GRAND CANYON UNIFIED SCHOOL DISTRICT

MASTER DRAINAGE PLAN

FINAL PROPOSAL DOCUMENT

SPRING 2018

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May 10, 2018

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1.0 Project Understanding

1.1 Project Purpose

Grand Canyon Unified School District (GCUSD) campus requires a new master drainage system. The current drainage infrastructure is inadequate and may lead to erosion of walkways and foundational edifices. The purpose of this project is to assess the needs for a safe hydraulic scheme and to design an adequate system for the students and faculty on campus.

1.2 Background Information

The following background information has been collected regarding location, current infrastructure, problem areas, hydrological data, and regulations.

1.2.1 Location

Grand Canyon Unified School District is located at 100 Boulder St, Grand Canyon Village, AZ 86023. This is the north central region of the state of Arizona at an elevation of 6,916 feet [1]. The campus lies within Grand Canyon National Park and, as such, must follow the corresponding federal guidelines. The geographical location of Grand Canyon Village is shown in Figure 1.

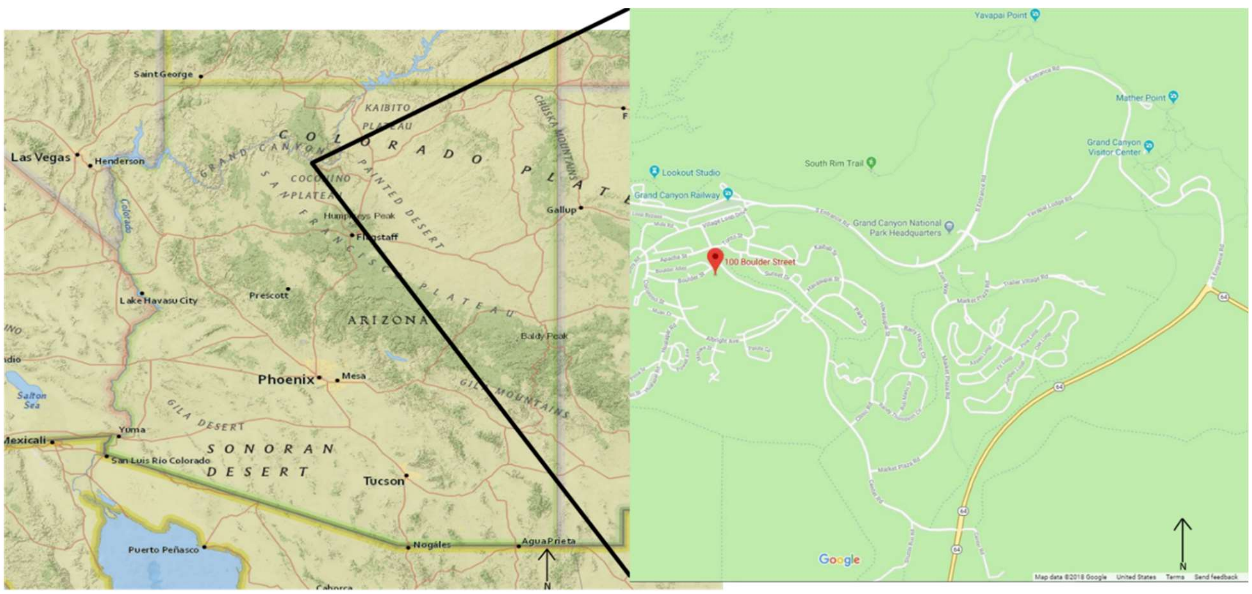

Figure 1:Combination of state [2] and regional [1] maps for Grand Canyon Unified School District

An aerial view of the campus is provided in Figure 3 of Appendix A.

1.2.2 Current Infrastructure

Knowledge of current infrastructure was provided by the client, Ivan Landry, GCUSD maintenance supervisor, during a preliminary phone interview. Photographs of the site and current infrastructure were provided by the project coordinator, Mark Lamer, PE NAU. The current infrastructure has evolved piecewise as the campus grew through its history. As a result, no master drainage plan exists. Presently, there are several small channels and culverts across the campus. There are signs of sedimentation decreasing the ability of current hydraulic structures to convey water off the premises. Figure 2 shows an example of the sedimentation disrupting a culvert's carrying capacity on site. Additional photos of the infrastructure are provided in Appendix A.

Figure 2: Example of current conditions of infrastructure and culvert carrying capacity [3]

Furthermore, during preliminary interviews, the client has expressed a need to address an area with a large rooftop. The impervious surface area associated with the large rooftop contributes to collection and concentration of rainfall to one side of the building, causing flooding of entryways. Similarly, there are areas of the landscape with berms at a higher elevation to the surrounding structures, which promotes flooding during rain events. These areas will be further addressed after a site visit is conducted.

