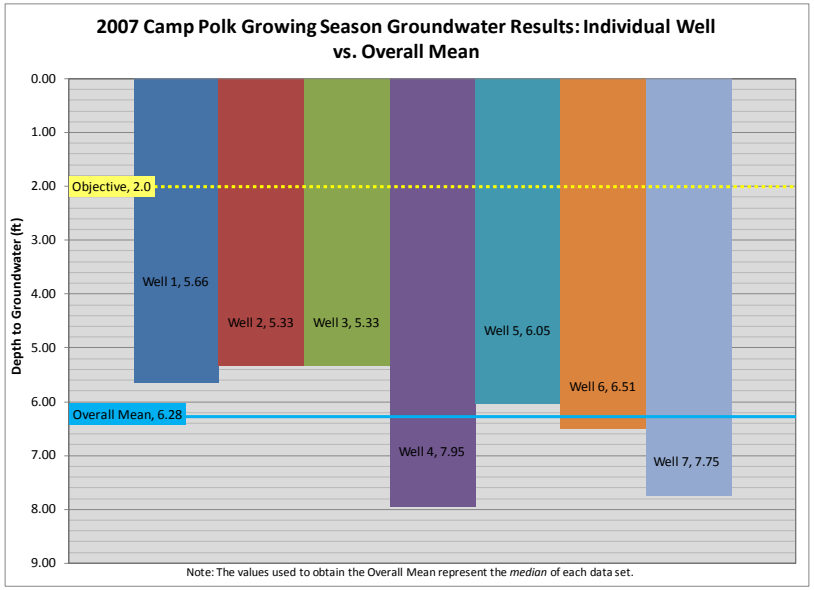
In 2009, groundwater data showed an improvement in groundwater levels. The six-well average groundwater level increased from the 2008 baseline of 4.98 ft below the surface to 4.69 ft (Figure 1a). The2008-2009 increase in mean depth to groundwater for the seven wells, including Well 1 values, was more dramatic, from 5.3 ft to 4.33 ft. The observed increase likely reflected the introduction of approximately 1.5 cfs into the new channel in June 2009; the greater change for the seven-well average reflects the relatively shallow depth to groundwater in Well 1, which may have resulted from the proximity of that well to the new channel.

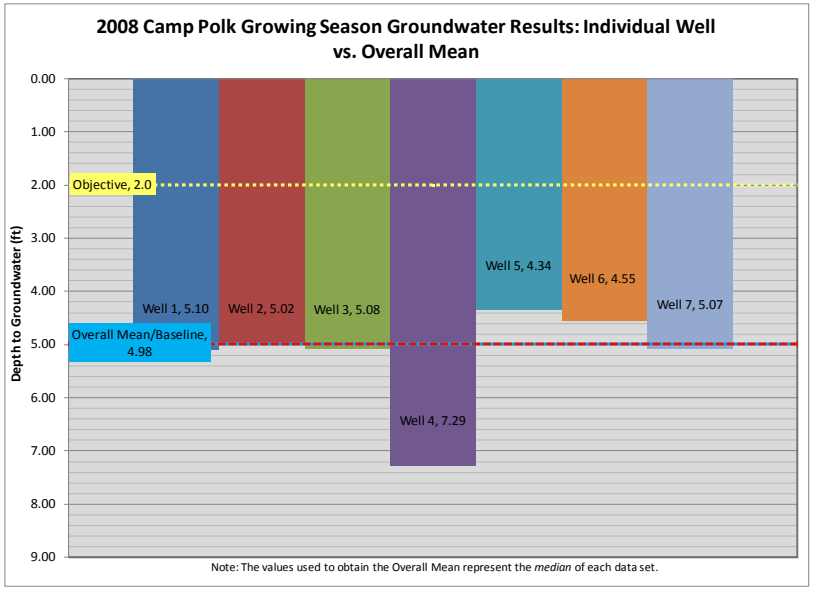
2010

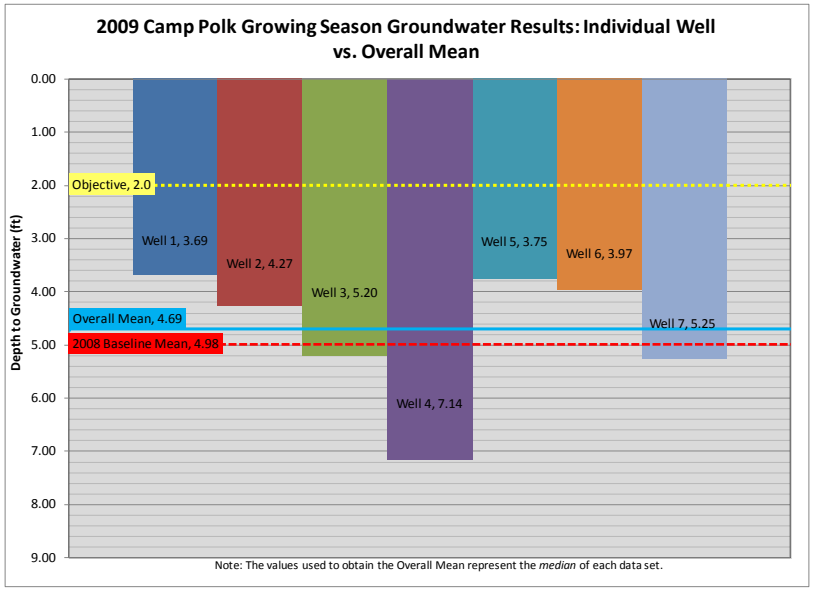
The six-well mean median depth to groundwater decreased again in 2010, to 4.03 ft, an improvement of 0.95 ft over the 2008 six-well baseline and an improvement of 0.66 ft over the 2009 depth (Figure 1a). The seven-well mean median depth to groundwater decreased to 3.61 ft, an improvement of 1.69 ft over the 2008 baseline depth and an improvement of 0.72 ft over the 2009 seven-well mean depth. Similar to the 2009 growing season, water ran in the new channel at a flow less than 1.5 cfs, which likely contributed to groundwater results, and Well 1 reached a new low depth to groundwater at 2.67 ft. In addition to the new channel flow, a sprinkler irrigation system was installed in the newly planted reaches of the meadow in May of 2010 and operated 24 hours a day during the growing season; however, effects of irrigation amounting to an inch of water per week probably had a minor influence, if any, on groundwater level. The observed increase was substantiated by USFS groundwater study data, which also indicated a rise in the water table (data not shown).

