I-40/COUNTRY CLUB DRIVE TRAFFIC INTERCHANGE DESIGN FINAL PROPOSAL

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1.0 Project Understanding

1.1 Project Purpose

The westbound I-40 on-ramp at Country Club Drive, shown in *Figure 1-1*, often experiences high volumes of traffic during peak hours. This existing traffic results in the capacity at this intersection being lower than it potentially could be, due to congestion. The purpose of this project is to decrease the traffic delay and increase the capacity at the intersection of the I-40 westbound on-ramp and Country Club Drive. The Arizona Department of Transportation (ADOT) has requested an analysis and design for implementing an additional dedicated right turn lane on the southbound approach on Country Club Drive. This analysis and design will also include an additional merging lane on westbound I-40 on-ramp.

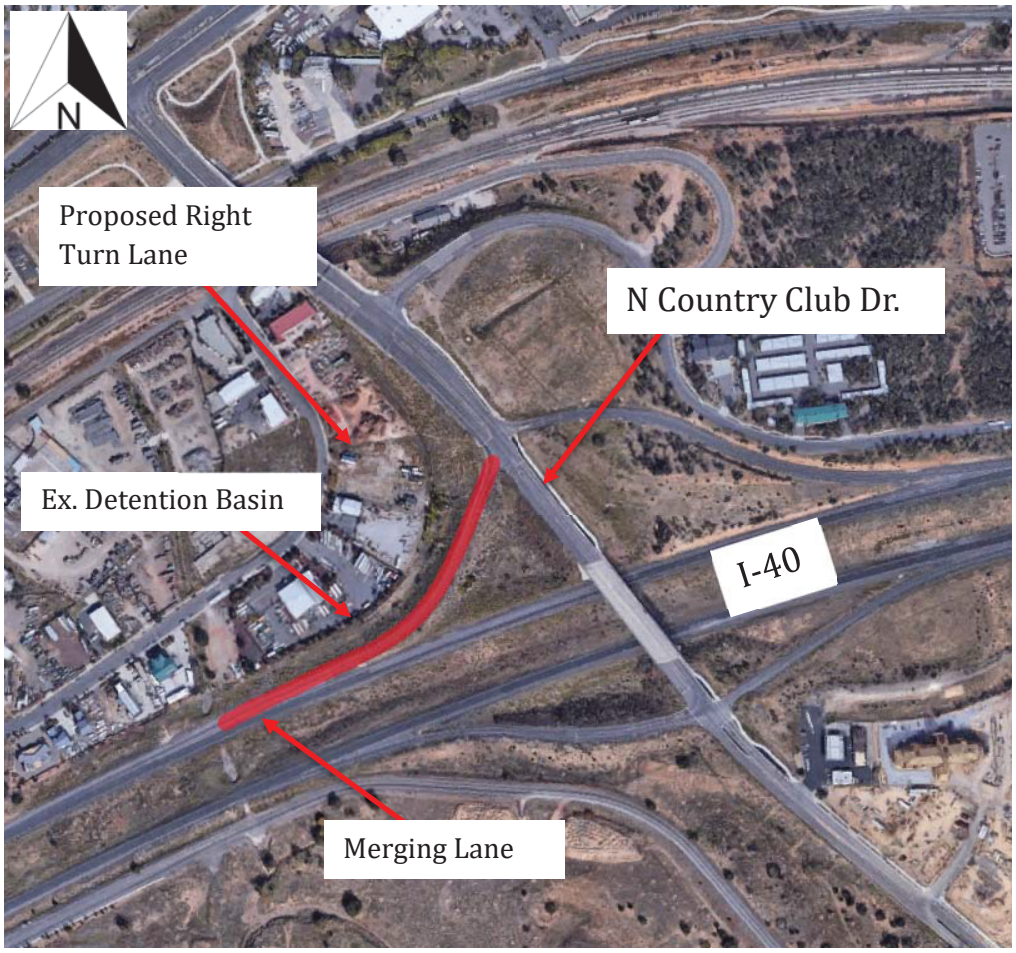


Figure 1-1: Existing Aerial View of Project Location (NTS) [1]

1.2 Project Background

1.2.1 Location of Site and Status

The project site is located in the city of Flagstaff, Arizona, with the existing infrastructure being maintained by ADOT. *Figure 1-2* displays a project location map. The I-40 westbound on-ramp at Country Club Drive contains only one lane to enter the interstate. In order to merge onto I-40, currently, there exists a dedicated right turn lane on the Country Club Drive southbound approach, as well as a dedicated left turn lane on the northbound approach. The dedicated right turn lane experiences a high volume of vehicles given its need for daily commuters. Both approaches must share a single on-ramp lane. Phasing at this intersection separates these movements to avoid conflict.

Figure 1-2: Project Location Map (NTS) [1]

The intersection adjacent to the westbound I-40 on-ramp, specified by the client for analysis and design improvement, is located at Country Club Drive. The northbound approach consists of two through lanes and a dedicated left turn lane, as shown in *Figure 1-3,* while the southbound approach contains two through lanes and a dedicated right turn lane, as shown in *Figure 1-4*. The on ramp contains only one through lane while the off ramp contains a dedicated right and dedicated left turn. The westbound on-ramp is shown in *Figure 1-5*. The condition of all approaches is fair to exceptional with respect to visibility. However, there is a need for increased capacity to ensure the intersection can function in an efficient manner.

