Proposal for:

Fanning Wash Soliere Ave Low Water Crossing Design

Prepared for:

City of Flagstaff
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1.0 PROJECT UNDERSTANDING

The goal of this project is to improve the Low-Water Crossing at the intersection of Fanning Wash and Soliere Avenue next to the I-40 in east Flagstaff, AZ. Soliere Avenue provides the connection from the residential area made up of multiple apartment complexes and neighborhoods to businesses such as grocery stores, banks, and more. The low water crossing at this intersection poses a public safety risk for vehicles, bicycles, and pedestrians. Existing conditions at the crossing allow stormwater runoff from upstream flow into Fanning Wash through the box culverts beneath the I-40E and I-40W and floods across the highly trafficked Soliere road.

To mitigate all flooding a culvert design is to be considered to allow the runoff to flow under the road and into the basin on the other side. Extensive research of hydrology in the area, geotechnical properties of the site, and hydraulic calculations of the culvert will be performed to create a design that can withhold peak flooding at the 100-year flood interval on the site and safely transport water to the other side of the road.

1.1 Project Background

This project is located in the City of Flagstaff on East Soliere Avenue just south of the I-40, at coordinates (35.214828, -111.5864986). Figure 1.1 below illustrates an aerial view of the location of the project within the city of Flagstaff.

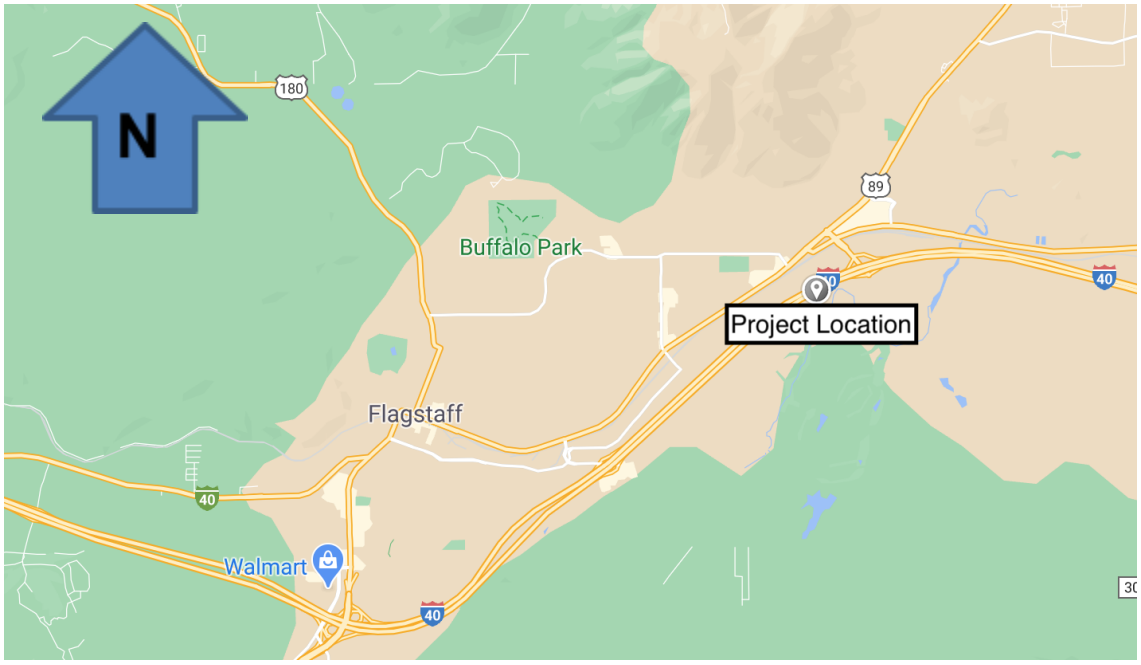

Figure 1.1: Project Location Flagstaff

Figure 1.2 shows the entirety of Fanning Wash and its relation to the relevant portion of the Rio de Flag, with the project location identified via the black arrow.

Figure 1.2: Fanning Wash and Rio De Flagstaff

Figure 1.3 shows a zoomed-in map of the project location

Figure 1.3: Project Location on East Soliere Avenue

Figure 1.4 shows the existing I-40 culvert upgradient of the crossing.

