Proposal for

Sinclair Wash Restoration Feasibility Study

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1.0 Project Understanding

1.1 Project Purpose

Riparian habitats aid in the dissipation of the energy in streams through curves in their path as well as vegetation. This reduction in the flow of the stream helps to reduce soil erosion, settle out suspended solids reducing the turbidity, and to filter out pollutants. These zones also provide habitats for diverse native wildlife and plants. When the balance of these habitats is disturbed, usually by human actions, the system can be thrown out of control resulting in reduced or increased water flow, invasive species being introduced, and the general decline of the habitat [1]. The purpose of this project is to identify areas within the Northern Arizona University stretch of Sinclair Wash in order to determine reaches which are healthy and may be preserved as they are as well as those which are in need of repair. Of the damaged reaches, those which may be repaired will be assessed and prioritized. The intent of the project is to develop a restoration plan to improve the wash and restoring it to its proper function as a riparian habitat as well as channel for floodplain health while promoting it as an area for recreational opportunities and interpretive educational experiences.

1.2 Project Background

The project site is located in the City of Flagstaff in the State of Arizona, as shown in Figure 1.1. The project location will be the section of Sinclair Wash between I-17 and Lone Tree Road.

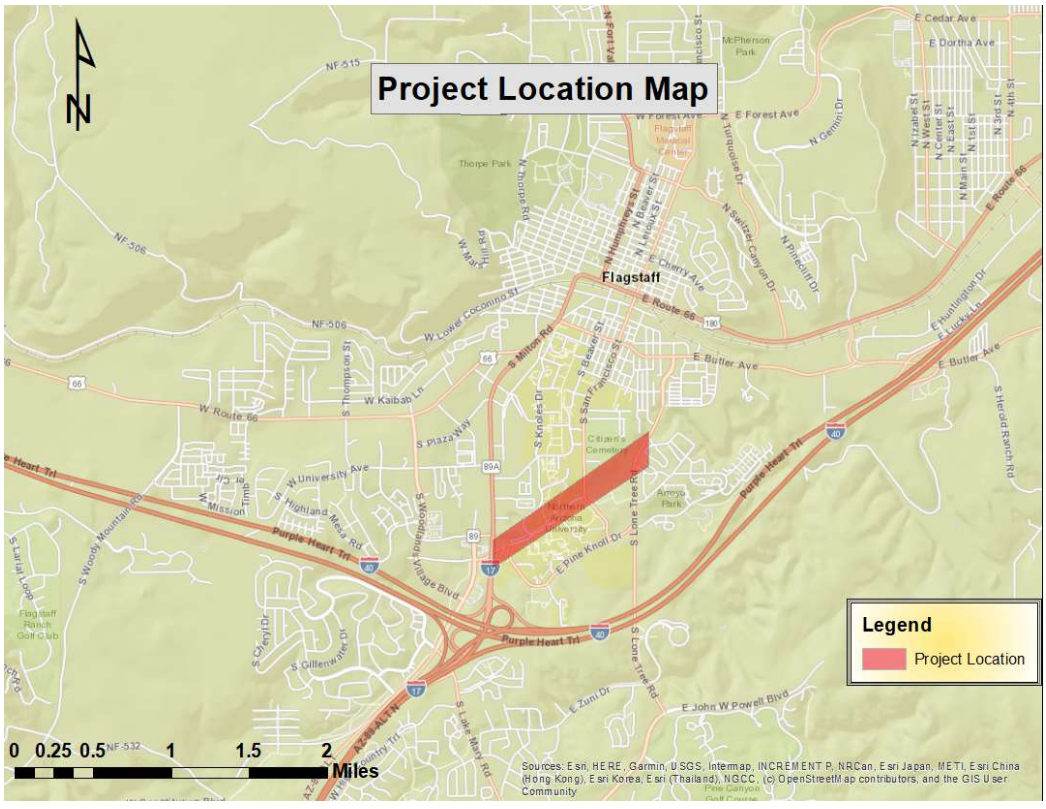

Figure 1.1 - Project location map

This section of Sinclair Wash, located within Northern Arizona University, will be the focus of the project and is outlined in Figure 1.2. The map also contains information from the FEMA Regulatory Floodway Map.

