Implementation – Post-Trip Report

Community:	Ait Bayoud, Bizdad
Country:	Morocco
Chapter:	Columbia University
Submittal Date:	
Dates Traveled:	December 30, 2016 - January 14, 2017
Scope of Implementation (100 words):	The following items were accomplished during this trip: 1. Pumped the well continuously for 5 hours to develop it and take water samples 2. Tested portions of the pipeline for leaks 3. Collected data on geological formations and water quality

Privacy: EWB-USA may release this report in its entirety to other EWB-USA chapters or interested parties.

Purpose: To archived, presented, and summarized the completed implementation for review. This includes notes, photographs, sketches, survey information, interview notes, measurements and any other pertinent data.

Instructions:
When completing this report, the chapter should

- Provide all the technical information about the project that was completed during the implementation.
- Modify the outline of the report if necessary to present the information more clearly. It is your chapter's responsibility to clearly and thoroughly present your project and the results of your completed assessment trip.
- Include additional information relevant to the specific project.
- Provide pertinent figures, tables, and photographs with figure numbers, table numbers and photograph numbers in the section where discussed. Full drawing sets, complete lab reports, and any information larger than 2 pages should be included at the end of the report as an appendix.

Section 1.0:

- Provide a concise description of the implementation sufficient for anyone who had not participated on the trip to understand what happened on the trip. (<500 words)
- Include an exact description of all the components of the design that were installed during the trip.
- Include a description of any difference between what was actually implemented and what was approved for implementation by the International Community Program (ICP) Reviewers and an explanation of this discrepancy.
- Include a description of how specific ICP Reviewer comments were incorporated into the implementation.
- Provide any details obtained through continued communication with the community partners or in-country NGOs after the implementation trip.
- Include important information such as work completed by community, or problems encountered after the chapter's departure.

- Provide as-built drawings of the constructed project components.
- Provide a description of the Operation and Maintenance (O&M) activities that took place on the trip. This includes items such as O&M training, preparations for future O&M activities such as hiring staff or collecting O&M fees.
- Present a short description of the sustainability issues that the chapter has identified for this project. At a minimum, this should include a discussion on the organizational, financial, and technical capacity of the community to sustain this project in the long-term. In addition, provide a summary of any project related education that the chapter carried out during the implementation trip.

Section 2.0:

- Provide a brief description of the next phase of the program in this community. Include anticipated future travel dates.

Section 3.0:

- Label each photo with a photo number and give a full description.
- Provide a few photos of relevant parts of the project along with a photo number and description. Photos are not limited to this section, please include photos where appropriate. Additional photos taken during the project along with a photo log can be included in an appendix.

List of Attachments:

List all attachments included as separate files, including:

- Water Summary Document
- Pipeline Progress

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1. Implementation Description

- **Provide a concise description of the implementation sufficient for anyone who had not participated on the trip to understand what happened on the trip. (<500 words)**

Piping

Piping implementation involved two steps; a small and large scale pressure test. The small scale test was conducted to determine the effectiveness of the sealing method, 5-6 wraps of PTFE tape and RectorSeal T+2 pipe sealant, implemented in Summer 2016. It was conducted on two 6m pipes connected by a sealed couple from the end of the well-side pipeline. The actual implementation involved capping one end, filling the pipes with 25 L of tap water, and pressurizing the system using a manually operated hydrostatic test pump. The calculated operational pressure for this location is 110 psi, pressure reached 50 psi, 150 psi, and 200 psi before the test was concluded. No signs of leakage were visible at the couple.

The second pressure test was conducted on the 630m of piping laid from the Chateau site, where water storage tanks will eventually be installed, to determine whether this section was ready for operation. The procedure for testing was the same except for the use of a water truck to fill the pipeline and a lower desired testing pressure of 60psi. Testing pressure was not achieved as small leaks formed in 35/105 couples. These were predominantly in the first half of the pipeline where hydrostatic pressure was greatest due to elevation differences.

Well Development

A generator was brought to the well site to run the pump almost continuously for about five hours, until time ran out for the day. Our purpose for pumping the well was to attempt to develop it and assess the quality of the water. Locals connected the outlet of the well to their own tubing to get the pumped water into holes in the ground covered with plastic tarps. This water was given to locals to use for washing and livestock, but not for drinking. Two different colored sediments were discharged by the well and the turbidity of the water, measured using a turbidity tube with a secchi disk, varied over time.

