Letter of Transmittal

Ruff Engineering, Inc.

NAU Civil & Environmental Engineering Department - Pets Return Home - Abigail Autieri, Ryann DuBose, Allyson Fedor, Crockett Saline

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12/10/2019

Mark Happe
Pets Return Home
4555 N Peyton Place
Clarkdale, AZ 86324

Dear Mr. Happe,

Attached is our project proposal titled Pets Return Home Site Design. The purpose of the proposal is to analyze the project in terms of research and design. This project will officially start on January 13th, 2020 and will complete on May 1st, 2020. This is submitted as the final copy of the proposal. Please let us know if you have any concerns.

Best,

Ruff Engineering, Inc.
Civil & Environmental Engineering, NAU
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Pets Return Home Project

Ruff Engineering

Abigail Autieri, Allyson Fedor,

Ryann DuBose, Crockett Saline

Final Report

December 10, 2019

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List of Abbreviations

ASTM - American Society for Testing and Materials
FEMA - Federal Emergency Management Agency
USDA - United States Department of Agriculture
USGS - United States Geological Survey
PPE - Personal Protective Equipment
SWPP - Stormwater Prevention Plan

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1.0 Project Understanding

1.1 Project Purpose

Pets Return Home is a dog rehabilitation, sanctuary, and adoption center. The purpose of the project is to evaluate the feasibility of modifying the kennel space at the rescue. The project is needed to improve the aesthetic appeal and the functionality of the kennel space. The increase in functionality will include improvements in maintenance, sanitation, drainage, and quality of life for those living in the kennel space. The problems with the current kennel location are the lack of run space for the dogs housed in kennels and the poor drainage of the wastewater from the kennel. The client wishes to expand the current kennel space by expanding the existing concrete pad; giving the dogs contained in the kennels a run space.

1.2 Project Background

The site is located 4555 N. Peyton Place in Clarkdale, Arizona. Clarkdale, Arizona is considered to be within the county boundaries of Yavapai County. Figures 1-1, 1-2, and 1-3 below depict the location of Yavapai County, the location of Clarkdale, Arizona, and an aerial view of the project site.

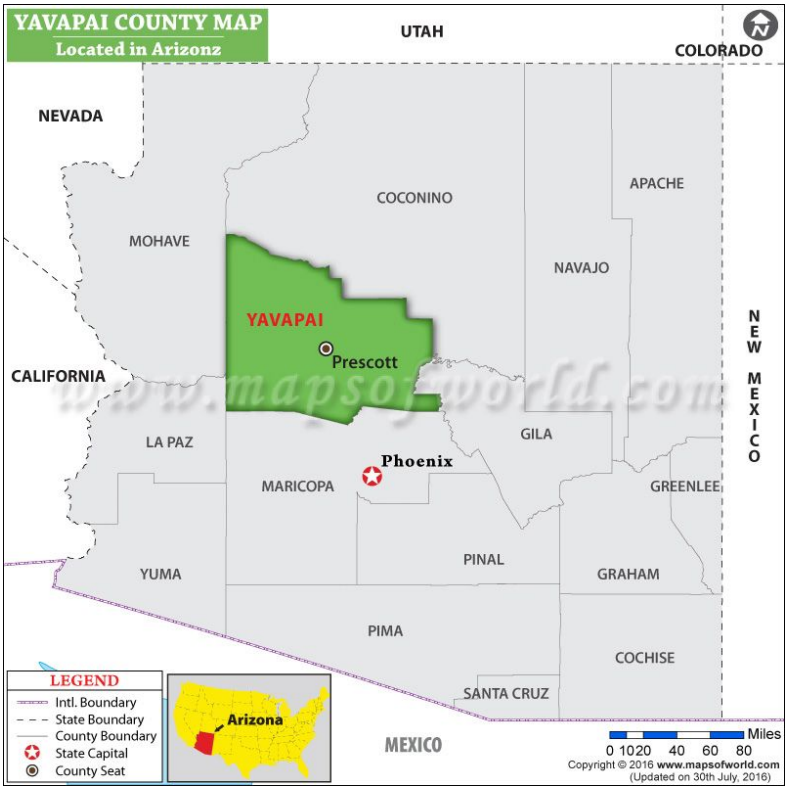


Figure 1-1: Location Map of Yavapai County, Arizona. [1]

