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Post-Project Assessment of Step-Pool and Channel Morphology at Wildcat Creek, Tilden Golf Course (Final Draft)

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Abstract

In recent years, river restoration has shifted towards natural, process-based approaches rather than fixed, engineered solutions. This new emphasis on natural approaches was implemented in a restoration design and subsequent experiment in the Tilden Park Golf Course reach of Wildcat Creek in Berkeley, California, USA. The restoration design implemented step-pools to address bank erosion and encourage channel stabilization, while the experiment highlighted the creek's ability to self-organize these desired step-pool formations without the need for human interference. The Restoration and Experimental Reaches were monitored consistently from 2012 to 2017 and again in 2022, and found that after the addition of step-pools, the channel bed remained fairly stable without significant aggradation or erosion. Our study conducted a post-project monitoring of the Restoration and Experimental Reach, to gain further insights on potential changes in the channel and step-pool morphology, as well as identifying three potential contributing factors: vegetation growth, precipitation, and disturbances.

Previous monitoring in 2022 noted that vegetation management greatly influences channel morphology, and willow growth in the Restoration Reach could thereby negatively impact channel stability. Further, since the most recent monitoring in 2022, a series of large winter precipitation events may have altered the channel morphology but have not yet been accounted for in analysis. Additionally, a willow fell into the Experimental Reach during the winter of 2015-2016, accumulating debris and causing aggradation. While the effects of this disturbance are noted through cross-sections taken in 2016 and 2017, it is unclear how the disturbance impacted step-pool morphology as well as longer-term trends in channel morphology. Through three days of field work, we surveyed cross sections, performed pebble counts, and observed the step-pool formations and coinciding slope in the restoration and Experimental Reach. Informally, we also replicated photos taken yearly at various perspectives along the creek and recorded occurrences of riparian species. We situated our data in the context provided by documents from and interviews with Dr. Anne Chin and Dr. Patina K Mendez, as well as Restoration Design Group (RDG). Results show that channel morphology, sediment composition, and step-pool morphology are heavily influenced by vegetative growth, precipitation, and the log jam disturbance. Specifically, the channel cross sections aggraded due to willow growth and the log jam, though the Experimental Reach impacted by the log jam has recently shown signs of incising and returning to pre-log jam conditions. High flows greatly impacted sediment composition, as high flows allowed for increased transport capacity, flushing out the coarser material added by RDG in the 2012 restoration. Without replenishment of coarse material, the sediment supply returned to pre-construction fines, decreasing grain size. High flows and the log jam also influenced step-pool morphology, high flows allowed for an increase in the number of step-pools, and the log jam allowed for a decrease in average slope and average five largest rock sizes.

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1 | Introduction

We conducted a survey at Wildcat Creek in Tilden Park Golf Course, Berkeley, CA, USA, examining channel cross sections, observing step-pool morphology, and collecting pebble counts at the Restoration and Experimental Reach. The research problem we addressed was how the channel form and step-pools responded to vegetation growth, heavy precipitation, and a log jam disturbance. Acknowledging the limitations of a semester-long research project, we selected a topic with a scope that was reasonable and still spoke to the shifting focus in river restoration communities towards natural approaches (Chin et al., 2021).

In the field of river restoration, the emphasis has shifted from engineered, structural interventions to more natural, process-based approaches that harness the river's inherent ability to self-regulate and achieve ecological stability. This transition is exemplified by the implementation of step-pool systems, a common feature in mountain streams, characterized by a sequence of steps formed by large stones and pools of slower-moving water. The concept of step-pool was first introduced in a theory proposed by Whittaker and Jaeggi in 1982. This theory, known as the antidune theory, was the first explanation of step-pool origin based on experimental data. It explains step-pool development as a bed deformation process at high flow that includes particle sorting and the formation of antidunes, a sediment bed feature that initially deforms in phase with standing waves. The formation of steps begins as large clasts deposit on the upstream side of each antidune and are anchored in place.

Over the years, the understanding and study of step-pool systems has evolved. These systems are now recognized for their role in energy dissipation, sediment transport, and habitat rehabilitation in river restoration (Chin, 2009; Chin et al., 2021). More artificial step-pools have emerged as a strategy for nature-based restoration projects, as was also introduced in the Wildcat Creek Restoration project.

The site of interest is in the headwaters of Wildcat Creek within Tilden Park Golf Course, which flows through the city of Berkeley, CA and into San Francisco Bay (**Figure 1**). The site is delineated into two reaches. The Restoration Reach contains Cross Section 2 and is situated downstream, between Hole 5 Bridge and Lower Hole 11 Bridge. The Experimental Reach contains Cross Section 4 and is situated upstream between Middle Hole 11 Bridge and Upper Hole 11 Bridge (**Figure 2**).

In 2000, a group that wished to keep anonymous conducted an initial restoration on the current Restoration Reach in response to persistent bank erosion, incision, and headcuts around small concrete dams (Chin, 2023). They used a riffle-pool design usually applied in lower gradient channels; however, the channel at the Restoration Reach has a 5–8% slope, and is thereby likely better suited to a step-pool design (Chin et al., 2021). The riffle-pools were thus washed out soon after heavy rains. East Bay Regional Park District (EBRPD) noted that the creek was thereafter continually incising since 2006, and hired Restoration Design Group (RDG) and FarWest Restoration Engineering in 2012 to address the incision and stabilize the channel by providing erosion control and vegetation management. In addressing these issues, RDG opted for a less engineered and more hands-off approach, leading to the adoption of step-pools due to their proven effectiveness (Chin, 1998; Chin, 1999). To implement their step-pool design, RDG placed coarse particles (larger than the natural sediment size of the creek) to form fixed keystones in the steps.

After RDG completed the aforementioned restoration project in 2012, they obtained permits to work with Chin's team to conduct a 2012 experiment in the same creek (Chin et al., 2021). RDG introduced clasts coarser than the natural bed material into the Experimental Reach to replicate step-pools similar to those in the Restoration Reach. Unlike in the Restoration Reach however, clasts in the Experimental Reach were not stabilized into keystones, which allowed Chin’s team to observe the channel’s evolution and self-organization in subsequent high flows. Chin et al., 2021 found that under the right hydraulic and biological conditions, the river would naturally self-organize its own step-pools without human interventions such as providing fixed clasts.

Our aim was to untangle the interplay between biotic growth, hydrological dynamics, and physical disturbances, providing insights into their collective influence on the restoration project. We evaluated willow proliferation, heavy rains, and a log jam disturbance as contributing factors which impacted the channel morphology, sediment composition, step-pool morphology, and biological condition in both the Restoration Reach and Experimental Reach of the Wildcat Creek within the Tilden Park Golf Course.

2 | Methods

Since 2012, RDG and Chin's team intermittently surveyed the Restoration Reach and Experimental Reach, collecting data on channel cross sections, pebble counts, and step-pool size and location. Our group then replicated RDG's historical cross sections, RDG's pebble counts, and Chin et al.'s step-pool drawings and b-axis measurements.

To address changes in channel morphology, we surveyed two channel cross-sections: one at the Restoration Reach (**Figure 3**) and one at the Experimental Reach (**Figure 4**). RDG first surveyed Cross Section 2 in the Restoration Reach in 2012, and left wooden stakes to monument both banks. In 2014, RDG surveyed the same cross section again using the same wooden stakes they left in 2012. In 2016 and 2017, RDG did not survey Cross Section 2 because they were unable to find the wooden stakes marking the cross section. In 2022, while RDG did not find the wooden stakes they left in 2012, they placed new stakes and took a new cross section, still named Cross Section 2 at the Restoration Reach. We opted not to include this 2022 cross section at the Restoration Reach in our analysis because it did not align with the cross sections taken in 2012 and 2014. To replicate RDG's Cross Section 2, we first located the approximate location of the cross section by comparing the bends of the creek, nearby trees, and neighboring golf features to those marked in a photo point and cross section map provided by RDG (**Figure 2**), as RDG did not record GPS coordinates for their cross section markers. We then scoped the site, searching for the four total wooden stake monuments that RDG left in 2012 and 2022. Deep in a willow thicket, we found one wooden stake, marking the end point of Cross Section 2 on the left bank, looking upstream. We confirmed through email correspondence with Natradee Quek from RDG that this was indeed a wooden stake left from their 2012 survey which RDG was unable to find again in surveys post-2014 (**Appendix B**) (Quek, 2023). As we only had one stake to go off of, we referenced the RDG's historical cross section data, eyeballing the shape of the channel and the shape of RDG's 2012 and 2014 cross section plots to decide how to best angle the cross section. We then positioned the tripod and level such that we could reference RDG's control point, 0CP1 orange cross on the curb, as marked with GPS and elevation in RDG's map (**Figure 2**). We then surveyed the cross section and overlaid our collected data with RDG's historical survey data, making minor adjustments to better align cross sections with each other.

RDG first surveyed Cross Section 4 in the Experimental Reach in 2012, again leaving wooden stakes to mark the right and left banks of the cross section. In 2013 and 2014, RDG replicated this cross section using the same wooden stakes. In 2016, RDG lost the wooden stake marking the right bank of Cross Section 4, looking downstream. They put in a new stake and took the survey with the new right bank stake that year. In 2017, RDG replicated the 2016 survey using the old left bank stake and the new right bank stake. In 2022, RDG was only able to find one right bank stake of the three total stakes RDG put in the ground to mark Cross Section 4. It is unclear whether this right bank stake is the old or new stake. Similar to our method with Cross Section 2 in the Restoration reach, to replicate RDG's surveys in Cross Section 4 in the Experimental Reach, we first used our best judgment to approximate what we assumed was the location of the cross section by comparing RDG's cross section map with the landforms we observed in the field (**Figure 2**). We then scoped the site, searching for any of the three wooden stakes, but we were unable to find any. Without any GPS coordinates or wooden stake monuments to demarcate the cross section, we did our best to measure out on RDG's map the distance from the cross section to the center of the oak tree around which formed a bend in the creek (**Figure 2**). We also, similar to Cross Section 2, made reference to RDG's historical survey data to best eyeball about how wide the channel bed should be at our cross section. Since we had very limited information, we decided as best we could what we thought was the most likely location of Cross Section 4. We positioned the tripod and level to reference RDG's control point B3 NE corner of bridge abutment base of rail (**Figure 2**). We then surveyed our cross section and overlaid the data with RDG's historical cross sections, making minor adjustments to better align cross sections with each other.

