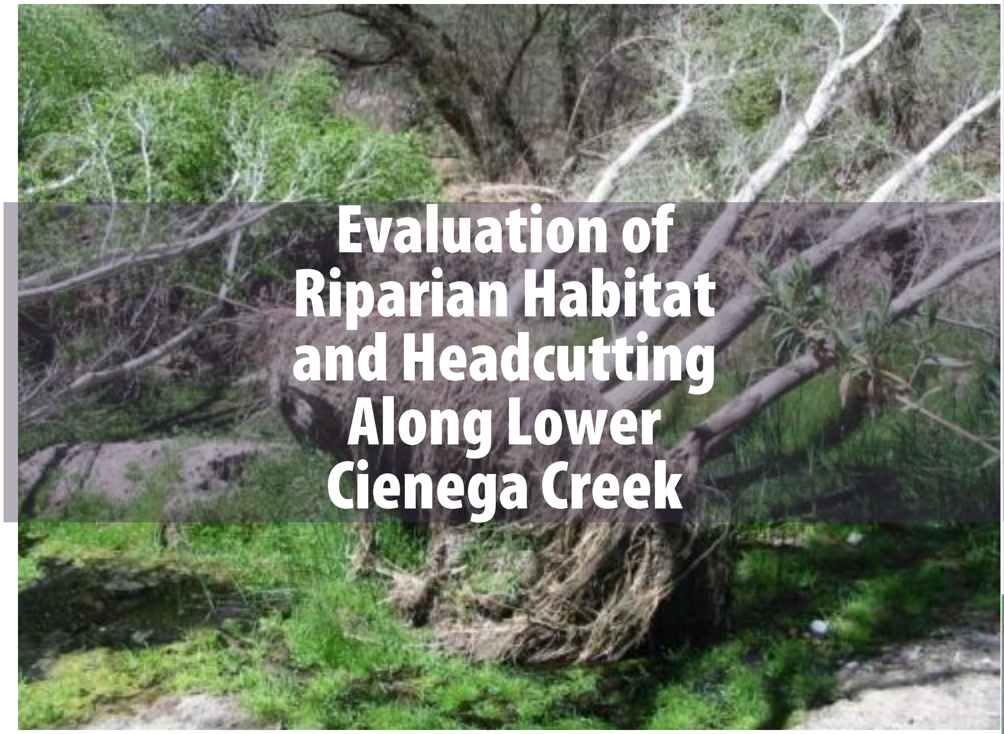


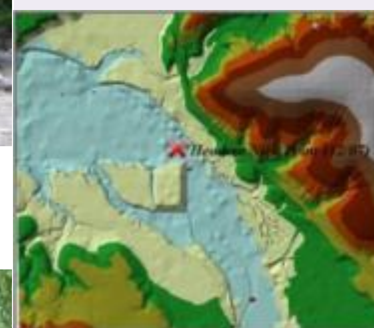
Evaluation of Riparian Habitat and Headcutting Along Lower Cienega Creek

Pima Association of Governments

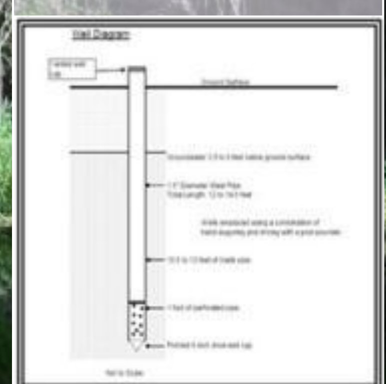
Final Report

Task #7

Submitted March 2010



Arizona Water Protection Fund
Grant #07-144



The Arizona Water Protection Fund Commission has funded all or a portion of this project. The views or findings presented are the Grantee's and do not necessarily represent those of the Commission, the State, or the Arizona Department of Water Resources.

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List of Acronyms and Terms (for the purposes of this study)

ADWR	Arizona Department of Water Resources
CFS	Cubic feet per second
Cross-Section	Geomorphic contours measured perpendicular to the streambed depicting the shape of the entrenched channel.
Diurnal Fluctuation	Daily fluctuation of groundwater due to cycles of vegetation evapo-transpiration
DTW	Depth to groundwater
Geomorphology	The physical shape of the land formed by the geology, erosion and aggradation of sediments
GPS	Global Positioning System: used to measure and record locations
Headcut Branches	Additional erosion channels stemming from the primary streambed channel
Headcut Zones	1) Downstream: the headcut has already widened the stream and is somewhat stable 2) Active: consists of areas affected from 2002 to 2007 where deepening entrenchment has, or is, occurring 3) Upstream: does not have any signs of headcutting and is typical of unaffected steam reaches
Headcut	An erosion feature that entrenches a stream channel and moves longitudinally upstream over time
Hydrologic Unit	A segment of stream which can be classified by having distinct aquatic habitat types, i.e. riffles, runs and pools. This concept is taken from part of the McCain et al (1990) channel habitat classification system. *Note 10 feet was chosen as the smallest size unit for this study
Nick Point	A sudden drop in elevation (break in the slope) of a stream at the head of an erosion feature
PAG	Pima Association of Governments
Piezometer	Water level logger, placed in the well to measure water levels and record the measurements on regular intervals, for subsequent download
Pool	A portion of the stream exhibiting comparatively still water, generally scoured to have a broader and deeper profile than the rest of the streambed
Riffle	A portion of the stream exhibiting turbulent, swiftly moving water and generally having winnowed sands in the thalweg portion of the streambed
Run	A portion of the stream exhibiting smooth flowing water, varying between having laminar flow to having small wave forms exhibiting a concentric wave pattern if a rock is dropped into it, and also showing 80% fines in the thalweg
Substrate	The material composing the streambed, either on the surface or directly underlying the surface
Thalweg	The fastest flowing and deepest points along the length of the stream, defining the channel
Vegetative cover	For the purposes of this study: Overstory density of the canopy within 10 feet of the stream bank and over five feet tall
WL BLS	Water level below land surface

Acknowledgements

Pima Association of Governments would like to thank the Arizona Water Protection Fund Board of Directors for funding this research. In addition, we are very grateful to Pima County Regional Flood Control District and in particular, to Julia Fonseca, David Scalero and Loy Neff, for assistance on this project and for long-term support of our work in Cienega Creek, without which this investigation would never have been possible. Special thanks to Jeff Trembly - Mogollon Environmental, for providing guidance and technical expertise for installing the piezometer wells and to the many volunteers that helped with the installation including the Master Watershed Program. We have been very fortunate in this work to collaborate and learn from a variety of biologists and hydrologists, including Gita Bodner - Tucson Nature Conservancy, Jeff Simms - Bureau of Land Management, Julie Stromberg - Arizona State University, and Iris Rodden - Pima County. Special thanks also go to Don Carter, Pima County, for sharing his knowledge of the creek on numerous field trips and for providing GPS information detailing the stream location. Finally, we would like to thank Staffan Schorr, who previously worked with PAG, for putting together the original grant application and provided great insight and knowledge about the creek.

Executive Summary

Pima Association of Governments' (PAG) Watershed Planning Program began a short-term study in 2007 to better understand the unique dynamics of a feature of major erosion on lower Cienega Creek. This stream, located in the arid region of southeastern Arizona, is undergoing sediment transition through a process called headcutting. Funded by an Arizona Water Protection Fund grant (#07-144), PAG evaluated the headcut's impact on the hydrology and the riparian habitat of the Cienega Creek Natural Preserve.

Background:

Cienega Creek is an important water, recreation, and wildlife resource in the Santa Cruz River watershed. It is one of the few low-elevation streams in Pima County with significant perennial flow. The watershed receives about 16-20 inches of rain per year, primarily in summer monsoons and winter rains. The contributing watershed is 456 square miles. Peak flows at the Del Lago Dam stream gage show that the baseflows of 2 cubic feet per second (cfs), rise up to 10,500 cfs during big storm events, causing major movement of sediments. Perennial reaches of Cienega Creek support native fish and the surrounding riparian vegetation provides habitat for a diversity of wildlife. In recognition of its value to the state of Arizona, the reach of Cienega Creek downstream from Interstate 10 to Del Lago Dam has been designated by the Arizona Department of Environmental Quality (ADEQ) as an "Outstanding Water," (R18-11-112) which means that site-specific standards are established to maintain and protect the existing water quality.

Pima Association of Governments (PAG) has consistently monitored the hydrology in Pima County's Cienega Creek Natural Preserve since 1989. The Preserve includes lower Cienega Creek and portions of lower Davidson Canyon. The reach designated an "Outstanding Water" is the focus of this monitoring program. Regular monitoring of groundwater levels, surface flow length and stream volume is conducted so that long-term trends are firmly established and conditions documented for in-stream flow rights. The certificate of in-stream flow rights was granted by the Arizona Department of Water Resources (ADWR) to Pima County Regional Flood Control District in December 1993 (No. 89090.0000).

The Problem:

The Cienega Creek watershed is experiencing transition of sediments and morphological change. In 1999, PAG and other researchers identified several headcuts developing along Lower Cienega Creek. A headcut is a localized erosion feature characterized by a discrete step change in channel bed elevation. These features migrate upstream until equilibrium or a barrier is reached. A study by the Arizona Department of Environmental Quality, which was funded by the Water Protection Fund (grant #90-068), confirmed that Lower Cienega Creek is impaired with sediment. The impairment is characterized by highly erosive stream channels and continuous adjustments to the creek's flow regimes.

In Lower Cienega Creek, where the stream channel is highly erosive and continues to adjust to the creek's flow regimes, sediment imbalance is particularly evident. One headcut in particular was incising quickly through an area with dense riparian vegetation and lush wetland. At the time of the grant proposal, the headcut had already migrated over 1,200 feet upstream and had entrenched five feet deep by 20 feet wide, within a 5 year time frame. Water levels in nearby wells had declined by as much as five feet in a relatively short time period, causing much of the upstream wetland of the headcut to dry out. The impacts by the large headcut on aquatic habitat and riparian resources needed to be studied to know if this was a natural process of equilibration of sediments or if it was a threat to the habitat, before land managers could decide whether capital improvement was necessary.

Monitoring Study:

The primary components of the project included a habitat survey, hydrologic monitoring, a geomorphic survey and public outreach. PAG conducted this research over a two year period.

The habitat survey was conducted annually along a four-mile reach of Cienega Creek. A habitat typing classification system using riffle:pool ratios, also used by the Bureau of Land Management on upper portion of the Cienega Creek watershed, was applied to assess native fish habitat conditions upstream and downstream from the large headcut. The investigation also included an analysis of fish distribution, pool sizes, dominant substrate and vegetation health. Vegetation was surveyed to assess dominant species, presence of invasive species, amount of tree mortality and vegetative cover.

The hydrologic monitoring program consisted of streamflow and groundwater level measurements at locations upstream and downstream from the large headcut in order to contrast the hydrologic conditions. Two shallow monitor wells were installed to assess changes in water level as the headcut migrated upstream. Piezometer data from the wells was analyzed for evapo-transpiration effects, seasonal change of groundwater and gradient of the water table between the wells. Precipitation data was also factored in using Pima County rain gages.

Geomorphology was measured in cross-section profiles perpendicular to the stream and was mapped over time by GPS as the nick point progressed longitudinally up the stream.

Results:

The Cienega Creek Headcut Study allowed us to evaluate the hydrology and habitat of the creek and how it changed with the rapid migration of the headcut. Over the two year study period, the headcut nick point advanced over 2, 000 feet upstream and the channel grew up to 12 feet deep.

The headcut showed an effect on many aspects of the study including the slope of the water table, the expression of surface flow, the distribution of sediment substrates, and the density of vegetation cover.

Several differences were found in habitat in the upstream, downstream and active zones of the proximal study area. These differences in habitat characteristics represent the unique conditions of the headcut migration stages that have been recorded since 2001. The second annual habitat survey confirmed many of these findings and helped to establish a baseline dataset.

It appears that this natural process will reach equilibrium by restoring more frequent streamflow and therefore more fish habitat to the study area in the long term. In addition, the short term benefit is that fish habitat diversity is increased during the active headcutting stage.

Several trade-offs of habitat transition presented themselves through this erosion process. The erosion has negative impacts such as reducing vegetative habitat and reducing shallow aquifer storage. In the upstream zone, although the sediment buries subflow removing aquatic habitat, more riparian vegetative cover is found which provides beneficial shade to the stream. Another trade-off is that although older, larger fish and potentially Chub (a rare endangered species of fish) favor the pool habitat provided temporarily by active headcut zone; runs are also important habitat to support fish - particularly top minnow, the endangered species of fish that appears to be more stable in Lower Cienega Creek than in the upper watershed.

Because this type of investigation has not previously been conducted in an arid environment, there is added scientific merit to the project. An increased steepness of the water table gradient was observed in the dry spring season. This dewatering of the aquifer appears to be associated with a loosening of sediments and subsequent erosion. This gradient effect, plus the impact that dry weather has on root zones, explains why large rain events (typical in our region) have the greatest ability to create large sediment transit when preceded by a long dry spell. In addition, this study is uniquely important to understanding intermittent arid streams, because the length of flowing segments through the year is dependent on the water table gradient and the accumulation of sediments.

Outcomes:

In addition to gaining a set of baseline data for this study area and assessing change that happened in the two year period, we have established unique field methods for this system and a field guide for repeating the methodology.

This project has increased public awareness of management issues for this valued resource near the Tucson urban area. In partial response to our outreach efforts, members to the Sky Island Alliance and the Cienega Watershed Partnership have created a restoration network and demonstration projects for stabilization of the uplands of the watershed.

Recommendations:

A part of this study's goal was to assess the need for additional studies and capital improvements along the creek. Due to the delicate nature of the creek, we cannot make a recommendation to create in-creek sediment stabilization. Stabilization of the wetland may help to preserve the vegetation of the wetlands and slow the flow of water through the system but if instead the stream is left to continue the erosion process, the erosion may create natural recovery of the surface water and aquatic fish habitat. Further monitoring for invasive species encroachment and continued monitoring of the erosion and hydrology is recommended for analysis of long-term change.

The management goals for the Cienega Creek Natural Preserve are to keep in-stream flows, maintain the shallow groundwater to sustain riparian trees and preserve native species. We therefore recommend a continued investigation into measures that will maintain or restore native riparian vegetation and habitat, stream geomorphology, channel characteristics, and floodplain functions. This may be best pursued by conservation of the shallow groundwater levels and by preserving the health of upstream portions of the watershed. Pima County Regional Flood Control District is investigating erosion control measures in the roadways and degraded drainages of the tributary arroyos to Cienega Creek in order to control the sediment inputs of the uplands.

Evaluation of Riparian Habitat and Headcutting along Lower Cienega Creek

Background

Cienega Creek is a critical wildlife, recreational and water resource located just east of Tucson, Arizona. It remains one of the few low-elevation perennial stream reaches in southern Arizona. The portion of the creek that is being evaluated in this study was classified as outstanding state resource water when it was designated a *Unique Water* by the State. In addition, in 1986 Pima County designated this stream reach as the *Cienega Creek Natural Preserve* in order to protect and preserve the natural resources of the creek.

Under contract to Pima County, Pima Association of Governments (PAG) has been monitoring the surface and groundwater hydrology of Cienega Creek since 1989. In the late 1990s, PAG staff noted that a large headcut was developing near the center of the *Natural Preserve*, and that the headcut was systematically migrating upstream. By 2001, researchers noted that the Cienega Creek headcut had continued to migrate upstream and had grown to be two feet deep and three feet wide. By 2004, the scar had increased to five feet deep and more than 30 feet wide and had migrated further upstream.

Headcuts develop when the channel gradient is out of equilibrium, causing a radical morphological accommodation. The Cienega Creek headcut migration has resulted in massive sediment and habitat removal as the headcut migrates through the system. Large, well established trees have been undercut and have fallen and numerous stream bank cuts have become steep and unstable. Although visual observations indicated dramatic changes to habitat and stream hydrology, PAG undertook an investigation of the process in order to quantify and describe the extent of change to the creek system. The broader hope was that the study of the Cienega Creek headcut would provide insight about how headcuts impact riparian areas in arid environments in order to help land managers better assess their needs and priorities.

Project Summary

In 2007, PAG received Arizona Water Protection Fund Grant #07-144 in support of a two-year study of the hydrology and habitat changes associated with headcut migration in Cienega Creek. PAG gained support from, and coordinated with, local experts at U.S. Fish and Wildlife Service, University of Arizona, Arizona State University, the Master Watershed Steward program, Pima County Natural Resources, and the Bureau of Land Management to create the study plan, establish field methods and gain input and feedback while the study was conducted.

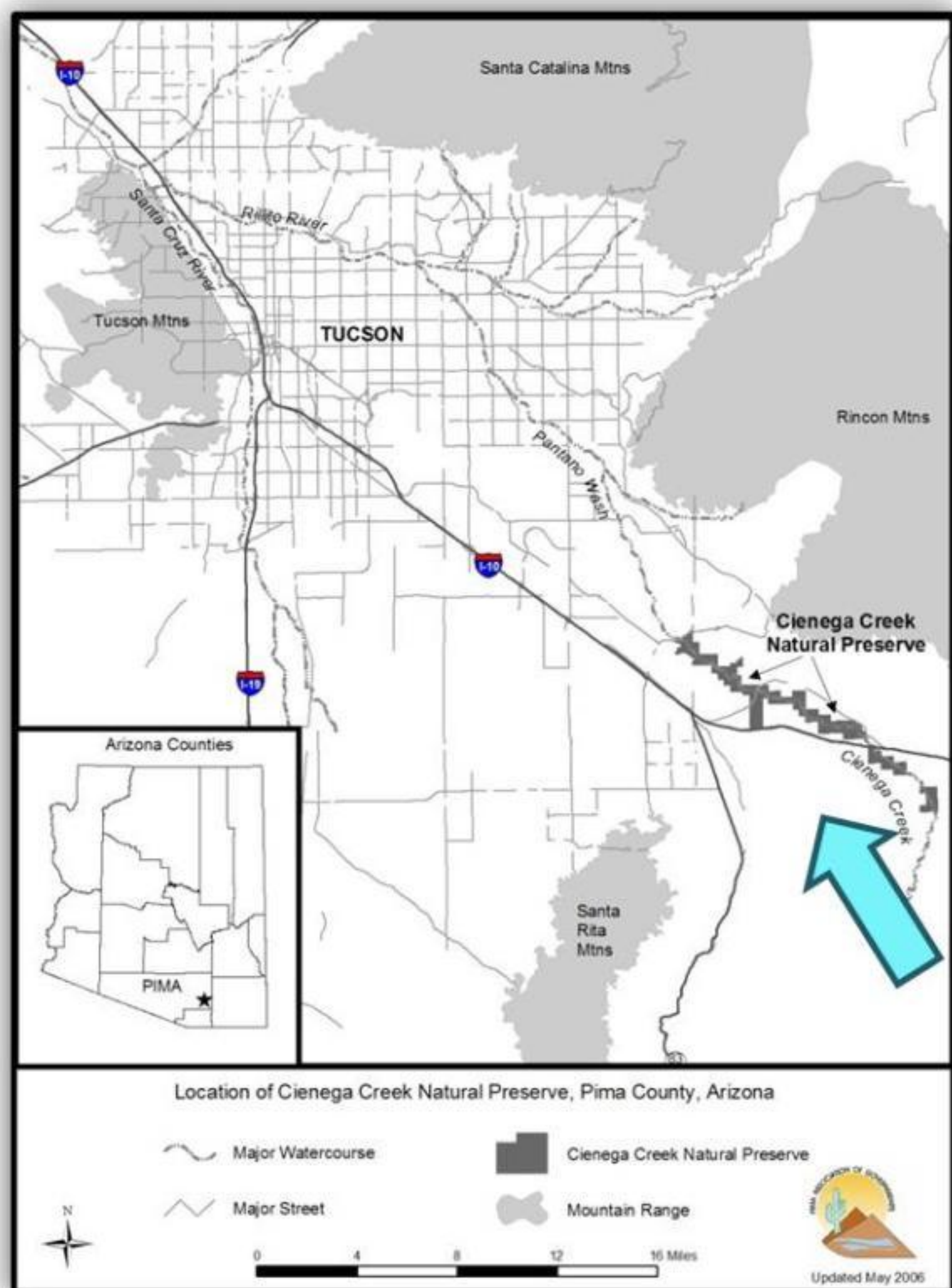
Documenting the extent of headcut migration and the physical changes along the creek were critical parts of this investigation. During each field visit, PAG recorded the nick point, showing over 2,000 feet of progression upstream since the study began. In addition, numerous photographs were taken to document vegetation and geomorphological changes at 15 different locations within the headcut study area. Lastly, transects across the creek were measured annually to document the width and depth of the headcut at the location of the wells and the headcut branches.

PAG focused on hydrologic monitoring and habitat evaluation as a means of characterizing the headcut and documenting changes over the two-year study period. Hydrologic monitoring consisted of measuring streamflows above and below the nick point and measuring water levels by installing two shallow piezometer wells within the streambed. By installing two wells, PAG could calculate the hydrologic gradient upstream from the headcut. Water level changes upstream from the area of active downcutting showed how the upstream water table was affected as headcutting progressed. Habitat monitoring consisted of classifying the structural habitat, surveying vegetation composition and cover, and assessing the aquatic life conditions within a two mile stretch of Cienega Creek in the headcut area. This was supplemented by identification of pools along an additional two miles of the creek and conducting wet/dry mapping throughout the preserve. Consistent with other area researchers, determining the structure of the creek (riffle, run and pool morphology of the hydrologic units) helps to assess the favorability of the stream for aquatic wildlife habitation.

Because Cienega Creek is one of the few perennial streams in the region and because it is host to a pristine riparian habitat, this study is of interest to researchers, management agencies and the general public. By coordinating with other researchers in the region during the design phase of the project, we were able to raise awareness about our work and to benefit from the experience of others. We also presented the project at a professional meeting, the 2007 AZ Hydrologic Society Annual Symposium, in an effort to distribute information about the unique study opportunity. The primary land management agency, Pima County Regional Flood Control District, received numerous updates about our progress and frequently accompanied us in the field. Likewise, reports have been shared as the work progressed and findings have been provided at PAG meetings, local interest group meetings and through field trips.

As drought and climate change have posed increased concerns in Arizona, PAG's Cienega Creek work, including our headcut study, has received greater interest. As part of our Local Drought Impact Group, PAG reports drought indicators, including habitat and hydrologic changes that occur on the creek. The Cienega headcut information has augmented existing data and continues to be useful when assessing drought impacts to the creek.

Figure 1: Location Map for the Cienega Creek Headcut Study



Methodology

Headcut Migration

Headcut migration is responsible for dramatic erosional features such as steep stream banks, undercut vegetation and bifurcated stream channels. These features were photographed in order to compile a qualitative record of the geomorphic changes. Photo-point records were documented in the hydrologic monitoring reports during the course of this study. The photo-point survey was also used to record the vegetative community and the stream structure at various GPS locations. The full photo dataset has been included in previous reports and is available electronically upon request from PAG.

<u>Geomorphic Contours</u>

Geomorphic contours were measured to assess change across the two transect cross-sections in the active headcut area in spring 2008 and spring 2009. This consisted of transects of each fork or channel at each well location. The cross-sections were measured by establishing points on two trees at opposite sides of the creek and then running a measuring tape at a level height between them. Channel geomorphic data included recording basic channel characteristics (depth and incision width) to record the physical effects of headcutting. We also used a GPS to record the location of bank edges. The longitudinal length of the headcut migration was assessed through GPS location recorded quarterly in March, June, September, and December throughout the entire study period.

Headcut Erosion on Cienega Creek

Erosion along the creek has caused undercutting of trees resulting in tree fall and loss of overstory canopy vegetation.

These two photos are from Repeat Photography Site 7, the location of the nick point in 2001 and the intersection of the primary channel with the middle branch. These were taken during the annual habitat surveys in March 2008 and 2009. The headcut is currently about 10 feet deep at this location (last measured in 2010).

Headcut Erosion on Cienega Creek, contd.

The nick point is located at the upstream end of the headcut. This is the point we locate using GPS in order to track the upstream migration of the feature.
These two photos were taken at Repeat Photography Site 11 and demonstrate channel deepening. The headcut grew from 3 to 5.5 feet deep at this location. The first photo is from May 2008 and the second from November 2009.

Erosion caused cut banks to form that measured over 15 feet in height in some places. Dewatering in the bank cut areas causes loss of vegetation along the creek, furthering the potential for erosion into the stream banks.