Figure 1.4: Project Location with I40 Culvert.

Figure 1.5 below shows a close-up image of the I-40 culvert.

Figure 1.5: I40 Culvert

Figure 1.6 shows the erosion due to the low water crossing to the south side of Soliere Ave.

Figure 1.6: Erosion at Low-Water Crossing

The condition of the area shows steep slopes near the road. This area has a lot of loose soil and less vegetation cover. Clay soils are common in the vicinity; these soils become water-logged after heavy rains. The area is predicted to have some volcanic rocks embedded in the clay soil. It can be seen how the flooding has deteriorated some of the material coming out of the culvert as well as the sediment leading into the wash.

1.2 Technical Considerations

The technical work called for on this project will incorporate the following; surveying, hydrologic research/analysis, hydraulics and the culvert design.

1.3 Potential Challenges

Weather may cause numerous challenges such as delays for surveying or sampling, an extreme event may alter the topography of the area, affecting the design. Another challenge may be the ability to rent the needed survey equipment or broken equipment. Sufficient time will be allowed in the schedule in case these types of challenges will not affect the outcome of the project.

1.4 Stakeholders

The general public using Soliere Rd and the owners and occupiers of residences, businesses and commercial properties near the project area are stakeholders in this project. The City of Flagstaff also will be considered as stakeholder.

2.0 Scope of Services

2.1 Task 1.0 Preliminary Site Research

This task will focus specifically on doing preliminary research necessary for the site. This research will help aid in the development of the design as the project moves forward.

2.1.1 Task 1.1 Existing I-40 Culvert Research

Previous plan-sets, drawings, and models about the existing culvert beneath I-40 will be reviewed to ascertain the design flow conditions into the site.

2.1.2 Task 1.2 Standards and Codes Research

The standards and codes applicable to this project will be researched to ensure that the no violations occur. Documents such as the Coconino Drainage Design Manual specified by the City of Flagstaff and the NRCS Manual will be identified and consulted.

2.2 Task 2.0 Field and Lab Work

This task focuses on obtaining site specific information to be able model the topography, flow and understand soil characteristics for strength and hydraulic conductivity.

2.2.1 Task 2.1 Site Mapping

2.2.1.1 Task 2.1.1 Site Inventory

An inventory of all geographical landforms will be noted for modeling purposes. This will include any vegetation or anything that could potentially disrupt the flow path in any way.

2.2.1.2 Task 2.1.2 Survey Site

Surveying techniques and equipment such as a total station, levels and rods will be used to determine the elevations and distances of the site. Elevations will be measured to the nearest 1’ interval and used to model the topography of the site.

2.2.1.3 Task 2.1.3 Topographic Map

AutoCAD will be used to create a detailed topographic model of the site using 1’ elevation intervals. This map will include all geological features such as plants and contour intervals.

2.2.2 Task 2.2 Geotechnical Analysis

A geotechnical analysis will be performed by collecting soil samples. Samples will be tested in the NAU Civil Engineering Soils Laboratory.

2.2.2.1 Task 2.2.1 Sampling Plan

Prior to sampling, a Sampling Plan will be created defining the location and number of samples, and the sampling techniques to be used.

An NAU Field Safety Checklist form will be prepared containing details on all lab procedures to be conducted. The lab binder must be approved by the NAU CENE Lab Manage prior to accessing the lab.

2.2.2.2 Task 2.2.2 Sampling

Soil samples will be collected in accordance with the Sampling Plan document.

2.2.2.3 Task 2.2.3 Particle Size Distribution and Sieve Analysis Test

ASTM D6913 “Standard Test Methods for Particle-Size Distribution of Soils Using Sieve Analysis” will be used to classify the soils at the site.

2.2.2.4 Task 2.2.4 Soil Limits Testing

ASTM 4318, “Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils” will be used to determine the strength limits of the soil under wet and dry conditions.

2.3 Task 3.0: HEC-RAS Hydraulic Analysis of Existing Crossing

A HEC-RAS model will be created to model flow from the I40 culvert across Soliere Ave to the Rio de Flag under current conditions. This will help determine the flow rates at the low water crossing, normal depths of the water and characteristics of the flow that will inform culvert design.

