2016

Museum of Northern Arizona Meadow Riparian Habitat Enhancement Proposal

GREEN GREY ENGINEERING

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1.0. Introduction

1.1 Background

The Museum of Northern Arizona has proposed a project to restore the Riparian Spring Habitat closely surrounding Coyote Springs and to improve the accessibility for the residents of the Peaks. The Peaks is a senior community that houses senior citizens, some with disabilities. That being said, any proposed ramps and sidewalks must follow the 2010 Americans with Disabilities Act (ADA) guidelines. The Museum hopes to promote plant diversity and preserve the cultural heritage sites while making the area more accessible for the community. Further technical considerations will include: removing old concrete infrastructure and piping, increasing the meandering channel and wet meadow habitat, and providing an environmentally appropriate trail to conduct on appropriate wetland vegetation land.

Figure 1- Current location using GIS map

Coyote Springs is located on property owned by the Museum of Northern Arizona (MNA). In order to access to the springs the commuter must park in The Peaks (a senior living community), which is near the Museum of Northern Arizona's research facility. Coyote Springs is one of the last natural functioning springs in the San Francisco Peaks area. Currently, there is a dirt trail leading from the street to the spring with an elevation of approximately 7,067 ft.

Therefore, the main objective is to create an ecologically friendly and aesthetically pleasing design that will replace the current conditions on the site location. This new design will improve the accessibility to Coyote Springs without removing an excess of the natural and cultural habitat. To that end, it will become a common gathering place for the residents of the Peaks and the citizens of Flagstaff.

1.2 Organization

The major tasks for this project are shown in Appendix A. Green Grey Engineering created a semester schedule to ensure that each of the necessary tasks could be completed in the allotted time. This can be seen in Appendix B, along with a corrected schedule. Corrections were made because water testing was seen as unnecessary and more survey work of Coyote Springs needed to be conducted. The predicted hours, along with a final amount of time spent per task are shown in Appendix C.

2.0. Methods

2.1 Field Evaluation

2.1.1 Existing Conditions Evaluation: Figure 2 below shows the general conditions of the surrounding habitat. There also seems to be a flourishing community of wildlife that shares

Figure 2- Existing Conditions

ecological values: indigenous vegetation, reptiles, insects, and birds living in the surrounding location.

2.1.2 Pathway Surveying: On the site there is a pathway that starts from the parking lots of The Peaks that leads down to connect to Flagstaff Urban Trail, which is next to the N Fort Valley Road (as shown in Figure 3). The width of that pathway varies between 5.7 ft. and 6 ft. and there are some shrinkages and cracks on the sides of the pathway. The surface material that is used is asphalt. As the pathway was inspected, some steep slopes were noticed that don't meet ADA standards (like the one that is in Figure 4). There is also an old, unstable bench (shown in Figure 5) that needs to be assessed.

Figure 3- Pathway main focus in red

Figure 4- Non ADA compliant section

Figure 5- Existing pathway bench

2.1.3 Channel Surveying: The team surveyed points from the spring box down to the southern end of the site. These points include the steam reaches and can be seen in Appendix D. Figures 6 and 7 show a comparison to the existing conditions of the spring box during two different time periods and weather conditions.

Figure 6- spring box flow in fall 2015 with door

Figure 7- Spring box flow in spring 2016 without door

2.2 Software

2.2.1 AutoCAD: To prepare a map of the existing topography, survey data was input into AutoCAD Civil 3D 2016 Imperial. The team used the map to determine critical design factors, such as ADA requirements for the pathway and stream placement. The site map displays the existing topography is shown in Appendix D. AutoCAD will also be used to create alignments and show typical cross sections for the proposed pathway and stream designs in order to assist the future constructability of the designs.

2.2.2 Sketchup: Sketchup is a 3D design program that transfers visual ideas into 3D models and shape physical world to the project. Therefore, Greengrey Engineering began with AutoCAD software as a base then attached coordinates of the project location to start a two-step process on Sketchup. The first step was to create a "before" development with the existing conditions; the second step was the after results: alternative possibilities implementation designs. (As can be seen below in Figures 9 and 10, thus leading to the final project proposal).