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Figure 2: Repeat Photography Sites Along Cienega Creek

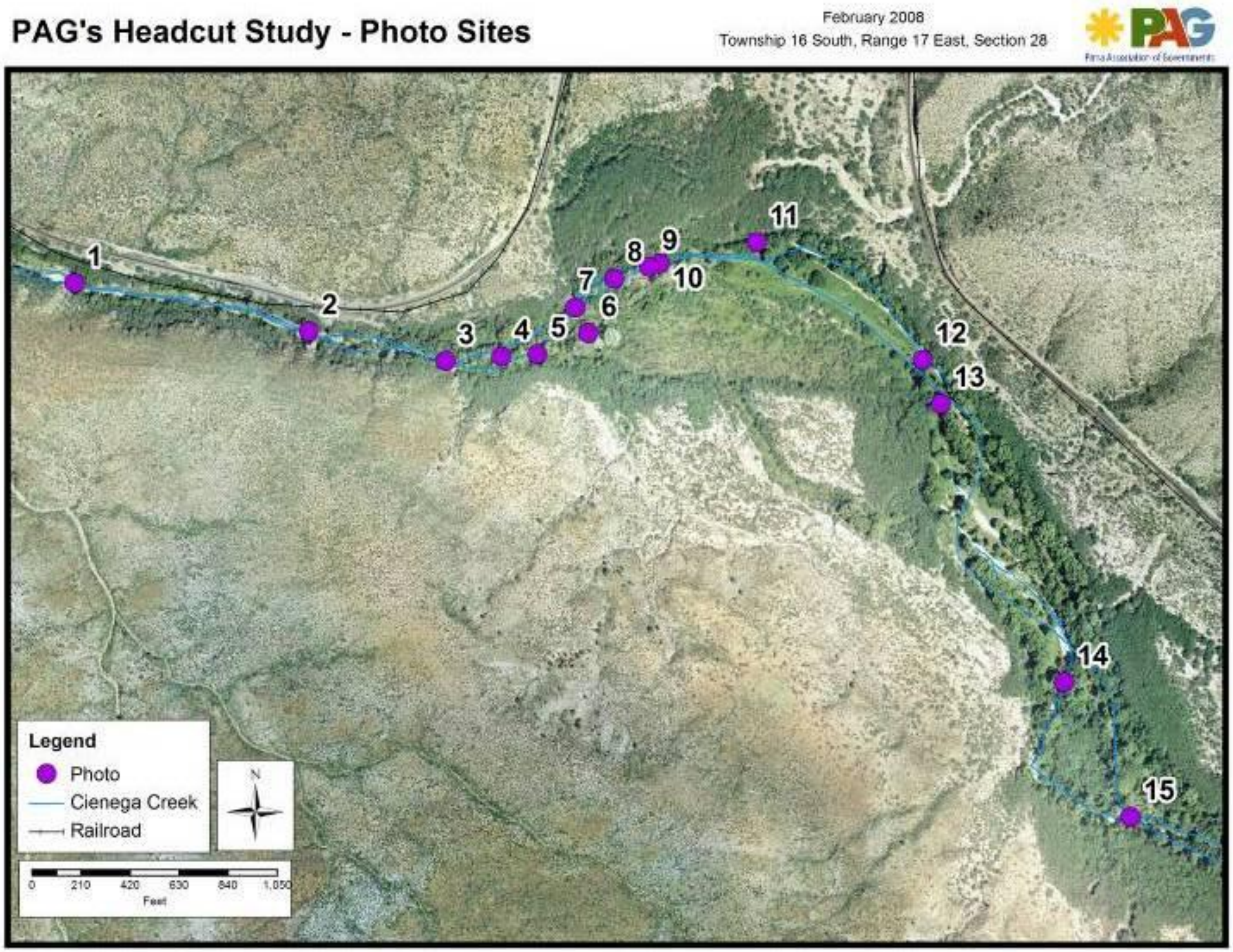


Table 1: List of Photographs Taken at Each Site

Photo Trip Date	Site ID#														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
2/7/08		X	X	X	X		X	X	X		X	X	X	X	X
3/18/08	X				X	X	X	X		X					
3/25/08						X									
5/6/08													X	X	
5/26/08		X								X	X	X	X	X	X
6/12/08	X			X	X	X		X		X					
6/24/08			X	X	X	X	X	X	X						
7/15/08													X	X	
7/22/08		X													X
8/26/08													X		
9/16/08				X	X		X			X	X				
11/18/08		X	a	X	X				X				X	X	X
12/29/08		X				X	X			X					
1/28/09													X		
3/4/09				X	X		X	X	X	X		X			
4/16/09													X	X	
5/11/09		X	X	X	X				X						X
6/11/09							X			X					
6/12/09													X	X	
7/28/09		X				X						X			X
8/26/09				X											
9/23/09				X	X	X	X	X		X					
11/17/09	X	X	X	X					X	X	X	X	X	X	X
12/7/09					X	X	X	X		X					
Total Photo Trips[1]	3	8	4	10	10	8	9	7	6	10	4	5	10	8	7

a = Site 3 photo taken on Nov. 18, 2008 was not included in final report folder due to blurry photo (river left)

[1] = This number does not denote how many photos were taken per site on each trip

Hydrologic Monitoring

Hydrologic monitoring included measuring streamflow at two locations along Cienega Creek and measuring water levels at two piezometer wells, on a quarterly basis (locations on Table 2 and Figure 3, dates visited on Table 3). Hydrologic parameters were used to evaluate how changes in streamflow, water levels and water table gradients change as the headcut migrates upstream.

Table 2: Monitoring Site Locations and Visitation Frequency

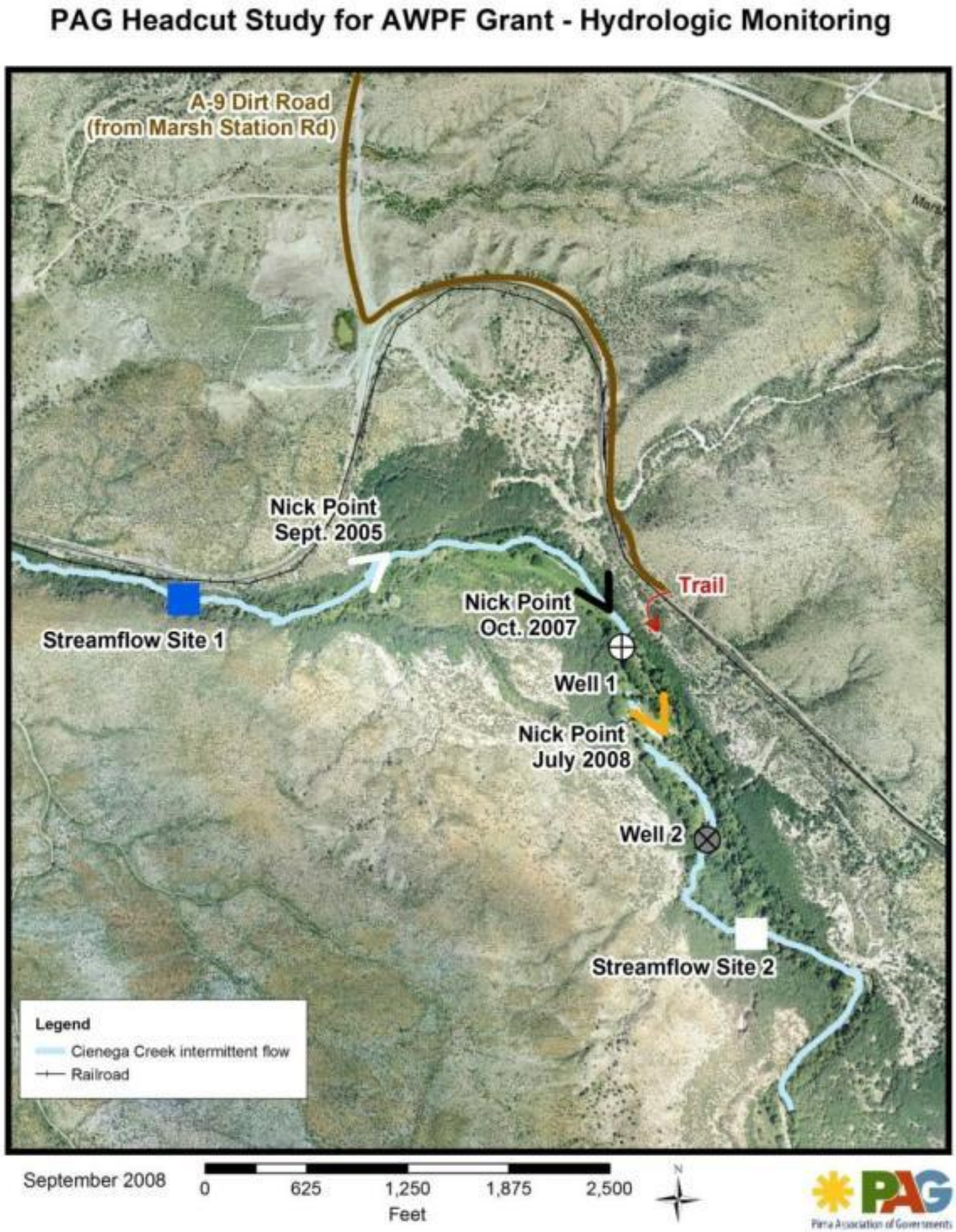
Monitoring Sites	Monitoring Frequency	Site Characteristics	Latitude/ Longitude *
Streamflow 1	Quarterly, plus four measurements during the rainy season each year	Downstream of headcut nick point, 1800 ft downstream of Railroad Wash	1100335.17694112 W 370743.743246383 N
Streamflow 2		Upstream of headcut nick point location in Feb. 2008,. 850 ft upstream from Well 2	1103900.14534911 W 368652.369382525 N
Barologger	Measured every five to 30 minutes, downloaded quarterly	On railroad access road just before canyon dip, on fence post	1103030.54445829 W 371472.946695868 N
Well 1		The downstream transducer: River left by canyon wall downstream of tree	1103065.97445847 W 370412.743989543 N
Well 2		Where stream merged from split going downstream, in middle island closer to channel on river right	103637.03851275 W 369211.163147462 N

**NAD 1983 HARN State Plane Arizona Central FIPS 0202 Feet. Locations captured using a Trimble GeoXT 2005 Series with sub-meter level accuracy represented in decimal degrees.*

Streamflow

Throughout the course of the study, PAG measured baseflow of the stream at locations upstream and downstream from the headcut along Cienega Creek (Table 2, Figure 4). Beginning in spring 2008, streamflow was measured quarterly at the two sites. Monitoring locations are shown on the attached site map. When there was not any flow during quarterly visits, the lack of flow was documented, and up to four additional visits were made annually during seasonal flows. We did not record streamflow within three days of rainfall, in order to capture clear baseflow and not storm events in the stream volume. Streamflow was measured in the field using a Pygmy meter (model 6205), on which the velocity is determined by counting the rotations in a 30-second time period. The flow velocity was measured at several intervals along a single stream transect. At each interval, we measured the depth of the water and the position along the transect width in order to calculate the area of flow. Streamflow was calculated by a standard midsection method with the formula Q = Va (Q is streamflow discharge, V is velocity, a is area).

Figure 3: Map of Hydrologic Monitoring Points



Groundwater Levels

Piezometer wells were installed at two locations upstream from the headcut in Cienega Creek. The well locations are shown on the attached site map. Water levels were automatically recorded by transducer data loggers in five to 30-minute increments. Records from the two transducers and a nearby Barologger were downloaded quarterly to a laptop. Transducer recordings were started in November 2007 and continued through the end of the two-year study period. Water levels were confirmed by hand measurement with a sounder on a quarterly basis. Depth to water for the entire study period is presented in charts in this report.

The transducers record the level of the water above the position of the transducer in the well. Using the Barologger data to compensate for barometric pressure changes allows us to obtain a truer water level measurement, since barometric pressure can affect the readings. The wells are located on sand banks adjacent to the flowing part of the stream to protect them from flood flows. They have survived monsoon seasons' flood flows, sediment transport, and tree debris movement, though some maintenance has been required.

Installation of piezometer wells

PAG staff, consultant Jeff Trembly, and volunteers install piezometer wells by the hand auger method. Two wells were installed within the creek bed in order to obtain frequent depth to groundwater measurements in the headcut area.

Table 3: Field Monitoring Dates for the Cienega Headcut Study

Work Conducted	Dates												
Installation	10/30/07												
Streamflow Presence/ Absence Noted	2/7/08	3/18/08	4/21/08	5/6/08	5/27/08	6/24/08	7/15/08	7/22/08	8/26/08	9/3/08	9/16/08	10/17/08	11/18/08
	12/12/08	1/28/09	2/20/09	3/4/09	4/16/09	5/11/09	6/12/09	7/28/09	8/26/09	9/23/09	10/14/09	11/17/09	12/21/09
Depth to Water Measured	2/7/08	5/6/08	5/27/08	6/24/08	7/15/08, 7/22/08	9/3/08	1/28/09	2/20/09	4/16/09	6/12/09	7/28/09	8/26/09	11/17/09
Levelogger Downloaded	11/14/07	2/7/08	5/27/08	6/24/08	7/15/08	9/3/08	11/13/08	4/16/09	6/12/09	7/28/09	11/17/09		
Streamflow Measured	2/7/08	5/7/08	7/22/08	8/26/08	11/18/08	2/20/09	5/11/09	7/28/09	11/17/09				
Habitat Survey	3/24/08	3/25/08	3/25/09	3/26/09									
Maintenance	5/27/08	7/22/08	9/4/08	11/18/08	1/28/09								
Photos Taken	12/18/07	2/7/08	3/18/08	3/25/08	5/6/08	5/26/08	6/12/08	6/24/08	7/15/08	7/22/08	8/26/08	9/16/08	11/18/08
	12/29/08	1/28/09	3/4/09	4/16/09	5/11/09	6/11/09	6/12/09	7/28/09	8/26/09	9/23/09	11/17/09	12/07/09	
Cross-Section Measured	5/6/08	6/12/09											

Habitat Evaluation

Site Location

The habitat survey maps identify the stream reaches monitored as part of the surveys. The headcutting migration zones, proximal and extended study reaches, and photo points are identified. Beginning at the downstream end of the study area, we moved upstream as we conducted the habitat survey in the proximal areas. Headcut migration zones had been identified based on records of where the nick point of the headcut migrated over time. In the downstream reach, we see a somewhat stable habitat where the headcut has already widened the stream. The active zone consists of areas affected from 2001 to 2007, where deepening entrenchment has, or is, occurring. Three directions of entrenchment through the old wetland are described as the primary (northern) channel, the middle (second) branch and third (southern/most downstream) headcut branch. While the primary channel headcut developed in 2001, the second and third branches did not develop until 2004. The rate of incising of the third branch began to outpace the second in 2007. The reach upstream of this active zone does not have any signs of headcutting and is typical of unaffected steam reaches.

Survey Methods

PAG staff conducted two habitat surveys within the grant period. The first survey was conducted between March 24^{th} and 26^{th}, 2008 and the second was conducted on March 25^{th} and 26^{th}, 2009.

Attributes Surveyed

Different attributes were surveyed in different portions of the stream. The attributes that were included in the survey are listed here by study area. Photos below illustrate the criteria for these attributes.

Proximal study area

- Riffle lengths measured with Global Positioning System (GPS)
- Pool sizes measured to record the average depth, maximum depth, average width, and length. One measurement of width was taken in uniform pools and three were taken in lobed pools to get an average. Three measurements were taken for average pool depth as well. Pool habitats were defined as beginning where the kinetic energy turns into static energy and ending at the next hydraulic jump point.
- Habitat classification was conducted using BLM standards (McCain et al, 1990). Habitats were classified as run, pool or riffle type for each hydro-morphological unit.
- Visual assessment of vegetation health included noting the presence of invasive species, such as Tamarisk, and exotic species, such as Johnson Grass. Vegetation was observed throughout the riparian floodplain. Additional notes were taken about dominant overstory and evidence for death or recruitment within each hydro-morphological unit. In 2009, the warmer March weather brought earlier leafing of the trees, which we had to factor in when estimating comparable cover.
- The dominant size of surface substrate was noted in stream riffles using the Rosgen et al, 1996, sizing definitions.
- The species and size of fish in pools or other aquatic life, if present, were documented.
- Morphological features were recorded, such as scouring and undercut banks.

Extended study area

The habitat survey's extended area is located along the two-mile reach upstream from the proximal study area, bringing the total longitudinal habitat survey length to four miles in extent.

In the extended survey area, pools were mapped and measured in the field. Vegetative health and the presence/absence of invasive species were visually assessed.

Pool

A portion of the stream exhibiting comparatively still water, generally scoured to have a broader and deeper profile than the rest of the streambed

Run

A portion of the stream exhibiting smooth flowing water, varying between having laminar flow to having small wave forms, and exhibiting concentric wave pattern if a rock is dropped into it, and also showing 80% fines in the thalweg portion of the streambed

Riffle

A portion of the stream exhibiting turbulent, swiftly moving water and generally having sands winnowed out of the thalweg portion of the streambed. Correlated with larger substrates.

Substrates Found at Lower Cienega Creek

	Silt	Sand	Gravel	Cobble
Diameter (inches):	0.0002 - 0.002	0 .002 - 0.08	0.08 - 2.5	2.5 - 10

Overstory Density as seen at Lower Cienega Creek in Spring (March)

No canopy cover

Sparse cover with small groups of trees along banks, none meet

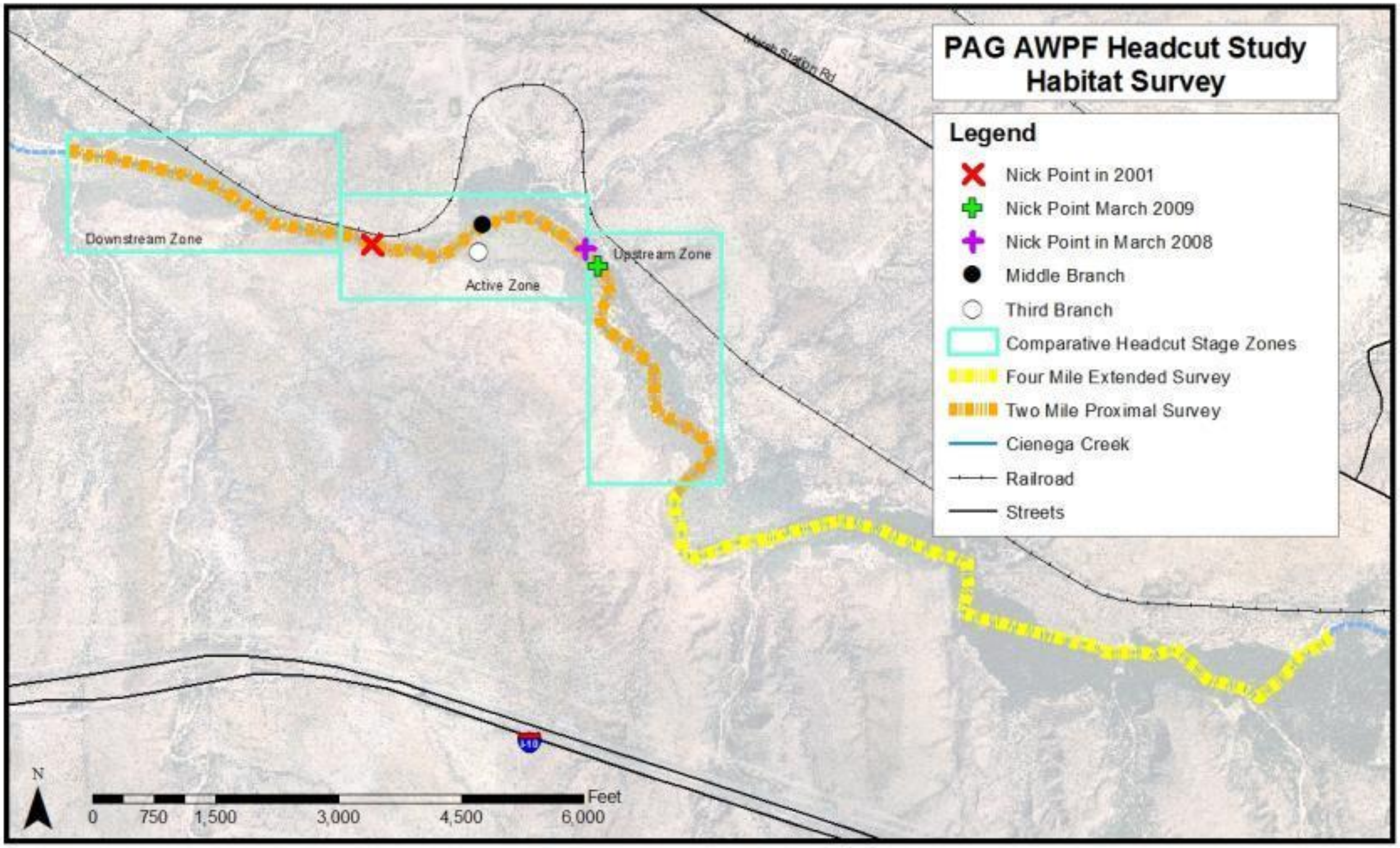
Crowns overlap, dappled light, older riparian growth, adjacent crowns, trees all along banks

Sky less visible, Overlapping branches, Banks lined densely with tall trees and possibly different heights and layers

A few isolated crowns, none meet above channel, Trees at least 5 feet in height

Adjacent crowns just meet, patches of light

Figure 4: Habitat Zones Defined within the Cienega Creek Headcut Study Area



Map revised December 2010

Results

PAG recorded increased erosion in the geomorphology surveys, the seasonal fluctuations in hydrology monitoring and unique habitat types distributed within each headcut zone. The progression of the nick point through the study area showed an effect on many aspects of the study, including slope of the water table, sediment substrates and vegetation cover. However, the nick point did not progress past the study area during our two-year study period. The study results also provide baseline data on effects of evapo-transpiration, pool distribution, and groundwater levels for comparison for future change.

Headcut Migration

Headcut migration was monitored and evaluated through tracking the progression of the nick point, with cross-section profiles at single study sites over time, and by measuring the entrenchment of the headcut branches.

Longitudinal Geomorphology

The longitudinal movement of the headcut is measured by the changing location of the nick point as it migrates upstream. Over the two-year study period, the headcut progressed up to 12 feet deeper at some of our study sites as it advanced longitudinally over 2,000 feet.

The headcut nick point progressed longitudinally upstream approximately 1,000 feet in each study year (see nick point map in Figure 6). It moved sporadically and most dramatically in the rainy seasons. The actual nick point was difficult to determine through the year since it changed from taking in form from a dramatic plunge in 2006 to a gradual incline with undulating sediments in 2007 (Figure 7). The nick point location in December 2007 had the form of a shallow slope of erosion with bank edges of just a few inches. As the gradual slope of erosion traveled upstream, by November 2009, that location of the December 2007 nick point had banks that were 5.35 feet in height.

At the most downstream monitoring site (Streamflow Site 1), the creek bed did not show discernible erosion over the study period. Prior to this study, the headcut nick point had already migrated past Streamflow Site 1. In August and November 2008, Streamflow Site 1 experienced aggradation (sand infill) which originated from scouring upstream from headcutting in the main channel of the creek and tributary washes.

Streamflow Site 2, located at the most upstream extent of the study area, has not experienced major transition yet. In July 2008, we recorded sands shifting at Streamflow Site 2, with one bank side eroding and the other building. By November 2008, the stream had cut one foot down into the built-up sand. The sediments at this site are exhibiting a state of transition. In July 2009, Streamflow Site 2 exhibited a small headcut creating a small channel in the streambed.