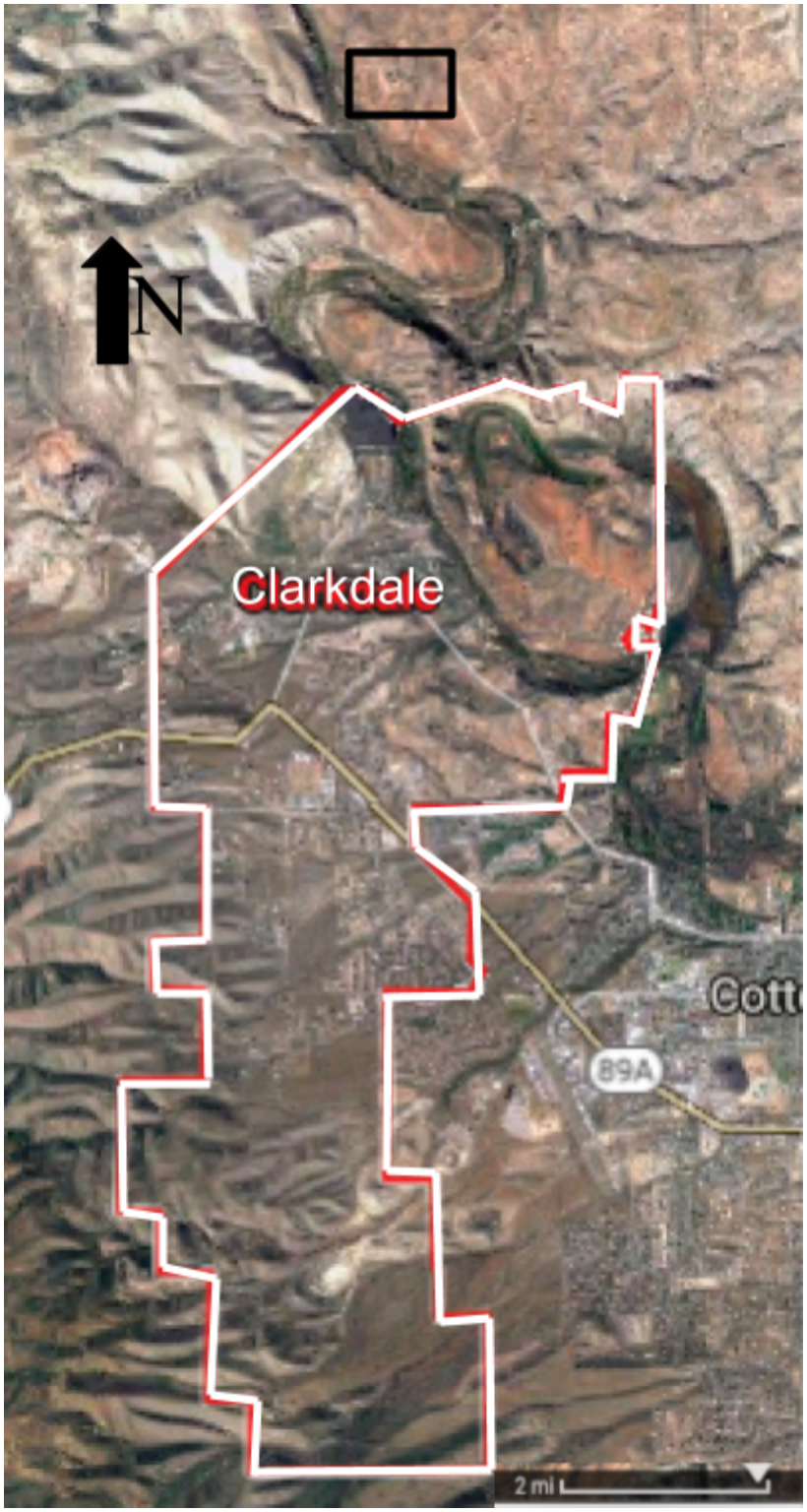


Figure 1-2: Location of the Town of Clarkdale in relation to Cottonwood, AZ Black box depicts where the site is located on the map.

Figure 1-3: Aerial view of project site in relation to Verde River. The entire site is outlined in a red box.

Figure 1-4: Aerial view of the project site. The outlined area highlights the project location at the site.

The project area is approximately 250 yards squared. The area is already developed to accommodate the dogs on the property. The site currently has 10 kennels, with dimensions 10 foot by 10 foot each. The spacing is five kennels on each side with approximately 8 foot walk path in between.

Figure 1-5: A visual of the project site's pre-existing development (red) and the available space (yellow) for the site design.

1.3 Technical Considerations

During the initial site walk, the client presented the surface drainage issues on the entire property, the need to expand the dog kennels, and increase its sanitation capacity. In order to provide a solution, it is recommended that a hydrologic and hydro-geological study, survey work, and geotechnical investigation be performed.

The purpose of performing the hydrological study is to find out how the existing surface drainage from the property and surrounding areas/properties drains. For the hydro-geologic study, an infiltration test (percolation test) may be needed to determine if the soils present may be utilized in the design of the sanitary containment and disposal of sewer/wash water of the kennels.

A survey of the site and surrounding areas is necessary to create a topographical map of the site to determine the current in-situ grade and provide data to help determine the cut/fill necessary for the proposed solution.

A geotechnical investigation of the in-situ soils present at the site will allow for soil classification to be determined. Soils present in and surrounding the project site must be considered to determine clays present that may prevent drainage of the surface runoff that the client would like to manage.

1.4 Potential Challenge

It is common for engineering projects to be delayed by unforeseen obstacles. For this project, weather may present a challenge. The Town of Clarkdale is located in the northern region of Arizona. Snowfall and precipitation is expected in this area, and on average approximately 1 inch in

the months of January and February in the form of snow and rain [2]. These adverse weather conditions may affect the ability to collect data essential to the design process. In situations where the weather is a concern for the safety of the team, and/or the equipment intended to be used can not operate without potential for error, the proposed technical investigation(s) may be rescheduled for a later date when conditions are more suitable.

