

Final Proposal: Low-Cost Water Filtration Project



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1.0 PROJECT PURPOSE

The 2 million acre area on the Navajo Nation known as the former Bennett Freeze area is occupied by approximately 20,000 individuals residing in an estimated 3,688 homes. Of the 3,688 homes, it is estimated that 2,685 (72.8%) do not have access to a regulated public water supply (Navajo Access Workgroup, 2010). Resident and client testimony support the assumption that most families residing in the former Bennett Freeze area zone obtain drinking water from unregulated water sources.

Unregulated water sources include groundwater wells, surface water deposits, springs, and man-made livestock tanks (U.S. Army Corps of Engineers, 2000). Due to a combination of naturally occurring uranium deposits and abandoned uranium mines, many unregulated water sources have expressed high concentrations of uranium. Unregulated water sources have also shown elevated concentrations of arsenic from natural sources and tested positive for coliforms (U.S. Army Corps of Engineers, 2000). Current Environmental Protection Agency (EPA) maximum contamination limits (MCLs) for uranium, arsenic, and total coliform bacteria are 30pCi/L, 0.010mg/L, and less than five percent of non-consecutive samples testing positive for coliforms per month, respectively (U.S. Environmental Protection Agency, 2013).

Health risks associated with consuming water with uranium concentrations above the MCL include an increased risk of cancer and kidney toxicity. Health risks associated with arsenic concentrations above the MCL include circulatory system damage, skin damage, and increased cancer risk. Health risks associated with consuming water containing bacteria can vary as the presence of coliforms is utilized as an indicator for the existence of a variety of pathogens. The effects of these pathogens may include acute and/or chronic gastric and respiratory illnesses (U.S. Environmental Protection Agency, 2013). In order to reduce the health risks associated with the drinking of contaminated unregulated water sources in the former Bennett Freeze area, it is necessary to assure the inhabitants of the area have access to water with concentrations of uranium, arsenic, and coliforms below EPA MCL standards.

The purpose of this project is to design a low-cost, energy efficient water filtration unit capable of reducing uranium, arsenic, and coliforms from variable concentrations above MCL to concentrations at or below the MCL set by the United States EPA.

2.0 PROJECT BACKGROUND

The former Bennett Freeze area consists of approximately 1.5 million acres (Navajo Access Workgroup, 2010). The area is named after former Commissioner of Indian Affairs, Robert Bennett. The Navajo and Hopi Settlement Act, Public Law 93-531, defines the borders of the area and the developmental restrictions imposed on its inhabitants. PL 93-531 defines the Bennett Freeze area as: “that portion of the Navajo Reservation lying west of the Executive Order Reservation of 1882 and bounded on the north and south by westerly extensions, to the reservation line, of the northern and southern boundaries of said Executive Order Reservation” (The 93rd Congress of The United States of America, 2009). There are few maps of the Bennett Freeze area in existence. The map in Figure 1 (page 4, top) shows the Bennett Freeze area as determined by the U.S. General Accounting Office’s Navajo-Hopi Resettlement Program in March 1991. A more detailed map is shown in Figure 2 (page 4, bottom). The Bennett Freeze area is outlined in red, and a red arrow points to Flagstaff, Arizona.