Water Testing

Water samples collected from the well, the Tagawowt River, and a spring which comes from the same aquifer as the well were tested for nitrates, phosphates, turbidity, salinity, conductivity, oxygen content, and pH. All of those measures, excluding nitrates and phosphates, were continuously sampled at varying intervals while the well was being pumped. Turbidity measurements were also taken from the pools at the well site and from bottled samples after the sediment was allowed to settle. The geological formations along the riverbed between the bridge and the spring were photographed and documented. The purpose of this is to compare the elevations and slopes of the formations to the location of the well and deduce what the formation at the well is like.

- **Include an exact description of all the components of the design that were installed during the trip.**

No permanent components were installed during the trip. At the well site the pipes leading into the electrical house from the wellhead were detached and the wellhead was unbolted from the well and rotated 180 degrees and so that tubing could be attached for the community to collect water. This was restored to its original state at the end of the pumping.

1. Difference Between Planned and Actual Implementation

- **Include a description of any difference between what was actually implemented and what was approved for implementation by the International Community Program (ICP) Reviewers and an explanation of this discrepancy.**

Piping:
Approved implementation involved two large-scale hydrostatic tests on both ~630m sections of piping. One of these sections begins at the Chateau site and the other at the Well site. Actual implementation involved a small-scale test on a localized portion of the well-side pipeline and then later a large-scale test at the Chateau-side pipeline. Desired test pressures for the Well-side were determined to be 60 and 120psi. Actual system pressure for the small-scale test was 50, 150, and then up to 200psi. Implementation and Water used for the test was tap water brought to the site in 5L containers as opposed to the original plan of using the water truck.
Plans for the large-scale test at the Chateau site involved pressurizing to 30 and then 60psi. Initial estimates for the operational pressure in this section of piping was 60psi. In the test, the system was unable to be pressurized to the first test pressure (30psi) due to leaks that occurred in the lowest elevation portion of the pipeline. Leak locations and severity were documented for all locations along the pipeline.

Well: The water samples collected from the well were not tested in a lab at a local Moroccan University because the only person available to collect samples had a medical emergency that required him to be in a different city.
The procedure outlined in the Pre-Trip Construction Safety Plan was slightly modified under the travel mentor's supervision and the guidance of the US Department of the Interior's *Ground Water Manual*. The well was pumped continuously for about five hours with only two breaks in pumping instead of pumping in fifteen minute increments. More turbidity data was collected throughout the process than initially planned in order to determine if the well was being developed by constant pumping.

- **Include a description of how specific ICP Reviewer comments were incorporated into the implementation.**

To the chapter's knowledge, ICP Gurus have not been involved in this project.

2. As-Built Drawings

3. Post Trip Follow-Up/Update

- **Provide any details obtained through continued communication with the community partners or in-country NGOs after the implementation trip.**

The ra'is continues to promise electricity to the electrical room at the well site. He has offered to purchase a generator to operate the pump until the electrical line can be completed.

One of the Peace Corps Volunteers notified us that some members of the community, eager to get water, want to build their own chateaus for water. They have been told to wait for EWB to distribute water as their actions may impact our work.

- **Include important information such as work completed by community, or problems encountered after the chapter's departure.**

The community members assisted the chapter with connecting hosing from the well to empty ponds to collect the water pumped from the well. They wrapped and tied pieces of old tires around connections from our steel pipes to HDPE tubing.

4. Operation and Maintenance

5. Sustainability

- **Present a short description of the sustainability issues that the chapter has identified for this project. At a minimum, this should include a discussion on the organizational, financial, and technical capacity of the community to sustain this project in the long-term. In addition, provide a summary of any project related education that the chapter carried out during the implementation trip.**

The current pipe connection method makes maintenance or replacement of a pipe in the middle of the pipeline extremely difficult. Because all of the pipes are connected by threaded couplings, removing a pipe requires twisting the pipes connected with it. The current plan is to install unions every five pipes when fixing the leaking connections in order to facilitate twisting and enable the community to independently make repairs. Additionally, the program is reconsidering the possibility of converting to High Density Polyethylene piping (HDPE), which is readily used in the area for water transport. Initially HDPE was ruled out due to the requirement of the use of specific machinery to fuse pipes together. During the Winter 2017 trip, the team observed that HDPE tubing was used as water transport and even incorporated a 30ft length tube in the well test to fill pools for community use. The benefits of switching to HDPE are reductions in material cost, installation cost, water lost due to leakages, and installation times. At present, the team is pursuing one method of joining the pipes using plastic fittings. If the program and community decide to follow through with the switch from 2" galvanized steel to 2" HDPE the two existing pipelines would be bridged with the HDPE.