1.5 Stakeholders

Stakeholders involved in this project are the co-founder Mark Happe, the Board of Directors, neighbors, volunteers, and donors of Pets Return Home. Also considered to be affected by this project are the canine inhabitants and rescues that use Pets Return Home as a sanctuary.

2.0 Scope of Services

2.1 Task 1: Zoning Due Diligence

2.1.1 Task 1.1: Zoning Due Diligence

Since the project location is within the boundaries of Yavapai County, the determination of the zone district and applicable ordinances is necessary. Adhering to zoning ordinances ensures that the proposed design will be legal and prevent future repercussions. The Planning and Zoning Ordinance for the Unincorporated Areas of Yavapai County may be utilized for the determination of ordinances related to the associated zone district.

2.1.2 Task 1.2: Arizona 811

Arizona 811 will be contacted prior to the field investigation at the site. This service marks only the primary utility lines in the roadway and dedicated utility easements and usually does not locate tributary lateral lines on private property. The Client is expected to provide all necessary information and drawings identifying the location of any additional underground lines or structures that may be within the site boundaries. A private utility locator can be retained if necessary and the costs of their services invoiced in addition to the fee quoted herein.

2.2 Task 2: Surveying

2.2.1 Task 2.1: Survey

A survey of the site should be completed using a rod and leveling rod and optical level. The recorded survey data will provide information of the current elevation and project site dimensions. This will allow for aid in further analyses of in-situ conditions and cut/fill volumes if needed for the proposed design.

2.2.2 Task 2.2: Topographic Map

The topographic map is created using the survey data gathered from the field investigation. This data will be gathered and put into Civil 3D so the design can be created within the representative surface. The survey will allow for cut/fill, drainage, and a proposed surface to be created.

2.3 Task 3: Field Investigation

2.3.1 Task 3.1: Field Sampling

A sampling plan will need to be supplied to identify parameters to be measured, range of possible values, how and when samples will be acquired, samples sizes, data storage format, and to assign roles and responsibilities. This will ensure that the resulting data will be representative of the parameters of interest and allow for all questions to be answered.

2.3.2 Task 3.2: Safety Plan

Prior to the field investigation, a safety plan will need to be created for the tests, sampling, and the data collected in the field. Personal protective equipment (PPE) may need to be brought out to the site if it is determined necessary for the in-situ test or sampling. Due to the data collection being close to the Verde River, PPE that may be required include: long pants, closed toe shoes and colored vest so each person can be easily found.

2.3.3 Task 3.3: Geotechnical Sampling

The determination of the existing soil conditions is recommended because the soil conditions may influence the effectiveness of the proposed design. Soil samples collected will be further analyzed in a lab.

2.3.4 Task 3.4: Infiltration Testing

An infiltration test will be conducted during the field investigation. This test analyzes the rate that water percolates through soil. This test will be performed according to the Arizona Department of Environment Quality R18-9-A309 [3]. This information is used to design a sanitation septic tank and drain field.

2.3.5 Task 3.5: Existing Slab Analysis

An analysis of the existing slab is recommended because the slab's characteristics may influence the final proposed design. The existing slab's composition, placement, reinforcement, and dimensions should be determined.

2.4 Task 4: Hydrology

2.4.1 Task 4.1: Previous Studies

Research is required to find previous hydrological studies done at or near the site. These studies can help determine the existing stormwater runoff, based off the weather, drainage, vegetation, and land use.

2.4.2 Task 4.2: Basin Delineation

Basin delineation is done to determine the bounds of a watershed. Delineation needs to be done for the site to help determine both existing and future storm runoff for the site. Basin delineations are often determined on topographic maps.

2.4.2.1 Task 4.2.1: Major Basin Delineation

Major basin delineation is the delineation of the watershed in which the site is contained. The delineation of the major basin is needed to delineate the sub-basins of the watershed.

2.4.2.2 Task 4.2.2: Sub-Basin Delineation

Sub-basin delineation is the delineation of smaller areas of the major basin. The sub-basin delineation is needed to complete the determination of the bounds of the watershed.

2.4.3 Task 4.3: Sub-Basin Variables

Sub-basin variables are used to determine storm event runoff for a watershed. Sub-basin variables include: time of concentration, flow routing, weighted curve number determination, and sub-basin storage. The variables are used to develop a hydrograph and to determine storm event runoff.

2.4.3.1 Task 4.3.1: Time of Concentration

Time of concentration is the time it takes for a drop of water to travel from the highest point in a sub-basin to the outlet of that sub-basin. Determining time of concentration is done using a topographic map of the basin.

2.4.3.2 Task 4.3.2: Flow Routing

Flow routing is the process of mapping the flow through a sub-basin using the contours of a topographic map.

2.4.3.3 Task 4.3.3: Weighted Curve Number Determination

A weighted curve number is determined for each sub-basin. It is a weighted average of the different drainage-types based on area. Standards for calculating a weighted curve number are given by the USDA [4].

2.4.3.4 Task 4.3.4: Sub-Basin Storage

Sub-basin storage is the volume of water a sub-basin holds after a storm event.

2.4.4 Task 4.4: Hydrograph Development

A hydrograph is a graph that shows the rate of flow versus time for a sub-basin. A hydrograph needs to be developed to show the change in flow over time after a storm event.