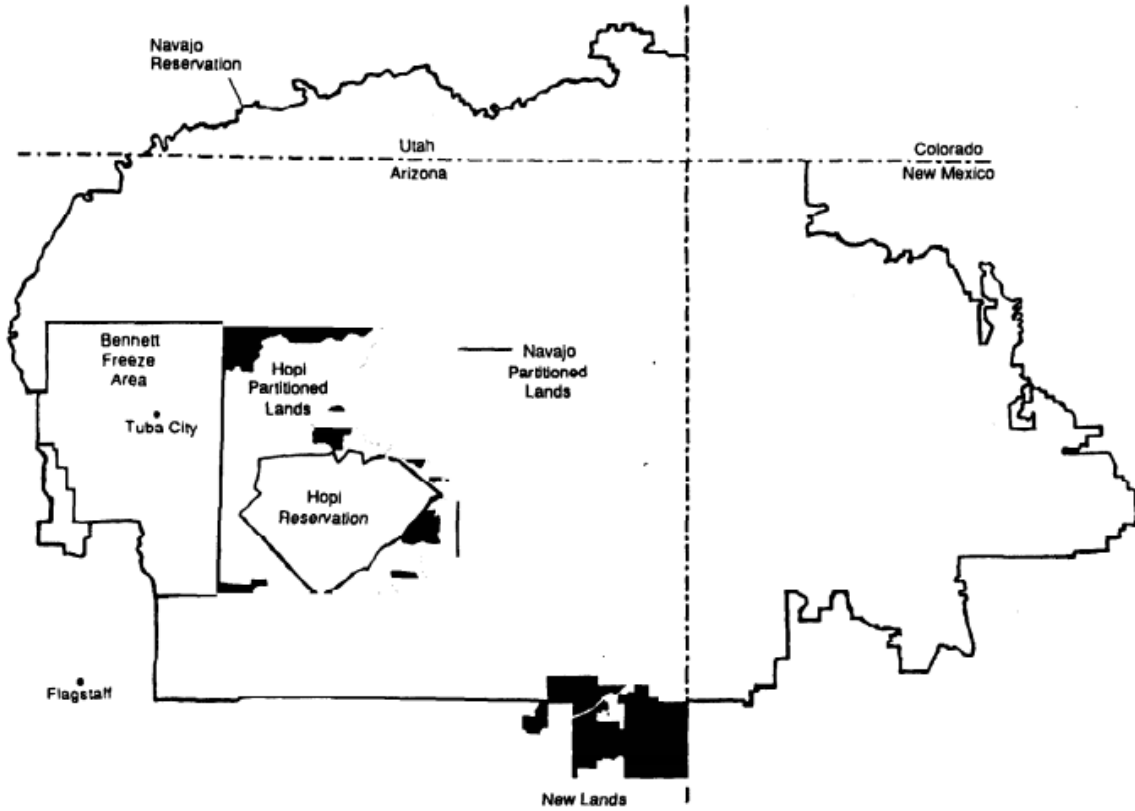


Figure 1: Map of the Bennett Freeze area, as determined by the U.S. General Accounting Office's Navajo-Hopi Resettlement Program (United States General Accounting Office, 1991)

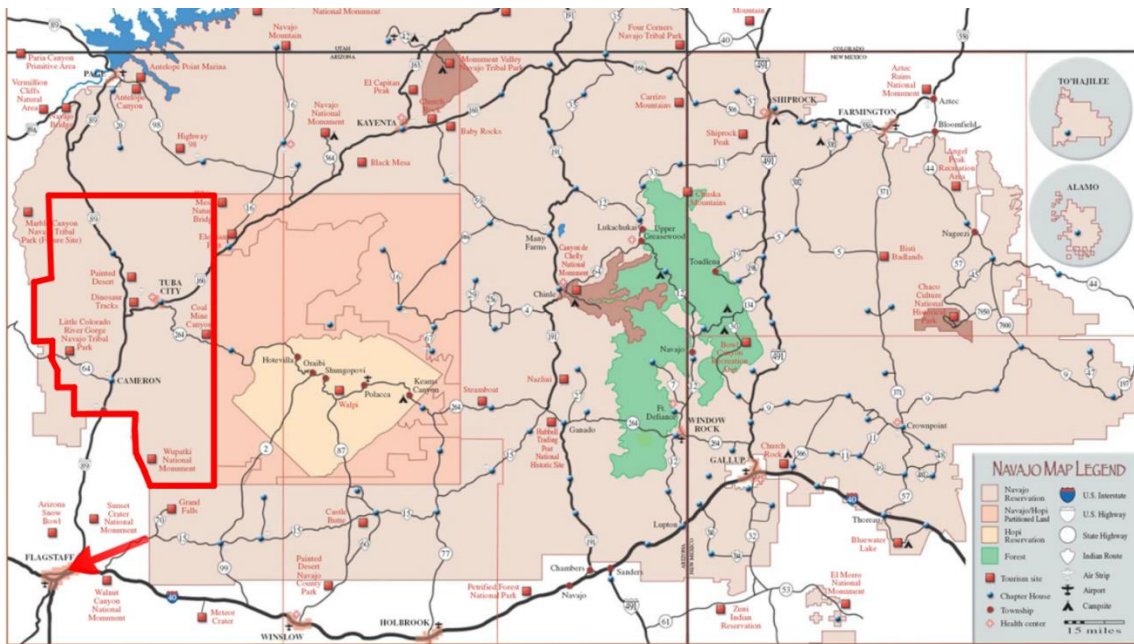


Figure 2: Map of the Bennett Freeze area, as shown by the area outlined in red (Navajo Nation Map, 2008)

The developmental restrictions placed on the residents of the Bennett Freeze area prohibited: “any new construction or improvement to the property and further includes public work projects, power and water lines, public agency improvements, and associated rights-of-way” (The 93rd Congress of The United States of America, 2009). The intention of PL 93-531 was to prevent development of the Bennett Freeze area until a land dispute between the Hopi and Navajo Nations could be settled. Unfortunately, the 43 year-long developmental freeze resulted in dire social and economic consequences for residents in the Bennett Freeze area; consequences exacerbated by an absence of infrastructure. Although the land dispute has not been resolved, PL 93-531 section 10(f), which prohibited development was repealed via PL 111-18 in 2009 (The 111th Congress of The United States of America, 2009). The repeal of PL 93-531 10(f) allows for the development of property and infrastructure to resume.