1.2.3 Hydrological Data

According to the Arizona Water Atlas, Grand Canyon National Park receives an average annual precipitation is 25.8 inches [4]. The Grand Canyon Village has an average annual evaporation rate of 44.04 inches [4]. Based on previous USGS research, the Grand Canyon has an infiltration rate of 0 to 0.5 cm per hour [5]. Figure 11 of Appendix B shows a USGS map showing the watershed connected to GCUSD campus. Precipitation frequency data for Grand Canyon Village [5] is located in Table 7 of Appendix B.

1.2.4 Regulations

GCUSD campus resides within Coconino County, and within a national park. Careful consideration of federal, county, state, and local regulations must be taken at all times. Some of the federal regulations that need to be considered include, but are not limited to:

- Title 49 chapter 2 "Water quality control" [6]
  - Federal water quality standards regarding pollutants, discharges, etc.
- Title 49 chapter 8 "Water infrastructure program" [6]
  - Federal design standards for basic water infrastructure
- Title 45 chapter 8 "Flood Control" [6]
  - Federal design standards for flood management, reuse, and rerouting of storm water.
- Coconino County Engineering and Construction Criteria Manual [7]
  - Aids in identifying the laws of Coconino County, its political subdivisions, and the State of Arizona in general.
- Coconino County meets the minimum federal requirements for designation by the United States Environmental Protection Agency (EPA) as a Small Municipal Separate Storm Sewer System Operator. [8]

1.3 Technical Considerations

Technical considerations were derived from background research which utilized historical precedent. The following technical considerations will be implemented for the completion of this project.

1.3.1 Surveying

An accurate survey greatly aides in the creation of viable models and maps. Some of these maps include site, topographic, and problem area locations. New survey technology allows for aerial mapping with LIDAR that can create digital terrain models. Surveying will be conducted with a Total Station. Data will be collected and saved in Excel spreadsheet. Evaluation of elevation points and terrain simulation will be conducted using AutoCAD Civil3d. [9]

1.3.2 Hydrology

Hydrology is directly concerned with the properties of water and how it interacts with land. This can include surface runoff, infiltration, evapotranspiration, and groundwater flow. With a low volume system, there is little treatment required for storm water drainage. Typical screen and basin percolation is commonly practiced. Storm water detention sites, low-impact development basins, and other structures will need to be identified and evaluated for volume and retention time. Continuous testing may be performed to ensure safety of downstream consumers, if applicable. [9]

1.3.3 Hydraulics

Hydraulics concern the use of mechanical force or gravity to convey water through pressurized pipes and open channels. A proper hydraulic system will safely transport the required flow without failure. Safety factors, friction losses, total energy and cavitation problems are analyzed independently during the design phase. Total surface runoff will be calculated and extrapolated through available precipitation, evaporation, and infiltration data. Expected volumetric flow rate for each area will be established. HEC-RAS will be used for the design of channels and pipe selection. Bentley systems such as StormCAD, CulvertMaster, and FlowMaster will also be utilized. [9]

1.4 Limitations and Challenges

Most projects require the aid of numerous contracts, companies, and overall bodies working in unison to be completed in an efficient manner. Potential challenges will always arise when there are so many pieces moving on the board that relate to one another. For the GCUSD Master Drainage project, some potential challenges will include historical preservation, evolving regulations, scheduling, and overall site restraints.

Historical preservation may prove to be the largest hurdle for this project. Any changes made to the current system cannot result in visually abnormal or displeasing structures. New designs must remain low key and rustic in style.

Geotechnical and Overall design of the infrastructure can create a plethora of potential challenges. Land constraints can directly affect storage facilities, construction, and plan design. Geotechnical constraints can create potential challenges as well. Past data must be found to locate the water table, possible flood or problem areas, and soil composition. Depending on the results, the soil composition may not allow for a basin or pond due to inadequate filtration or drainage, so storage may be needed, or vice versa.

Scheduling conflicts may occur due to school schedules regarding both Grand Canyon High School and Northern Arizona University. Every effort will be made to coordinate between the needs and demands of both schools.

1.5 Stakeholders

The following stakeholders are directly affected by the project. The effects may be financial, societal, or environmental. Safety, wellbeing, concerns, and comments of the stakeholders will be considered throughout the duration of this project.

1.5.1 GCUSD Students and Faculty

The students and faculty will be affected directly by any changes to the current infrastructure occurring as a result of this project.

1.5.2 Grand Canyon Historical Society

Oversight for the preservation of historical attributes related to the vicinity, is supervised by the Grand Canyon Historical Society. As such, visible alterations will need approval from the society panel.

2.0 Scope of Services

The following Scope of Services dictates the tasks which will be completed throughout the course of this project including field work, surveying, hydrology, hydraulics, conceptual design, documentation and project management.

2.1 Task #1: Field Work

The field work that needs to be done for 486 is delineated into two minor sections consisting of field safety and field investigation.

2.1.1 Complete NAU Safety Forms

The team will need to obtain safety vests and complete NAU forms for all site visits regarding information gathering.