2.4.5 Task 4.5: Storm Event Runoff Determination

Storm event runoff is calculated using the sub-basin variables above. Storm event runoff should be determined for both existing and proposed conditions. Once both have been calculated, comparison is important to see how the proposed conditions will change the hydrology of the site.

2.4.5.1 Task 4.5.1: Existing

The existing storm event runoff is determined using the existing conditions of the site.

2.4.5.2 Task 4.5.2: Proposed

The proposed storm event runoff is determined using the proposed conditions of the site.

2.5 Task 5: Hydraulics

2.5.1 Task 5.1: Previous Studies

It is suggested that the previous hydraulic studies performed, if any, in and around the project site should be reviewed. Previous hydraulic analyses may allow for further insight into the current hydraulic conditions and may allow for comparison of results to ensure the success of the technical work performed.

2.5.2 Task 5.2: Proposed Channel Hydraulic Analysis

If the proposed solution utilizes a channel to convey drainage, a hydraulic analysis of the proposed channel will need to be performed. The analysis will determine the capacity of the proposed channel and flow rate of the drainage. This information will help determine if the proposed design meets the needs of the client.

2.6 Task 6: Geotechnical Analysis

2.6.1 Task 6.1: Previous Studies

Soil studies that have been previously performed in or near the project site could give insight to existing soil conditions. Previous studies can contain useful information and can be compared to the results of the recommended analyses.

2.6.2 Task 6.2: Laboratory Testing

An engineer will examine the samples and field logs and assign the laboratory tests. Results from laboratory tests will allow for soil classification(s) to be determined using the ASTM soil classification system [6]. The following laboratory test may be performed:

- Field moisture contents (ASTM D2216) [7]
- In-situ soil density (ASTM D2937) [8]
- Remolded expansion potential (ARIZ 249) [9]
- Compression (modified ASTM D2435) [10]
- Liquid limit and plasticity index (ASTM D4318-17e1) [11]
- Compressive strength test of rock sample (ASTM C39/C39M) [12]
- Compaction proctor (ASTM D698-12e2) [13]

2.7 Task 7: Site Design

2.7.1 Task 7.1: Develop Alternatives

Multiple alternative designs will be created, each meeting the specified design criteria.

2.7.2 Task 7.2: Decision Matrix

A decision matrix will be used to identify the design that best meets the client's needs and the design criteria provided by Yavapai County and the Town of Clarkdale [14,15]. This design will then be used for the completion of the project.

2.7.3 Task 7.3: Drainage Plan

2.7.3.1 Task 7.3.1: Grading

The existing surface will be modified to create a proposed surface. This proposed surface will allow the site to be drained in a manner that is required by the hydrologic study.

2.7.3.2 Task 7.3.2: Cut/Fill

Cut and fill needed will be determined using the proposed graded surface and existing surface data in Civil 3D. If any soil is determined to be needed on the site or

to be removed from the site, specific quantities will be listed in the construction documents.

2.7.4 Task 7.4: Construction Documents

A complete set of plans will be created including a drainage,stormwater prevention plan (SWPP), and concrete pad plans for the site. Along with the plan sets there with an engineering design report that includes how the plans were created.

2.7.5 Task 7.5 Cost Estimate

A cost estimate will be created using the quantities determined in the construction documents and the current costs of materials and labor.

2.8 Task 8: Impacts

2.8.1 Task 8.1: Environmental Impacts

Environmental impacts will look at the impacts the proposed design has on the surrounding environment and if the construction should be performed.

2.8.2 Task 8.2: Economic Impacts

The effect of the proposed design on property values and the sanctuary will be assessed to determine economic impact.

2.8.3 Task 8.3: Social Impacts

The social impacts of the proposed design on the neighboring communities will be evaluated, and will include the aesthetic appeal of the site as well as the quality of life for both the residents and the animals living at the site.

2.9 Task 9: Deliverables

2.9.1 Task 9.1: 30% Submittal

This will include a report of the progress of the project at this time and a schedule of the upcoming work with a powerpoint to report the project's progress to our colleagues. The 30% submittal will be February 14, 2020.

2.9.1.1 Task 9.1.1: 30% Report

The 30% report will contain the findings from the site investigation and results of the analyses performed so far. The tasks that will be completed for the 30% report are Task 1: Due Diligence, Task 2: Surveying, Task 3: Field Investigation, Task 4.1: Previous Studies, Task 4.2: Basin Delineation, Task 4.3: Sub-basin Variables, and Task 6: Geotechnical Analysis

2.9.1.2 Task 9.1.2: 30% Presentation

The 30% presentation will discuss the results outlined in the 30% report.

2.9.2 Task 9.2: 60% Submittal

This will include a report of the progress of the project at that time and a schedule of the upcoming work with a powerpoint to report the project's progress with our colleagues. The 60% submittal is due Tuesday, March 10, 2020.

2.9.2.1 Task 9.2.1: 60% Report

The 60% report will contain the results of the analyses performed so far. The tasks that will be completed for the report include those for the 30% report as well as Task 4.4: Hydrograph Development, Task 4.5: Storm Event Runoff Determination, Task 5: Hydraulics, Task 7.1: Develop Alternatives, and Task 7.2: Decision Matrix.

