# Comparing the Costs of Three Stream Restoration Projects Constructed on Mill Creek between 2004 and 2007 in Lower Merion Township, Pennsylvania

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## *Abstract*

Three stream restoration projects were designed, permitted and constructed on private properties along the Mill Creek near Gladwyne, PA over a three year period. The projects addressed a wide variety of infrastructure and stream stability problems, with a range of bank stabilization and natural channel design techniques. Design and construction costs are compared and contrasted and the differences in costs between the projects are analyzed. Total consulting fees are presented as a percent of total construction costs and compared to industry averages for other civil engineering projects.

## *Background*

On August 1, 2004, heavy rains fell in southeastern Pennsylvania causing flooding in some areas, temporarily shutting down Philadelphia's Broad Street Subway and SEPTA's regional railways and trigging mudslides on portions of the Schuylkill Expressway. (DRBC, 2007) Along the Mill Creek in Lower Merion, Montgomery County, flooding causing severe bank erosion and destabilization. Three stream restoration projects were performed by F. X. Browne, Inc., to repair the damage from the storm. The projects were completed separately on individual residential properties along the Creek, between one and three miles from the confluence of the Schuylkill River.

### Project #1

The first project was to restore a 160 foot stretch of creek with severe incision and bank failure. The erosion was threatening the driveway that crossed over the creek and a large headcut was caused by a dam failure that occurred downstream during the storm. A gully had also formed on the right bank, just downstream of the driveway, which was destabilizing the bank in that area.

A number of stream restoration and stabilization measures were installed along the stretch of the Mill Creek. The section of the bank that was most severely eroded was also the area with the least vegetative cover. A boulder toe was installed along the length of the left bank in order to withstand the high velocities and shear stresses in that area. Above the boulder toe, a vegetated geo-grid was used to reduce the grade in that area and provide vegetation along the bank. In the area where the gully had developed, coconut fiber biologs were placed along the right bank to act as check-dams for runoff coming down the slope. Due to the full shade of the project area, a shade tolerant native seeding mix was used throughout the entire project. Approximately midway down the length of stream, a j-hook was used to direct the water flow back into the middle of the stream channel and away from the bank as well as to deepen the channel. Finally, a rock cross vain was constructed in the area of the headcut to stabilize that are and prevent the headcut from moving any further upstream.

Figure 1 shows the project area before and after the various stream restoration measures were installed.  The erosion on the left bank is very evident in the picture on the left.  The picture on the right shows the cross-vain and the geo-grid that were installed.

**Figure 1: Project #1 Stream Condition Before and After Construction**

Project #2

The second project area was 310 feet long and had the least amount of damage to the stream channel.  The main concern was that the existing masonry wall which supports the patio and pool area was being undermined by erosion and scour.

A concrete footer was constructed to stabilize the existing masonry wall.  Boulders were placed on top of riprap gabions set into the stream bank to the depth of maximum scour to stabilize the slope from the existing wall to the stream bank.  A rock J-hook was placed upstream of the masonry retaining wall and eroding stream bank in order to redirect the stream flow and move the thalweg away from the eroding bank and into the center of the channel.  This should cause the channel to deepen which will allow for energy dissipation.  Two additional J-hooks were constructed along the length of the stream to maintain flow in the center of the channel, away from the eroding banks.

Figure 2 shows the retaining wall and stream bank before the construction.  The wall was being undermined by during high flows and the banks had little vegetation to protect from erosion.  The picture on the right shows

**Figure 2: Project #2 Retaining Wall Before and After Restoration**

Project #3

The final project included the restoration of a 450 foot length of the Mill Creek. A gabion basket wall located upstream of a stone patio was preventing stream bank erosion along the eastern bank of the creek. The wall, however, was directing high flows toward the opposite bank and causing erosion in that area and undercutting areas exposing the roots of small trees. A patio juts into the stream channel only a few feet from the thalweg of the stream downstream of the gabion wall, causing large boulders to be deposited in the area. This has prevented the channel from deepening over time which has caused both banks down stream of the patio to be severely eroded.

A J-hook was installed at the upstream end of the patio area to relocate the thalweg to the center of the channel, reduce stress on the bank and deepen the channel for energy dissipation. A boulder toe was constructed along the eroded area on the left bank, across from the gabion wall and the slope was re-vegetated. Downstream of the patio, along the right bank, the stream bank was stabilized with a system of natural boulder toes placed randomly to create a natural appearance. Vegetated geo-grids were interspersed between the sections of boulder toe as well as above the boulder toe wall to reduce the grade in that area and re-vegetate the bank.