2. Next Phase of the Partnership/Project

- **Provide a brief description of the next phase of the program in this community. Include anticipated future travel dates.**

The next phase of the water project is to complete a step drawdown test on the well with a water level gauge to better estimate the hydraulic properties of the well and implement a temporary water distribution site. Because bacteria testing was not completed this past trip, the water will be provided for non human consumption unless testing can be completed at the beginning of the next trip. The distribution site will be located at the current end of the pipeline extending from the well. This will require the leaking connections in that section of the pipeline to be fixed. In addition to the storage tank, a settling tank will be implemented to remove sediment from the water.

The next trip will take place in the summer of 2017, most likely in August.

3. Photo Documentation

Figure No.	Image	Description
1		One of the ponds set up to collect water pumped from the well. Plastic tarps were put down in basins and secured by rocks.
2		The fine sediment in the pools after a few hours of settlement.

3		Shed used to house electrical pump equipment and spare supplies. The pipe extending into the shed was disconnected and rotated to connect to tubing for the well development pumping.
4		Connection between pipe extending from the well to the tubing used to transport water to the ponds
5		Pipe connection with minor leaking

6		Tapered pipe end.

List of Attachments

Water Summary Doc

Well Development Log:

Our plan was to pump the well for an extended period of time in order to begin the development process (creating stable subterranean matrix) of the well. On January 10th, 2017 the team detached the pipes leading from the well into the electrical house. The well plate was then unbolted and rotated 180° so that 30m of plastic tubing purchased in Meskala could be attached to it. Using a rubber coupling, the tubing was attached to the pump outlet and directed into the first of four pools.

Setup/First Pool (0:00 - 0:30)
The generator arrived at 10:30AM and the connections to the pump control panel in the shed were set up. Pumping began just before 11AM but was stopped after a few minutes because of a water leak at the connection between the pipe and the tubing. The generator team disassembled the connection and sawed off the jagged edges of the end of the hose that was creating a gap for water to escape through. Pumping was then restarted with no leaks. Six flow rate measurements were made using a stopwatch and a 10L bucket. The average rate was 5.7 L/s (105 L/h) which was 30% higher than anticipated. It was later determined that this was due to the generator supplying more power than the pump specs assumed. This difference increased the rate with no adverse impact on the pump. Additionally, a number of measurements were taken using the Sonde as well as the turbidity meter. Turbidity measurements rapidly decreased from 150 NTU down to a low of about 35 NTU around the time the first pool filled up and the pump was temporarily shut off. The sediment was reddish in appearance throughout the first 30 minutes of pumping.

Second Pool (0:30 - 2:40)
Following a 10 minute pause to extend the tubing to a second pool, pumping restarted. A noticeable spike in turbidity occurred to over 100 NTU but receded to 35 NTU after 20 minutes. In the following 40 minutes, the turbidity increased to over the maximum reading of the turbidity meter (240 NTU) and remained at 240+ for another 20 minutes. The turbidity then dropped to 180 just as the second pool was filled to capacity and the pump was shut off. Three flow rate measurements were made using the same method as before and no change in flow rate was detected. The sediment was reddish in appearance throughout the filling of the second pool.

Third Pool (2:40 - 4:30)
The third pool location was a large area of excavated land that the sloped road near the well site ran into. In order to fill it, additional tubing was attached and laid directly onto the road. Water flowed along the road and into the basin. Much of this pumping occurred while the team broke for lunch; this accounts for the hour gap in turbidity measurements. Turbidity readings began above 240 NTU and dropped to a low of 85

within 35 minutes after which the team spent one hour having lunch. Upon returning, the team noticed that the discharged sediment was no longer reddish and now had a whitish appearance. Turbidity had also risen to 150 NTU at the time of this observation. For the next 30 minutes turbidity increased until it was above 240 NTU. Flow rate tests were not conducted for pool three.