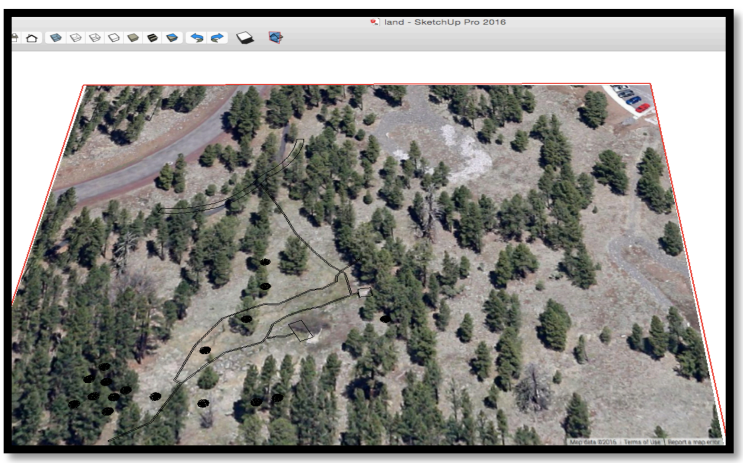

Figure 8- Location and surveyed points pinned out

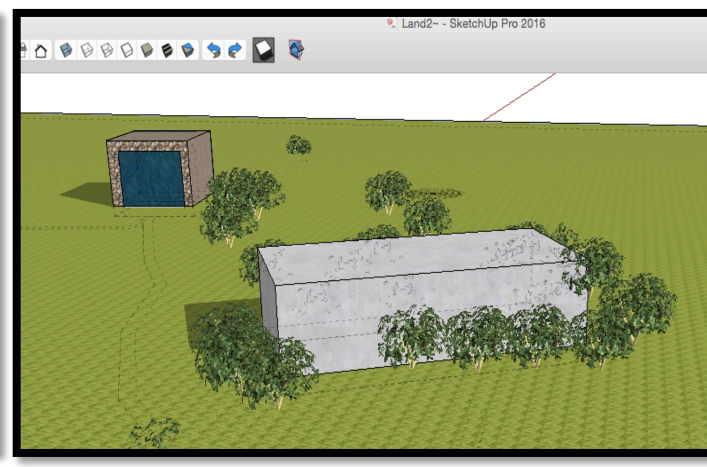

Figure 9- Basic visual overview of the spring box and concrete structure

2.3 Photo-Trapping Evaluation

Greengrey Engineering proposed to adopt the Smithsonian Tropical Research Institute Center for Tropical Forest Science protocol. The Smithsonian uses camera-trap surveys of mammals to outline the procedures for medium to large sized mammals in order to collect data on the identity and potential interaction these mammals have with the vegetation that is being monitored [1]. After analyzing the current conditions on the coyote spring location and collecting information from the Spring Stewardship Institute (SSI)--which reports the sight of mammals such as deer, moose and coyotes—(figures 11 and 12 are examples of how the Smithsonian method is proved to be a reliable source and successful method to configure), Greengrey Engineering's adopted the Smithsonian method to use two sensor cameras at the current site location. The cameras were placed in the outer Eastern and Western outer limits—resulting in the capture of mule deer, feral cats, raccoons and black jackrabbits.

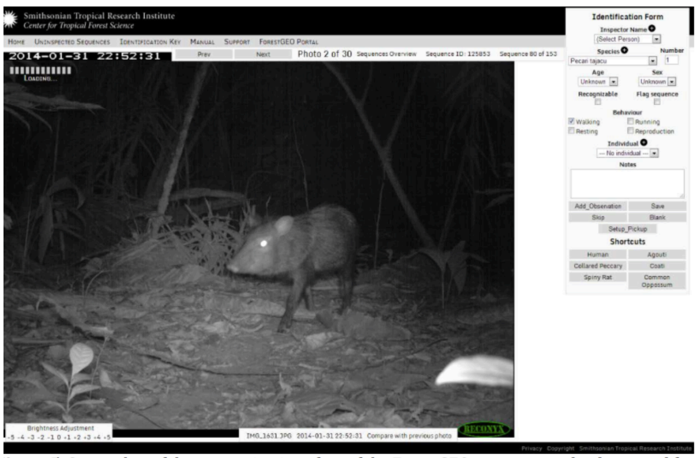

Figure 10- Photo trapping example

Figure 11- Coyote Springs spots three mule deer onsite

3.0. Design Concepts

3.1 Hydrology

3.1.1 Spring Box: After further inspection of the spring box, one of the biggest issues at risk was the open-air exposure. The door-less spring box leaves a constant open risk for water contamination--ranging from animal feces to dead animals to mosquito's nests harvesting inside the spring box. Therefore, Greengrey Engineering decided on creating a strong new exterior for spring box. This exterior includes a transparent door made from polymer smart glass that's durable and tough, and will also give access to monitor the inside. Also, there will be an easy access frame with a heavy pull (for security purpose) placed on the door that can give necessary accessibility (as seen in Figure 12 on the following page).