The development of public water supply (PWS) infrastructure in the former Bennett Freeze area falls under the jurisdiction of the Navajo Nation Environmental Protection Agency (NNEPA), The Navajo Nation Department of Water Resources (NDWR), and the Navajo Tribal Utility Authority (NTUA) (Navajo Access Workgroup, 2010). Development prohibition in the Bennett Freeze area resulted in the inability of these organizations to extend the delivery of PWS infrastructure development projects to the majority of residents in the area (Navajo Access Workgroup, 2010). Due to the lack of access to a regulated PWS and a combination of poor transportation infrastructure, lack of employment opportunities, and high cost of fuel, most residents in the Bennett Freeze area rely on local unregulated water sources for drinking water. Grab samples of unregulated water sources believed to have been utilized for drinking water on the Navajo Nation were analyzed by the U.S. Army Corps of Engineers and the U.S. EPA between 1994 and 2000 (U.S. Army Corps of Engineer, 2000). Samples analyzed during this study exhibited concentrations of uranium and arsenic in excess of the U.S. EPA MCLs.

3.0 KEY STAKEHOLDERS

The key stakeholders in this project are the residents of the former Bennett Freeze area and Forgotten People, which is a non-profit organization that advocates for the well-being of the residents of the former Bennett Freeze area by coordinating with other organizations interested in infrastructure development projects within the area.

4.0 EXISTING CONDITIONS

The former Bennett Freeze area is occupied by approximately 20,000 individuals residing in an estimated 3,688 homes. Of the 3,688 homes, it is estimated that 2,685 (72%) do not have access to a regulated water supply (Navajo Access Workgroup, 2010). According to Thomas Rock, an NAU PhD student studying bioaccumulation of uranium in sheep on the Navajo Nation under the supervision of Dr. Jani Ingram, most residents haul their drinking water from unregulated water sources using trucks and a combination of truck-mounted large water tanks, 50 gallon drums, and 5 gallon containers. Some residents purchase drinking water from providers in Flagstaff or Tuba City; however, transportation costs do not favor this alternative.

Water obtained from the unregulated water sources is utilized as drinking water for both human and livestock consumption. Mr. Rock estimates that the average family of three possesses 15 sheep. The sheep, in general, consume more water than the average human. Both Mr. Rock and representatives of Forgotten People state that contaminant-free water should be provided to both

humans and livestock. Both Mr. Rock and representatives of Forgotten People independently stated that recent drinking water provision efforts have consistently ignored the well-being of livestock; residents have generally found this approach to be both inadequate and confusing. Mr. Rock estimates that the total water demand per family, including livestock, ranges from 500 to 1,500 gallons per week.

Grab sample water analysis data obtained by the U.S. Army Corps of Engineers and EPA details existing contamination levels of verified unregulated water sources located in the former Bennett Freeze area. Total uranium concentrations, a summation of Uranium 234, Uranium 235, and Uranium 238 isotopes, range from 1.7 pCi/L to 84pCi/L. Arsenic concentrations range from 0 µg/L to 145 µg/L (U.S. Army Corps of Engineer, 2000). Coliform contamination data is not available at this time.

5.0 PROJECT RELATED CHALLENGES

There are numerous challenges that may influence this project. These challenges include securing adequate funding, safety and hazardous waste handling and disposal, political sensitivity, acquiring reliable water quality data, and travel to remote locations.

5.1 FUNDING

Forgotten People is a non-profit organization that was developed to serve the residents of the Bennett Freeze area. Due to the economic strife experienced by this population, the Forgotten People organization operates on a small budget and does not have funding to contribute to the development of a water filtration system or associated engineering services. To overcome this challenge, Sublime Engineering will utilize funding provided by the NAU Department of Civil Engineering, Construction Management, and Environmental Engineering to cover transportation costs, low-cost building materials, and water quality testing. Student engineering services will be provided free of charge.

5.2 SAFETY AND HAZARDOUS WASTE HANDLING AND DISPOSAL

The well water to be sampled must contain levels of uranium, arsenic, and bacteria that exceed MCLs. This may present safety concerns while acquiring samples or while using the samples during testing of the bench-scale model. Proper safety precautions and sampling techniques may be addressed by Professor Terry Baxter, Lecturer Alarick Reiboldt, or Instructor Adam Bringham, all of whom work in the Engineering Water Quality Laboratory at NAU. All Sublime Engineering team members are required to take a safety training course to minimize the risk of exposure when performing laboratory analysis.