Figure 6: Headcut Nick Points Map within the Cienega Creek Headcut Study Area

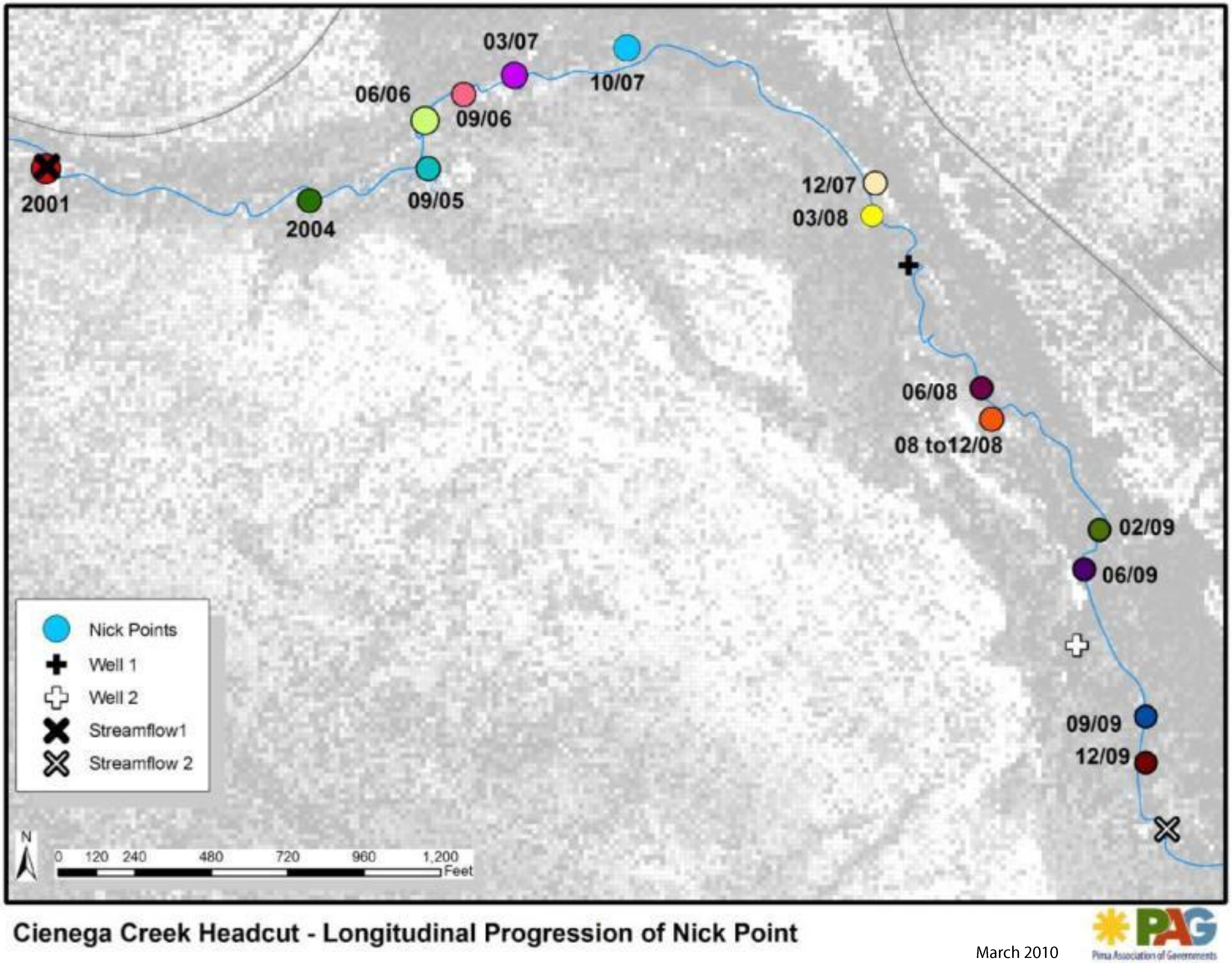
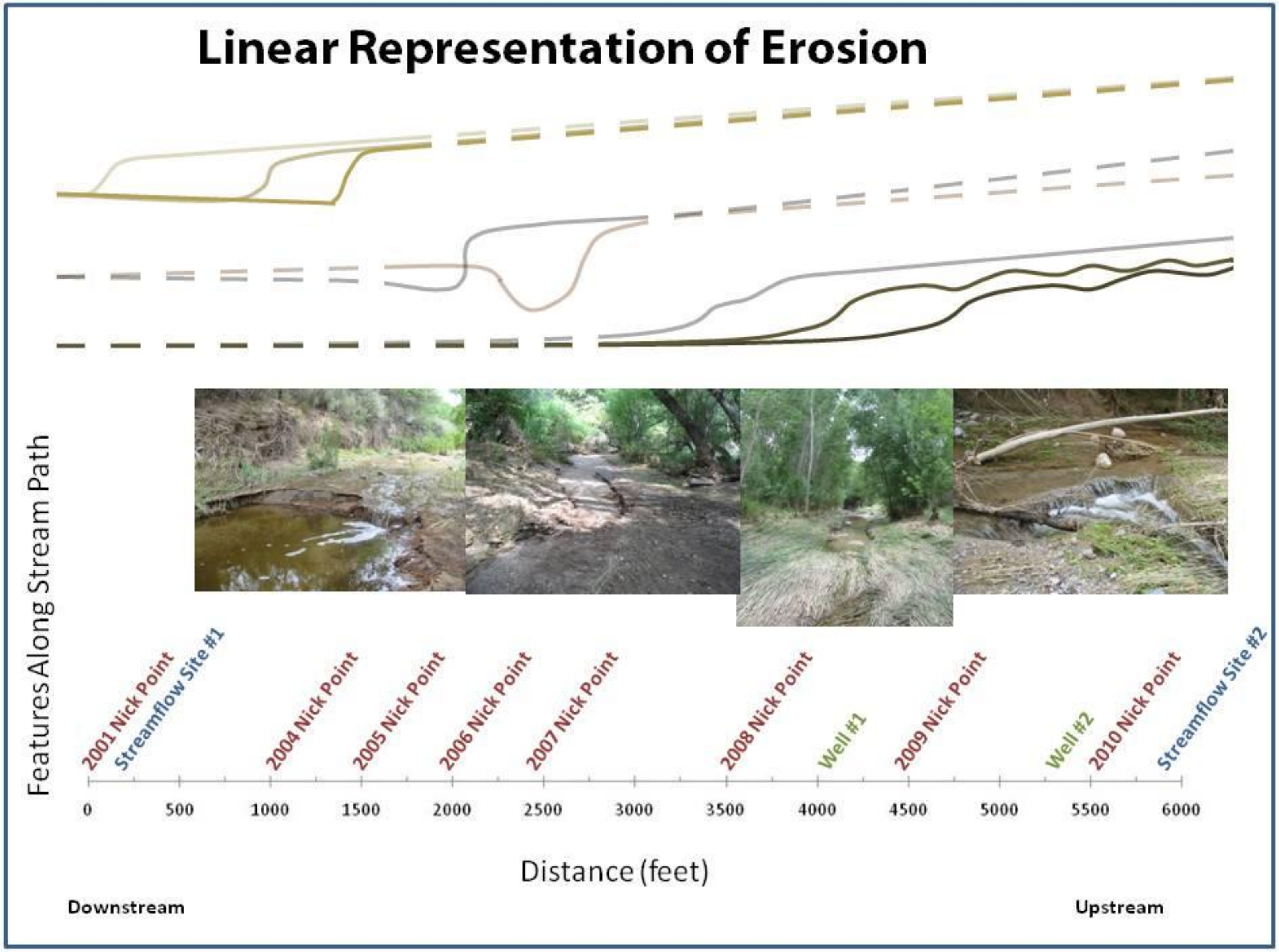


Figure 7: Timeline and Change of Nick Points Shape



Cross-Section Transect Profiles

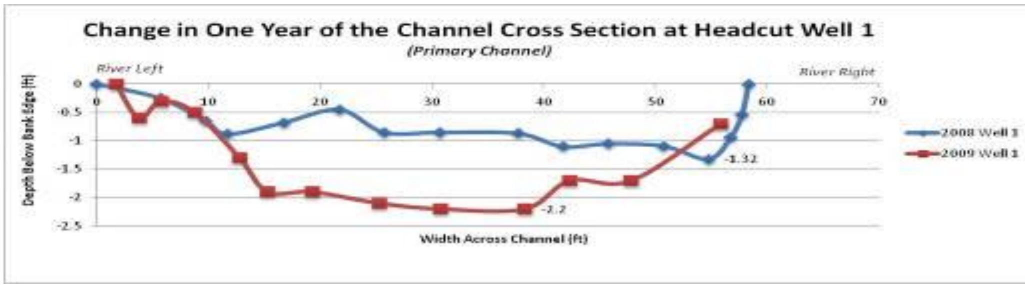
Cross-section measurements recorded the impact of loss of sediments at stationary transects sites. The transect sites were measured in the streambed adjacent to the wells, which were located upstream of the nick point at the beginning of the study period. The entrenchment of the banks at the well sites that occurred over one year is recorded in Table 4 and Figure 5. The streambed transitioned from having no evidence of erosion between the well's transect sites in the first year, to having distinguishable erosion effects migrating gradually upstream. In 2008, the well sites' transects had similar profiles. At Well 1, we began seeing numerous fallen Cottonwood trees due to unstable soils at the beginning of May 2008. By the end of May, the erosion had traveled upstream cutting into the stream channel at Well 1. This coincides with the observation of a drop of groundwater levels, streamflow levels, and mid-month storm after a two-month dry spell. We continued to see more significant change at Well 1 in July 2008, with flood waters causing debris piling on the banks and more trees uprooted and leaning. Sediments appeared to be mobilized by the end of 2008, forming an undulating shape in a streambed of sand, but there was not a clear incision near the downstream well. The cross-section profile comparison of May 2008 to June 2009 reveals an increase in streambed depth (degradation) near Well 1 by 0.87 feet, whereas the upstream well site, Well 2, increased in depth by only 0.29 feet.

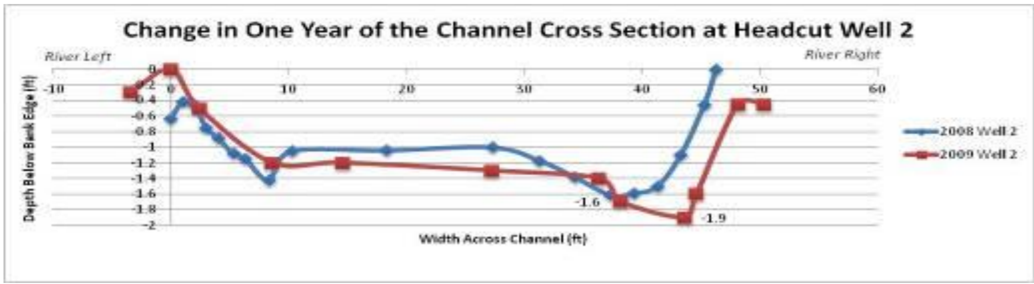
Table 4: Cross-Section Measurements

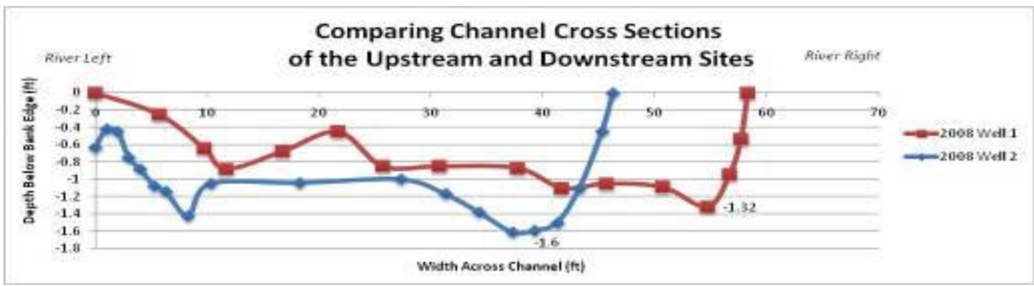
	Well 1 (Downstream)		Well 2 (Upstream)	
Year	**2008**	**2009**	**2008**	**2009**
Maximum Depth	1.33	2.20	1.61	1.90
Streambed Width	45.0	40.5	41.0	48.1

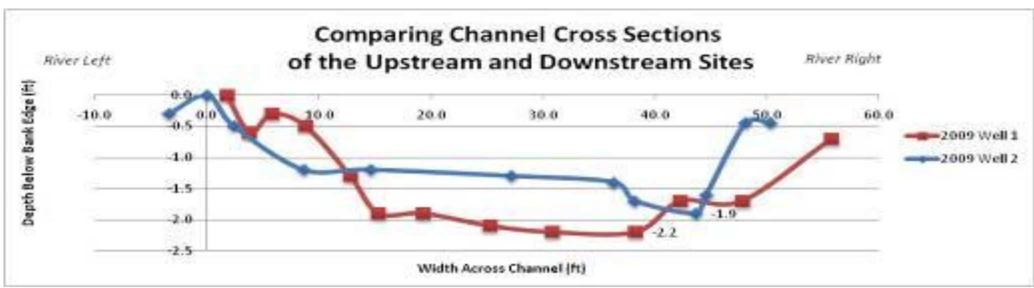
Measured on 5/6/08 and 6/12/09. Measured in Feet.
Note: Debris pile-up affected streambed width more so than erosion affected it.

Figure 5: Geomorphic Transect Comparisons









Branching Entrenchment

Figure 4 shows the location of nick points of each branch of the headcut through the active zone. Scouring was present primarily in the active headcut zone. Table 5 shows the one year change of these branches, as recorded during annual surveys in March. The length of the primary channel incision was measured from where the nick point was first noticed in 2001 to where the nick was recorded in the survey. The primary channel had a gradual sloping of entrenchment of several hundred feet, while the two side branches had deep plunging nick points. The primary channel nick point advanced 270 feet between habitat surveys.

The other incision branches were measured from where they separate from the main channel to their nick points. From 2008 to 2009, the branches each grew wider at the recorded measuring points, but also became less deep due to sediment aggradation. The middle branch of the headcut was dry and less entrenched (not deep enough to access the water table) throughout the study period. The nick of the middle branch extended 137 feet further upstream between annual habitat surveys. The nick of the third branch maintained streamflow and extended 37 feet from 2008 to 2009. Due to the proximity of the branches, it is possible that the channels will merge at some point in the near future as the walls between them become closer.

Table 5: Size of Headcut Branches in Active Zone

Channel	Year	Depth (ft)	Width (ft)	Length (ft, measured in GIS)
Primary Channel	2008	9	30	3,111
	2009	8	65	3,381
Middle (second) Branch	2008	6	14	284
	2009	6.25	22	421
Third Branch (southern / downstream)	2008	8	25	130
	2009	5.75	30	167

Measured in March each year at these particular points within the branches. This is not a measure of change within the full two years of the study

Hydrologic Monitoring

Hydrology was monitored and evaluated through groundwater levels, streamflow, precipitation, evapo-transpiration, and calculating the slope of the water table.

Rainfall Analysis

The amount and distribution of rainfall varied considerably during each year of the study. The total rainfall received between 12/1/08 and 11/30/09 was half what we saw in 2008 (6.97 inches). In comparison, the total rainfall received the previous year, between 11/30/07 and 11/30/08, was 14.25 inches, the highest in at least five years. Significant precipitation events occurred in July and August 2008 (Figure 8), whereas we experienced less rain than usual for July 2009 (Figure 9), when we usually see large stormflows that move sediment. Rainfall measurements were reported from the nearest downstream weather gage, located at Del Lago Dam. The effect of rainfall on streamflow, groundwater levels and sediment movement is discussed in each of those sections of this report.

Figure 8: Rainfall for the First Annual Study Period

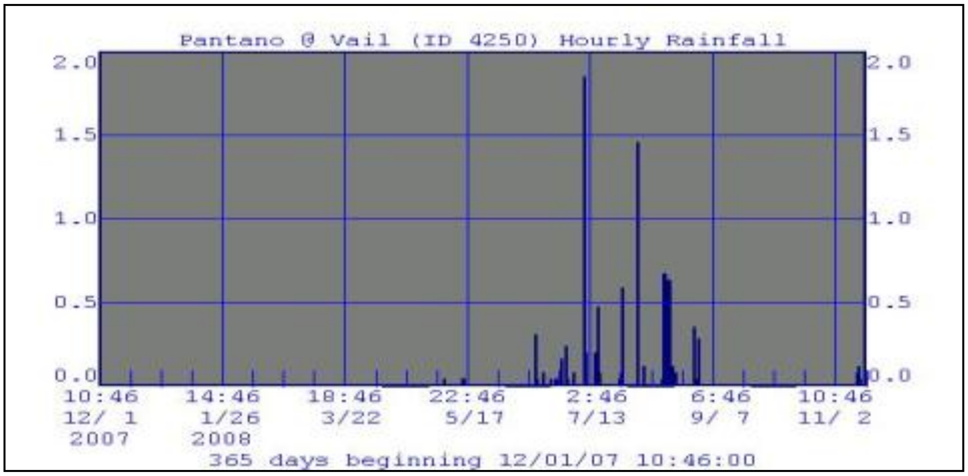
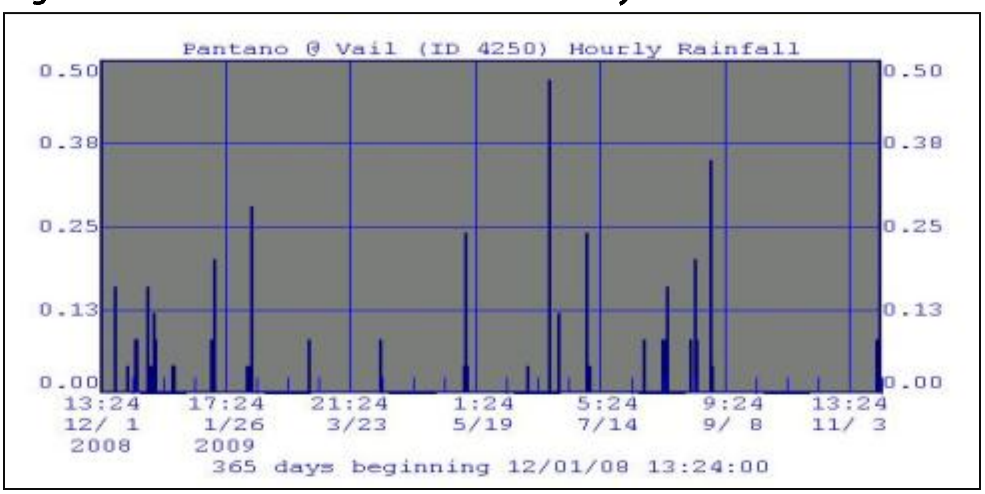


Figure 9: Rainfall for the Second Annual Study Period



Hourly rainfall displayed in inches per rain event.* ***Note difference in scale between the two graphs.*

Pima County Regional Flood Control District precipitation and streamflow data from the ALERT system: http://159.233.69.3/perl/pima.pl

Streamflow Observations

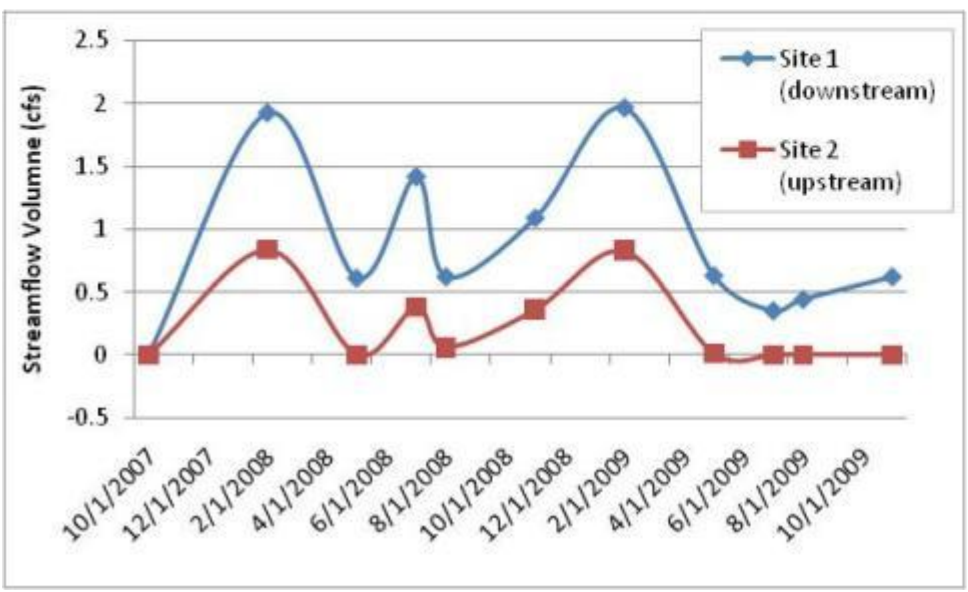
Most frequently, PAG staff noted less streamflow volume upstream of the headcut than downstream of the headcut, by as much as 1.1cfs when both were flowing (see Table 6 and Figure 10)). The smaller upstream streamflow may be due to the sand substrate that is considered a thick layer of fines forming a sediment plug over the water. The average difference between streamflow sites throughout the study period was 0.66 cfs. The difference of flow between the sites was generally consistent except during the highest flow times of the year (February of both years and July 2008). The upstream site was also completely dry more frequently than the downstream site. The highest baseflows were found not only during monsoons, but also after the smaller and more consistent winter rain months. Monsoons in 2008 raised streamflow volume at both sites, but the lack of monsoons in 2009 resulted in minimal streamflow. The longest lasting large volumes of base streamflow (which we found in winter) do not appear to be associated with the largest rainfall events (summer monsoons).

Table 6: Cumulative Streamflow Measurements at Streamflow Survey Sites

Date	Site 1 (downstream)	Site 2 (upstream)
10/ 30/07	0.0	0.0
2/ 7/08	1.93	0.84
5/ 27/08	0.61	0.0
7/22/08	1.42	0.38
8/26/08	0.62	0.06
11/18/08	1.09	0.36
2/20/09	1.97	.83
5/11/09	0.63	0.01
7/28/09	0.35	0.0
8/26/09	0.44	0.0
11/17/09	0.62	0.0

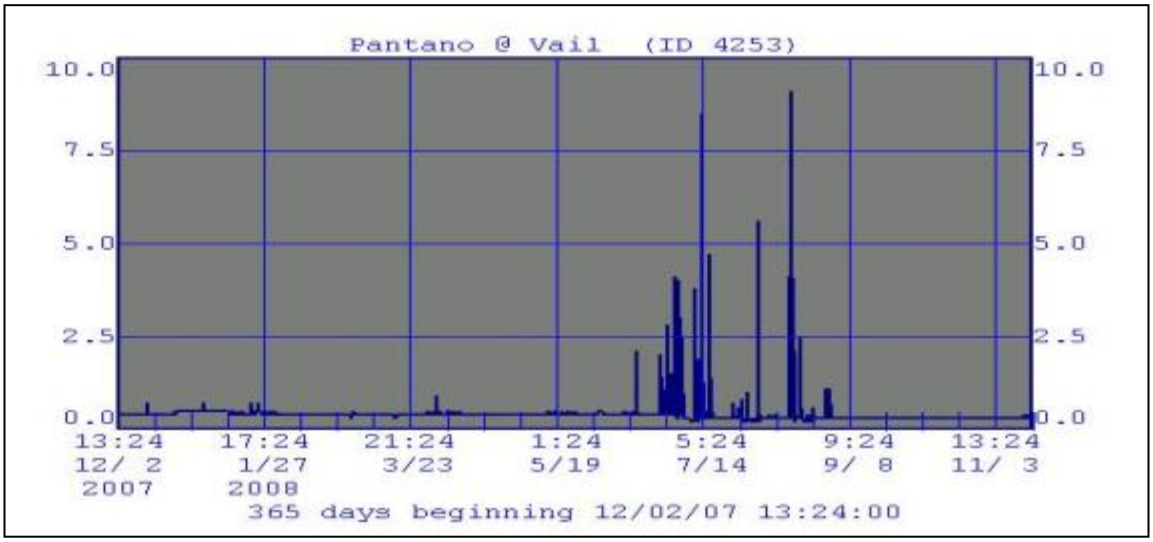
Measured in cubic feet per second.

Figure 10: Cumulative Streamflow Measurements at Streamflow Survey Sites



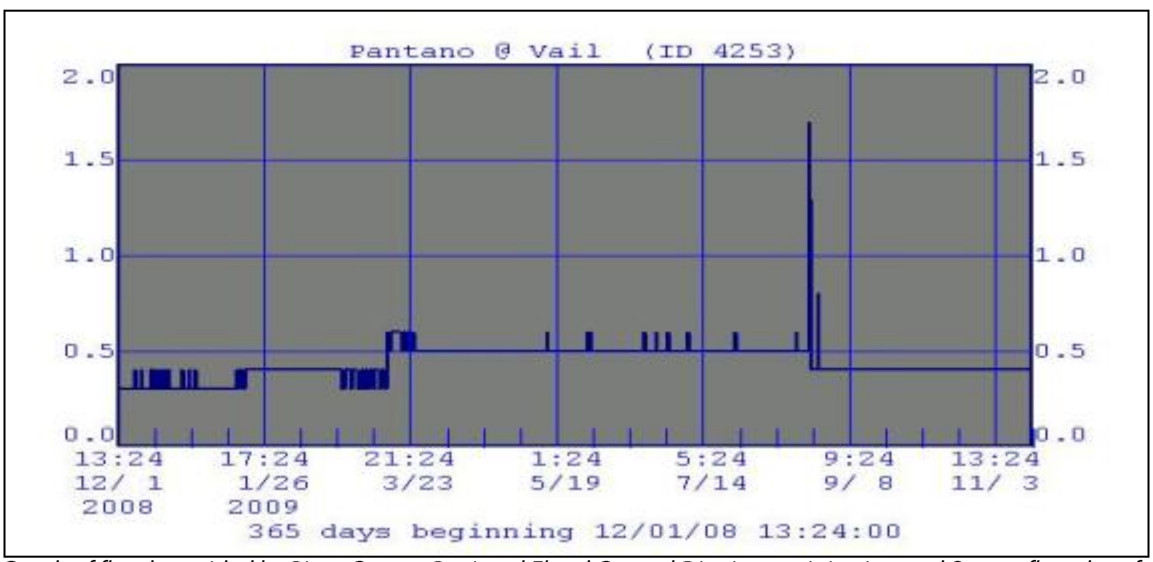
In addition to baseflow volumes, this report includes an investigation of peak stormflow events. The streamflow at the Pantano ALERT gage, the nearest downstream gage, reveals the major monsoon events which most affect sediment transport. In 2008, there were about a dozen storm events over 2.5 ft at the Pantano gage, whereas there was only one event over 1.5 ft high in 2009 (Figures 10 and 11).