Fourth Pool/Test Conclusion (4:30 - 4:50)

Following a decision to begin wrapping up the test in order to return home before dark, a fourth containment location was prepared. The pump was turned off for less than five minutes in order to attach tubing. Turbidity remained undeterminable as it was above 240 NTU. Flow rate tests were not conducted for pool four. A 5L plastic bottle was filled from the output hose preceding final pump shut off.

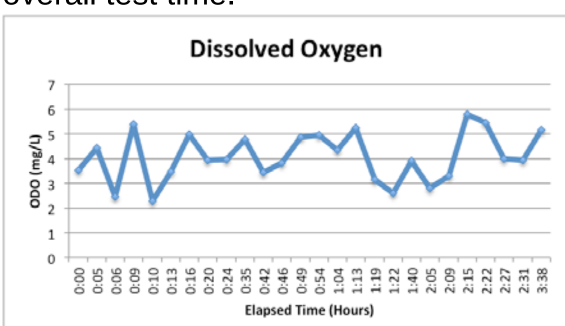
Sample Collection/ Final Observations

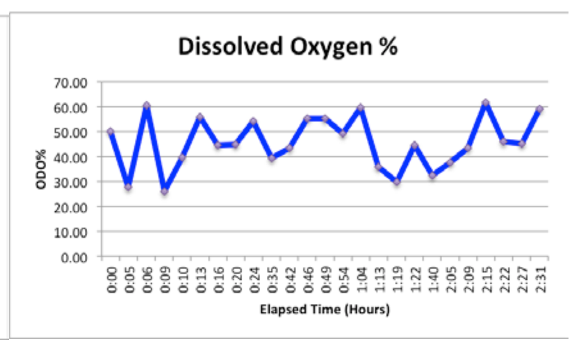
Ziploc bags of water and sediment were taken from the first pool and directly from the tubing outlet at the conclusion of the test. During sample collection, the team observed that in the first and second pools the reddish sediment had settled to the bottom, leaving the water above fairly clear; these had been sitting for 4:30 and 2:30 hours respectively. Water was collected from the top of the pools to test the turbidity after settlement. Water from the first pool, which was unsheltered from the wind, had a turbidity of 35 NTU. Water from the second pool, which had a small rock barrier providing slight protection from the wind, had a turbidity of 27 NTU.

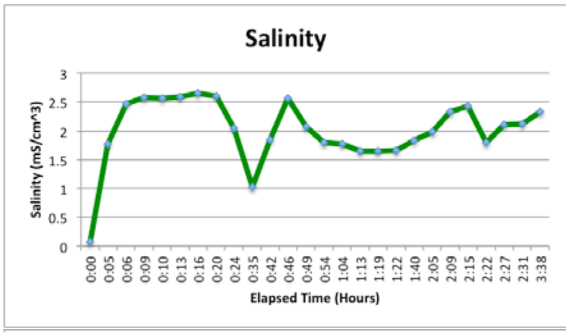
Results

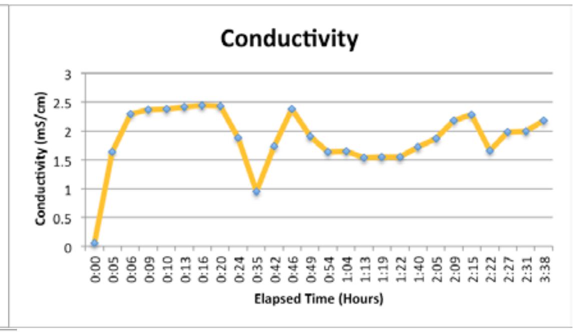
Sonde Data

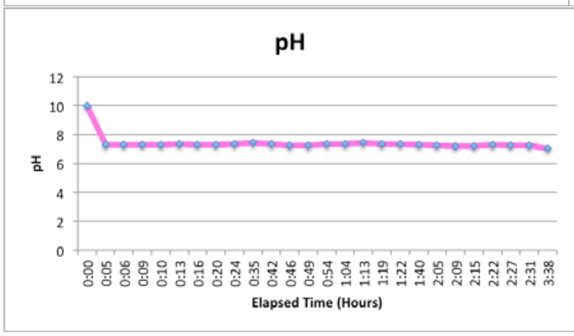
Measurements were conducted at irregular intervals; trends are not proportional to overall test time.