To investigate changes in sediment composition, we performed a pebble count, using a gravelometer. Each year that RDG conducted a cross section survey, they conducted a pebble count at the location of the cross section. To replicate this data, we collected 120 counts 6m upstream of Cross section 2 and 125 counts 9.5m downstream of Cross Section 4. We chose these locations based on both proximity to cross sections and to clearly visible step-pools with water. We then compared our pebble count data with historical data from RDG's Monitoring Report, though we do recognize that RDG conducted pebble counts at the exact location of both cross sections while we conducted pebble counts at locations further from the cross sections.

To characterize the step-pool morphology, we identified and sketched step-pools within the Experimental Reach. In 2012, 2014, and 2015, Chin et al. 2021 took a longitudinal profile of the Experimental Reach, sketched step-pools and recorded the average size for each step. Chin defines a step to be "the accumulation of cobbles and boulders that spanned the channel width and caused a drop in water surface elevation during low flow" (Chin et al., 2021). We followed this definition as best we could to replicate Chin et al.'s step-pool analyses, though in areas where there was no surface water present, we faced difficulty evaluating what constituted a step. We sketched the Experimental reach with each step label and recorded the average size (measured as the intermediate axis) of the five largest rocks. We then compared our collected data to sketches published in Chin et al., 2021 and b-axis measurements supplemented through Dr. Patina K Mendez's field notes from 2012, 2014, and 2015. While time and equipment constraints prevented a full longitudinal profile of the experimental cross section, we were able to produce a slope profile using seven survey points along the longitudinal profile and calculated average slope behind the log jam using **Equation 1**. We calculated the average slope behind the log jam from the top of the log jam (5 m upstream of Middle Hole 11 Bridge) to where Chin et al. 2021 longitudinal profiles ended (35 m upstream of Middle Hole 11 Bridge) and compared to Chin et al.'s longitudinal profiles (**Figure 13**).

We also replicated historical RDG photographs taken from specific photo point locations along the creek (marked with GPS coordinates and directions) to visually assess changes in the Restoration and Experimental Reaches over time. We also broadly identified riparian species observed in the field to compare with EBRPD's Biological Assessment Report (EBRPD, 2010).

3 | Results & Discussion

3.1 | Channel Morphology

Restoration Reach

The overlaid cross section profiles of the Restoration Reach are depicted in **Figure 5**. While the left bank aligns remarkably well with the 2012 and 2014 cross sections, we found that the right side of the channel has aggraded. At Station 7.82, the point along the cross section of maximum aggradation, the bank has aggraded 2.17 ft. At the right bank where we found the 2012 stake, the bank aggraded 0.54 ft.

It is important to note that observation of changes in channel morphology took place almost ten years after the last pictured cross section by RDG. Several factors could have influenced the channel morphology during this period, which were not extensively documented during the data gap. Perhaps the biggest contributing factor to the aggradation in the Restoration Reach is the presence and growth of willow (*Salix spp*). A previous vegetation survey noted the presence of willows, specifically *Salix laevigata* and *Salix lasiolepis*, which are also visible in yearly documented photos looking upstream at the Restoration Reach (EBRPD, 2010). Photo Point 2, taken by RDG immediately post-construction in 2012 showed that young willow trees were planted along the Restoration Reach, and more mature willow trees were already established further upstream in the channel (**Figure 6a**). Comparing photos taken yearly thereafter revealed prolific willow growth, although the exact location of the stake demarcating the cross-section profile is not always clear in these photos (**Figures 6b & 6c**). The stake that we found from 2012 is located deep underneath thick vegetation of a large willow tree, as shown in **Figure 7**. This is likely why the stake hadn't been found in previous years. Considering the prolific annual growth of willows and that it is highly unlikely that the 2012 and 2014 channel cross sections were taken inside of a willow thicket, we speculate that the large willow tree in the middle of the cross section must have established itself post-2014. We noted that the willow's roots were mostly situated on the right bank where the surface is locally elevated relative to the creek bed. The presence of this willow and its dense root system likely allowed for channel aggradation, as the roots trap sediment and these sediments build over time.

Experimental Reach

Figure 8 shows the cross-sectional profile of the Experimental Reach for seven years from 2012 to 2023. From 2012 to 2014, the channel morphology remained relatively stable. Between 2014 to 2016, the bed aggraded nearly 3 ft, followed by more than 1 ft of further aggradation from 2016 to 2017. However, between 2017 and 2022, the channel stopped aggrading and instead began to downcut, resulting in a 2 ft lowering compared to 2017. Our 2023 cross section indicates no significant aggradation or incision compared to the 2022 cross section.

In the winter of 2015-2016, a log jam formed just downstream of the Experimental Reach (**Figure 9 & 9b**), causing 4 ft of aggradation in the upstream Experimental Reach cross section. Despite this disturbance, the 2022 and 2023 cross sections are remarkably similar and in fact echo the original as-built channel form in 2012, suggesting that perhaps the channel may have reached an equilibrium in channel morphology similar to the pre-log jam conditions. Additionally, the log jam may have begun to break down since 2017, allowing increased flows and more incision in the channel bed.

We noted in the field that the right bank seemed to be eroding, easily crumbling as we climbed in and out of the channel. Some of this erosion on the right bank is visible by comparing the cross section in 2022 to that in 2023. We did not note, however, any signs of erosion on the Restoration Reach.

It is also possible that there may be some error in the cross sections collected, as RDG took their cross sections with missing and entirely new stakes in 2022 for the Restoration Reach, 2016 for the Experimental Reach, and 2022 again in the Experimental Reach. We took our 2023 cross section on the Experimental Reach without any stakes, as we were unable to find any of the stakes RDG placed in this cross section since 2012. This introduces some error into our analysis, but despite this, we believe that our cross section at the Experimental Reach aligns fairly well with those RDG took in previous years. This could be because the general area of this cross section was fairly easy to locate on the provided cross section map (**Figure 2**) relative to the bend of the channel and the positioning of landmarks like trees. In the reach we identified as the most likely for this cross section, the channel was also relatively uniform, i.e., the channel cross section did not visually vary significantly along its length.

3.2 | Sediment Composition

Restoration Reach

We observed an increase in grain size across all particle size distribution percentages in 2014 and a subsequent decrease in particle sizes larger than the D50 starting from 2016 and continuing to 2023 (**Table 1**). However, we note a lack of measurements between 2017 and 2022, so we don't know if this has been a steady trend towards fining or if the grain size has fluctuated in between. Despite this, it is apparent that 2016 marks the beginning of a transition towards a finer sediment composition (**Figure 10a & 10b**). Below, we further discuss potential causes of the fluctuation in grain size during 2016 when looking at the Experimental Reach.

Experimental Reach

Table 2 and **Figure 11a** show similar trends in sediment composition between the Experimental Reach and Restoration Reach, with a notable increase in D50 in 2014 and a general decrease in subsequent years after 2016, potentially shifting towards the sediment composition observed in 2012 (**Figure 11b**). The 2012 grain size reflects the natural sediment supply of the creek without the coarse particles RDG manually added into the creek during construction. Because RDG collected the 2012 pebble count before rains were able to carry the manually added coarse particles downstream to Cross Section 4 where the pebble count was collected, we don't see a large D50 in the 2012 data (RDG, 2022). The 2014 data, however, does reflect RDG's 2012 manual addition of coarse clasts, as we see through the increase in D50 from 2012 to 2014. After heavy rainfall in water years 2016-2017 and 2022-2023 (Raguso, 2023), heavy flows likely flushed out these coarser sediments along with the finer sediments. But because the natural sediment supply is finer than the sediment supplied by RDG in 2012, we see a reduction in particle size in subsequent years after 2016 (**Appendix A**) (Chin, 2022).

As noted in Section 2 Methods, RDG conducted their pebble counts at the exact locations of Cross Section 2 and 4, while we took pebble counts at locations determined by proximity to cross sections and clearly visible step-pools. As such, our and RDG's pebble count locations do not coincide and thus may introduce uncertainty into our analysis.

3.3 | Step-Pool Morphology

Chin et al., 2021 documented the fewest step-pools in 2012 (start of the project), with only four steps, and the most step-pools in 2014 and 2015 (end of monitoring) with seven steps **(Figure 12)**. We identified fourteen step-pools (**Figure 13**), twice as many as in 2015. The Experimental Reach was initiated in 2012 before the rains, with no constructed step-pools and homogenous bed material of various sized-rocks conducive to step-pool formation (RDG, 2022; Chin et al., 2021). Since 2015 there have been two extremely wet water years, 2016-2017 and 2022-2023, with substantially more total precipitation than between 2012-2015 (Raguso, 2023). These storm events would have likely caused heavy flows in Wildcat Creek (no stream gauge data available), allowing for reformation and rearrangement of the step-pools along the Experimental Reach, as we see in the increase in number of step-pools (**Figure 13**). We performed our survey in November, before any significant rains, with no water flow at some spots, and lower creek levels than during Chin's springtime monitoring. This may have led to errors or inconsistencies in our identification of steps.