2.1.2 Field Investigation

The site visit allows the team to gather surveying information, data point collection, elevation and terrain information. This also consists of some qualitative analysis and any visual inspection done during the walkthrough.

2.2 Task #2: Survey With GPS

Primary surveying needs consist of gathering data points, coordinates, and general terrain knowledge. The gathered information will then be used for analysis and map creation.

2.2.1 Inventory of Existing Infrastructure

Investigation of the existing infrastructure consists of gathering the needed information about the site. This includes the allowable flooding and storage (if any), locations of catch basins, culverts, and problem areas. More data such as elevations of inverts upstream and downstream, manholes, and other needed data will be completed during the overall GPS field survey.

2.2.2 Create Topographic Map with AutoCAD Civil3D

The imported XLM file will be overlaid with an aerial photo to ensure quality and accuracy of the results. This map will be used for the rational method and software analysis and to determine the flow path based on topography.

2.3 Task #3: Calculate Discharge from Hydrological Data

The discharge will be calculated using the modified rational equation. The information and inputs needed will be gathered from delineation of water sheds, calculating the runoff coefficients. and completing the analysis. [10]

2.3.1 Watershed Delineation

The site of the GCUSD campus has its own major watershed. A delineation of that watershed into many sub watersheds will be completed. The numerous sub sections will be transposed on a topography map to aid in the design process by determining direction of flow caused by gravity.

2.3.2 Runoff Coefficient Determination

Once delineation of the major watershed is completed, the calculation of the runoff coefficient can begin. Areas of each watershed will be calculated and accounted for with a safety factor regarding excess runoff. The amount of impermeable area will then be taken into consideration to know the runoff percent coming off each watershed. This percent is the amount of discharge from that sub watershed that will flow through the system.

2.3.3 Calculate Discharge

The discharge will be calculated using the modified rational equation. This includes the antecedent precipitation factor, precipitation intensity, area and runoff coefficient. The antecedent precipitation factor is found within the Flagstaff Drainage Design manual [11]. The Modified Rational Equation is provided below in Equation 1.

Equation 1: Modified Rational Equation

$$Q_P = C_f * C * i * A$$

$where\ Q_P = Peak\ Discharge$

$C_f = Antecedent\ Preipitation\ Factor$

$C = Runoff\ Coefficient$

$i = Rainfail\ \ Intensity\ \left(\frac{in}{hr}\right)$

$A = Area\ (ft^2)$

2.4 Task #4: Evaluate Hydraulics

Evaluation of hydraulics consists of analyzing current infrastructure based on the design needs. Alternative channel and culvert designs will be analyzed and provided based on flow volume, codes, and standards.

2.4.1 Existing Culvert Analysis

Analysis of the existing culverts will begin with compiling survey data. This includes the culvert crown and inlet elevations, slopes, entrances, conditions, and types. Compiled data will then be entered in Bentley CulvertMaster and HEC-RAS to examine whether current infrastructure meets the capacity and flow requirements as well as all codes regarding flow regime and velocity.

2.4.2 Develop Alternative Culvert Designs

Based on the results of the culvert analysis, new options may need to be considered. If the culverts are not able to convey the needed flow for the design storm at the correct self cleaning and non-scouring velocities, an analysis for an alternative design will be conducted. This new alternative will meet the needed flow, velocities, and specifications needed.

2.4.3 Existing Channel Analysis

Analysis of the existing channels will begin with compiling survey data. This includes the thalwag, channel slopes, bank slopes, overbank, width, and floodplain elevations. The compiled data will then be entered in Bentley FlowMaster and Hec-Ras to examine whether current infrastructure meets the capacity and flow needed.

2.4.4 Develop Alternative Channel Designs

Based on the results of the existing channels analysis, new options may need to be considered. If the current system can not convey the discharge needed without overflowing into the floodplain and causing damage, an analysis for an alternative design will be conducted. This new alternative will work in unison with the culverts and convey the needed flow with minimal settling, ensuring minimal maintenance

2.5 Task #5: Generate Conceptual Design Plans

The generation of conceptual design plans will provide the visual representation required to demonstrate the proposed alternatives to the client.

2.5.1 Overlay Existing Maps

Existing maps of the site, including aerial images, infrastructure schematics, and processed topographic data, will be collected and imported to layers within AutoCAD. This will provide orientation in space for draft work and location of existing infrastructure with respect to overland flow and proposed alternative designs.

2.5.2 Draft Alternatives

Alternatives will be drafted on separate sheets in AutoCAD for ease of comparison. Design notes and details will be included with each alternative drafted.

2.5.3 Determine Material Quantities

Material quantities include all channel and culvert material proposed, as well as any cut or fill requirements determined for each design alternative. Channel and culvert material will be evaluated using dimensional analysis in AutoCAD Civil3D. Cut and Fill needs will also be calculated using Civil 3D.

2.6 Task #6: Provide Documentation

Documentation will be provided for use and maintenance of each design alternative, including recommendations for existing infrastructure.