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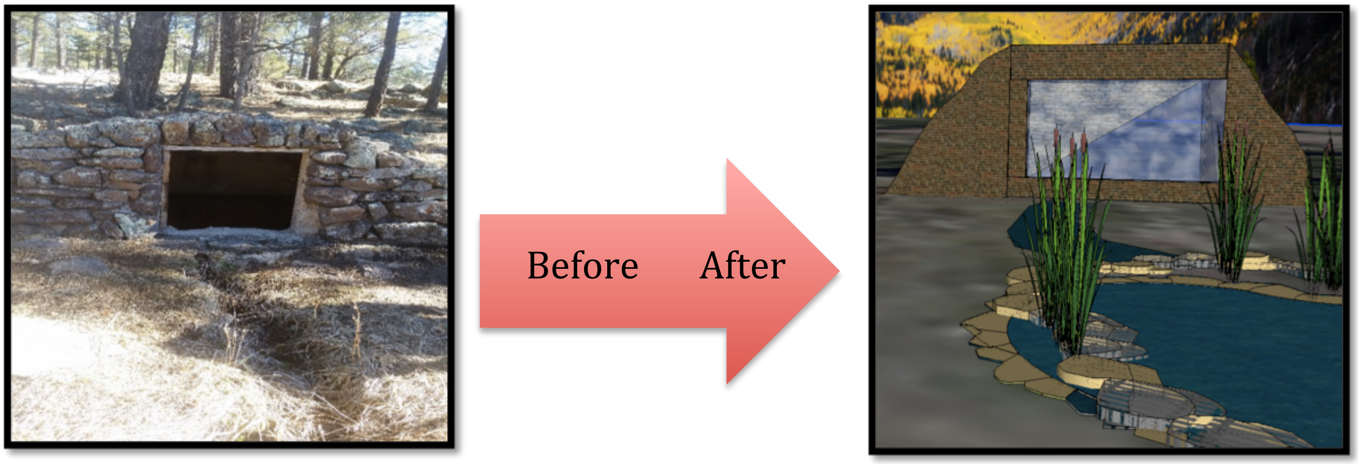

Figure 11- Before & after door design

3.1.2 Channel Morphology: For the stream design, a few assumptions had to be made. First, since the existing stream reaches had varying widths and depths, the team assumed a typical cross-section to be 1ft wide and 1ft deep. Second, the effluent from the concrete box was assumed to be coming from an existing, unknown spring. The proposed stream design involves increasing the stream's footprint in order to create a riparian wetland, and to also increase the sinuosity of the stream. Sinuosity is calculated by dividing the stream length by the valley length. The proposed plan showing the current status of the stream design is shown in Appendix E. The hatched areas show the roughly 489ft of proposed stream to increase the riparian wetland aspect. The existing sinuosity is 1.06 ft/ft, (which represents a straight stream). The proposed sinuosity will be 1.22 ft/ft, (which represents a winding stream). The proposed design is effective in increasing the stream's footprint and the sinuosity.

3.1.3 Concrete Removal-Pond: According to our main client, Dr. Larry Stevens, there are studies proving that the concrete block serves no purpose anymore for Coyote Springs. Therefore, Greengrey Engineering consulted the situation with Dr. Darell Kaufman, a Northern Arizona University earth scientist, for further information. According to Dr. Kaufman, because of the box's location and position, there is a steady flow of water seepage within the concrete and by demolishing the block of concrete, a steady still water pond is predicted to be within its position. Therefore, Greengrey designed a small natural pond that blends with the current environment (figure 14 on the following page shows an optional solution created through sketchup).