Since uranium must be removed by the designed device, there may be a need to dispose of it as hazardous waste. Filters that may contain uranium in higher concentrations should be disposed of properly. To determine the proper disposal methods, NAU's Director and Radiation Safety Officer, John McGregor, will be contacted.

5.3 POLITICAL, CULTURAL, AND SOCIAL SENSITIVITY

Due to the recent lift of the freeze on infrastructure development, working in the Bennett Freeze area may be politically, culturally, and socially sensitive. According to the client, the residents of the Bennett Freeze area maintain at least a minimal degree of suspicion of non-residents, especially of those claiming to provide assistance. This is due to their experience of living for many years without Navajo Nation or outside assistance for infrastructure development. Therefore, any site visits performed by Sublime Engineering must be discussed with residents and coordinated by Forgotten People in advance. If necessary, a letter of invitation to Sublime Engineering can be drafted by Forgotten People. Furthermore, when traveling into the area, it is best to be accompanied by a member of the Navajo Nation. It is preferable that a chaperone be a resident of the Bennett Freeze area or the community served by the selected water source.

5.4 ACQUIRING RELIABLE WATER QUALITY DATA AND SOURCE WATER

Previous water sample analysis of unregulated water sources in the Bennett Freeze area has been irregular and not very thorough. Therefore, establishing reliable background concentrations of contaminants may be challenging. This challenge can be overcome by selecting a well with the most reliable data, either using Dr. Ingram's existing data, or via independent testing of the selected water source for the three contaminants of concern: uranium, arsenic, and bacteria.

It may also be a challenge to retrieve water samples from the Bennett Freeze area or any location on the Navajo Nation. The Navajo Nation requires that a Resolution be passed by one of their Chapter Houses in order for water samples to be removed from the Nation. Securing a Chapter House Resolution could potentially take several months. If this is the case, synthetic water must be developed using another water source from northern Arizona. This water should contain bacteria and must be spiked with uranium and arsenic in order to simulate the water in the Bennett Freeze area.

5.5 TRAVEL TO REMOTE LOCATIONS

In order to collect the water samples and to understand the cultural, economic, and social situation of the residents this project serves, travel to what may be rather remote locations in the Bennett Freeze area will be necessary. A reliable 4-wheel drive vehicle will be required to traverse poorly maintained roads. Traveling to remote well sites or resident's homes for site visits may also prove difficult due to unmarked roads. To overcome this challenge, it is best if a local resident or other Navajo speaker accompany the team. This individual will help prevent the team from becoming lost and can assist with translation in areas where English may not be the preferred language. Appropriate travel time must also be budgeted.

6.0 SCOPE OF SERVICES

The scope of services encompasses all tasks necessary to complete the project objective. The scope consists of five primary tasks. The tasks include: identification and acquisition of a contaminated water source, water sample analysis, a literature review, design and design testing,

and the creation of a website. Primary tasks may be divided into several subtasks. Details describing each subtask are included.

6.1 TASK ONE: IDENTIFICATION AND ACQUISITION OF CONTAMINATED WATER SOURCE

The first task is to identify one or more contaminated water sources in the Bennett Freeze area. The selection of the water source is based on several pre-defined criteria. The criteria include: ease of access, confirmation of use as a drinking water source, and confirmation of contamination by contaminants of concern. The contaminants of concern include uranium, arsenic, and coliform bacteria at levels higher than the MCLs established by the U.S. EPA. The purpose of this task is to assure the water source contains the contaminants of concern as communicated by the client.

6.1.1 SUBTASK 1.1: IDENTIFICATION OF SOURCE WATER

This subtask addresses the establishment of a suitable water source for testing in the designed water treatment device. To complete this subtask, water quality data from research on the Navajo Nation conducted by Dr. Jani Ingram, Associate Professor of Chemistry at Northern Arizona University, may be used to identify a water source in the Bennett Freeze area which satisfies the aforementioned criteria. Due to political boundaries, the location of the source is very important. The location of the source is utilized in subtask 1.2, Acquisition of Water Samples. If water cannot be retrieved from the Navajo Nation, a suitable water source in northern Arizona that contains bacteria must be identified. This water can then be spiked with uranium and arsenic, as described in subtask 1.2.

