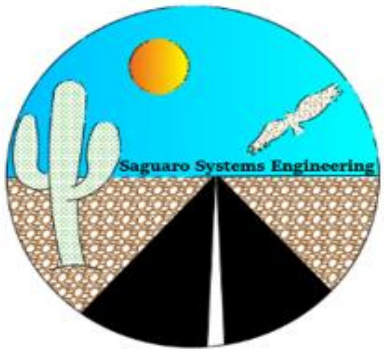

Letter of Transmittal

TO: National Park Service, Rich Goepfrich, Jr.

FROM: Desmin Fontaine, Dylan Edens, Julia Trivers, and Raquel Severino

DATE: Monday, May 4, 2020

SUBJECT: Project Proposal

Dear Mr. Goepfrich Jr.,

The project proposal is attached, titled Saguaro National Park Parking Lot Assessment and Design: Proposal. The purpose of the proposal is to analyze the project in terms of research, design and assessment. The design and assessment will be completed per the clients' needs. This is submitted as the 6th version copy of this proposal. Please let us know if you have any comments or concerns.

Best,
Saguaro Systems Engineering
Civil & Environmental Engineering, NAU
Rls477@nau.edu

5/4/2020

Saguaro National Park Parking Lot Assessment and Design: Proposal

Version 6

Spring 2020 - CENE476C - Sec. 1

To Grading Instructor:

Dr. Jeffrey Heiderscheidt

Written By:

Saguaro Systems Engineering

Members:

Desmin Fontaine, Dylan Edens, Julia Trivers, and Raquel Severino

NORTHERN ARIZONA UNIVERSITY

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List of Abbreviations

Abbreviation	Definition
3D	Three Dimensional
AASHTO	American Association of State Highway Transportation Officials
ADA	Americans with Disabilities Act
ASTM	American Society for Testing and Materials
CCC	Civilian Conservation Corps
EIT	Engineer
GI	Grading Instructor
HEC-HMS	Hydraulic Modeling System
LID	Low Impact Design
NAU	Northern Arizona University
NPS	National Park Services
PE	Project Engineer
PM	Project Manager
PMP	Project Management Professional
TA	Technical Advisor
US	United States
USB	Universal Serial Bus
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture

1.0 Project Understanding

1.1 Purpose of Project

The purpose of the project includes designing a parking lot in Saguaro National Park in the Cam-boh Picnic Area that will be adequate for trail visitors, including visitors with horse trailers, trucks, and other vehicles. In order for the trail to serve its intended purpose for the users and increased visitation, an evaluation of the site's current parking lot needs to be completed and a new lot must be designed to suit the client's needs.

The primary objective is the assessment and design of a parking lot for the Saguaro National Park. There is a need for the design and implementation of a parking lot which will provide a safe area for visitors to the park, as well as, ensure the natural desert is preserved by preventing parking in undesired areas. The client is requesting a revision to the current site because of the following: limited parking area for vehicles and buses due to visitors parking on the shoulder of the road, Americans with Disabilities Act (ADA) accessibility parking, and lack of clear signage.

1.2 Project Location

The project site area is located in the southern part of Arizona, in Saguaro National Park located in the Tucson Mountain District seen in *Figure 1.1*. The current and intended site, the Cam-boh Picnic Area (32°19'9.98"N, 111° 9'57.97"W), is located on the west side of Saguaro National Park just south of Picture Rock Road, 12.5 miles north-west of Tucson, Arizona seen in *Figure 1.2*. The available land encompasses approximately 4.5 square acres. The site is between a small development of residential homes and a natural wash that is approximately 160 feet to the west of the park's entrance displayed in *Figure 1.3*. The site's associated trail is the Cam-boh Trail – which runs parallel to Picture Rock Road from Cam-boh Picnic Area and is a major connection between the east and west parts of the Tucson Mountain District providing several loop opportunities for mountain bikers, hikers, and equestrian riders. [1]