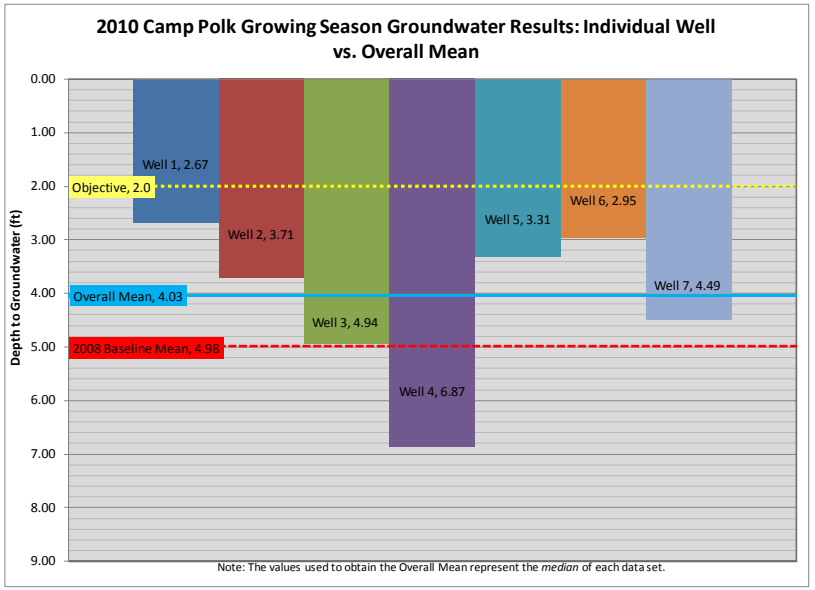
Figure 1. Mean growing season groundwater depth in individual wells, and 2008 baseline mean depth, overall mean growing season depth, and objective mean growing season depth, a) from 2007 to 2010; b) from 2011-2014; and c) in 2015. 2008 baseline and overall means were adjusted following the 2015 failure of Well 1 to reflect the average of the median monthly value from wells 2-7.

a)