Figure 1-3: Country Club Drive Northbound [1]

Figure 1-4: Country Club Drive Southbound [1]

Figure 1-5: I-40 Westbound On-Ramp [1]

The Project Site is located in the city of Flagstaff, AZ with the facility (Interstate 40) maintained by the Arizona Department of Transportation. The intersection adjacent to the on-ramp specified by the client for analysis and proposal is located at Country Club Drive and the Eastbound Off-Ramp/Westbound On-Ramp. The northbound approach consists of two through lanes and a dedicated left turn lane while the southbound approach contains two through lanes and a dedicated right turn lane. The on ramp contains only one through lane while the off ramp contains a dedicated right and dedicated left turn. The condition of all approaches is fair to exceptional with respect to visibility, delay, and efficiency.

The I-40 Westbound Country Club On-Ramp contains only one lane to enter the interstate. In order to enter the I-40, currently, there exists a dedicated right turn lane on the southbound approach as well as a dedicated left turn lane on the northbound approach. The dedicated right turn lane experiences a high volume of vehicles given its proximity and access to local businesses. Both approaches must share a single on-ramp lane. Phasing at this intersection separates these movements to avoid conflict.

1.3 Technical Considerations

1.3.1 Highway Design [2]

Horizontal alignment is important in ensuring the proper design of the additional I-40 westbound on ramp by taking into consideration safety, type of facility, topography, right of way, design speed, intersections, and construction cost. The horizontal alignment of the I-40 westbound on ramp must take into account each curve and tangent in the roadway. Vertical alignment is important in ensuring the uniform operation throughout the on ramp through the final merge onto the I-40 westbound by making sure the roadway stays relatively flat. This project will consist of creating both horizontal and vertical alignments to ensure the safety of the users entering the I-40 westbound. There are multiple general studies showing the ideal grades, length of grades and vehicle operations, which creates a safe and efficient driving experience.

1.3.2 Codes and Standards [2] [3]

Three sets of standards will be used periodically throughout the project: the Arizona Department of Transportation (ADOT) has a set of design standards and specifications called *Roadway Design Guidelines* (2012). The ADOT standards will ensure the I-40 westbound additional on ramp lane and the additional right turn lane on Country Club Drive southbound meet the specified standards for the state. The American Association of State Highway and Transportation Officials (AASHTO) has a set of standards called the AASHTO Green Book (2019). The Green Book lays out proper procedures for highway and street design. AASHTO standards will be referenced while performing geometric changes to the additional I-40 westbound on ramp lane and the additional right turn lane on Country Club Drive southbound. The third set of standards that will be used is The Manual on Uniform Traffic Control Devices (MUTCD) (2019). This set of standards describes procedures and warrants for various traffic operations and design.

1.3.3 Hydraulics

Hydraulics is important to the I-40 and Country Club Drive expansion to ensure the safety of vehicles traveling on the road and prevention of deterioration of the foundation. A catch basin is located at the beginning of the I-40 westbound on ramp at the Country Club Drive intersection along with a culvert which goes underneath I-40 westbound. The catch basin will need to be relocated and reconfigured due to the expansion of the southbound right turn lane widening. To account for this, an embankment curb will be placed at an appropriate location to ensure proper drainage. The culvert will also need to be expanded because of the expansion of the I-40 westbound on ramp lane. The catch basin and the culvert are required to meet the specifications of AASHTO's policy in association with meeting the standards of ADOT's standard specifications.

1.3.4 ADOT Road Safety Assessment Application

An ADOT Road Safety Assessment Application is a formal examination of user safety for an existing highway, proposed highway or roadway, which is performed by a qualified and experienced independent team. The Road Safety Assessment Application will be filled out by the team and will include information pertaining to the project including: type of assessment requested, specific project location, length of segment, traffic volumes for the intersection and proposed development.

1.3.5 Field Site Investigation

The first step of the I-40 and Country Club Drive expansion project is to perform a site visit during peak hour flow to observe traffic movements and the areas of congestion in conjunction with identifying areas in which drainage is and could cause potential issues. The site investigation will also bring familiarity to the area and the potential problem areas that may arise further into the project.

1.3.6 Topographic Mapping

Topographic mapping is a technical aspect of any highway design project because it is essential to have elevation data when constructing a highway or local road on any stretch. If the elevation data is not sufficient, it can lead to errors in calculations in making a safe and efficient road. Topographic maps also identify where there are low points to identify drainage problems.

1.3.7 Software Programs

We will be using AutoCAD and Civil3D software to create the existing and proposed design. The software will be used in transportation engineering portion of our highway design, and road design. This software can import survey data and that data can be manipulated to become a road alignment, which allows the engineers to use the data to calculate horizontal and vertical alignment values. Once survey data is inputted, a topographic map and surface will be created on Civil 3D. Other computer software can accurately estimate the changes in drainage and runoff when a structure is added. This is critical in modeling the changes made to a specific area and its effects on drainage in the area.