2.9.2.2 Task 9.2.2 Task: 60% Presentation

The 60% presentation will discuss the results outlined in the 60% report.

2.9.3 Task 9.3: 90% Submittal

This will include a report of the progress of the projects at the time and a schedule of the final work required to complete the job with a powerpoint to report the job's progress with our colleagues. A website should be started and allow anyone to review and see the progress of the project. The 90% submittal is due Thursday, April 9, 2020.

2.9.3.1 Task 9.3.1: 90% Report

The 90% report will contain the final results of the analyses performed and the design consideration. The tasks that will be completed for the 90% report include those from the 30% and 60% reports as well as Task 7.3: Drainage Plan, Task 7.4: Construction Drawings, Task 7.5: Cost Estimate, and Task 8: Impacts.

2.9.3.2 Task 9.3.2: 90% Presentation

The 90% presentation will discuss the final results outlined in the 90% report.

2.9.3.3 Task 9.3.2: 90% Website

The 90% website will depict the final results of the analyses performed and the resulting design consideration.

2.9.4 Task 9.4: Final Submittal

This will be the final report of the project that will include construction plans, a final presentation to report to our colleagues, and an operating website of the project. The final submittal is due May 1, 2020.

2.9.4.1 Task 9.4.1: Final Report

The final report will contain the final results of the analyses performed and the final proposed design to be submitted to the client. All tasks will be complete for the final submittal.

2.9.4.2 Task 9.4.2: Final Construction Documents

A plan set will be created for the design. This will include drainage and concrete plans. In the plans, cross sections and qualities will be provided and other data that is needed to construct.

2.9.4.3 Task 9.4.3: Final Presentation

The final presentation will discuss the final results and the proposed design outlined in the final report.

2.9.4.4 Task 9.4.4: Final Website

The final website website will depict the final results and the proposed design.

2.10 Task 10: Project Management

2.10.1 Task 10.1: Meetings

Team meetings will happen on a regular basis. Periodic meetings will be had with the Technical Advisor, Grading Instructor, and the Client. The content of these meetings will be established by an agenda and documented in the meeting minutes.

2.10.1.1 Task 10.1.1: Grading Instructor

Meetings with the grading instructor will contain project progress updates and discussing deliverables, redlined and future.

2.10.1.2 Task 10.1.2: Technical Advisor

Meetings with the technical advisor will contain project progress updates and technical advice about the project and information about technical considerations that need to be made for the project.

2.10.1.3 Task 10.1.3: Client

Client meetings will be for determining the scope and for updates about the project.

2.10.1.4 Task 10.1.4: Team

Team meetings will be had to work on the project and to check in on the progress of the project and deliverables.

2.10.2 Task 10.2: Schedule/Resource Management

Schedule and resource management will be a task the team will work on together to get work done within the time constraints of the project. Any setbacks in scheduling will be addressed quickly to prevent further delays.

2.11 Exclusions

Exclusions included for this project are structural engineering, floodplain mapping, landscape architecture, and construction management. Structural engineering of the kennel space will be needed if the client wants a more permanent fenced structure but will not be provided. Floodplain mapping in reference with the Verde River and the project site will not be provided for this project. Landscape architecture may be sought by the client but will not be included because it is outside of the scope of this project and Ruff Engineering's expertise. Construction management will be crucial during the construction of the proposed design but will not be performed by Ruff Engineering as it is outside of the firm's expertise.