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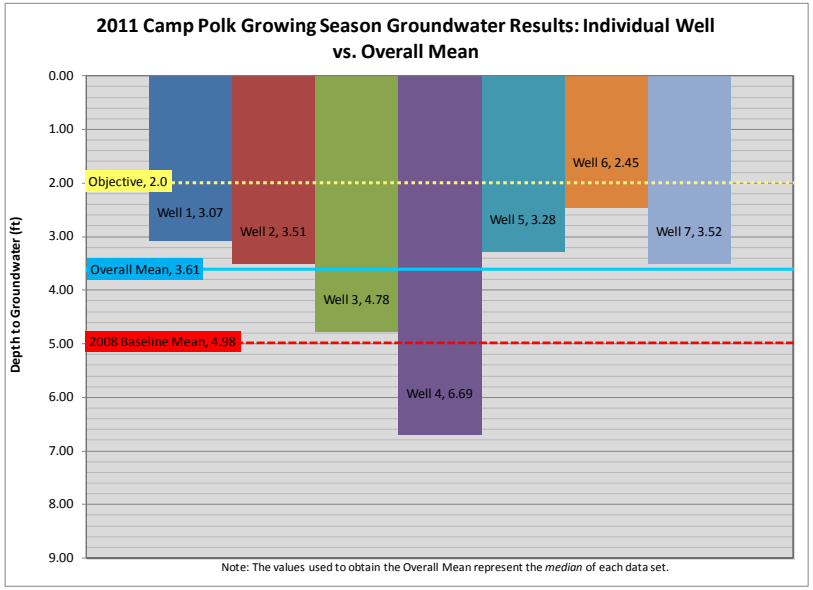
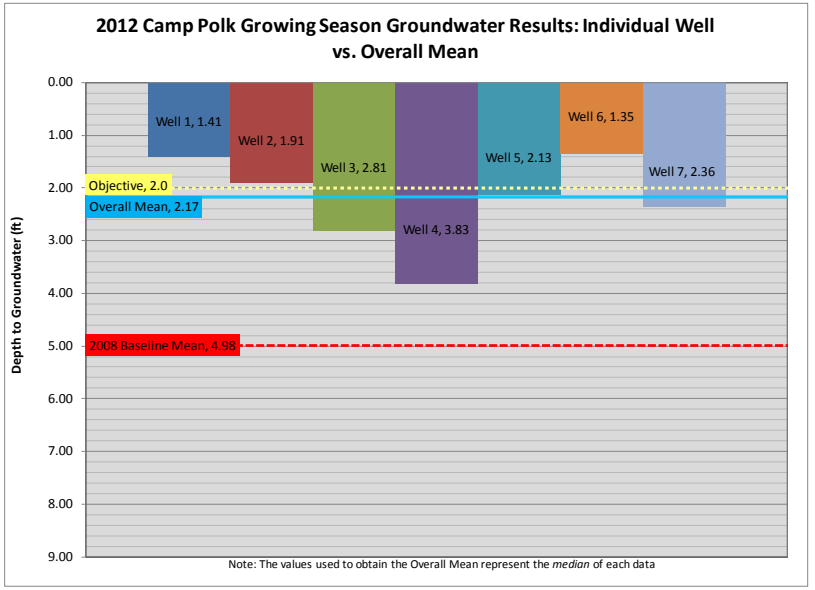
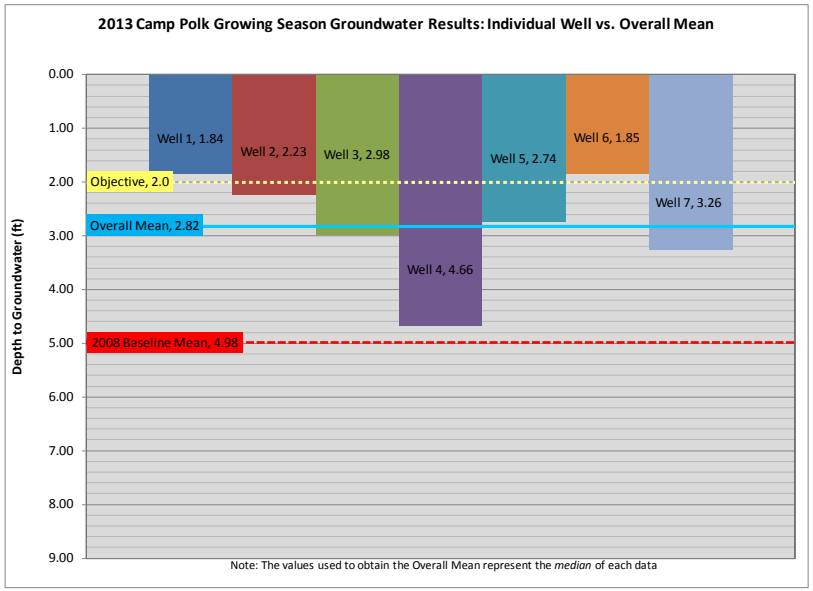
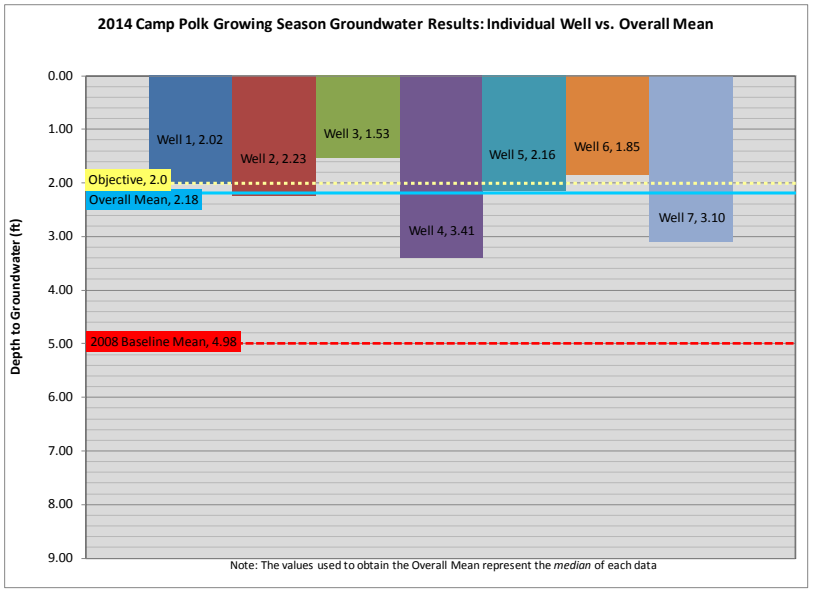
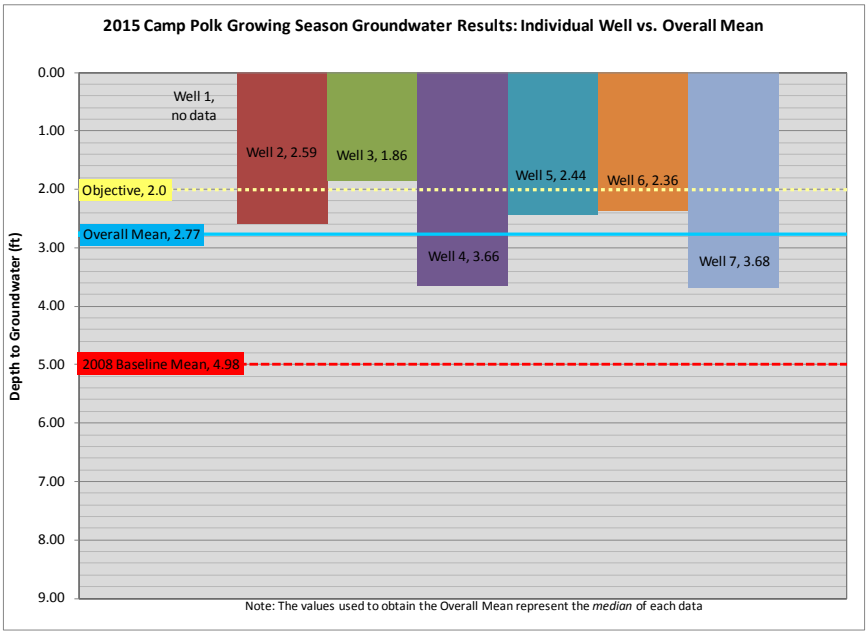

