NORTHERN ARIZONA UNIVERSITY

Solutions & Advancements
Water & Wastewater Engineering

PROPOSAL

To

Christopher Fernandes

Sun Valley Ranch, Inc.

7561 Sundown Rd

Sun Valley, AZ

For

Development Plans of Sun Valley

Water & Wastewater Systems

By

Solutions & Advancements in

Water & Wastewater Engineering:

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1.0 Introduction

Wastewater and water systems are needed in a ranch located in Sun Valley, Arizona because there are currently no existing public systems to which the owner can connect. This proposal includes the project understanding, scope of work, and staffing & cost summary for the Sun Valley Water & Wastewater Project. With this information, a clear plan for the development of water and wastewater systems has been established.

2.0 Project Understanding

2.1 Project Description

The purpose of this project is to provide cost effective wastewater and water systems for the Sun Valley Ranch, a proposed self-sufficient ranch in Sun Valley, Arizona that will incorporate ecologically friendly buildings. The ranch will be open from the months of May through October and will host visitors looking for a retreat in writing and art. The client has requested that the systems be as non-intrusive as possible, support an average of 5-10 people regularly, and allow for an increase in the population as needed.

The wastewater system must cost less than a conventional wastewater system (e.g. package plant), excluding estimated permit and application fees. The system design must meet the requirements set by the Arizona Department of Environmental Quality (ADEQ) and Navajo County for on-site wastewater treatment facilities. This facility might include a septic tank; if so it must meet the ADEQ requirements that govern the performance, design & installation, trench & bed details, and operation & maintenance. Regardless of the type of wastewater system adopted, its design must adhere to the regulatory requirements.

Water supply options will be investigated and a preferred alternative will be identified and developed through design. The Arizona Department of Water Resources (ADWR) has specific requirements for wells that are not within the active management areas (as defined by the ADWR) and used primarily for household use. If a well is a feasible option for the design, its design will adhere to these requirements. Water treatment options will be researched, taking into consideration the U.S. Environmental Protection Agency (EPA) Safe Drinking Water Act (SDWA) goals and maximum contaminant levels for primary & secondary water quality constituents.

2.2 Background Information

Sun Valley, Arizona, is a small town located in the Painted Desert that has a dispersed rural population of approximately 300-350 people, according to the client. As shown in **Figure 2.1**, the town is near Holbrook and the Petrified Forest National Park. The Sun Valley Ranch is a 10 acre lot of land located at 7561 Sundown Road. The main stakeholder for the project will be the client, Christopher Fernandes, and his company, Sun Valley Ranch, LLC.