2.6.1 Instructions on Use of Design

Instructions on use of design will include the capabilities and limitations of design as well as information related to improper or inadvisable use of design alternatives.

2.6.2 Instructions on Maintenance

Instructions on maintenance for each design alternative and the current infrastructure will also be provided including recommended frequency, methods, and areas of interest.

2.7 Task #7 Project Management

Project Management includes all objectives required for the team to function as a unit and to stay on track to complete the project.

2.7.1 Meetings

The meetings which will ensure success of the project are described below

2.7.1.1 Group

The success of this project relies heavily on coordination between group members. This will be advanced through frequent group meetings. At a minimum, it is expected for this group to meet twice weekly through the entirety of the semester.

2.7.1.2 Coordinator

Oversight for the project is provided through the coordinator, Mark Lamer, PE. As such, meetings with Mark will be required for feedback regarding deliverables of the project. Meetings with the project coordinator will be held bi-weekly.

2.7.1.3 Technical Advisor

Guidance regarding technical assessment and analysis is provided through Jeffrey Heiderscheidt, PhD. Meetings with Dr. Heiderscheidt will be held bi-weekly. The technical advisor Contract is provided in Figure 12 and Figure 13 of Appendix C.

2.7.1.4 Client

Ivan Landry is the GCHS contact to stay informed on quality of progress and clarification on expectations. Due to the client's busy schedule and great responsibilities, with the exception of site visits, meetings with Ivan Landry will be kept at a minimum. The team expects to perform at least one site visit to gather data, with which the client must be attendance as per GCUSD regulations. If additional contact is required, this will be performed through email or phone call. The cover letter to client Ivan Landry, is provided in Figure 14 of Appendix C.

2.7.2 Minutes and Notes

All meetings will include minutes and notes documenting all pertinent information that was gathered or decided upon.

2.7.3 Task Assignment and Feedback

Task assignment and feedback is an integral part of a successful project and will present clear notification of what is expected from each team member. This refers to individual tasks assigned within the group and all feedback given for each task completed. In order to keep the team functioning as a solid unit, task assignment and feedback will occur at least twice per week.

2.7.4 Deliverable Items

The deliverable items include all the assignments and documents that will be submitted during the fall of 2018 for CENE486c. Deliverables will show the progress and quality of the project.

2.7.4.1 Status Updates

The status update will include the progress of the project and potential designs. Status updates occur bi-weekly as an informal presentation to fellow classmates and grading instructors and allow for timely feedback throughout the course of the project.

2.7.4.2 30% Design

The 30% design will include preliminary results as well as a framework for the project moving forward.

2.7.4.3 60% Design

The 60% design will include additional results as well as a preliminary discussion of results.

2.7.4.4 Triple Bottom Line-Cost Benefit Analysis

The Triple Bottom Line – Cost Benefit Analysis (TBL-CBA) will evaluate social, environmental, and financial impacts. This will help evaluate performance on a broader spectrum and will be submitted as an independent document.

2.7.4.5 Final Presentation

A final presentation of results including all design alternatives will be performed at the Undergraduate Symposium. The presentation will include an introduction to the project, justification for the project, explanation of the tasks performed, detail regarding staff hours, and a summary of expenses.

2.7.4.6 Final Report/Plans

The entirety of compiled documentation regarding the project, including TBL-CBA, conceptual design plans, and instructional notation, will be submitted as a Final Report. The Final Report will be the culmination of the project and will be featured on the web page for public viewing.

2.7.4.7 Web Page

The project's website will include information about the project, the team members, and all associated information. Progress of the work performed will be updated frequently on the web page.

2.8 Project Limitations

2.8.1 Challenges

The challenges regarding completion of this project are travel and schedule. While travel and schedule are common challenges for all projects, this is particularly important in the context of the GCUSD Master Drainage Study. The site is located approximately 1.5 hours by road from Northern Arizona University. Additionally, as stated above, the client must be present for site visits per GCUSD policy. Furthermore, the client does not reside in Grand Canyon Village. Rather, the client resides in Flagstaff and is only in Grand Canyon Village Monday through Thursday. As such, careful planning and coordination between team members and the client will be required.

2.8.2 Exclusions

Below are the tasks that will not be performed by this team.

2.8.2.1 Floodplain Delineation

Delineation of the floodplain is typically completed during a master drainage study to determine the movement of overland flow beyond the overbanks of channels. However, floodplain delineation will not be performed during this project.

2.8.2.2 Structural Analysis

Structural analysis of existing infrastructure and analysis of weakened edifices will not be performed for this project.

2.8.2.3 Construction and Implementation

All proposed alternative designs will be evaluated solely through computer simulations and mathematical analysis. Alternatives will be presented to client; however, this project will not perform any implementation of design.

2.8.2.4 Water Quality Testing

Water quality should be evaluated downstream of new system to ensure implementation of design has not affected contaminant concentrations beyond EPA regulations.