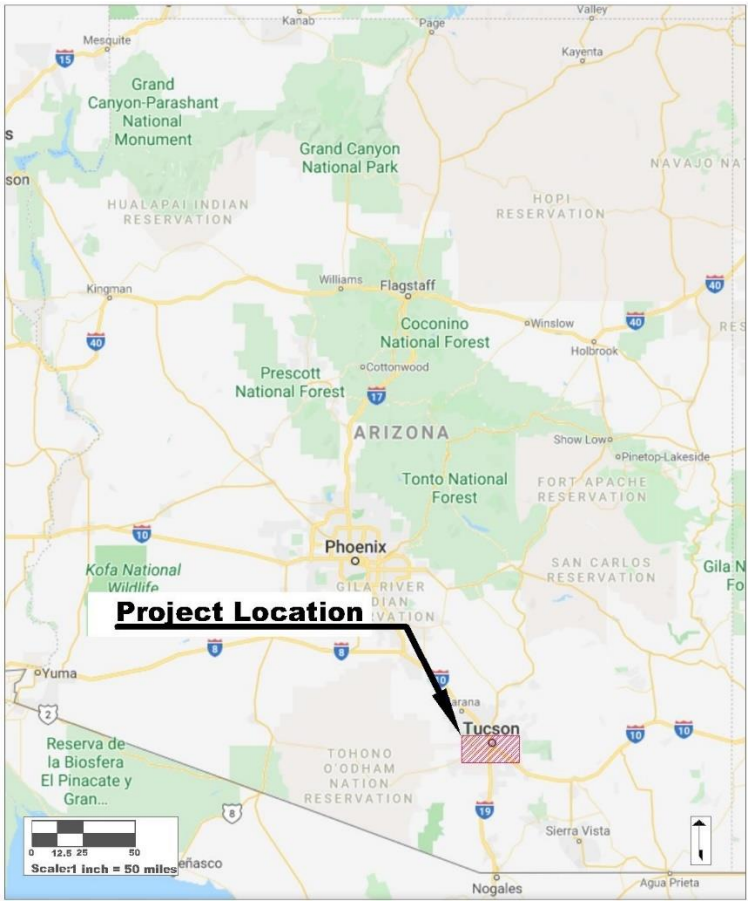


Figure 1.1. Project Location in Arizona

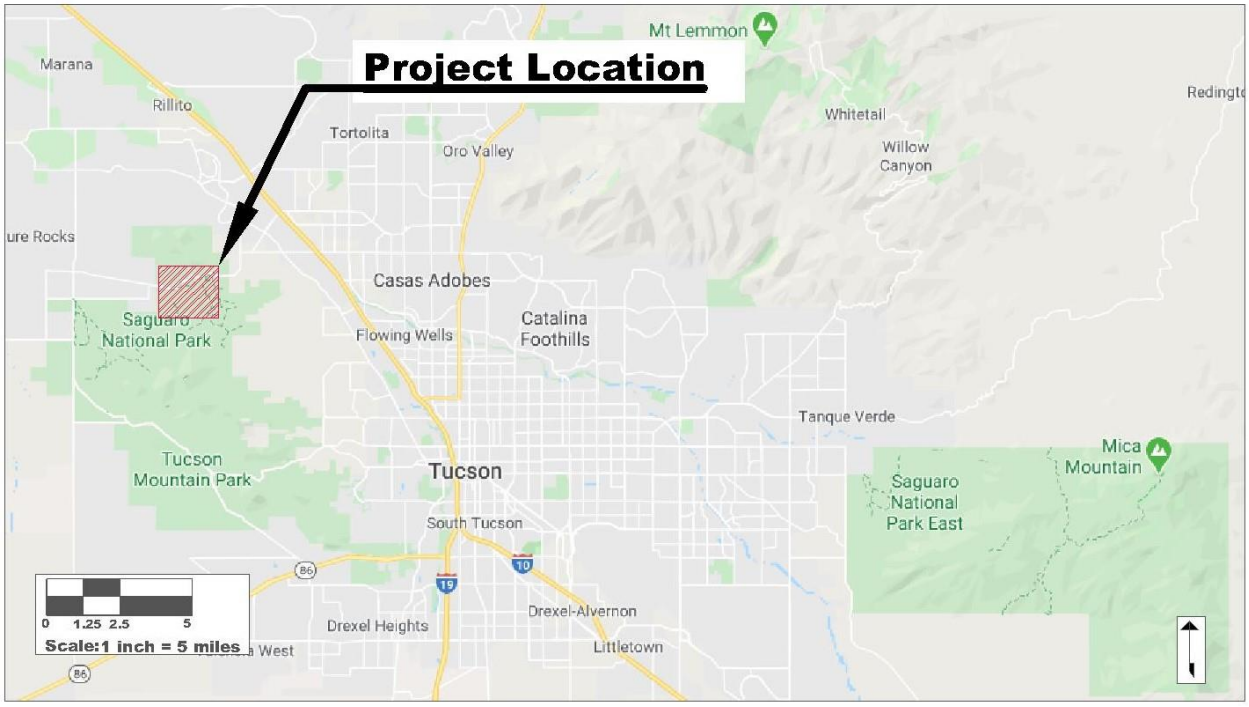


Figure 1.2. Project Vicinity Map

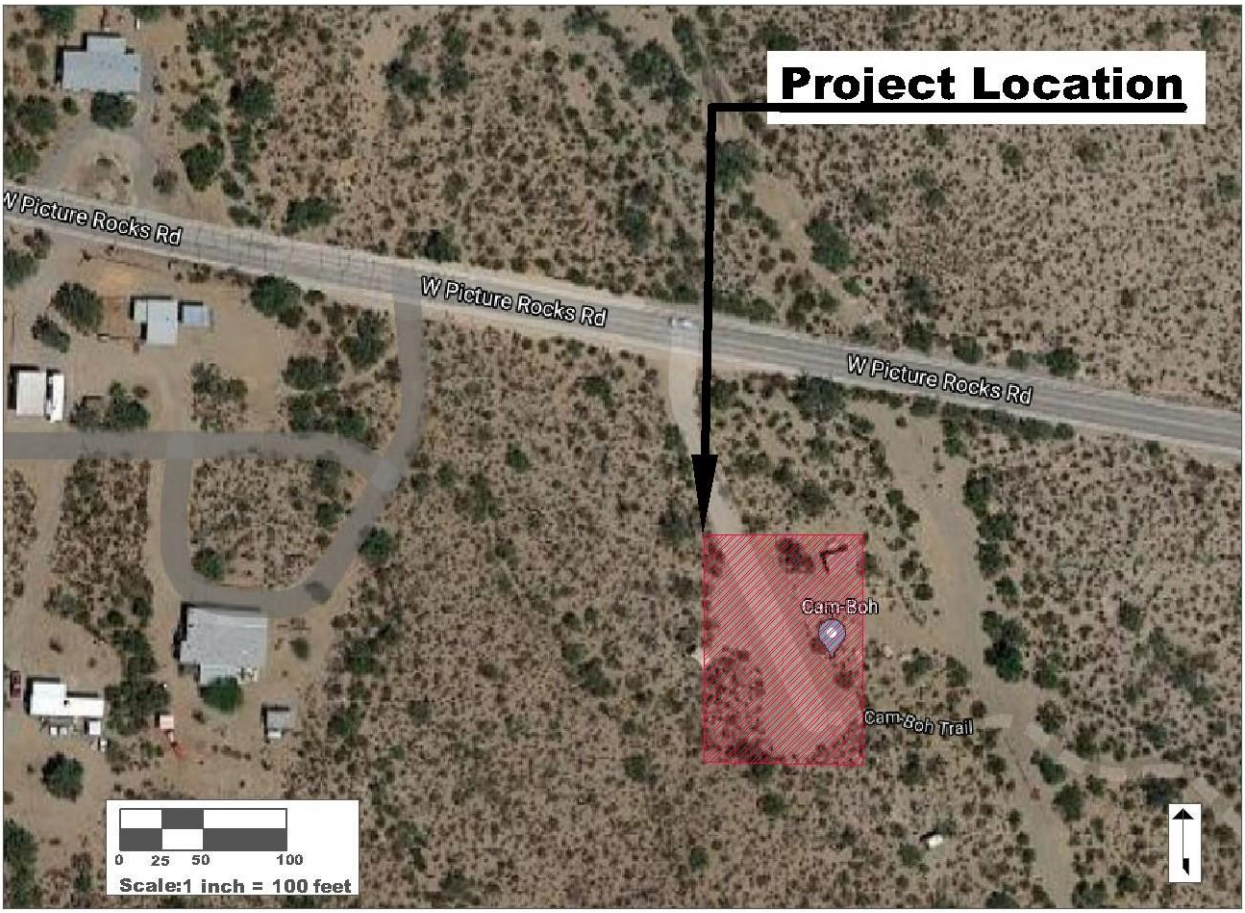


Figure 1.3. View of Project Site.