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Figure 12- The current site location with the concrete box

Figure 12- A possible solution of replacing the concrete box with a still pond

3.2 Pathway

To improve the accessibility of Coyote Springs, Greengrey is proposed a pathway be installed in the place of the existing dirt trail (Appendix D) running from the asphalt sidewalk to Stream Reach B. The plan view layout can be seen in Appendix E. The pathway will be 184ft x 5ft and will be composed of Decomposed Granite (DG) with an estimated volume of about 250ft^3. DG was chosen for this design due to several factors: ADA compliance, aesthetic value to the site, cost, permeability, and maintenance. A detailed decision matrix can be seen in in table 1 below. Figure 13 shows a typical section of the proposed pathway, including the DG thickness, anchor boards, and anchor stakes. The anchor stakes will be installed in 4ft increments on center and on the outside end of the header boards.

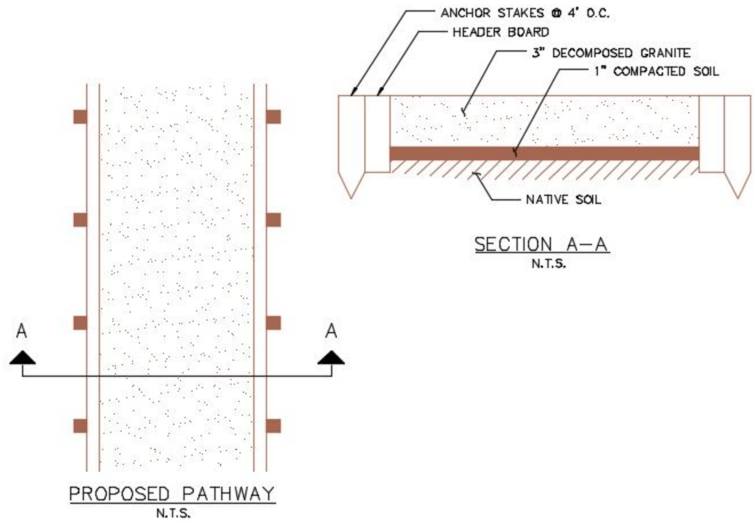

Figure 13- Plan and section view of proposed pathway

Table 1- Pathway material decision matrix

Criteria	D.G.	Asphalt	Concrete
ADA	6	8	9
Cost	($8 square ft) 4	($2.87 square ft) 6	($3.25square ft) 8
Aesthetics	9	1	4
Environmental Impact	9	3	5
Total Score	28	18	26

3.2 Education

3.3.1 Warning Signs: From monitoring the location, it has been noted that bicyclists enter the center of the field destroying the vegetation and creating a dark trail because of the continuous action over a period of time. Therefore, in order to preserve the current trail and locations, it's very important to install a No Bicycle Sign. Since this a privately owned land site, Greengrey proposes to MNA to install a no bike sign in the near future.

Figure 14- Example of a clear No Bike sign

3.3.2 Education Flip Signs: The current location has a wide range of visitors: the residents of the peaks, the researchers from MNA, school field trips, and the general public of Flagstaff. Therefore, a more broad solution for education is to install a podium chained with laminated information. This information would include facts about the area and history of Flagstaff, and would benefit all visitors (see Figure 16 as an example).

Figure 15- Example of an Educational flip sign

3.3.3 Educational Section Website: Greengrey Engineering will be posting a separate education section on the project website, where it will include easy access to documents and facts collected on the location, site and history of Coyote Springs, and free public access to citations and references of the information.

Figure 16- Section on the website

4.0. Discussion

4.1 Exclusions

Greengrey will not provide any of the following services:

- New geotechnical studies will be conducted
- New vegetation survey
- Hydraulic models will be designed
- Water quality testing will be conducted

4.2 Cost of Engineering Services

The engineering services for this project were divided into four categories: Project Manager, Software Engineer, Lab Technician, and Design Specialist. Table 1 and 2 show the tables for predicted and actual cost for the engineering services. An estimated total of $27,000 was saved from the predicted cost.

Table 2- Predicted engineering services cost

Classification	Billing Rate $/hr	Hours	Cost ($)
Project Manager	114	172	19,677
Software Engineer	91	380	34,485
Lab Technician	48	120	5,775
Design Specialist	31	40	1,254
Personnel Total		712	61,191

Table 3- Actual engineering services cost

Classification	Billing Rate $/hr	Hours	Cost ($)
Project Manager	114	103	11,783
Software Engineer	91	176	15,972
Lab Technician	48	110	5,294
Design Specialist	31	32	1,003
Personnel Total		421	34,052

4.3 Cost of Implementing Design

The total cost for design implementation is shown below in Table 3. It is recommended that the special cleaning and the maintenance be sub-contracted to another group. General requirements include the cost to install the DG pathway and replace the spring box door. Excavation and demolition refer to the work that will need to be completed to remove the concrete box and dig out the space for the stream and the pathway. The final cost of implementing the design comes out to an estimated $12,561.