3.0 Schedule

Each of the seven major tasks for the GCUSD Master Drainage Study have been incorporated into the Gantt chart located in Figure 15 of Appendix D. Subtasks from the Scope of Services are aligned on Gantt chart with durations, start, and end dates included. Relationships between each task correlate the beginning and ending of specific units. Included in the Gantt chart are milestones as well as the critical path for this project.

The critical path is shown in read on the Gantt chart in Figure 13. This is the shortest path through time that with which the project can be completed. Tasks which are parallel within the critical path are those which can be performed simultaneously.

4.0 Staffing

Table 1 shows the breakdown of work hours proposed for each staff member regarding every task included in the scope. The corresponding task number is located in the left-hand column, followed by the task. Total hours for each task is found in the right-hand column. The final row provides the summation of hours worked for each position as well as the total number of hours projected for completion of the project.

Table 1: Full Staffing Hours for Grand Canyon Unified School District Master Drainage Study

Full Staffing Hours for GCUSD Master Drainage Study								
#	Task	Principle	Manager	PE	EIT	Tech	Admin	Task Total
1.0	Field Work	1	1	3	12	13	2	32
1.1	Complete NAU Safety forms	1	1	1		1	1	5
1.2	Field Investigation			2	12	12	1	27
2.0	Surveying with GPS	0	0	4	24	24	1	53
2.1	Inventory of Existing Infrastructure			2	16	16		34
2.2	Create Topographic Map with AutoCAD® Civil 3D			2	8	8	1	19
3.0	Hydrology	0	0	6	12	12	0	30
3.1	Watershed Delineation			2	4	4	0	10
3.2	Weighted Runoff Coefficient Determination			2	4	4		10
3.3	Obtain Discharge			2	4	4		10
4.0	Evaluate Hydraulics	15	17	24	24	30	10	120
4.1	Existing Culvert Analysis	9	5	10	10	10	10	54
4.2	Develop Alternative Culvert Designs	6				6		12
4.3	Existing Channel Analysis		6	6	6	6		24
4.4	Develop Alternative Channel Designs		6	8	8	8		30
5.0	Generate Conceptual Design Plans	2	0	8	16	16	12	54
5.1	Overlay Existing Maps				6	6	6	18
5.2	Draft Alternatives			4	4	4		12
5.3	Determine Material Quantities	2		4	6	6	6	24
6.0	Provide Documentation	0	0	2	4	4	4	14
6.1	Instructions on Use			1	2	2	2	7
6.2	Instructions for Maintenance			1	2	2	2	7

Table 2: Full Staffing Hours for Grand Canyon Unified School District Master Drainage Study Continued

Full Staffing Hours for GCUSD Master Drainage Study								
#	Task	Principle	Manager	PE	EIT	Tech	Admin	Task Total
7.0	Project Management	39	27	49	109	109	67	400
7.1	Meetings	24	18	26	61	61	26	216
7.1.1	Group	10	10	10	30	30	16	106
7.1.2	Coordinator	10	4	10	10	10	10	54
7.1.3	Technical Advisor				15	15		30
7.1.4	Client	4	4	6	6	6		26
7.2	Minutes and Notes						16	16
7.3	Task assignment and feedback			4	8	8	4	24
7.4	Deliverables	15	9	19	40	40	21	144
7.4.1	Status Updates	4	4	4	4	4	4	24
7.4.2	30% design			4	8	8	4	24
7.4.3	60% design	6		4	8	8	4	30
7.4.4	TBL-CBA			1	4	4	1	
7.4.5	Final Presentation	1			2	2		5
7.4.6	Final Document	4	4	6	10	10	8	
7.4.7	Web page		1		4	4		9
	Total Staffing Hours	57	45	96	201	208	96	703

The qualifications for each staff member are as follows:

- The Principal engineer is the lead position for the project and will oversee all final submissions. As such, hours spent on the project by the principal engineer are low.
- The manager will provide coalescence of team members and be responsible for the assignment of tasks.
- The Professional Engineer (PE) will provide the bulk of the experience necessary to complete the project. This position will be working directly with both the engineer in training (EIT) and technician.
- The EIT and technician will complete the bulk of labor under supervision of the PE. As such, these staff members acquire a large proportion of the hours for this project. While EIT will perform engineering analyses, the technician will perform surveying duties, as well as, computer aided drafting and hydraulic analysis with Bentley systems.
- The administrator will develop meeting minutes, document all notation, and file necessary paperwork.

Table 3 summarizes the major tasks and staffing hours associated with each staff member.