1.3 Background

In the 1930's the Civilian Conservation Corps (CCC) performed extensive improvements to Saguaro National Park focusing their efforts on the western half of the park to make the park more accessible to daily visitors. The CCC's improvements consisted of land restoration, erosion control, access roads, and water supply, as well as, creating facilities for park visitors that included campgrounds, overlooks, picnic areas, and new trails. The Cam-boh picnic area was one of the improvements performed by the CCC in the 1930's. The area is used today as a rest stop and picnic area, as well as, a launching point for equestrian riders, hikers, and mountain bikers. The existing gravel lot is too small for equestrian/horse users due to their large trailers causing the lot to become congested for other users. Additionally, the small size and amount of congestion make it difficult for equestrian users to turn vehicles with trailers around and exit the lot. Currently, the visitors to the park have a limited open dirt lot parking area with a picnic area. Many visitors are forced to park along the busy roadway and have been parking on sensitive natural desert landscape.

The current parking lot footprint is inadequate in size for horse trailers and for the many visitors using the existing dirt parking lot. In the picnic area there is a comfort station, a shade shelter, multiple picnic tables, and a few trail heads that lead into the interior of the park. Boulders were placed along the gravel lot to create a boundary for the parking lot. The vegetation surrounding the Cam-boh picnic area consists of two biotic communities: desert scrub and desert grassland. These biotic communities are consistent throughout the Sonoran Desert encompassing the surrounding regions of the park.

1.4 Technical Considerations

The design and assessment for the parking lot in Saguaro National Park will require travel to the project location for analysis to occur. During a site investigation the collection of data and design research in the below scopes will be conducted and gathered from existing site data for future analysis.

The first technical objective for this project will include completing a survey of the land. This will help analyze potential challenges or restrictions such as vegetation or slope that will restrict the design process. During this site visit, the team will complete an environmental review that will require a determination of the natural history including the flora and fauna in the specified area. Next the team will create a topographic map utilizing drafting tools like AutoCAD or Civil3D, from the surveying data gathered from the site investigation. A traffic analysis will need to be completed next to ensure visitation statistics are applied to consider aspects of the design such as the lot's size and type of material needed for the demand. The next step in the technical considerations will include a geotechnical analysis. This analysis studies different aspects of the site's soil such as properties, foundations, and soil reports that the proposed infrastructure will take place on. This will be used to help find specific constraints such as grading, drainage points and engineering properties of the soil below the desired project footprint. Further objectives will include the hydrologic and hydraulic analysis and designing. This step will help determine the precipitation data, infiltration rate, and drainage points of the existing and proposed site. Design considerations of the parking lot may include striping and signage design adhering to National Park Service (NPS) regulations, ADA compliance, grading and drainage design, pavement surface options, and a plan set for the production of the design.

1.5 Potential Challenges

There are a number of potential challenges including: of the NPS codes/regulations, location, equipment, weather conditions, and protected species/vegetation. No challenge will be excluded in the design and assessment of this project because they will all play a crucial part in the design step of the project, and cannot be ignored. One of the challenges involved with this project is the relocation of existing protected vegetation and species. If the existing footprint is not an adequate size for the design then vegetation including ironwood tree and saguaro cactus will be removed and relocated per NPS regulations.

The site is a potential challenge because it is 251 miles south of Northern Arizona University and the number of trips to the site will be limited. Other challenges that may be encountered include unpredicted weather conditions in Flagstaff or Tucson, Arizona. If there is a snow storm

or monsoon that delays the team in the visitation to the site during a planned time, then the overall schedule may be impacted.

If lab equipment needs to be used to determine different engineering properties such as geotechnical analysis or hydraulic analysis, the equipment alone can play a challenge on results. If equipment breaks or is damage, the time required to complete the data analysis will increase and effect the schedule of the design.

1.6 Criteria and Constraints

All new land developments cause changes to the stormwater and land characteristics including, so there needs to criteria to follow. The constraints of the design project include: the available space for the existing parking lot design, protection and removal of native plants, possess adequate drainage, parking spaces available for horse trailers/trucks, and abide by National Park Service regulations.

The Department of the Interior and the Department of Agriculture jointly administers the National Park System. To remove native plants from National Park Service land, the current landowner, an Application for Arizona Protected Native Plants and Wood Removal needs to be obtained from Arizona Department of Agriculture and the protected plant needs to be relocated, must grant permission. This will play a constraint on the design process of the project because in areas that have high vegetation of saguaro cactus and ironwood trees, the design will have to be configured to avoid these plants, or have a removal plan to move the plants to a new location.

1.7 Stakeholders

The stakeholder primarily involved in this project is the National Park Service because it is on US National Park land. The Arizona and United States Department of Transportation both have concern regarding the parking along the roadsides regarding the safety and interference with regular traffic flow. The United States Environmental Protection Agency and the Arizona Department of Environmental Quality are stakeholders due to the damage during construction and use of the park affecting the natural soils, the flora and fauna. The visitors to Saguaro National Park and to the trail systems are an included stakeholder because they will experience the benefits the new enhancements will bring. Per *Figure 1.3*, the homeowners are a noted stakeholder because being located on the west side of the parking lot; they will experience negative and positive effects of the construction of the parking lot advancements.