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Table 3- Cost of design implementation

DIV	Discription	Materials	Equipment	Subcontract	Cost/SF	Line Total
1	General Requirements	$700	$3,000		$30	$3,730
2	Excavation			$4,330	$2.92	$4,333
3	Demolition			$700	$20	$720
4	Speical Cleaning			$1,000		$1,000
5	Maintanence			$400	$0.44	$400
Sales Tax	4.95%	$34	$148.50	$287	$1.73	$471.23
Contingency	20%	$140	$600	$1,160	$7	$1,907
Totals		$874	$3,749	$7,247	$44.62	$12,561

5.0. Impacts

In order to display the positive impacts that this project will provide to the Flagstaff community, Table 4 was created. This table includes the elements of the triple bottom line (TBL), which is a measure of the environmental, social, and economic impacts of a project. By analyzing the table, it is apparent that this project will positively affect Coyote Springs and the surrounding area.

Table 4- TBL impacts of design

Environmental	Social, Health & Cultural	Economic
Reduce Water Pollution	Promote recreational activities	Increase the nearby property value
Low damage to vegetation	Increase levels of tourism	Low maintenance cost
Promote plant diversity	Enhance educational experience	Low design construction cost
Low soil erosion and compaction	Preserve culture heritage	Expand small business growth

6.0. Conclusion

Greengrey Engineering has determined that the Museum of Northern Arizona has a few problem areas that need special attention. These areas include the repair of asphalt pathways, the spring box door, the channel morphology, and the new decomposed granite dirt trail. The design document that has been prepared assesses all of the design problems for this project. Upon implementing this design, the surrounding community will gain a positive space to gather and the proper function of the stream and wildlife habitat will be promoted.

6.0. Acknowledgements

GreenGrey Engineering team would like to express our sincere profound gratitude to our client, Dr. Larry Stevens, from the Spring Stewardship Institute. Without him this project would not be possible. Thank you to Professor Wilbert Odem, Ph.D., PE for providing regular and useful suggestions to improve upon this important process for our academic careers. Our team is very appreciative of your supervision and technical advising throughout your tenure for this particular project. The team is grateful to FALA high school environmental sciences Emily Bell and STEM coordinator Mindy Bell, for continuous guidance and cooperation to make this work proficient and successful. Many thanks to those who helped our team directly or indirectly in completion of this project report. We are successful because of you.

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7.0. References

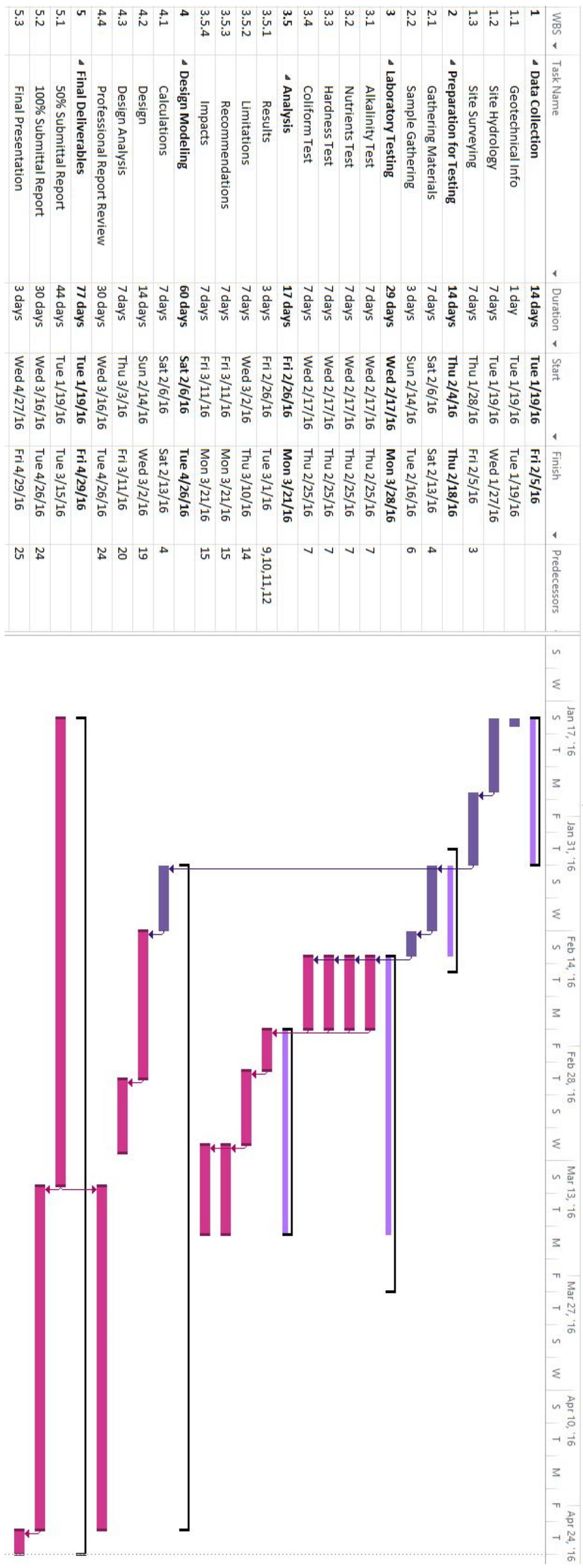
[1] P. Jansen, T. Forrester and W. Mcshea, "Protocol for camera-trap surveys of mammals at CTFS-ForestGEO sites", 2014. [Online]. Available: http://Protocol for camera-trap surveys of mammals at CTFS-ForestGEO sites. [Accessed: 10- Mar- 2016].