1.3.8 Traffic Operations Analysis

Traffic operations analysis is an important aspect to ensure the lengths of roadway are adequate to handle the volumes of the roadway. The relationship between length of roadway and volume of vehicles is the density of vehicles in a given lane. Ensuring a proper length of roadway directly impacts the flow (volume) of a given lane and prevents a traffic jam. The traffic operations analysis will also help determine what lane widths will be used for effective travel. The traffic signal pole will need to be removed and relocated once the additional right-hand turn lane is added for more vehicles to get onto the I-40 westbound on ramp. Additionally, it is required that the intersection runs a permitted right with a protected left, after the proposed design is implemented Synchro will be used to better understand the affected traffic flows.

1.3.9 Construction Plan Set

Construction plan sets help the team be able to build the desired plan set to the exact specifications of the engineering team. The specifications will also be designed up to code per ADOT design specifications and AASHTO policy of Geometric Design of Highways and Streets. Some of the drawings inside the construction plan set include: typical roadway sections, plan and profile sheets, roadway cross sections, pavement marking and signing plans, quantities and combined cost estimates and special provisions.

1.3.10 Quantities and Combined Cost Estimate

Combined cost estimates are an important part of the bidding process. If a project has too high of a cost estimate it will not be selected and if a project has too low of a cost estimate it will not include enough work on the projects scope. It is critical to make the cost estimate as accurate as possible to ensure the client is happy with the overall cost and happy with the overall design of the project. Quantities is important when making an accurate cost estimate to make sure not a single dollar goes to waste when the bidding process begins.

1.4 Potential Challenges

1.4.1 Drainage Design

One of the main challenges presented in this project is an increase in surface runoff, due to an increase in impervious surfaces. This presents an issue for existing drainage facilities in the area. These facilities are a detention basin just north of the existing westbound on-ramp of I-40 and Country Club Drive. This challenge will be addressed by first verifying the capacity of the existing detention basin. If this basin can hold the increase in flow, then further design will not be needed. However, if the basin's capacity is too small, then it will need to be redesigned for the increase in flow.

1.4.2 Grading

Another challenge, specific to this project, is the grading to install a second right turn lane to the I-40 on-ramp, as well as a second lane being added to the I-40 on-ramp. This will be a challenge because of the high slopes on both sides of the on-ramp. Essentially, due to these high slopes, there will be a considerable amount of grading needed for the proposed design to meet the existing grade. This high grading can be relatively costly. In order to minimize this, the proposed design will need to use minimum spacing requirements, i.e. lane width and shoulder width, to prevent the design cost from becoming unfeasible. It should be noted that the high amount of grading could warrant a retaining wall in the area.

1.4.3 Limited Right-of-Way

Due to the inability of acquiring any additional right-of-way, the proposed design must fit within the existing right-of-way limits. This will be a challenge in the design process because the proposed design must function successfully within a limited space. In order to account for this, various spacing and drainage standards may need design exceptions. If this is not possible then non-typical highway/interchange design components may be necessary. For example, installing a curb and gutter would help to divert runoff from adjacent properties. However, a retaining wall could be installed in the area to account for issues caused by limited right-of-way.

1.5 Stakeholders

1.5.1 Arizona Department of Transportation

The main stakeholders in this improvement project is ADOT. ADOT is an essential stakeholder because of their key association in maintaining and enhancing federal roadways in the state of Arizona.

1.5.2 City of Flagstaff

Once again, this project is located on the eastern side of the City of Flagstaff. This causes the City of Flagstaff to be an essential stakeholder in this improvement project.

1.5.3 General Public

Largely consequential stakeholders affected by this project would be the users that interact with the proposed project. The public has a stake in the outcome of the project due to the project funding, consisting primarily of tax collection.

2.0 Scope of Services

2.1 Task 1: Analyze/Review Existing Conditions

2.1.1 Task 1.1: Conduct Site Visit

The first site visit will be to assess the existing conditions of the on-ramp, intersection, traffic capacity, and drainage conditions. This initial assessment will help the team to visualize and understand the geometry and constraints of the existing infrastructure.

2.1.2 Task 1.2: Process Survey Data

The existing survey data for the project location has already been collected, so there is no need to conduct a new survey. The data exists in GIS form and will be processed onto a Civil 3D topographical surface. If GIS data cannot be processed, the topographic data will be drawn in using feature lines and topographical aerial pictures from Google Earth.

2.1.3 Task 1.3: Analyzing Existing Drainage Studies and As-Built Information

Currently, all runoff due to impervious surfaces drains into an adjacent detention basin just northwest of the I-40 westbound on-ramp. Existing studies completed in this area will be compiled and compared to verify if the existing detention basin can support the increase in runoff due to the increase in impervious surfaces. Also, as-built information will be obtained from previous projects located within the project site. These as-built documents will allow for the team to know what existing infrastructure is in the project area and how it was designed.

2.1.4 Task 1.4: Existing Runoff Calculations

There are currently no existing runoff or flow data calculations available to analyze. Therefore, this data must be calculated and analyzed by the project team for submittals. The rational method will be used in this aspect due to the project area being relatively small. The calculated results will then be implemented into the proposed design.