6.1.2 SUBTASK 1.2: ACQUISITION OF WATER SAMPLES

Permission from political bodies of the Navajo Nation may be necessary to legally procure samples from the source identified in subtask 1.1, Identification of Source Water, for use in analysis, task one, Water Sample Analysis. Water samples may be acquired or created in a variety of ways:

1. Acquisition of Navajo Nation Water:
Samples are retrieved from the source water identified in subtask 1.1. Sample collection requires permission from one of the Navajo Nation's Chapter houses in the form of a Resolution. The particular Chapter House is dependent on the location of the selected water source. In order to acquire a Resolution to take water samples, the client must attend a Chapter House meeting to request the support of Sublime Engineering in sampling the water and transporting it off of the Navajo Nation.
2. Acquisition of Non-Navajo Nation Water and Synthetic Water Development:
If a resolution cannot be secured, then water from another source in northern Arizona, such as Upper Lake Mary, can be acquired to

create synthetic water containing bacteria, uranium, and arsenic. The creation of synthetic water allows for various concentrations of uranium and arsenic to be tested by creating several different synthetic waters at various concentrations. The alkalinity, hardness, pH, turbidity, and solids of the synthetic water must be analyzed, as will be discussed in task two.

6.2 TASK TWO: WATER SAMPLE ANALYSIS

Task two involves a detailed analysis of the acquired water mentioned in subtask 1.2. Testing protocols established in the performance of this task are also necessary for the testing of the treated water from the bench-scale device. These protocols are also utilized in task four, Design and Design Testing. The following subsections detail the subtasks that must be addressed in order to complete the water analysis.

6.2.1 SUBTASK 2.1: ESTABLISHMENT OF SAMPLE COLLECTION METHODS

This task requires research to determine standard of practice sample collection methods. The methods should identify proper water sampling techniques and chain of custody standards for sample collection. The purpose of this task is to establish quality control and quality assurance of experimental results, as well as to ensure the safety of the samplers.

6.2.2 SUBTASK 2.2: ESTABLISHMENT OF SAMPLE ANALYSIS METHODS

This task requires research of procedures that can be utilized to establish the background characteristics of the acquired or synthetic water and background concentrations of the contaminants of concern. The contaminants of concern include uranium, arsenic, and bacteria. Analysis of common water characteristics is also necessary to assure that any physical or chemical processes utilized in the final design consider their effects on performance. The intent is to assure that the final design considers the effects of variations in characteristics of the acquired or synthetic water. Common water characteristics that may be considered include, but are not limited to, solids, turbidity, hardness, alkalinity, and pH. A list of equipment necessary to complete the water analysis is generated and utilized in subtask 2.3, Identification of Laboratory Testing Facilities.

6.2.3 SUBTASK 2.3: IDENTIFICATION OF LABORATORY TESTING FACILITIES

The identification of laboratory testing facilities is required to complete the analysis of water samples. Utilizing the information from subtask 2.2, the equipment required to complete the detailed water analysis should be compared with the capabilities of Northern Arizona University (NAU) facilities. The purpose of this comparison is to identify which NAU facilities are viable for the completion of the water analysis and to determine any necessary radioactive or

hazardous waste disposal requirements. Requests for access to the facilities identified during this process are made. If it is determined that a necessary procedure cannot be completed at NAU, it will be outsourced to a capable facility at a minimal cost.

6.2.4 SUBTASK 2.4: PERFORMANCE OF WATER SAMPLE ANALYSIS

This task requires the analysis of acquired or synthetic water samples in accordance with testing methods and guidelines outlined in subtask 2.2. Test results shall be analyzed and interpreted. Water quality reports will be generated.

6.3 TASK THREE: LITERATURE REVIEW

Task three involves conducting a literature review to establish existing technologies capable of removing the contaminants of concern. The purpose of the literature review is to assist in the process of generating ideas for the design alternatives of subtask 4.2, Identification of Alternative Designs. Research into potential impacts is also a subtask of the literature review.

6.3.1 SUBTASK 3.1: EVALUATION OF EXISTING TECHNOLOGIES

An investigation of potential physical, biological, and chemical separation processes to remove the contaminants of concern from the untreated water is necessary. An extensive literature review should ensure that a thorough evaluation of technologies is completed. The literature review also includes an examination of the best available technologies (BATs) for each of the contaminants, as suggested by the U.S. EPA or Arizona Department of Environmental Quality (AZDEQ). Any potentially useful technologies from the literature review should be categorized by their level of technological complexity, from low-tech to high-tech. The literature review will help to determine which technologies can be excluded as potential design alternatives. Investigating water treatment technologies utilized by the mining industry may also prove useful.

6.3.2 SUBTASK 3.2: RESEARCH OF IMPACTS OF SIMILAR DESIGNS

Cultural, social, economic and public health implications of a low-cost device that is able to provide water free of uranium, arsenic, and bacteria is researched. These impacts shall be considered for both the Bennett Freeze area and other economically disadvantaged areas that may have similar water contamination.

6.4 TASK FOUR: DESIGN AND DESIGN TESTING

Design and testing of the treatment device are required. The following subsections detail the subtasks that must be addressed in order to complete the design and testing.