[2] Flagstaff.az.gov, 2016. [Online]. Available: http://www.flagstaff.az.gov/DocumentCenter/Home/View/14708.

Appendix A: Major Project Tasks and Sub Tasks

WBS	Task Name	Finish
1	**Data Collection**	**Fri 2/5/16**
2	**Methods**	**Thu 4/14/16**
2.1	Field Evaluation	Thu 4/14/16
2.2	Photo-Trapping	Fri 3/11/16
3	**Design Modeling**	**Tue 4/26/16**
3.1	Hydrology	Thu 3/10/16
3.2	Pathway	Thu 3/10/16
3.3	Software	Tue 4/26/16
3.5	Education	Mon 3/14/16
4	**Analysis**	**Fri 4/29/16**
4.1	Cost	Fri 4/29/16
4.2	O & M	Fri 4/29/16
4.3	Final Review	Fri 4/29/16
5	**Final Report & Website**	**Thu 5/19/16**
5.1	Final Presentation	Mon 5/16/16

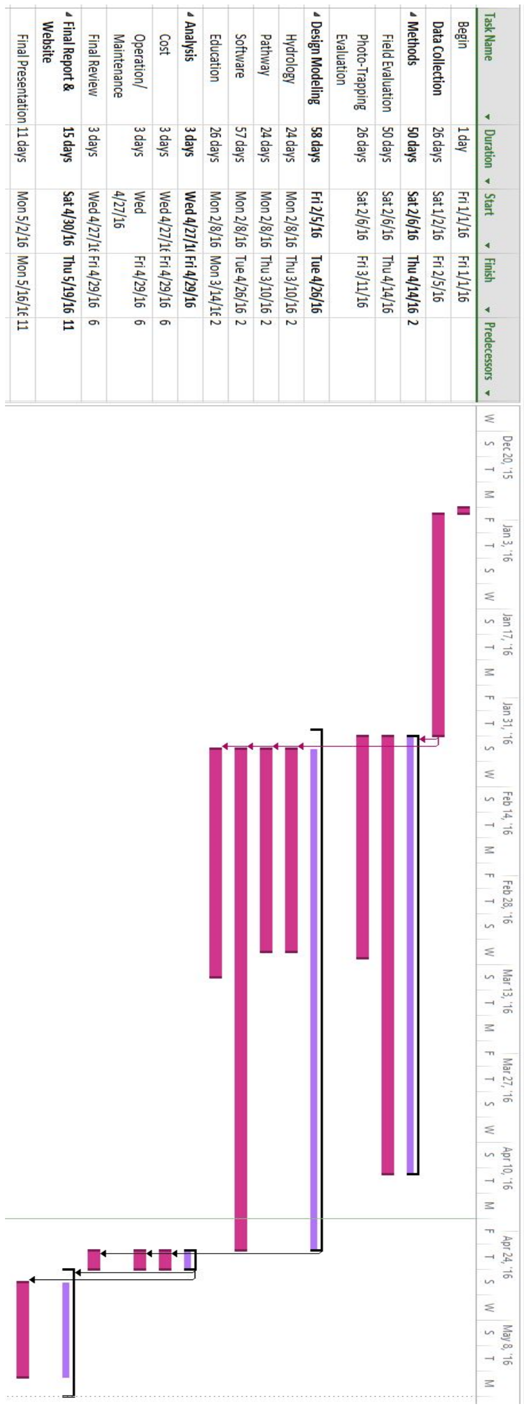
Appendix B: Initial and Final Project Schedule