Figure 2.1 Location of the site in North-Eastern Arizona

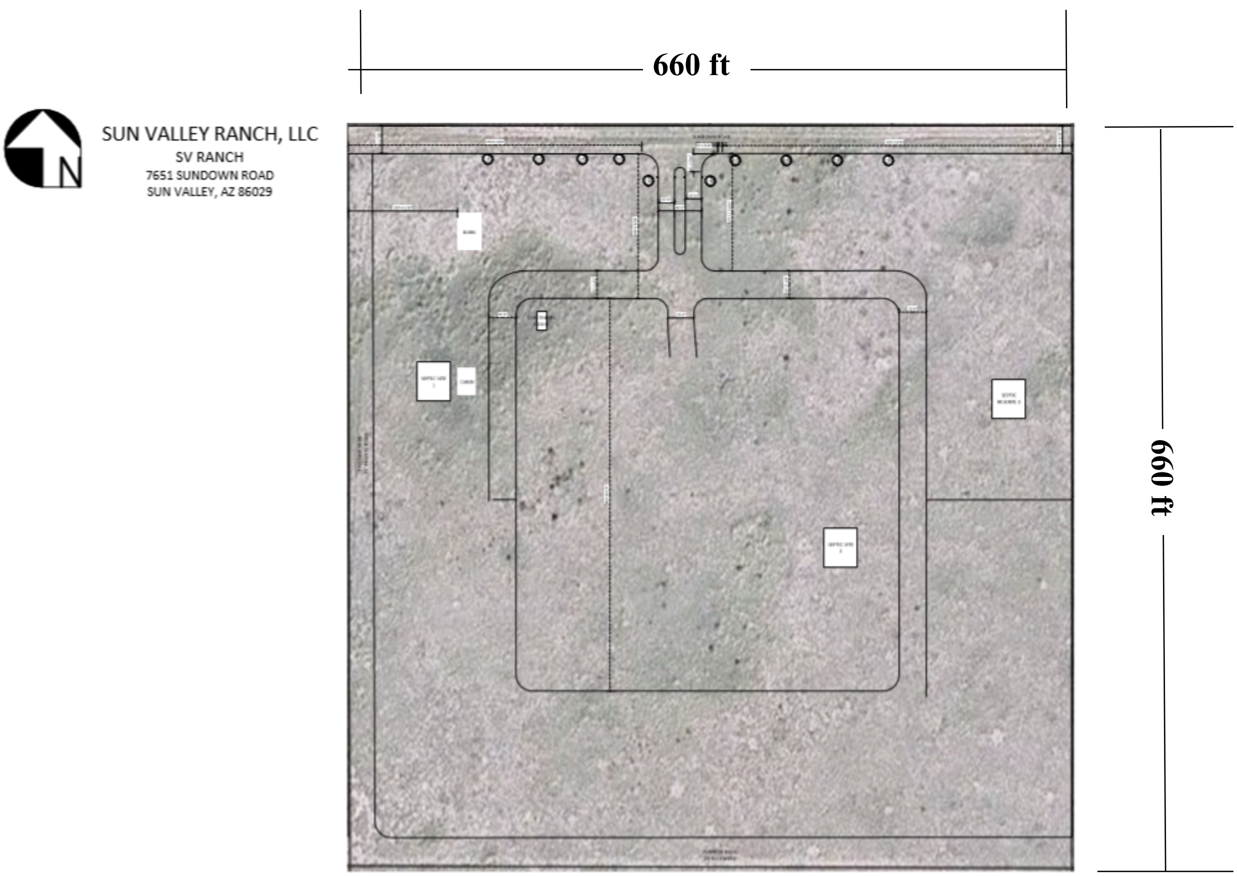

Figure 2.2 Current Site Plan for the Sun Valley Ranch (10-Acre Parcel)

As **Figure 2.2** shows, there is no existing infrastructure, such as utilities or wells, on the site. According to the client, the site is flat with no relief over 5 feet, contains sandy loam soil, and has a 60 inch depth to bedrock. A custom soil resource report performed by the United States Department of Agriculture, indicated that the site contains sandy loam soil which is desirable for septic systems. Additional information on the soil type can be found in Appendices 6.1 and 6.2. The ranch is in the same area as the Petrified National Park, so petrified wood fragments cover the property. Appendix 6.3 shows a photo of the site.

2.3 Technical Tasks

The team will evaluate, analyze, prioritize, select, and develop a design for the preferred alternative for both the water and wastewater systems. Preliminary unsealed construction plans and specifications will be included in the final report. The design plans will include the specifications necessary for the construction of the systems and cost estimates for each system.

The team will prepare a design that will include the following:

- Site plan, showing system layouts;
- Analysis of the site and groundwater supplies to identify an appropriate and reliable water supply;
- Design reports for each of the water & wastewater systems, taking into consideration all County, ADEQ & ADWR requirements and allowing for optimally functioning systems;
- Evaluations to assess whether the water and wastewater systems designed are likely to meet the water quality standards set by the ADEQ & Navajo County;
- Cost analysis for the fixed costs required for the construction of the systems, projected maintenance & operational costs, and permitting costs
- Operations & maintenance needs for each system

2.4 Potential Challenges

The team brainstormed potential challenges associated with the water and wastewater systems. The challenges for each system along with their proposed solutions are shown below:

- <u>Challenges Associated with the Water Supply System</u>
  Because the site is within a high desert, surface water supplies may not be readily available. If this is the case, alternative water sources, including water hauling and cistern or other tank storage, will be investigated.