2011 Camp Polk Growing Season Groundwater Results: Individual Well vs. Overall Mean
Depth to Groundwater (ft)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Objective, 2.0
Overall Mean, 3.61
2008 Baseline Mean, 4.98
Well 1, 3.07
Well 2, 3.51
Well 3, 4.78
Well 4, 6.69
Well 5, 3.28
Well 6, 2.45
Well 7, 3.52
Note: The values used to obtain the Overall Mean represent the median of each data set.


2012 Camp Polk Growing Season Groundwater Results: Individual Well vs. Overall Mean
Depth to Groundwater (ft)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Objective, 2.0
Overall Mean, 2.17
2008 Baseline Mean, 4.98
Well 1, 1.41
Well 2, 1.91
Well 3, 2.81
Well 4, 3.83
Well 5, 2.13
Well 6, 1.35
Well 7, 2.36
Note: The values used to obtain the Overall Mean represent the median of each data


2013 Camp Polk Growing Season Groundwater Results: Individual Well vs. Overall Mean
Depth to Groundwater (ft)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Objective, 2.0
Overall Mean, 2.82
2008 Baseline Mean, 4.98
Well 1, 1.84
Well 2, 2.23
Well 3, 2.98
Well 4, 4.66
Well 5, 2.74
Well 6, 1.85
Well 7, 3.26
Note: The values used to obtain the Overall Mean represent the median of each data


2014 Camp Polk Growing Season Groundwater Results: Individual Well vs. Overall Mean
Depth to Groundwater (ft)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Objective, 2.0
Overall Mean, 2.18
2008 Baseline Mean, 4.98
Well 1, 2.02
Well 2, 2.23
Well 3, 1.53
Well 4, 3.41
Well 5, 2.16
Well 6, 1.85
Well 7, 3.10
Note: The values used to obtain the Overall Mean represent the median of each data

c)



2011

The six-well growing season mean depth to groundwater was 3.61 ft in 2011, an improvement of 1.37 ft over the six-well 2008 baseline and a 0.42 improvement over the 2010 growing season six-well mean depth (Figure 1b). The seven-well growing season mean depth to groundwater was 3.46 ft in 2011, an improvement of 1.84 ft over 2008 baseline data and a 0.15 ft improvement over the 2010 growing season mean depth. Average depth to groundwater in 2011 was again likely influenced by flows of less than 1.5 cfs diverted into the new stream channel. This resulted in a growing season mean groundwater level that exhibited only slight improvement over 2010 data, consistent with similar flows in the new channel between the two years.

While each individual well exhibited improved mean growing season groundwater levels, Well 7 showed the greatest improvement with a 0.97 ft increase. This well is the farthest from the new channel, and the factors which influenced this increase in groundwater levels are unclear. It is possible that the historic wetland area in which this well is located may contribute to increased water holding capacity. Depth to groundwater in Well 1 increased from 2010 to 2011 by 0.4 ft, while depth to groundwater in all other wells decreased by 0.2 to 0.5 ft.

2012

In 2012 there was a marked improvement in depth to groundwater following the February diversion of Whychus Creek into the reconstructed meadow channel. The six-well growing season mean depth to groundwater was 2.17 ft in 2012, representing a 2.81 ft improvement over the 2008 six-well baseline and a 1.44 ft improvement over the 2011 mean depth (Figure 1b). The seven-well growing season mean depth to groundwater was 2.02 ft in 2012, a 3.28 ft improvement over the 2008 seven-well baseline and also a 1.44 ft improvement over the 2011 seven-well mean depth. Using either the seven-well or six-well growing season depths to groundwater, 2012

results show a distinct change in groundwater, with 2012 growing season mean depths coming in just shy of the 2-ft depth to groundwater monitoring objective.

Each well displayed an improvement over 2011 mean growing season groundwater levels. Depth to groundwater in wells 1-7 decreased by over 1.0 ft, with Well 4 showing the greatest decrease at 2.86 ft over its 2011 mean. As Well 4 is located roughly midway between the old channel and the newly restored meadow channel, this suggests substantial progress toward Project Goal 2, to restore functioning meadow hydrology, including floodplain connectivity, an increase in the groundwater table and enhanced summer base flow.