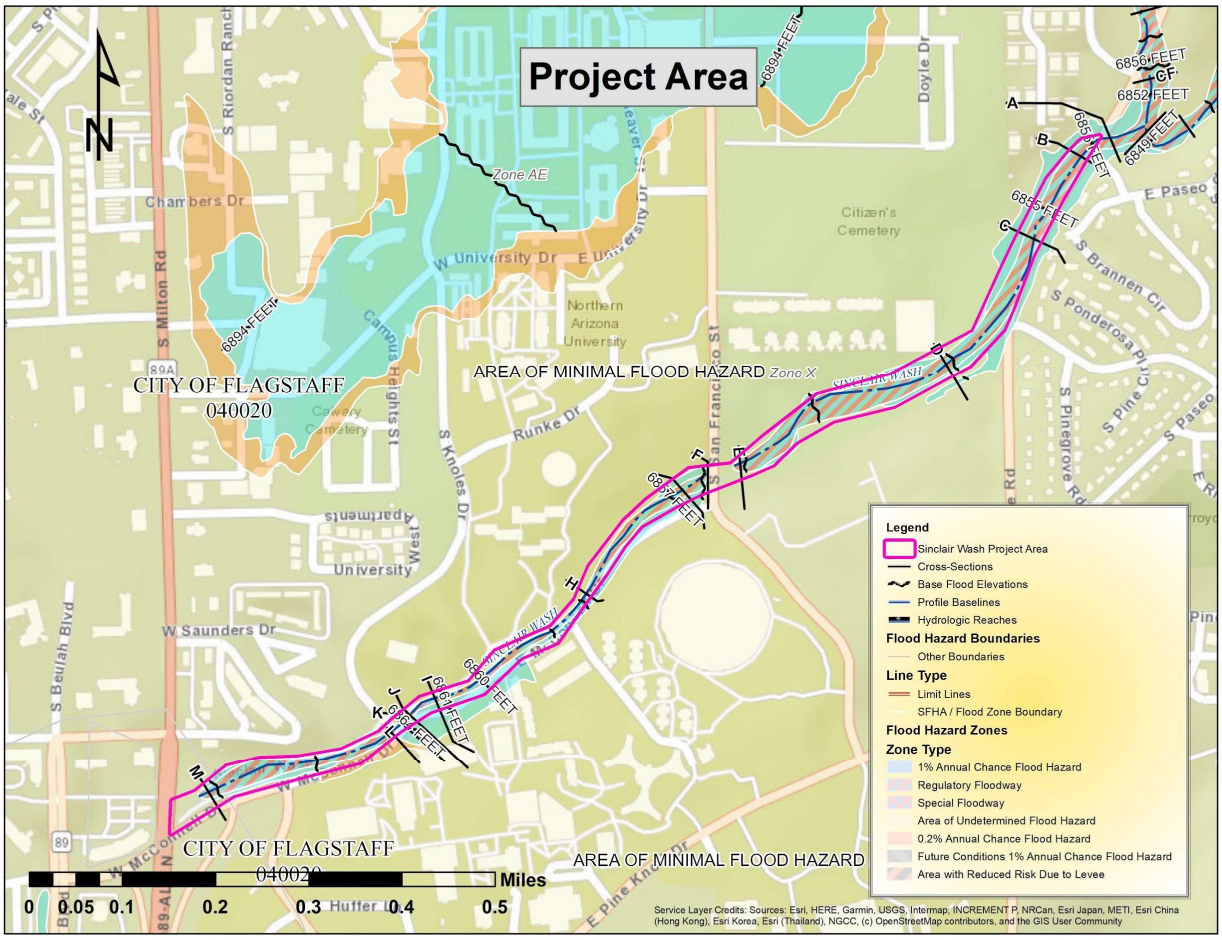

Figure 1.2 - Site location map outlining Sinclair Wash Project

Currently Sinclair Wash contains multiple problem areas. Portions of the wash contain sediment deposits which impede the normal flow of the channel. Overgrown vegetation, such as that in Fig. 1.3, causes the water carried by the channel to flow at lower speeds which can result in backflow as well as puddling in areas where the channel bed has eroded. During instances of heavy rain portions of the Flagstaff Urban Trail system, which runs adjacent to Sinclair Wash's path through the NAU campus, become flooded and become hazardous to users as well as eroded by the larger water flows.

Figure 1.3 - Overgrown vegetation in portion of Sinclair Wash

There are also portions of the wash which allow for the puddling of water at low flows, such as the Knoles Drive culvert shown in Fig. 1.4. These areas provide habitats for insects as well as result in the growth of mold.

Figure 1.4 - Knoles Drive culvert with water flowing (left) and water pooled (right)

1.3 Technical Considerations

1.3.1 Site Selection Research

By reviewing information available about the project area multiple technical aspects of the project may be determined. In order to determine what kind of work may be done as well as the uses for the site the City of Flagstaff's Zoning code will need to be checked [2]. It will also be necessary to check the available standard/data of FEMA Regulated Floodways In order to perform an analysis on the wash it will be necessary to review surveying data along the entirety of the reach within campus that is available. The data available will be analyzed using AutoCAD and/or Civil 3D software in order to observe the channels shape and determine possible adjustments as well as their effects. Existing hydrological data as well as previous studies will be examined to determine the possible flows and changes previously considered.

1.3.2 Plan Production

Using the information determined from the analysis of the channel, the habitat restoration guidelines, and the guidelines set out by the City of Flagstaff, Coconino County, FEMA, and the Army Corps of Engineers, a plan set will be produced in order to guide future construction and development of the site.

1.3.3 Hydraulic Analysis

In order to better design the channel, a hydraulic analysis will be performed. The analysis will determine optimal channel geometry, slopes, and culvert sizes. These will need to be designed to the standards which are set out within the city's stormwater manual and code [3].

1.3.4 Open Channel Design

The wash is almost entirely earthen open channel in design with some areas containing concrete or corrugated metal culverts or brick or vegetative lining. The redesign of the channels as well as the culverts must adhere to the City of Flagstaff municipal code 12-2 stormwater management utility as well as guidelines found in Title 10 Flagstaff Zoning code. [3].

1.3.5 Geotechnical Evaluation

In order to better determine the proper coefficients to utilize it will be necessary to perform a sieve analysis determine the soils makeup at various points in the site. In order to get accurate data, it will be necessary to perform random sampling of the soil while performing collections.

1.3.6 Environmental and Biological Assessments and Riparian Habitat Restoration

The main goal of the riparian habitat restoration is to return the habitat to its original state. In order to do this, it is necessary to determine what sorts of plants and animals are currently in the area [4][5]. Using the information from these assessments, a plan will be created in order to restore the habitat to its original state [6].