Table 3: Summary of Major Tasks and Staffing Hours

Major Tasks and Staffing Hours								
#	Task Description	Principle	Manager	PE	EIT	Tech	Admin	Task Total
1.0	Field Work	1	1	3	12	13	2	32
2.0	Surveying with GPS	0	0	4	24	24	1	53
3.0	Hydrology	0	0	6	12	12	0	30
4.0	Evaluate Hydraulics	15	17	24	24	30	10	120
5.0	Generate Conceptual Design Plans	2	0	8	16	16	12	54
6.0	Provide Documentation	0	0	2	4	4	4	14
7.0	Project Management	39	27	49	109	109	67	400
Total Staffing Hours		57	45	96	201	208	96	703

As seen in Table 3, the Engineer in Training and technician are expected to perform a bulk of the duties for this project. Principal Engineer and Manager will both offer supervision throughout the course of project and thus are expected to incur fewer hours. Project Management has the largest amount of total hours required for completion due to the inclusion of all meetings and all deliverables stated above. Deliverables and meetings are expected to be the two largest time sinks throughout the course of the project.

5.0 Cost of Engineering Services

Table 4 shows the staff member rates and total hours projected for the completion of the project. Rates include base pay, benefits, and multiplier [9]. Provided in the final row is a total number of hours required for the project.

Table 4: Staff Member Rates and Total Hours for GCUSD Master Drainage Plan

Staff Member Rates and Hours		
Position	Rate ($/hr)	Total Hours
Principal Engineer	200	57
Manager	125	45
Project Engineer	142	96
EIT	105	201
Tech	80	208
Administration	50	96
Total Staffing Hours		703

Table 5 provides a list of miscellaneous expenses projected for the completion of the project. Miscellaneous expenses include cost of travel and cost of equipment. Cost of travel and equipment are both calculated for two site visits.

Table 5: Summation of Miscellaneous Expenses for GCUSD Master Drainage Plan

MISCELLANEOUS EXPENSES	
Cost of Travel	
Mileage Cost	$120
Car Rental ($/day)	$55
Total Travel Cost for 2 days	$230
Cost of Equipment	
Surveying Equipment ($/day)	$250
Total Equipment Rental for 2 days	$500

Table 6 provides a summary of the total cost of engineering services, including total miscellaneous cost and total staffing costs.

Table 6: Total Cost of Engineering Services for GCUSD Master Drainage Plan

TOTAL COST OF ENGINEERING SERVICES	
Total Miscellaneous Cost	$730
Total Staffing Cost	$71,842
Total Cost of Project	$72,572

As seen in Table 6, the total cost of the project is expected to be $72,572.

References

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Appendix A: Site Photos

Figure 3: Aerial view of GCUSD campus [1]

Figure 4: Example of culvert on site [3]

Figure 5: Example of channel on site (a) [3]

Figure 6: Example of channel on site (b) [3]

Figure 7: Example of surface flow causing erosion [3]

Figure 8: Example of berm on site [3]

Figure 9: Example of drainage area (a) [3]

Figure 10: Example of drainage area (b) [3]

Appendix B: Hydrological Data

Figure 11: USGS map of watershed for GCUSD campus site [12]

Table 7: Precipitation Frequency Data for Grand Canyon Village [5]

PRECIPITATION FREQUENCY ESTIMATES (in inches)[1]										
	Average recurrence interval (years)									
duration	1	2	5	10	25	50	100	200	500	1000
5-min:	0.141	0.18	0.25	0.32	0.428	0.528	0.649	0.794	1.03	1.24
10-min:	0.214	0.273	0.381	0.486	0.652	0.804	0.988	1.21	1.57	1.89
15-min:	0.265	0.339	0.472	0.602	0.808	0.997	1.22	1.5	1.94	2.34
30-min:	0.357	0.456	0.636	0.811	1.09	1.34	1.65	2.02	2.61	3.16
60-min:	0.442	0.564	0.787	1	1.35	1.66	2.04	2.5	3.23	3.91
2-hr:	0.601	0.753	1	1.24	1.62	1.96	2.37	2.85	3.62	4.34
3-hr:	0.663	0.83	1.08	1.3	1.65	1.99	2.4	2.88	3.66	4.36
6-hr:	0.824	1.02	1.27	1.5	1.84	2.13	2.44	2.91	3.68	4.39
12-hr:	1.01	1.24	1.54	1.79	2.13	2.4	2.69	2.99	3.74	4.46
24-hr:	1.22	1.52	1.91	2.22	2.65	2.99	3.35	3.71	4.23	4.62
2-day:	1.41	1.76	2.21	2.57	3.07	3.47	3.89	4.32	4.91	5.38
3-day:	1.5	1.87	2.35	2.74	3.29	3.71	4.17	4.63	5.28	5.79
4-day:	1.59	1.99	2.49	2.91	3.5	3.96	4.44	4.95	5.64	6.2
7-day:	1.83	2.3	2.91	3.4	4.08	4.61	5.17	5.74	6.54	7.16
10-day:	2.02	2.55	3.26	3.83	4.63	5.28	5.95	6.66	7.64	8.42
20-day:	2.64	3.31	4.14	4.8	5.69	6.38	7.09	7.8	8.77	9.51
30-day:	3.19	4.01	4.99	5.76	6.77	7.53	8.29	9.05	10.1	10.8
45-day:	3.78	4.75	5.99	6.96	8.29	9.31	10.4	11.4	12.9	14
60-day:	4.35	5.47	6.92	8.07	9.63	10.8	12.1	13.4	15.1	16.4

Appendix C: Paperwork

CENE 476 Technical Advising Contract

An essential element in the education of engineering students is their culminating senior design experience, also known as capstone. In Civil and Environmental Engineering, students work in teams with a client, usually external to the department, to develop a real-world engineered design. The PRIMARY role of the technical adviser (TA), as a practicing engineer, is to advise the students with technical and practical advice to avoid critical mistakes (incorrect assumptions, analyses methods, missing work, etc.) that have the potential to derail the project.