2013

In 2013 the six-well growing season mean depth to groundwater fell to 2.82 ft, an increase of 0.65 ft over the 2012 six-well mean, but a sustained improvement of 2.16 ft over the six-well 2008 baseline (Figure 1b). The seven-well mean depth was 2.66, a 0.64 ft increase over 2012 and a 2.64 ft improvement over the seven-well 2008 baseline. A number of reasons may have contributed to the increase in depth, including inter-annual climate variability and higher water requirements associated with an increase in primary production within the meadow as riparian plants have grown. Anecdotally, we observed this growing season to be drier, warmer, and longer than several previous years, which may have contributed to the increased depth to groundwater in Camp Polk Meadow.

2014

Groundwater monitoring data for the 2014 growing season showed continued improvement in overall water depth, with the six-well growing season mean depth, at 2.18 ft, a 0.64 ft increase over the 2013 six-well mean, a 2.8 ft improvement over the 2008 six-well baseline mean, and hovering slightly below the 2.0 ft objective (Figure 1b). The seven-well 2014 growing season depth was 1.98 ft, 0.68 ft less than the 2013 seven-well mean, 3.32 ft better than the seven-well baseline mean, and slightly better than the 2.0 ft objective.

Mean depths to groundwater for individual wells showed that 3 wells, Wells 1, 3, and 6, met the objective of 2.0 ft below the surface. Most wells showed similar mean depths to groundwater as those recorded in 2013. However, wells 3 and 4 showed substantial improvements, with decreases in depth to groundwater of 1.51 ft and 1.39 ft, respectively. These data demonstrate a markedly higher water table in some areas of the meadow, such as the area where wells 3 and 4 are located, as well as maintenance of an elevated water table in other areas of the meadow.

Data from all seven wells collectively showed that the monthly median depth to groundwater in 2014 met the project objective of 2.0 ft below the surface for the months of March, April, and May, with median depths calculated as 1.27, 1.63, and 2.02 ft depth to groundwater, respectively. The following months, June through October of 2014, showed slightly greater median depths to groundwater at 2.14, 2.28, 2.38, 2.43 and 2.42 ft below the surface, in order from June to October.

2015

The 2015 mean depth to groundwater of 2.67 ft represents an approximately half-foot (0.49) decline from the 2014 six-well mean depth of 2.18 ft (Figure 1c). The 2015 overall mean is a 2.31 ft improvement from the 2008 six-well baseline mean depth to groundwater of 4.98 ft. All individual well measurements increased in depth to groundwater compared with 2014 results. Only Well 3 met the 2.0 ft objective, with an individual mean depth to groundwater of 1.85 ft. Well 6 approached the objective at 2.36 ft and all other well growing season mean values missed the objective by 0.50 ft or more. Wells 4 and 7 were substantially deeper than the 2.0 ft objective with mean growing season depths of 3.66 ft and 3.68 ft, respectively. March was the only month to meet the objective at a monthly median depth to groundwater of 1.97 ft; April through October median depths were all greater than the 2.0 ft objective, at 2.25 ft, 2.53 ft, 2.68 ft, 2.79 ft, 3.22 ft, 2.95 ft and 2.96 ft, in order from April through October.

No data could be recorded for Wells 5 and 6 on August 19th, therefore monthly median depth to groundwater for August only includes data from Wells 2, 3, 4, and 7. The meter tape appeared to hit the bottom of Well 5 at 9.43 ft and Well 6 at 9.17 ft. At construction of the wells, Well 5 was installed to 10 ft and Well 6 was installed to 9.8 ft. Correct, repeated readings at other wells indicated the meter tape used to take measurements from all wells on August 19th was working correctly, despite subsequent repeat 'no readings' at Wells 5 and 6.