- <u>Challenges Associated with the Wastewater System</u>
  Navajo County officials and staff may not be experienced with the alternative type of wastewater system the client has in mind. The project report may need to inform these agencies of the feasibility and advantages of systems that are less conventional than those that are currently in place. Designing an alternative system is typically more expensive than simply designing a conventional system. Therefore, the team must focus on creating

a system that is cost efficient but still meets the requirements of the county. Also, the soil characteristics must be compatible with such an alternative system. Possibly, as part of the design, waste or gray water may be reused in order to reduce the demand on the water supply. Incorporating this option could lead to additional constraints on the wastewater system design, depending on ADEQ water reuse requirements.

The capacity of the systems is an integral aspect of the design. If there is an increase in demand then the systems must have expansion options to support this change in demand. This way the existing systems will be utilized while still allowing for expansion to accommodate the growth in population.

3.0 Scope of Work

To help the team create the water supply & wastewater system plans by their deadlines and assess each task that leads to completion, the list of technical tasks that they will be completing is provided below. A Gantt chart was also developed to show the timeline and critical path of the project.

3.1 Task List

A numbered list of each technical tasks and their subtasks was created so that the team can easily track their progress throughout the project. The list is provided below.

Task 1 Field Evaluation

To determine the current site conditions, the team will visit the site for a field evaluation. During this evaluation, several soil samples will be collected. The week after the samples have been collected, they will be analyzed to verify that the soil is appropriate for both the water and wastewater systems.

Task 2 Research

Before the team can determine feasible options for systems and components within each system, similar systems within the vicinity of the site, conditions of the site, and requirements for the systems must be researched.

- Subtask 2.1 Appropriate Soils for the Systems
  The soils on the site will be researched. Also, the range of soil types that would be appropriate for both type of systems will be determined.

- Subtask 2.2 Geography, Topography, Geology, and Vegetation of the Soil
  The general landscape features and geological features will be investigated to help the team determine if there are certain areas within the site that would be more appropriate for the systems than others. Other aspects such as adjoining on-site land, off-site drainage, utilities, and transportation access that may influence the systems will be evaluated.

- Subtask 2.3 Water Supplies
  The available nearby groundwater, surface water, and reclaimed water options will be researched. The typical rainfall and nearby wells will be identified to determine if these sources will be feasible options for water supply.

- Subtask 2.4 Alternative Options to Conventional Water & Wastewater Systems
  Alternative options to conventional water and wastewater systems (if nearby supplies are not an option) will be identified, including wastewater package treatment plants and potable water importation, to determine if they would be appropriate for either system.

- Subtask 2.5 ADEQ & ADWR Requirements & Navajo County Codes
  The requirements for on-site wastewater treatment facilities stated by the ADEQ & Navajo County will be researched and summarized. The general requirements for well options stated by the ADWR will be researched in the event that groundwater is an option for the water supply system. The ADWR regulations for water quality will be identified and listed as well.

- Subtask 2.6 Water Quality of Water Source
  The water quality of nearby water sources within the Sun Valley, Arizona region will be researched to determine the common contaminants that the water supply system will have to treat. This subtask excludes water quality testing of water sources.

- Subtask 2.7 List of Constraints & Criteria
  After the bulk of research is complete, an initial list of the constraints and criteria for the project and each system will be constructed based on limitations and requirements for the systems and the client's requirements.

Task 3 Analysis

The team will be able to brainstorm and identify several alternatives for options within each system and then they will evaluate and analyze these options based on their constraints & criteria.

- Subtask 3.1 Evaluation of Alternative Options
  Sketches and a brief description of the alternative options properties will be constructed to show the differences between each option and their placement on the site.
- Subtask 3.2 Testing of Alternatives against Constraints & Criteria
  Each option will be evaluated and analyzed according to the constraints & criteria that apply. A decision matrix will be constructed to weigh each alternative against the constraints and criteria to determine which option is the most appropriate.

- Subtask 3.3 Selection of Preferred Alternative
  The team will select a preferred alternative and present this information to the client and adviser.

