KUAE Consulting Engineers Proposal

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Fall 2016

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1.0 Project Understanding

1.1 Project Purpose

The purpose of this project is to improve the current condition of some reaches in the stream, and assess the main issues in the stream including the infrastructures. Furthermore, to provide a solution to city of Flagstaff to enhance the wash and to make it efficient. The project will focus on the implementations of low impact development to manage the peak flow in runoff conditions, and to enhance the quality of water.

1.2 Project Background

1.2.1 Location

Sinclair Wash is one of the largest stream washes in the city of Flagstaff. The wash runs for over 7 miles through the city. It starts near Woody Mountain and ends near Fort Tuthill Park. The wash passes both rural and urban areas of the city of Flagstaff, which gives it its varied nature. The wash goes through open grassland and Ponderosa pines then further east the wash goes through commercial areas near Woodland Village in Flagstaff and runs also through the campus of Northern Arizona University (NAU). The highest elevation in the wash is 6988 ft. and the lowest point is 6805ft. [1][2]

1.2.2 History

Over the past few years, Sinclair wash went through major modifications in its original alignments and removed the vegetation due to the new installations of city utility lines like sewage or reclaimed water. These modifications made some reaches in the Wash not efficient any more. Some reaches of the wash over the past few years have been flooded many times. The flooding in the reaches was due to the modifications made on the reach, and because of the poor design of some reaches like the reach that passes through NAU campus. Due to the lack of data, it was hard to predict flooding in the wash on the annual precipitation at the location of the wash. Data recording in the wash did not start until 1969 when a study started by the US Geological Survey (USGS) to collect data for areas near Flagstaff. [2][3]

1.2.3 Current conditions

The function of the channel currently is less efficient due to the extension of urban developments near some reaches of the wash. In addition, the channel modifications for city utilities improvements made by the city of Flagstaff lowered its efficiency. One of the issues associated with the wash, especially in reaches that are near NAU campus is the high speed of stream water, which is causing erosion on the other side of the wash. Several attempts were made by NAU to decrease the speed of the water by putting blocks in the bottom of the wash. However, the sediment transported by the stream made the blocks inefficient by filling the gaps between the blocks. The wash could not be efficient due to poor maintenance of the infrastructures in some reaches. The current situation of the wash would lead to more flooding during big storm events, which needs to be under immediate consideration because of the Flagstaff weather. The wash

currently serves only as a conveyance for storm water, but the city of Flagstaff wants to add and enhance other uses of the wash. The city is planning to add a recreational opportunity along the reaches of the wash, also, it wants to improve the wildlife habitat near the wash. [1][5][6]

1.2.4 Low Water Crossing

Along some reaches of the Sinclair wash, there are many low water crossing areas. The low water crossing areas along the wash show signs that these areas need to be redesigned due to sediment depositing and poor maintenance of the crossings. Low water crossing along Sinclair wash will be assessed by the team to design a better low water crossing system that handle the flood events in Flagstaff, and overcome the current issues with the low water crossing in the wash. [7]

1.2.5 Wildlife and Vegetation

Due to the variety in the Sinclair wash, the wildlife and vegetation vary from one section of the wash to another. Some reaches near NAU campus tend to have less wildlife habitat because of the heavy use by students all the year but there is still wildlife and vegetation in those sections of the wash and need to be preserved. Moving to the rural sections of the wash, there is a variety of wildlife and vegetation because of the low human access to these areas. The wildlife along the wash includes some species of animals like squirrels, elk, birds and other species like bats. The vegetation in the wash varies from Ponderosa pine to small flowers. The overall condition of the wildlife and vegetation in wash is fair in some reaches, and in some other reaches needs enhancement. [4] [2]

1.3 Technical Considerations

Technical considerations required for the project will be discussed in this section. It does define the work the team committed to do for the project. Technical work will be assigned between team members based on member's qualifications and experience, furthermore the work distribution will guarantee work will be done on time. The technical work needed for the Sinclair wash feasibility study will be detailed below.

1.3.1 Filed Evaluation

Team members will conduct several filed visits to certain reaches of the wash. Filed visits will focus on unhealthy reaches of the wash based on Dr. Odem's (Project Grading Instructor) and

Mark Lamer's (Project Technical Advisor) recommendations of unhealthy reaches to assess the conditions of these reaches. The importance of the in-field evaluationis to collect data, information and pictures about the reaches. The data collection will help in selecting the proposed work area and will help in establishing a proposed design solution for the Sinclair wash.

1.3.2 Selecting Work Area

After the in-field assessment and data collecting, the grading instructor and the technical advisor will select the reaches that the team will be working on for an intensive study of the chosen reach.