Figure 11: Pantano Stream Gage for the First Annual Study Period



Graph of flood provided by Pima County Regional Flood Control District precipitation and Streamflow data from the ALERT system: http://159.233.69.3/perl/pima.pl Streamflow stage measured in feet. ALERT graph format the label for the end date – 12/2/2009.

Figure 12: Pantano Stream Gage for the Second Annual Study Period



Graph of flood provided by Pima County Regional Flood Control District precipitation and Streamflow data from the ALERT system: http://159.233.69.3/perl/pima.pl Streamflow stage measured in feet. ALERT graph format the label for the end date – 12/1/2010.

Groundwater Levels

Groundwater levels varied with the seasons. The water levels rose after winter and summer rains and fell during the dry season in both wells (Figure 13 and Table 7). These data were measured during field visits and data were also collected about whether the stream was flowing in the adjacent channel. This finding generally parallels the seasonal change of the streamflow levels. Both wells fluctuated by about 5 feet (through the seasons) and both appeared to rise and sink together, with the downstream well slightly lagging in response. The highest and lowest water table levels were similar each year at both wells and ranged from approximately one to six feet below land surface. Water levels at the wells sank about three to four feet during the dry April to June season each year. The water levels were highest from July 2008 through March 2009. In comparison, the previous year had a shorter period of high weeks from January 2008 through March 2008. The highest water tables can be linked to seasons of greater rainfall and greater streamflow; however, groundwater remained more stable after the 2008 monsoons than did the streamflow volume.

Figure 13: Water Table Depth through Study Period

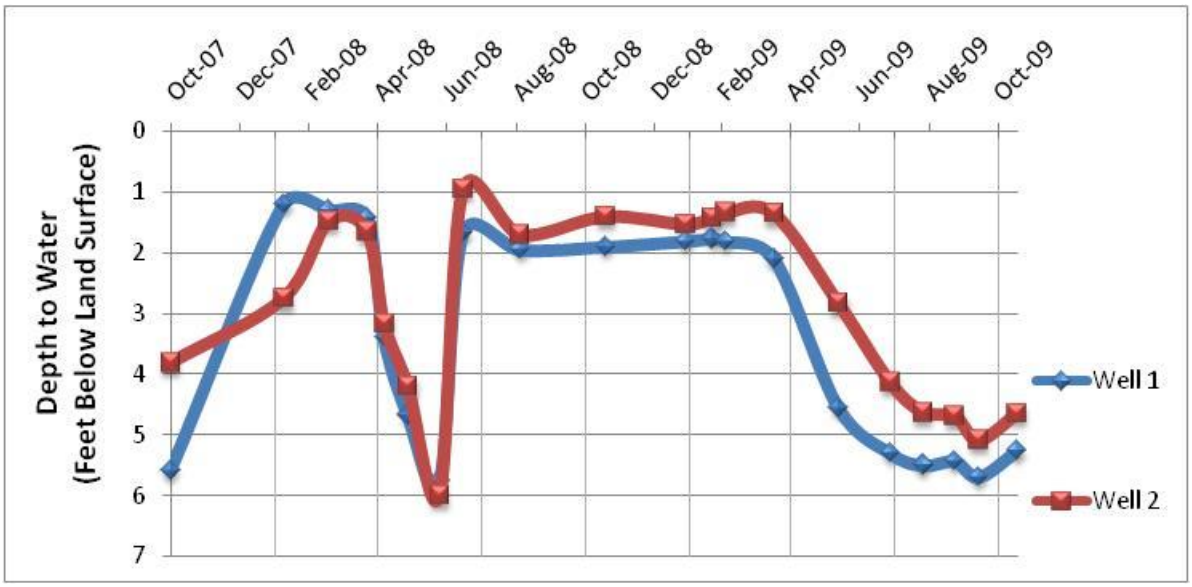


Table 7: Cumulative Depth to Groundwater (DTW)

Date	Well1 (downstream)		Well 2 (upstream)		Water Table Slope Between Wells: Height Difference from Land Slope
	Streamflow Presence	DTW (feet below land surface)	Streamflow Presence	DTW (feet below land surface)	
10/30/07	absent	5.58	absent	3.81	1.77
2/7/08	present	1.2	present	2.75	-1.55
3/18/08	present	1.3	present	1.48	-0.18
4/21/08	present	1.43	present	1.65	-0.22
5/6/08	absent	3.4	present	3.17	1.73
5/27/08	absent	4.68	absent	4.2	1.98
6/24/08	absent	5.76	absent	6.0	1.26
7/15/08	present	1.67	present	0.95	0.72
9/3/08	present	1.95	present	1.7	0.25
11/18/08	present	1.9	present	1.4	0.5
1/28/09	present	1.81	present	1.53	0.35
2/20/09	present	1.77	present	1.43	0.32
3/4/09	present	1.81	present	1.34	0.27
4/16/09	present	2.1	present	1.35	0.75
6/12/09	absent	4.55	absent	2.83	1.72
7/28/09	absent	5.30	absent	4.14	1.16
8/26/09	absent	5.50	absent	4.63	0.87
9/23/09	absent	5.43	absent	4.69	0.74
10/14/09	absent	5.69	absent	5.09	0.6
11/17/09	absent	5.26	absent	4.65	0.61

The distance between the two wells is 1,350 feet. There is an estimated three foot change in elevation between the two wells surface levels.

Water Table Slope

The difference between the well sites' groundwater levels can be seen in an analysis of the water table slope. The slope of the water table between the wells fluctuated with the seasons. The slope of the water table paralleled the slope of the land during the wet seasons when groundwater levels were high and the creek was flowing on the surface of the streambed at a 0.2% grade (Figure 14). The wet winter of 08-09 had a surface water slope of 0.1 % which was shallower than the land surface. Because our wells sat upon the banks, water levels that extended above the streambed ground surface were measureable. During the dry part of the year, the slope increases, first at the downstream well, followed one month later by the upstream well. In May 2008 and June 2009, the average slope of the water table during these dry seasons was ~0.3% (Figure 15). The height difference of the water table slope was temporarily almost two feet larger than the land slope and neither site exhibited surface flow. The additional wedge of space that was found to be dewatered in the summer by the steeper slope may be what contributes to loosened sediments and vegetation loss.

Figure 14: Streamflow Gradient

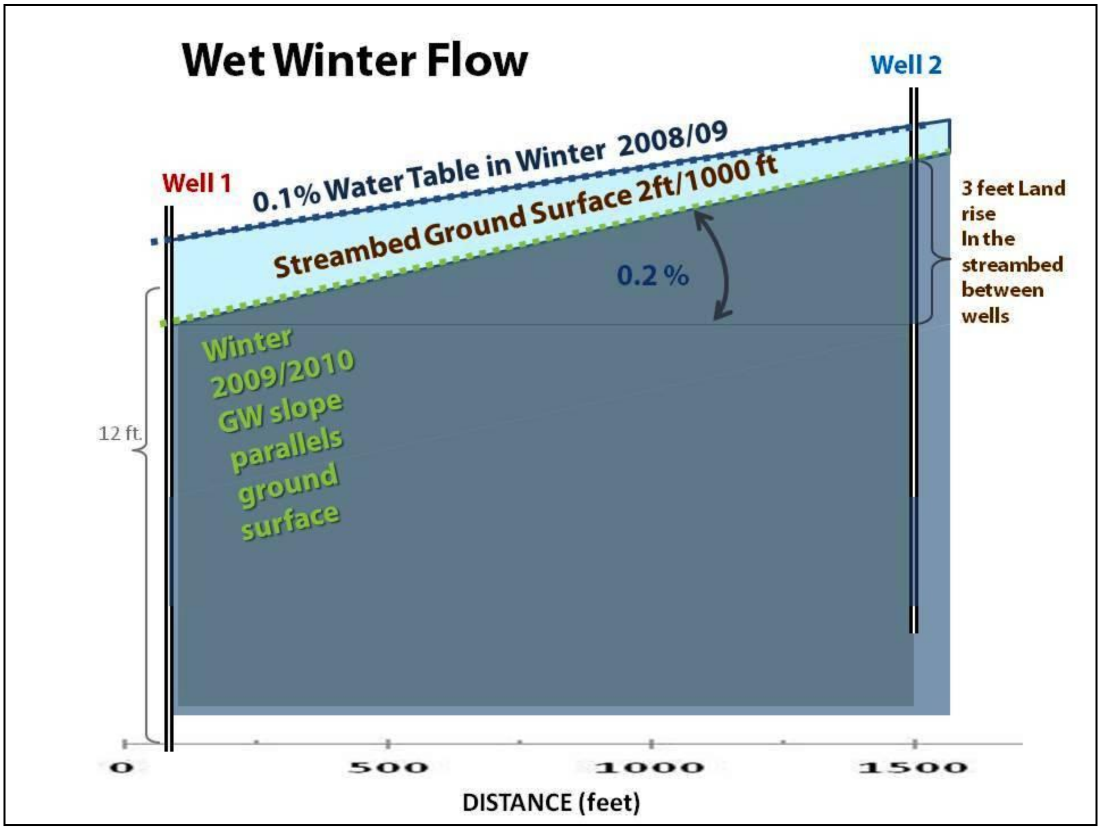
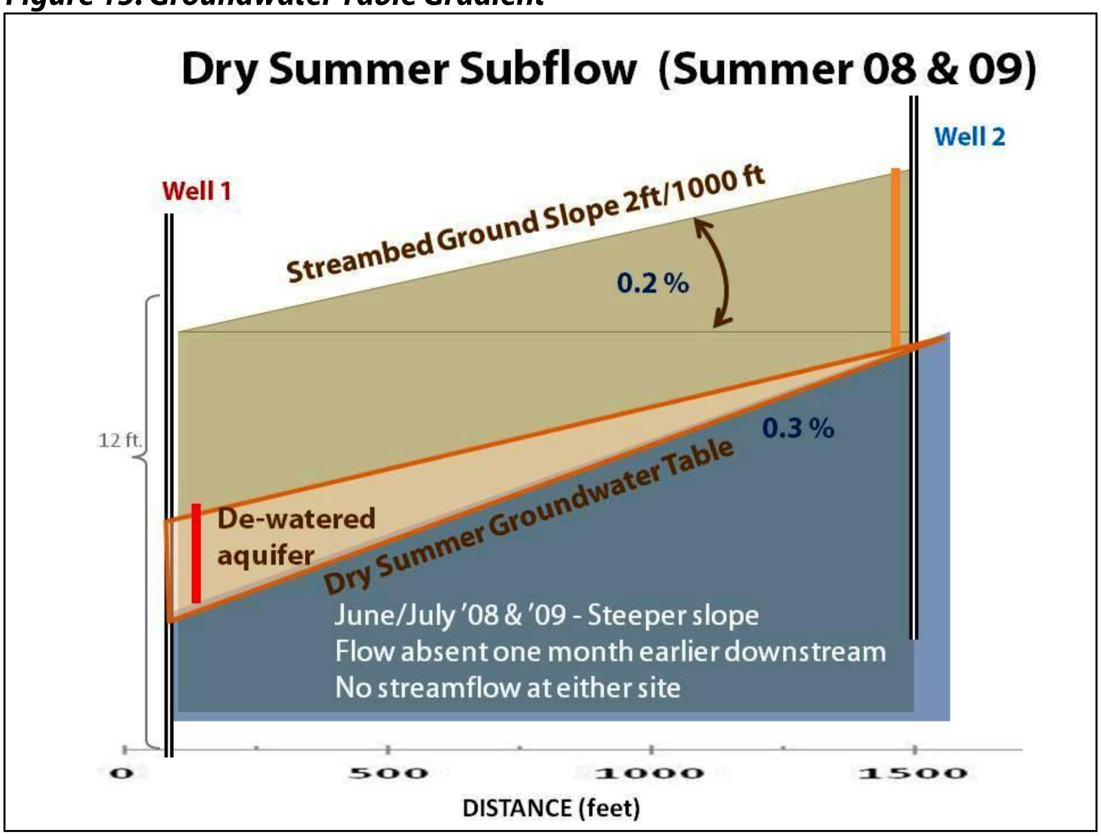


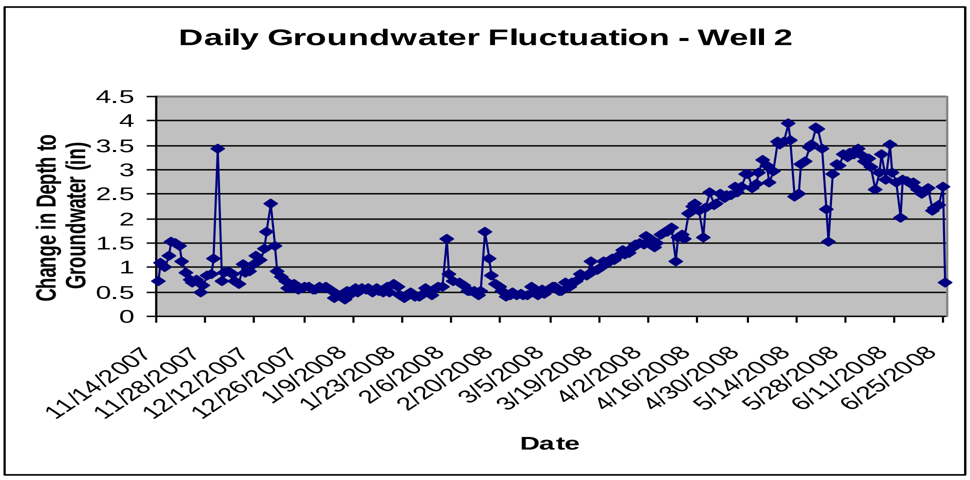
Figure 15: Groundwater Table Gradient



Evapo-Transpiration (ET) Influences on Hydrographs

On a daily basis, water levels fluctuated by approximately .5 to 3.5 inches (Figure16). During the rainy winter months, levels fluctuated 0.5 inches per day on average. The daily fluctuation steadily increased through the dry season until it reached about 3.5 inches just before the first June rain. Low water levels are seen at midday (10 am to 6 pm), followed by recovery with peak levels between 11 pm and 8 am (Figure 17). This is likely indicative of evapotranspiration (ET) needs of vegetation in the watercourse. The increasing daily variation of water levels around the mean can also be seen in Figure 18, which illustrates the effect of ET in March as the rains taper off, trees leaf more fully and temperatures increase. There are two peaks of ET during daylight, with a lull during the hottest afternoon hours. The withdrawal by ET began at 8 am in December, 7 am in March, and 6 am in May, in each instance, following about half an hour after sunrise.

Figure 16: Daily Groundwater Fluctuations for -Nov. 2007-June 2008



Calculated by subtracting minimum depth from maximum depth for each day.

Figure 17: Diurnal Fluctuation of Groundwater Levels

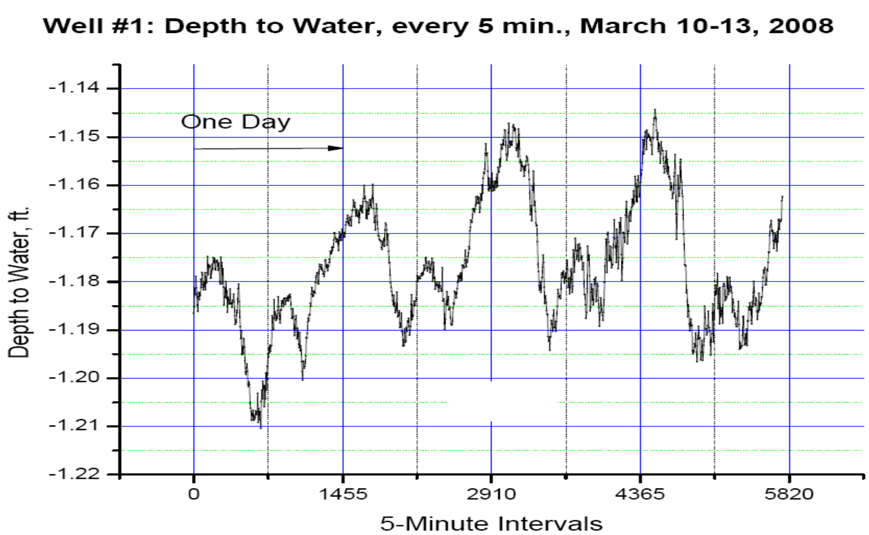
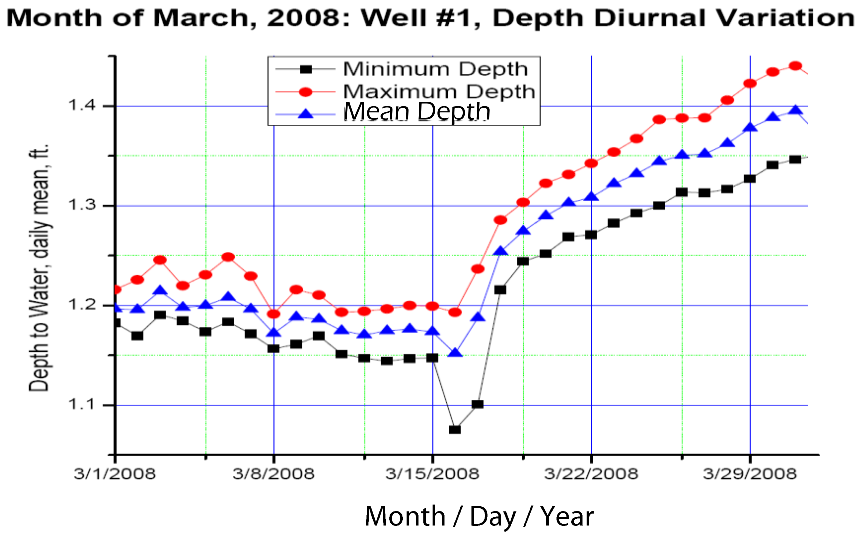


Figure 18: Variations in Mean Groundwater Levels



Hydrologic Findings Summary

This study found that while the streamflow site downstream of the headcut had perennial flow, the upstream streamflow site exhibited flow intermittently and with consistently less volume than the downstream site (averaging 0.66cfs less flow on average). The highest baseflows were seen after winter rains. The daily breathing of the groundwater, seen in the transducer data, showed an increase in diurnal fluctuation in wetter season due to increased evapotranspiration. This could decrease with reduced tree cover. The seasonal change in groundwater levels varied with the amount of rainfall available each year. The streambed aquifer experience much greater dewatering during the dry spring period (due to evapotranspiration) than in the dry fall period when leaves are and temperature start dropping. The streambed aquifer recharges during monsoon season and winter rains.

Habitat Evaluation

This analysis compares the habitat conditions for different hydrologic units and compares the downstream areas to upstream areas within each survey year, as well as any changes that happened between the years. The habitat conditions we looked at were ratios of runs:riffles, pool size and locations, dominant vegetation type and density, dominant substrate and fish presence and distribution. All references to upstream and downstream areas refer to the proximal study area unless otherwise indicated.

Habitat Unit Classification

Lawson and Huth characterized a healthy stream as more heterogeneous, having an even mixture of hydrologic unit types (ADEQ Report # EQR0303, WPF Grant #09-068). Runs were the most common type of hydrologic unit found over the full length of the proximal study area, spanning three times as much length of the stream as the riffles. Hans Huth and Lin Lawson also found a disproportionate amount of runs in their surveys of Cienega Creek in 2003 and determined that this indicated that the stream was in a state of sediment transition.

In both annual habitat surveys, the upstream zone least closely resembles the description of heterogeneous health (Table 8) which, when comparing only riffles to runs, was composed of 70% runs. Using both annual surveys as baseline conditions for the study area, we found downstream to have the best habitat diversity with 54% runs. The active zone was similar with 57% runs.

In 2009, the stream was less dominated by runs than in 2008 and the ratio of runs to riffles became more even. In 2009, the units were longer, so there were 25 fewer units spanning the survey area. The ratio of the number of hydrologic units that were runs to the number of riffle for each zone in 2008 was approximately 1.5:1 downstream, and 1:1 in the active zone and 2:1 upstream, showing different habitat type availability in each zone. In 2009, this was slightly different, with the active zone and downstream zone swapping ratios (1:1, 1.4:1, 2:1).

By assessing the distribution of the pools, which are concentrated in the recently active headcutting zone, we can identify distinctly different habitat zones within the study area. Pools are habitat for larger fish, and the presence of a greater number of pools within the active headcut may indicate a temporary positive effect for fish habitat. An equal number of pools were found in the upstream and downstream zones, providing similar large fish habitat before and after active headcutting. If the zones are looked at in terms of percentage of habitat unit types, there is a decrease in pool habitat in the downstream zone after the headcut has completed passing through. Eight percent of units are pool habitat downstream as opposed to 15% upstream, and the highest number is 21% pools in the active zone.

The average percentage of habitat units that were pools over the two survey years was greatest in the active zone (21%). The least number of pools were found downstream (8%) and a greater percentage (15%) was found in the upstream zone where the headcut had not impacted habitat. During drier past of the year than the March survey, however, the upstream zone was more frequently found to be dry.

There were fewer pools and they were more evenly distributed through the different zones in 2009 than in 2008. In 2009, pools were larger in width and length, but shallower than in 2008 (Table 9). The decreased depth and number of pools in 2009 can be correlated to an aggradation of fine sediments that was observed in the year between the habitat surveys.

Table 8: Habitat Classification Unit Counts

Zone	Number of Runs	Number of Riffles	Number of Pools	Total
2008				
Downstream	24	16	3	*43*
Active Headcutting	14	11	12	*37*
Upstream (Within Proximal Survey)	19	9	3	*28*
Total	*57*	*35*	*18*	*110*
2009				
Downstream	15	17	3	35
Active Headcutting	21	15	4	40
Upstream (Within Proximal Survey)	5	3	2	10
Total	*41*	*35*	*9*	*85*

Table 9: Average Size of Pools

Year	Depth	Width	Length
2008	1.9	8.8	13.1
2009	.93	14	21.1

Vegetation

The amount of overstory cover varied from sparse cover downstream to overlapping tree canopy upstream (Table 10). The results were the same in 2008 and 2009 for the percentage of overstory. More so than in 2008, a portion of the cover in the active zone in 2009 was from fallen and leaning trees. Most of the fallen trees in 2009 were freshly down and with live leaves remaining on them. Much of the active zone's tree cover and a portion of the upstream zone's cover were composed of trees that were in the process of falling down due to headcutting. Loss of vegetation, especially vegetation overhanging and within the stream, indicates a loss of cover for fish habitat among other wildlife.

Both Cottonwood and Goodding Willow were more dominant (outnumbering other trees) upstream than downstream. Both trees were also more abundant and densely covering upstream than they each were downstream. Where Goodding Willow and Cottonwood are abundant, we find the greatest percentage of overall cover. Cottonwood was found to be co-dominant with Goodding Willow in comprising the overstory in the upstream and active zones, but fell out of the running for co-dominance downstream where Cottowoods were most susceptible to falling over due to erosion in the past or where there are drier stretches and Goodding Willow remained if overstory was found. Cottonwoods were the primary tree falling upstream and in the active headcutting zone, though Goodding Willows were also affected. The past die off of Cottonwood could be the reason that fewer Cottonwood trees were found downstream and may continue to decrease its abundance upstream in the future as the headcut migrates. It appears that the zones that have undergone past headcutting (i.e. downstream) have one-third the cover of locations that have not undergone headcutting.

Given that Ash trees thrive in full sun, it is consistent that Ash was more dominant in downstream areas, where overstory cover is less dense. Exotics, such as Johnson Grass and Rabbitsfoot Grass and the invasive tree, Tamarisk, were found throughout the survey, and did not appear to correlate with areas of erosion (active zone), abundant fine sediments (the run-dominated upstream zone), or decreased vegetation cover (downstream zone).

Table 10: Percentage of Overstory Cover

Zone	Overstory Cover *
Downstream	25%
Active Headcutting	50%
Upstream	75%

**Assessed as approximately 0%, 7%, 25%, 50%, 75%, or 100% for each hydrologic unit and calculated for each zone as an average of all the units in each zone.*

Surface Substrate

Dynamic stream processes are underway. Fine substrates dominate and continue to be flushed into the stream from upland and stored in the stream throughout the site. This indicates that there is impairment and instability as pool slopes are filled with sand (Lawson and Huth, 2003). Sand was the most common substrate found throughout all reaches (upstream, within and downstream of the active headcutting) as well as in both the pool and run hydrologic units (Table 11). Sand became even more prevalent in 2009, advancing from being dominant in 50% of units to 75% of units. In riffles, gravel was the dominant substrate. Gravel was the most common sub-dominant substrate in all zones. We found more cobble where there was major sediment erosion in the active zone due to the winnowing of fines that occurs in the swifter water.