2.0 Scope of Services

2.1 Task 1: Existing Site Due Diligence

The primary focus of this task is identifying necessary documents and existing records that will be necessary to complete the project. Gather all preexisting data given to the team from outside

sources. Determine what gaps are in all different types of data provided by the client, i.e. geotechnical report and traffic analysis, hydrology reports. Additionally, existing mapping is gathered to determine existing property boundaries for the specific site which will be used for the site survey analysis of the project. Site due diligence is completed to determine the current existing zoning area of the site, any easements located on the site, and any other conditions which will impact the design aspect of the project.

2.2 Task 2: On-Site Investigation

It is necessary to visit the Saguaro National Park and obtain site data and samples. This data will be used for lab testing, parking lot design and drainage design, for future aspects per the project deliverables. It may require several site visits to accomplish the tasks requires. A well-organized field notebook will include initial observations, hand sketches and maps of important features, where the nearby trails are located, as well as, any other pertinent data.

In preparation for a site visit the team will complete weekly logs to keep track of all miles pertaining to the project. The record keeping is important in recording all project travel as well as any advising with the project team if aligned with the budget. The weekly logs will also need driving approval logs to be attached and turned into Northern Arizona University Facility Services. The driving approval form will need to be completed at least two weeks prior to any site visit. This will give enough time for NAU to access and review the teams driving records.

2.2.1 Task 2.1: Site Field Surveying

This will include attaining survey data point through using a total station in which all major man-made and natural features will be marked, a boarder grid will be marked, and a grid pattern will be marked as surveying data points.

Due to the travel distance of this project, there will be two job site visits throughout the semester. The first will be a visual survey, with no equipment for the other tasks but to see the area and visualize what needs to be done. The second visit will be then the time to survey the land and collect samples. Equipment: Using lab equipment such as a total station, prism rod, tripod, control point nail, a prism, and a GeoMax PS336E Data Collector, the team will go to the existing site and begin the data collection process. With the surveying equipment, the team will coordinate positioning and shoot field points at the site.

2.2.2 Task 2.2: Soil Sample Planning and Soil Sampling

To fill in the existing soil properties that were not given to the team by the pre-existing soil reports, new soil samples from the site will need to be taken for testing's in the lab. Before this begins, a new soil sampling plan will need to be created to ensure the soil samples collected are organization and stored in the correct manner. Materials needed include a soil sampling tube, auger or trowel, and a clean pail will

be used to obtain a thin slice or borings of soil from a minimum of 12 locations at a depth of two to three inches.

2.2.3 Task 2.3: Formal Report

A summarized report following the site visit including previous assumptions, newly developed assumptions, primary concerns, and other important information.

2.3 Task 3: Geotechnical Analysis

The main purpose of the geotechnical analysis is to understand the engineering properties of the soil on the site, underneath the desired project. The soil can be classified using the AASHTO, USDA and USCS standards and the suggested uses can be determined from this. Analysis of the results will determine if existing soil will be suitable for the desired use in application to the design. Using the given pre-existing soil reports from the client, the analysis of the existing reports will need to be completed prior to the geotechnical analysis of the soil samples in order to determine what gaps in engineering properties and knowledge is needed to be found.

2.3.1 Task 3.1: Complete Soil Testing

The soil testing may include the moisture content, the water content, the sieve analysis, the Atterberg test for plastic and liquid limits, and the hydrometer test.

2.3.1.1 *Task 3.1.1: Moisture Content (ASTM D2216)*

Moisture content can be used to determine the water content in soil, which can aide our team in determining further soil properties. Water content is used to find the percent of soil that is saturated to determine the unit weight of the soil. This is primarily done to determine how clay will play a role in the design load.

2.3.1.2 *Task 3.1.2: Atterberg limit (ASTM D4318)*

The plastic limit is found by rolling out a piece of the soil sample until it is at 1/8 inches to determine the soil strength which is necessary to determine the strength of the soil. The liquid limit is determined using the Casagrande device and cup to evaluated the properties of the water held within the soil.

2.3.1.3 *Task 3.1.3: Sieve Analysis (ASTM D6913)*

The sieve analysis is used to separate particles into size ranges and to determine quantitatively the mass of particles in each range.

2.3.1.4 *Task 3.1.4: AASHTO/ USCS Soil Classification*

Soil classification is used to determine the suggested and allowed uses of the soil following the AASHTO and USCS soil classification guidelines.

2.3.1.5 *Task 3.1.5: Hydrometer Test (ASTM D7928)*

A hydrometer test is required is the sieve analysis results show 90% of the soil passing through the #200 sieve. This test examines soil that are too fine for the sieve analysis test because the standard classifications are not sufficient enough for fine soil.

2.3.1.6 Task 3.1.6: Direct Shear Test (ASTM D3080)

This test covers the determination of the consolidated drained shear strength of a specimen of a specific soil material under direct shear boundary conditions.

2.3.1.7 Task 3.1.7: Relative Compaction Test (ASTM D698)

This test requires compaction of parking lots to be between 90%-95% compaction with a 0.004 ft/ft slope to be an approved ADA parking lot. This test will help determine the compaction percentage of the boring samples as well as the dry unit weight and moisture content of the specific soil.

2.3.2 Task 3.2: Soil Report

An analysis of the new soil classifications along with the new engineering properties will be summarized into a post-analysis geotechnical report determining if the soils are suitable as hydraulic barriers, as a subgrade for a parking lot, and/ or as fill material.

2.4 Task 4: Survey Data Analysis

Using surveying data from the site visit, the topographic map is created and used to determine site elevations to assist in different design factors. The map will be used to determine other aspects such as site limitations, drainage points, grade of existing area, and parking lot size. A topographic map will be created using the collected site data. Using AutoCAD software and all collected field coordinate points; a topographic map will be created for the design procedures of this project.

2.5 Task 5: Hydrology and Hydraulics Analysis

The design of the parking lot will provide optimal drainage flow and proper drainage function through the analysis of hydrological and hydrological modeling programs, the

examination of current hydraulic structures, and evaluating the necessary designs for proposed hydraulic structures.