Task 4 Plans for Final Design

Detailed specifications for the final design will allow the team to construct a clear outline of the designs that will be implemented on the site. This will help the team address some of the potential issues that the systems may have. The team will not include details for specific components from the manufacture of the systems but will be doing construction in other aspects. Roadway design is excluded.

- Subtask 4.1 Wastewater System Design
  The wastewater system design plans will assess the following items
  - Necessary intake structures & pumps, the minimum, maximum, and average inflows and monthly and seasonal variations of inflows
  - Sizing of the system
  - Wastewater characteristics, seasonal variations, rainfall/runoff intrusion, and groundwater infiltration
  - Treatment and disinfection requirements
  - Disposal and reuse options
  - Operation and maintenance
  - Cost analysis

- Subtask 4.2 Water System Design
  The water supply system design plans will assess the following items:
  - Water supply/demand requirements and the necessary intake structures and pumps, capacity, groundwater capacity, wells, the minimum, maximum, and average demands and monthly and seasonal variations of demands
  - Sizing of the system
  - Water characteristics; including the raw water quality, seasonal and other variations
  - Storage options and needs
  - Distribution including pumps and pressurization
  - Treatment and filtration requirements
  - Firefighting flow requirements
  - Disposal and reuse options
  - Operation and maintenance
  - Cost analysis

Task 5 Project Management
The project will consist of several different deliverables that will have their own deadlines, so these were created as their own tasks.

- Subtask 5.1 50% Completion of Final Report
  The team aims to complete approximately 50% of the final report by Monday, March 16, 2015. The intake structure details, sizing of the structure, water characteristics, and treatment, disinfection, and filtration requirements for both the water and wastewater systems will be evaluated and described in the final report by this time.
- Subtask 5.2 90% Completion of Final Report
  The team aims to complete approximately 90% of the final report by Wednesday, March 25, 2015. All information listed within the Task 4 section will be evaluated and described in the final report by this time.
- Subtask 5.3 100% Completion of Final Report
  The team aims to complete the final report by Monday, April 6, 2015. The final report will have undergone final edits and reviewal by the team by this time.
- Subtask 5.4 Final Presentation
  The final presentation slides will be submitted, and the team will be presenting the final presentation during the first week of May 2015.
- Subtask 5.5 Website
  The website will have all required pages, content, and documents by the end of the first week of May 2015.

3.2 Project Schedule
The technical tasks were assigned dates and formatted into the Gantt chart shown in **Figure 3.1** shown on the following page. This chart shows the approximate duration of each task and its subtasks. The team focused on completing the preliminary research tasks and identifying the constraints and criteria for most of October and November. The team will begin to analyze the alternatives against the constraints and criteria until the end of this semester, near mid-December, as well as into next January and February. The plans for the final design will be completed near the end of March next semester. The research must be completed before analysis can begin, and the analysis of the alternatives must be completed before the plans for the final designs are created. The tasks shown in red indicate the steps in the critical path. These tasks must be completed within their allocated timeframe otherwise there will be a delay in the project completion.