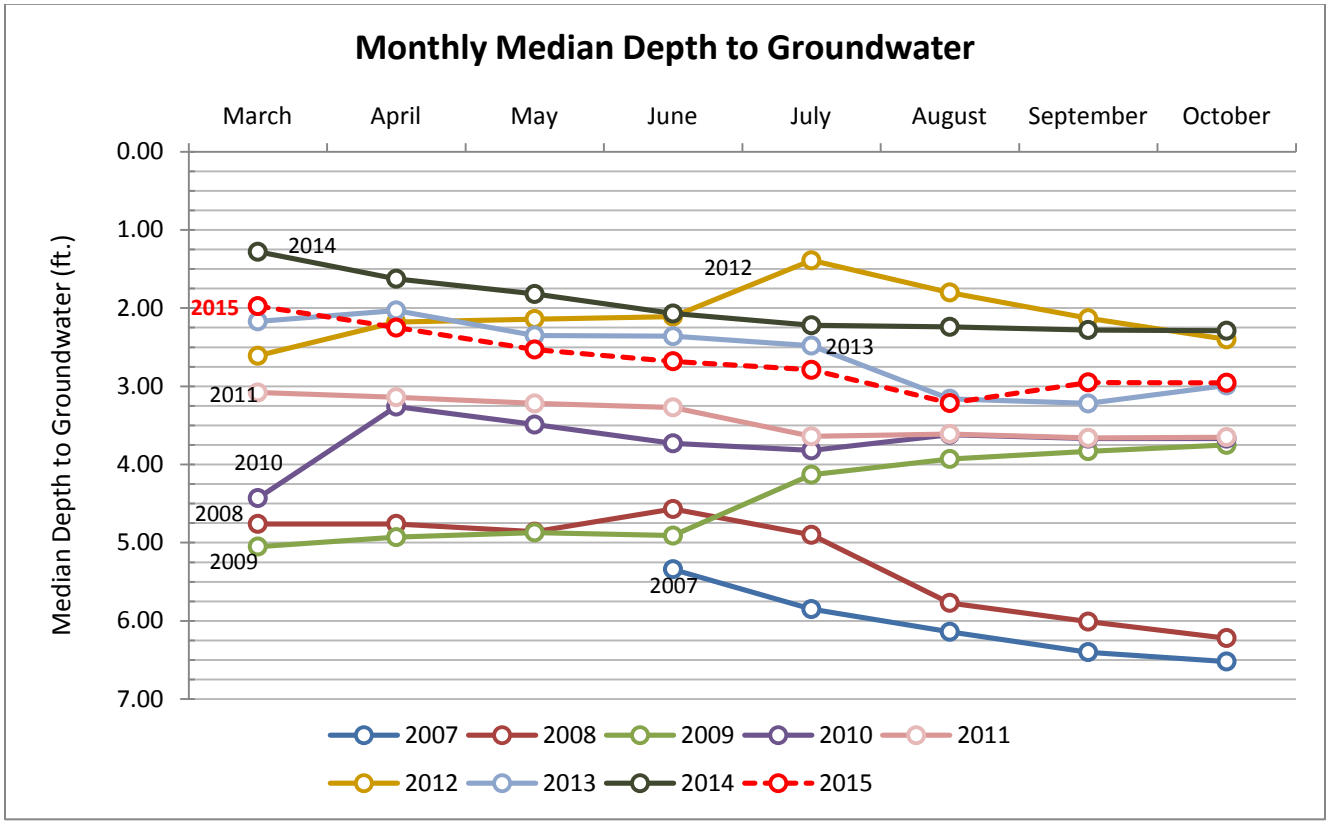


Figure 11. Monthly median depth to groundwater during the growing season, 2008 – 2015. Data were not collected March – May of 2007 because groundwater monitoring had not yet begun.

Conclusions

Groundwater levels at Camp Polk Meadow were low in 2015, showing an evident decline from 2014 data. The 2015 mean growing season depth to groundwater remained better than the 2.82 ft 2013 mean growing season depth. 2015 data show a sustained improvement in the overall mean depth to groundwater, compared with 2007-2011 data. Groundwater levels at Camp Polk Meadow will continue to fluctuate from year to year as a result of inter-annual climatic differences in snowpack, runoff, precipitation, and temperature, and may continue to change with ongoing channel evolution and increasing water demands of more abundant riparian vegetation. Nonetheless, the dramatic 2012 increase in the water table following the diversion of Whychus Creek and the maintenance of an elevated water table from 2013 through 2015 are early indicators of the project's success in restoring the meadow hydrology and floodplain connectivity (Goal 2), increasing the groundwater table and summer base flow (Goal 2), and increasing the average groundwater elevation depth to approach two ft below ground during the growing season (Objective 3). The observed increase in the groundwater level also contributes to restoring and enhancing a high quality riparian wetland habitat along the stream corridor (Goal 3), establishing a minimum of 35 acres of wetland and riparian communities (Objective 4), and decreasing stream temperatures to help meet Oregon's state temperature standards (Goal 5).

References

Sprecher, S. W. (1993, August). Installing Monitoring Wells/Piezometers in Wetlands. *Wetlands Research Program Technical Note HY-IA-3.1* . Vicksburg, MS: US Army Corp of Engineers. S:\UDWC\Projects\Metolius & Whychus\Camp Polk\Monitoring\Groundwater\Design\USACE monitoring well guidelines.pdf

Appendices

Appendix:	A
Title:	Monitoring Table
Prepared by:	Lauren Mork
Date:	September, 2012

Whychus Creek Restoration Project at Camp Polk

Monitoring Plan Summary

September-12

Monitoring Parameter	Goals[1]	Protocol/Citation	Reporting	Location	Season	Frequency	Duration	Lead	Annual Budget	Baseline	Notes
Priority 1[2]											
I. Hydrology											
Groundwater	2, 3, 5	Groundwater well measurements. S:\UDWC\Projects\ Metolius & Whychus\Camp Polk\Monitoring\Groundwater\Data\Monitoring Well Protocol	Annual groundwater monitoring report written by UDWC intern	2 x-sections of 5 and 2 wells	Thaw and growing season, March - October	Monthly March - October	2007 - 2017. Installed in 2007.	UDWC	Installation (2007), maintenance, data management	2008	Assistance from UDWC intern, UDWC or DLT volunteer.
Temperature Heterogeneity	1,5	2010 Temperature Heterogeneity at Rimrock Ranch and Camp Polk Meadow; Benewah Creek Model Watershed Effectiveness Monitoring 2009	UDWC Intern or Monitoring Coordinator	Pools and downstream riffles within existing channel reach (pre project) and new channel (post project)	July (hottest days of the year)	Once, post phase II construction.	2013. Additional monitoring will depend on results from 2013.	UDWC	Labor for field work and write up.	2010	Baseline study conducted at Rimrock Ranch and Camp Polk by an OSU student.
II. Water Quality											
Continuous Temperature	1, 2, 5	Data collected with Vemco temperature dataloggers. UDWC QAPP 2008, SOP 2008.	Excerpted from annual Whychus Creek Monitoring Technical Report by Monitoring Coordinator.	Above new channel (RM 19.50); Below new channel (RM 18.25).	April - October	Annually	2007 - 2017. Begun in 2007.	UDWC	Deployment, audits, maintenance, data management	Upstream data from 1998, 2000-2012; Downstream data 2001, 2003-2012 (UDWC)	Camp Polk sites are a subset of the Whychus Creek Model Watershed Monitoring
III. Geomorphology											
Channel dimension, pattern and profile	3,4, 5	Full Channel survey / total station survey with cross-sections and 2009 Lidar data	Paul Powers, Fisheries Biologist, and Cari Press, Hydrologist, Deschutes National Forest	16 cross sections; entire project reach	Summer or fall	2009: Reaches 2-5; 2013: As-built for Reaches 1-6, cross sections for Reach 1 and 6.	Evaluate need for additional surveys after 2013 pending further changes to system	UDWC w/ field work conducted by USFS	Labor for field work and write-up	Lidar data was collected in 2009 post Phase I construction	Add years as needed and if funding allows. As built survey will be done in 2013.