2.5.1 Task 5.1: Watershed and Stormwater Runoff Analysis

Watershed analysis will be conducted utilizing modeling programs to assist in evaluating the topographic models with the expected precipitation, infiltration, and evapotranspiration. The modeling programs which will be utilized include Civil 3D and HEC-HMS. Establish the design watershed area and the specified sub-basins. Sync the modeling parameters including the control specifications, the time-series data, the meteorological models, and the precipitation models.
Generate the watershed model as a calibrated base model for the current conditions. Predicted changes will be made based on the proposed design changes to compare the current watershed to the proposed watershed changes to establish any potential negative effects on the watershed.

The design flow in conjunction with determining the depth of flow will assist in finding the minimum parking lot elevations and slopes. The 2-year, 10-year, 50-year, and 100-year flood flows data will be used to assist in determining the design dimensions.

2.5.2 Task 5.2: Existing and Proposed Infrastructure Analysis

The existing culvert at the entrance of the existing parking lot will be evaluated to determine its existing flow capacity. This will be necessary to implement the existing culvert as a part of the new parking lot drainage system. Additional hydraulic structures will be considered includes additional culverts, open channels, riprap, and detention basins. These structures will be analyzed will the assistance of programs like Bentley FlowMaster and CulvertMaster. The evaluation of proposed structures to ensure the proposed flow conditions meet the design standards and are capable to withstand the design flood flows.

2.6 Task 6: Traffic and Visitation Statistics

A traffic analysis and assessment will be need to be completed to see how many visitors will be using the designed parking lot at different times. The analysis will have to be done on different days, for example week days verses weekends as well as on different time of days, mornings or nights. This will help determine the size of the parking lot and drainage points.

Bring all lab equipment needed for this task to the existing project site. The equipment will be the JAMAR traffic count board, extra batteries, data collection USB cord, protective reflective vests. Using a JAMAR traffic count board, the lab teams will be able to count the different traffic movements that will be taking place. The hikers, visitors, and equestrian riders will be counted during a site visit to determine the visitation during the winter season when the peak is estimated to be the highest. The team is anticipating a

supplemental visitation count from the client that will be an additional resource to analyze the site's visitors.

2.7 Task 7: Parking Lot Design & Development

This task will use the developed topographic map as well as the initial site visit data to determine a new parking lot design. Current drainage conditions will be analyzed so they can be utilized with the new design as well to avoid having to install a completely new drainage runoff design.

Proposed Drainage, analyze if new drainage points need to be implemented or can existing points work for parking lot upgrade. Parking lot layout, determine the size of parking lot per boundary restrictions, number of spots, recreational uses for lot. Make sure all design regulations and codes are up to correct specifications by the desired governmental regulations needed for the parking lot design. The Parking lot material needed will need to be designed for a low impact design (LID) standard. The options will vary due to all the steps stated above. A review will be completed to see the accuracy and precision of the parking lot design to all standards.

From the above analysis, a new layout will be designed with a new boundary, number of parking spots, and ensuring the lot adheres to National Park Regulations and ADA compliant.

2.8 Task 8: Construction Plan Set

Construction plans are used in the job site field during the construction as guidance for the general contractor. Specific engineering recommendations and requirements are referenced to provide as much clear and concise information as possible on the site to help the construction process move smoothly. Once a solution is determined and chosen for implementation, the team will create a plan set. This will include information describing how the solution will go into effect as well as an updated schedule on the build process. Pages entitling: a cover sheet, notes and details, existing site layout, and a proposed site layout will be created.

2.9 Task 9: Construction Cost

The costs of a constructed parking lot to the client include both the initial capital cost and the subsequent operation and maintenance costs, but the Saguaro Systems Engineering Team is only providing cost for the overall design of the lot. Once the material, layout, and plan sets are completed the cost can be calculated.

2.10 Task 10: Impact Analysis

Any new project that is designed and constructed will come with both negative and positive impacts for the given area. Different kinds of impacts that will be analyzed in this task are social, economic and environmental impacts.

Social impacts are the impacts that affect the people, such as citizens, visitors and the surrounding stakeholders. Some of the positive effects that need to be considered are, the increases in visitors to the surrounding trails, the new lot will encourage visitors to the existing National Park, and will as well decrease the parking confusion for the guests. Some negative social impacts that will be considered in the design will be the construction period and how the said construction will create more disturbance to the area.

Economic impacts effect the government bodies and companies to either help increase or decrease revenue. Some examples of this kind of impact can be an increase in revenue for the Saguaro National Park but also can increase the in-site maintenance cost for the designed parking lot.

The environmental impacts that will be considered during this project will affect the vegetation, wildlife and natural features of the Saguaro national park. The impacts that could possibly affect the environment of this national park can be an increase in greenhouse gas emissions; the lot will increase traffic congestion and will increase the awareness of native plant species.

2.11 Task 11: Project Management

Project management is an essential part of any project to stay on a strict schedule, record meetings, stay on budget, and up to date with deliverables and finalized design aspects for completion of the project.

2.11.1 Task 11.1: Meetings

An agenda will be sent 24 hours prior to the meetings with the involved parties.

2.11.1.1 Task 11.1.1: Technical Advisor (TA)

There will be 4 meetings during Fall 2020 semester. The meetings are necessary to ensure the technical aspects of the project is being met and any advice can be given to the team to ensure quality submittals.

2.11.1.2 Task 11.1.2: Client

There will meetings as requested by the client, and following tasks 2, 6, and 8. Client meeting will be comprehensive, concise, prepped, and minimized due the location of the team and the client. These meetings will ensure that the team is creating a sufficient proposal for the client's needs.

2.11.1.3 Task 11.1.3: Grading Instructor (GI)

The meetings will be arranged following every submittal and are necessary to ensure communication between GI and the team, to ensure the submittals are being adequately submitted to the TA's expectations.

2.11.2 Task 11.2: Resource and Schedule Management

The design team will develop a strategy to best utilize the resources available to complete the project. To track and managed the team's resources, the group will check in at least twice a week to see if all resources are used to the specific need. This includes developing a professional team that will use the sections of this proposal below to complete the project on time and within the specified budget. The tracking and management of resources include calculating the manpower, the budget, the equipment, and any other needed supplies.