6.4.1 SUBTASK 4.1: DEVELOPMENT OF DESIGN CRITERIA AND CONSTRAINTS

In this subtask, the design criteria and constraints are fully developed. Adherence to the criteria and constraints must occur in subtasks 4.2, Identification of Alternative Designs, 4.5, Final Design Selection, 4.6, Construction of Bench-Scale Model, and 4.7, Laboratory Testing of Model.

6.4.2 SUBTASK 4.2: IDENTIFICATION OF ALTERNATIVE DESIGNS

This subtask involves the identification of multiple alternative designs to achieve the design objective. These alternatives are based upon task three, Literature Review. Any design ideas that would require special permitting from the Navajo Nation are excluded at the request of the client, including any designs that would be implemented at the water source.

6.4.3 SUBTASK 4.3: MATERIAL PURCHASING AND ACQUISITION

Any materials or equipment necessary for the preliminary testing or for the selected design of the bench-scale model must be purchased.

6.4.4 SUBTASK 4.4: PRELIMINARY TESTING OF DESIGN COMPONENTS

Before decisions are made for the final design, preliminary testing of various alternative designs or sub-components may be necessary. Design ideas are tested and analyzed for their efficacy using sample or synthetic water. Testing procedures follow those determined in task two, Water Sample Analysis.

6.4.5 SUBTASK 4.5: FINAL DESIGN SELECTION

Decision matrices are developed and utilized to determine which of the designs best meets the design criteria and constraints established in subtask 4.1. Analysis of the decision matrices leads to the selected final design.

6.4.6 SUBTASK 4.6: CONSTRUCTION OF BENCH-SCALE MODEL

A bench-scale model for the design selected in subtask 4.5, Final Design Selection, must be constructed. Materials purchased and acquired in subtask 4.3 are utilized. A full-scale model for implementation will not be built. Therefore, full-scale construction and implementation is excluded.

6.4.7 SUBTASK 4.7: LABORATORY TESTING OF MODEL

The bench-scale model constructed under subtask 4.6 must be tested for its efficacy in adherence with the design criteria and constraints developed in subtask 4.1. The testing follows the procedures for water analysis as described in task two, Water Sample Analysis. All testing of the bench-scale model will be completed in a laboratory setting. Field testing is excluded.

If testing shows design failure, adjustments will be made. An iterative design approach will be followed, and the Sublime Engineering team will repeat subtasks 4.4-4.7 if necessary.

6.4.8 SUBTASK 4.8: OPERATIONS AND MAINTENANCE MANUAL

This subtask includes the formulation of an operations and maintenance manual for any potential users of the final device as designed. The operations and maintenance manual shall include:

- Descriptions on how the device should be operated, stored, and cleaned
- Details on the frequency of maintenance required for the device and any removable components such as filters
- A disposal plan for any radioactive or hazardous waste

6.4.9 SUBTASK 4.9: ECONOMIC ANALYSIS OF FINAL DESIGN

An economic analysis of the final design is performed using engineering economic principles. The economic analysis shall provide a cost estimate to build, operate, and maintain a full-scale device. The potential for mass production may also be considered.

6.4.10 SUBTASK 4.10: 50% COMPLETION DESIGN REPORT

This subtask includes the formulation of the 50% Completion Design Report to be delivered to the client, technical advisor, and Capstone course instructors.

6.4.11 SUBTASK 4.11: INTERIM PRESENTATION

An interim presentation is given, summarizing the 50% Completion Design Report.

6.4.12 SUBTASK 4.12: FINAL PRESENTATION

A final presentation is given summarizing the Final Design Report.

6.4.13 SUBTASK 4.13: FINAL DESIGN REPORT

This subtask includes the formulation of the Final Design Report to be delivered to the client, technical advisor, and Capstone course instructors. This design report is to include an analysis of the potential impacts of the final design. These impacts may concern improvement to public health or may address cultural, social, or economic impacts.

6.5 TASK FIVE: WEBSITE

This task involves the creation of a website via the use of Dreamweaver software to present information about the project to the interested observer. The website must include, at a minimum, the following webpages:

- Home Page
- Project Information Page
- Documents Page

7.0 PROJECT SCHEDULE

A project schedule showing the tasks to be performed by Sublime Engineering is shown in Appendix A.

The schedule provides start and completion times for each primary task and subtask and also notes milestone dates for deliverables. The Sublime Engineering team may attend the WERC competition, and the details for the competition are provided in Appendix B. The schedule is adjusted account for the deadlines of the WERC competition. The critical path for success, as shown by the red line on the schedule, is described in Table 1 (below).