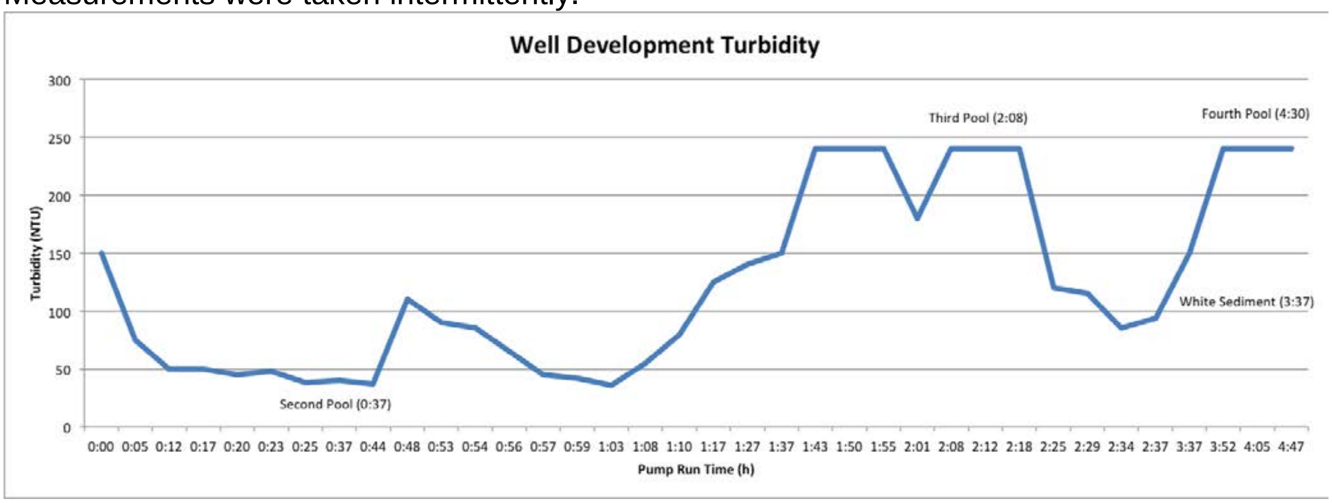






Turbidity Tube

Measurements were taken intermittently.



Note: Values above 240 NTU could not be measured.

Water Testing Results

1. Well Water

A 5L sample of well water was collected on 01/10/17 at 4 PM near the end of the well development pumping. The water was tested in various ways over the next two days.

On 01/11/17 nitrate and phosphate tests were conducted on the well water sample in a rock enclosure to shelter the experiment from high winds (estimated 30-35 mph). The phosphate kit was expired and produced no color change after 5 minutes. The nitrate test showed no signs of color change after 3 minutes and was slightly pink (<0.2 ppm reading) after an additional 2 minutes. Water from the same sample was placed on the bacteria kits and kept in a Ziploc gallon bag wrapped in a grocery bag and incubated in a Peace Corps volunteer's jacket for 24 hours. When the kits were checked on 01/12/17, no signs of bacteria were found upon inspection in full sunlight.

The 5L sample of well water taken at the end of pumping on 01/10/17 was split into two containers. One container was filled with no head space and will be kept in the fridge until it is taken to be tested for metals at a laboratory. The other container was left undisturbed overnight and tested on 01/11/17. After the sediment had settled overnight, a portion of water was decanted into a turbidity tube and the secchi disk was seen very clearly, indicating that the turbidity was below 14, the lowest value marked on the tube. The water was then tested with the sonde. The turbidity values measured varied greatly, most likely due to particles floating in front of the sensor, but stabilized for a few seconds at a low point of 10.8 NTU. It was measured again with the sonde later in the day as 9.6.

2. Spring Water

Spring water was collected and immediately tested on 01/12/17.

Sonde Results:

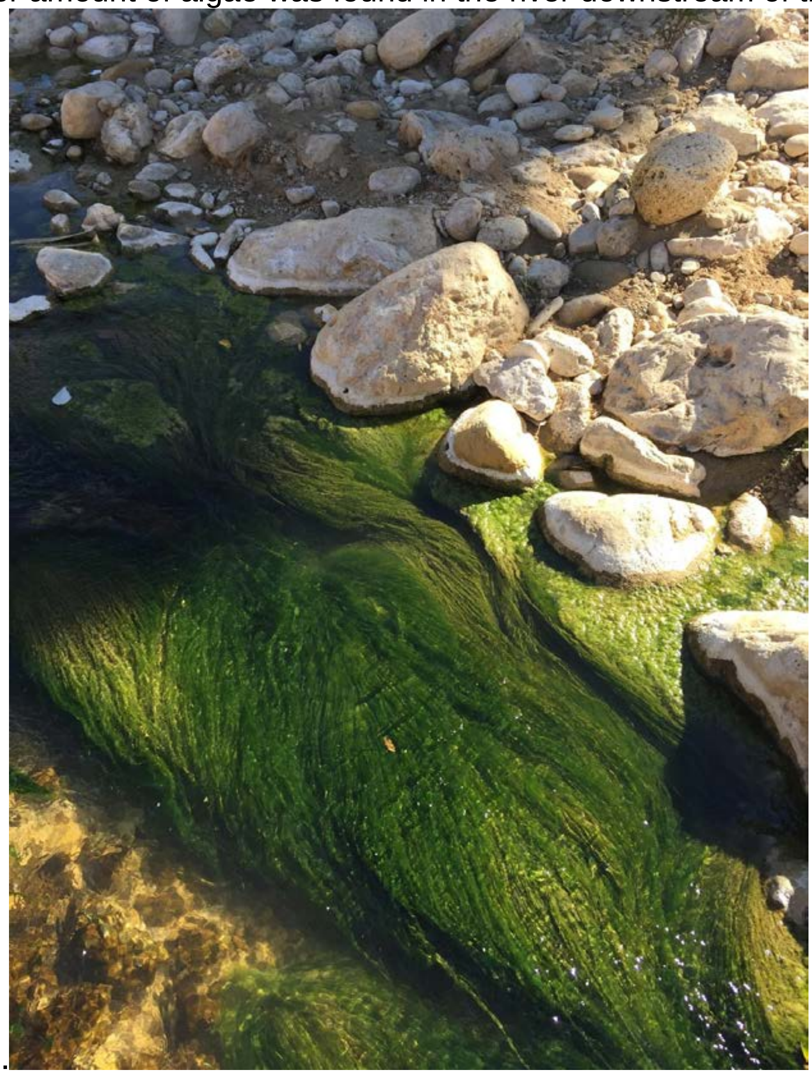
Turbidity	6.8-7.0 NTU
Salinity	1.173 mS/cm^3
Conductivity	1.016 mS/cm
pH	7.21
Dissolved Oxygen %	76.7 ODO%
Dissolved Oxygen	7.23 ODO mg/L

Nitrate/Phosphate/Bacteria Results:

The phosphate test showed no color change during the test. The presence of donkeys in the area of water where the sample was collected confirms that the expired phosphate kit is unreliable. The nitrate test showed about 5 ppm.

1. Phosphate test of spring water.   *2. Nitrate test of spring water.*

A significantly greater amount of algae was found in the river downstream of the spring than near the bridge.



3.   River Water

Location R1: ***4 riffles upstream from bridge***

Turbidity	2.4 NTU
Salinity	1.027 mS/cm^3
Conductivity	0.679 mS/cm
pH	8.28
Dissolved Oxygen %	96.0 ODO%
Dissolved Oxygen	11.66 ODO mg/L

Location R2: ***1 riffle downstream from bridge***

Turbidity	12 NTU
Salinity	0.847 mS/cm^3
Conductivity	0.562 mS/cm
pH	8.31
Dissolved Oxygen %	92.4 ODO%
Dissolved Oxygen	11.07 ODO mg/L

Location R3: ***Side pool 1 riffle down***

Turbidity	11 NTU
Salinity	1.039 mS/cm^3
Conductivity	0.769 mS/cm
pH	7.74
Dissolved Oxygen %	91.3 ODO%
Dissolved Oxygen	9.94 ODO mg/L