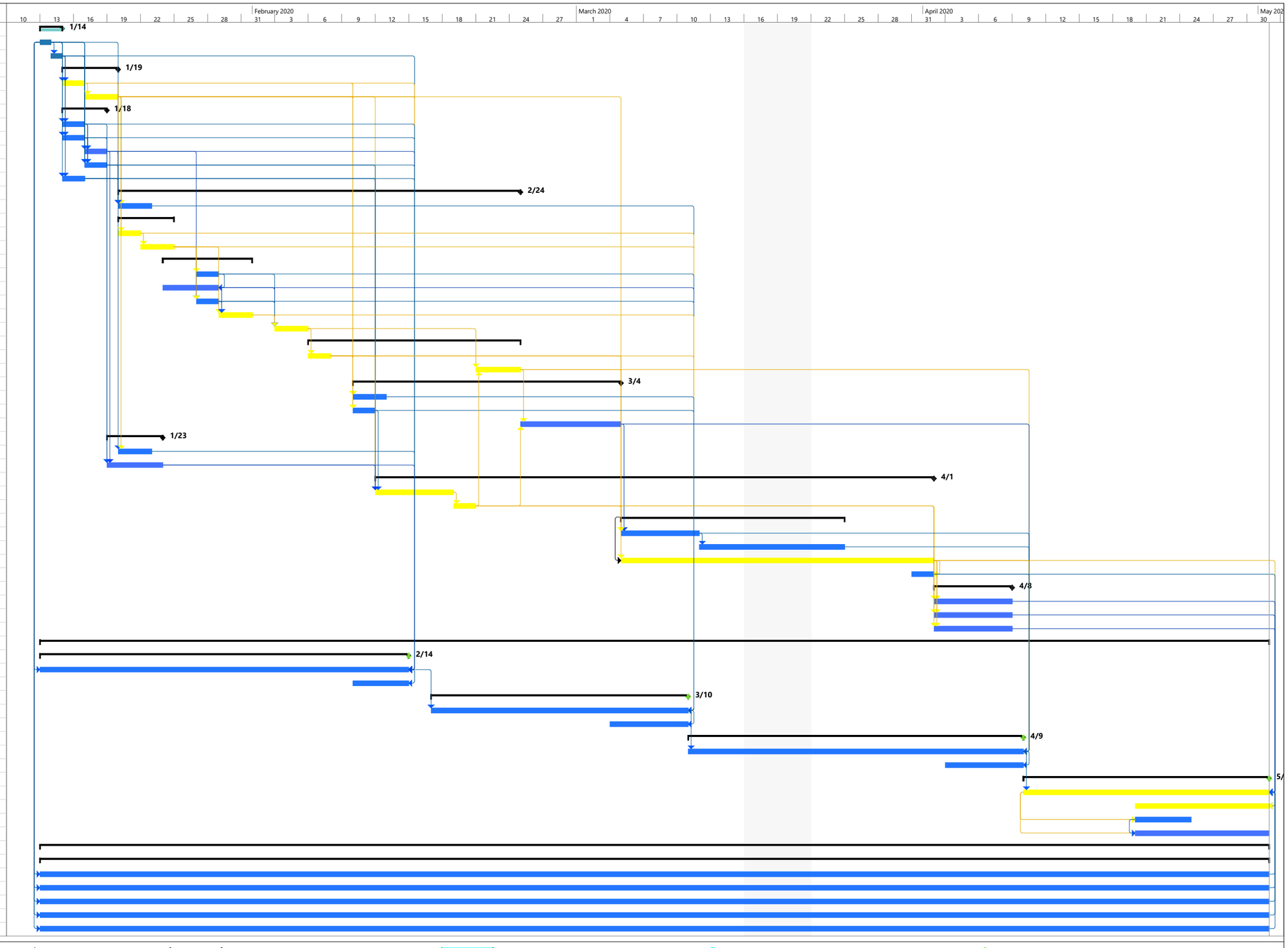
3.0 Project Schedule

Total duration for the project is expected to be from January 11, 2020 to May 7, 2020. The GANTT Chart is shown in Figure 3-1.

3.1 Critical Path

The critical path is the chain of events that define the minimum amount of time to complete the project. The critical path has been identified as: Task 2.1 Survey, Task 2.2 Topographic Map, Task 4.2.1 Major Basin Delineation, Task 4.2.2 Sub-Basin Delineation, Task 4.3.4 Sub-basin Storage, Task 4.4 Hydrograph Development, Task 4.5.1 Existing Storm Event Runoff Determination, Task 4.5.2 Proposed Storm Event Runoff Determination, Task 7.1 Develop Alternatives, Task 7.2Decision Matrix, Task 7.4 Construction Drawings, Task 9.4.1 Final Report, and Task 9.4.2 Final Construction Documents. This is the critical path because it consists of a chain of tasks that takes the longest duration to complete and must be completed on time in order to complete the project on time. The timing and duration of the critical path will be maintained by making those tasks priority, properly scheduling predecessors, and preparing for the next upcoming tasks.

ID	Task Mode	Task Name	Duration
1		**Task 1: Due Diligence**	**2 days**
2		Task 1.1: Zoning Due Diligence	1 day
3		Task 1.2: Arizona 811	1 day
4		**Task 2: Surveying**	**5 days**
5		Task 2.1: Survey	2 days
6		Task 2.2: Topographic Map	3 days
7		**Task 3 Field Investigation**	**4 days**
8		Task 3.1: Sampling Plan	2 days
9		Task 3.2: Safety Plan	2 days
10		Task 3.3: Geotechnical Sampling	2 days
11		Task 3.4: Infiltration Testing	2 days
12		Task 3.5: Existing Slab Analysis	2 days
13		**Task 4: Hydrology**	**26 days**
14		Task 4.1: Previous Studies	3 days
15		Task 4.2: Basin Delineation	5 days
16		Task 4.2.1: Major Basin Delineation	2 days
17		Task 4.2.2: Sub-Basin Delineation	3 days
18		Task 4.3: Sub-Basin Variables	6 days
19		Task 4.3.1: Flow Routing	2 days
20		Task 4.3.2: Time of Concentration	3 days
21		Task 4.3.3: Weighted Curve Number	2 days
22		Task 4.3.4: Sub-basin Storage	3 days
23		Task 4.4: Hydrograph Development	3 days
24		Task 4.5: Storm Event Runoff Deter.	13 days
25		Task 4.5.1: Existing	2 days
26		Task 4.5.2: Proposed	2 days
27		**Task 5: Hydraulics**	**18 days**
28		Task 5.1: Previous Studies	3 days
29		Task 5.2: Existing Floodplain Mapping	2 days
30		Task 5.3 Proposed Channel Hydraulics	7 days
31		**Task 6: Geotechnical Analysis**	**5 days**
32		Task 6.1: Previous Studies	3 days
33		Task 6.2: Laboratory Testing	5 days
34		**Task 7: Site Design**	**31 days**
35		Task 7.1: Develop Alternatives	5 days
36		Task 7.2: Decision Matrix	2 days
37		Task 7.3: Drainage Plan	9 days
38		Task 7.3.1: Grading	5 days
39		Task 7.3.2: Cut/fill	4 days
40		Task 7.4 Construction Drawings	15 days
41		Task 7.5 Cost Estimate	2 days
42		**Task 8: Impacts**	**5 days**
43		Task 8.1: Environmental	5 days
44		Task 8.2: Economic Impacts	5 days
45		Task 8.3: Social Impacts	5 days
46		**Task 9: Deliverables**	**77 days**
47		Task 9.1: 30% Submittal	27 days
48		Task 9.1.1: 30% Report	27 days
49		Task 9.1.2: 30% Presentation	5 days
50		Task 9.2: 60% Submittal	17 days
51		Task 9.2.1: 60% Report	17 days
52		Task 9.2.2: 60% Presentation	5 days
53		Task 9.3: 90% Submittal	17 days
54		Task 9.3.1: 90% Report	17 days
55		Task 9.3.3: 90% Website	5 days
56		Task 9.4: Final Submittal	16 days
57		Task 9.4.1: Final Report	16 days
58		Task 9.4.2: Final Construction Doc.	10 days
59		Task 9.4.3: Final Presentation	5 days
60		Task 9.4.4: Final Website	10 days
61		**Task 10: Project Management**	**77 days?**
62		Task 10.1: Meetings	77 days?
63		Task 10.1.1: Client Meetings	77 days?
64		Task 10.1.2: Grading Instructor	77 days?
65		Task 10.1.3: Technical Advisor	77 days?
66		Task 10.1.4: Team	77 days?
67		Task 10.2: Schedule/Resource Management	77 days?