Scheduling for the project is a primary responsibility for the project manager who oversees the entirety of the project. They are responsible for allotting the appropriate amount of time for tasks to be completed for the project by controlling the amount of float for each task to ensure the project runs as effectively as possible. This includes ensuring all team members are utilizing the schedule and the budget in order to complete the project in a timely manner that is within the specified budget. This will keep track of all project responsibilities for ensuring completion on time, or earlier if possible.

2.11.3 Task 11.3: Deliverables

2.11.3.1 Task 11.3.1: 30% Submittal

The first preliminary deliverable will cover tasks 1-3 as well as a report and presentation on the submittal.

2.11.3.2 Task 11.3.2: 60% Submittal

The second preliminary deliverable will cover edits on tasks 1-3 and an addition of tasks 4-7 as well as a report and presentation due.

2.11.3.3 Task11.3.3: 90% Submittal and Website

The third preliminary deliverable will cover edits on tasks 1-7 and an addition of tasks 8-10 as well as an initial website, report, and presentation due.

An internet-based resource will serve as a reference to the client, TA, GI and public about the project. This website will be used to navigate the

main portions of the project, as well as, provide the completed documents by the team.

2.11.3.4 Task 11.3.4: Final Submittal and Website

The final deliverable will cover edits on tasks 1-10 and a final website and report are due at the end of Fall 2020 semester and a presentation will be completed by Undergraduate Presentations.

The internet-based website will be updated and revised in a complete and professional manner.

2.12 Exclusions

The exclusions will include any pre-existing data that was given to us by other outside sources. These outside sources include clients, subcontractors, or stakeholders. The pre-existing data that has been already been given to us that will end up being an exclusion is a geotechnical analysis report of the soil as well as the traffic count data for the specific site. Other exclusions that will be ignored will be city, public government or other organizations meetings to assess neighborhood or visitor concerns about the new upcoming project. City and state regulations will not be considered for the design as an exclusion because of the land will be designed based on federal standards.

3.0 Project Schedule

3.1 Overview of Schedule

The proposed schedule for the Saguaro National Park Parking Lot Design and Assessment presents the period in which the team will complete the proposed work. It demonstrates the timeline of the project from the start through the completion by task as identified in 2.0 Scope of Services. Refer to the Gantt Chart in the Appendix to view the proposed schedule.

The total duration of the project will be over 156 days. The major tasks of the schedule include: Existing Due Diligence, On Site Investigation, Geotechnical Analysis, Site Surveying Analysis, Hydrology and Hydraulics Analysis, Traffic and Visitation Statistics, Parking Lot Design and Development, Construction Plan Set, Construction Costs, Project Management, and Impact Analysis.

3.2 Milestones

The required deliverables of this project include: 30%, 60%, 90%, final plan set and website. The 30% submittal will cover Tasks 1-3 with a report and presentation following the submittal. 60% submittal will cover edits on Task 1-3 as well as the addition of Tasks 4-6

with a report and presentation following the submittal. 90% submittal will cover all the edits on Tasks 1-6 and an addition of Task 7-8 as well as an initial website, report and presentation following the submittal. The final deliverable will cover edits of Tasks 1-8 and a final website and report are due at the end of Fall 2020 semester and a presentation will be completed during Undergraduate presentations.

3.3 Critical Path

The critical path is shown in red on the Gantt Chart in the Appendix. This path includes collecting pre-existing data and visitation statistics, creating a site layout, adhering to NPS regulations, and completing quality assurance upon completion. The noted tasks in the critical path are crucial to the completion of the project because the team needs to collect pre-existing data before knowing if further collection needs to be completed. The collection of the visitation statistics needs to be completed prior to the designing the layout because it is imperative to understand the capacity the site experiences. In order to maintain the timing and duration of all items on the critical path, the team will check in with each other, the grading instructor as well as the technical advisor a week prior to each submittal as stated. This will ensure proper time for edits and input from the technical advisor and the grading instructor.

4.0 Staffing

4.1 List of Staff Roles

The staff below are the five personnel responsible for the execution and completion of the project at Cam-boh Picnic Area. The personnel working on the project include: Project Manager (PM), Project Engineer (PE), Engineer in Training (EIT), intern, and Lab Technician.

4.1.1 Project Manager

The project manager is responsible for the oversite of the whole completion of the project and is in charge of the coordination, execution, and control of the employees. This role has an abundance of knowledge in the field of land development and will inspect and stamp the construction plans as they are created. The qualifications of this role include having a minimum of a bachelor’s degree in engineering, have acquired five or more years in delegating to 20 or more junior staff members and have been in a delegating role for more than five job sites in their career role. The project manager is self-motivated to meet budgetary objectives, enforce adjustments to the project based on financial analysis and the needs of the client, and be the point of contact for the project. It is preferred that the project hold a PMP (Project Management Professional) Certification or equivalent and has experience with inventory control and Procore software.

4.1.2 Project Engineer

The project engineer is responsible for the design and implementation of technical deliverables by performing the analyses, and creating plan sets. This role will also support in resolving issues by the employees, and instruct the EIT, intern, and lab technician. The qualifications of this role include having five years of experience of land development or less, aided in some of the management roles under the direction of a previous project manager, able to commit to 6- or 12-month assignments (full travel assignments), and able to utilize AutoCAD, Procore, and Bluebeam. It is preferred that they hold a professional engineering license (PE) or have between five to ten years in the field. The project engineer is able to effectively communicate with managers, junior staff members, and vendors and is able to solve practical problems and compose tangible solutions.

4.1.3 EIT

The EIT is responsible for preforming engineering tasks under close supervision of the project engineer and is encouraged to solve engineering problems using experience, judgement, and education but is expected to ask for assistance when needed. In addition, the EIT will analyze pre-existing reports, maps, drawings, and aerial photographs on the soil composition, hydrological characteristics, and other topographic features and will research codes and permitting requirements for the intended project site. The qualifications of the role include having a minimum Bachelor's degree in engineering from a four-year accredited college or university and has passed EIT examination, contains knowledge or experience working with computer software of AutoCAD Civil 3D, and is able to troubleshoot design or software issues. The EIT is under the responsibility of the Project Engineer, but is responsible to efficiently utilize time in completing tasks accurately, on schedule, and on budget.