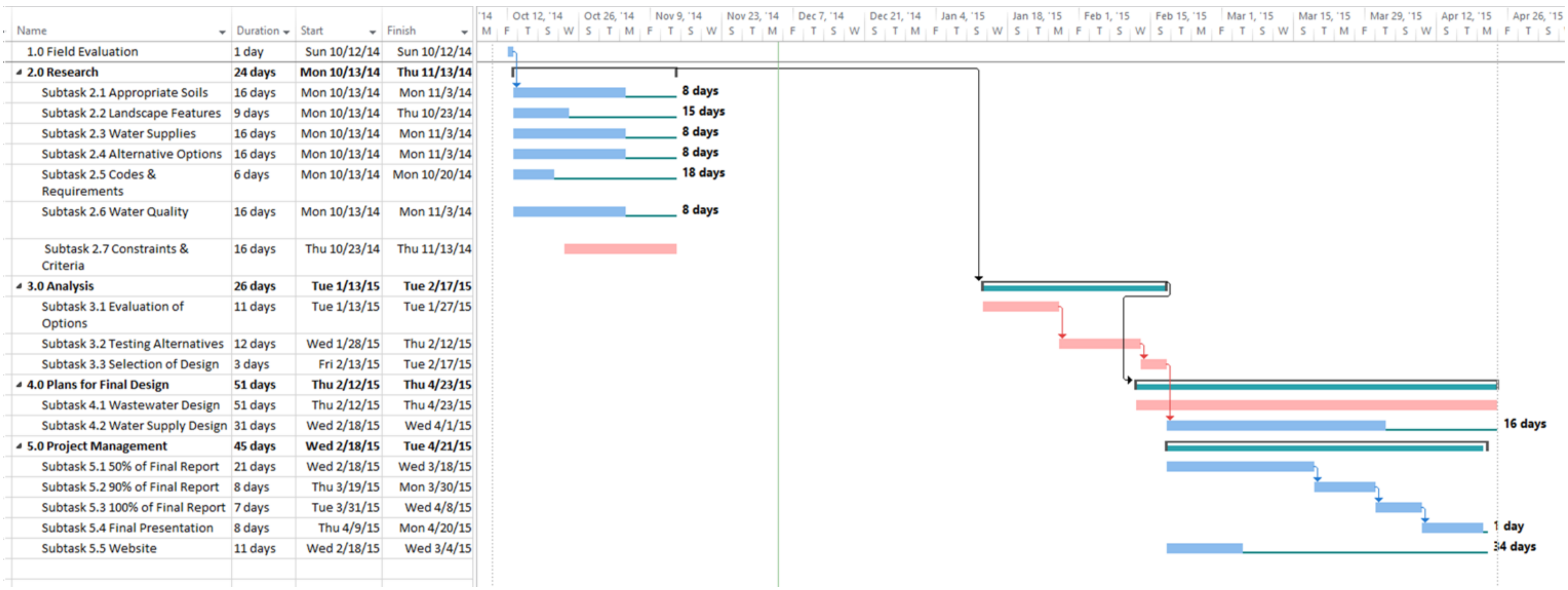

Figure 3.1 Gantt Chart for Sun Valley Water & Wastewater Project

4.0 Staffing & Cost Summary

The following section provides a description of the staffing requirements, time dedicated to the project, cost of the staff's time, cost of work done by subcontractors, and travel-related costs. The charts below will provide a clear representation of the staffing plan and cost estimate for the engineering services required for this project.

4.1 Staffing Positions

The following list describes the three main positions that the team will fulfill during the Sun Valley Water and Wastewater project.

- Project Manager (PM)
  The project manager will lead the meetings and guarantee that the team is staying on track based on their goals that are established on the Gantt chart. Adam Cordero will act as the project manager.
- Engineer (ENG)
  The engineer will complete research, sketches, and provide analysis, including calculations, to determine feasible alternatives and details for the final selected alternative. Mohammad Alsabah will complete most of the engineering tasks for this project.
- Lab Technician (LAB)
  The lab technician will perform a basic soil sample experiment, analyze and record the data for the experiment, and research and interpret data on the water quality of areas near the site to determine appropriate filtration and disinfection options. Mary Strong will complete the majority of the lab technician tasks for this project.
- Administrative Assistant (AA)
  The administrative assistant will create the meeting minutes and agendas; act as the main contact for communication between the team members, adviser, and contact; compile the submittals of the lab technician and engineers for the final report; review and edit the report, and collect and organize research on the existing conditions of the site and information provided by the client. Sara Bateman will complete most of the administrative assistant tasks.

Although the positions will be filled by particular team members, some of the tasks that each team member does will likely fall into the other positions. For example, although Mohammad is the engineer for the project, he may provide assistance with editing the report.

4.2 Staffing Task Allocation

Table 4.1 shows the number of 8-hour working days that each task and subtask for the project will require for each staffing position. Because the majority of the tasks require engineering or administrative expertise, the project manager and lab technician will complete many tasks that will fall under these two positions.