WBS	Task Name	Duration	Start	Finish	Predecessors
1	**Data Collection**	**14 days**	**Tue 1/19/16**	**Fri 2/5/16**	
1.1	Geotechnical Info	1 day	Tue 1/19/16	Tue 1/19/16	
1.2	Site Hydrology	7 days	Tue 1/19/16	Wed 1/27/16	
1.3	Site Surveying	7 days	Thu 1/28/16	Fri 2/5/16	3
2	**Preparation for Testing**	**14 days**	**Thu 2/4/16**	**Thu 2/18/16**	
2.1	Gathering Materials	7 days	Sat 2/6/16	Sat 2/13/16	4
2.2	Sample Gathering	3 days	Sun 2/14/16	Tue 2/16/16	6
3	**Laboratory Testing**	**29 days**	**Wed 2/17/16**	**Mon 3/28/16**	
3.1	Alkalinity Test	7 days	Wed 2/17/16	Thu 2/25/16	7
3.2	Nutrients Test	7 days	Wed 2/17/16	Thu 2/25/16	7
3.3	Hardness Test	7 days	Wed 2/17/16	Thu 2/25/16	7
3.4	Coliform Test	7 days	Wed 2/17/16	Thu 2/25/16	7
3.5	**Analysis**	**17 days**	**Fri 2/26/16**	**Mon 3/21/16**	
3.5.1	Results	3 days	Fri 2/26/16	Tue 3/1/16	9,10,11,12
3.5.2	Limitations	7 days	Wed 3/2/16	Thu 3/10/16	14
3.5.3	Recommendations	7 days	Fri 3/11/16	Mon 3/21/16	15
3.5.4	Impacts	7 days	Fri 3/11/16	Mon 3/21/16	15
4	**Design Modeling**	**60 days**	**Sat 2/6/16**	**Tue 4/26/16**	
4.1	Calculations	7 days	Sat 2/6/16	Sat 2/13/16	4
4.2	Design	14 days	Sun 2/14/16	Wed 3/2/16	19
4.3	Design Analysis	7 days	Thu 3/3/16	Fri 3/11/16	20
4.4	Professional Report Review	30 days	Wed 3/16/16	Tue 4/26/16	24
5	**Final Deliverables**	**77 days**	**Tue 1/19/16**	**Fri 4/29/16**	
5.1	50% Submittal Report	44 days	Tue 1/19/16	Tue 3/15/16	
5.2	100% Submittal Report	30 days	Wed 3/16/16	Tue 4/26/16	24
5.3	Final Presentation	3 days	Wed 4/27/16	Fri 4/29/16	25