Table 1: Critical Path for Success

Task	Begin	End
Subtask 1.1 Identification of Source Water	Early October	Mid-November
Subtask 1.2 Acquisition of Water Samples	Mid-November	Late November
Subtask 2.4 Performance of Water Sample Analysis	Mid-November	Early December
Subtask 4.2 Identification of Alternative Designs	Mid-January	Late-January
Subtask 4.5 Final Design Selection	Mid-February	Late February
Subtask 4.6 Construction of Bench-scale Model	Late February	Early-March
Subtask 4.7 Laboratory Testing of Model	Early-March	Mid-March

There are five major deliverables for this project with independent due dates. The 50% Completion Design Report and Interim Presentation are to be delivered by March 6, 2014. On April 25, 2014, the website is to be completed and the Final Presentation is to be delivered. The Final Design Report is due May 2, 2014.

8.0 COST OF ENGINEERING SERVICES

As seen in Table 2, the total cost estimate for engineering services is \$64,225. The cost estimate is a summation of costs and fees associated with personnel, travel, subcontractors, and overhead. The personnel includes a senior engineer (SENG), engineer (ENG), laboratory technician (LAB), intern (INT), and an administrative assistant (AA). Four local meetings estimated at 120 round-trip miles each and 10 water hauling trips at 10 round-trip miles each have been included in the cost of services. Additionally, subcontractor fees for analytical laboratory services for uranium and arsenic analysis have been estimated for 200 total samples at \$49 per sample. An estimated 200 samples will be analyzed for arsenic and uranium over the course of the project. It is

estimated that the treated water will need to be tested four times at 50 samples per trial. The number of samples is based upon a matrix of design alternatives and sampling n-values to achieve proper precision and accuracy of statistical laboratory results. The cost per sample was quoted by Test America based in Phoenix, Arizona. Additional information about sampling and costs associated with laboratory tests can be furnished upon request. Overhead costs for this project have been included, estimated at \$14,673.

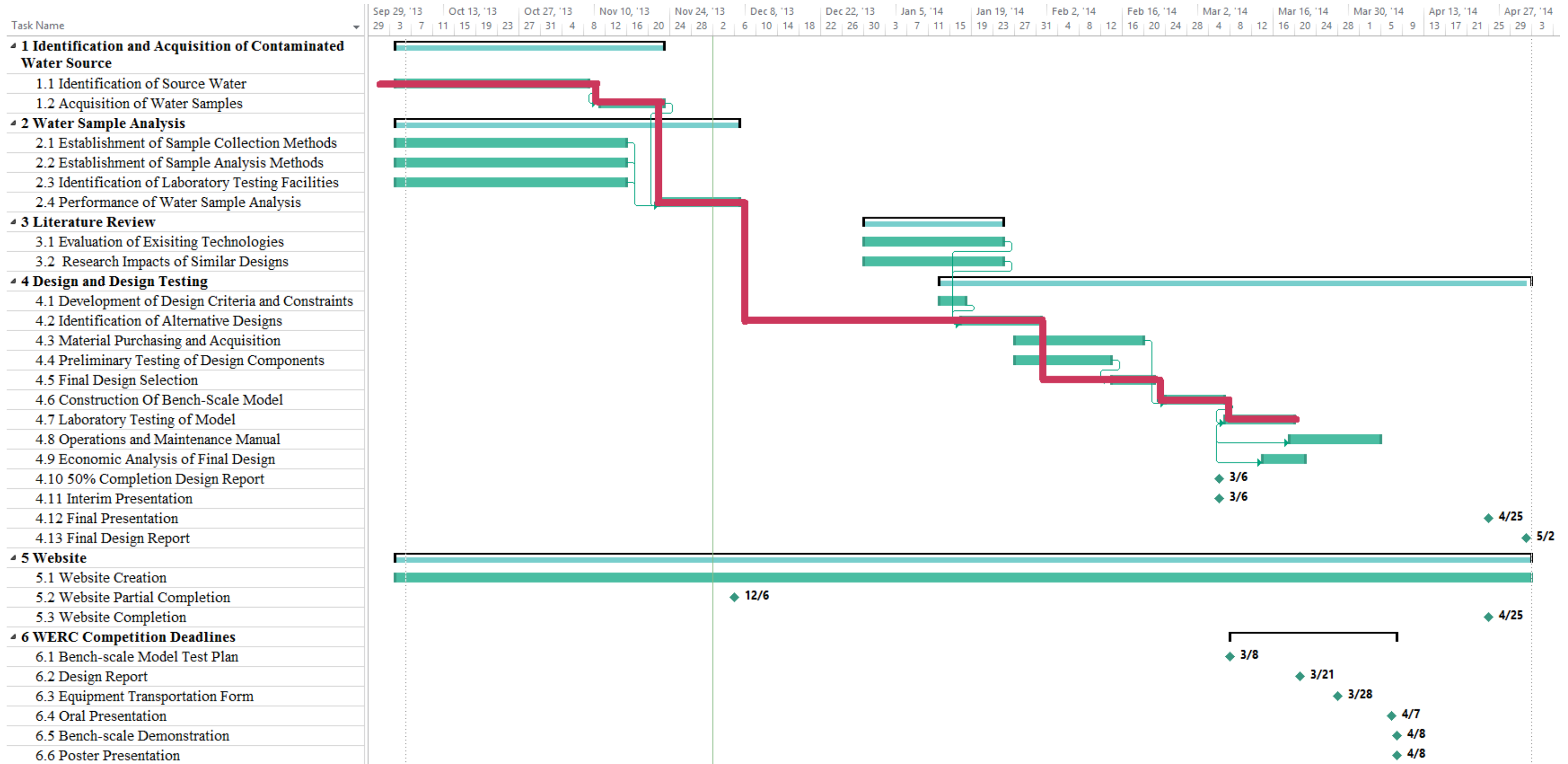
Table 2: Cost Estimate for Engineering Services