1.3.3 Surveying

Surveying the proposed work area will be useful for the wash hydraulics study. The team will collect survey data for the proposed reaches. The data collected from land surveying include measurements of land physical features, land boundaries and angle measurements. The data will help creating a topography map of the reaches to create 3 dimensional points so they can be imported to computer software for analysis. The capstone team that worked on the wash previously in fall 2015 surveyed Sinclair wash.

1.3.4 Hydrological analysis

The U.S. Geologic Survey (USGS) conducted a hydrological analysis of the Sinclair wash. The data found on the analysis will be helpful in estimating current runoff, estimating the 10, 50 and 100-year flood, peak discharge, and other stream data. The hydrological analysis will help in the solution for the unhealthy reaches.

1.3.5 Hydraulics analysis

The hydraulics analysis is a critical analysis in designing a solution for the unhealthy reaches. The hydraulics analysis will include the calculation of current velocity, head losses and other flow features to identify the hydraulics reasons behind making the wash not as functional as it was designed for. The hydraulics analysis will be conducted using computer software like HEC-RAS or any other software based on the project instructor's or technical advisor's recommendations.

1.4 Potential Challenges

A major challenge in the project at this stage is surveying the wash and collecting accurate data. The surveying is a challenge because of snowy weather of Flagstaff, which could affect the data accuracy or make it difficult to collect the data. In order to avoid the weather obstacle, team decided to do the surveying work as soon as possible before snow season starts in northern Arizona. Lack of data of the wash is another challenge for the team. The data includes the runoff, velocity, and other stream characteristics that are essential to get the calculations accurate for the design.

1.5 Stakeholders

The stakeholders for this project include city of Flagstaff, Northern Arizona University, Coconino County, Arizona Department of Transportation, Arizona Game and Fish Department and the Community of City of Flagstaff. The City of Flagstaff will be affected by this project economically and environmentally. The City of Flagstaff will be the responsible party for funding the project if the design is approved, also the city environment level will increase due to the enhancement of the Sinclair wash. Since some reaches of the wash cross the campus of NAU, the university will be effected by this project by having some areas of campus closed temporarily during the construction of the new design. Sinclair wash is under the Coconino County, which is responsible for the Sinclair wash land and the condition of the wash. Arizona Department of Transportation will be affected by the project because many roads under the department cross the wash and may be affected by the proposed design. Arizona Game and Fish department will be affected by the enhancement of the natural habitat of the wildlife and vegetation in Sinclair wash. Finally, the Community of Flagstaff will be affected by the proposed recreational opportunities along Sinclair wash.

2.0 Scope of Services

Technical and non-technical tasks detailed below will be performed by the KUAE engineers, to meet our client's need for the Sinclair wash project. All technical tasks discussed in the scope of service will be completed by the scheduled due dates for each task. Tasks that are listed in the exclusions will not be part of KUAE work toward Sinclair wash project.

2.1 Field

2.1.1 Sinclair Wash Site Visit

KUAE will visit parts of Sinclair wash in order to have a general idea of Sinclair wash, and provide initial design alternatives. The visit will include reference reaches of the wash and reaches with problems to compare and understand the wash conditions.

Deliverable: Memo; reaches identified on map.

2.1.2 Sinclair Wash Documentation

During the visit, team will take pictures of some areas of Sinclair wash to document the current situation, current vegetation status, and the level of recreational opportunities in the wash. Furthermore, the visit will be documented for future reference or future work by the team.

Deliverable: Photo documentation and a memo on the visit.

2.1.3 Assessment of Infrastructure

In some reaches of Sinclair wash, the infrastructure will be identified and evaluated. The infrastructure includes culverts, low crossing bridges, pipes, manholes and other infrastructure found in the wash. The evaluations of the infrastructure will help analyzing the current function of the wash and issues in the wash and provide initial design alternatives.

Deliverable: Photo documentation, a memo on the visit and identification of infrastructure locations on map.

2.2 Data Collection

2.2.1 Surveying

Surveying points will be surveyed by the team. Team will perform GPS surveying for selected reaches for further studying, re-design and analysis.

Deliverable: Survey points and topography map.

2.2.2 Vegetation and Wildlife

Team will perform a site visit regarding vegetation and wildlife in order to collect site information. The current condition of the reach will be examined by the team. Vegetation is a

crucial aspect to consider when visiting the location. Different types of vegetation might be expected at the location. Furthermore, wildlife is an issue to consider when visiting the site location, so any design should consider the wildlife, and ensure that the wildlife will not be negatively affected by any modification to the reach.