Initial Gantt chart

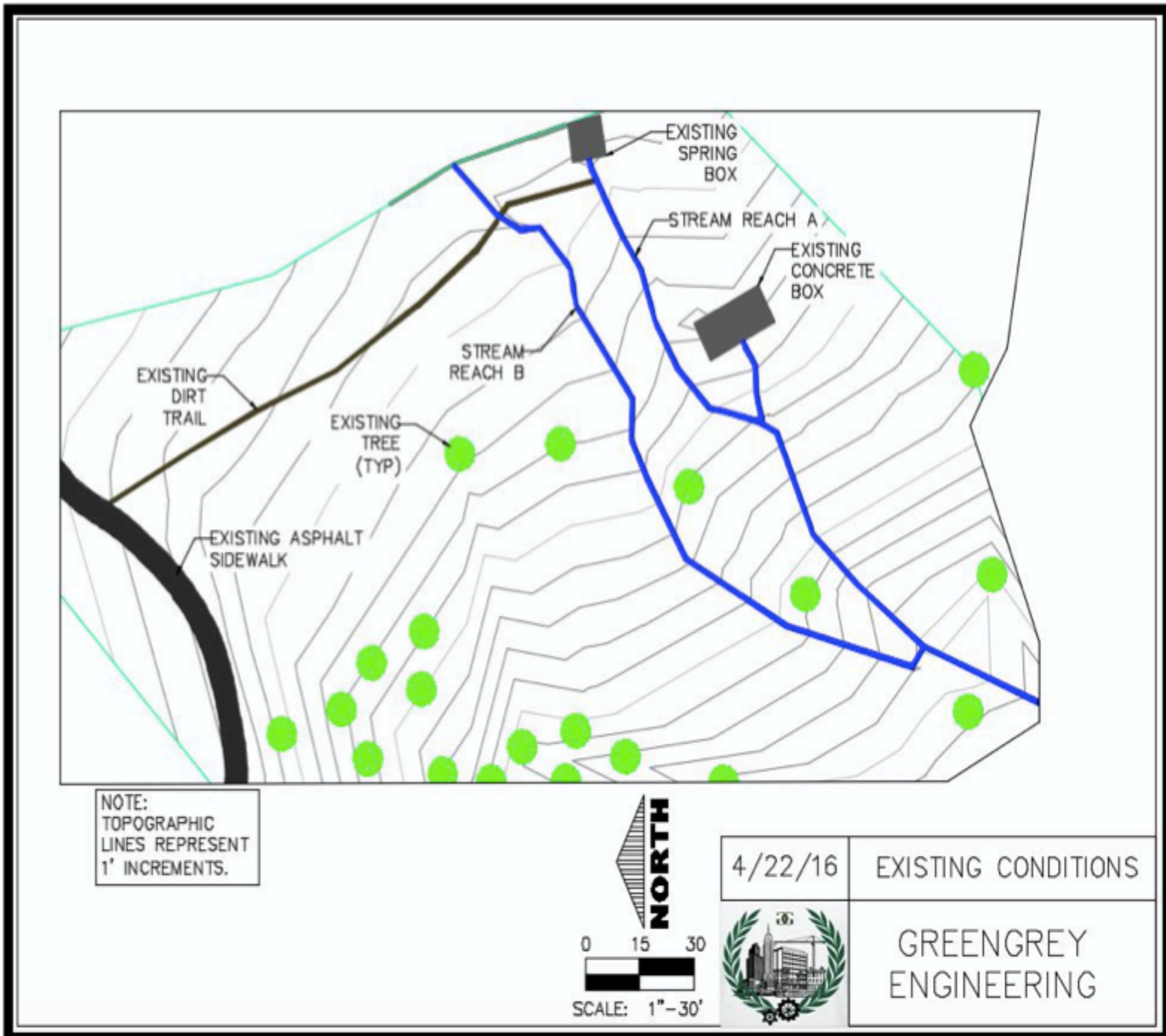
Appendix C: Proposed and Final Hours



Task Name	Duration	Start	Finish	Predecessors
Begin	1 day	Fri 1/1/16	Fri 1/1/16	
Data Collection	26 days	Sat 1/2/16	Fri 2/5/16	
Methods	50 days	Sat 2/6/16	Thu 4/14/16	2
Field Evaluation	50 days	Sat 2/6/16	Thu 4/14/16	
Photo-Trapping Evaluation	26 days	Sat 2/6/16	Fri 3/11/16	
Design Modeling	58 days	Fri 2/5/16	Tue 4/26/16	
Hydrology	24 days	Mon 2/8/16	Thu 3/10/16	2
Pathway	24 days	Mon 2/8/16	Thu 3/10/16	2
Software	57 days	Mon 2/8/16	Tue 4/26/16	2
Education	26 days	Mon 2/8/16	Mon 3/14/1	2
Analysis	3 days	Wed 4/27/1	Fri 4/29/16	
Cost	3 days	Wed 4/27/1	Fri 4/29/16	6
Operation/ Maintenance	3 days	Wed 4/27/16	Fri 4/29/16	6
Final Review	3 days	Wed 4/27/1	Fri 4/29/16	6
Final Report & Website	15 days	Sat 4/30/16	Thu 5/19/16	11
Final Presentation	11 days	Mon 5/2/16	Mon 5/16/1	11

Actual Gantt chart

Appendix D: Site Map with Stream Reaches



Appendix E: Stream Design Status