The next step in our step-pool morphology analysis was looking at the five largest rocks (FLR) in each identified step. In our study, the average FLR diameter at each step ranged from 108 mm to 230 mm with an average of approximately 178 mm across the 14 steps (**Figure 13**). This is significantly smaller than the ranges in Chin et al. 2021 findings, which reported larger FLRs ranging from 183 mm to 367 mm (**Figure 12**). The smallest average FLR size at a single step in Chin's study was greater than our FLR overall average. We came to the conclusion that the large storm events 2016-2017 and 2022-2023 likely moved much of the coarser material deposited by RDG at the the top of the Experimental Reach in 2012 out of the reach (**Appendix A**) (Chin, 2023). Without further human intervention, the sediment supply returned to pre-construction finer grains, which would explain the decrease in the average of the five largest rocks between Chin's et al. 2021 study from 2012-2015 and our study in 2023 (**Appendix A**) (Chin, 2023).

Upstream of the log jam in the Experimental Reach, the slope decreased from an average of approximately 6.0% in Chin's study from 2012-2015 to 4.2% in our study (**Table 3** & **Figure 14**). This slope decrease appears to be due to aggradation from the 2016 log jam, which would reduce transport capacity of the creek and allow finer sediment to deposit (RGD, 2022). Our hypothesis is also corroborated by RGD's Monitoring Report, which noted a reduction in larger sediment in 2022 as compared to previous years due to log jam-induced gravel deposition (RGD, 2022). The change in slope would have little impact on the movement of large rocks out of the reach during high flows, they could substantially impact low flows in their ability to move fine sediment, resulting in increased fine sediment deposition. This log jam has also seemingly altered the channel shape just upstream and downstream the log jam as shown in red in **Figure 13**.

The observed increase in the number of step-pools, the decrease in average slope, and the reduction in the size of the largest rocks at each step are likely correlated. The 2016 log jam and high flow periods in 2016-2017 and 2022-2023 could have restructured the creek with large sediment and bed loads, changing the bed composition and forming step-pools.

3.4 | Photo Points

At Photo Point 5, which looks downstream from Middle Hole 11 Bridge at Lower Hole 11 Bridge, there are slight changes to specific rocks within the step-pools pictured in the photo point from 2022 to 2023. However, there remains a notable self-organization of rocks within the channel bed (**Figure 15** & **15b**). Additionally, at Photo Point 6, which looks upstream from Middle Hole 11 Bridge, shows a tree growing horizontally across the middle of the channel bed during the 2012 construction (**Figure 16**). This is likely the tree which fell and created a log jam in 2016, as it disappeared in subsequent photo points post-2016 and in its place is the log jam (**Figure 16b**). Each years' photos since then have shown bed aggradation upstream of the log jam and a resultant large pool forming downstream (**Figure 16c**). Photo Point 7, looking upstream from Upper Hole 11, shows that during the 2012 construction, the rocks were organized in very neat clasts creating steps and pools (**Figure 17a**). This distinct arrangement remained fairly visible in 2017 (**Figure 17b**), but in 2023, more medium-sized rocks appeared within the pools, creating a less clear distinction between step and pool than in the 2012 construction (**Figure 17c**). Apart from aforementioned photo points, most others, including ours and previously documented ones, are not very useful for comparing changes in the channel bed, as they were either taken at different perspectives than previous years or the landscape features of interest are obscured by vegetation.

3.5 | Biological Observation

Restoration Reach

The Restoration Reach only has one large patch of riparian vegetation near Cross Section 2 (**Figure 6**). The major vegetative species found in this reach were arroyo willow (*Salix lasiolepis*) and red willow (*Salix laevigata*). Other identified species were coyote brush (*Baccharis pilularis*), horsetail

(*Equisetum*), and alder (*Alnus glutinosa*). Willows, known for their rapid growth, are adept at reestablishing themselves after disturbances. RDG's Monitoring Report emphasizes the need for willow maintenance to reduce foliage density. We noted that the golf course has clear cut riparian zones in the direct line of play where golfers often traverse and neglected areas unaffected by golf activities. The Restoration Reach has a long stretch of clearcutting downstream of Cross Section 2 and a largely unmaintained stretch at and upstream of Cross Section 2. At Cross Section 2, we found the stake on the right bank looking downstream embedded a few feet deep within a willow thicket(**Figure 7**), which, according to previous photos, had not yet grown when the restoration was completed in 2012. There are two willows in this cross section that greatly manipulated the river bed in the cross section line, illustrating how vegetation maintenance can greatly impact channel morphology. The dichotomy of clear-cutting and dense willow growth, which has likely shaded out other species, appeared to have reduced species diversity in the Restoration Reach.

Experimental Reach

We identified following species in the Experimental Reach: Himalayan blackberry (*Rubus armeniacus*), stinging nettle (*Urtica dioica*), coastal live oak (*Quercus agrifolia*), coastal redwood (*Sequoia sempervirens*), thimbleberry (*Rubus parviflorus*), forget-me-nots (*Myosotis*), straggly gooseberry (*Ribes divaricatum*), pink-flowered currant (*Ribes sanguineum var. glutinosum*), arroyo willow, alder, and horsetail (**Figure 18**). Himalayan blackberry heavily dominated, outcompeting some of the other riparian vegetation. Despite the heavy overgrowth of Himalayan blackberry, there was still a diverse number of species in the riparian zone. The lower end of the experimental reach was more willow-dominated instead of Himalayan blackberry-dominated. This allowed for a different mix of vegetation to grow, causing greater diversification. The prebuilt conditions saw both straggly gooseberry and currant in the riparian zone. Neither were reintroduced by RDG's revegetation efforts, but are rebounding naturally (RDG, 2022). The majority of the plant growth in this reach was seen along the left bank looking downstream, which has a gradual slope without heavy signs of erosion. In contrast, the right bank looking downstream had little vegetation and a heavily-eroding bank to a nearly vertical profile. This observation could be an indicator of the importance of vegetation to help prevent bank erosion.

The only two animals observed during our survey were a brush rabbit (*Sylvilagus bachmani*) and an Alameda whipsnake (*Masticophis lateralis euryxanthus*). The Alameda whipsnake was found in the side channel that connects downstream to the Experimental Reach. Listed as federally threatened species and known to have critical habitat within and around the Tilden Golf Course, the Alameda whipsnake requires a habitat that offers both shade and sun, with low shrubs for hunting and hiding. Its presence implies that the habitat, disrupted by RDG's restoration work, has recovered sufficiently to support sensitive species like the Alameda whipsnake (EBRPD, 2010).

4 | Conclusions

Studying the Restoration and Experimental Reach of Wildcat Creek has provided insight on how channel form and step-pools responded over time to underlying factors such as vegetation growth, heavy precipitation, and disturbances.

Restoration Reach

The vegetation in the Restoration Reach had little diversity and the reach consisted of areas of dense willow, which likely shaded out other species, and areas of complete clear-cutting. These two dynamics of vegetation are thought to have influenced the creek bed morphology. Cross Section 2 within the Restoration Reach saw significant bank aggradation, up to 2.17 ft, over the ten year span of cross sections taken. In the area of the greatest aggradation, there was a well-established willow with its roots catching sediment and pushing up the soil around it, showing the direct influence of vegetation on morphology of the creek bed.

Looking at other factors of bed morphology, the Restoration Reach pebble count data had some gaps but showed an increase in D50 gravel size in 2014, which then decreased to nearly to 2012 levels by 2023. We hypothesized the increase between 2012 and 2014 pebble count data is due to 2012 pebble count data not reflecting the coarser particle size that was deposited during the 2012 restoration project, whereas the 2014 pebble count data did reflect the coarser particles deposited in 2012. The general decrease from 2014 to 2023 is thought to be due to large flow events and a return of the sediment supply to pre-construction finer material.

Experimental Reach

We saw a far greater diversity of plant types in this reach compared to the Restoration Reach, with the dominant plant being Himalayan Blackberry. The left bank had most of the vegetation and showed little erosion with a gradual incline, while the right bank was nearly vertical due to significant erosion. This could demonstrate the importance of vegetation for bank stabilization. Although there was not a significant amount of vegetation growing in the creek bed, the 2016 log jam at the downstream end of the Experimental Reach, changed the channel morphology of Cross Section 4 upstream of the log jam, leading to a 3ft bed aggradation between 2016-2017 and subsequent 2ft down-cutting by 2022 with a trend towards stabilization in 2023.

We examined the slope of the Experimental Reach, five largest rocks at each step, and pebble count, and we found that the number of steps doubled from seven steps in 2015 after the last monitoring of Chin et al.'s study to fourteen steps in 2023. This is likely due to creekbed reorganization following heavy flows in the 2016-2017 and 2022-2023 water years. The total average of five largest rocks across all steps in 2023 was significantly smaller than in years prior. We saw a similar trend of decreasing large particle size in our pebble count data. We believe this is due to RDG adding clasts larger than the natural sediment load to the Experimental Reach during their 2012 restoration, combined with high flow events in 2016-2017 and 2022-2023 water years which flushed the larger anthropogenically added clast out of the reach. Without replenishment of coarse material, the sediment supply and thereby pebble size returned to finer natural loads. Finally, we observed an Alameda whipsnake, indicating that since construction, the habitat in this reach has recovered sufficiently to support this threatened species again.

Potential Sources of Error

Since we were unable to find all of the stakes that marked RDG's historical data cross sections, our cross section profiles could potentially be in a slightly different location. Additionally, we took pebble counts at different locations than RDG. The gravelometer we used didn't have the largest size measurement that RDG used. Finally, we may have variations in step-pool identification methods compared to Chin et al.

Future research

We suggest future studies install metal stakes at each of the cross sections with high-resolution GPS coordinates for precise cross-section profiling; conduct H/L/S (mean high/space between step/mean gradient of the step-pool sequence) assessments, as done in Chin et al.'s study, on the step-pool sequence to determine how the step-pool geometry has evolved; and expand the cross section surveys to other cross sections monitored by RDG on Wildcat Creek to better draw holistic conclusions. Further, we were limited in this study by scope and lack of supporting data and research, which prevented us from drawing definitive conclusions about the merits of nature-based versus artificial step-pool solutions. As such, future research could address these shortcomings through a controlled flume experiment. This would allow for better isolation of contributing factors and ability to compare self-organizing step-pools versus engineered step-pools, providing deeper insight to what is truly happening in the field.