2.4 Task 4.0: Design Alternatives & Selection of Final Design

Alternative culvert designs at the crossing will be developed, assessed and a final design will be selected.

2.4.1 Task 4.1 Develop Alternatives

Three alternative designs will be developed and a preliminary design will be made. The preliminary design will include culvert type, material, size based upon the flow requirements. Preliminary drawings will be created in AutoCAD.

2.4.2 Task 4.2 Analyze Alternatives

Alternatives will be analyzed to aid in the selection of the best alternative.

2.4.2.1 Task 4.2.1 Preliminary Hydraulic Models

HEC-RAS will be used to model the flow through each alternative to ascertain its ability to handle the required flow volumes. Alternatives will be revised until three acceptable designs are created.

2.4.2.2 Task 4.2.2 Decision Matrix

A decision matrix will be developed based on selected criteria such as cost, effectiveness, maintainability, and ease of construction.

2.4.2.3 Task 4.2.3 Select Final Design

The final design will be selected based on the results from the decision matrix.

2.5 Task 5.0: Final Design

The selected design will be fully designed in this step.

2.5.1 Task 5.1 Plan Set Development

A Plan Set for the selected design will be created using AutoCAD and will be created with sufficient detail for construction, including annotations specifying dimensions, spacing, materials of construction, and slopes.

2.5.2 Task 5.2 Construction Cost Estimate

A construction cost estimate will be developed for the selected design based on labor and materials.

2.6 Task 6.0: Impacts

The impacts of the project on the area will be evaluated.

2.7 Task 7.0: FEMA Floodplain Analysis

A floodplain analysis post-construction will be discussed. LIDAR data of the existing downstream area will be collected and used to map a new floodplain of the area of the low water crossing.

2.8 Task 8.0: Deliverables

This task involves all the deliverables for the project. Impacts will address the associated social, environmental and economic issues of the project.

2.8.1 Task 8.1 30% Submittal

2.8.1.1 Task 8.1.1 30% Design Report

A design report at 30% completion will be prepared. It is expected that work through "*Task 3.0; Existing HEC RAS Model"* will be completed. Completing everything up to this task will be considered the 30% milestone.

2.8.1.2 Task 8.1.2 30% Presentation

A professional presentation at 30% project completion will be created.

2.8.1.3 Task 8.1.3 30% Plan Set

A Plan Set will be started and will include title pages and data found from geotechnical sampling, an existing topographic map, and an existing HEC-RAS model.

2.8.2 Task 8.2 60% Submittal

2.8.2.1 8.2.1 60% Design Report

A design report at 60% completion will be prepared. It is expected that work through "*Task 5.0; Final Design Selection"* will be completed. Completing everything up to this task will be considered the 60% milestone.

2.8.2.2 Task 8.2.2 60% Presentation

A professional presentation at 60% project completion will be created.

2.8.2.3 Task 8.2.3 60% Plan Set

A Plan Set will be continued including everything from the 30% plan set and a basic design in AutoCAD. The design will include only some materials and dimensions.

2.8.3 Task 8.3 90% Submittal

2.8.3.1 Task 8.3.1 90% Design Report

A design report at 90% completion will be prepared. It is expected that work through *"Task 7; FEMA Floodplain Analysis"* will be completed. Final edits will be the only work needed. Completion of all work up to this task will be considered the 90% milestone.

2.8.3.2 Task 8.3.2 90% Presentation

A professional presentation at 90% project completion will be created.

2.8.3.3 Task 8.3.3 90% Plan Set

A Plan Set will be continued including everything from the 30% and 60% Plan Sets and ultimately finished. This will include all dimensions, spacing, gradient, and materials.

2.8.3.4 Task 8.3.4 90% Website

A professional website will be created based on the final design. This website submission will include all work done up to the 90% milestone.

2.8.4 Task 8.4 Final Submittal

2.8.4.1 Task 8.4.1 Final Report

A final report at 100% completion will be completed. It is expected that all work will be completed. This will be considered the final milestone at 100%.

2.8.4.2 Task 8.4.2 Final Presentation

A professional final presentation at 100% project completion will be created.