Table 11: Dominant Surface Substrate plus Unique Findings in each Zone and Unit Type

Zone	**Substrate Findings**	
	2008	2009
Downstream	Sand Dominant. Silt more common here than other zones.	Sand Dominant. Change from 2008 in that no units had silt or detritus was as the dominant substrate.
Active Headcutting	Sand Dominant. Cobble more common here than in other zones.	Sand Dominant. Cobble remains more common here than in other zones. No silt or detritus as dominant substrate.
Upstream	Sand Dominant. No silt found here.	Sand Dominant. No cobble found here.
Total	Sand was found in every zone and dominant in 50% of all units surveyed. Gravel was the second most common at 30%.	Sand was found in every zone and dominant in ~75% of all units surveyed. Gravel was the second most common at 22%.

Unit Type	Dominant Substrate
Pool	Sand
Run	Sand
Riffle	Gravel (80%)

Fish Presence

The fish were found primarily in the downstream reach, less frequently in the active headcutting zone, and least in the upstream reach. In 2009, half of the upstream units had fish, whereas in 2008, none of the upstream units had fish. The small number of fish in the upstream reach shows a major difference in the distribution of fish between the reaches and may be due to a lack of connectivity to perennial portions of the stream.

Fish were present in 45% of the hydrologic units in 2008 and in 77% in 2009. We found that runs were frequent habitat for fish; half of the fish were found in runs. About 50% of the riffles and runs had fish in 2008 and 90% of riffles and runs had fish in 2009. Longfin Dace was the dominant fish species found.

Within pool habitat types, a smaller percentage of fish were found in 2009 than in 2008 (possibly due to their decreased depth), but fish were more frequent overall in 2009, perhaps showing the importance of run type habitats in this system since there was an increase in fish but a decrease of pool habitat. One-third of the pools had fish in 2008 and one-fourth in 2009. Pools contain larger numbers and larger sizes of fish, so they serve a function for a different life stage of the fish. Pools without fish were primarily the receding-pool type or were disconnected from the main creek flow.

Habitat Summary

Several differences were found in habitat in the upstream, downstream and active portions of the proximal study area. These differences in habitat characteristics correlate with unique conditions of the headcut migration zones that have been recorded since 2001. The second annual habitat survey confirmed many of these findings and helped to establish a baseline dataset.

The downstream zone was found to have the best fish habitat complexity, being the least run dominated, however we know that our less common, but endangered fish species, the Gila Top Minnow, prefer run habitat. Simms (1992) found that Gila Top Minnow prefer sandy substrates, which are common in runs, and may not prefer deep pools. Over the last 16 years, the upper part of the watershed, the Las Cienega Conservation area, has had major declines in Gila Top minnow populations while Lower Cienega has had an increase.

The active zone had the highest percentage of habitat units that were pools, indicating a short term benefit for Longfin Dace in the stage of life when they are largest, and for Chub, another endangered species which is much rarer than the Gila Top Minnow, which tend to only be found in large pools in Cienega Creek. These pools are unstable and the benefit of this erosion stage is not long lived since the downstream zone where the headcut has already passed is the zone in which fish are most infrequent.

Although there were more pools upstream of the headcut, less fish were found in these pools due to the intermittent flow. The lack of flow upstream and the segmented nature reduces the availability of fish habitat regardless of the habitat type. The erosion may be helping the stream channel to access more aquatic habitat by accessing the subsurface flows.

Habitat for non-fishes species may be observed through canopy cover and composition monitoring results. Less overstory of large long-lived trees was found downstream of the headcut as a result of tree fall in the active zone, creating a more exposed wildlife corridor. Leenhouts (2006) found that although vegetation is responsible for transpiration, trees reduce water loss through lowered temperatures, increased infiltration and slowing flooding. Fish also prefer shade, so with reduced canopy cover, there may be a lag time of shade in the newly accessed subflows before the new recruitment of trees can grow to shade the stream again.

Conclusions

Headcutting in the Cienega Creek watershed is taking part in the process of sediment fluctuation within the stream system. Through a habitat survey, hydrologic monitoring and a geomorphic survey PAG was able to evaluate stream system changes with the advancement of erosion.

Geomorphology Results:

- Over the two-year study period, the headcut nick point progressed up to 12 feet deeper at some of our study sites, as it advanced longitudinally over 2, 000 feet.
- The cross-section profile comparison of May 2008 to June 2009 reveals a larger increase in streambed depth (degradation) near Well 1 than Well 2 (upstream of the nick point).
- From 2008 to 2009, the branches each grew wider at the recorded measuring points, but also became shallower due to sediment aggradation. The nick point of the dry middle branch extended 137 feet further upstream and the third branch maintained streamflow and extended 37 feet from 2008 to 2009, between March habitat surveys.

Hydrology Results:

- The amount and distribution of rainfall varied considerably during each year of the study. In 2008, there were about a dozen storm events over 2.5 ft at the Pantano gage, whereas there was only one event that high in 2009. Large storm events have the largest effect on erosion.
- Sediment inputs of tributary washes and nearby groundwater pumping are other factors impacting the system that we were not able to factor out of the results.
- We noted less streamflow volume and more frequent dry streambed status upstream of the headcut than downstream of the headcut. The smaller upstream streamflow may be correlated with a thick layer of sediments that remain upstream. The highest baseflows were seen after winter rains
- Groundwater levels varied with the seasons. The water levels rose after winter and summer rains and fell during the dry season in both wells. This finding generally parallels the seasonal change of the streamflow levels. Both wells fluctuated by about 5 feet (through the seasons) and both appeared to rise and sink together, with the downstream well slightly lagging in response.
- The streambed aquifer experienced much greater dewatering during the dry spring period (due to evapotranspiration) than in the dry fall period when leaves and temperature start dropping.
- The slope of the water table between the wells fluctuated with the seasons. The slope of the water table remained similar to the slope of the land during the wet seasons, when groundwater levels were high and the creek was flowing on the surface of the streambed. During the dry part of each year, the water table gradient increased.
- If the headcut eventually cuts past the upstream well, giving access to surface flow, we are less likely to see a seasonal difference in water table gradient between the wells.
- The daily breathing of the groundwater, seen in the transducer data, showed an increase in diurnal fluctuation in wetter season due to increased evapotranspiration. On a daily basis, water levels fluctuated by approximately .5 to 3.5 inches. This could decrease with reduced tree cover.

Habitat Findings:

- Overall, runs are more common than riffles, especially in the upstream reach.
- The stream was less dominated by runs in 2009 and the ratio of runs to riffles became more even (increase in riffles).

- The upstream zone least closely resembles the description of heterogeneous health (less even distribution of runs:riffles in both years).
- Pools are more abundant in the active zone.
- Pools were more evenly distributed throughout the different zones in 2009 than in 2008.
- With increased fine sediments in 2009, pools were fewer and shallower, but larger in width and length than in 2008.
- Larger fish are found in pool habitat, but runs also support fish.
- Fish were present less frequently in the upstream reach.
- More cover is found in the upstream reach.
- A considerable number of fallen Goodding Willow and especially Cottonwood are found in the active zone.
- Cobble is more common in the active zone than in other reaches.
- Sand substrates were consistently dominant throughout study area.

Discussion:

The Cienega Creek Headcut Study allowed us to evaluate the hydrology and habitat of the creek and how it evolved with the rapid migration of the headcut. A general equilibrium is taking place, when examining a long term timeframe examined, depending on the value attributed to trade offs of certain habitat types. The immediate results show that stream flow is restored and may last until (and if) the area experiences another wave of sediment accumulation. The trade off for increased surface flow is loss of local shallow aquifer storage and possibly faster movement of flow out of the system. Loss of vegetation increases temperature and evaporation, decreases infiltration and speeds floods. When looking at a the long term, the current older growth tree-fall is reducing vegetative overstory which will take 30 years to fill back in while the next generation of tree recruitment fully replaces the fallen trees. In the shorter term, it appears that this erosion process will restore fish habitat in the active headcutting area which has approximately a10 year life span in our study area.

Because this type of investigation has not previously been conducted in an arid environment, where the typical stream has segmented perennial flow and intermittent ephemeral flow, there is added scientific merit to the project. The surface flow is dependent upon the water table gradient and by sediment aggradation and erosion. Large rain events, which follow long dry spells (typical of our region), have the greatest ability to create large sediment transit. In addition, this study shows that the timing of the transition of sediments is correlated to the gradient of the water table. The extra wedge of dewatered alluvium in the summer, created by the steeper water table slope, may contribute to collapsed sediment structure and wetland vegetation die-off. Both of these changes could be loosening the sediments prior to the large erosion events that we witnessed.

Because this type of investigation has not previously been conducted in an arid environment, we have established unique field methods for this system. This project has increased public awareness of management issues for this valued resource near the Tucson urban area. Due to the delicate nature of the creek preserve, we cannot make a recommendation to create in-creek sediment stabilization, although efforts in tributaries and uplands may be beneficial. We recommend a continued investigation into measures that will maintain or restore native riparian vegetation and habitat, stream geomorphology, channel characteristics, and floodplain functions. Keeping in alignment with the management goals for the Cienega Creek Natural Preserve, the erosion process may be aiding efforts to keep in-stream flows. We recommend continued maintenance of shallow groundwater preservation which aligns both with management goals and preventing catastrophic erosion events.

Suggested Follow-Up:

- Continue to monitor cross sections and water levels at well sites. Installation of a downstream monitoring well would be valuable.
- Cross-sections of water depths across the channel throughout different times of year
- Investigate evapo-transpiration impacts
- Evaluate association with cycles of drought, threshold of tolerance for low rainfall levels, climate change and large floods
- Research relationship to: land use, pumping history, groundwater elevations, vegetation cover studies, and relationship to cattle exclusion
- Historic aerial photography and LiDAR would help to document the waves of vegetation and sediment plug changes
- Use additional methods to assess habitat for other species, such as herptiles
- Calculate the volume of sediment that has been removed from the system and where it had gone
- Look at trends of groundwater elevations and downcutting further downstream as well as location of cuts throughout the stream
- Evaluate the impact of related restoration projects, including the potential re-introduction of beaver upstream

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Appendix 1

Outreach and Public Education Activities

Outreach and Public Education

During the course of the Cienega headcut study, PAG staff worked to inform the interested public about the investigation and to involve other professionals that are working on similar projects in the region. This effort primarily consisted of presenting information at meetings and educational events, running field trips and preparing reports, posters, and flyers for distribution.

Meeting Presentations and Public Educational Events

PAG made numerous presentations to inform people about the project, both at its inception and as it progressed (Table 1). Meeting attendees showed a keen interest in the project especially at the Cienega Corridor Conservation Council, which is a community group comprised of public citizens with a particular interest in environmental issues within the Cienega Creek corridor. In addition, the presentation at the Arizona Hydrological Society professional meeting paved the way for collaboration installing the piezometer wells and allowed us to connect with other researchers in the region. The presentations at Pioneer Days were extremely successful and the displays attracted a lot of interested youth.

Table 1: Meetings and events at which PAG staff presented Cienega headcut study data

Date	Meeting	Description
Sep. 2007	AZ Hydrological Society Annual Symposium	Poster presentation at the meeting. As a result, project discussions were held with various hydrologists and researchers.
Oct. 2007 March 2009	Cienega Watershed Pioneer Day Information Fair	PAG educated the public about Cienega Creek hydrology and the headcut migration. PAG staffed the information table and spoke to visitors at each event.
Nov. 2007 Nov. 2009	Cienega Corridor Conservation Council	Presentation at their semi-monthly meeting. Attendees included interested citizens and professionals working in the region.
Jan. 2008 April 2008 Oct. 2009	PAG Environmental Planning Advisory Committee (EPAC) and the Watershed Planning Subcommittee	PAG committees were updated throughout the process. Attendees included environmental professionals and agency personnel.
Jan. each year 2007-2010	Agency meetings with various Pima County and City of Tucson departments	PAG staff met with key personnel at PC Regional Flood Control District and Wastewater Department and the COT Water Department. Updates were provided about the Cienega headcut study, as well as other PAG projects.

Field Trips

PAG conducts quarterly field trips along Cienega Creek, which consist of walking the entire length of the hydrologic monitoring study area, including the headcut area, within the Pima County Natural Preserve. Field trip attendees were able to observe the field work, gain greater understanding about the creek, and discuss the headcut migration within the drainage system. In December 2009, PAG focused the quarterly walk-through field trip on the headcut study by distributing a field guide and leading additional discussions about the headcut project.

Table 2: Field Trips and Technical Collaboration with Professional Colleagues

Date	Field Trip/Attendees	Description
Informal field trip held each quarter	Cienega walk-through field trip. Attendees may include water professionals, local researchers and interested citizens.	The field trip consists of walking the length of the stream, visiting the headcut site, and explaining our field monitoring conducted during the trip such as observing habitat, photographing designated points and taking GPS measurements of headcut nick points.
Dec. 2009	Specific Cienega walk-through trip provided to discuss the final findings of the headcut study. Attendees included citizens and agency personnel.	A field trip guide was prepared and distributed to help the attendees understand the study. Signage was brought to the field trip start area in order to better explain the work and provide geographic context to attendees.
Fall 2007	U.S. Geological Survey, AZ Dept. of Water Resources	Provided technical support and information about piezometer installation.
Fall 2007	Master Watershed Stewards, Pima County, PAG staff (other than Watershed staff)	Worked as volunteers to install the piezometer wells on Cienega Creek.
Spring 2008	Tucson Nature Conservancy, Bureau of Land Management	Provided technical expertise and collaboration for structural habitat analysis.
Throughout	Pima County Parks and Recreation and Pima County regional Flood Control District	Provided historical background on the natural environment.
2008-2010	Arizona State University	Collaborated on the habitat evaluation. PAG provided hydrologic information in return for additional habitat analysis to be provided in summer/fall 2010 (not part of the original project or required in outreach).

Printed Documentation

PAG prepared numerous maps and diagrams to illustrate the purpose, objective, methodology, and results from the Cienega headcut study. These documents were used in presentations, field trips, discussions, and some of them were distributed to PAG mailing lists. Several of the interim progress reports were distributed to interested parties during the course of the project. In addition, presentations made at PAG meetings were placed on the PAG Web site to inform those who could not attend and as a permanent reference for those who did attend.

Table 3: Documentation and distribution

Date	Document	Description
Sep. 2007	Abstract and Poster	AZ Hydrological Society Symposium
Sep. 2007 March 2009	Posters and flyers	2007 Pioneer Days presentation
Nov. 2007 Nov. 2009	PowerPoint presentation	Presented at the Cienega Corridor Conservation Council meeting.
Dec. 2007	Regional Outlook Article	Article announcing and describing the Cienega headcut study. Distributed to 3,000 e-mail addresses.
Jan. 2008 April 2008 Oct. 2009	PowerPoint presentation	Presented at PAG Committees: EPAC and Watershed Planning Subcommittee, and also posted the presentations on the PAG Web site.
Nov. 2009	Field guide	Distributed to field trip participants and to Pima County Regional Flood Control District.
Various dates	Interim reports	Distributed to interested parties on request
Annually	PAG Annual Report	PAG accomplishments, including the headcut study, are summarized and distributed to approximately 4,000 contacts.

Appendix 2

Habitat Survey Data

2008 Cienega Headcut Habitat Study Data

Project Name:	**WPF Cienega Headcut Study**					
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:	11:20					
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:	sunny, warm; no rain within last 7 days					
Seasonal Conditions:	Goodding Willow just leafing					
Misc. Comments:	starting at downstream end, walking upstream					
Beginning Location:	most downstream point of 2-mi. reach					
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	1	2	3	4	5	6
GPS #	U1	U2	U3	U4	U5	U6
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Dry	Run	Riffle	Run-glide	Run-braid	Run-glide
Dominant / Primary Substrate		Sand	Sand	Silt	Silt	Clay
Sub-Dominant Substrate		Silt	Silt	Sand	Sand	Clay
Unit Mean Length		see GPS	30 feet			
Unit Mean Width		10-15 feet				
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height		none	none	2-4 feet	5 feet	5 feet
Headcut Entrenchment Width		none	none	40 feet	25 feet	25 feet
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks		0	0	0	1	1
Dom. Veg. Overstory		na	na	na	Mesquite	Goodding Willow, Mesquite
Dom. Veg. Understory		Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass
Exotic Veg Spp.		Johnson Grass	Johnson Grass	Johnson Grass, Tamarisk	Johnson Grass	Johnson Grass
Additional Veg Present						
Aquatic Life (fish type and avg/max size)		Larval fish	Dace 1.5 inches	Dace 1.5 inches	Dace 1.5 inches	Dace 1.5 inches
Location (Landmark)	most downstream point of 2-mi. reach					
Photos				56	57	58-62
Comments					3/4 of channel is flat and wet, only 1/4 is flowing	Has lateral pools <5 feet diameter

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	7	8	9	10	11	12
GPS #	U7-8	U7-8 (minus 30 ft)	U9	U10	U11	U12
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Riffle	Run	Run-step w/braid	Run	Riffle	Run
Dominant / Primary Substrate	Clay	Clay	Sand	Sand	Sand	Sand
Sub-Dominant Substrate	Clay	Clay	Silt	Silt	Silt	Silt
Unit Mean Length	30 feet					
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height	5 feet	5 feet	5 feet	5 feet	5 feet	5 feet
Headcut Entrenchment Width	25 feet	25 feet	25 feet	25 feet	25 feet	25 feet
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	2	3	1	1	3	1
Dom. Veg. Overstory	Ash	Ash, Mesquite	Goodding Willow, Ash, Mesquite	Mesquite	Ash, Cottonwood, Mesquite	Mesquite
Dom. Veg. Understory	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Desert Broom, Coyote Willow, Johnson Grass	Four-winged Saltbush	Four-winged Saltbush
Exotic Veg Spp.	Johnson Grass	Johnson Grass, Tamarisk	Johnson Grass, Tamarisk	Johnson Grass	Johnson Grass	Johnson Grass
Additional Veg Present		Juniper			Goodding Willow, Cottonwood	
Aquatic Life (fish type and avg/max size)	Dace 1.5 inches	Dace	Dace 2 inches, larval fish	Dace 2 inches, larval fish	Fish 2 inches, larval fish	Dace 1.5 inches
Location (Landmark)						
Photos	63-65		66-68		69-71	
Comments					Island present	

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	13	14	15	16	17	18
GPS #	U13 (downstream end)	U14	U15 (down)	U16	U17	U18
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Riffle	Run	Riffle	Run	Run-step	Run-glide-braid
Dominant / Primary Substrate	Sand	Sand	Small gravel	Sand	Gravel	Gravel
Sub-Dominant Substrate	Sand	Sand	Sand	Gravel	Gravel	Sand/silt
Unit Mean Length						
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height						
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	1	2	1	2	1	2
Dom. Veg. Overstory	Mesquite, Cottonwood	Goodding Willow	Goodding Willow	Cottonwood	Goodding Willow	Goodding Willow
Dom. Veg. Understory	Four-winged Saltbush	Coyote Willow, Cattail or Bulrush	Coyote Willow	Coyote Willow	Coyote Willow	Coyote Willow
Exotic Veg Spp.	Johnson Grass	Johnson Grass		Johnson Grass	Johnson Grass	Johnson Grass
Additional Veg Present	Goodding Willow	Deer Grass	Cattail	Cattail	Horsetail, Deer Grass, Cattail	Ash, Cattail
Aquatic Life (fish type and avg/max size)	Dace 1.5 inches	Fish 1 inch	No fish	Dace 1 inch	Fish 2 inch	Fish 2 inch
Location (Landmark)						
Photos	72	73				74
Comments						Tiny riffles by islands with veg.

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	19	20	21	22	23	P23
GPS #	U19	U20	U20-21	U21	U22 (down)	UP23
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Riffle with small run	Run	Riffle	Run-glide	Riffle	Pool-convergence
Dominant / Primary Substrate	Gravel	Gravel	Gravel	Sand	Gravel	Sand
Sub-Dominant Substrate	Sand	Sand	Small cobble	Gravel	Sand	Sand
Unit Mean Length						25 feet
Unit Mean Width						20 feet
Unit Mean Depth						2.5 feet
Pool Max Depth						4.0 feet
Headcut Entrenchment Height						
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	1	0	0	2	2	4
Dom. Veg. Overstory	Cottonwood	na	na	Goodding Willow, Ash	Cottonwood, Goodding Willow	Mesquite, Ash
Dom. Veg. Understory	Cattail	Cattail	Cattail	Coyote Willow		Coyote Willow
Exotic Veg Spp.				Tamarisk, Johnson Grass	Tamarisk, Johnson Grass	
Additional Veg Present	Ash, Deer Grass, Horsetail, Coyote Willow	Deer Grass, Coyote Willow	Coyote Willow, Horsetail	Deer Grass, Cottonwood	Ash	
Aquatic Life (fish type and avg/max size)	Fish 2 inch	Dace 2 inch; possible male Topminnow	Dace 2 inch	Dace 2 inch	Dace 1.5 inch	Dace 3 inch
Location (Landmark)						
Photos						75, 76
Comments					Pool within unit	Formed by side tributary convergence

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	24	25	26	27	28	P28
GPS #	U24	U25	U26	U27	U28	UP28
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Run	Riffle	Run-braid	Riffle	Run	Pool-receding ephemeral, lateral scour
Dominant / Primary Substrate	Gravel	Gravel	Sand	Gravel	Sand	Sand
Sub-Dominant Substrate	Sand	Gravel	Gravel	Sand	Sand	Sand
Unit Mean Length						10 feet
Unit Mean Width						1 feet
Unit Mean Depth						4 feet
Pool Max Depth						7 inches
Headcut Entrenchment Height						
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	2	4	3	1	1	0
Dom. Veg. Overstory	Ash, Cottonwood	Goodding Willow	Goodding Willow	Cottonwood	Goodding Willow	none
Dom. Veg. Understory	Cattail	Cattail	Deer Grass	Cattail		none
Exotic Veg Spp.					Johnson Grass	
Additional Veg Present	Goodding Willow, Desert Broom, Coyote Willow	Cottonwood, Ash, Coyote Willow	Ash, Cattail	Coyote Willow	Ash	
Aquatic Life (fish type and avg/max size)	Dace 2 inch	Dace 2 inch	Fish 1.5 inch	Fish 1.5 inch	Algae	
Location (Landmark)						
Photos						77, 78
Comments			Some areas of scour and gliding	Bend around outcrop		Actually 4 small pools, bedrock formed

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	29	P29	30	31	32	33
GPS #	U29	UP29	U30	U31	U32	U33
Primary, Secondary, or Tertiary Channel	P	P29	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Riffle	Pool-backwater	Run-braid	Riffle	Run-braid	Riffle
Dominant / Primary Substrate	Gravel	Sand	Sand	Gravel	Sand	Gravel
Sub-Dominant Substrate	Sand	Sand	Gravel	Sand	Gravel	Sand
Unit Mean Length		5 feet				
Unit Mean Width		5 feet				
Unit Mean Depth		5 inches				
Pool Max Depth		5 inches				
Headcut Entrenchment Height						
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	4	3	1	2	2	2
Dom. Veg. Overstory	Goodding Willow	Ash	Ash	Cottonwood, Goodding Willow	Goodding Willow, Cottonwood	Goodding Willow
Dom. Veg. Understory	Deer Grass	Desert Broom	Deer Grass, Horsetail	Deer Grass	Cattail, Deer Grass	Johnson Grass
Exotic Veg Spp.				Johnson Grass	Johnson Grass	Johnson Grass
Additional Veg Present	Ash, Coyote Willow		Desert Broom	Desert Broom, Horsetail	Small Ash, Desert Broom, and Elymus sp.	Ash, Horsetail, Cattail, Deer Grass, Coyote Willow
Aquatic Life (fish type and avg/max size)	Algae	Dace 3 inch	Dace 1.5 inch	Fish 1 inch	Fish 1 inch	Fish 1 inch
Location (Landmark)						
Photos			79	80	81, 82, 83	84
Comments		Bedrock formed pool				

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	34	35	36	37	38	39
GPS #	U34	U35	U36	U37	U38	U39
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Downstream	Downstream	Downstream	Downstream	Downstream	Downstream
Habitat Type	Run	Riffle	Run	Riffle	Run-braid	Run
Dominant / Primary Substrate	Sand	Gravel	Sand	Gravel	Sand	Sand
Sub-Dominant Substrate	Gravel	Sand	Sand	Sand	Gravel	Gravel
Unit Mean Length						
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height					3-5 feet	6-8 feet
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)				sloped	vertical	vertical
Overstory Est. - Stream and banks	3	3	4	3	2	3
Dom. Veg. Overstory	Goodding Willow	Goodding Willow	Goodding Willow	Cottonwood	Goodding Willow	Mesquite, Goodding Willow
Dom. Veg. Understory	Deer Grass	Desert Broom	Desert Broom	Johnson Grass	Coyote Willow	Desert Broom
Exotic Veg Spp.	Johnson Grass			Johnson Grass, Tamarisk	Johnson Grass, Tamarisk	Johnson Grass
Additional Veg Present	Desert Broom, Cottonwood, Ash, Cattail	Horsetail, Desert Broom, Ash	Ash, Deer Grass, Cattail	Goodding Willow, Ash, Cattail, Deer Grass	Desert Broom, Ash	Coyote Willow
Aquatic Life (fish type and avg/max size)	Dace 2 inch	Dace 2 inch	Dace 1 inch	Dace 1.5 inch	Dace 1.5 inch (more than in last unit)	Fish 1.5 inch
Location (Landmark)						***Below Active Zone***
Photos		87		89-91	92	
Comments	Top of unit is faster and has short riffle; unit is wide			Minor riffle/agitated, wide, fast run; minor winnowing of sands; ends with big riffle		