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Restoration Design Group, Inc. (2022) Wildcat Creek Restoration at Tilden Golf Course 2022 Monitoring Report YEAR 10. *East Bay Regional Park District (Berkeley, CA).* November.

Triska, F. J. (1984) Role of wood debris in modifying channel geomorphology and riparian areas of a large lowland river under pristine conditions: A historical case study: With 7 figures and 4 tables in the text. Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie. [Online] 22 (3), 1876–1892.

Whittaker, J. G. & Jaeggi, M. N. R. (1982) Origin of Step-Pool Systems in Mountain Streams. Journal of the Hydraulics Division. [Online] 108 (6), 758–773.

6 | Tables and Figures:

6.1 | Introduction

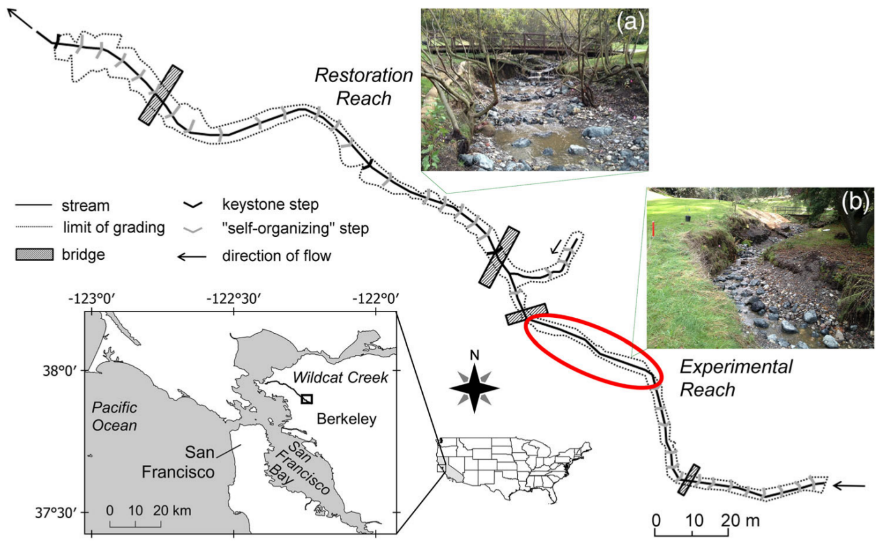

Figure 1: Map of the location of Wildcat Creek, Berkeley, CA. and its two reaches (restoration and experimental) relative to Berkeley, CA. Figure reproduced from Chin et al. (2021).

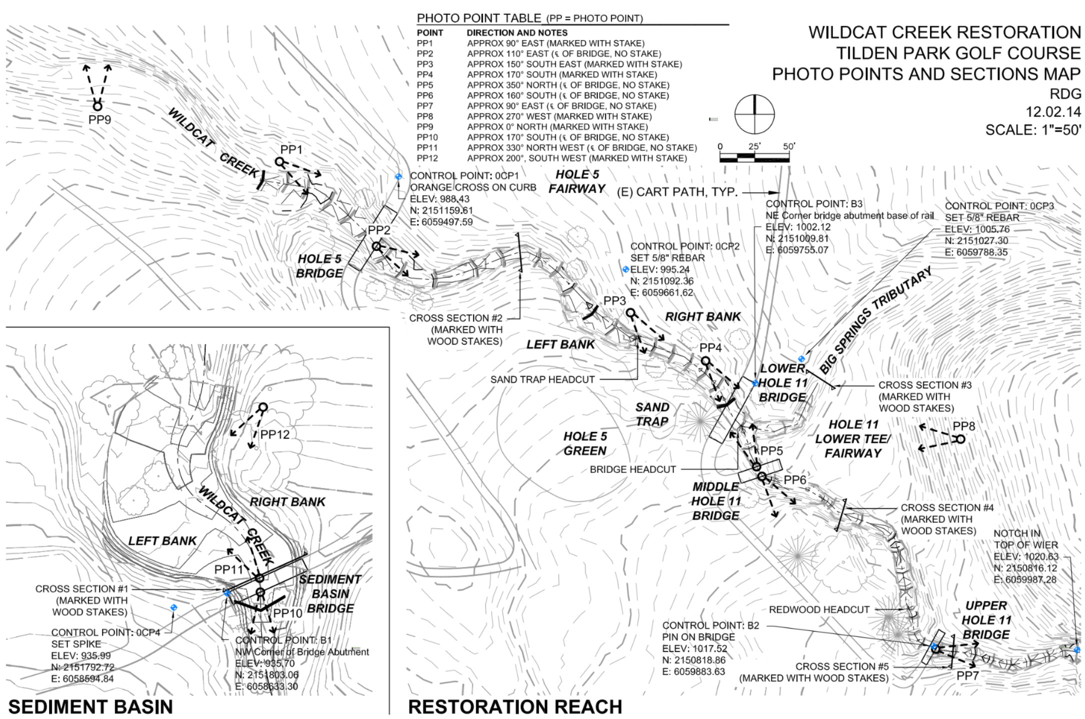

Figure 2: Photo point and cross section map for Wildcat Creek, Berkeley, CA. provided by RDG.

6.2 | Methods

Figure 3*: Photograph of Cross Section 2 in Restoration Reach marked by white tape measure and surveyed in 2023. Wildcat Creek in Berkeley, CA.*

Figure 4: *Photograph of Cross Section 4 in Experimental Reach marked by white tape measure and surveyed in 2023. Wildcat Creek in Berkeley, CA.*

6.3 | Results & Discussion

6.3.1 | Channel Morphology

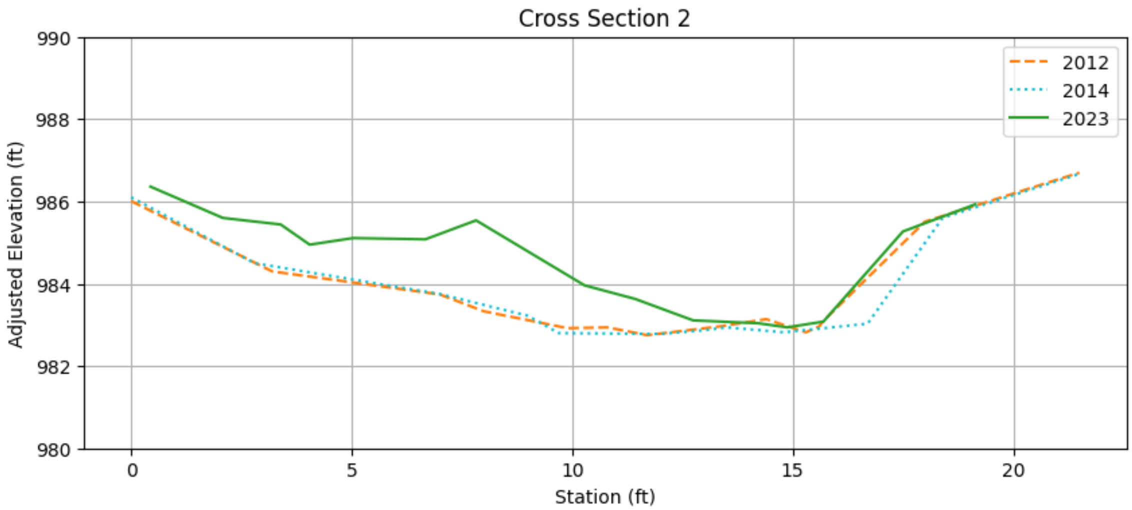

Figure 5: *Overlaid 2023 and historical cross sections of Cross Section 2 in the Restoration Reach on Wildcat Creek in Berkeley, CA.*

Figure 6a: *Photo Point 2, taken immediately post-construction in 2012. Originally presented in RDG's 2022 Monitoring Report. Restoration Reach of Wildcat Creek in Berkeley, CA.*

Figure 6b: *Photo Point 2, taken in 2014 showing rapid willow growth in just two years post-construction. Originally presented in RDG's 2022 Monitoring Report. Restoration Reach of Wildcat Creek in Berkeley, CA.*

Figure 6c: *Photo Point 2, taken in 2023 showing barren area and crop of willow further upstream. Restoration Reach of Wildcat Creek in Berkeley, CA.*

Figure 7: *Stake found on the right bank of Cross Section 2 in Restoration Reach at Wildcat Creek in Berkeley, CA.*

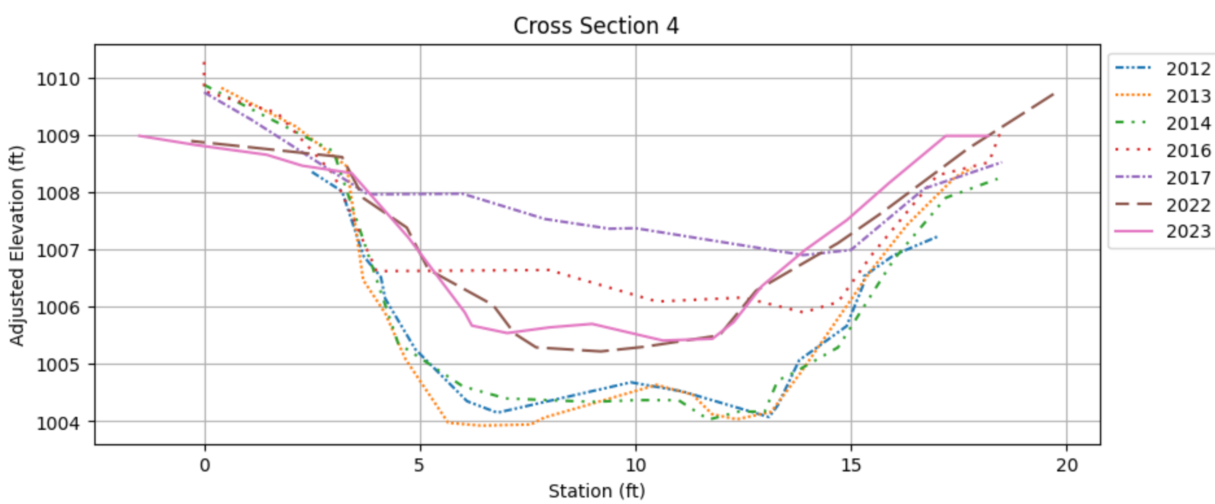

Figure 8: *Overlaid 2023 and historical cross sections of Cross Section 4 in Experimental Reach on Wildcat Creek in Berkeley, CA.*