1.4 Potential Challenges

There are several challenges which may arise in the process performing the project. The first challenge arises from the location of the project site which brings the possibility of snow during the winter months. The project is to begin in January which increases the possibility that it may snow. If it were to snow during the beginning of the stages of the project it will delay any needed surveying and site visits necessary to collect information for analysis. In order to minimize the effects of possible snow, any needed surveying will be completed in the fall/early winter. Site visits to determine problem areas will also need to be completed within this time frame as well.

Another challenge to come from the fact that Sinclair wash does not have a continuous flow of water running through it. Without this continuous flow, observing areas of concern becomes slightly more difficult. In order to address this, if the opportunity presents itself to observe flows through the wash, the team will need to make the effort to visit the sight and do so.

In order to perform analysis on the flows of Sinclair Wash flow data will be needed. Data containing this information may not be available to the detail needed for analysis. In order to perform our analysis, it may be necessary to make assumptions as well as use information from sources such as the National Oceanic and Atmospheric Administration as well as the United States Geological Survey pertaining to the larger area around the wash. This information may be used for analysis using the Rational Method as well as IDF Analysis [7].

1.5 Stakeholders

Stakeholders are those people who will benefit from this project in either a positive way or negative way. The Sinclair Wash Project would impact many people in the area. The wash helps in providing a recreational area for fitness conscious individuals as well as outdoor enthusiasts, it aids in channeling flood waters, and the area provides an on-campus retreat for students. Though much of the site lies on campus, there are also portions in close proximity which are privately owned, meaning that the project will impact these private owners as well. Sinclair Wash also considered a FEMA Regulatory Floodway which are overseen by both FEMA and the Army Corps of Engineers.

Northern Arizona University, both the school as well as students are stakeholders in the project due to the site being located on campus. Since Sinclair Wash aids in the transference of stormwater and runoff through the area and into the Rio de Flag and the management of flood waters falls under the jurisdiction of both the City of Flagstaff as well as Coconino County both entities will be considered stakeholders. The close proximity of project site makes the adjacent property owners stakeholders in the project as well since improvements to the area. With their oversight over Sinclair Wash the Army Corps of Engineers and FEMA would be considered stakeholders in the project.

2.0 Scope of Work

2.1 Site Selection Research

2.1.1 Surveying Data

Survey data from previous studies will be researched. From the most recent data a topographic map will be created as well as a profile of the wash.

2.1.2 FEMA Floodway and FIS

Information from FEMA's Regulatory Floodway data as well as their Flood Insurance Studies will be reviewed. The information will provide necessary restrictions as well as historical data for Sinclair Wash that will be useful in the analysis. Reviewing the FEMA FIS will tell the severity of the flood hazards occur around Sinclair Wash.

2.1.3 Hydrologic Data

In order to determine the flows through Sinclair Wash previous hydrological studies as well as historical data will be researched. The data will aid in determining the expected flows through

the Sinclair Wash. This information will be critical in determining the required channel conditions as well as culvert sizes.

2.1.4 Hydraulic Data

Existing hydraulic studies will be reviewed in order to determine if their findings are still applicable. The studies that are still valid may be implemented in the design while those that are not may still be utilized as a starting position for newer altered designs.

2.1.5 Geomorphic Data

An assessment of previous geomorphic analysis will be performed. The models will be assessed to determine the conditions within the channel due to erosion and sediment deposition.

2.1.6 Site Selection Criteria

From the information determined by the previous research tasks a set of selection criteria will be developed. These criteria will help in determining a set of four locations that will be the focus of the study.

2.2 Effective Hydraulic Model

Effective Hydraulic Models are created in order to match previous models of an area. These models are used as a starting point for later analysis.

2.2.1 Input Data Development

Using the information found in the research of the site input data for a hydraulic model will be developed. This data is necessary in order to make an accurate model of Sinclair Wash, which will be the basis for future models to be developed in the study.

2.2.2 Hydraulic Modeling

Using the input data developed and HEC-RAS, a model depicting Sinclair Wash will be developed. This model will depict the entire Sinclair Wash section from I-17 to Lone Tree Road in a similar fashion to the latest model of the wash to be developed.

2.2.3 Site Selection

Four areas of study will be determined using the selection criteria developed, the wash model, previous studies, and the profile of the wash. These four areas will be the focus of the remainder of the study.

2.3 Corrected Effective Hydraulic Model

Corrected Effective Hydraulic Models will be created for each site in the study. These models will more closely resemble the current conditions of Sinclair Wash at the selected sites.

2.3.1 Site 1 Corrected Effective Model

A corrected effective model for site 1 will be created in HEC-RAS, using the Effective Model as a basis. This Corrected Effective Hydraulic Model will be created using changes made to the site location in the channel since the last model was created, better reflecting the current flow conditions.

2.3.1.1 Site 1 Input Data Development

In order to develop a corrected model, input data for Site 1 will be created. This data will include updated boundary conditions, flow conditions, and geometric data that may have changed since the last modeling of the site. Any additions to the area, such as new lining conditions and culvert or obstruction additions will be included as well. This data is necessary to create a more accurate current condition representation of Sinclair Wash at Site 1.

2.3.1.2 Site 1 Hydraulic Modeling

Using the input data created for Site 1, a Corrected Effective Hydraulic Model will be developed. The model will be created using HEC-RAS and utilized in the assessment of the site as well as the basis for restoration modeling.

2.3.2 Site 2 Corrected Effective Model

A corrected effective model for site 2 will be created in HEC-RAS, using the Effective Model as a basis. This Corrected Effective Hydraulic Model will be created using changes made to the site location in the channel since the last model was created, better reflecting the current flow conditions.