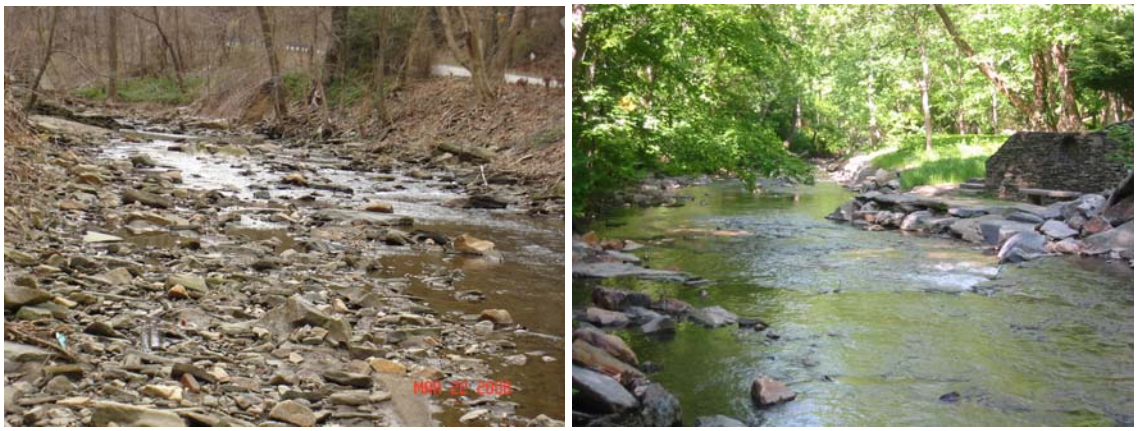

**Figure 3: Project #3 Before and After Stream Restoration**

## Consulting Fee Analysis

Consulting services for these projects included survey, hydraulic modeling, restoration design, permitting, construction observation and project management. Project #2 also included retaining wall stability analysis. For purposes of this report, the cost associated with the retaining wall stability analysis is included in the restoration design figure.

Table 1 shows the percent of the total design fee of each consulting service for the three projects.

| Consulting Service | Stream Restoration Project | | |
|---|---|---|---|
| | #1 | #2 | #3 |
| Survey | 15% | 17% | 14% |
| Hydraulic Modeling | 8% | 10% | 12% |
| Restoration Design | 31% | 33% | 38% |
| Permitting | 10% | 13% | 8% |
| Bidding Assistance | 8% | 10% | 7% |
| Construction Observation | 24% | 14% | 17% |
| Project Management | 5% | 4% | 4% |

**Table 1: Consulting Services as a Percent of the Total Consulting Fee**

While there is some slight variation of the percent of the total design fee per consulting service between the three projects, Figure 4 shows that the overall relationship between the services was the same for each project.