Figure 9a: *Photograph of log jam, taken December 2017 by Roger Leventhal and provided in correspondence by Dr. Anne Chin. Experimental Reach of Wildcat Creek in Berkeley, CA.*

Figure 9b: *Photograph of log jam taken in 2023 Experimental Reach of Wildcat Creek in Berkeley, CA.*

6.3.2 | Sediment Composition

Table 1: *Compiled 2023 and historical pebble count at Cross Section 2 of Restoration Reach.*

RDG XS 2	D16	D35	D50	D60	D84	D95
2012	7.3	12	19	30	93	180
2014	8.4	21	38	65	120	270
2016	7.6	20	29	64	100	210
2023	12.3	19.2	35.4	42.2	83.1	150.8

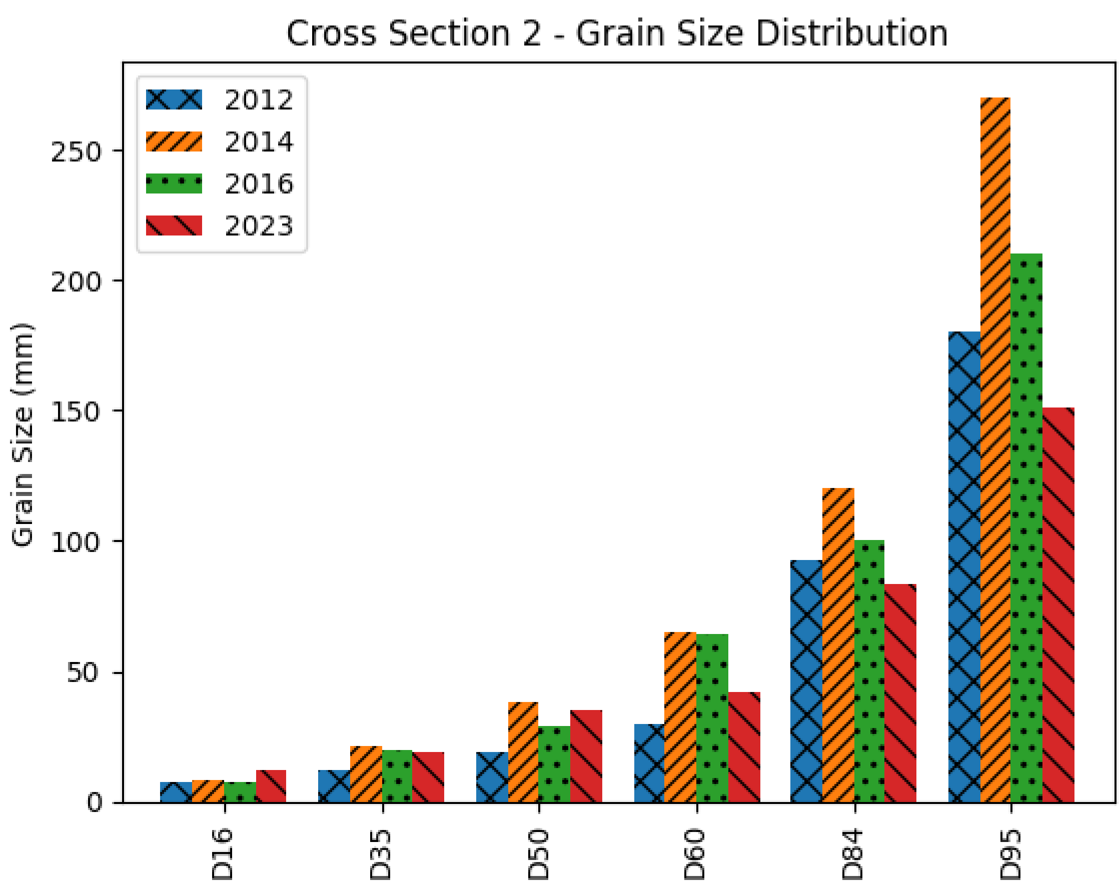

Figure 10a: *Compiled 2023 and historical grain size distribution at Cross Section 2 of Restoration Reach on Wildcat Creek in Berkeley, CA.*

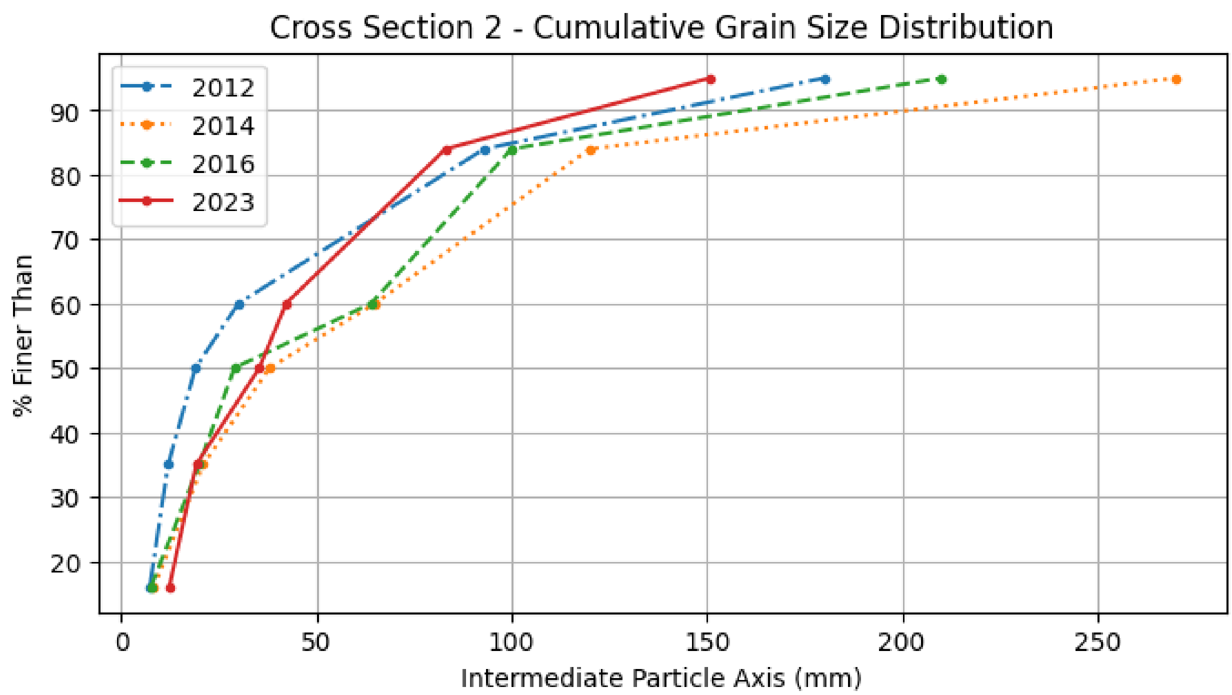

Figure 10b: *Overlaid 2023 and historical cumulative grain size distribution at Cross Section 2 of Restoration Reach on Wildcat Creek in Berkeley, CA.*

Table 2: *Compiled 2023 and historical pebble count at Cross Section 4 of Experimental Reach on Wildcat Creek in Berkeley, CA.*

RDG XS 4	D16	D35	D50	D60	D84	D95
2012	8.4	13	17	20	29	40
2014	7.5	16	22	38	97	220
2016	1.9	11	20	30	48	77
2017	8.4	17	28	42	80	120
2022	10	19	28	41	66	92
2023	6.7	15.8	17.9	22.7	49.2	63.7

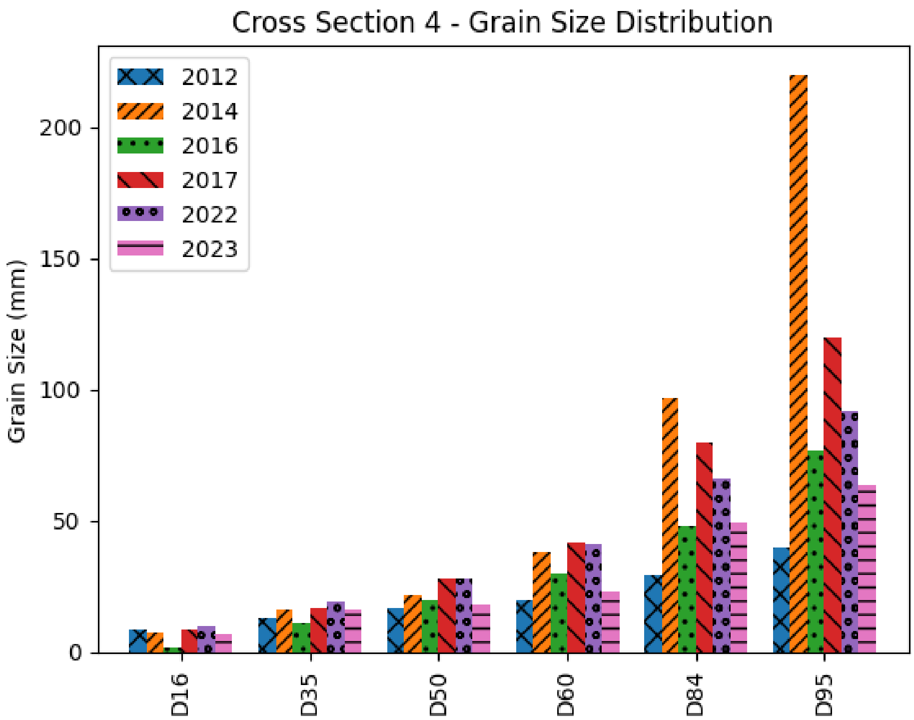

Figure 11a: *Compiled 2023 and historical grain size distribution at Cross Section 4 of Experimental Reach on Wildcat Creek in Berkeley, CA.*