#1: Project Goals:

1. Provide 1.7 miles of high quality redband trout, chinook and steelhead spawning and rearing habitat.
2. Restore functioning meadow hydrology, including floodplain connectivity, an increase in the groundwater table and enhanced summer base flow.
3. Restore and enhance high quality riparian wetland habitat along the stream corridor.
4. Provide natural channel stability, including dimension, pattern and profile that meets reference conditions.
5. Decrease stream temperatures to help meet Oregon's State Temperature Standards.

#2: Monitoring Priorities. Priority 1 monitoring is that which helps define project success and for which funding will be prioritized. Priority 2 monitoring is above and beyond that suggested to evaluate the success of the project, but which would provide valuable data if resources are available.

Monitoring Parameter	Goals[1]	Protocol/Citation	Reporting	Location	Season	Frequency	Duration	Lead	Annual Budget	Baseline	Notes
IV. Biological Parameters											
Riparian Vegetation - Transects	1, 2, 3, 4	Percent cover monitoring. 2012 Camp Polk Vegetation Monitoring Report	Annual vegetation monitoring report written by UDWC intern	Twelve stratified randomly located transects in riparian beltwidth	First week of August	Annually	2012 - 2017	UDWC	Labor for field work and write-up (Monitoring Coordinator, Intern). Consulting contract with Karen Allen.	2012	UDWC intern, Monitoring Coordinator
Riparian Vegetation - Grids	1, 2, 3, 4	Percent cover monitoring. 2010 UofO CPM Vegetation Monitoring Report.	U of O Field Course Reports	Five transects and grids along monitoring well cross sections	Summer	Annually 2007-2010; evaluate frequency in 2013.	Resume in 2013 or later depending on vegetation conditions.	Karen Allen, UofO.	In-kind from UofO field ecology course.	2007 (Grid #1), 2008 (Grids #2,3), 2009 (Grids #4,5), 2010 (Grids #1,2,3)	Independent UofO work not coordinated by UDWC or DLT.
Riparian Plant Survival	1, 2, 3, 4	Belt transects perpendicular to channel. 2010 Camp Polk Vegetation Monitoring Report.	2010 and 2011 Camp Polk Vegetation Monitoring Reports written by UDWC intern	Twelve stratified randomly located transects in riparian beltwidth	Summer	Annually	2010 - 2011	UDWC	Labor for field work and write-up; Contract with Karen Allen (2010 and 2011)	2010	Discontinued in 2012 due to abundance of vegetation and inability to distinguish planted individuals and detect dead plants.
Invasive Weeds - **Revisit December 2012**	3	Direct observation focusing on targeted species. 2006 Weed Monitoring and Evaluation	Annual DLT report summarizing Weed Management Plan, Weekly Weed Monitoring Reports and Monthy Accomplishments	Restoration project area delineated by implementation boundary on implementation schematics (2009)	Spring, Summer, Fall	Annually	Funding through 2013. Should continue as long as possible	DLT	Labor for weed removal including manual and herbicide applications, materials and reporting.	DLT 2006	Annual Weed Management Plans
Macroinvertebrate sampling	1, 5	Level 2 Benthic Macroinvertebrate survey. 2009 Whychus Creek Monitoring Technical Report.	Excerpted from annual Whychus Creek Monitoring Technical Report by Monitoring Coordinator.	Two original sites (UDWC 2009); two sites in new channel established in 2011 (UDWC 2011)	Third week of August	2005, 2009, 2011, 2012; Annually depending on status and trends	2011-2017	UDWC	Labor for write-up and/or in-kind.	UDWC 2005	Camp Polk sites are a subset of the Whychus Creek Model Watershed Monitoring
Fish Habitat	1	Refer to Camp Polk Restoration Plan Appendix B and E	Excerpted from annual Whychus Creek Monitoring Technical Report by Monitoring Coordinator.	Within project reach, as determined by PGE, ODFW and UDWC	Summer	1997; 2008-2009; 2013	Evaluate need for additional surveys after 2013 pending further changes to system	PGE, ODFW, UDWC	Labor for field work and write-up	ODFW 2008-2009	Camp Polk sites are a subset of the Whychus Creek Model Watershed Monitoring
Fish Populations	1	Refer to Camp Polk Restoration Plan Appendix B and E	Excerpted from annual Whychus Creek Monitoring Technical Report by Monitoring Coordinator.	Within project reach, as determined by PGE, ODFW and UDWC	Spring, Summer	Annually as part of PGE reintroduction monitoring; 2013 ODFW sampling	Continue through 2017	PGE, ODFW, UDWC	Labor for field work and write-up	PGE 2007	Camp Polk sites are a subset of the Whychus Creek Model Watershed Monitoring

#1: Project Goals:

1. Provide 1.7 miles of high quality redband trout, chinook and steelhead spawning and rearing habitat.
2. Restore functioning meadow hydrology, including floodplain connectivity, an increase in the groundwater table and enhanced summer base flow.
3. Restore and enhance high quality riparian wetland habitat along the stream corridor.
4. Provide natural channel stability, including dimension, pattern and profile that meets reference conditions.
5. Decrease stream temperatures to help meet Oregon's State Temperature Standards.