Project: Capstone Schedule
Date: Sun 12/8/19

Task | Milestone | Project Summary | Inactive Milestone | Manual Task | Manual Summary Rollup | Start-only | External Tasks | Deadline | Manual Progress
Split | Summary | Inactive Task | Inactive Summary | Duration-only | Manual Summary | Finish-only | External Milestone | Progress

4.0 Staffing Plan

A staffing plan has been constructed for all tasks/subtasks listed in section 2.0. The following personnel are included: Senior Engineer, Project Engineer, Engineer in Training, and Technician.

4.1 Senior Personnel

The following personnel are required to complete this project and must have the following qualifications:

1. Senior Engineer
   A senior engineer would need to have a Bachelor's or Master's Degree in Civil Engineering and a PE license. They will also need a minimum of 12- 15 years experience in the engineering industry.

2. Project Engineer
   A project engineer will need to have a Bachelor's Degree in Civil Engineering or a Master's Degree in Civil Engineering. They will also have obtained a PE license and have 5-10 years experience in the engineering industry.

3. Engineer in Training (EIT)
   An EIT will need to have a Bachelor's Degree or Master's Degree in Civil Engineering and passed the Fundamentals Exam. It is best that they have 1 year of experience.

4. Technician
   A technician will need to have graduated with a Bachelor's Degree in Civil Engineering or Civil Drafting. They will need to be an Arizona Registered Land Surveyor (RLS), have a minimum of 10 years of relevant survey experience, and a valid driver's license with an acceptable driving record. The technician is an individual that has 2-4 years of experience under another experienced technician. A technician needs to have the capabilities to perform tasks in and out of the lab, and able to perform necessary test and operate the equipment.