2.3.2.1 Site 2 Input Data Development

Similar to Site 1, input data will be developed for the corrected model. This data will once again include updated boundary conditions, flow conditions, and geometric data that may have changed since the last modeling of the site. Any additions to the area, such as new lining conditions and culvert or obstruction additions will be included as well. This data is necessary to create a more accurate current condition representation of Sinclair Wash at Site 2.

2.3.2.2 Site 2 Hydraulic Modeling

A corrected effective model for site 2 will be created in HEC-RAS. This Corrected Effective Hydraulic Model will be created using the input data created for the site showing changes to the site location in the channel since the last model was created and better reflecting the current flow conditions. This model will be used as the basis for Site 2 assessment and restoration modeling.

2.3.3 Site 3 Corrected Effective Model

A corrected effective model for site 3 will be created in HEC-RAS, using the Effective Model as a basis. This Corrected Effective Hydraulic Model will be created using changes made to the site location in the channel since the last model was created, better reflecting the current flow conditions.

2.3.3.1 Site 3 Input Data Development

Site 3 input data will be created in order to create a corrected model. This data will include updated boundary conditions, flow conditions, and geometric data that may have changed since the last modeling of the site. Any additions to the area, such as new lining conditions and culvert or obstruction additions will be included as well. This data is necessary to create a more accurate current condition representation of Sinclair Wash at Site 3.

2.3.3.2 Site 3 Hydraulic Modeling

A corrected effective model for site 3 will be created in HEC-RAS. This Corrected Effective Hydraulic Model will be created using the input data created for the site showing changes to the site location in the channel since the last model was created and better reflecting the current flow conditions. This model will be used as the basis for Site 3 assessment and restoration modeling.

2.3.4 Site 4 Corrected Effective Model

A corrected effective model for site 4 will be created in HEC-RAS, using the Effective Model as a basis. This Corrected Effective Hydraulic Model will be created using changes made to the site location in the channel since the last model was created, better reflecting the current flow conditions.

2.3.4.1 Site 4 Input Data Development

Site 4 input data will be created in order to create a corrected model. This data will include updated boundary conditions, flow conditions, and geometric data that may have changed since the last modeling of the site. Any additions to the area, such as new lining conditions and culvert or obstruction additions will be included as well. This data is necessary to create a more accurate current condition representation of Sinclair Wash at Site 4.

2.3.4.2 Site 4 Hydraulic Modeling

A corrected effective model for site 4 will be created in HEC-RAS. This Corrected Effective Hydraulic Model will be created using the input data created for the site showing changes to the site location in the channel since the last model was created and better reflecting the current flow conditions. This model will be used as the basis for Site 4 assessment and restoration modeling.

2.4 Proposed Restoration Plan

Using the information from the HEC-RAS corrected model a plan for the restoration of riparian habitat will be developed. These plans will promote the restoration of the habitat in the selected sites while also making the necessary changes to the channel to improve flow conditions at each of the four sites.

2.4.1 Site 1 Restoration Plan

In order to develop a restoration plan for Site 1, geomorphic plans, hydrologic plans, and vegetation plans will need to be developed. These plans will address the needs of the site, improving its function as well as restoring the habitat around it.

2.4.1.1 Site 1 Geomorphic Plan

A plan for changes to the geomorphology of Site 1 will be developed. This plan will need to address concerns such as erosion, bank stability, and channel conditions such as channel slope and sediment deposits. The plan must adhere to the regulations set out in the City of Flagstaff ordinances as well as those found in the FEMA Regulatory Floodway Regulations.

2.4.1.2 Site 1 Hydraulic Plan

A hydraulic plan for Site 1 will be developed ensuring that the site will allow for the required flow conditions through the area. This plan will utilize the corrected effective model for Site 1 as its

base and will utilize proposed changes to the site to create a HEC-RAS model depicting the effects of the changes to the channel geometry, alignment, and lining. The final channel conditions which result from the model analysis will need to adhere to the ordinances set out by the City of Flagstaff [2] as well as FEMA Regulatory Floodway Regulations [8] as well as ensure they meet guidelines to promote habitat restoration [6].

2.4.1.3 Site 1 Vegetation Plan

A plan for Site 1 will be created in order to remove invasive species from the area. Overgrown native species will also be assessed to determine if they are also inhibiting the flow of the channel and also need to be removed to an extent. For areas where there is a need for vegetation a plan will be developed for the planting of native species to promote restoration of the natural habitat.

2.4.2 Site 2 Restoration Plan

In order to develop a restoration plan for Site 2, geomorphic plans, hydrologic plans, and vegetation plans will need to be developed. These plans will address the needs of the site, improving its function as well as restoring the habitat around it.

2.4.2.1 Site 2 Geomorphologic Plan

A plan for changes to the geomorphology of Site 2 will be developed. This plan will need to address concerns such as erosion, bank stability, and channel conditions such as channel slope and sediment deposits. The plan must adhere to the regulations set out in the City of Flagstaff ordinances as well as those found in the FEMA Floodway Regulations.

2.4.2.2 Site 2 Hydraulic Plan

A hydraulic plan for Site 2 will be developed ensuring that the site will allow for the required flow conditions through the area. This plan will utilize the corrected effective model for Site 2 as its base and will utilize proposed changes to the site to create a HEC-RAS model depicting the effects of the changes to the channel geometry, alignment, and lining. The final channel conditions which result from the model analysis will need to adhere to the ordinances set out by the City of Flagstaff [2] as well as FEMA Regulatory Floodway Regulations [8] as well as ensure they meet guidelines to promote habitat restoration [6].