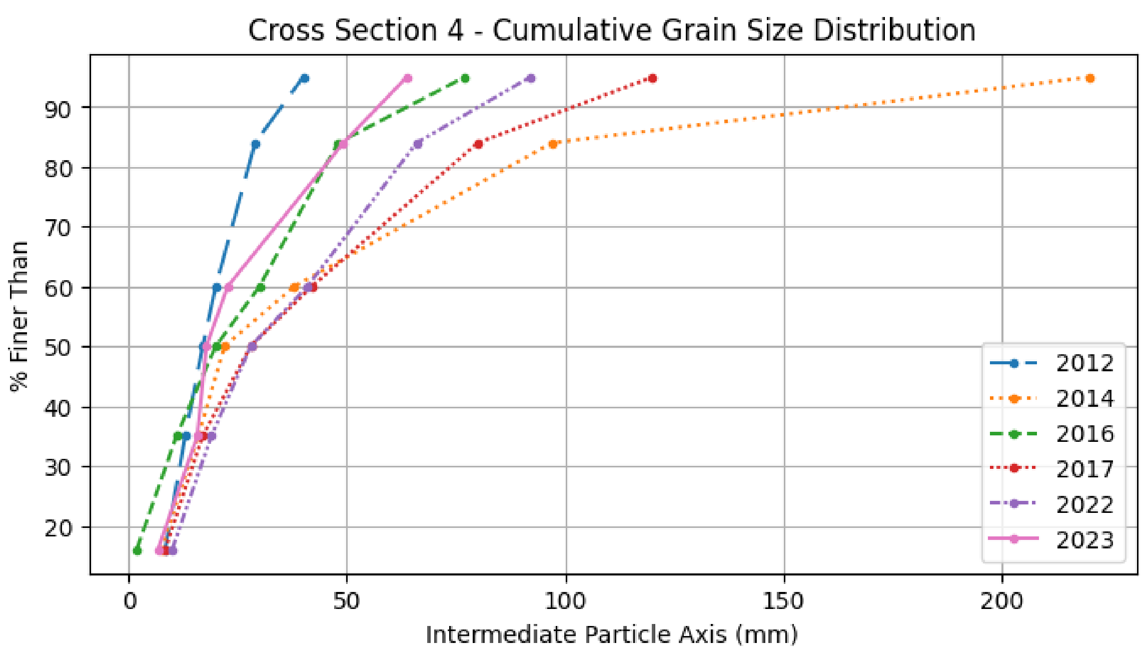

Figure 11b: *Overlaid 2023 and historical cumulative grain size distribution at Cross Section 4 of Experimental Reach of Wildcat Creek in Berkeley, CA.*

6.3.3 | Step-Pool Morphology

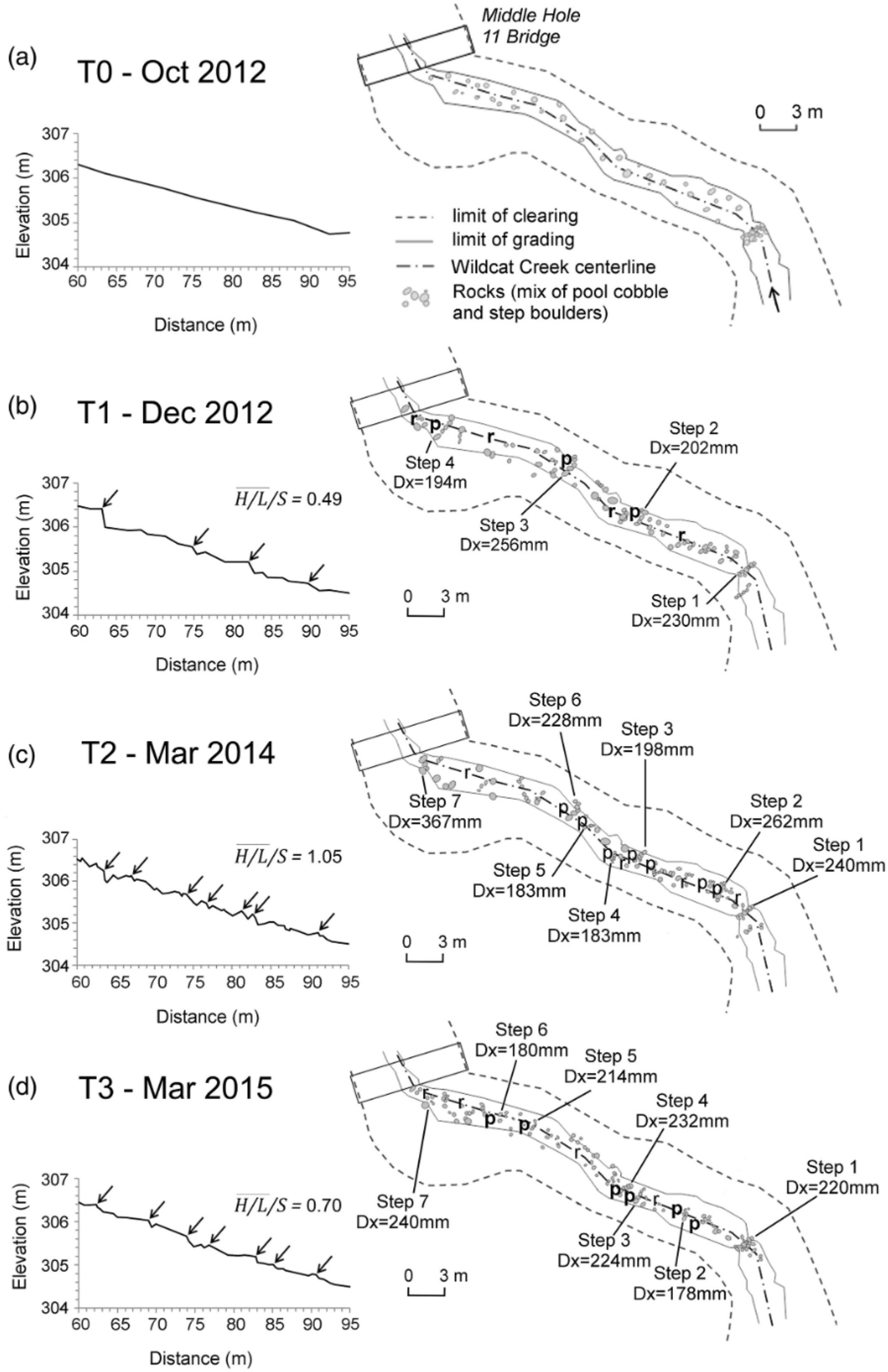

Figure 12: *Plan view of step-pool morphology and five-largest rock average at each step from 2012-2015 in the Experimental Reach of Wildcat Creek in Berkeley, CA. Data from Chin et al. 2021*

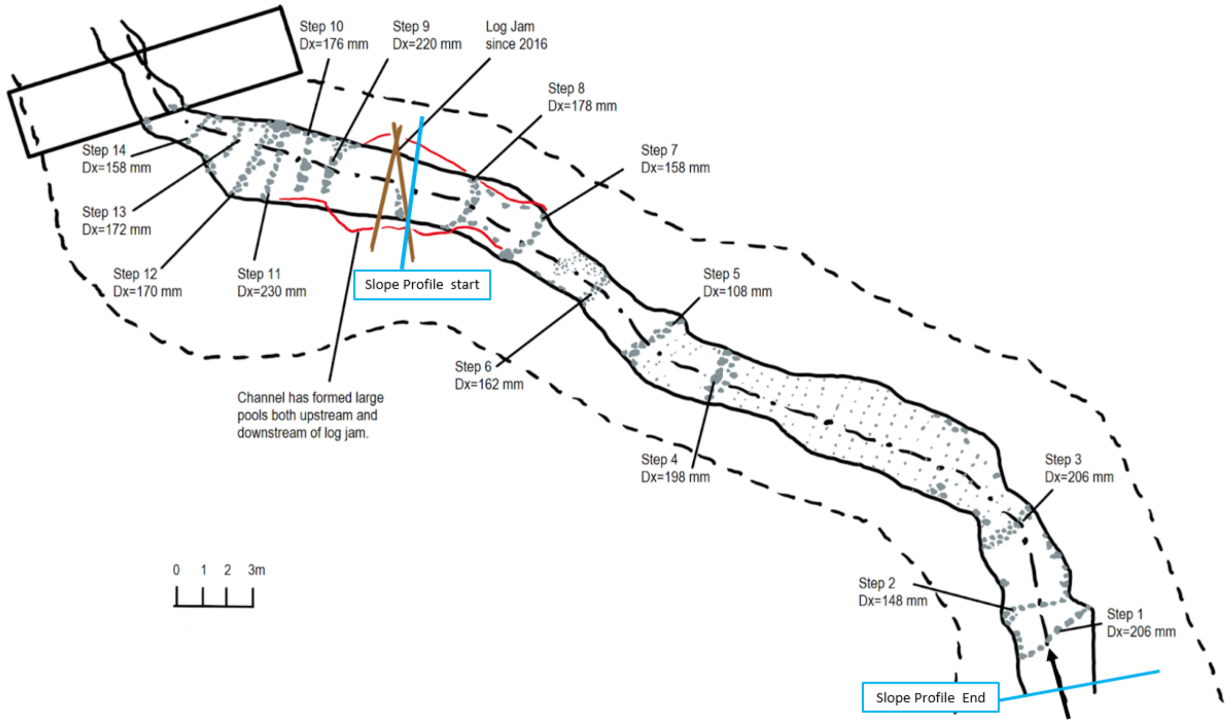

Figure 13: *Plan view of step-pool morphology and five-largest rock average at each step in 2023 in the Experimental Reach on Wildcat Creek, Berkeley, CA.*