#2: Monitoring Priorities. Priority 1 monitoring is that which helps define project success and for which funding will be prioritized. Priority 2 monitoring is above and beyond that suggested to evaluate the success of the project, but which would provide valuable data if resources are available.

Monitoring Parameter	Goals[1]	Protocol/Citation	Reporting	Location	Season	Frequency	Duration	Lead	Annual Budget	Baseline	Notes
Priority 1[2]											
V. Photographic Monitoring											
Photopoints	1, 2, 3, 4	Established photopoints using DLT protocol.	Annual photo management by DLT; Photopoint binders (2008 pre-implementation photos, 2009 and 2010 Phase I implementation photos)	Various points throughout Camp Polk Meadow Preserve that are good vantage points of the restoration project area.	Summer	Set up in 2008 (year 1); repeated in 2009 Immediately following construction (Year 2); 2010-2015 (Years 3-8)	Continue through 2017	DLT	Labor for field work and write-up	2008 and/or 2009	Photo points were established in 2008 and modified after phase 1 construction. After phase II, we will reassess if all photopoints should be monitored in the future.
Aerial photos	1, 2, 3, 4	Check with Deb Quinlan annually regarding availability from stock (Bend Mapping and Blueprint) or low elevation from USFS	Retain in UDWC GIS library	Whole site	Summer	Annually as available	Continue as long as possible	UDWC		2008 NAIP	
Priority 2 [2]										2004?	
VI. Supplemental Monitoring											
Bird surveys – presence and breeding data	3	Spring/fall migration counts, Christmas Bird counts, Breeding bird atlas surveys	DLT, intern, or volunteer	Throughout meadow and existing & new riparian corridor	Spring, summer, fall, winter	2000 (pre-implementation); Annually 2008-2017	2008-2017	DLT	In-Kind	DLT 2000	
Vegetation Community Mapping	2, 3	USACE Wetland Delineation or GPS mapping of wetland areas and communities.	Whychus Creek Restoration Project: Vegetation Monitoring Report 2010	Throughout meadow, as in 2007	Spring, early summer	Once, post phase II construction.	Evaluate - 2017?	UDWC	Labor for field work and write-up. Contract with Karen Allen.	Wetland Delineation (2007)	Complete mapping as long as possible after Phase II construction.

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Appendix:	B
Title:	Upper Deschutes Watershed Council Camp Polk Stream Restoration Project Groundwater Monitoring Well Installation
Prepared by:	Kristine Senkier
Date:	May 21, 2007

On May 21, 2007, the Upper Deschutes Watershed Council installed 7 groundwater monitoring wells in Camp Polk Meadow. The following is the identification information and data for each well.

Cross Section 1

Monitoring Well 1 (start card #191827)

- Installed to 10 ft.
- Groundwater level was at 5.0 ft during installation
- 0 to 5 ft sandy loam
- 5 to 7.5 ft sand and gravel
- 7.5 to 10 ft gravel (1 to 2 inch diameter)

Monitoring Well 2 (start card #191828)

- Installed to 10 ft
- Groundwater level was at 5.0 ft during installation
- 0 to 5 ft sandy loam
- 5 to 10 ft gravel (1 to 2 inch diameter)
- 8.5 to 10 ft clay with gravel

Cross Section 2

Monitoring Well 3 (start card #191829)

- Installed to 10 ft
- Groundwater level was at 4.5 ft during installation
- 0 to 3 ft sandy loam
- 3 to 5 ft sand and gravel
- 5 to 10 ft coarse sand and gravel
- 7.5 to 10 ft larger gravel with little clay

Monitoring Well 4 (start card #191830)

- Installed to 9.5 ft
- Groundwater level was at 9.3 ft during installation and then came up to 9.1 within a few minutes
- 0 to 3.5 ft sandy loam
- 3.5 to 10 ft gravel

- Soft layer at 8.0 ft
- Stopped at 9.5 ft due to a hard layer

Monitoring Well 5 (start card #191831)

- Installed to 10 ft
- Groundwater level was at 7.0 ft during installation
- 0 to 7 ft sandy loam
- 7 to 9 ft gravel
- 9 to 10 ft boulders (hard layer)

Monitoring Well 6 (start card #191832)

- Installed to 9.8 ft
- Groundwater level was at 5.5 ft during installation
- 0 to 7 ft sandy loam
- 7 to 9 ft gravel
- 9 to 9.8 ft boulders (hard layer)

Monitoring Well 7 (start card #191833)

- Installed to 9.5 ft
- Groundwater level was at 6.0 ft during installation
- 0 to 7.5 ft sandy loam
- 7.5 to 9 ft gravel
- 9 to 9.5 ft boulders (hard layer)