2.4.2.3 Site 2 Vegetation Plan

A plan for Site 2 will be created in order to remove invasive species from the area. Overgrown native species will also be assessed to determine if they are also inhibiting the flow of the channel and also need to be removed to an extent. For areas where there is a need for vegetation a plan will be developed for the planting of native species to promote restoration of the natural habitat.

2.4.3 Site 3 Restoration Plan

In order to develop a restoration plan for Site 3, geomorphic plans, hydrologic plans, and vegetation plans will need to be developed. These plans will address the needs of the site, improving its function as well as restoring the habitat around it.

2.4.3.1 Site 3 Geomorphologic Plan

A plan for changes to the geomorphology of Site 3 will be developed. This plan will need to address concerns such as erosion, bank stability, and channel conditions such as channel slope and sediment deposits. The plan must adhere to the regulations set out in the City of Flagstaff ordinances as well as those found in the FEMA Floodway Regulations.

2.4.3.2 Site 3 Hydraulic Plan

A hydraulic plan for Site 3 will be developed ensuring that the site will allow for the required flow conditions through the area. This plan will utilize the corrected effective model for Site 3 as its base and will utilize proposed changes to the site to create a HEC-RAS model depicting the effects of the changes to the channel geometry, alignment, and lining. The final channel conditions which result from the model analysis will need to adhere to the ordinances set out by the City of Flagstaff [2] as well as FEMA Regulatory Floodway Regulations [8] as well as ensure they meet guidelines to promote habitat restoration [6].

2.4.4 Site 3 Vegetation Plan

A plan for Site 3 will be created in order to remove invasive species from the area. Overgrown native species will also be assessed to determine if they are also inhibiting the flow of the channel and also need to be removed to an extent. For areas where there is a need for vegetation a plan will be developed for the planting of native species to promote restoration of the natural habitat.

2.4.4.1 Site 4 Restoration Plan

In order to develop a restoration plan for Site 4, geomorphic plans, hydrologic plans, and vegetation plans will need to be developed. These plans will address the needs of the site, improving its function as well as restoring the habitat around it.

2.4.4.2 Site 4 Geomorphologic Plan

A plan for changes to the geomorphology of Site 4 will be developed. This plan will need to address concerns such as erosion, bank stability, and channel conditions such as channel slope and sediment deposits. The plan must adhere to the regulations set out in the City of Flagstaff ordinances as well as those found in the FEMA Floodway Regulations.

2.4.4.3 Site 4 Hydraulic Plan

A hydraulic plan for Site 4 will be developed ensuring that the site will allow for the required flow conditions through the area. This plan will utilize the corrected effective model for Site 4 as its base and will utilize proposed changes to the site to create a HEC-RAS model depicting the effects of the changes to the channel geometry, alignment, and lining. The final channel conditions which result from the model analysis will need to adhere to the ordinances set out by the City of Flagstaff [2] as well as FEMA Regulatory Floodway Regulations [8] as well as ensure they meet guidelines to promote habitat restoration [6].

2.4.5 Site 4 Vegetation Plan

A plan for Site 4 will be created in order to remove invasive species from the area. Overgrown native species will also be assessed to determine if they are also inhibiting the flow of the channel

and also need to be removed to an extent. For areas where there is a need for vegetation a plan will be developed for the planting of native species to promote restoration of the natural habitat.

2.5 Plan Set

A plan set will be developed in order to provide guidance in implementing proposed changes to the channel. These plans will include a cover page, notes, details, topographic map, and site plans.

2.5.1 Cover Page

A professional cover page including a scaled border filled with project specific details and a company logo will be produced. The cover page will show client interest in regards to what is included for design process. To be able to create this border, AutoCAD software will be utilized and viewport will be selected in layout and headings will be filled.

2.5.2 Notes

Notes will contain information regarding project details for inlet and outlet structures that includes code requirements for area of interest. They are required in order to specify detailed information for the production of culverts and other construction details. They will be produced once the feasibility study is fully done. Notes will be labeled with multi leader tool in site layout and providing dimensions for inlet and outlet of culverts, and identifying all sections and material types.

2.5.3 Details

Details will be created in order to show the work that is to be accomplished in the project process. They will explain describe the construction of various portions of the projects design elements. These plans will be developed using standard drafting processes and with the use of AutoCAD software.

2.5.4 Topographic Map

A detailed map showing topographical view of Sinclair Wash will be produced. The map will show the topography of the area as well as highlight the four sites to be assessed. The map will be created using the surveying data points uploaded and analyzed using AutoCAD software.

2.5.5 Site Plans

Plans for each site's specific required work will be created using AutoCAD software. These plans will allow for the specific construction information for each site to be implemented with ease. The site plans will include readable diagrams for each of the four sites in Sinclair Wash features such as areas containing tall grasses grass, trees, large rocks, culverts, drainage facilities, and sewer connections. Site specific plans will be created for necessary cuts, fills, vegetation removal and planting, regrading, and culvert installations. The plans will also include cost estimate for the needed work on a site by site basis.

2.6 Deliverables

2.6.1 30% Submittals

In the course of completing the project progress reports will be completed. The 30% progress reports will be completed for the project report and will also include a presentation and plan set to

be submitted as well. The updates for the 30% submittals will inform on the progress of the project, issues that are occurring and methods of overcoming them, and upcoming milestones. The 30% plan set will include the topographic map and the necessary details and notes for the Sinclair Wash restoration feasibility. The 30% presentation will be presented in relation to all work done for the 30% report, and it will present all the analysis performed and inform on the progress in a presentation format. The presentation will also layout the tasks to be completed for the 60% submittals.