2.3 Data Analysis

2.3.1 Hydraulic Assessment

2.3.3.1 Hydraulic Engineering River Analysis System (HEC-RAS)

A model will be developed by the team using HEC-RAS software for hydraulics analysis. The model also will be used to analyze the proposed design and compare it to the existing conditions.

Deliverable: HEC-RAS model for existing and future conditions.

2.3.3.2 Bentley Flow Master

Bentley flow master will be used in culverts design and analysis if it is required in the proposed design.

Deliverable: Flowmaster analysis report.

2.3.2 Geomorphic Assessment

Channel geomorphology for the current condition will be evaluated to address the channel deposition, bank stability, channel width, and channel degradation. There are major aspects to consider for the channel geomorphology like width and depth, slope of channel, bank resistance, roughness coefficient, and sediment input.

Deliverable: Memo with channel classification of reaches.

2.4 Design Alternative

2.4.1 Low Crossing Design Analysis

Low crossings will be evaluated in some reaches of Sinclair wash for either re-design or a new design if required. The evaluation will be for current issues at certain crossings areas.

Deliverable: Excessive erosion report and hydraulic analysis.

2.5 Project Impacts

2.5.1 Environmental Impacts

The project will impact on the environment by improving the condition for vegetation and wildlife habitat in the selected reaches. Other environment impacts due to construction will be identified.

Deliverable: Memo on environmental impact of the project.

2.5.2 Economics Impacts

Possible economic impacts of Sinclair wash project would be due to enhanced stream stability. Lower erosion problems, enhanced recreational opportunities, and improved habitat.

Deliverable: Memo identifying Economic impacts.

2.6 Project Submittals

2.6.1 50% Report

The 50% report will include all the analysis and result up to the date of submittal of the 50% report. The report will make sure that the project is progressing sufficiently.

Deliverable: 50% completion of the report.

2.6.2 Project Report

Final project report will be delivered to the client and grading instructor. The final report will include a final design and a project analysis.

Deliverable: a final project report.

2.6.3 Project Presentation

A final presentation will be presented at the UGRADS symposium in April 2017. This will be an oral presentation with electronic copy delivered to instructor.

2.6.4 Website

A website will be created to publish all the information and documentation for future use. The project website will also include team information and information on the project.

Deliverable: Project website.

2.7 Exclusions

For this project, there are aspects of a full and complete design which are needed to complete the project. A list of exclusions is needed to clarify the aspects that are the responsibilities of the team and what are not.

2.7.1 Geotechnical Analysis

Geotechnical analysis is needed for the selected site but the team will not be responsible for any geotechnical analysis regarding the site.

2.7.2 Construction

If the proposed design gets approved by City of Flagstaff, team will not be responsible for constructing the project.

2.8 Project Management

2.8.1 Project Meetings

a) Team Meetings - weekly with all members of KUAE to discuss project updates and concerns.

Deliverable: Meeting agenda and minutes.

b) Meeting with Grading Instructor - weekly or bi-weekly as needed to answer questions or concerns.

Deliverable: Meeting agenda and minutes.

c) Meeting with Technical Advisors – weekly or bi-weekly as needed.

Deliverable: Meeting agenda and minutes.

d) Meeting with Client as needed.

Deliverable: Meeting agenda and minutes.

3.0 Project Schedule

Attached is a detailed schedule for the project tasks. The project schedule includes the critical path tasks and duration of each task. The project schedule was created using Gantt Chart software. The critical path is important for the project to ensure that the project is on the right track. The project consists of four main tasks, field assessments, design alternative, project management, and project submittals. Each of the main tasks have subtasks associated with it. Furthermore, the Gantt Chart shows the milestones of the project. The milestone are the start and end date of the project or any specific date to show the client the progress of the project. The date of tasks is subject to change; client and the grading instructor will be notified when a due date is changed.

4.0 Staffing and Cost of Engineering Service

4.1 Staff Qualifications and Rolls

4.1.1 Project manager:

- Degree seeking student (Bachelor of Science in Engineering: Civil Engineering).
- Familiarity with engineering projects steps and procedures.
- Worked on previous projects.
- Ability to guide teams and hold meetings.

4.1.2 Project engineers:

- Degree seeking student (Bachelor of Science in Engineering: Civil Engineering).
- Experience in project plans, sketches, drawings, etc.
- Ability to make designs and select the best alternatives based on engineering skills.
- Familiarity with contracts and documentations.

4.1.3 Lab experience:

- Degree seeking student (Bachelor of Science in Engineering: Civil Engineering).
- Experience in software associated with the project (AutoCAD, HEC-RAS, Water GEMS, Bentley Flow master, etc.)