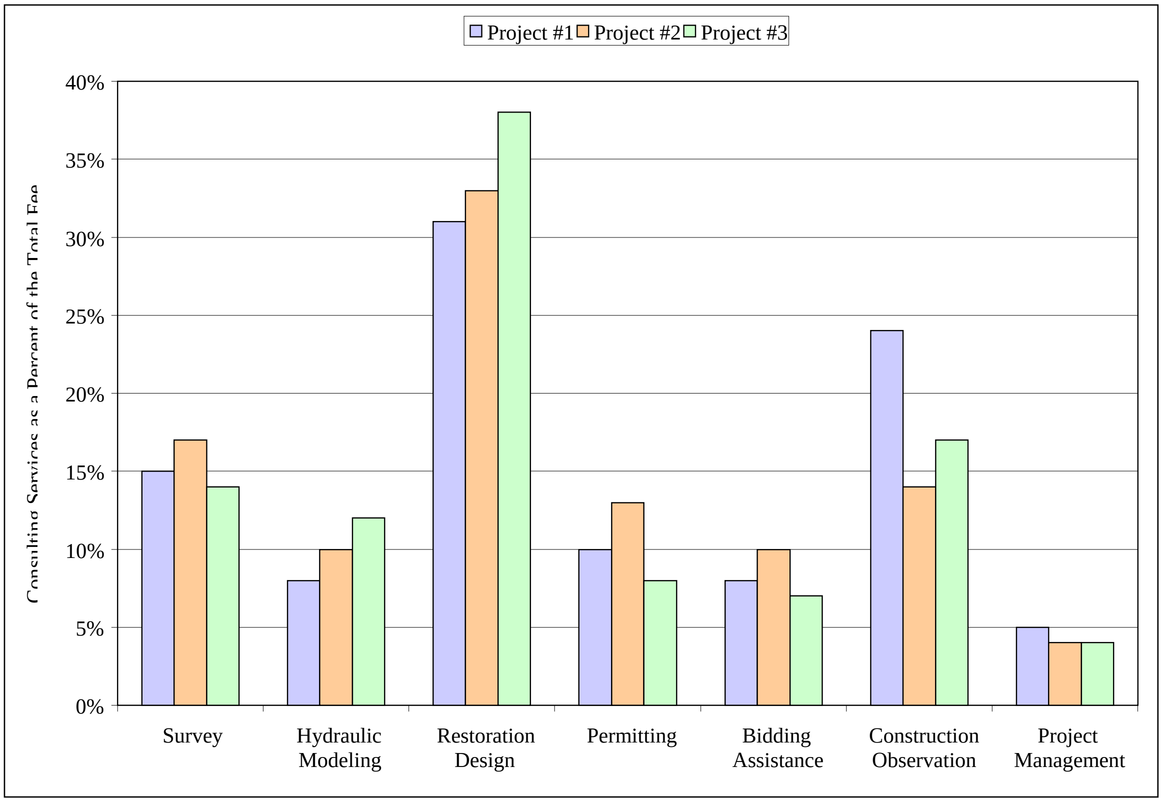

**Figure 4: Comparison of Consulting Services Fees by Percent of the Total Fee**

Overall, the percent of the design fee for each service was relatively equal, within a few percentage points. Construction observation varied the most, though this is likely due to Project #1 being the first stream restoration project completed by this design team and spending more time on site making sure that the construction was being performed per the specifications.

Table 2 presents the cost for each consulting service normalized per linear foot of stream.

| Consulting Service | Stream Restoration Project | | |
|---|---|---|---|
| | #1 | #2 | #3 |
| Survey | $9 | $5 | $7 |
| Hydraulic Modeling | $5 | $3 | $6 |
| Restoration Design | $20 | $9 | $19 |
| Permitting | $6 | $4 | $4 |
| Bidding Assistance | $5 | $3 | $3 |
| Construction Observation | $16 | $4 | $9 |
| Project Management | $3 | $1 | $2 |

**Table 2: Consulting Services Fee per Linear Foot of Stream**

When you look at the costs associated with each service per linear foot of stream, the fees are relatively equal. The restoration design category showed the most variation across the three projects. The fees per linear foot were almost exactly the same for Projects #1 and #3 but were about half for Project #2. Project #2, however, was the easiest design with the least amount of impairment and was more of an infrastructure protection project than a stream restoration project.

When you look at the permitting fees as a percent of the overall fee, Project #3, the longest of the three projects, had the smallest percentage of permitting fees. For this project, an emergency permit was obtained, which probably resulted in lower overall costs. Looking at the normalized costs, the emergency permit seems to have less of an effect on the cost. The permitting for the first project was the most expensive but it was also the most complex project. The second and third projects probably also benefited from having been through the permitting process in the same county and township for the first project and having the experience with the process and permitting agencies.

Permitting appears not to be as length dependent as it is on the complexity of the project. Hydraulic modeling, however, should be more length dependent than Table 2 suggests. Again, this may be due to Project #2 being less of a stream restoration project and more of an infrastructure stabilization issue which requires less stream modeling. Bidding assistance, construction observation and project management seem to have some length dependency but appear to be more dependent on the complexity of the project as well as the benefit of the learning curve as more projects are completed.

### ***Design Fees vs. Construction Costs***

Typically, the rule of thumb is that consulting fees for engineering services are approximately 10% of the total construction costs. Stream restoration projects, however, can be very complex when it comes to permitting issues, intensive modeling requirements, and an iterative design process. The Stream Habitat Restoration Guidelines in Washington State suggest that the design fees for habitat restoration projects generally range from 15 to 50% of construction costs. They noted that this is higher than that for traditional civil engineering works mainly due to the same analysis being required whether the project is large or small which means that the percentage of construction cost will be larger for smaller projects as well as that habitat restoration projects are very site specific and it is generally not possible to apply designs used on previous projects to new ones. (Saldi-Caromile, 2004) One study looking at stream restoration cost estimates found the planning, design and permitting fees for stream restoration projects to be between 45 and 114% of the construction costs when estimated per river mile. (Bair, 2000)

For this study, the total consulting fees for the three projects were compared against the total project costs as shown in Table 3 below.

| Project | Total Consulting Fees | Total Construction Costs | Percentage |
|---|---|---|---|
| #1 | $10,900 | $35,441 | 31% |
| #2 | $8,700 | $82,609 | 11% |
| #3 | $23,500 | $93,525 | 25% |

**Table 3: Consulting Fees as a Percentage of Construction Costs**

As the research suggested, the design fees were higher than the typical 10% of the construction costs. Project #1 and #3 were 25 and 31% of the total construction cost while Project #2, which involved less stream restoration design, was close to the estimated 10% for typical engineering projects.

### *Conclusion*

This analysis of stream restoration projects found that the costs associated with consulting services were higher, when compared to the overall construction costs, than for typical civil engineering projects. This is due to the iterative nature of the design development and the complexity of the permitting process. Some services, such as restoration design, can be normalized per linear foot of stream, while others, such as permitting, depend more upon the complexity of the project and are relatively independent of length. This analysis also highlighted the benefit of having done similar work on the same stream, as the subsequent projects benefited from the familiarity with the watershed and knowledge of the local permitting processes.

### *References*

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