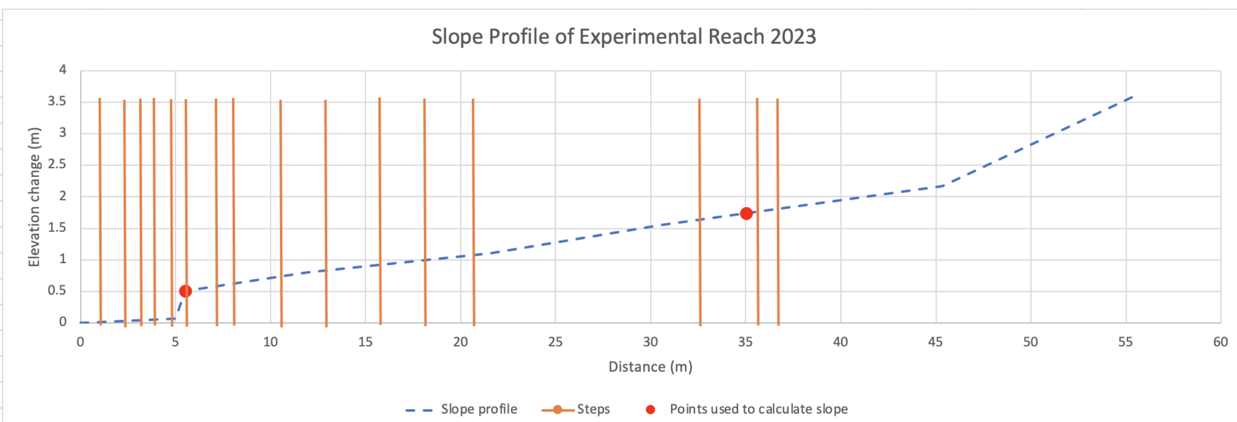

Figure 14: *Average slope longitudinal profile and step-pool locations in the Experimental Reach on Wildcat Creek in Berkeley, CA. The red dots indicate the locations used to calculate slope behind the log jam.*

Table 3: *Average slope of step-pool reach ranging from 2012-2023. Experimental Reach on Wildcat Creek in Berkeley, CA.*

Year	Average Slope (%)
2012	6.1%
2014	6.1%
2015	5.9%
2023	4.2%

Equation 1: *Equation for slope of the Experimental Reach behind the log jam on Wildcat Creek in Berkeley, CA. Slope was calculated only behind the log jam between 5.5 m to 35 m above the bridge*

$$Slope \ = \ \Delta H / \Delta L$$

ΔH = change in height
ΔL = length of reach

Example calculation:
Slope for 2023 year (see red dots in Figure 14).
L_1 = 5.5 m, L_2 = 35 m, H_1 = 0.5 m, and H_2 = 1.74 m.

Slope = $\frac{35\ m - 5.5\ m}{1.7\ m - 0.5\ m} \times 100 \ = \ 4.2\%$

6.3.4 | Photo Points

Figure 15a: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 5, taken in 2022. Originally presented in RDG's 2022 Monitoring Report.*

Figure 15b: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 5, taken in 2023. There are some changes in how the rocks are organized in the channel bed between 2022 and 2023.*

Figure 16a: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 6, taken post-construction in 2012. The willow growing in the bed is likely the willow which fell and caused the log jam in 2016. Originally presented in RDG's 2022 Monitoring Report.*

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Figure 16b*: Experimental Reach on Wildcat Creek, Berkeley, CA Photo Point 6, taken in 2017 . The willow pictured in Figure 16a has fallen and created a log jam. Originally presented in RDG's 2022 Monitoring Report*

Figure 16c: *Experimental Reach on Wildcat Creek, Berkeley, CA Photo Point 6, taken in 2022. The fallen willow is shown as well as a deep pool which has formed immediately downstream of the log jam. Originally presented in RDG's 2022 Monitoring Report.*

Figure 17a: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 7, taken immediately post-construction in 2012. The grouping of large rocks as steps and areas with smaller sediment as pools is very clear at this point in time.*


Figure 17b: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 7, taken in 2017. The structure of steps and pools is still very much clear and present here.*

Figure 17c: *Experimental Reach on Wildcat Creek, Berkeley, CA. Photo Point 7, taken in 2023. More medium-sized rocks are present, making the clear distinction between steps and pools less visible here.*

6.3.5 | Biological Observation

Figure 18: *Experimental Reach on Wildcat Creek, Berkeley, CA. Snapshot of general vegetation. Pictured and identified is Thimbleberry, Coastal Redwood, Coastal Live Oak, and Himalayan Blackberry.*

7 | Appendices

7.1 | Appendix A: Email Correspondence with Dr. Anne Chin & Dr. Patina Mendez

bConnected powered by Google **Carina Rose Valentine Swann <carinaswann@berkeley.edu>**

Request for Term Project Paper Review
6 messages

Vermouth Li <vermouth@berkeley.edu> Wed, Nov 29, 2023 at 6:16 PM
To: Anne Chin <anne.chin@ucdenver.edu>, Patina K Mendez <patina.mendez@berkeley.edu>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>, carinaswann@berkeley.edu

Dear Anne and Tina,

I hope this email finds you well. We're excited to share that our team has completed the field survey and initial drafts of our term project, which couldn't have been accomplished without your support. After incorporating feedback from peer reviews and a dress rehearsal symposium, we are now preparing for our formal symposium on December 9th.

As we continue to refine our work, we were wondering if you're available to review our paper by any chance? There are two specific questions where we hope to gain your insights:

Who led the 2000 restoration project using a riffle pool design template, where, and why? Based on our research, The Urban Creeks Council led the project in the lower reaches of Wildcat Creek to address flooding within the city of San Pablo. However, we're unsure if this is the same project you mentioned in your 2021 paper. If so, could you help us clarify how this lower reach restoration project correlates with our study of step pools upstream?

We observed a notable increase in pebble size in 2014 and a decrease in 2016 for both cross section 2 (restoration reach) and cross section 4 (experimental reach). Our initial hypothesis attributes the larger pebble size in 2014 to low annual precipitation and the fluctuations starting in 2016 to log jam disruptions, but both assumptions have been questioned. Your thoughts on them would be very helpful!

We understand this is a particularly busy time of year, so any comments or guidance you can provide, even if brief, would be very much appreciated! We look forward to hearing from you.

Thanks,
Vermouth, Ashley and Carina

W **LA227_ThirdDraft_Swann_Cao_Li.doc**

Chin, Anne <anne.chin@ucdenver.edu> Fri, Dec 1, 2023 at 3:42 PM
To: Vermouth Li <vermouth@berkeley.edu>, Patina K Mendez <patina.mendez@berkeley.edu>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>, "carinaswann@berkeley.edu" <carinaswann@berkeley.edu>

Hi Vermouth, Ashley and Carina

Great that you completed your project!

I can try to look through your paper this weekend. I requested access to the document. Is it possible to just send it via e-mail?

Very best wishes

Anne

Anne Chin PhD

Professor of Geography and Environmental Sciences

University of Colorado Denver

From: Vermouth Li <vermouth@berkeley.edu>
Sent: Wednesday, November 29, 2023 7:17 PM
To: Chin, Anne <anne.chin@ucdenver.edu>; Patina K Mendez <patina.mendez@berkeley.edu>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>; carinaswann@berkeley.edu
Subject: Request for Term Project Paper Review

[External Email - Use Caution]

[Quoted text hidden]

Vermouth Li <vermouth@berkeley.edu> Fri, Dec 1, 2023 at 4:52 PM
To: "Chin, Anne" <anne.chin@ucdenver.edu>
Cc: Patina K Mendez <patina.mendez@berkeley.edu>, Ashley Jia Cao <ajcao@berkeley.edu>, "carinaswann@berkeley.edu" <carinaswann@berkeley.edu>

Thank you so much Anne! Sorry for the inconvenience - I've processed your access request and also attached a word document to this email for your use.
PS because the file is larger than 25mb, it may still appear as a google drive link although I upload it as a word doc. Let me know if you have any questions accessing it!

Thanks,
Vermouth

LA227_ThirdDraft_Swann_Cao_Li.docx

[Quoted text hidden]

Chin, Anne <anne.chin@ucdenver.edu> Mon, Dec 4, 2023 at 3:09 PM
To: Vermouth Li <vermouth@berkeley.edu>
Cc: Patina K Mendez <patina.mendez@berkeley.edu>, Ashley Jia Cao <ajcao@berkeley.edu>, "carinaswann@berkeley.edu" <carinaswann@berkeley.edu>

Hi Vermouth, Hi All, Below are my thoughts to your two key questions. Later I'll try to send a few more points for clarification of some minor issues in your text. Hope this is helpful, -- Anne.

Who led the 2000 restoration project using a riffle pool design template, where, and why? Based on our research, The Urban Creeks Council led the project in the lower reaches of Wildcat Creek to address flooding within the city of San

Pablo. However, we're unsure if this is the same project you mentioned in your 2021 paper. If so, could you help us clarify how this lower reach restoration project correlates with our study of step pools upstream?