- Experience in field work (Analysis, Reports, etc.)
- Familiarity with topo maps and using them properly.

4.1.4 Intern Engineers:

- Degree seeking student (Bachelor of Science in Engineering: Civil Engineering)
- Familiarity with collecting information.
- Ability to help in field work (collecting data, testing, etc.)
- Good writing skills

4.1.5 Engineers in training:

- Degree seeking student (Bachelor of Science in Engineering: Civil Engineering).
- Familiarity with data analysis.
- Ability to make schedules and estimate costs.
- Familiarity with results check using previous knowledge.

4.2 Hours Breakdown

The detailed project plan is provided using Gantt Chart. Gantt Chart is provided to explain the critical tasks and duration for each task. Using Gantt Chart will increase the efficacy of the project and save time. The Project Task is divided into four main categories, field assessment, design alternative, project management and project submittals. Each Task contains several sub-tasks. Additionally, Gantt chart provided milestone of the project, which going to be provided to the client, technical advisor, and the grading instructor. The Gantt chart might be updated based

Task	Project Manager Hours	Project Engineer Hours	Lab Technician Hours	Engineer in Training	Intern Hours
1.0 Filed Assessment	3	5	15	20	35
2.0 Data Collection	1	20	85	90	55
3.0 Data Analysis	2	30	35	95	75
4.0 Design Alternative	2	25	20	10	35
5.0 Project Management	72	50	35	5	35
Total	80	130	190	220	235

Task	Project Manger	Project Engineer	Engineer in Training	Lab Technician	Intern
1.0 Field Assessment					
1.1 Site Visit	1	2	5	3	20
1.2 Visit Documentation	1	2	10	5	10
1.3 Identify Infrastructures	1	1	5	7	5
2.0 Data Collection					
2.1 Rent Survey Equipment		2	18	20	5
2.2 Surveying	0	10	23	21	10
2.3 Identify Vegetation in Reach	0	1	8	5	12
2.4 Identify Wildlife in Reach	0	2	16	16	13
2.5 Analyze Survey Data	0	3	17	17	6
2.6 Create Topo Map	0	2	8	6	8
3.0 Data Analysis					
3.1 Hydraulic Assessment	0	5	10	8	12
3.1.1 HEC-RAS Model	0	3	17	9	15
3.1.2 Bentley Flowmaster Model		3	23	3	23
3.2 Geomorphic Assessment	1	15	22	2	9
3.2.1 Channel Classification	0	4	23	12	16

4.0 Design Alternative	0	5	2	10	15
4.1 Low Water Crossing	1	12	5	7	12
4.2 Propose Low Water Crossing Design	0	8	3	3	8
5.0 Project Management					
5.1 Team Meetings	5	7	1	2	5
5.2 TA Meetings	9	5	0	6	2
5.3 Grading Instructor Meetings	1	3	0	2	3
5.4 Budget Management	7	8	1	8	3
5.5 Project Submittals	12	2	0	3	4
5.6 50 % Report	13	1	1	3	2
5.7 Project Website	15	3	1	4	6
5.8 Project Presentation	5	7	0	3	5
5.9 Project Report	8	14	1	5	5

4.3 Cost of Service

In table 1 below the billing rate is estimated based on each staff position. It was calculated based on base pay rate, benefits, and profit of actual account. Online source is used to estimate the engineering paying system based on the shown classification.

Classification	Base Pay $/hr	Benefits of Base	Actual Pay $/hr	OH% of base pay	ctual OH% pay $/hr	rofits % of actual pay	Billing Rate $/hr
Project manager	60	30%	82	72%	140	10%	155
Project engineers	45	50%	60	16%	72	10%	77
Lab experts:	30	40%	47	16%	55	10%	59
ntern Engineers	45	55%	60	9%	67.5	10%	70