2.8.4.3 Task 8.4.3 Final Plan Set

A final plan set will be developed with everything needed for construction. This entails dimensions, gradients, materials, and schedules.

2.8.4.4 Task 8.4.4 Final Website

A final website will be created with all the project's information and documents.

2.9 Task 9.0: Project Management

This task entails the management of the schedule, materials, financial resources, and human resources.

2.9.1 Task 9.1 Resource Management

This task entails the proper organization of time, finances, labor, and other materials needed to complete the project. Staff time will be tracked, and the project schedule will be regularly evaluated to assure the project is on track. The

complexity and scope of this project require an analysis to identify and manage the inevitable challenges and potential risks. The task will enable the team to avoid or mitigate the risk impacts.

2.9.2 Task 9.2 Team Management and Meetings

A meeting binder will be created to document all client, technical advisor, grading instructors, and team meetings. Agenda and minutes will be recorded for each of these meetings.

2.10 Exclusions

The following exclusions are needed to complete the project but will not be performed by the team.

- Roadway Design
- Construction
- Condition relation to unforeseen site conditions

3.0 Schedule

3.1 Schedule Discussion

A Gantt chart for the project may be found in the attached file titled “Fanning Wash Project Gantt Chart”. The project will start on 8/30/21 and be completed on 12/03/21; the project is expected to take 70 days.

3.2 Critical Path Discussion

The Critical Path is denoted on the Gantt Chart attached by the red line following the flow path on the left of the tasks.

Task time allocations have been made to allow sufficient time to complete, plus additional float in case of delays. Task 9.0: Project Management, will assure maintenance of the project schedule.

4.0: Staffing Plan

This section details the staffing-plan for the project.

4.1: Staff Positions

The list of staff positions for this project includes:

- Chief Engineer (CEN)
- Project Engineer (PEN)
- Intern Engineer (INT)
- Technician (TE)

4.2: Qualifications List

The Chief Engineer must have a bachelor's degree in civil or environmental engineering and be a registered professional engineer. Experience with the drainage characteristics of the Flagstaff region and project management experience are also required.

The Project Engineer must have a bachelor's degree in civil or environmental engineering, be a registered professional engineering, and have experience in designing canals, channels, culverts, or other drainage systems.

Intern Engineers must be taking or have completed civil or environmental engineering courses. The intern must know hydrology, flood-plain analysis Auto-CAD, surveying, and geotechnical analysis.

The Technician must have a diploma or certificate in civil or environmental engineering. Knowledge in designing hydraulic systems, soil testing, flood-plain analysis sieve analysis tests, and general construction is also required.

Qualifications of each team member are listed below:

Abdalla Alatar: Completed relevant courses such as Geotech, Geotech lab, Hydraulics, AutoCAD, and Surveying

Preston Meek: Proficient in the following programs: Google Applications, AutoCAD, HEC-RAS, FlowMaster, and CulvertMaster. Completed relevant courses such as Geotech, Hydraulics, Hydraulics Lab, AutoCAD/Tech, Surveying.

Austin Simmons: Proficient in the following programs: AutoCAD, HEC RAS and Culvert Master for modeling software. Completed relevant courses such Geotech, Hydraulics, AutoCAD, Surveying and Hydrology.

Muhammad Muhammad: Completed relevant courses such as Hydraulics, Hydraulics lab, Hydrology, Geotech, and Surveying.

4.3: Staff Work Hours Estimation

Table 4.3.1 below shows the scope of work of each project member plus the estimated hours required to complete the task.