- *I am unable to confirm that the Urban Creeks Council led the initial restoration in 2000. I believe it was indeed in the same area of the recent efforts (e.g., the Restoration Reach). The initial restoration occurred in response to persistent bank erosion, incision, and headcuts around small concrete dams. Our research group did not want to highlight WHO led and designed the project, since it failed. So we felt that leaving out this information was preferable.*

We observed a notable increase in pebble size in 2014 and a decrease in 2016 for both cross section 2 (restoration reach) and cross section 4 (experimental reach). Our initial hypothesis attributes the larger pebble size in 2014 to low annual precipitation and the fluctuations starting in 2016 to log jam disruptions, but both assumptions have been questioned. Your thoughts on them would be very helpful!

➔ *It might be important to highlight that the restoration efforts placed coarse step particles in the Restoration Reach and Experiment Reach. The reduction in particle size in subsequent years after 2016 could reflect (1) the log jam that interrupted movement of coarse materials down the channel; (2) the large flow years 2017 and 2023 that flushed out further the coarse materials; and (3) sediment supply from upstream. In the Experimental Reach, coarse clasts were ramdomly strewn in the channel (as discussed and shown in the photos), while an additional pile of coarse rocks were piled at the start of the reach. In the Restoration Reach, the artificial steps were also created with coarse materials introduced into the channel. The important point is that the restoration effort placed coarse materials into the channel reaches. Without replenishment from upstream (i.e., sufficient supply of coarse material) and large flow events, not to mention the blockage from the fallen tree, the reduction in particle sizes is not surprising. The decrease in particle size in subsequent years then could likely point to SEDIMENT SUPPLY from upstream (you could say something about this, rather than parent material).*

[Quoted text hidden]

Chin, Anne <ANNE.CHIN@ucdenver.edu> Mon, Dec 4, 2023 at 7:31 PM
To: Vermouth Li <vermouth@berkeley.edu>
Cc: Patina K Mendez <patina.mendez@berkeley.edu>, Ashley Jia Cao <ajcao@berkeley.edu>, "carinaswann@berkeley.edu" <carinaswann@berkeley.edu>

Hi again,

There were just a couple of additional points of clarification:

The RDG obtained the permit for us to conduct the experiments, so on Page 2 (Introduction): "After RDG completed their 2012 restoration project, the group obtained permits for Chin's team to conduct an experiment in the same creek begun in the same year (Chin et al., 2021)."

Also to be sure to credit Roger Leventhal for the photos of the fallen tree that I provided, so the figure caption for Figure 9a should be edited: Figure 9a: Photograph of log jam, taken December 2017 by Roger Leventhal and provided in correspondence by Dr. Anne Chin. Experimental Reach of Wildcat Creek in Berkeley, CA.

You've done an amazing job with the project over a very short time! Good luck with the symposium on the 9th – we will be cheering you on!

Very best wishes

Anne

[Quoted text hidden]

Vermouth Li <vermouth@berkeley.edu> Mon, Dec 4, 2023 at 7:41 PM
To: "Chin, Anne" <ANNE.CHIN@ucdenver.edu>
Cc: Patina K Mendez <patina.mendez@berkeley.edu>, Ashley Jia Cao <ajcao@berkeley.edu>, "carinaswann@berkeley.edu" <carinaswann@berkeley.edu>

Hi Anne,

Thanks so much for the clarifications! This is super helpful! We'll update our paper and photo credits as you suggested. Really appreciate your support!

Best,
Vermouth
[Quoted text hidden]

7.2 | Appendix B: Email Correspondence with RDG

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Carina Rose Valentine Swann <carinaswann@berkeley.edu>

Request for Tilden Park Golf Course Wildcat Creek Restoration Documents

5 messages

Ashley Jia Cao <ajcao@berkeley.edu> Wed, Oct 25, 2023 at 2:05 PM
To: rich@rdgmail.com
Cc: Carina Rose Valentine Swann <carinaswann@berkeley.edu>, Vermouth Li <vermouth@berkeley.edu>

Hi Rich!

Hope that you're doing well! We met briefly at the end of Prof. Matt Kondolf's River Restoration class field trip and chatted about the RDG Wildcat Creek restoration project at Tilden Park Golf Course. For the final project in Prof. Kondolf's class, we'd like to revisit the restoration reach of Wildcat Creek as well as the experimental reach as studied by Dr. Anne Chin. Ideally, we'll redo some of the analyses that Dr. Anne Chin put together and overlay cross-sections over time to see how the the two reaches have responded to time and the recent heavy rainfall.

You had mentioned on Saturday that RDG has monitored the site up until last year. If possible, could you please share those documents, particularly the yearly cross-sections but also any other relevant documentation that you might have? Additionally, do you happen to know what the pins are for the site? We'd like to go out and visit in person tomorrow and any tips or information you might have to help us find the exact location where the cross-sections were taken would be great!

Thank you so much for your time & help!

All the best,
Ashley, Carina, & Vermouth

Rich Walkling <rich@rdgmail.com> Wed, Oct 25, 2023 at 3:46 PM
To: Ashley Jia Cao <ajcao@berkeley.edu>
Cc: Carina Rose Valentine Swann <carinaswann@berkeley.edu>, Vermouth Li <vermouth@berkeley.edu>, Natradee Quek <Nat@rdgmail.com>

Ashley, Carina, and Vermouth-

I have posted several files here: https://rdgmail.sharepoint.com/:f:/s/Projects849/EprPHMcHD_FlhbpfgH-empoBj6er2v8GBaD8qk7130LSfw

-Construction documents (PDF)

-Pre-project biological assessment (PDF)

-2022 Monitoring Report (PDF)

-Photopoint and sections map (PDF)

-Spreadsheet with as-built profile and lots of other information (XLS)

-Spreadsheet with last surveyed (2017) profile (XLS)

-Spreadsheet with multiple years' cross sections (XLS)

I have also cc'd Nat Quek. Nat lead the monitoring for the last couple of years and can answer your question regarding the pin locations if the Photopoint and sections map isn't sufficient. She can also help decipher some of the monitoring results and let you know about access within the golf course.

Let us know if you have further questions. We look forward to your findings!

-Rich

Rich Walkling

Managing Principal/CFO | Restoration Design Group Inc. | O 510.495.6911 | 800 Hearst Avenue, Berkeley, CA 94710 | RestorationDesignGroup.com

-----Original Message-----

From: Ashley Jia Cao <ajcao@berkeley.edu>

Sent: Wednesday, October 25, 2023 2:06 PM

To: Rich Walkling <rich@rdgmail.com>

Cc: Carina Rose Valentine Swann <carinaswann@berkeley.edu>; Vermouth Li <vermouth@berkeley.edu>

Subject: Request for Tilden Park Golf Course Wildcat Creek Restoration Documents

[Quoted text hidden]

Carina Rose Valentine Swann <carinaswann@berkeley.edu> Tue, Oct 31, 2023 at 11:21 AM
To: Rich Walkling <rich@rdgmail.com>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>, Vermouth Li <vermouth@berkeley.edu>, Natradee Quek <Nat@rdgmail.com>

Hello Rich and Nat,

Last week our team went to the Wildcat Creek study area to see if we could find the cross sections marked by stakes. We possibly found one stake on the right bank of cross section two (images attached to this email). Is this one of the stakes? The areas where the cross sections were taken are overgrown making it difficult to see the banks and markers, and we were struggling to find any other stakes. We were wondering if any of them were removed and/or if there are any other markers that could point us to where the cross sections were taken? Are the stakes just straight wood or are they painted? Do you have any pictures of when the cross sections are set up during the surveying process? If you have any information that could help us find the cross sections we would appreciate it.

Thank you so much for your help,

Carina
[Quoted text hidden]

2 attachments

Screen Shot 2023-10-31 at 11.06.46 AM.png
2712K

Screen Shot 2023-10-31 at 11.07.01 AM.png
6832K

Natradee Quek <Nat@rdgmail.com> Tue, Oct 31, 2023 at 12:17 PM
To: Carina Rose Valentine Swann <carinaswann@berkeley.edu>, Rich Walkling <rich@rdgmail.com>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>, Vermouth Li <vermouth@berkeley.edu>

Hello Carina,

Our team had a similar issue last year. Many of the stakes are missing as it has been over a decade since the project was constructed. In fact, you will see in the 2022 report that we misaligned Cross Section 5.

This is an important lesson too, as stakes/rebar will not always reliably be there when you go out to monitor projects. The photo you took is definitely one of the stakes (in fact, I think it is one we missed!). I was not working for RDG when the stakes were set up but even if they were painted, it has likely faded. I could not find any photos of the stakes/cross section locations in our files.

It is worth taking some time to get your bearings on site. The golf course map is a little confusing but try to read the landscape based on the photopoints from last year, and locations of meanders in the creek channel and of golf course bridges. We picked up a golf course map from the front desk to take with us too. (Watch out for golf balls!) It is a little bit of a scavenger hunt at times and monitoring data is far from perfect, but we try to do our best! We usually have a machete with us to clear vegetation or have at least a team of 3 to bend/move vegetation aside. Know that willow is robust and can take a beating!

Hope this helps. Feel free to send over other questions you may have.

Best,

Nat

P.S. One thing I'm curious to know is how the golf course is managing the Limited Height Vegetation Areas. Would love to see some photos and we are happy to read over your report if you'd like.

[Quoted text hidden]

Carina Rose Valentine Swann <carinaswann@berkeley.edu> Tue, Oct 31, 2023 at 12:43 PM
To: Natradee Quek <Nat@rdgmail.com>
Cc: Ashley Jia Cao <ajcao@berkeley.edu>, Rich Walkling <rich@rdgmail.com>, Vermouth Li <vermouth@berkeley.edu>

Hello Nat,

That is very helpful! Thank you for all the information and ideas for best determining where the cross sections are. It's helpful to know that it's not going to be perfect.

We would really appreciate having someone read over the report once we have a draft! Thank you so much.

We would be more than happy to send photos over after our next field days. We will be going out on Thursday and Sunday this week and will definitely reach out if we have more questions.

Thank you,

Carina
[Quoted text hidden]