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	40	41	42	43	44	P44
GPS #	U40	U41	U42	U43	U44	UP44
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P44
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Riffle	Run	Riffle	Run	Riffle	Pool-lateral scour
Dominant / Primary Substrate	Gravel	Sand	Gravel	Sand		
Sub-Dominant Substrate	Sand	Sand	Sand	Sand		
Unit Mean Length						8 feet
Unit Mean Width						12 feet
Unit Mean Depth						1.2 feet
Pool Max Depth						2 feet
Headcut Entrenchment Height	8 feet					
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	3	2	0	2	4	4
Dom. Veg. Overstory	Mesquite, Goodding Willow	Cottonwood, Goodding Willow	na	Goodding Willow	Goodding Willow	Goodding Willow
Dom. Veg. Understory	Johnson Grass	variety of veg - none dominant	variety of veg - none dominant	Desert Broom	Johnson Grass	none
Exotic Veg Spp.	Johnson Grass	Tamarisk, Johnson Grass	Johnson Grass	Johnson Grass	Johnson Grass, Tamarisk	none
Additional Veg Present	Ash, Desert Broom, Cottonwood	Ash, Cattail, Coyote Willow	Ash, Desert Broom, and small Goodding Willow	Ash, Desert Broom, Coyote Willow, and downed Goodding Willow	Downed Goodding Willow	
Aquatic Life (fish type and avg/max size)	Dace 1.5 inch	Dace 2.5 inch	Dace 2.5 inch	Fish 2 inch	Fish 2 inch	Dace 1.5 inch
Location (Landmark)						outcrop
Photos		93, 94				97
Comments	Stream doesn't extend from bank to bank					Bedrock formed

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008	3/24/2008
Sample Time:						
Field Crew:	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ	MM, RL, MB, CZ
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	45	P45	P45-2	46	47	48
GPS #	U45	UP45	UP46	U46	U47	U48
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Riffle	Pool-backwater	Pool-backwater	Run	Riffle	Run
Dominant / Primary Substrate	Gravel	Sand	Sand	Sand	Gravel	Sand
Sub-Dominant Substrate	Sand	Sand	Sand	Sand	Gravel	Gravel
Unit Mean Length		9 feet	22 feet			
Unit Mean Width		22 feet	15 feet			
Unit Mean Depth		0.8 feet	4 feet			
Pool Max Depth		2.5 feet	2 feet			
Headcut Entrenchment Height				8 feet	8 feet	
Headcut Entrenchment Width					30 feet	
Condition of Bankful Banks (angle)					vertical	
Overstory Est. - Stream and banks	3	2	4	5	4	4
Dom. Veg. Overstory	Cottonwood, Goodding Willow	Mesquite	missing data	Cottonwood	Cottonwood	Cottonwood
Dom. Veg. Understory	Coyote Willow	Coyote Willow	na			Johnson Grass
Exotic Veg Spp.	Johnson Grass			Tamarisk	Johnson Grass	Johnson Grass
Additional Veg Present	Ash		Mesquite, Cottonwood, and downed Ash	Goodding Willow, Ash	Ash, plus standing and downed Goodding Willows	
Aquatic Life (fish type and avg/max size)				none		
Location (Landmark)						headcut zone
Photos		98, 99				
Comments	unit is winnowed, minor riffle					

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:	sunny, warm; no rain within last 7 days					
Seasonal Conditions:	Goodding Willow just leafing					
Misc. Comments:	starting at downstream end, walking upstream					
Beginning Location:	downstream end of headcut zone near lunch spot					
Ending Location:	most upstream point of 2-mi. reach					
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	49	P49	P49-2	PHC3-1	HC3-1	HC3-2
GPS #	U49	UP49	UP49-2	UPHC3 (first pool)	UHC3-1	UHC3-2
Primary, Secondary, or Tertiary Channel	P	P	P	T	T	T
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Riffle-braid	Pool-convergence	Pool-receding	Pool-backwater	Riffle	Run
Dominant / Primary Substrate	Large gravel	Silt	Sand	Silt	Large gravel	Large gravel
Sub-Dominant Substrate	Small gravel	Sand	Silt	Silt	Large gravel	Large gravel
Unit Mean Length		25 feet	3 feet	13 feet	6 feet	
Unit Mean Width		15 feet	2 feet	6 feet		
Unit Mean Depth		1 foot	0.6 feet	0.7 feet		
Pool Max Depth		1.5 feet	0.8 feet	0.5 feet		
Headcut Entrenchment Height			9 feet			8 feet
Headcut Entrenchment Width			27 feet			25 feet
Condition of Bankful Banks (angle)						vertical
Overstory Est. - Stream and banks	3	2	0	3	1	3
Dom. Veg. Overstory	Cottonwood, Goodding Willow	Goodding Willow	none	Goodding Willow	Cottonwood	Cottonwood, Goodding Willow
Dom. Veg. Understory		Unknown grass	none	Rabbitsfoot Grass	Coyote Willow	Rabbitsfoot Grass
Exotic Veg Spp.	Johnson Grass			Rabbitsfoot Grass		Rabbitsfoot Grass
Additional Veg Present	Bulrush, Coyote Willow, Ash					Elymus sp.
Aquatic Life (fish type and avg/max size)	Dace 1.5 inch	Dace 3 inch	none	Larval fish; Dace 0.5 inch	none	Dace 2 inch
Location (Landmark)		at confluence with HC2 (site of old plunge pool)		HC3		
Photos	105-107 (#107 also in Unit HC2)					
Comments	wet side channel w/algae present; primary channel is mildly agitated		u-shaped; downed wood present; pool is dense with aquatic veg.; includes second smaller pool	Log formed; dense aquatic veg.		

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	PHC3-2	HC3-3	PHC3-3a	PHC3-3b	PHC3-3c	HC3-4
GPS #	UPHC3-2 (taken at upstream end)	UHC3-3	UPHC3-3	UPHC3-4	UPHC3-5	UHC3-4
Primary, Secondary, or Tertiary Channel	T	T	T	T	T	T
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Pool-mid-channel	Riffle	Pool-mid-channel	Pool-receding	Pool-plunge	Run
Dominant / Primary Substrate	Silt	Small cobble	Large cobble	Large cobble	Detritus decay	Silt
Sub-Dominant Substrate	Silt	Gravel	Small cobble	Small cobble		Small cobble
Unit Mean Length	28 feet	25 feet	see GPS	6 feet	12 feet	
Unit Mean Width	8 feet		8 feet	4 feet	12 feet	
Unit Mean Depth	0.5 feet		2 feet	0.5 feet	1.2 feet	
Pool Max Depth	1 foot		0.7 feet	0.5 feet	1.6 feet	
Headcut Entrenchment Height						8 feet
Headcut Entrenchment Width						17 feet
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	5	4	3	0	5	3
Dom. Veg. Overstory	Cottonwood, Goodding Willow	Goodding Willow	Goodding Willow	none	Downed Cottonwood	Cottonwood
Dom. Veg. Understory	Bulrush	Bulrush	Bulrush	Bulrush	none	Bulrush
Exotic Veg Spp.		Johnson Grass	Johnson Grass	Johnson Grass, Tamarisk		Tamarisk, Johnson Grass
Additional Veg Present	Downed Cottonwood	Ash	Coyote Willow	Penstemon		
Aquatic Life (fish type and avg/max size)	none	none	Dace 3 inch max.	none	none	none
Location (Landmark)						
Photos	100, 101					103
Comments	dense aquatic veg.			Side pool; downed trees; dense aquatic veg	formed on side at erosive head; scum on surface of water	

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	HC3-5	PHC3-5a	PHC3-5b	HC2	HC2	HC2
GPS #	UHC3-5	UPHC3-6	UPHC3-7	UHC2-3	UHC2	UHC2-nick
Primary, Secondary, or Tertiary Channel	T	T	T	S	S	S
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Dry	Pool-plunge	Pool-plunge	Dry	Dry	Dry
Dominant / Primary Substrate	Small cobble	Clay (Mud)				
Sub-Dominant Substrate	Large cobble	Large gravel				
Unit Mean Length		8 feet	10 feet			
Unit Mean Width			8 feet			
Unit Mean Depth			1.3 feet			
Pool Max Depth		0.4 feet	1 foot			
Headcut Entrenchment Height	4 feet		8 feet	6 feet	4.6 feet	2.3 feet
Headcut Entrenchment Width	51 feet			14 feet	11 feet	5 feet
Condition of Bankful Banks (angle)				vertical	vertical	vertical
Overstory Est. - Stream and banks	1	1	4	4	4	4
Dom. Veg. Overstory	Cottonwood	Ash	Ash	Cottonwood, Goodding Willow	Cottonwood, Goodding Willow	Cottonwood, Goodding Willow
Dom. Veg. Understory	Coyote Willow		none	Coyote Willow	Coyote Willow	Coyote Willow
Exotic Veg Spp.		Johnson Grass				
Additional Veg Present				Thistle	young Ash	
Aquatic Life (fish type and avg/max size)			none			
Location (Landmark)				at confluence with main channel		HC2 nick point
Photos	102		104	107		
Comments		surrounded by several small ~4ft diameter stagnant pools		*a couple of fallen trees throughout HC2		

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	50	51	52	53	54	55
GPS #	U50	U51	U52	U53	U54correction	U55
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Active	Active	Active	Active	Active	Active
Habitat Type	Run	Riffle	Run-agitated	Riffle	Run-braid-agitated	Run-glide
Dominant / Primary Substrate	Sand	Small gravel	Small gravel	Small gravel	Small gravel	Sand
Sub-Dominant Substrate	Sand	Small gravel	Small gravel	Small gravel	Small gravel	Sand
Unit Mean Length						
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height						5.5 feet
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	4	4	2	4	4	4
Dom. Veg. Overstory	Goodding Willow	Goodding Willow	Goodding Willow	Goodding Willow	Downed Cottonwood and Goodding Willow	Goodding Willow, Cottonwood
Dom. Veg. Understory	Coyote Willow	Coyote Willow	Coyote Willow	none	none	Coyote Willow
Exotic Veg Spp.	Johnson Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass		Tamarisk, Johnson Grass
Additional Veg Present	Fallen Cottonwood; Rabbitsfoot Grass			a few fallen Cottonwood	dense with fallen Cottonwoods and Goodding Willow	Mesquite and patches of fallen Goodding Willow and Cottonwood
Aquatic Life (fish type and avg/max size)	Fish 1.5 inch	none	Dace 2 inch	Dace 2 inch	none	none
Location (Landmark)						
Photos				108	109	
Comments				has small runs; diminishing side channel is flowing and has algae cover	heavy treefall begins within unit	lots of leaf litter on stream banks; run is very smooth and shallow; unit width varies from narrow to wide; 10 ft. dry area present

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:		Unit	Unit	Unit	Unit	Unit
Seq. No.	none	56	57	58	59	60
GPS #	UHC1	U56	U57	U58	U59	U60
Primary, Secondary, or Tertiary Channel		P	P	P	P	P
Headcut Study Zone		Active	Active	Active	Active	Active
Habitat Type	entrenchment measurement, not a habitat unit	Run-agitated	Run-glide	Riffle	Run-agitated	Riffle
Dominant / Primary Substrate		Sand	Sand	Small cobble	Sand	Small cobble
Sub-Dominant Substrate		Small gravel	Sand	Small cobble	Sand	Sand
Unit Mean Length						
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height	5 feet					3.5 feet
Headcut Entrenchment Width	16.5 feet					
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks		4	5	5	2	3
Dom. Veg. Overstory		Goodding Willow, Cottonwood	Goodding Willow, Cottonwood	Cottonwood	Cottonwood	Cottonwood
Dom. Veg. Understory			Johnson Grass	Coyote Willow	Coyote Willow	Johnson Grass
Exotic Veg Spp.		Tamarisk, Johnson Grass	Tamarisk, Johnson Grass	Tamarisk, Johnson Grass	Tamarisk, Johnson Grass, Bermuda Grass	Tamarisk, Johnson Grass
Additional Veg Present				Goodding Willow		
Aquatic Life (fish type and avg/max size)		none	none	none		none
Location (Landmark)						
Photos			110			
Comments	repeated GPS point for headcut entrenchment location of measurement	more Tamarisk cover in unit; no fallen trees; few minor (5 ft) riffle steps	no fallen trees	no fallen trees; overstory closer to 90%	no fallen trees	

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	61	62	63	64	65	66
GPS #	U61	U62	U63	U64	U65	U66
Primary, Secondary, or Tertiary Channel	P	P	P	P	P	P
Headcut Study Zone	Active	Active	Upstream	Upstream	Upstream	Upstream
Habitat Type	Run	Riffle	Run	Riffle	Run-agitated	Riffle
Dominant / Primary Substrate	Sand	Small gravel		Small gravel	Sand	Small gravel
Sub-Dominant Substrate	Sand	Small gravel		Small gravel	Sand	Sand
Unit Mean Length						
Unit Mean Width						
Unit Mean Depth						
Pool Max Depth						
Headcut Entrenchment Height				3.0 feet	none	
Headcut Entrenchment Width				60 feet	none	
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	5	2	3	5	5	4
Dom. Veg. Overstory	Goodding Willow, Cottonwood	Goodding Willow, Cottonwood	Goodding Willow, Cottonwood	Downed Cottonwood, standing Goodding Willow	Cottonwood	Goodding Willow, Cottonwood
Dom. Veg. Understory	Coyote Willow	Johnson Grass		none	none	none
Exotic Veg Spp.	Tamarisk, Johnson Grass	Tamarisk, Johnson Grass, Bermuda Grass	Tamarisk, Johnson Grass, Bermuda Grass	none	none	none
Additional Veg Present			Coyote Willow			
Aquatic Life (fish type and avg/max size)	none	none	none	none	none	none
Location (Landmark)		HC1 nick point	***Above Nick***			
Photos	111	112, 113		114		
Comments	damp side channel		Cover is dense on north bank, absent on south bank; small, riffle steps present; no fallen trees; headcut opens up in this unit		open floodplain (no headcut)	cover is 80%

2008 Cienega Headcut Habitat Study Data

Project Name:						
Sample Date:	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008	3/25/2008
Sample Time:						
Field Crew:	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC	MM, RL, MB, SC
Data Entry:	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL	MM, RL
Recent Weather:						
Seasonal Conditions:						
Misc. Comments:						
Beginning Location:						
Ending Location:						
INVENTORY:	Unit	Unit	Unit	Unit	Unit	Unit
Seq. No.	72	P72	73	74	75	76
GPS #	U72	UP72	U73 (down end), Garmin 88 (up end)	U74	U75	U76
Primary, Secondary, or Tertiary Channel	P	P	S	P	P	P
Headcut Study Zone	Upstream	Upstream	Upstream	Upstream	Upstream	Upstream
Habitat Type	Riffle-braid	Pool-receding-backwater	Run-glide	Run-agitated	Run	Riffle
Dominant / Primary Substrate			Detritus	Sand	Sand	Sand
Sub-Dominant Substrate				Large gravel	Sand	Small gravel
Unit Mean Length		7 feet				
Unit Mean Width		2.9 feet	8 feet			
Unit Mean Depth		0.5 feet	0.6 feet			
Pool Max Depth						
Headcut Entrenchment Height						
Headcut Entrenchment Width						
Condition of Bankful Banks (angle)						
Overstory Est. - Stream and banks	4	3	5	5	5	3
Dom. Veg. Overstory	Cottonwood, Goodding Willow	Goodding Willow	Cottonwood, Goodding Willow	Cottonwood	Cottonwood, Goodding Willow	Cottonwood
Dom. Veg. Understory	Coyote Willow	Coyote Willow	none	none	none	none
Exotic Veg Spp.	Johnson Grass	Johnson Grass	none	none	none	Tamarisk
Additional Veg Present	Ash			Ash	small quantity of Horsetail	Goodding Willow
Aquatic Life (fish type and avg/max size)	none	none	none	none	none	none
Location (Landmark)						
Photos						
Comments	one channel in the braid was a run, one was a riffle: decided to name it a riffle	formed by fallen trees, located at convergence of braid	Leaning Cottonwoods, one has fallen; unit is a truncated second channel (does not connect to main channel); stagnant; covered with Cwood seeds	95% overstory est.		

2009 Cienega Headcut Habitat Study Data

Project Name:	**WPF Cienega Headcut Study**			
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:	10:20 AM			
Field Crew:	MM, RL, MB, BP			
Data Entry:	MM, RL			
Direction:	downstream to upstream			
Recent Weather:	sunny, no recent rain			
Seasonal Conditions:	Cwood and Ash leaves are more developed than last years'; catkins on Gwills			
Misc. Comments:	photos taken of scenery and field crew; bulrush photo #109, fish photos #110-111			
Beginning Location:	2-mile start			
Ending Location:				
INVENTORY:	Unit			
Seq. No.	1	2	3	4
GPS #	1	2	3	4
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	dry	run	run	agitated run
Dominant / Primary Substrate	sand	sand	sand	sand
Sub-Dominant Substrate	clay	small gravel	small gravel	small gravel
Unit Mean Length				
Unit Mean Width				
Unit Mean Depth			0.5 feet	0.4 feet
Pool Max Depth				
Head Cut Entrenchment Height	4.5 feet	4.5 feet	5 feet	
Head Cut Entrenchment Width	63 feet	63 feet	40 feet	narrows
Condition of Bankful Banks (angle)	45 degrees	45 degrees	45 degrees	45 degrees
Overstory Est. - Stream and banks	0	0	1	2
Dom. Veg. Overstory	Mesquite	Mesquite	Mesquite, Tamarisk	Gwill, Mesquite, Ash
Dom. Veg. Understory	Desert Broom	Desert Broom	Desert Broom	Desert Broom
Exotic Veg Spp.	Tamarisk, Johnson Grass, Buffelgrass	Johnson Grass, Tamarisk	Buffelgrass, Tamarisk	Johnson Grass, Tamarisk
Additional Veg Present	Gwill, Cwill present; assume Bermuda present in all units	Cwill	Cwill, Deer Grass	Cwill, Deer Grass, Lotebush
Aquatic Life (fish type and avg/max size)	none	larval fish up to 0.5 inch	1 inch fish	1-2 inch fish
Location (Landmark)	2-mile start			
Photos				#116 - bear track, #117- #120 - Lotebush
Comments:		some algal interruptions		steps of agitation present; bear tracks present

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	5	6	7	8
GPS #	5	6	7	8
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	riffle-braid	run	riffle	run
Dominant / Primary Substrate	sand	sand	small gravel	sand
Sub-Dominant Substrate	small gravel	sand	sand	small gravel
Unit Mean Length				
Unit Mean Width				
Unit Mean Depth	0.3 feet	0.3 feet	0.4 feet	0.45 feet
Pool Max Depth				
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	1	1	3	1
Dom. Veg. Overstory	Mesquite	Mesquite	Gwill, Cwood	Mesquite, Cwood
Dom. Veg. Understory	Cwill	Cwill	Cwill	Fourwing Saltbush
Exotic Veg Spp.	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Ash, Deer Grass	Ash, Deer Grass, Desert Broom	Ash, Deer Grass, Desert Broom, Fourwing Saltbush	Ash, Cwill, Deer Grass
Aquatic Life (fish type and avg/max size)	1-2 inch fish	1-2 inch fish	1-2 inch fish	1-2 inch fish
Location (Landmark)				
Photos		#121, 122 - unknown seedlings		
Comments:	unit braid is caused by plants	recruitment of unknown tree		

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	9	10	11	12
GPS #	9	10	11	12
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	riffle	run	riffle	agitated step-run
Dominant / Primary Substrate	small gravel	sand	small cobble	small gravel
Sub-Dominant Substrate	small gravel	small gravel	sand	sand
Unit Mean Length				17 feet (flowing bank to bank)
Unit Mean Width		10 feet	3 feet	
Unit Mean Depth	0.4 feet	0.4 feet	0.4 feet	0.25 feet
Pool Max Depth	0.8 feet	0.5 feet	0.8 feet	0.7 feet
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	2	2	2	3
Dom. Veg. Overstory	Gwill, Mesquite	Gwill	Gwill	Gwill, Ash
Dom. Veg. Understory	Fourwing Saltbush	none dominant	Cwill	Cwill
Exotic Veg Spp.	Rabbitsfoot Grass	Rabbitsfoot Grass	none	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Cwood, Cwill	Cwood, Cwill, Mesquite, Fourwing Saltbush	Deer Grass, Cwood	Deer Grass, Horsetail, Cattail, Bulrush
Aquatic Life (fish type and avg/max size)	0.5-3.0 inches	0.5-3.0 inches	0.5-3.0 inches	0.5-3.0 inches
Location (Landmark)				
Photos				
Comments:	includes small scour pool	slight agitation	higher gradient riffle, narrow chute, ends in narrow mid-channel scour	algal braids present

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	13	14	15	16
GPS #	13	14	15	16
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	riffle	run	riffle-braid	run-small agitated braid
Dominant / Primary Substrate	large gravel	sand	large gravel	sand
Sub-Dominant Substrate	sand	small gravel	small gravel	large gravel
Unit Mean Length				
Unit Mean Width	4 feet	10 feet	25 feet (bank to bank)	25 feet (bank to bank)
Unit Mean Depth	0.25 feet	0.25 feet	0.3 feet	0.25 feet
Pool Max Depth			0.65 feet	
Head Cut Entrenchment Height	0	0	0	0
Head Cut Entrenchment Width	none	none	none	none
Condition of Bankful Banks (angle)	none	none	none	none
Overstory Est. - Stream and banks	3	2	3	3
Dom. Veg. Overstory	Gwill, Ash	Gwill, Ash	Cwood, Gwill	Cwood, Gwill
Dom. Veg. Understory	Cwill	Cwill	Cwill	Cwill
Exotic Veg Spp.	Rabbitsfoot Grass	Tamarisk, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Rabbitsfoot Grass
Additional Veg Present	Cattail		Ash, Desert Broom	Ash, Desert Broom, Cattail, Bulrush, Deer Grass
Aquatic Life (fish type and avg/max size)	average size: 2-3 inches	average size: 2-3 inches	many, avg. 2 inches	avg. 1.5 inches
Location (Landmark)				
Photos				
Comments:	some Ash and Gwill are freshly fallen			

2009 Cienega Headcut Habitat Study Data

Project Name:			
Sample Date:	3/25/2009	3/25/2009	3/25/2009
Sample Time:			
Field Crew:			
Data Entry:			
Direction:			
Recent Weather:			
Seasonal Conditions:			
Misc. Comments:			
Beginning Location:			
Ending Location:			
INVENTORY:			
Seq. No.	P15	17	18P
GPS #	P15	17	18P
Primary, Secondary, or Tertiary Channel	P	P	P
Headcut Study Zone	downstream	downstream	downstream
Habitat Type	pool-receding wash convergence, side pool	chute	mid-channel pool - scour
Dominant / Primary Substrate	sand	sand	sand
Sub-Dominant Substrate	sand	scattered cobble	sand
Unit Mean Length	10 feet		30 feet
Unit Mean Width	25 feet	8 feet	15 feet
Unit Mean Depth	0.7 feet	0.4 feet	0.8 feet
Pool Max Depth	1.5 feet	0.8 feet (in scour)	2.3 feet
Head Cut Entrenchment Height	0	0	0
Head Cut Entrenchment Width	none	none	none
Condition of Bankful Banks (angle)	none	none	none
Overstory Est. - Stream and banks	3	1	1
Dom. Veg. Overstory	Mesquite	Gwill, Cwood	Gwill
Dom. Veg. Understory	Cwill	Deer Grass	none present
Exotic Veg Spp.	Johnson Grass	Rabbitsfoot Grass	Rabbitsfoot Grass
Additional Veg Present	unknown grass	Ash, Cwill, Bulrush	
Aquatic Life (fish type and avg/max size)	none	avg. 2 inches	many tadpoles, many fish, avg. 2.5, smallest at 0.5 inch (large 3.0 inch fish in deeper part = chub?)
Location (Landmark)			
Photos		#124-125 - bulrush, #126 - chute	#127-129 - tadpole, #130 - fish
Comments:	stagnant and isolated; Mesquite has no foliage		pool is in two sections, second half is bedrock formed