2.1.5 Task 1.5: Obtain Geotechnical Information

All geotechnical information at the project site has been previously collected and analyzed by ADOT. As a result, soil analysis and testing will not be required. However, all geotechnical information will need to be obtained from ADOT in order to create a proposed design per ADOT standard details and specifications.

2.1.6 Task 1.6: Input and Process Existing Geometry in Civil3D

All existing geometrical data within the project limits will need to be placed into AutoCAD/Civil3D. This includes inserting existing structures within the project limits, such as buildings, traffic devices, and guardrails.

2.1.7 Task 1.7: Create Existing Cross-Sections

Existing cross-sections of Country Club Drive and the I-40 westbound on-ramp will be created to show the existing cross-sectional information. This information will include cross-slopes, pavement and subgrade thickness, striping information, right-of-way information, lane uses, and embankment information.

2.1.8 Task 1.8: Create Roadway Alignments/Base Files

Roadway centerlines and edge alignments will be created as references for all stationing and offset information. These alignments will be in-line with roadway centerline and roadway shoulder information, where appropriate.

2.2 Task 2: Design

2.2.1 Task 2.1: Create Proposed Cross-Sections

Proposed typical cross-sections will be created to show the proposed improvement information at Country Club Drive and the I-40 westbound on-ramp. These cross-sections will include the same information as the existing cross-sections. However, all existing information will be identified as existing in these proposed cross-sections. The specific improvement information on Country Club Drive includes an additional right-turn lane as well as embankment information. The improvement information regarding the I-40 westbound on-ramp includes an additional lane to the on-ramp for a total of two lanes that will merge into one lane entering the interstate. These improvements will be designed per ADOT and AASHTO (American Association of State Highway and Transportation Officials) standard details, guidelines, and specifications. Other standards that could be used for this design include standards listed in the MUTCD. It will be noted in all submittals what standards were used for each component of all improvements.

2.2.2 Task 2.2: Initial Design

The initial design of this project will consist of superimposing a design, per ADOT standard details and specifications, onto the existing infrastructure within Civil3D. This includes determining the appropriate line types and block information, as well as designing to ADOT standard specifications and details.

2.2.2.1 Task 2.2.1: Intersection Design

The intersection design of this project will consist of creating an additional right-turn lane on Country Club Drive to enter the I-40 westbound per ADOT standard details and specifications. AASHTO guidelines will also be considered with respect to, but not limited to: lane widths, shoulder widths, sight distances, drainage, geometry of the intersection and pedestrian and bike considerations. A majority of the project hours assigned to this project will be allocated to this sub-task. The reason for this is, this task is expected to take up a considerable number of man-hours to complete.

2.2.2.2 Task 2.2.2: On-Ramp Design

The on-ramp design of this project will consist of a lane addition to the existing single lane. ADOT and AASHTO respective standard details and specifications will be followed and will include, but not limited to: recommended lane length and width, lane balance, revised grading, signage placement, horizontal alignments, vertical alignments, drainage, and tapering aspects. Once again, a majority of the project hours assigned to this project will be allocated to this sub-task, for the same reasons given for intersection design.

2.2.3 Task 2.3: Final Design Geometry/Cross-Sections

The final design will be shown with multiple plan and profile views as well as typical cross-sections. This information will, once again, meet ADOT standard details and specifications, as well as any standards used by AASHTO or MUTCD. All physical information will be finalized in this design, including cut/fill information, construction quantities, striping information, and drainage information. In addition to this, the final design submittal will include a preliminary traffic control plan and utility relocation plan.

2.2.4 Task 2.4: Final Drainage Design

The final drainage design will primarily consist of determining the increase in runoff due to an increase in impervious surfaces to the area. This increase will be added to the existing runoff flows, and the existing infrastructure will, once again, be verified for capacity. The infrastructure that must be verified includes the previously mentioned detention basin, culvert crossing I-40 westbound, and the catch basin that will be removed and replaced at the right turn onto I-40 westbound. The proposed catch basin will be designed per ADOT standard details and specifications to control the increase in discharge.

2.2.5 Task 2.5: Storm water Pollution Prevention Control Plan

A storm water pollution prevention control plan (SWPPP) will be developed in order to implement erosion control during construction of the proposed improvements.

2.2.6 Task 2.6: Construction Plan Set

A full 30% design concept construction plan set will be provided following the ADOT plan set requirements. This will include a cover sheet, a sheet index, standard details, general notes, typical cross-sections, plan and profile sheets. These plan and profile sheets will include removal and construction notes and quantities per ADOT requirements. There will also be summary sheets provided along with this plan set.

2.2.7 Task 2.7: Synchro Analysis and Traffic Signal Recommendation

The team will use the computer program, Synchro to perform a capacity analysis of the intersection with traffic data given to the team from ADOT, per the client's request. All Synchro Analysis will be performed in the traffic lab located at the engineering building at NAU. Traffic signal recommendations will also be made based on the final design for the right turn expansion and the additional on ramp lane.

2.3 Task 3: Deliverables

2.3.1 Task 3.1: 30% Submittal

The 30% submittal will primarily consist of a final determination of existing studies including a site visit assessment of the project site, processing of topographical survey data from GIS, analysis of existing drainage studies, runoff calculations, analysis of existing geotechnical data, implementation of existing geometry of the interchange into Civil3D, and creation of existing cross sections, and roadway alignments/base files.