Cost Estimate for Engineering Services				
Personnel	Role	Hours	Rate (\$/hr)	Cost (\$)
	SENG	73	114	8,294
	ENG	223	58	12,952
	LAB	219	44	9,518
	INT	318	21	6,706
	AA	55	38	2,050
	Total Personnel	886		39,520
Travel				
	<u>Local Meetings</u>			
	4 mtgs x 120mi/mtg	\$0.40/mi		192
	<u>Water Hauling</u>			
	10 times x 10mi/haul	\$0.40/mi		40
Subcontractors				
	<u>Analytical Laboratory Tests</u>			9,800
	200 samples x \$49/sample			
Overhead				
				14,673
Total Cost Estimate				
				64,225

9.0 REFERENCES

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APPENDIX A: PROJECT SCHEDULE



APPENDIX B: WERC COMPETITION GUIDELINES

NEW MEXICO STATE UNIVERSITY'S WERC COMPETITION GUIDELINES

Sublime Engineering may decide to enter the final design of the water filtration device into the 2014 Environmental Design Contest from WERC: A Consortium for Environmental Education and Technology Development. The contest is sponsored by New Mexico State University's Institute for Energy & the Environment and is held in Las Cruces, NM from April 6 – 8, 2014. The purpose of the competition is for teams composed of university students to present solutions to environmental problems, especially those focused on energy and water. The WERC competition highly encourages submissions of projects that are of national importance.

If Sublime Engineering were to enter the WERC Competition, the following WERC Competition requirements must be considered (Environmental Design Contest - 2014, 2013).

Problem Statement Requirement:

- Identify a real-life environmental, energy, or water related issue and the market for the solution to this issue
- Discuss the advantages and disadvantages of the solution versus current technologies and other possible approaches

Design Considerations:

- The performance impact of variations in operational conditions of the technology
- The limitations of the technology and the conditions that produce the most effective results for the technology
- The appropriate metrics for evaluating the technology (i.e. cost to implement and maintain, energy requirements, waste generation, ease of operation, etc.)
- A comparison of this technology to other possible methods of problem mitigation
- Identification of appropriate federal, state and local laws and regulations
- An explanation of the hazards of the proposed solution and approaches to mitigate them

Bench-scale Demonstration Requirements:

- The demonstration must cover technical performance and financial, regulatory, and safety information
- A detailed testing plan for the model must be submitted one month prior to the competition
- If analytical testing of a treated water sample is necessary, the testing must take place over no more than a 48 hour period and prior to the conclusion of the contest

Evaluation Criteria:

- Technical fundamentals, performance, safety and other issues stated in the problem statement
- Potential for real-life implementation
- Thoroughness and quality of the business plan and economic analysis
- Originality, innovativeness, functionality, ease of use, maintainability, reliability, and affordability of the proposed technology

Important Deadlines:

- January 6, 2014: Contest registration must be complete
- January 14, 2014: The non-refundable entry fee of \$950 must be paid (This fee covers 5 team members and one faculty advisor)
- March 8, 2014: Bench-scale model test plan must be submitted
- March 19, 2014: Safety Summary, MSDS Sheets, and Flow Sheet must be submitted
- March 21, 2014: The written report must be submitted
- March 28, 2014: The Equipment Transportation Form must be submitted
- April 7, 2014: A 15-minute oral presentation must be given
- April 8, 2014: A fully-operational bench-scale demonstration must be completed
- April 8, 2014: A poster must be presented