2.6.2 60% Submittals

The 60% progress updates will include the 60% report, presentation, and plan sets. The report will include the preliminary analysis of all technical issues in the project. The plan set will include all deliverables from the 30% with corrections, analyses in the project and includes topographic maps, sample identification, hydrological assessment and hydraulic analysis. The 60% presentation will present the progress and improvements made. The presentation will once again set up the following deliverable.

2.6.3 90% Submittals

The 90% submittals will contain an almost complete report and plan set as well as a presentation. The report will include all analysis completed, hydraulic assessments, improvement plans, impact assessments, and costs. The plan set will include all plans for each site, vegetation plans. The 90% presentation will show the progress made since the 60% submittals and layout the steps to the final deliverables.

2.6.4 Final Report

The final report should aim to show the customer the final product of the project. The report will include the final corrections from the 90% including finalized models, results, and the final feasibility analysis of the restorations of the sites as well as a final plan set.

2.6.5 Final Presentation

The final presentation will explain the final deliverables and provide all improvements from on-site investigations, hydraulic analysis, and impact interpretation. The final plan set will include the finalized maps, details, and construction plans for each site. A summary of all completed work and the results of the analysis will be included in the final presentation.

2.6.6 Meeting Memo Binder

In order to keep track of meetings between team members, grading instructors, technical advisors, and clients a meeting memo binder will be kept. The binder will be organized by meeting type with sections for: Team Meetings, Technical Advisor Meetings, Client Meetings, and Grading Instructor Meetings. The binder will record the time of when the meeting started and when the meeting is over and include an overview of the discussion of the meeting.

2.6.7 Website

A website will be created in order to present the information from the project to any interested observer as well as serving as a portfolio to archive the work completed. The site will include a Home Page displaying the project title, team information and client information, a Project Information Page containing detailed project information with links to specific project

deliverables, a Documents Page containing all written and presentation documents, and any other pages needed to communicate the projects final design. The site will be created using programs such as Bootstrap or Dreamweaver.

2.7 Project Management

2.7.1 Team Meetings

Team members will have a team meeting after each lesson to discuss the next step in the project. At the meeting everyone will be encouraged to express their opinions, which will be considered by the group before a decision will be made as a team.

2.7.2 Technical Advisor Meetings

When team members encounter difficulties or problems a meeting with the Technical Advisor will be scheduled. Technical Advisor Meetings are a very effective way to solve difficult problems and get the team going on the correct path once again.

2.7.3 Client Meetings

In order to ensure that the project is going in the correct direction, the client will be consulted regularly. In client meetings the project will be assessed to ensure that the requests are being fulfilled and any changes to the request are addressed. The client will be able to bring up their concerns with the project's direction as well as any new things that will need to be addressed at these times as well.

2.7.4 Schedule Management

In order to keep on track of all deliverables and required tasks proper schedule management will be needed. A Project Management Plan will be created in order to help ensure that tasks are being completed on time. The plan will include the smaller steps needed to complete larger tasks, overlapping scheduling of tasks, and milestones and deliverables.

2.7.5 Resource Management

Project resource management is needed in order to ensure that the teams limited manpower, materials, machinery, technology, and funds are allocated in a proper manner. By ensuring that these resources are properly allocated it is less likely that problems will arise. The resources will be individually managed and those which are shared between members will be discussed before being utilized to ensure that they are not wasted.

2.7.6 Impacts

Three major impacts of the project will be assessed, economic, societal, and environmental. These findings will be used to inform stakeholders on the possible impacts the project may have, and will help to explain the benefits of the project's completion.

2.7.6.1 Economic Impacts

The economic impacts of the project will likely not result in an increase of revenue to the city or the surrounding area due to Sinclair Wash being free and open to the public for use. There is a possibility of increased property values nearby due to the restoration of Sinclair Wash but that is

not likely to occur due to the small scale of the improvements to be made when compared to the entirety of the reach.

2.7.6.2 Societal Impacts

The impacts to society will likely not be very extreme. The use of the area may increase due to the improvements to the wash, resulting in more activity to the area. There are likely to be negative impacts initially, but those will only be temporary as the inconveniences caused will only be during the construction phase of the restoration in the wash.

2.7.6.3 Environmental Impacts

The environmental impacts are likely to be the greatest. The purpose of the project is to repair and restore portions of Sinclair Wash. In doing so invasive species will be removed from the area, native species will be planted, the flow through the wash will be improved, and a plan will be developed in order to be used as an example for further improvements to the entirety of the wash.

2.8 Exclusions

2.8.1 Structural Engineering

Structural engineering is the focus in designing projects needs as far as construction goes, and faces various challenges related to load and forces. This aspect will not be conducted by the team. The purpose of the project is a feasibility study that will produce a construction plan set and not the actual construction. Any needed analysis will need to be performed by the proper professionals for needed structures. These analyses will include engineering work such as bridges in the wash and any reinforcement of elements located near the channel.

2.8.2 Biological and Ecological Assessment

Whenever engineering work is performed it is common practice to perform biological and ecological assessments in order to determine the impacts on the plant and animal life near the site. With Sinclair Wash being a riparian habitat, the animals and plants surrounding the wash area are closely connected. Although the developed plans will affect the organisms living in the area, no assessment will be completed further than a vegetation survey. The evaluation will be used to determine native species in the area and determine those necessary for removal. The native species may be determined using the Low Impact Development guidelines from the City of Flagstaff.

2.8.3 Traffic Assessments

When work is being performed around roadways it is usually required to create traffic plans in order to ensure that traffic is able to continue to operate in the area. Although portions of Sinclair Wash are near roadways, no traffic plans will be developed due to the project being a feasibility study. If the project were to be approved for actual construction it will be necessary to create traffic plans.