2.3.2 Task 3.2: 60% Submittal

The 60% submittal will primarily consist of a preliminary proposed design, which will include proposed cross sections, intersection design, on-ramp design, preliminary drainage design, and a construction plan set. The submittal of the 60% will also include the redline revisions of the 30% submittal.

2.3.3 Task 3.3: 90% Submittal

The 90% submittal will primarily consist of an essentially completed final design with previous major tasks fully completed such as the overall design, impact analysis, final drainage design and analysis, and proposed cross sections. Redlines and comments received will be the only revisions made at this point to ensure proper presentation and quality.

2.3.4 Task 3.4: Final Design Report Submittal

The final design report submittal will consist of the completed design concept report, 90% redline revisions, and a final presentation. A finalized construction plan set will be included in the final design report, with finalized construction quantities.

2.4 Task 4: Impacts

2.4.1 Task 4.1: Social Impacts

The social impacts will be determined by first assessing who will be impacted by this project and how they will be affected. This impact will be assessed both during construction and upon project completion. The anticipated primary users impacted by this project would be local commuters who frequently use the area to travel to work. There are also users who live in the area who use the on-ramp to travel for longer destinations outside the city limits, along with drivers who are not from the area using the roadway.

2.4.2 Task 4.2: Economic Impacts

An economic impact analysis will be conducted to determine how positively this project impacts saved cost and time to the commuters and the public. Some examples of economic analysis for this project is measuring the amount of crashes at the intersection and on ramp, measuring the amount of police reports filed for car accidents, measuring the number of emergency vehicles which come to the intersection for an accident, and measuring the number of repairs conducted on the intersection due to an accident.

2.4.3 Task 4.3: Environmental Impacts

An environmental impact analysis will be conducted by determining how this project will impact the environment in the corresponding area. This analysis will be considerably limited to the expertise of the members of this team and will consist of much more practical studies and potential impacts. These impacts will be analyzed with respect to the additional impervious surfaces for the study area. With the expected outcome of the design being reduced delay due to an increase in capacity, vehicle emissions will be reduced. (Obtaining and reviewing environmental reports from ADOT will also aid in assessing the environmental impact of this project)

2.5 Task 5: Project Management

2.5.1 Task 5.1: Grading Instructor Meetings

Grading Instructor meetings will occur on a frequent basis to touch base on the status of the project. These meetings will also provide guidance and recommendations for the progress made on milestones and submittals. Grading Instructor meetings will be set up with Gary Miller from the City of Flagstaff Department of Community Development and will be scheduled for one day, every other week.

2.5.2 Task 5.2: Client Meetings

Client meetings will occur periodically to ensure the team creates a design that satisfies the clients' expectations. Client meetings will be set up with Nate Reisner from ADOT after major deliverable submissions to go over comments and concerns about the subject submittal. Meetings with the client will be scheduled after the 30%, 60%, 90%, and final design.

2.5.3 Task 5.3: Technical Advisor Meetings

Meetings will be scheduled with the team's technical adviser to ensure the team is completing the necessary tasks and to provide any assistance and clarification if needed. The Technical advisor meetings will be set up with Caleb Lanting from Peak Engineering and meetings will be scheduled prior to the 30%, 60%, 90%, and final design submissions to the client.

2.5.4 Task 5.4: Team Meetings

Team meetings will occur once per week at a minimum. There will be additional team meetings scheduled when they are required to complete tasks or submit deliverables for the project.

2.5.5 Task 5.5: Schedule Management

The team will have to keep an up to date project schedule that includes all major and minor tasks, which need to be achieved in order to not fall behind schedule. The critical path of the schedule will anticipate the completion of the final design.

2.5.6 Task 5.6: Cost/Resource Management

It is necessary to manage resources and costs within the design process to ensure the project can proceed on schedule and on budget. The major resource associated with this project is time/man hours, which is directly related to cost.

2.6 Exclusions

2.6.1 Full Survey

A full topographical survey will not be included in the scope of services per the client's request. The client request that due to the location of the project and lack of insurance covering the team, a full survey will not be conducted by the team. All data regarding the topography of the area will be processed GIS data from the City of Flagstaff's website under the Public GIS Mapping Portal site. However, if the team is unable to use GIS data, feature lines will be created and used as topographical information.

2.6.2 Geotechnical Analysis

A geotechnical analysis will be excluded in the scope of services as the client has offered existing geotechnical data from other projects in the same area. The geotechnical analysis has been previously conducted and therefore, the client does not expect to receive a geotechnical analysis. All geotechnical data will be provided by ADOT.

2.6.3 Collection of Traffic Data

Traffic data collection of the existing intersection and on ramp will not be included in the scope of services per request by the client. The team will also not be performing a Level of Service analysis of the intersection per request from the client.

2.6.4 Traffic Signal Plans

Due to the final proposal being limited to a 30% design concept report, the final proposal will not include traffic signaling plans. Temporary traffic control will be included in the final proposal per request by the client and will consequently effect traffic operations at the intersection of the on-ramp and Country Club Dr.