4.1.4 Intern

The intern is responsible for completing basic engineering tasks related to the design, analysis, test, and operations of the project. The role will include preforming documentation and tracks documents for reports, and assisting the EIT and project engineer in assigned tasks. The functions of this role consist of preparing maps, visiting the site, and aiding the lab technician in completing the collection of data. The qualifications of the role included currently or a recent graduate of an accredited engineering program from a four-year college or university and is anticipating graduating before June 2021. The intern is under the responsibility of the project manager but will be coordinating work with the project engineer and the EIT. This role will include shadowing, mentoring, and training opportunities with the professionals included on the project.

4.1.5 Lab Technician

The lab technician is responsible for participating in field site visits to determine parameters of data, preforming collection of data, using it to complete various lab tests, and creating report per the findings relating to the project of interest. It is required that the lab technician has good written communication and math skills as well as strong attention to detail is required. The qualifications of this role include at least three years of experience directly related to geotechnical testing and at least one applicable certification. The lab technician will report to the project manager or the Project Engineer with the findings and site concerns.

4.2 Staffing Table and Hours

Table 1 displays the breakdown for the distribution of the staffing man hours below represent the estimated working hours broken down for each major task per staffing role. It is clearly shown that the lab tech and EIT has most hours required for the project due to the extensive amount of analysis and lab data collection on the site. The project manager has the least number of hours predicted to work on the project due the number of other projects and roles occurring at the same time. They are the greatest amount of cost and responsibility for the project due to their experience in the specific field.

Table 1. Staffing Table with Hours

Staffing Plan (hours)						
Task	Project Manager	PE	EIT	Intern	Lab Tech	Total/Task
1.0 Existing Site Due Diligence	3	3	24	24	2	56
2.0 On-Site Investigation	1	2	25	39	5	72
3.0 Geotechnical Sampling/Analysis	1	2	40	40	21	104
4.0 Survey Data Analysis	1	5	15	15	20	56
5.0 Hydrology and Hydraulics Analysis	1	5	20	30	0	56
6.0 Traffic and Visitation Statistics	0	5	19	40	0	64
7.0 Parking Lot Design and Development	5	10	31	50	0	96
8.0 Construction Plan Set	15	25	35	37	0	112
9.0 Construction Cost	8	18	25	5	0	56
10.0 Impacts	0	0	9	15	0	24
11.0 Project Management	50	40	15	15	0	120
Total Hours per Role	**85**	**115**	**258**	**310**	**48**	
				Total Hours:		**816**

5.0 Cost of Engineering Services

Table 2. Cost Estimates, below shows the total hours worked on the project for each individually member of the professional design team. The project manager will make about $200 per hour, the project engineer will make $130 per hour, the Engineer in Training will make $100 per hour, the intern will make $22 per hour and the lab technician will make $60 per hour. There will be a total of three in person meetings needed to be done for this project completion. The capstone team is about 504 miles away from the job site so traveling, lodging and meals will need to be included in the cost estimation and added to the overhead cost. Travel costs for each time the team or a portion of the team visits the site is also calculated using $0.40 a mile for every mile travelled by the team. Meals will cost about $180 per day for all team members depending on the places going to eat from. Lodging will be on average of $200 per night per room. There will be one male room and one female room so two rooms will need to be present for lodging during the site visits. Finally, the total costs of the project ae calculated by summing up all the costs involved within the design to net a total of $114,575.

Table 2. Cost Estimates

Roles	Total Hours Worked	Base Pay Rate ($/Hr)	Billing Rate ($/Hr)	Total $ Spent
Project Team Personel				
Project Manager	85	$ 200.00	$ 320.00	$ 27,200.00
Project Engineer	115	$ 130.00	$ 234.00	$ 26,910.00
EIT	258	$ 100.00	$ 220.00	$ 56,760.00
Intern	310	$ 30.00	$ 75.00	$ 23,250.00
Lab Tech	48	$ 60.00	$ 156.00	$ 7,488.00
Over Head Expenses				
Supplies	5 Month Duration	$400 Per Month	5 Month Project Duration * $400/Month	$ 2,000.00
Travel	$0.15/mile	75.6	3 meetings * 504 miles	$ 226.80
Lodging	$400/day		3 meetings * $400 Per Visit	$ 1,200.00
Meals	$180/day (All Team)		3 meetings * $180 Per Visit	$ 540.00
			Total Costs =	**$ 145,574.80**