2.8.4 Geotechnical Analysis

An extensive Geotechnical Analysis of the sites will not be performed. These analyses aid in determining the properties of the soil as well as the effects of precipitation and runoff. In order to

determine this information previous research on the area will be utilized. In the event that data is not available, small supplemental analysis will be performed.

2.8.5 Surveying

Extensive surveying of the area will not be performed. In order to better analyze the project area surveying data will be needed for the creation of topographic maps, plan and profile drawings, and site plan drawings. Recent surveying data from previous groups is available and usable for the study. In the event that the data is not detailed enough or contains mistakes, smaller supplemental surveys will be performed.

3.0 Scheduling

3.1 Duration, Tasks, and Deliverables

The Sinclair Wash Stream Project will start on January 13, 2020, and the final report and presentation will be completed by April 22, 2020 for a total project length of 73 days. Major tasks for the project include the creation of effective and corrected effective models, site plans, and the 30%, 60%, 90% and final reports and presentations. In order to better schedule tasks a Gantt Chart was created.

3.2 Gantt Chart

A Gantt Chart depicting the required project tasks was created and can be found in Appendix A. The critical path for the project is highlighted in red on the chart. The path shown in the chart depicts which tasks must be completed before moving on to the next, those that can be completed concurrently, and the required tasks for each major task. The following of this path ensures that the project is completed in as timely a manner as possible.

4.0Staffing Plan and Qualifications

4.1 List of Staff

There will be four types of personnel necessary to aid in the completion of the project. The personnel working on the project are a Senior Engineer (SENG), Engineer II (ENG II), Engineer I (ENG I), and an Engineering Intern (INT).

4.1.1 Senior Engineer

The Senior Engineer is the most experienced and qualified member of the group. The SENG has a wealth of knowledge gained from years of experience practicing and fills the role of the group leader. They will mainly supervise and manage the team while also inspecting work and giving guidance on tasks. The Senior Engineer will not be as involved as the other members of this project, but will guide the team in their tasks.

4.1.2 Engineer II

The Engineer II is not as experienced as the SENG, but still aids in some of the management roles. Their role is to help in design and implementation of technical deliverables by performing basic methodology. The ENG II will support in resolving issues, preparing plans, and developing standard methods of analysis for complex tasks.

4.1.3 Engineer I

The Engineer I is the lower tier of the engineers. He is not as experienced as the SENG or ENG II. The main duties of the ENG I will be to perform the basic analysis and modeling required and to instruct the intern on the aspects that are new to them. The ENG I will also aid in the plan set production.

4.1.4 Engineering Intern

Engineering intern will not have as much experience compared to rest of staff members due to being a student and is still learning the capabilities. Being a student going to school for engineering, the intern has some basic knowledge of tasks given to them and is instructed on things which they may not be as familiar with. The Engineering Intern's main duties will be processing data to be used in software modeling, assist in technical research, and to aid in the organization of the completion of tasks. Other tasks may include beginning tasks which will be picked up and completed by either the Engineer I or II.

4.2 Staff Qualifications

Below is a list of staff with their individual qualifications.

4.2.1 Eric Lima

- Senior Year Civil Engineering Student
- 4+ years of drafting/CAD experience
- ArcMap/GIS
- Water Resources I and II
- Geotechnical Engineering I and II
- Land Surveying
- Municipal Engineering
- Internship experience – Technical Research, Drafting, and Report Writing

4.2.2 Saud Bohasan

- Senior Year Civil Engineering Student
- 1 year CAD experience
- Water Resources I and II
- Geotechnical Engineering I and II
- Land Surveying
- Municipal Engineering

4.2.3 Bolun Yang

- Senior Year Civil Engineering Student
- 1 year CAD experience
- Water Resources I and II
- Geotechnical Engineering I
- Land Surveying
- Municipal Engineering

4.2.4 Xiaolei Wang

- Senior Year Civil Engineering Student
- 1 year CAD experience
- Water Resources I and II
- Geotechnical Engineering I and II
- Land Surveying
- Municipal Engineering

4.3 Matrix Table

Table 4.1 below represents the estimated working hours for all four personnel broken down by task. It is clearly shown that the Engineer I will work the most, this illustrates that this project is mostly dependent on him completing his analysis and modeling. The Engineering Intern comes second where most of his work will be spent in modeling software. The Engineer II ranks third as far as working hours goes, and most of his work is going to be related to analyzing as well as quality checking the Engineer I and Intern. The Senior engineer has the fewest amount of hours but also has the most important job. He must oversee management roles and meet with the client and team, all while ensuring the work being done is of the utmost quality.

Table 4.1 -- Matrix Table of Staffing Positions

	Senior Engineer	Engineer II	Engineer I	Engineering Intern	Total
Task Name	**SENG**	**ENG II**	**ENG I**	**INT**	
1.0 Site Selection Research	6	10	12	12	40
1.1 Surveying Data	1	1	3	3	
1.2 FEMA Flood Way and FIS Data	1	2	2	2	
1.3 Hydrologic Data	1	2	2	2	
1.4 Hydraulic Data	1	1	2	2	
1.5 Geomorphic Data	1	2	2	2	
1.6 Site Selection Criteria	1	2	1	1	
2.0 Effective Hydraulic Model	4	6	9	11	30
2.1 Input Data Development	1	1	4	5	
2.2 Hydraulic Modeling	2	3	3	3	
2.3 Site Selection	1	2	2	3	