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	18P-a	19	20	21
GPS #	18P-a	19	20	21
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	side pool	riffle	run	chute
Dominant / Primary Substrate	sand	small gravel	small gravel	medium gravel
Sub-Dominant Substrate	sand	large gravel	sand	sand
Unit Mean Length	30 feet			
Unit Mean Width	17 feet	8 feet	20 feet	
Unit Mean Depth	1 foot	0.3 feet	0.2 feet	0.2 feet
Pool Max Depth	2.5 feet			
Head Cut Entrenchment Height	0	0	0	0
Head Cut Entrenchment Width	none	none	none	none
Condition of Bankful Banks (angle)	none	none	none	none
Overstory Est. - Stream and banks	5	3	2	3
Dom. Veg. Overstory	Gwill	Gwill	Gwill, Cwood	Gwill, large Ash
Dom. Veg. Understory	none present	Desert Broom	none dominant	Small Ash
Exotic Veg Spp.	Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present		Fourwing Saltbush, Cattail, Bulrush, Cwood, Deer Grass, Cwill, Horsetail, Ash	Ash, Bulrush, Cattail, Fourwing Saltbush, Cwill	Bulrush, Deer Grass
Aquatic Life (fish type and avg/max size)	small frog	many fish, avg. 2 inches	avg. 1 inch	avg. 1.5 inch
Location (Landmark)				
Photos			#131 - lush run, #132-133 - bulrush & cattail combo, #134-136 - bulrush cross-section	
Comments:	on side of 18P	skunk	small section of creek is split; other part of run is a wide glide	bulrush lines the banks

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	22	23	24	25
GPS #	22	23	24	25
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	riffle-step	run-agitated	riffle-braid	run
Dominant / Primary Substrate	medium gravel	sand	large gravel	sand
Sub-Dominant Substrate	small gravel	small gravel	small gravel	small gravel
Unit Mean Length				
Unit Mean Width				10 feet
Unit Mean Depth	0.2 feet		0.25 feet	0.3 feet
Pool Max Depth				
Head Cut Entrenchment Height	1.5-4.0 feet	3-4 feet		
Head Cut Entrenchment Width	30 feet	26 feet		
Condition of Bankful Banks (angle)		45-60 degrees		
Overstory Est. - Stream and banks	3	4	3	2
Dom. Veg. Overstory	Gwill, large Ash	Cwood, Gwill	Gwill, leaning Ash	Cwood, Gwill
Dom. Veg. Understory	Cwill	Desert Broom	Small Ash	Cwill
Exotic Veg Spp.	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Bulrush, Deer Grass, Horsetail	Ash, Deer Grass, Horsetail	Deer Grass, Horsetail, Cwill, Desert Broom, Bulrush	Deer Grass, Horsetail
Aquatic Life (fish type and avg/max size)	less than 1 inch	fish present	fish present	no fish
Location (Landmark)				
Photos				
Comments:	substrate has band of sand	single channel; first instance of no algae or aquatic veg; dragonfly and larval caddis fly	no Bermuda grass; unit is braided through a narrow, single channel	trees mostly on south bank

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	26	27	28	29
GPS #	26	27	28	29
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	riffle	run	chute	riffle
Dominant / Primary Substrate	medium cobble	sand	large gravel	medium gravel
Sub-Dominant Substrate	gravel	sand	bands of sand	sand
Unit Mean Length				
Unit Mean Width	6 feet			
Unit Mean Depth	0.35 feet	0.1 feet	0.3 feet	0.3 feet
Pool Max Depth				
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	missing	2	3	3
Dom. Veg. Overstory	Gwill	Mesquite, Gwill	Gwill, Mesquite	Gwill, Mesquite
Dom. Veg. Understory	small, leaning Ash	small Gwill	none dominant	none dominant
Exotic Veg Spp.	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Cwood, Desert Broom, Cwill, Deer Grass, Bulrush	Cwill, Desert Broom, Cwood, dead Cattail	Deer Grass, Cwood, Cwill, Desert Broom, Water Speedwell	Deer Grass, Ash, Cwill, Desert Broom
Aquatic Life (fish type and avg/max size)	2 inch dace	1 inch fish	0.5 -3.5 inch fish	none
Location (Landmark)				
Photos		#137, 139-140 - toe biter	#144 -Water Speedwell	
Comments:	most cobble seen so far is protruding from water		narrow and agitated with some riffle; Gwill lines south bank, Mesquite lines north bank	Gwill lines south bank, Mesquite lines north bank

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	30	31	32	33
GPS #	30	31	32	33
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	downstream	downstream	downstream	downstream
Habitat Type	run	riffle	run-agitated	riffle
Dominant / Primary Substrate	sand	medium to large gravel	sand	sand
Sub-Dominant Substrate	small gravel	sand	small gravel	medium and large cobble
Unit Mean Length				
Unit Mean Width				
Unit Mean Depth	0.4 feet	0.4 feet	0.3 feet	0.3 feet
Pool Max Depth				0.5 feet (not a pool)
Head Cut Entrenchment Height				3.5 feet on south edge, 6.5 on north edge
Head Cut Entrenchment Width				60 feet
Condition of Bankful Banks (angle)				60 degrees
Overstory Est. - Stream and banks	3	3	2	1
Dom. Veg. Overstory	leaning and fresh downed Gwill, Mesquite	Gwill	Cwood, Gwill	Cwood
Dom. Veg. Understory	downed Gwill	none dominant	downed Gwill	fresh downed Gwill
Exotic Veg Spp.	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Cwood, Deer Grass, Desert Broom	young Cattail, Desert Broom, Water Speedwell, Bulrush, Ash	young Cattail, Desert Broom, Cwill, Bulrush	Cwill, Desert Broom, Ash
Aquatic Life (fish type and avg/max size)	0.5 -1 inch (many fish this size); tadpoles	tadpoles	1.5 - 3 inch fish	fish present
Location (Landmark)				
Photos		#146 - example of #3 overstory		
Comments:	one channel			cobble protrudes from water

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	34	P34-a	P34-b	35
GPS #	34	P34-a	P34-b	Trimble 35
Primary, Secondary, or Tertiary Channel	P	P	P34-b	P
Headcut Study Zone	downstream	active	active	active
Habitat Type	chute	pool - side (second channel, flowing)	pool- side	riffle
Dominant / Primary Substrate	sand	sand	sand	large gravel
Sub-Dominant Substrate	gravel	gravel and detritus	sand	small cobble
Unit Mean Length		25 feet	20 feet	
Unit Mean Width		10 feet	25 feet	
Unit Mean Depth		1.75 feet	2 feet	
Pool Max Depth		4 feet	4.5 feet	0.5 feet (not a pool)
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	3	1	4	4
Dom. Veg. Overstory	Gwill, Cwood, leaning Gwill	Mesquite	Mesquite, leaning Cwood, Ash	Cwood, Gwill
Dom. Veg. Understory	Cwill	Cwill	leaning Ash	little Ash, Cwill
Exotic Veg Spp.	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Rabbitsfoot Grass	Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Desert Broom, Ash, Penstemon			Desert Broom, Bulrush, recruitment of Cwill
Aquatic Life (fish type and avg/max size)	fish present	1 - 3 inch dace	3 inch fish	none
Location (Landmark)		Outcrop 1		unit begins as a braid at confluence of third fork
Photos				
Comments:		mid-channel, second channel before bedrock	pool is dark	many freshly fallen Cwood and Gwill; javelina spotted

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	36	37	38	39
GPS #	Garmin 36	Garmin 37	Trimble 38	39
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	active	active	active	active
Habitat Type	run - agitated braid	riffle-braid	chute	run-agitated braid
Dominant / Primary Substrate	sand	medium gravel	medium to large gravel	sand
Sub-Dominant Substrate	small gravel	sand (in shallows and second channel)	sand	medium gravel
Unit Mean Length				
Unit Mean Width		flowing bank to bank		
Unit Mean Depth		0.4 feet	0.3 feet	0.1 feet
Pool Max Depth	0.4 feet (not a pool)	0.6 feet	0.5 feet	
Head Cut Entrenchment Height	south bank = 7 ft, north bank = 7.25 ft (last yr's point is called UP-49)	north = 8 ft, south = 7.75 ft		
Head Cut Entrenchment Width	65 feet	35 ft - primary channel; 55 ft total includes second fork		
Condition of Bankful Banks (angle)	90 degrees	90 degrees		
Overstory Est. - Stream and banks	3 (less coverage than last year)	3	3 (veg along banks, but not over channel)	4
Dom. Veg. Overstory	Cwood, Gwill	Cwood, Gwill	Cwood primarily on south bank, Gwill	Gwill, downed Gwill
Dom. Veg. Understory	Cwill	Cwill	Cwill	none present
Exotic Veg Spp.	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Bulrush, fallen Cwood and Gwill, Mesquite	Mesquite, young Cattail, Yerba Mansa, Wildrye		Wildrye
Aquatic Life (fish type and avg/max size)	fish present	~ 2-3 inches	~ 2-3 inches	no fish
Location (Landmark)		old plunge pool at second fork	RR Wash	
Photos				
Comments:	braid includes 10 ft chutes and 10 ft riffles	some pocket waters; unit has chute in thalweg with swampy edges; turkey vulture present	freshly fallen Cwood and Gwill	javelina tracks

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/25/2009	3/25/2009	3/25/2009	3/25/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	40	41	42	43
GPS #	40	41	42	43
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	active	active	active	active
Habitat Type	run	run	riffle	run-sprawling braid
Dominant / Primary Substrate	sand	sand	large gravel	sand
Sub-Dominant Substrate	sand	sand	sand	sand
Unit Mean Length				
Unit Mean Width		bank to bank flow	bank to bank flow	bank to bank flow
Unit Mean Depth			0.3 feet	0.2 feet
Pool Max Depth				
Head Cut Entrenchment Height	south bank = 5 ft, north bank = 6.75 ft (last yr's point is called uhc1)		south bank = 6.5 ft, north bank = 3.75 ft	
Head Cut Entrenchment Width	32 feet		21.5 feet	
Condition of Bankful Banks (angle)	90 degrees			
Overstory Est. - Stream and banks	4	5	3	4
Dom. Veg. Overstory	Gwill, both upright and leaning	Cwood, Gwill	Cwood, Gwill	Cwood
Dom. Veg. Understory	Cwill	Cwill	Cwill	Cwill
Exotic Veg Spp.	Tamarisk, Johnson Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Cwood, Mesquite, Ash	Mequite, Ash, Deer Grass		
Aquatic Life (fish type and avg/max size)	larval fish and 1.5-2 inch fish	larval fish and 1-2 inch fish	many fish, including larval	many fish, including larval
Location (Landmark)				
Photos				
Comments:	single channel, filled in with sand this year	no fallen trees; first 100 ft is Mesquite-dominant; small sections have agitation		small agitations

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:	am			
Field Crew:	MM, RL, MB, BP, Netzin Seklos			
Data Entry:	RL, MM			
Direction:	downstream to upstream			
Recent Weather:	sunny, no recent rain			
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:	RR Wash and 3rd fork			
Ending Location:	end of 2 mile mark			
INVENTORY:				
Seq. No.	44	45	46	47
GPS #	44	45	46	47
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	active	active	active	upstream
Habitat Type	riffle	run	riffle	run-agitated
Dominant / Primary Substrate	sand	sand	medium gravel	sand
Sub-Dominant Substrate	medium gravel	small gravel	sand	sand
Unit Mean Length				
Unit Mean Width				
Unit Mean Depth	0.3 feet	0.2 feet	0.3 feet	
Pool Max Depth	0.6 feet, where there is scouring (not a pool)	0.4 feet (not a pool)	0.6 feet (not a pool)	
Head Cut Entrenchment Height				south bank = 4.5 ft, north bank = 3 ft (last yr's point is u64)
Head Cut Entrenchment Width				42 feet
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	5	4	3	4
Dom. Veg. Overstory	Cwood	Cwood, Gwill	Cwood, Gwill	Cwood, both upright and fallen, Gwill
Dom. Veg. Understory	Cwill	Cwill	Cwill	Cwill
Exotic Veg Spp.	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass
Additional Veg Present		Yerba Mansa		Ash
Aquatic Life (fish type and avg/max size)	fish and dragonfly larvae present	larval fish	many fish 1-2.5 inches	many fish 1-2.5 inches
Location (Landmark)				
Photos			#166-167 - Malini and Brooke with galoshes	#160-162 - dragonfly nymph
Comments:	unit varies between a chute and sprawling riffle	single channel		

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	48	49	50	51
GPS #	48	49	50	51
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	upstream	upstream	upstream	upstream
Habitat Type	riffle	run-agitated	riffle	run
Dominant / Primary Substrate	small gravel	sand	sand	sand
Sub-Dominant Substrate	sand	small gravel	large gravel (in thalweg)	sand
Unit Mean Length				
Unit Mean Width		15 feet		
Unit Mean Depth	0.3 feet	0.4 feet	0.3 feet	0.3 feet
Pool Max Depth		0.5 feet (not a pool)		0.5 feet (not a pool)
Head Cut Entrenchment Height	new nick		south bank = 2.5 ft, north bank = 0.5 ft (last yr's point is u70)	
Head Cut Entrenchment Width			50 feet	
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	3	5	5	5
Dom. Veg. Overstory	standing and old downed Cwood	Cwood, Gwill	Cwood, Gwill	Cwood, Gwill
Dom. Veg. Understory	none dominant	Tamarisk	none dominant	Cwill
Exotic Veg Spp.	Rabbitsfoot Grass	Tamarisk, Rabbitsfoot Grass	Rabbitsfoot Grass	Rabbitsfoot Grass
Additional Veg Present	standing and leaning Gwill; Ash	Ash	Ash, tons of Cwood seedlings	Ash
Aquatic Life (fish type and avg/max size)	many fish	fish present		1.5 inch fish
Location (Landmark)				
Photos				
Comments:				

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	T1	T2	T-Pa	S1
GPS #	T1	T2 (ends at TNick, minus 12 ft)	T-Pa	S1 (end pt. is SNick)
Primary, Secondary, or Tertiary Channel	T	T	T	S
Headcut Study Zone	active	active	active	active
Habitat Type	riffle	run-braid	pool	dry
Dominant / Primary Substrate	medium gravel	sand	sand	sand
Sub-Dominant Substrate	sand	small gravel	large cobble	small gravel
Unit Mean Length			12 feet	
Unit Mean Width	8 feet		25 feet	
Unit Mean Depth	0.2 feet	0.3 feet	1 foot	
Pool Max Depth			2.5 feet	
Head Cut Entrenchment Height		south bank = 5.5 ft , north bank = 6 ft (last yr's point is uphc3-2); at TNick = 6.8 ft		south bank = 2.5 ft, north bank = 3.65 ft (last yr's point is uhc2-3 and/or uhc2)
Head Cut Entrenchment Width		30 feet		12 feet
Condition of Bankful Banks (angle)		90 degrees		90 degrees
Overstory Est. - Stream and banks	3	4	4	4
Dom. Veg. Overstory	Cwood, Gwill	Cwood, Gwill	Tamarisk	Gwill
Dom. Veg. Understory	Cwill	Cwill	Ash	Cwill
Exotic Veg Spp.	Johnson Grass, Tamarisk, lots of Rabbitsfoot Grass in the water, Buffelgrass	Johnson Grass, Tamarisk, lots of Rabbitsfoot Grass in the water, Buffelgrass	Tamarisk, Rabbitsfoot Grass	Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Ash, Bulrush	Bulrush, Wildrye, Penstemon, downed Cwood and Gwill	Aquatic plants, fallen Gwill, Cwill	Ash, Cwood, Thistle, Wildrye
Aquatic Life (fish type and avg/max size)	2 inch fish	2-2.5 inch fish	cannot see in pool (due to veg cover)	no fish
Location (Landmark)				
Photos	#150-155 - Wildrye	#156 - 3rd fork nick point		
Comments:	less water than in main channel	unit ends in two channels; hummingbird present; coati platforms; Rabbitsfoot Grass slows the streamflow; downed trees have reduced canopy cover from last yr.	this is springhead of 3rd fork; clear water	overstory is almost a 5; buffelgrass present, but outside monitored area

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.		S1-pa	52	53
GPS #	S-Nick	S1pa	52	53
Primary, Secondary, or Tertiary Channel		S	P	P
Headcut Study Zone		active	upstream	upstream
Habitat Type	entrenchment measurement, not a habitat unit	pool	riffle	run
Dominant / Primary Substrate		sand, detritus	medium/large gravel	sand
Sub-Dominant Substrate		sand	sand	small gravel
Unit Mean Length		14 feet		
Unit Mean Width		6 feet		
Unit Mean Depth		0.2 feet	0.5 feet (not a pool)	0.4 feet
Pool Max Depth		0.3 feet		0.6 feet
Head Cut Entrenchment Height	2.5 feet (last yr's point is uhc2-nick)	6.25 feet		
Head Cut Entrenchment Width	8.5 feet	22.0 feet		
Condition of Bankful Banks (angle)		90 degrees		
Overstory Est. - Stream and banks		4	4	5
Dom. Veg. Overstory		Gwill	Gwill; leaning, live Cwood	Gwill; leaning, live Cwood
Dom. Veg. Understory		Cwill	none dominant	none dominant
Exotic Veg Spp.		Buffelgrass, Rabbitsfoot Grass	Rabbitsfoot Grass	Rabbitsfoot Grass
Additional Veg Present		Cwood, old&fallen Gwill	Ash	Ash
Aquatic Life (fish type and avg/max size)		no fish	1.5 inch fish	1.0 inch fish
Location (Landmark)			channel splits	
Photos				
Comments:		stagnant, isolated, mid-channel pool	some medium-size cobble	

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	54	55	56	57
GPS #	54	55	56	57
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	upstream	upstream	upstream	upstream
Habitat Type	riffle	run	riffle	run
Dominant / Primary Substrate	small gravel	sand	large gravel, small cobble	sand
Sub-Dominant Substrate	sand	sand	sand	small gravel
Unit Mean Length				
Unit Mean Width				bank to bank
Unit Mean Depth	0.4 feet		0.4 feet	0.3 feet
Pool Max Depth	0.6 feet		0.7 feet	0.5 feet
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	5	5	5	5
Dom. Veg. Overstory	Cwood	Cwood	Cwood, Gwill	live, dead and downed, and leaning Cwood; Gwill
Dom. Veg. Understory	none dominant	none dominant	none dominant	none dominant
Exotic Veg Spp.	Rabbitsfoot Grass	Rabbitsfoot Grass	Rabbitsfoot Grass	Johnson Grass, Tamarisk, Rabbitsfoot Grass
Additional Veg Present	Gwill	Ash, Cwill		Ash, Cwill
Aquatic Life (fish type and avg/max size)				many 0.5 - 2 inch fish
Location (Landmark)				
Photos				
Comments:			lots of leaf litter outside of streambed	small, agitated sections of approx. 5 feet

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	58	59	60	61
GPS #	58	59	60	61
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	upstream	upstream	upstream	upstream
Habitat Type	riffle	run	run-agitated	run-braid
Dominant / Primary Substrate	sand	sand	sand	sand
Sub-Dominant Substrate	large gravel (in thalweg)	small gravel	small gravel (where agitated)	small gravel
Unit Mean Length				
Unit Mean Width				
Unit Mean Depth	0.3 feet	0.2 feet	0.25 feet	
Pool Max Depth				
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	5	missing	4	4
Dom. Veg. Overstory	Cwood	Gwill, Cwood	Cwood	Cwood, Gwill
Dom. Veg. Understory	none dominant	none dominant	young Gwill	none dominant
Exotic Veg Spp.	Tamarisk, Rabbitsfoot Grass	Tamarisk, Rabbitsfoot Grass	Tamarisk, Rabbitsfoot Grass	Tamarisk, Rabbitsfoot Grass
Additional Veg Present	Ash, Cwill, Gwill, Horsetail	Ash, Cwill, Horsetail	Ash, Horsetail	fresh fallen Cwood, Horsetail, tall Ash, Deer Grass
Aquatic Life (fish type and avg/max size)		1.0 inch fish	0.75 inch fish	1.0 inch fish
Location (Landmark)				
Photos	#158 - Overstory 5 -Cwood			
Comments:				debris pile

2009 Cienega Headcut Habitat Study Data

Project Name:				
Sample Date:	3/26/2009	3/26/2009	3/26/2009	3/26/2009
Sample Time:				
Field Crew:				
Data Entry:				
Direction:				
Recent Weather:				
Seasonal Conditions:				
Misc. Comments:				
Beginning Location:				
Ending Location:				
INVENTORY:				
Seq. No.	62	63	64	65
GPS #	62	63	64	65
Primary, Secondary, or Tertiary Channel	P	P	P	P
Headcut Study Zone	upstream	upstream	upstream	upstream
Habitat Type	riffle	run	riffle (single channel)	run (single channel)
Dominant / Primary Substrate	sand	sand	sand	sand
Sub-Dominant Substrate	large gravel	sand	sand	sand
Unit Mean Length				
Unit Mean Width	5 feet	5 feet	8 feet	8 feet
Unit Mean Depth	0.3 feet	0.275 feet	0.3 feet	
Pool Max Depth				
Head Cut Entrenchment Height				
Head Cut Entrenchment Width				
Condition of Bankful Banks (angle)				
Overstory Est. - Stream and banks	3	3	5	4
Dom. Veg. Overstory	Cwood, Gwill	Cwood, Gwill	Cwood, Gwill	Cwood
Dom. Veg. Understory	none dominant	none dominant	none dominant	none dominant
Exotic Veg Spp.	Rabbitsfoot Grass	Tamarisk, Johnson Grass, Rabbitsfoot Grass	Rabbitsfoot Grass	live, downed, and sapling Tamarisk; Johnson Grass, Rabbitsfoot Grass
Additional Veg Present	Deer Grass	young Ash	Ash, Horsetail	Ash, Horsetail, Gwill, Deer Grass
Aquatic Life (fish type and avg/max size)	fish present	1.5 inch fish		1.5 inch fish
Location (Landmark)				
Photos				
Comments:			small gravel in thalweg; width of majority of flow is 4 feet	includes short steps and mild agitation

Appendix 3

Photo Disc Table of Contents

PAG Headcut Photos CD
Table of Contents

The following is a complete list of the.JPG files for the repeat photography taken for the PAG Cienega Creek Headcut Study from 2008-2009. They are listed in order of the 15 sites and grouped by the direction faced within the channel for the photograph. This provides a reference for photos that are available digitally through the Watershed Planning Section Library by request. The lists state the folders that the files are found in between backslashes. The naming convention of the file indicates the site name, direction, date, and additional details.