Table 4.3: Estimated Work Hours

Tasks	CEN-hours	PEN-hours	INT-hours	TEC-hours	Total Hours
Task 1.0 Preliminary Site Research	**-**	**-**	**-**	**-**	**-**
Task 1.1 Existing I-40 Culvert Research	3	3	10	5	21
Task 1.2 Standard and Codes Research	4	3	1	0	8
Task 2.0 Field and Lab Work	**-**	**-**	**-**	**-**	**-**
Task 2.1 Site Mapping	-	-	-	-	-
Task 2.1.1 Site Inventory	0	1	7	5	13
Task 2.1.2 Survey Site	0	1	15	15	31
Task 2.1.3 Topographic Map	0	1	20	20	41
Task 2.2 Geotechnical Analysis	0	0	15	20	35
Task 2.2.1 Sampling Plan	0	1	10	10	21
Task 2.2.2 Sampling	0	0	12	16	28
Task 2.2.3 Particle Size and Sieve Analysis Test	0	0	7	10	17
Task 2.2.4 Soil Limits Testing	0	0	7	10	17
Task 3.0 HEC-RAS Hydraulic Analysis	**10**	**20**	**15**	**10**	**55**
Task 4.0 Design Alternatives & Selection of Final Design	**-**	**-**	**-**	**-**	**-**
Task 4.1 Develop Alternatives	12	12	0	0	24
Task 4.2 Analysis Alternatives	1	1	5	0	7
Task 4.2.1 Preliminary Hydraulic Models	13	15	10	0	38
Task 4.2.2 Decision Matrix	3	10	6	0	19
Task 4.2.3 Select Final Design	3	5	2	0	10
Task 5.0 Final Design	**-**	**-**	**-**	**-**	**-**
Task 5.1 Plan Set Development	2	2	2	20	26
Task 5.2 Construction Cost Estimate	2	5	2	2	11
Task 6.0 Impacts	**1**	**2**	**1**	**1**	**5**
Task 7.0 FEMA Floodplain Analysis	**5**	**10**	**10**	**5**	**30**
Task 8.0 Deliverables	**-**	**-**	**-**	**-**	**-**
Task 8.1 30% Submittal	-	-	-	-	-
Task 8.1.1 30% Design Report	4	6	0	0	10
Task 8.1.2 30% Presentation	1	1	2	1	5
Task 8.1.3 30% Plan Set	1	1	1	1	4
Task 8.2 60% Submittal	-	-	-	-	-
Task 8.2.1 60% Design Report	5	5	0	0	10
Task 8.2.2 60% Presentation	2	1	2	1	6
Task 8.2.3 60% Plan Set	2	2	2	1	7
Task 8.3 90% Submittal	-	-	-	-	-
Task 8.3.1 90% Report	3	1	0	0	4
Task 8.3.2 90% Presentation	1	1	1	1	4
Task 8.3.3 90% Plan Set	1	1	1	1	4
Task 8.3.4 90% Website	0	1	1	1	3
Task 8.4 Final Submittal	-	-	-	-	-
Task 8.4.1 Final Report	3	5	0	0	8
Task 8.4.2 Final Presentation	1	1	1	1	4
Task 8.4.3 Final Plan Set	2	2	1	1	6
Task 8.4.4 Final Website	0	1	2	2	5
Task 9.0 Project Management	**-**	**-**	**-**	**-**	**-**
Task 9.1 Resource Management	10	8	0	0	18
Task 9.2 Team Management and Meetings	20	20	20	20	80
Total Hours	**115**	**149**	**191**	**180**	**635**

4.4: Summary Table

Table 4.4 shows the summary for all staff hours in the project.

Table 4.4: Summary of Work Hours

Staff	Hours
CEN	115
PEN	149
INT	191
TEC	180
Totals	**635**

5.0: Cost of Engineering Services

All the personnel in table 5.1 were derived from the positions created before in the staffing section. The base pay rates for each position were gathered from averages of pay rate per hour according to the amount of work that specific position has to do. The surveying equipment was determined from our planned surveying time of one day and the standard rate of surveying equipment. There is no need for subcontractors for this specific project. The final cost for this project is 67,455$.

Table 5.1: Cost of Engineering Services

	Classification	Hours	Rate, $/hr	Cost
Personnel	CEN	115	190	21,850
	PEN	149	120	17,880
	INT	191	75	14,325
	TEC	180	60	10,800
Personnel Total				64,855
Supplies	Surveying Equipment Rental	24	2,400 per day	2,400
	Geotechnical Equipment	N/A	Flat Rate	200
Cost of Engineering Services Total				67,455

References

[1] "Google Maps", *Google Maps*, 2021. [Online]. Available: https://www.google.com/maps. [Accessed: 15- Feb- 2021].

[2] Hdsc.nws.noaa.gov. 2021. PF Map: Contiguous US. [online] Available at: <https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html> [Accessed 15 February 2021].