3.0 Corrected Effective Model	16	24	30	31	101
3.1 Site 1 Corrected Effective Model					
3.1.1 Site 1 Input Data Development	2	3	5	6	
3.1.2 Site 1 Hydraulic Modeling	2	6	4	4	
3.2 Site 2 Corrected Effective Model					
3.2.1 Site 2 Input Data Development	2	2	4	4	
3.2.2 Site 2 Hydraulic Modeling	2	3	3	3	
3.3 Site 3 Corrected Effective Model					
3.3.1 Site 3 Input Data Development	2	2	4	4	
3.3.2 Site 3 Hydraulic Modeling	2	3	3	3	
3.4 Site 4 Corrected Effective Model					
3.4.1 Site 4 Input Data Development	2	2	4	4	
3.4.2 Site 4 Hydraulic Modeling	2	3	3	3	
4.0 Proposed Restoration Plan	17	48	59	56	180
4.1 Site 1 Restoration Plan					
4.1.1 Site 1 Geomorph Plan	1	4	6	5	
4.1.2 Site 1 Hydraulic Plan	3	6	8	10	
4.1.3 Site 1 Vegetation Plan	1	8	6	5	
4.2 Site 2 Restoration Plan					
4.2.1 Site 2 Geomorph Plan	1	3	4	3	

4.2.2 Site 2 Hydraulic Plan	2	3	5	6	
4.2.3 Site 2 Vegetation Plan	1	4	4	3	
4.3 Site 3 Restoration Plan					
4.3.1 Site 3 Geomorph Plan	1	3	4	3	
4.3.2 Site 3 Hydraulic Plan	2	3	5	6	
4.3.3 Site 3 Vegetation Plan	1	4	4	3	
4.4 Site 4 Restoration Plan					
4.4.1 Site 4 Geomorph Plan	1	3	4	3	
4.4.2 Site 4 Hydraulic Plan	2	3	5	6	
4.4.3 Site 4 Vegetation Plan	1	4	4	3	
5.0 Plan Set	5	45	71	65	186
5.1 Cover Page	1	4	6	3	
5.2 Notes	0	3	4	4	
5.3 Details	1	7	8	6	
5.4 Topographic Map	0	1	3	2	
5.5 Site Plans	3	30	50	50	
6.0 Deliverables	31	55	56	45	187
6.1 30% Submittals	2	10	10	8	
6.2 60% Submittals	4	10	10	8	
6.3 90% Submittals	4	10	10	8	
6.4 Final Report and Plan Set	6	8	8	10	
6.5 Final Presentation	7	8	8	5	
6.6 Meeting Memo Binder	1	1	1	2	
6.7 Website	5	5	6	2	
6.8 Impacts	2	3	3	2	
7.0 Project Management	49	34	23	23	129
7.1 Team Meetings	15	15	15	15	
7.2 Technical Advisor Meetings	8	8	8	8	

7.3 Client Meetings	5	5	0	0	
7.4 Schedule Management	1	3	0	0	
7.5 Resource Management	20	3	0	0	
Total hours	128	222	260	243	853

Table 4.2 shows the working hours summarized for each task across all four personnel. Senior engineer ended up in having a total of 128 working hours to spend in completing this project. Whereas the Engineer 2 will spend 222 hours for all tasks to complete his duty. It will take 260 hours for Engineer 1 to complete the whole project, and a total of 243 working hours an engineering intern will be spending to finish the project. In total, personnel hours are expected to be 853 hours.

Table 4.2 - Summarized Matrix Table of Staffing Positions

	Senior Engineer	Engineer II	Engineer I	Engineering Intern	Total
Task Name	**SENG**	**ENG II**	**ENG I**	**INT**	
1.0 Site Selection Research	6	10	12	12	40
2.0 Effective Hydraulic Model	4	6	9	11	30
3.0 Corrected Effective Model	16	24	30	31	101
4.0 Proposed Restoration Plan	17	48	59	56	180
5.0 Plan Set	5	45	71	65	186
6.0 Deliverables	31	55	56	45	187
7.0 Project Management	49	34	23	23	129
Total hours	128	222	260	243	853

5.0 Cost of Engineering Services

The base pay and billing rates for each member of the engineering team are shown in Table 5.1.

Table 5.1 - Base pay and billing rates table

Class	Base Pay Rate $/hr	Benefits % of Base Pay Rate	Actual Pay $/hr	OH % of Base Pay	Actual Pay + OH $/hr	Profit % of Actual Pay	Billing Rate $/hr	Multiplier
SENG	90	25	113	70	193	10	213	2.37
ENG II	65	50	98	25	123	10	136	2.09
ENG I	40	60	64	20	77	10	85	2.125
INT	15	15	18	8	20	10	22	1.47

Table 5.2 - Cost of Engineering Services

1.0 Personnel	Classification	Hours	Rate, $/hr	Cost
	SENG	128	213	$ 27,264.00
	ENG II	222	136	$ 30,192.00
	ENG I	260	85	$ 22,100.00
	INT	243	22	$ 5,346.00
	Total Personnel			**$ 84,902.00**
2.0 Travel	N/A			$ -
3.0 Supplies	Surveying Equipment Rental (Tentative)		$100/day	$ 100.00
	Geotechnical Lab Time (Tentative)		$100/day	$ 100.00
4.0 Subcontract	N/A			$ -
5.0 Total				**$ 85,102.00**

As can be seen in Table 5.2, the total cost of engineering services is estimated to be $85,102 all most all of which is due to the personnel costs. The tentative costs that appear in the supplies category are costs that are not expected at this time but may be needed later.

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APPENDIX

Appendix A