2.6.5 Environmental Permits/Mitigation Measures

Environmental permits will not be included in the scope of services because the project will not disturb large portions of undeveloped land rather, it will expand on land which has already been developed. Mitigation measures will also not be included as the project will not conflict with current parcels or businesses near the project site.

2.6.6 Bridge Design

There will likely be a need to widen the bridge at Country Club Drive, extending from the I-40 westbound on-ramp to Route 66. However, the design team does not have the knowledge, or the experience to complete this portion of the design.

2.6.7 New Drainage Infrastructure Design

If the existing infrastructure located at the I-40 and Country Club Dr. is not sufficient, the team will not design new infrastructure. Examples of the new infrastructure which will not be designed include: a new detention basin or a new culvert that goes underneath the I-40 eastbound and westbound.

3.0 Project Schedule

The schedule, shown in Appendix A: Project Schedule, shows all major and minor tasks needed to achieve the client expectations for the I-40 & Country Club Drive westbound on-ramp project. All tasks have an expected date of starting as well as an achievement date. The schedule includes the critical path which will demonstrate tasks that must be completed before or on the end date expected. The first task of existing studies will take the team a total of 19 days for a total of 8 tasks. The majority of the work involved is the second task (design) which has a total of 55 days. The deliverable section of the project is approximately 51 days and includes all submissions and the respective deadlines for those submissions. The impacts of the assignment will take a total of two days combined while starting all impacts at the same time. The last task to be completed is the project management task which will elapse through the entire semester and contain weekly team meetings and bi-weekly meetings with the technical advisor and grading instructor. As a whole, this project contains a total of 5 major tasks for a total of approximately 68 working days.

The critical path of this project is specific because if one item of the critical path gets pushed back or delayed, the entire project will be pushed back however long the critical path was delayed. The critical path is intended to be followed by completing each task in the revised schedule on time, which includes a more accurate timeline of milestones and the final submission deadline. Since the critical path is vital in keeping the project deadlines on time, multiple group members will be tasked with working on a critical path task if the team falls behind.

4.0 Staffing

4.1 Staffing Estimation Description

The staffing plan, shown in Appendix B: Staffing Estimate includes a Project Manager (PM), Project Engineer (ENG), Engineer in training (EIT), and Civil Engineering Technician (TECH). Staffing and cost estimation tables were created to estimate the cost of the project. These tables show the expected hours by each team member to complete a task and/or subtask.

4.2 Qualifications of Team Members

4.2.1 Maxxwell Townsend

- Transportation Roadway Design
- Highway Design
- Cross-Sectional Design
- Pavement Design
- AutoCAD/Civil 3D Drafting

4.2.2 Zachary Johnson

- Civil 3D Drafting
- Cross-Sectional Design
- Highway Signage Plans
- Pavement Design
- Transportation Highway Design
- Intersection Design

4.2.3 Ramon Lopez

- Traffic Signal Operations
- Roadside Design
- Traffic Count Analysis
- Drafting Design
- Condition Assessment Analysis

4.2.4 Mohammed Alshaiban

- Auto CAD Design
- Macro ArcGIS
- Civil 3D Drafting
- HCS Highway Design
- Traffic Analysis

4.3 Typical Qualifications of Design Team Members

4.3.1 Project Manager

The typical qualifications for a project manager are primarily focused around on-the-job experience. Project managers have usually worked on many successful projects, as both project managers and as typical design team members. This role focuses on ensuring that the project is moving on schedule and on budget, while also meeting the clients expectations. Employees in this role must have passed their Professional Engineering (P.E.) exam and obtained their licensure as a professional engineer, due to the fact that their engineering seal is likely to be stamped onto the final plans.

4.3.2 Project Engineer

Project engineers have typically worked as engineers in training for many years before being promoted to project engineer. However, they may have also gained experience in other roles as well. Project engineers are the lead designers in a project. Meaning that they make important decisions regarding specific details of a project. Once again, employees in this role must have passed their Professional Engineering (P.E.) exam and obtained their licensure as a professional engineer.

4.3.3 Engineer in Training

Engineers in Training complete a large amount of design work for a project. They do not typically make large-scale design decisions, but rather write reports and create drafts for construction plans. Engineers in Training must pass their Fundamentals of Engineering (F.E.) exam, before they are able to be a licensed engineer.

4.3.4 Technician

Technicians take on a wide variety of duties within a project. These employees can be surveyors, drafters, lab analysis personnel, and much more. However, the employees in this role are not typically licensed engineers. The main role of these employees is to complete technical work within a project, which requires them to be proficient in a specific area. This expertise can be for computer software, engineering testing methods, surveying, construction inspections, etc.

5.0 Cost Estimation

The estimated cost, displayed below, is broken down by personnel and travel. Each team member has their own billing rate shown, which results in the total cost of labor. As for the travel rates, these costs were determined based on federal government rates and are charged on a per mile traveled basis, to typical meetings.