Each student team will work with their TA to identify and direct students to technical content necessary to develop a proposal for the project due at the end of CENE476, which may include help with codes/standards, scoping items, methods/approaches, time commitment for tasks, equipment/material/software resource identification, and overall advising.

Student Team Terms and Conditions:

- Provide TA with all necessary capstone documents (this document, proposal rubric, presentation rubric, TA evaluation form), and applicable communications
- Interact with their technical adviser in a professional manner at all times.
- Request meetings via a calendar appointment request according to TA preferred time. **Meeting request must include meeting agenda and any items the TA could review prior to the meeting**
- Use the adviser's time efficiently and effectively by providing agendas as well as being prepared for consultation and meaningful discussion
- Keep detailed meeting minutes from meetings and **provide to advisor (with CC to all team members and the grading instructor) within 48 hours of meeting**
- Students are not to ask for meetings individually or without the entire team present
- Follow all reasonable recommendations made by the tech adviser.
  - Where a team does not adhere to their adviser's advice, they must justify and document reasons why they chose not to follow the TA input

TA Terms and Conditions:

- Provide the minimum expected interactions **(four total meetings and five total assessments to grading instructor)**
  - Provide four meetings, one prior to submission for the Project Introduction (1st), Scope and Schedule (2nd), Staffing and Cost (3rd), and Final Presentation (4th)
  - Provide feedback to the grading instructors via emails approving the meeting minutes as provided by the teams for the above meetings, and providing a team evaluation at the end of the semester
    - Note that both of the TA feedback items will adjust the individual and team grades via a final grade multiplier applied at the end of the semester
- Interact with their student team in a professional manner at all times.
- Be available to the student team, approximately one (1) hour per week on average
- Prepare for meetings with their team in advance by reviewing meeting agenda and provided documents
- Provide honest and constructive feedback with respect to the technical approaches used on their project
- **Provide the capstone grading instructor** with assessments of various team activities including meetings (preparedness, agendas, minutes, review documents, engagement, attitude) quality technical work provided in documents reviewed, and ability for the team to follow provided recommendations

UNDER NO CIRCUMSTANCES IS IT EXPECTED THAT THE TA WILL:

- Track down the students for meetings or contact
- Do any of the research/analysis/design/document prep
- Provide financial support
- Be forced to meet or advise without proper notice
- Contact the client for the capstone team
- Supervise field/lab work
- Provide reviews of submittals for grammar, punctuation, spelling, etc.

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TA Initials

Figure 12: Technical Advising Contract for Jeffrey Heiderscheidt – front

CENE 476 Technical Advising Contract

General information for TA communication and interaction (to be filled out by technical advisor):

- Provide your contact information: jeffrey.heiderscheidt@nau.edu ; jheiders@yahoo.com cell: 719-243-9188
- Preferred means of contact: any
- Minimum number of days needed to have a meeting scheduled: 7 days
- Preferred meeting location: my office (room 215)
- Preferred meeting days and/or timeframe: TU/TH 9:30-2:30, FRI 12:30-2:00
- Are you willing to be contacted via phone (YES or NO) and/or email (YES or NO) for quick questions from individual team members
- Are you willing to meet more the identified minimum of four times (YES or NO)
- Any other comments:

The foregoing CONTRACT with its identified **Terms and Conditions** has been has been read, is understood, and is hereby accepted.

EXECUTED BY:

[signature] Technical Advisor Signature	JEFFREY L. HEIDERSCHEIDT Technical Advisor Typed or Printed Name	1/23/2018 Date
[signature] Student Signature	Sean Heckmann Student Typed or Printed Name	1/23/18 Date
[signature] Student Signature	Ahmed Alsahili Student Typed or Printed Name	1/23/18 Date
[signature] Student Signature	JASON MACDONALD Student Typed or Printed Name	1/23/18 Date
SAH Student Signature	Sulaiman Alhabashi Student Typed or Printed Name	1/23/2018 Date
Student Signature	Student Typed or Printed Name	Date
Student Signature	Student Typed or Printed Name	Date

2 TA Initials [initials]

Figure 13: Technical Advising Contract for Jeffrey Heiderscheidt – back

GRAND CANYON HIGH SCHOOL

| Ivan Landry | 100 Boulder St | Grand Canyon Village, AZ 86023

CONTACT

2112 S Huffer Ln

Flagstaff, Az 86001

Sulaiman Alhabashi – saa429@nau.edu

Ahmed Alsahili – aaa626@nau.edu

Sean Heckmann – smh429@nau.edu

Jason MacDonald – jwm255@nau.edu

02/15/18

Dear Ivan Landry

Thank you for allowing our firm to work with you over the next year.