<u>**Site 1 Down**</u>

\Site 01\Down\Site 1 Down_12Jun08_with_outcrop3.JPG
\Site 01\Down\Site 1 Down_17Nov09_a.JPG
\Site 01\Down\Site 1 Down_17Nov09_b.JPG
\Site 01\Down\Site 1 Down_17Nov09_lookdownto_outcrop3.JPG
\Site 01\Down\Site 1 Down_17Nov09_pool_closeup.JPG
\Site 01\Down\Site 1 Down_18Mar08.JPG

<u>**Site 1 River Left**</u>

\Site 01\River Left\Site 1 River Left_17Nov09_atpool.JPG
\Site 01\River Left\Site 1 River Left_17Nov09_downfrompool.JPG

<u>**Site 1 River Right**</u>

\Site 01\River Right\Site 1 River Right_17Nov09.JPG

<u>**Site 1 Up**</u>

\Site 01\Up\Site 1 Up_12Jun08.JPG
\Site 01\Up\Site 1 Up_17Nov09_outcrop_closeup.JPG
\Site 01\Up\Site 1 Up_18Mar08.JPG

<u>**Site 2 Down**</u>

\Site 02\Down\Site 2 Down_11May09.JPG
\Site 02\Down\Site 2 Down_17Nov09.JPG
\Site 02\Down\Site 2 Down_18Nov08.JPG
\Site 02\Down\Site 2 Down_22Jul08.jpg
\Site 02\Down\Site 2 Down_26May08.jpg
\Site 02\Down\Site 2 Down_28Jul09.JPG
\Site 02\Down\Site 2 Down_29Dec08_lookdownto_outcrop.jpg
\Site 02\Down\Site 2 Down_7Feb08_furtherdownstream.jpg

Site 2 River Left

\Site 02\River Left\Site 2 River Left_11May09.JPG
\Site 02\River Left\Site 2 River Left_17Nov09.JPG
\Site 02\River Left\Site 2 River Left_18Nov08.JPG
\Site 02\River Left\Site 2 River Left_22Jul08.jpg
\Site 02\River Left\Site 2 River Left_26May08.jpg
\Site 02\River Left\Site 2 River Left_26May08_outcrop.jpg
\Site 02\River Left\Site 2 River Left_28Jul09.JPG

Site 2 River Right

\Site 02\River Right\Site 2 River Right_11May09.JPG
\Site 02\River Right\Site 2 River Right_17Nov09.JPG
\Site 02\River Right\Site 2 River Right_18Nov08.JPG
\Site 02\River Right\Site 2 River Right_22Jul08.jpg
\Site 02\River Right\Site 2 River Right_26May08.jpg
\Site 02\River Right\Site 2 River Right_28Jul09.JPG

Site 2 Up

\Site 02\Up\Site 2 Up_11May09.JPG
\Site 02\Up\Site 2 Up_17Nov09.JPG
\Site 02\Up\Site 2 Up_18Nov08.JPG
\Site 02\Up\Site 2 Up_22Jul08_upfrom_outcrop.jpg
\Site 02\Up\Site 2 Up_26May08.jpg
\Site 02\Up\Site 2 Up_26May08_outcrop_view.jpg
\Site 02\Up\Site 2 Up_28Jul09_upfrom_outcrop.JPG
\Site 02\Up\Site 2 Up_7Feb08.jpg

Site 3 Down

\Site 03\Down\Site 3 Down_11May09.JPG
\Site 03\Down\Site 3 Down_17Nov09.JPG
\Site 03\Down\Site 3 Down_17Nov09_closer.JPG
\Site 03\Down\Site 3 Down_24Jun08.jpg
\Site 03\Down\Site 3 Down_24Jun08_downfrom_outcrop.jpg
\Site 03\Down\Site 3 Down_24Jun08_furtherupstream.jpg
\Site 03\Down\Site 3 Down_7Feb08.jpg

Site 3 River Left

\Site 03\River Left\Site 3 River Left_17Nov09.JPG

Site 3 River Right

\Site 03\River Right\Site 3 River Right_17Nov09.JPG

Site 3 Up

\Site 03\Up\Site 3 Up_11May09 .JPG
\Site 03\Up\Site 3 Up_11May09_upstreamfrom_outcrop.JPG
\Site 03\Up\Site 3 Up_17Nov09.JPG
\Site 03\Up\Site 3 Up_24Jun08.jpg
\Site 03\Up\Site 3 Up_24Jun08_2.jpg
\Site 03\Up\Site 3 Up_24Jun08_furtherdownstream.jpg
\Site 03\Up\Site 3 Up_24Jun08_upstreamfrom_outcrop.jpg
\Site 03\Up\Site 3 Up_7Feb08_furtherdownstream.jpg

Site 4 Down

\Site 04\Down\Site 4 Down_11May09.JPG
\Site 04\Down\Site 4 Down_12Jun08.JPG
\Site 04\Down\Site 4 Down_16Sep08.JPG
\Site 04\Down\Site 4 Down_18Nov08.JPG
\Site 04\Down\Site 4 Down_23Sep09.JPG
\Site 04\Down\Site 4 Down_4Mar09.JPG
\Site 04\Down\Site 4 Down_4Mar09_closer.JPG
\Site 04\Down\Site 4 Down_7Feb08.jpg

Site 4 River Left

\Site 04\River Left\Site 4 River Left_18Nov08_horizontal.JPG
\Site 04\River Left\Site 4 River Left_24Jun08_horizontal.jpg
\Site 04\River Left\Site 4 River Left_24Jun08_vertical.jpg

Site 4 Up

\Site 04\Up\Site 4 Up_11May09.JPG
\Site 04\Up\Site 4 Up_16Sep08_erosion&fallentrees.JPG
\Site 04\Up\Site 4 Up_16Sep08_fallentrees.JPG
\Site 04\Up\Site 4 Up_16Sep08_treesovercreek_nearoutcrop.JPG
\Site 04\Up\Site 4 Up_17Nov09_nearoutcrop.JPG
\Site 04\Up\Site 4 Up_18Nov08_fallentrees.JPG
\Site 04\Up\Site 4 Up_18Nov08_fallentrees_closeup.JPG
\Site 04\Up\Site 4 Up_24Jun08_nearoutcrop.jpg
\Site 04\Up\Site 4 Up_26Aug09_fallentrees.JPG
\Site 04\Up\Site 4 Up_4Mar09_nearoutcrop.JPG
\Site 04\Up\Site 4 Up_7Feb08.jpg

Site 5 Up 3rd Fork

\Site 05\Up 3rd fork\Site 5 Up_11May09.JPG
\Site 05\Up 3rd fork\Site 5 Up_12Jun08_pool.JPG
\Site 05\Up 3rd fork\Site 5 Up_16Sep08.JPG
\Site 05\Up 3rd fork\Site 5 Up_18Nov08.JPG
\Site 05\Up 3rd fork\Site 5 Up_23Sep09.JPG
\Site 05\Up 3rd fork\Site 5 Up_24Jun08_ in 3rdfork_lookup_.jpg
\Site 05\Up 3rd fork\Site 5 Up_4Mar09.JPG
\Site 05\Up 3rd fork\Site 5 Up_7Dec09.JPG

\Site 05\Up 3rd fork\Site 5 Up_7Feb08 .jpg

Site 5 Up Main Channel at 3rd Fork

\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel&3rdfork_18Mar08_intersection.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_12Jun08.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_16Sep08.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_18Nov08.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_18Nov08_3rdfork_intersection_.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_23Sep09_3rdfork_intersection.JPG
\Site 05\Up Main Channel at 3rd Fork\Site 5 UpMainChannel_4Mar09.JPG

Site 6 Across Bank

\Site 06\Across bank\Site 6 AcrossBank_25Mar08.jpg
\Site 06\Across bank\Site 6 AcrossBank_28Jul09_horizontal.JPG
\Site 06\Across bank\Site 6 AcrossBank_28Jul09_vertical.JPG
\Site 06\Across bank\Site 6 AcrossBank_7Dec09.JPG

Site 6 Down

\Site 06\Down\Site 6 Down_24Jun08.jpg
\Site 06\Down\Site 6 Down_7Dec09_end_lookdown.JPG

Site 6 Up

\Site 06\Up\Site 6 Up_12Jun08.JPG
\Site 06\Up\Site 6 Up_18Mar08.JPG
\Site 06\Up\Site 6 Up_18Mar08_erosion_closeup.JPG
\Site 06\Up\Site 6 Up_23Sep09.JPG
\Site 06\Up\Site 6 Up_25Mar08_lookinguptonick.jpg
\Site 06\Up\Site 6 Up_25Mar08_side finger.jpg
\Site 06\Up\Site 6 Up_28Jul09.JPG
\Site 06\Up\Site 6 Up_28Jul09_2.JPG
\Site 06\Up\Site 6 Up_28Jul09_onesideoftree.JPG
\Site 06\Up\Site 6 Up_29Dec08.jpg
\Site 06\Up\Site 6 Up_29Dec08_2.jpg
\Site 06\Up\Site 6 Up_29Dec08_3.jpg
\Site 06\Up\Site 6 Up_29Dec08_Lone Tree_ cut.jpg
\Site 06\Up\Site 6 Up_29Dec08_newnick.jpg
\Site 06\Up\Site 6 Up_7Dec09.JPG
\Site 06\Up\Site 6 Up_7Dec09_end_lookup.JPG
\Site 06\Up\Site 6 Up_7Dec09_end_lookup_closeup.JPG
\Site 06\Up\Site 6 Up_7Dec09_headcut advance_behindtree.JPG

Site 7 Down

\Site 07\Down\Site 7 Down_11Jun09.JPG
\Site 07\Down\Site 7 Down_16Sep08.JPG
\Site 07\Down\Site 7 Down_18Mar08.JPG
\Site 07\Down\Site 7 Down_23Sep09.JPG
\Site 07\Down\Site 7 Down_23Sep09_2.JPG

\Site 07\Down\Site 7 Down_29Dec08.jpg
\Site 07\Down\Site 7 Down_4Mar09.JPG
\Site 07\Down\Site 7 Down_7Dec09.JPG
\Site 07\Down\Site 7 Down_7Feb08.jpg

Site 7 Up

\Site 07\Up\Site 7 Up_11Jun09.JPG
\Site 07\Up\Site 7 Up_16Sep08.JPG
\Site 07\Up\Site 7 Up_18Mar08.JPG
\Site 07\Up\Site 7 Up_23Sep09.JPG
\Site 07\Up\Site 7 Up_24Jun08.jpg
\Site 07\Up\Site 7 Up_4Mar09.JPG
\Site 07\Up\Site 7 Up_7Dec09.JPG
\Site 07\Up\Site 7 Up_7Feb08.jpg
\Site 07\Up\Site 7 Up_7Feb08_upmidfork.jpg

Site 8 Down

\Site 08\Down\Site 8 Down_12Jun08.JPG
\Site 08\Down\Site 8 Down_12Jun08_channel .JPG
\Site 08\Down\Site 8 Down_18Mar08.JPG
\Site 08\Down\Site 8 Down_18Mar08_channel.JPG
\Site 08\Down\Site 8 Down_23Sep09_end.JPG
\Site 08\Down\Site 8 Down_23Sep09_end_closeup.JPG
\Site 08\Down\Site 8 Down_4Mar09.JPG
\Site 08\Down\Site 8 Down_7Dec09_end.JPG
\Site 08\Down\Site 8 Down_7Dec09_end_closeup.JPG
\Site 08\Down\Site 8 Down_7Feb08.jpg
\Site 08\Down\Site 8 Down_7Feb08_channel.jpg

Site 8 Up

\Site 08\Up\Site 8 Up_23Sep09.JPG
\Site 08\Up\Site 8 Up_24Jun08_midchannel.jpg
\Site 08\Up\Site 8 Up_4Mar09_lookuptoend.JPG
\Site 08\Up\Site 8 Up_7Feb08_halfwayup.jpg
\Site 08\Up\Site 8 Up_7Feb08_midchannel.jpg

Site 9 Down

\Site 09\Down\Site 9 Down_11May09.JPG
\Site 09\Down\Site 9 Down_17Nov09.JPG
\Site 09\Down\Site 9 Down_18Nov08.JPG
\Site 09\Down\Site 9 Down_24Jun08.jpg
\Site 09\Down\Site 9 Down_4Mar09.JPG
\Site 09\Down\Site 9 Down_7Feb08.jpg

Site 9 River Left

\Site 09\River Left\Site 9 River Left_17Nov09.JPG

Site 9 Up

\Site 09\Up\Site 9 Up_11May09.JPG
\Site 09\Up\Site 9 Up_17Nov09.JPG
\Site 09\Up\Site 9 Up_18Nov08.JPG
\Site 09\Up\Site 9 Up_18Nov08_downfromRRWash.JPG
\Site 09\Up\Site 9 Up_24Jun08.jpg
\Site 09\Up\Site 9 Up_4Mar09.JPG
\Site 09\Up\Site 9 Up_7Feb08.jpg

Site 9 Up RRWash

\Site 09\Up RRWash\Site 9 UpRRWash_11May09.JPG
\Site 09\Up RRWash\Site 9 UpRRWash_17Nov09_cutbank.JPG
\Site 09\Up RRWash\Site 9 UpRRWash_18Nov08.JPG
\Site 09\Up RRWash\Site 9 UpRRWash_24Jun08.jpg
\Site 09\Up RRWash\Site 9 UpRRWash_4Mar09.JPG
\Site 09\Up RRWash\Site 9 UpRRWash_7Feb08.jpg

Site 10 Down

\Site 10\Down\Site 10 Down_11Jun09.JPG
\Site 10\Down\Site 10 Down_12Jun08.JPG
\Site 10\Down\Site 10 Down_16Sep08.JPG
\Site 10\Down\Site 10 Down_16Sep08_vanishingbanks.JPG
\Site 10\Down\Site 10 Down_17Nov09.JPG
\Site 10\Down\Site 10 Down_17Nov09_vertical.JPG
\Site 10\Down\Site 10 Down_18Mar08.JPG
\Site 10\Down\Site 10 Down_18Mar08_erodedbanks.JPG
\Site 10\Down\Site 10 Down_23Sep09.JPG
\Site 10\Down\Site 10 Down_26May08.jpg
\Site 10\Down\Site 10 Down_29Dec08.jpg
\Site 10\Down\Site 10 Down_29Dec08_2.jpg
\Site 10\Down\Site 10 Down_29Dec08_closeup.jpg
\Site 10\Down\Site 10 Down_4Mar09.JPG
\Site 10\Down\Site 10 Down_7Dec09.JPG

Site 10 River Left

\Site 10\River Left\Site 10 River Left_17Nov09_banktrees.JPG

Site 11 Down

\Site 11\Down\Site 11 Down_16Sep08_debris_pileup.JPG
\Site 11\Down\Site 11 Down_17Nov09.JPG
\Site 11\Down\Site 11 Down_26May08.jpg
\Site 11\Down\Site 11 Down_7Feb08.jpg

Site 11 River Left

\Site 11\River Left\Site 11 River Left_17Nov09.JPG
\Site 11\River Left\Site 11 River Left_26May08.jpg

Site 11 River Right

\Site 11\River Right\Site 11 River Right_17Nov09.JPG
\Site 11\River Right\Site 11 River Right_17Nov09_bank height.JPG
\Site 11\River Right\Site 11 River Right_26May08.jpg

Site 11 Up

\Site 11\Up\Site 11 Up_17Nov09.JPG
\Site 11\Up\Site 11 Up_26May08.jpg
\Site 11\Up\Site 11 Up_7Feb08.jpg

Site 12 Down

\Site 12\Down\Site 12 Down_17Nov09.JPG
\Site 12\Down\Site 12 Down_26May08.jpg
\Site 12\Down\Site 12 Down_28Jul09.JPG
\Site 12\Down\Site 12 Down_4Mar09.JPG
\Site 12\Down\Site 12 Down_7Feb08.jpg

Site 12 River Left

\Site 12\River Left\Site 12 River Left_17Nov09.JPG
\Site 12\River Left\Site 12 River Left_17Nov09_2.JPG
\Site 12\River Left\Site 12 River Left_26May08.jpg
\Site 12\River Left\Site 12 River Left_28Jul09.JPG
\Site 12\River Left\Site 12 River Left_4Mar09_differentspot_upstream.JPG

Site 12 River Right

\Site 12\River Right\Site 12 River Right_17Nov09.JPG
\Site 12\River Right\Site 12 River Right_26May08.jpg
\Site 12\River Right\Site 12 River Right_28Jul09.JPG

Site 12 Up

\Site 12\Up\Site 12 Up_17Nov09.JPG
\Site 12\Up\Site 12 Up_26May08.jpg
\Site 12\Up\Site 12 Up_28Jul09.JPG
\Site 12\Up\Site 12 Up_4Mar09 .JPG
\Site 12\Up\Site 12 Up_7Feb08.jpg

Site 13 Down from Well 1

\Site 13\Down from Well 1 site\Site 13 DownfromWell1_15Jul08.jpg
\Site 13\Down from Well 1 site\Site 13 DownfromWell1_6May08.jpg

Site 13 Down Primary Channel

\Site 13\Down Primary Channel\Site 13 DownPrimary_12Jun09_transect.JPG
\Site 13\Down Primary Channel\Site 13 DownPrimary_15Jul08.jpg
\Site 13\Down Primary Channel\Site 13 DownPrimary_16Apr09.JPG
\Site 13\Down Primary Channel\Site 13 DownPrimary_17Nov09.JPG
\Site 13\Down Primary Channel\Site 13 DownPrimary_18Nov08.JPG
\Site 13\Down Primary Channel\Site 13 DownPrimary_26Aug08.jpg
\Site 13\Down Primary Channel\Site 13 DownPrimary_26May08.jpg
\Site 13\Down Primary Channel\Site 13 DownPrimary_28Jan09.JPG
\Site 13\Down Primary Channel\Site 13 DownPrimary_6May08.jpg
\Site 13\Down Primary Channel\Site 13 DownPrimary_7Feb08.jpg

Site 13 Down Secondary Channel

\Site 13\Down Secondary Channel\Site 13 DownSecondary_12Jun09.JPG
\Site 13\Down Secondary Channel\Site 13 DownSecondary_15Jul08.jpg
\Site 13\Down Secondary Channel\Site 13 DownSecondary_16Apr09.JPG
\Site 13\Down Secondary Channel\Site 13 DownSecondary_17Nov09.JPG
\Site 13\Down Secondary Channel\Site 13 DownSecondary_18Nov08.JPG
\Site 13\Down Secondary Channel\Site 13 DownSecondary_26Aug08.jpg
\Site 13\Down Secondary Channel\Site 13 DownSecondary_26May08.jpg
\Site 13\Down Secondary Channel\Site 13 DownSecondary_28Jan09.JPG
\Site 13\Down Secondary Channel\Site 13 DownSecondary_6May08.jpg
\Site 13\Down Secondary Channel\Site 13 DownSecondary_7Feb08.jpg

Site 13 River Left Primary Channel

\Site 13\River Left Primary Channel\Site 13 River Left Primary_12Jun09.JPG
\Site 13\River Left Primary Channel\Site 13 River Left Primary_15Jul08.jpg
\Site 13\River Left Primary Channel\Site 13 River Left Primary_16Apr09.JPG
\Site 13\River Left Primary Channel\Site 13 River Left Primary_17Nov09.JPG
\Site 13\River Left Primary Channel\Site 13 River Left Primary_18Nov08.JPG
\Site 13\River Left Primary Channel\Site 13 River Left Primary_26Aug08.jpg
\Site 13\River Left Primary Channel\Site 13 River Left Primary_26Aug08_closeup.jpg
\Site 13\River Left Primary Channel\Site 13 River Left Primary_26May08.jpg
\Site 13\River Left Primary Channel\Site 13 River Left Primary_28Jan09.JPG

Site 13 River Left Secondary Channel

\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_12Jun09.JPG
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_15Jul08.jpg
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_16Apr09.JPG
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_17Nov09.JPG
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_18Nov08.JPG
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_26Aug08.jpg
\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_26May08.jpg

\Site 13\River Left Secondary Channel\Site 13 River Left Secondary_28Jan09.JPG

Site 13 River Right Primary Channel

\Site 13\River Right Primary Channel\Site 13 River Right Primary_12Jun09.JPG
\Site 13\River Right Primary Channel\Site 13 River Right Primary_12Jun09_2.JPG
\Site 13\River Right Primary Channel\Site 13 River Right Primary_15Jul08.jpg
\Site 13\River Right Primary Channel\Site 13 River Right Primary_16Apr09.JPG
\Site 13\River Right Primary Channel\Site 13 River Right Primary_17Nov09.JPG
\Site 13\River Right Primary Channel\Site 13 River Right Primary_18Nov08.JPG
\Site 13\River Right Primary Channel\Site 13 River Right Primary_26Aug08.jpg
\Site 13\River Right Primary Channel\Site 13 River Right Primary_26May08.jpg
\Site 13\River Right Primary Channel\Site 13 River Right Primary_28Jan09.JPG

Site 13 River Right Secondary Channel

\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_12Jun09.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_15Jul08.jpg
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_16Apr09.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_17Nov09.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_18Nov08.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_18Nov08_2.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_26Aug08.jpg
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_26May08.jpg
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_28Jan09.JPG
\Site 13\River Right Secondary Channel\Site 13 River Right Secondary_6May08.jpg

Site 13 Up from Well 1

\Site 13\Up from Well 1 site\Site 13 UpfromWell1_15Jul08.jpg
\Site 13\Up from Well 1 site\Site 13 UpfromWell1_6May08.jpg

Site 13 Up Primary Channel

\Site 13\Up Primary Channel\Site 13 UpPrimary_12Jun09.JPG
\Site 13\Up Primary Channel\Site 13 UpPrimary_15Jul08.jpg
\Site 13\Up Primary Channel\Site 13 UpPrimary_16Apr09.JPG
\Site 13\Up Primary Channel\Site 13 UpPrimary_17Nov09.JPG
\Site 13\Up Primary Channel\Site 13 UpPrimary_18Nov08.JPG
\Site 13\Up Primary Channel\Site 13 UpPrimary_26Aug08.jpg
\Site 13\Up Primary Channel\Site 13 UpPrimary_26May08.jpg
\Site 13\Up Primary Channel\Site 13 UpPrimary_28Jan09.JPG
\Site 13\Up Primary Channel\Site 13 UpPrimary_6May08.jpg
\Site 13\Up Primary Channel\Site 13 UpPrimary_7Feb08.jpg

Site 13 Up Secondary Channel

\Site 13\Up Secondary Channel\Site 13 UpSecondary_12Jun09.JPG
\Site 13\Up Secondary Channel\Site 13 UpSecondary_15Jul08.jpg
\Site 13\Up Secondary Channel\Site 13 UpSecondary_16Apr09.JPG
\Site 13\Up Secondary Channel\Site 13 UpSecondary_17Nov09.JPG

\Site 13\Up Secondary Channel\Site 13 UpSecondary_18Nov08.JPG
\Site 13\Up Secondary Channel\Site 13 UpSecondary_26Aug08.jpg
\Site 13\Up Secondary Channel\Site 13 UpSecondary_26May08.jpg
\Site 13\Up Secondary Channel\Site 13 UpSecondary_28Jan09.JPG
\Site 13\Up Secondary Channel\Site 13 UpSecondary_6May08.jpg
\Site 13\Up Secondary Channel\Site 13 UpSecondary_7Feb08.jpg

Site 14 Down

\Site 14\Down\Site 14 Down_12Jun09.JPG
\Site 14\Down\Site 14 Down_15Jul08.jpg
\Site 14\Down\Site 14 Down_16Apr09.JPG
\Site 14\Down\Site 14 Down_17Nov09.JPG
\Site 14\Down\Site 14 Down_18Nov08.JPG
\Site 14\Down\Site 14 Down_26May08.jpg
\Site 14\Down\Site 14 Down_6May08.jpg
\Site 14\Down\Site 14 Down_7Feb08.jpg

Site 14 River Left

\Site 14\River Left\Site 14 River Left_12Jun09.JPG
\Site 14\River Left\Site 14 River Left_15Jul08.jpg
\Site 14\River Left\Site 14 River Left_16Apr09.JPG
\Site 14\River Left\Site 14 River Left_17Nov09.JPG
\Site 14\River Left\Site 14 River Left_18Nov08.JPG
\Site 14\River Left\Site 14 River Left_26May08.jpg
\Site 14\River Left\Site 14 River Left_6May08.jpg

Site 14 River Right

\Site 14\River Right\Site 14 River Right_12Jun09.JPG
\Site 14\River Right\Site 14 River Right_15Jul08.jpg
\Site 14\River Right\Site 14 River Right_16Apr09.JPG
\Site 14\River Right\Site 14 River Right_17Nov09.JPG
\Site 14\River Right\Site 14 River Right_18Nov08.JPG
\Site 14\River Right\Site 14 River Right_26May08.jpg
\Site 14\River Right\Site 14 River Right_6May08.jpg

Site 14 Up

\Site 14\Up\Site 14 Up_12Jun09.JPG
\Site 14\Up\Site 14 Up_15Jul08.jpg
\Site 14\Up\Site 14 Up_16Apr09.JPG
\Site 14\Up\Site 14 Up_17Nov09.JPG
\Site 14\Up\Site 14 Up_18Nov08.JPG
\Site 14\Up\Site 14 Up_26May08.jpg
\Site 14\Up\Site 14 Up_6May08.jpg
\Site 14\Up\Site 14 Up_7Feb08.jpg

Site 15 Down

\Site 15\Down\Site 15 Down_11May09.JPG
\Site 15\Down\Site 15 Down_17Nov09.JPG
\Site 15\Down\Site 15 Down_18Nov08.JPG
\Site 15\Down\Site 15 Down_22Jul08.jpg
\Site 15\Down\Site 15 Down_26May08.jpg
\Site 15\Down\Site 15 Down_28Jul09.JPG
\Site 15\Down\Site 15 Down_7Feb08.jpg

Site 15 Nick Down

\Site 15\Nick Down\Site 15 DownNick_17Nov09.JPG
\Site 15\Nick Down\Site 15 DownNick_28Jul09.JPG
\Site 15\Nick Down\Site 15 DownNick_28Jul09_bend.JPG

Site 15 Nick Up

\Site 15\Nick Up\Site 15 UpNick_11May09.JPG
\Site 15\Nick Up\Site 15 UpNick_17Nov09.JPG
\Site 15\Nick Up\Site 15 UpNick_28Jul09.JPG

Site 15 River Left

\Site 15\River Left\Site 15 River Left_11May09_nearbend.JPG
\Site 15\River Left\Site 15 River Left_17Nov09.JPG
\Site 15\River Left\Site 15 River Left_18Nov08.JPG
\Site 15\River Left\Site 15 River Left_22Jul08.jpg
\Site 15\River Left\Site 15 River Left_26May08.jpg
\Site 15\River Left\Site 15 River Left_28Jul09.JPG

Site 15 River Right

\Site 15\River Right\Site 15 River Right_11May09.JPG
\Site 15\River Right\Site 15 River Right_17Nov09.JPG
\Site 15\River Right\Site 15 River Right_18Nov08.JPG
\Site 15\River Right\Site 15 River Right_22Jul08.jpg
\Site 15\River Right\Site 15 River Right_26May08.jpg
\Site 15\River Right\Site 15 River Right_28Jul09.JPG

Site 15 Up

\Site 15\Up\Site 15 Up_17Nov09.JPG
\Site 15\Up\Site 15 Up_18Nov08.JPG
\Site 15\Up\Site 15 Up_22Jul08.jpg
\Site 15\Up\Site 15 Up_26May08.jpg
\Site 15\Up\Site 15 Up_28Jul09.JPG
\Site 15\Up\Site 15 Up_7Feb08.jpg