Table 5-1: Cost Estimate

1.0 Team Members	Billing Rate	Hours	Cost
PM	$195.00	77	$15,015.00
PE	$155.00	117	$18,135.00
EIT	$110.00	224	$24,640.00
TECH	$75.00	194	$14,550.00
Total			$72,340.00
2.0 Travel			
8 Meetings @ 4 mi/meeting		$0.58 mi/meeting	19
5 Meetings @ 2.5 mi/meeting		$0.58 mi/meeting	10
Total			29
Total Cost of Engineering Services			$72,369.00

6.0 References

[1] "Google Maps", *Google Maps,* 2019. [2019]. Available: https://www.google.com/maps/@35.2171255.5857948.17z [Accessed 05- Dec- 2019].

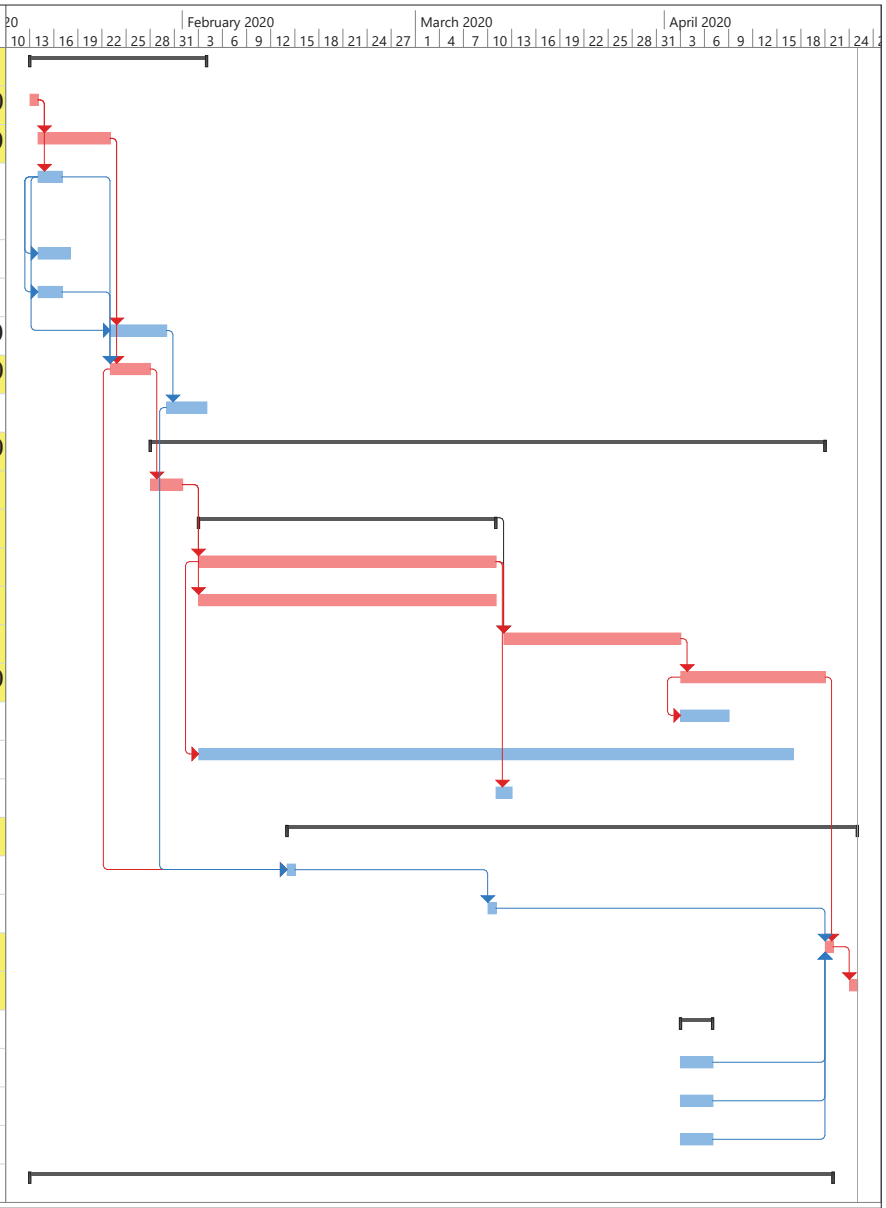
[2] American Association of State Highway Transportation Officials, "AASHTO Roadside Design Guidelines," vol. 4, 2011.

[3] Arizona Department of Transportation, "ADOT Roadway Design Guidelines," ADOT, 2012.