Table 4.1 Staffing Requirements for Project Tasks

Project Tasks	ENG days	LAB days	AA days	PM days
1.0 Field Evaluation		1		
2.0 Research				
2.1 Appropriate Soils for the Systems		2		
2.2 Geography, Topography, Geology	1		1	1
2.3 Water Systems	1	2	2	1
2.4 Alternative Options of W & WW	2	1	1	1
2.5 ADEQ, ADWR, & Navajo Codes	2		2	1
2.6 Water Quality of Water Source	1	1		1
2.7 List of Constraints & Criteria	1	1	1	1
3.0 Analysis				
3.1 Evaluation of Alternative Options	3	1	1	2
3.2 Test Alternatives to Constraints & Criteria	2	4		2
4.0 Plans for Final Design				
4.1 Wastewater System Design	3	2	3	4
4.2 Water Supply System Design	3	2	3	3
5.0 Project Management				
5.1 50% Completion of Final Report	2	2	4	3
5.2 90% Completion Final Report	1		2	
5.3 100% Completion of Final Report			2	
5.4 Final Presentation	1		1	
TOTAL (days)	**23**	**20**	**23**	**21**

4.3 Cost of Engineering Services

Once the billing rate, which factored in benefits and overhead costs, was determined, the overall cost for each position was calculated. First, the estimated working days, shown in **Table 4.1**, were multiplied by 8 because each working day would last 8 hours. The hours were then multiplied by the billing rate to determine the cost. Travel to the site to meet with the client as well as geotechnical analysis work for the project were factored into the overall cost as well. According to the Internal Revenue Service, the standard mile rate for the use of a car is $0.56 per mile for business mile driven. The number of meetings was multiplied by the number of miles and cost per mile to determine the overall cost. The subcontract expenses include an estimated $5000 for geotechnical analysis. This estimation assumes that both a field supervisor and field engineering technician will be conducting the analysis for several days, and it includes possible lab testing service fees. As **Table 4.2**, shows the estimated overall cost for the project is approximately $62,000.

Table 4.2 Cost of Engineering Services

1.0 Personnel	Classification	Hours	Rate $/hr	Cost
	PM	168	92	**$15,456.00**
	ENG	184	132	**$24,288.00**
	LAB	160	63	**$10,080.00**
	AA	184	40	**$7,360.00**
	Total Personnel			**$57,184.00**
2.0 Travel	2 meetings @ 100 mi/meeting	$0.56/mi		**$112.00**
3.0 Subcontract	Geotechnical Analysis			**$5,000.00**
4.0 TOTAL				**$62,296.00**

5.0 Next Steps

The team has created a project description, scope of work and schedule, and staffing & cost summary for the Sun Valley Water and Wastewater Project. The alternatives will be created and evaluated, and the final design plans for both the water and wastewater systems will be developed during the spring semester.

6.0 Appendices

6.1 Soil Report from United States Department of Agriculture

Navajo County Area, Arizona, Central Part

20—Grieta sandy loam, 1 to 3 percent slopes

Map Unit Setting

Elevation: 4,800 to 5,500 feet
Mean annual precipitation: 8 to 10 inches
Mean annual air temperature: 53 to 56 degrees F
Frost-free period: 150 to 180 days

Map Unit Composition

Grieta and similar soils: 80 percent

Description of Grieta

Setting

Landform: Fan terraces on plateaus
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Mixed alluvium derived from volcanic and sedimentary rock

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.2 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated
Land capability classification (irrigated): 3e
Land capability (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Sandy Loam Upland 6-10" p.z. (R035XB219AZ)

Typical profile

0 to 3 inches: Sandy loam
3 to 20 inches: Sandy clay loam
20 to 44 inches: Sandy clay loam
44 to 60 inches: Sandy loam

6.2 Soil Analysis Data

SIEVE ANALYSIS			
Initial Weight of Soil:266g			
Sieve #	**Weight(g)**	**Percent by Weight (%)**	**Classification**
#4	0	0	Fine Gravel
#10	0.4	0.152	Coarse Sand
#40	31	11.76	Medium Sand
#200	187.8	71.22	Fine Sand
Pan	44.5	16.88	Silts and Clay
	263.7		
NOTE: 2.3g of soil lost during testing			

6.3 Site Photo