Engineers in training	15	0%	15	9%	20	10%	21

Table 1

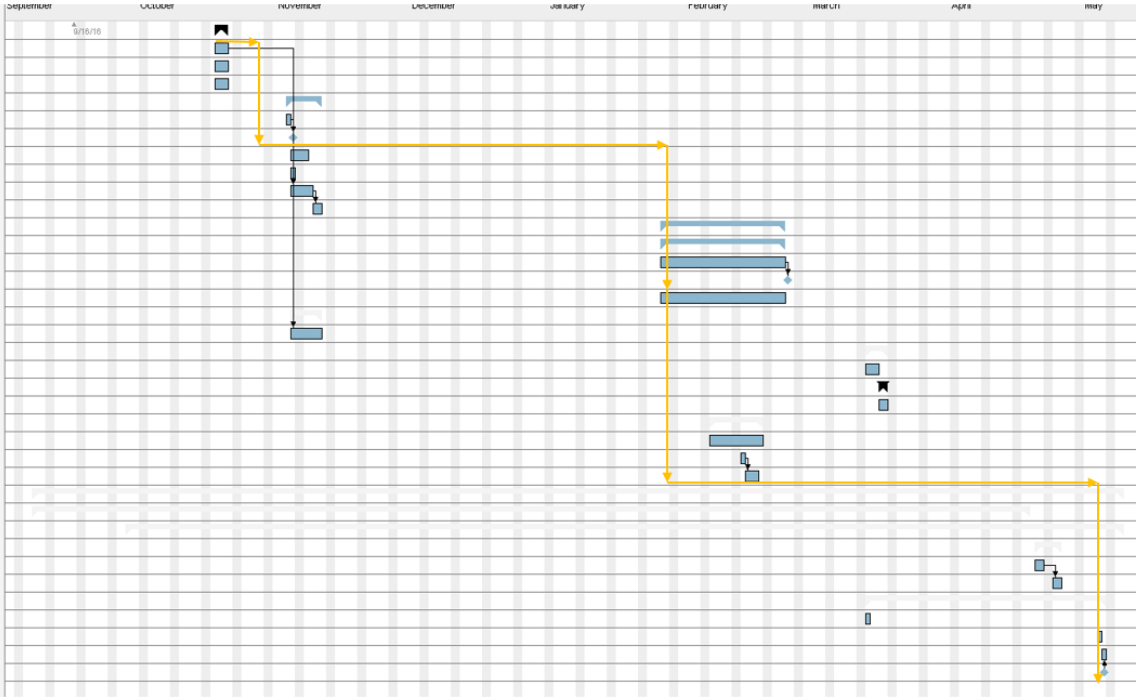
Classification	Base Pay $/Hr	Billing Rate $/Hr	Multiplier
Project Manager	65	160	2.46
Project engineers	37	75	2.027
Lab Experts	30	60	2.0
Intern Engineers	35	77	2.2
Engineering in training	22	20	0.90

Personnel	Classification	Hours	Rate ($/hr.)	Cost ($)
	Project Manger	80	145	11,600
	Project Engineer	130	85	11,050
	Lab Technician	190	65	14,300
	Engineer in Training	220	70	13,300
	Intern	235	17	3,995
Surveying Equipment		20	130	2,600
Total				**56,845**

5.0 References

6 Appendices

Name	Begin date	End date	Duration
Field Assessment	10/18/16	10/20/16	3
Site Visit	10/18/16	10/20/16	3
Visit Documentation	10/18/16	10/20/16	3
Identify Infrastructure	10/18/16	10/20/16	3
Data Collection	11/3/16	11/10/16	6
Obtain Survey Equipment	11/3/16	11/3/16	1
Survey Section	11/4/16	11/4/16	0
Identify Vegetation at Sinc...	11/4/16	11/7/16	2
Identify Wildlife at Sinclair...	11/4/16	11/4/16	1
Analyze Survey Data	11/4/16	11/8/16	3
Create Topo Map	11/9/16	11/10/16	2
Data Analysis	1/26/17	2/22/17	20
Hydraulic Assessment	1/26/17	2/22/17	20
HEC-RAS Module 1	1/26/17	2/22/17	20
HEC-Ras Module 2	2/23/17	2/23/17	0
Bently Flow Master M...	1/26/17	2/22/17	20
Geomophic Assessment	11/4/16	11/10/16	5
Channel Classification	11/4/16	11/10/16	5
Project Impacts	3/13/17	3/17/17	5
Environmental Impact	3/13/17	3/15/17	3
Econimcs Impact	3/16/17	3/17/17	2
Recreational opportun...	3/16/17	3/17/17	2
Design Alternative	2/6/17	2/17/17	10
Low Crossing Design	2/6/17	2/17/17	10
Obtain Appropriate maps	2/13/17	2/13/17	1
Select Low water Crossing...	2/14/17	2/16/17	3
Project Mangment	9/7/16	5/9/17	175
Technical Advisor Meeting	9/7/16	4/18/17	160
Grading Instructor Meeting	9/28/16	5/9/17	160
Budget Mangment	4/20/17	4/25/17	4
Man Hours	4/20/17	4/21/17	2
Final Project Budget	4/24/17	4/25/17	2
Project Submittals	3/13/17	5/5/17	40
50 % Report	3/13/17	3/13/17	1
Project Website	5/4/17	5/4/17	1
Project Presentation	5/5/17	5/5/17	1
Final Report	5/5/17	5/5/17	0



*Yellow Lines Represents Project Critical Path.