7.0 Appendix

Appendix A: Project Schedule

ID	Task Name	Duration	Start	Finish
1	Task 1: Existing Studies	16 days	Mon 1/13/20	Mon 2/3/20
2	1.1: Site Visit	1 day	Mon 1/13/20	Mon 1/13/20
3	1.2: Process Survey Data from GIS	7 days	Tue 1/14/20	Wed 1/22/20
4	1.3: Studying/Analyzing Existing Drainage Studies/As-Built Information	3 days	Tue 1/14/20	Thu 1/16/20
5	1.4: Runoff Calculations	4 days	Tue 1/14/20	Fri 1/17/20
6	1.5: Analyze Existing Geotechnical Information	3 days	Tue 1/14/20	Thu 1/16/20
7	1.6: Input and Process Existing Geometry into Civil3D	5 days	Thu 1/23/20	Wed 1/29/20
8	1.7: Create Existing Cross-Sections	3 days	Thu 1/23/20	Mon 1/27/20
9	1.8: Create Roadway Alignments/Base Files	3 days	Thu 1/30/20	Mon 2/3/20
10	Task 2: Design	56 days	Tue 1/28/20	Mon 4/20/20
11	2.1: Create Proposed Cross-Sections	4 days	Tue 1/28/20	Fri 1/31/20
12	2.2: Initial Design	27 days	Mon 2/3/20	Tue 3/10/20
13	2.2.1: Intersection Design	27 days	Mon 2/3/20	Tue 3/10/20
14	2.2.1: On-Ramp Design	27 days	Mon 2/3/20	Tue 3/10/20
15	2.3: Final Design Geometry/Cross-Sections	12 days	Thu 3/12/20	Thu 4/2/20
16	2.4: Final Drainage Design	12 days	Fri 4/3/20	Mon 4/20/20
17	2.5: Stormwater Pollution Prevention Control Plan	4 days	Fri 4/3/20	Wed 4/8/20
18	2.6: Construction Plan Set	50 days	Mon 2/3/20	Thu 4/16/20
19	2.7 Synchro Analysis and Traffic Analysis Recommendation	2 days	Wed 3/11/20	Thu 3/12/20
20	Task 3: Deliverables	47 days	Fri 2/14/20	Fri 4/24/20
21	3.1: 30% Submittal	1 day	Fri 2/14/20	Fri 2/14/20
22	3.2: 60% Submittal	1 day	Tue 3/10/20	Tue 3/10/20
23	3.3: 90% Submittal	1 day	Tue 4/21/20	Tue 4/21/20
24	3.4: Final Design Report	1 day	Fri 4/24/20	Fri 4/24/20
25	Task 4: Impacts	2 days	Fri 4/3/20	Mon 4/6/20
26	4.1: Social Impacts Assessment	2 days	Fri 4/3/20	Mon 4/6/20
27	4.2: Economic Impacts Assessment	2 days	Fri 4/3/20	Mon 4/6/20
28	4.3: Environmental Impacts Assessment	2 days	Fri 4/3/20	Mon 4/6/20
29	Task 5 Project Management	68 days	Mon 1/13/20	Tue 4/21/20



Appendix B: Staffing Estimate

Table B-2: Staffing Estimate

Tasks	PM	PE	EIT	TECH	Total
2.1 Task 1: Existing Studies	6	18	40	52	116
2.1.1: Task 1.1 Site Visit	2	4	4	4	14
2.1.2: Task 1.2 Process Survey Data from GIS	0	2	4	6	12
2.1.3: Task 1.3 Studying/Analyzing Existing Drainage Studies/As-Builts	2	2	6	6	16
2.1.4: Task 1.4 Runoff Calculations	1	2	4	4	11
2.1.5: Task 1.5 Analyze Existing Geotechnical Information	1	2	4	4	11
2.1.6: Task 1.6 Input an Process Existing Geometry into Civil3D	0	2	8	12	22
2.1.7: Task 1.7 Create Existing Cross-Sections	0	2	6	8	16
2.1.8: Task 1.8 Create Roadway Alignments/Base Files	0	2	4	8	14
2.2 Task 2: Design	17	38	98	74	227
2.2.1: Task 2.1Create Proposed Cross-Sections	1	4	8	6	19
2.2.2: Task 2.2 Initial Design	8	16	48	32	104
2.2.2.1: Task 2.2.1 Intersection Design	4	8	24	16	52
2.2.2.2: Task 2.2.2 On-Ramp Design	4	8	24	16	52
2.2.3: Task 2.3 Final Design Geometry/Cross-Sections	2	2	6	8	18
2.2.4: Task 2.4 Final Drainage Design	2	4	16	6	28
2.2.5: Task 2.5 Storm water Pollution Prevention Control Plan	1	2	2	0	5
2.2.6: Task 2.6 Construction Plan Set	2	8	16	14	40
2.2.7: Task 2.7 Synchro Analysis	1	2	2	8	13
2.3 Task 3: Deliverables	9	16	42	30	97
2.3.1: Task 3.1 30% Submittal	2	4	10	6	22
2.3.2: Task 3.2 60% Submittal	2	4	10	6	22
2.3.3: Task 3.3 90% Submittal	2	4	10	6	22
2.3.4: Task 3.4 Final Design Report	2	2	4	4	12
2.3.5: Website	1	2	8	8	19
2.4 Task 4: Impacts	3	3	6	0	12
2.4.1: Task 4.1 Social Impacts Assessment	1	1	2	0	4
2.4.2: Task 4.2Economic Impacts Assessment	1	1	2	0	4
2.4.3: Task 4.3 Environmental Impacts Assessment	1	1	2	0	4
2.5 Task 5 Project Management	42	42	38	38	160
2.5.1: Task 5.1 Grading Instructor Meetings	8	8	8	8	32
2.5.2: Task 5.2 Client Meetings	5	5	5	5	20
2.5.3: Task 5.3 Technical Advisor Meetings	5	5	5	5	20
2.5.4: Task 5.4 Team Meetings	16	16	16	16	64
2.5.5: Task 5.5 Schedule Management	4	4	2	2	12
2.5.6: Task 5.6 Cost/Resource Management	4	4	2	2	12
Total	77	117	224	194	612