Attached for your review is a rough draft of the GCHS master drainage plan project understanding. This is to gather any comments, feedback, and clarification that either parties have. We want to ensure complete scope and understanding of the end goals for everyone.

We know you're very busy, but ask that you respond by Friday, February 23rd. This will allow us to promptly address any suggestions or modifications that you may have.

We look forward to hearing your feedback and thank you for your time.

Sincerely,

Hydro Applicable Engineering

Figure 14: Cover Letter for Ivan Landry, client and contact at GCUSD

Appendix D: Gantt Chart

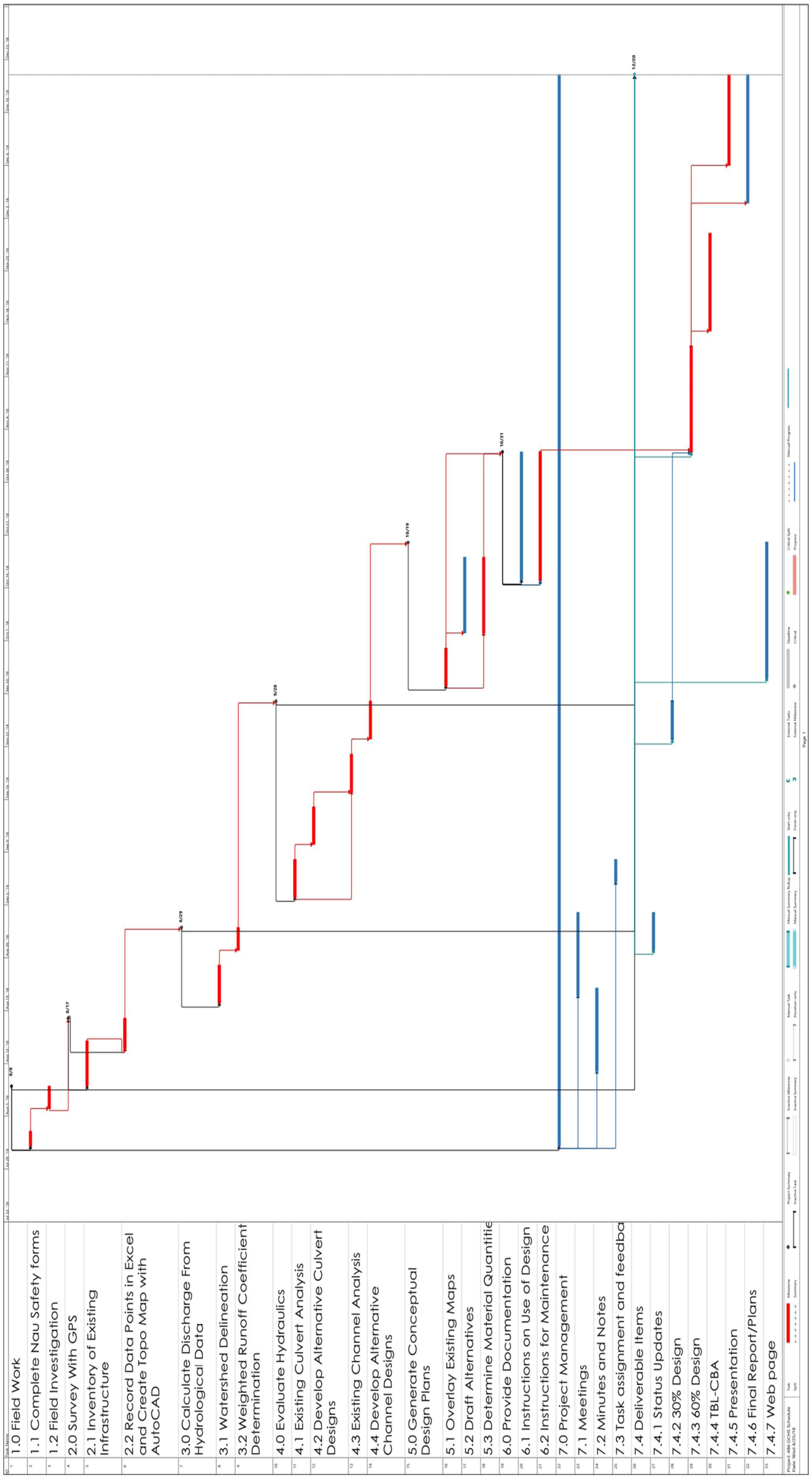

Figure 15: Gantt chart for GCUSD Master Drainage Study