Table 4-1: Staffing Matrix

STAFF HOURS					
Task	**SENG**	**PE**	**Technician**	**EIT**	**Task Total**
Task 1: Due Diligence					18
Task 1.1: Zoning Due Diligence	1	6	0	4	
Task 1.2: Arizona 811	1	4	0	2	
Task 2: Surveying					42
Task 2.1: Survey	2	6	16	0	
Task 2.2: Topographic Map	1	3	6	8	
Task 3: Field Investigation					80
Task 3.1: Sampling Plan	2	5	5	3	
Task 3.2: Safety Plan	1	2	0	1	
Task 3.3: Geotechnical Sampling	0	10	6	8	
Task 3.4: Infiltration Testing	3	10	6	8	
Task 3.4: Existing Slab Analysis	2	8	0	0	
Task 4: Hydrology					222
Task 4.1: Previous Studies	1	8	0	8	
Task 4.2: Basin Delineation					
Task 4.2.1: Major Basin Delineation	1	20	0	10	
Task 4.2.2: Sub-Basin Delineation	1	30	0	10	
Task 4.3: Sub-Basin Variables					
Task 4.3.1: Flow Routing	1	8	0	8	
Task 4.3.2: Time of Concentration	1	8	0	6	
Task 4.3.3: Weighted Curve Number	1	10	0	6	
Task 4.3.4: Sub-basin Storage:	1	12	0	10	
Task 4.4: Hydrograph Develoment	1	10	0	8	
Task 4.5: Storm Event Runoff Deter.					
Task 4.5.1: Existing	2	10	0	9	
Task 4.5.2: Proposed	2	10	0	9	
Task 5: Hydraulics					49
Task 5.1: Previous Studies	1	6	0	8	
Task 5.2 Proposed Channel Hydraulics	2	20	0	12	
Task 6: Geotechnical Analysis					30
Task 6.1: Previous Studies	1	3	0	4	
Task 6.2: Laboratory Testing	2	0	20	0	
Task 7: Site Design					93
Task 7.1: Develop Alternatives	1	9	5	6	
Task 7.2: Decision Matrix	2	6	0	2	
Task 7.3: Drainage Plan					
Task 7.3.1: Grading	1	6	8	5	
Task 7.3.2: Cut/fill	1	3	4	8	
Task 7.4 Construction Drawings	2	9	6	5	
Task 7.5 Cost Esitmate	0	2	0	2	
Task 8: Impacts					72
Task 8.1: Environmental	2	12	0	10	
Task 8.2: Economic Impacts	2	12	0	10	
Task 8.3: Social Impacts	2	12	0	10	
Task 9: Deliverables					98
Task 9.1: 30% Submittal					
Task 9.1.1: 30% Report	2	4	2	4	
Task 9.1.2: 30% Presentation	1	1	0	1	
Task 9.2: 60% Submittal					
Task 9.2.1: 60% Report	2	4	2	4	
Task 9.2.2: 60% Presentation	1	2	0	2	
Task 9.3: 90% Submittal					
Task 9.3.1: 90% Report	2	4	2	4	
Task 9.3.2: 90% Presentation	1	1	0	1	
Task 9.3.3: 90% Website	1	6	0	6	
Task 9.4: Final Submittal					
Task 9.4.1: Final Report	2	4	2	4	
Task 9.4.2: Final Construction Docs	2	6	0	6	
Task 9.4.3: Final Presentation	1	2	0	2	
Task 9.4.4: Final Website	1	3	0	3	
Task 10: Project Management					81
Task 10.1: Meetings					
Task 10.1.1: Grading Instructor	3	3	0	3	
Task 10.1.2: Technical Advisor	3	3	0	3	
Task 10.1.3: Client	3	3	0	3	
Task 10.1.4: Team	8	8	8	8	
Task 10.2: Schedule/Resource Management	2	10	0	10	
TOTAL	71	309	81	244	**705**

4.2 Staffing

1. Senior Engineer (SE)
   The SE will complete a total of 71 hours of work for the project. These hours are split between every task as shown: 2 hours due diligence, 3 hours surveying, 8 hours field investigation, 12 hours hydrology, 3 hours hydraulics, 3 hours geotechnical analysis, 7 hours site design, 6 hours impacts, 16 hours deliverables, and 19 hours on project management. Most of these hours are for quality assurance of each task.

2. Project Engineer (PE)
   The PE will complete a total of 309 hours of work for the project. These hours are split between every task as shown: 10 hours due diligence, 9 hours surveying, 35 hours field investigation, 126 hours hydrology, 26 hours hydraulics, 3 hours geotechnical analysis, 35 hours site design, 36 hours impacts, 37 hours deliverables, and 27 hours on project management. These hours will be spent working on the project and overseeing the EIT and technician.

3. Engineer in Training (EIT)
   The EIT will complete a total of 244 hours of work for the project. These hours are split between every task as shown: 6 hours due diligence, 8 hours surveying, 20 hours field investigation, 84 hours hydrology, 20 hours hydraulics, 4 hours geotechnical analysis, 28 hours site design, 30 hours impacts, 37 hours deliverables, and 27 hours on project management. These hours will be spent working with the project engineer, and also completing major task that will be reviewed by the PE or the SE.

4. Technician
   The technician will complete a total of 81 hours of work for this project. The hours are split between most tasks except due diligence, hydrology, hydraulics, and site design. The hours completed for this project are split up as follows: 22 hours surveying, 17 hours field investigation, 20 hours geotechnical analysis, 23 hours site design, 8 hours deliverables, and 8 hours on project management.

5.0 Cost of Engineering Services

Total cost of the completion of the design project amounts to $105,906. Table 5-1 shows a breakdown of overall costs for staffing, supplies, and laboratory testing. The supplies included for surveying cost are as follows: Total Station, tripod set up, rod, level, and AutoCAD Civil 3D. The supplies included for Geotechnical are as follows: Sieves, baggies, bowls, latex sleeve, and laboratory access.

Table 5-1: Final Project Cost Estimate

1.0 Personnel	Classification	Hours	Rate, $/hr	Cost
	SENG	71	$219	$15,549
	PE	309	$175	$54,075
	EIT	244	$110	$26,840
	Technician	81	$65	$5,293
	Total Personnel			**$101,757**
2.0 Travel	**Classification**	**Item Total**	**Unit Cost**	**Cost**
	4 meetings @ 140 mi (roundtrip)	560	$0.58	$325
	Vechicle Rental (per day/trip)	4	$125.00	$500
	Total Travel			**$825**
3.0 Supplies	**Classification**	**Days**	**Unit Cost ($/day)**	**Cost**
	Surveying	3	$275	$825
	Geotechnical			
	Equipment	3	$200	$600
	Lab	5	$380	$1,900
	Total Supplies			**$3,325**
4.0 Total				**$105,906**

6.0 References

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