Location R4: ***Common washing point in stream***

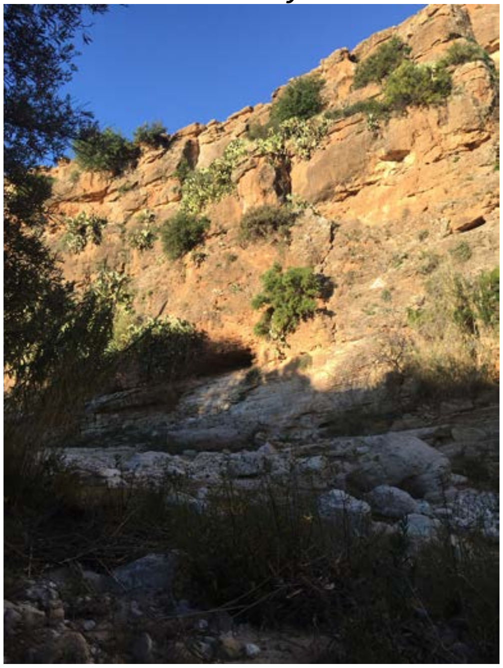
Turbidity	5 NTU
Salinity	1.044 mS/cm^3
Conductivity	0.783 mS/cm
pH	7.77
Dissolved Oxygen %	97.8 ODO%
Dissolved Oxygen	11.53 ODO mg/L

Algae a few feet downstream of the washing point at location R4.

Geological Observations

Location G1:

Note: The panoramic image shown above distorts the height of the bank. The top of the formation was mostly level as shown more clearly below.



Description:

- Right bank descending
- Thinly bedded white rock sloped about 30 degrees NE
- Layer of 23-30 ft thick weathered, highly-jointed (vertical) dark grey rock
- 50 ft layer of redder rock, bedding 2-6 ft, jointing 2-5 ft, some solutioning (little holes) in lower half
- Strong vegetation change between the grey and red rock layers
- Left bank much lower than right bank

Location G2:

Description:

- Left bank descending
- heavily weathered, flocky bank

Description:

- Right bank ascending (opposite last photo)
- Very low bank with a height around 8 ft
- Silty clay interbedded with cobbles at 3 ft intervals

Location G3:

Path down to the river. *Fossilization of tube worms.*

The white rock seen along the river and near the well was also visible on this path up from the river.

Location G4:

Description:

- Solution layer around 10 ft above bank full flood plain
- Bank full flood plain about 12 ft above riverbed
- Elevation at chalk layer 614m

Hydrostatic Testing

Small Scale Test

Pressure testing installed portions of the pipeline was necessary to determine the effectiveness of the new sealing procedure implemented in Summer 2016. Calculations indicated that the operational pressure of the pipeline near the well site would be 110psi. The test itself involved pressurizing to 50%, 100%, and ultimately 150% of this operational pressure and used water as the test medium. A manually operated hydrostatic test pump was used to pressurize the system for the small scale test as well as for a test on the entire chateau-side pipeline that was conducted two days later.

On January 9, 2017, 30L of water, the hydrostatic pump, an end cap, and reducing couples used to attach the pressure hose to the non-capped end of the test pipes, were brought to the well site.

Two pipes connected with a couple that had been put together in the summer were detached as a group from the pipeline. This was capped at one end, filled with water, and pressurized. The system quickly reached ~150psi, but leaks developed at the two ends where the additional parts had been installed. In order to hold at this pressure the pump was continually pumped for 10 seconds. Following this the pressure was increased to 200psi and released. No leaks were detected at the couple connection.

Pressure gauge reading of 200psi at the conclusion of the small scale pressure test.

Chateau Test 1/11/17

The Chateau test involved a similar procedure as the small scale test. 105 pieces of 6m, 2” galvanized steel pipes had been connected using the same joining technique used for the pipes in the small scale test--5-6 wraps of PTFE tape and RectorSeal T+2 thread sealant were used for each male/female combination. The desired test pressure was 60psi for these pipes.

Filling of the pipeline revealed that there was a section of pipe at a higher elevation than the pipe closest to the Chateau site. Consequently, water reached equilibrium at two equal-altitude locations; one at the top of the hill and the other inside the water truck. Experimentation with pressurizing using the pump allowed for the flow of some water over the hill and into the rest of the pipeline. Pressurizing was called off due to the inability to completely fill the system and pipeline filling ceased. Leakages along the pipeline were recorded and photographed. There were 35/105 cases of leaks, varying in severity from a moist area around the couple to a small stream of water. These were centralized around the lowest elevation of the pipeline, where hydrostatic pressure was the greatest.

After detaching the water truck hose the threading on the pipes were inspected. Inspection revealed that the threads were tapered. As the couples were not, a significant portion of the threading did not contact the couple and was thus ineffective for seal creation. Furthermore, it was observed that the pipe walls were particularly thin, so much so that the grooves created by the threading were visible on the interior surface of the pipes.

Visible tapering of threads.