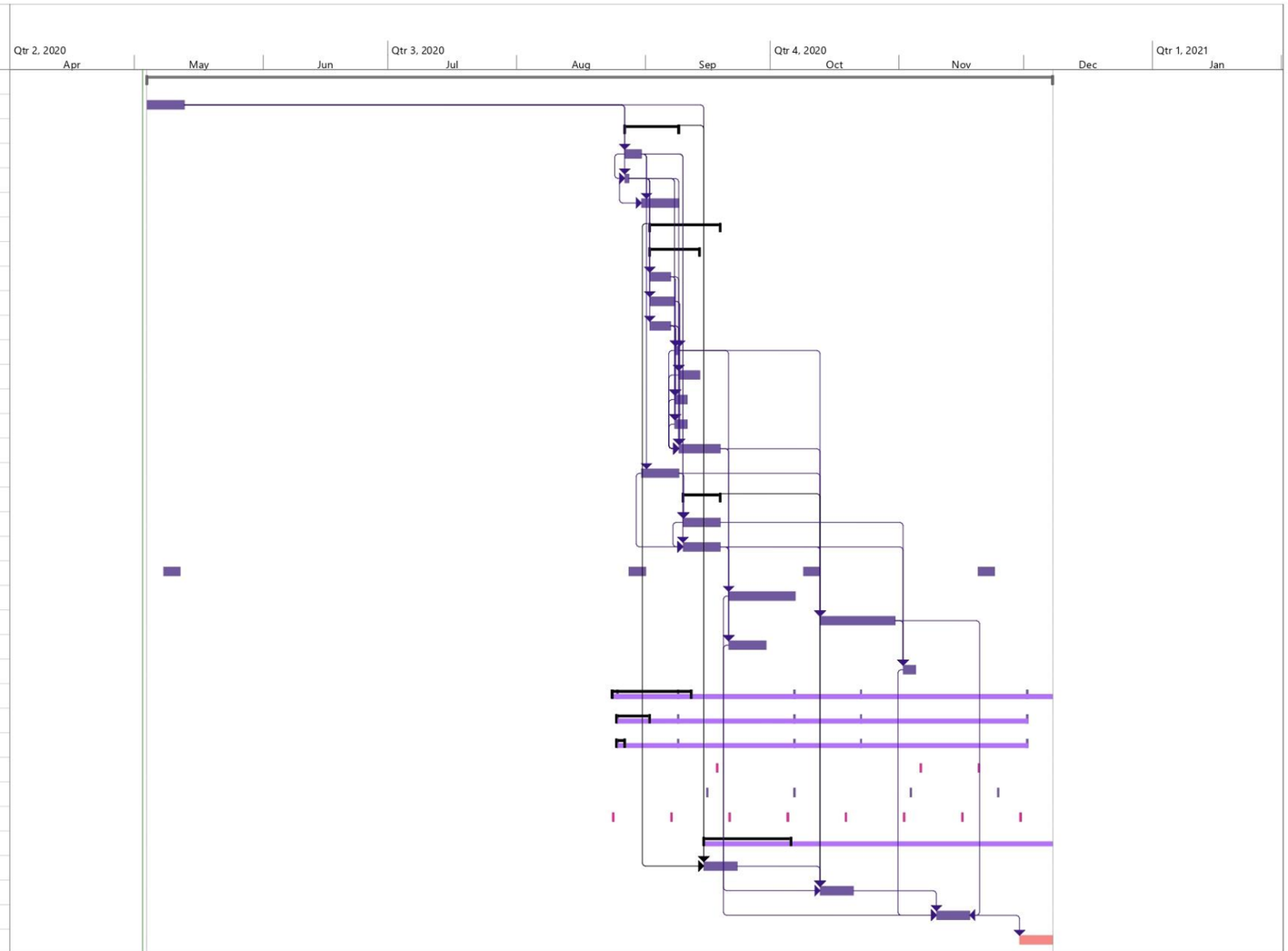
References

[1] Red Hills Visitor Center. “Trails in the Tucson Mountain District,” U.S. Department of Interior, National Park Service, Saguaro National Park. Tucson, Arizona: US Department of the Interior, 2020, pp. 1-2. Available : *https://www.nps.gov/sagu/planyourvisit/upload/Trails%20in%20the%20Tucson%20Mountain%20District.pdf* [Accessed: February 4, 2020].

[2] Salary.com, “Salary Wizard- Do you know what you're worth?": Salary-Calculator,” Salary.com. [Online]. Available : https://www.salary.com/tools/salary-calculator/project-manager-iii-hourly/tucson-az?view=table. [Accessed: 31-Mar-2020].

Appendix: Gantt Chart of Schedule

ID	Task Name	Duration
0	**FINAL SCHEDULE-Version 6**	**156 days**
1	Task 1: Existing Due Diligence	7 days
2	**Task 2: On Site Investigation**	**9 days**
3	Task 2.1: Site Land Surveying	2 days
4	Task 2.2: Soil Sample Planning and Soil Sampling	1 day
5	Task 2.3: Formal Report	7 days
6	**Task 3: Geotechnical Analysis**	**13 days**
7	**Task 3.1: Complete Soil Testing**	**8 days**
8	Task 3.1.1: Moisture Content	3 days
9	Task 3.1.2: Atterberg Limits	4 days
10	Task 3.1.3: Sieve Analysis	3 days
11	Task 3.1.4: AASHTO/ USCS Soil Classification	1 day
12	Task 3.1.5: Hydrometer Test	3 days
13	Task 3.1.6: Direct Shear Test	3 days
14	Task 3.1.7: Relative Compaction Test	3 days
15	Task 3.2: Soil Report	8 days
16	Task 4: Survey Data Analysis	7 days
17	**Task 5: Hydrology and Hydraulic Analysis**	**7 days**
18	Task 5.1: Watershed and Stormwater Runoff Analysis	7 days
19	Task 5.2: Existing and Proposed Infrastructure Analysis	7 days
20	**Task 6: Traffic and Visitation Statistics**	**8 days**
25	Task 7: Parking Lot Deisgn and Development	12 days
26	Task 8: Construction Plan Set	14 days
27	Task 9: Construction Costs	7 days
28	Task 10: Impact Analysis	3 days
29	**Task 11: Project Management**	**15 days**
30	**Task 11.1: Meetings**	**6 days**
31	**Task 11.1.1: Technical Advisor Meetings**	**2 days**
37	**Task 11.1.2: Client Meetings**	**2 days**
41	**Task 11.1.3: Grading Instructor**	**2 days**
46	**Task 11.2: Resource and Schedulig Management**	**2 days**
55	**Task 11.3: Deliverables**	**15 days**
56	Task 11.3.1: 30% Submittal	6 days
57	Task 11.3.2: 60% Submittal	6 days
58	Task 11.3.3: 90% Submittal Website	6 days
59	Task 11.3.4: Final Submittal and Website	6 days



Project: FINAL SCHEDULE-Versi
Date: Sun 5/3/20

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Path Predecessor Milestone Task
Path Driving Predecessor Milestone Task
Path Predecessor Summary Task
Path Driving Predecessor Summary Task
Path Predecessor Normal Task
Path Driving Predecessor Normal Task
Critical
Critical Split
Progress
Manual Progress

Page 1

Figure 1.4. Gantt Chart Schedule Displaying Critical Path